



Short Note

The process of drey construction in red squirrels – nestbox observations based on a hidden camera

Stefan BOSCH^{a,*}, Peter W. W. LURZ^b^aMetterstraße 16, D-75447 Sternenfels-Diefenbach, Germany^bLurzgasse 3, D-97236 Randersacker, Germany**Keywords:**

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Abstract

We present unique footage and an analysis of recorded data of a free-ranging red squirrel building its drey in February 2012 inside a nestbox fitted with a hidden camera. Drey construction occurred over a period of three days that was dominated by an initial phase of transporting material; this then shifted more and more to construction of the outer twigg-shell of the drey and to the processing of materials for the soft inner lining and core of the drey. Total construction time in terms of minutes of red squirrel presence logged was 3.6 hours. Construction occurred after a period of 4–5 days of dry weather and at temperatures that were well above 0° C. After the squirrel abandoned the drey, the dry material was explored and used by songbirds indicating the importance of accessible structures and dry construction material for other species.

The video is available as supplemental material in the online version.

Introduction

Red squirrels (*Sciurus vulgaris* L.) normally build their dreys among branches in both deciduous and conifer trees several meters above the ground or in natural tree cavities (dens). On occasion, they also make use of man-made structures such as nest boxes (Wauters and Dhondt, 1990; Magris, 1998; Shuttleworth, 1999; Bosch and Lurz, 2012). Different drey constructions or structures have been correlated with use such as resting during the day and dreys used for sleeping at night. For resting in summer, squirrels may also build simple platforms of branches or make use of abandoned bird nests. In contrast, dreys used for wintering can consist of highly dense structures with insulating lining; and dreys for reproduction may be larger and relatively “spacious” to accommodate the litter of up to seven young (Wauters and Dhondt, 1990; Mari et al., 2008; Bosch and Lurz, 2012).

Dreys usually consist of an outer, ball-shaped shell of twigs and an inner, hollow core of densely-woven grass, moss, lichens and other soft or insulating materials that are locally available. For example, the inner core of a drey in Switzerland was almost entirely made out of lichens (Bosch and Lurz, 2012), and winter dreys in Finland were found to be lined with willow grouse (*Lagopus lagopus*) feathers (Pulliainen, 1973). Tittensor (1970), studying red squirrels in Scotland, describes the lining of a drey to consist of 57% grass, 19% moss, 16% pine needles and 8% other items. The latter included stripped and flaked bark, bud scales and cone bracts of *Pinus sylvestris*, leaves of *Vaccinium myrtillus* and woodpigeon feathers (*Columba palambus*).

Whilst there are ample studies describing drey materials in different forest ecosystems, or the location of dreys in the canopy (e.g. height above ground etc.), few studies focused or reported on the actual process of drey construction. Little is therefore known about how squirrels actually go about constructing a drey. Here we present unique footage and an analysis of recorded data of a free-ranging red squirrel building its nest.



Figure 1 – Stream-side habitat dominated by poplar, alder and willow, Sternenfels-Diefenbach, Enzkreis, Southwest Germany.

Methods

Study area

The nest box was placed at the edge of Sternenfels-Diefenbach, Enzkreis, Southwest Germany (49.025 N, 08.858 E) within a row of trees along the stream Metterbach (Fig. 1). The stream side tree cover is predominantly composed of alder (*Alnus glutinosa*), poplar (*Populus nigra*) and willow (*Salix alba*) trees and constitutes both an important dispersal corridor from woods along the hill tops (Enchelberg, Southwest Germany) down through vineyards and orchards to village gardens that contain prized hazel and walnut trees; and a convenient location for dreys. Over the last years, squirrels repeatedly used the 15 m tall poplars to construct dreys and also made use of an abandoned magpie (*Pica pica*) nest among the alders. The distance from the streamside corridor to the nearest mixed woodland (dominated by oak *Quercus robur*, beech *Fagus sylvatica* and spruce *Picea abies*) is approximately 435 meters.

* Corresponding author

Email address: stefan-bosch@web.de (Stefan Bosch)



Figure 2 – Red squirrel entering the provided nestbox.

Nestbox set up

In the autumn of 2011, a wooden squirrel nest box (30 cm wide × 40 cm long × 55 cm high, entrance hole was 7 cm in diameter) was put on the trunk of an alder approximately 4 m above ground. It is not a common practice to provide nestboxes for red squirrels in this region of Germany, and red squirrels are not used to them. Following the sighting of a red squirrel carrying alder twigs into the nest box on a clear and cold 29th of January (Fig. 2), we installed a Mini-CCD-camera (Fa. Hanydkam; Colour 420 line CCD, high resolution camera kit) on the inside roof of the nestbox. The camera records colour images during daylight and switches to infrared-lighting and black-and white images at night. The camera was linked via a 30 m cable to a DV-recorder inside a nearby house. The camera was triggered by a movement-sensor and all activity and sound inside the nest box were recorded. This allowed the recording of the construction of a drey inside the box in 2012 and its subsequent fate.

Description and classification of squirrel behaviour for analysis

The observed squirrel activities during drey construction can be classified into three groups:

1. Collection and transport of nest material (Fig. 3a): The squirrel gathers construction materials from the immediate environment consisting of twigs, small branches as well as items for padding such as grass, bark and dried leaves. The materials are held with the mouth and are either pushed or pulled through the nestbox entrance hole.
2. Construction of the drey inside the nestbox (Fig. 3b): For the building of the base, the sides and the roof of the outer twig shell, twigs are gripped with the mouth and the front paws and bent and placed to create the structure. Subsequent material is layered on top and used to make the structure denser. The squirrel uses both its head and its face to bend resistant items into the desired shape. The front legs are used to push material whereby the squirrel completely stretches itself out on occasion. The football-like shape of the drey is achieved by the animal taking up position in the centre of the drey. The squirrel then places items by rotating (Fig. 3c). No directional bias (e.g. frequent left or right turns) could be discerned.
3. Processing of collected items (Fig. 3d): for the soft inner core of the drey, the squirrel processes materials such as grass, bark or dry leaves by holdings them with the front paws and using the incisors to chew and tear them into smaller and finer items. These are then distributed around the inner core and pushed into place with the head.

Results and discussion

Temporal sequence of construction

In the initial phase of drey construction, the main activity consists of selection and transport of building materials. Over the period of a few hours during the day, the squirrel industriously brings items every 1.5 to 2 minutes to the nest box. Initially the building materials are simply deposited and the squirrel leaves the nest box straight away. Then more and more time between deliveries is spent building the nest. The squirrel starts with a base for the outer frame or shell made out of strong twigs on the nestbox floor. This is followed by the twig structure for the sidewalls and lastly the roof (see also supplementary information).

It is noteworthy that, consistent with literature reviewed by Pulliainen (1973) in which squirrels site the entrance hole away from prevailing winds, the squirrel observed in this study entered the nest box and used the bottom right as access and 'stairs' into the nest. There was no indication that the squirrel purposefully left space for an opening in a specific location of the drey but moved through gaps in the twigs. However, the path from the box entrance hole into the soft core of the nest appeared pre-determined and remained the same throughout the observation period.

Our observations show that red squirrels build dreys quickly and effectively and spend approximately four highly focused hours on construction spread out over three days. During the first three hours transport of materials and construction of the outer frame predominate. Activity then more and more shifts to processing of items for padding of the soft inner core (see Fig. 4 and 5). In this instance and given the tree species composition along the Metterbach, the outer shell of the drey was built of alder and poplar twigs, and the inside consisted of a woven basket of grass with some alder leaves.

Consistent with described winter activity patterns of a single active period approximately between 7 am and 2 pm (e.g. Tonkin 1983; Wauters and Dhondt 1987), drey construction is focused on a few hours in the morning or at lunchtime. The mornings of the 23rd and 25th of February between 9 and 11 am are focused on the gathering and transport of material for drey construction. This reaches a peak on the morning of the 25th of February with over 40 visits bringing material. In the subsequent hours on the 25th, behaviour shifts to construction and the processing of materials for the inner core and lining of the drey. After bouts of intense activity, the squirrel often stops and rests for several seconds in front of the box entrance hole and looks outside. The length of these pauses increases after very intense building activity.

Weather – is there a preference for dry construction materials?

With respect to weather patterns, the two main days of drey construction occurred after a week in February 2012 in which the temperature remained above 0° C with a slight frost during the night up to about -6° C. The 25th of February, the main day of construction, was the warmest day with a minimum of 7° and a maximum of 10° C. The construction days were dry and more importantly followed 4-5 days of dry weather (data based on weather station Mühlacker; www.wetteronline.de). These observations suggest a preference for dry building materials and that energetic costs in terms of exposure to cold are important factors in drey construction.

Subsequent fate of the drey

Despite several brief follow on visits post completion on February 26th and March 12 and 22, the squirrel subsequently abandoned the drey. It is unclear and open to speculation why the drey was not used despite successful completion. Disturbance from a nearby footpath used by dog walkers or predation are just two of several possibilities. The nestbox was visited by redstart (*Phoenicurus ochrurus*), blue tit (*Cyanistes caeruleus*), great tit (*Parus major*) and starling (*Sturnus vulgaris*). The blue tit "recycled" the soft padding materials of the inner core for its nest in a nearby nestbox and after several visits in March, the starling constructed a nest inside the nestbox on top of the drey. As no squirrels showed any interest for the drey throughout the remaining year, the box



(a) Squirrels collect and transport nest material by carrying it with their mouth.



(b) During construction, twigs are gripped with the mouth and the front paws and bent and placed to create the structure.



(c) The round, football-like shape of the drey is achieved by the animal taking up position in the centre of the drey. The squirrel then places items by rotating its body around this central position.



(d) For the soft inner core of the drey, the squirrel holds soft items such as grass with the front paws and uses its incisors to chew and tear them into smaller and finer items.

Figure 3 – Drey construction phases.

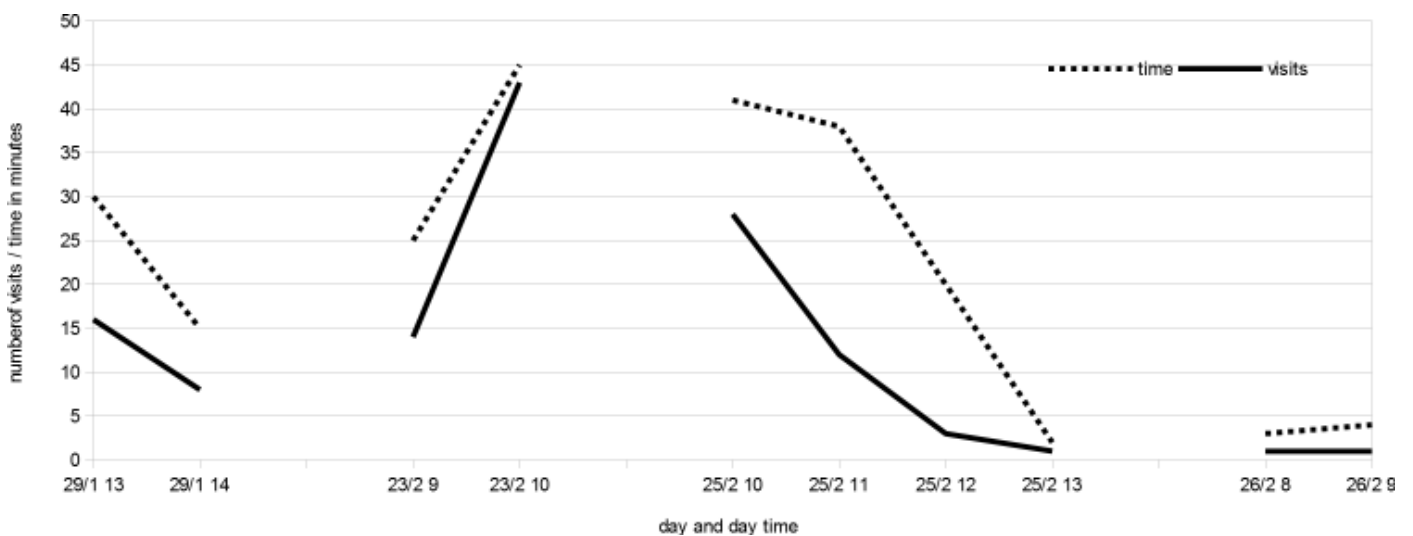


Figure 4 – Drey building activity in terms of the number of visits per day and the time spent constructing the drey. After initial exploratory visits (29th of January), peaks of activity occurred on the 23rd and 25th of February. Total time spent in the next box constructing the drey was 3.6 hours. Note x-axis indicates the date and the time after which activity occurred.

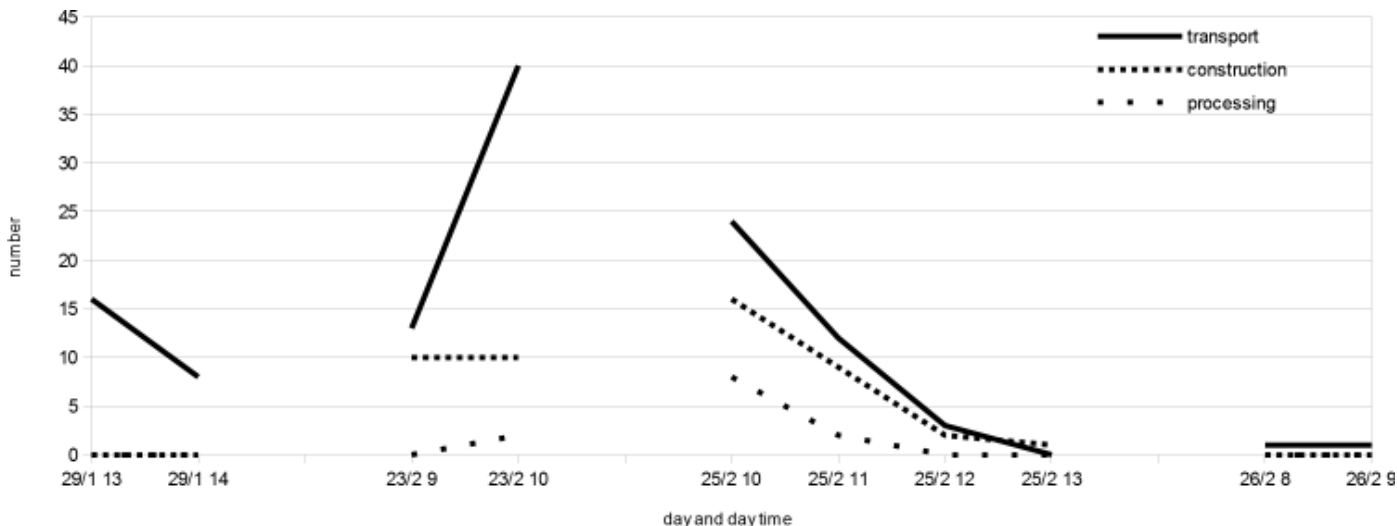


Figure 5 – A split of drey construction by type of activity clearly shows that transport of material was the dominant activity on the first day (23rd Feb.) with an increase and shift to construction and the processing of softer materials for the inner lining of the drey on the 25th of February.

was cleaned and the structure removed in December 2012. Measurements of the structure showed that it was 40 cm wide, 30 cm long and 35–40 cm high. The dried materials weighed 763 g, more than twice the average body weight of a red squirrel.

The current study illustrates the benefits of available small recording devices that provide us with “keyhole” views of behaviours that have been hidden from us up to now. The approach does not disturb or hinder the animals and has, for example, successfully been applied in a number of songbird studies (Ribic et al., 2012; Bosch, 2012, 2013). The camera surveillance also showed how important “cavities” and existing nest structures in terms of easily accessible and dry construction material are for other species.

Whilst the drey built inside the nestbox is not equivalent to a typical drey built up in the tree crowns, the current approach offered a unique view of red squirrel activity patterns, allocation of efforts and drey building techniques. The recorded 3.6 hours of intense squirrel activity logged inside the nestbox (excluding time spent collecting material outside) will allow future studies to set drey construction and its relatively minimal cost into context with other squirrel activities. It may also assist in the current debate and legal protection (WANE ACT, 2010) of dreys for red squirrel conservation in Scotland (Bosch and Lurz, 2012).

References

- Bosch S., Lurz P.W.W., 2012. The Eurasian Red Squirrel. Westarp Wissenschaften, Hohenwarsleben, Germany.
- Bosch S., 2012. Nest box secrets: Using a nest box camera to detect details of the breeding biology of redstarts *Phoenicurus phoenicurus* in southwest Germany. *Ornithol. Jh. Bad.-Württ.* 28: 93–105. [in German with English summary and captions]
- Bosch S., 2013. When wrens go to sleep: Behaviour of a single winter wren *Troglodytes troglodytes* at its roost in winter. *Vogelwarte* 50: 31–38. [in German with English summary and captions]
- Magris L., 1998. The ecology and conservation of the red squirrel (*Sciurus vulgaris*) on Jersey C. I. Ph.D. Thesis, University of London.
- Mari V., Martini S., Romeo C., Molinari A., Martinoli A., Tosi G., Wauters L., 2008. Record litter size in the Eurasian red squirrel (*Sciurus vulgaris*). *Hystrix* 19(1): 61–65. doi: 10.4404/hystrix-19.1-4418
- Pulliainen E., 1973. Winter ecology of the red squirrel (*Sciurus vulgaris* L.) in northeastern Lapland. *Ann. Zool. Fennici* 10: 487–494.
- Ribic C.A., Thompson F.R. III, Pietz P.J., 2012. Video surveillance of nesting birds. *Studies in Avian Biology* 43. Cooper Ornithological Society. University of California Press, Berkeley, CA, USA.
- Shuttleworth C.M., 1999. The use of nest boxes by the Red Squirrel *Sciurus vulgaris* in coniferous habitat. *Mammal Review* 29: 61–66.
- Tittensor A.M., 1970. Red squirrel dreys. *Journal of Zoology, London* 162: 528–533.
- Tonkin J.M., 1983. Activity patterns of the red squirrel (*Sciurus vulgaris*). *Mammal Review* 13: 99–112.
- Wauters L.A., Dhondt A.A., 1987. Activity budget and foraging behaviour of the red squirrel (*Sciurus vulgaris*, Linnaeus 1758) in a coniferous habitat. *Zeitschrift für Säugetierkunde* 52: 341–353.
- Wauters L.A., Dhondt A.A., 1990. Nest-use by red squirrels (*Sciurus vulgaris* Linnaeus, 1758). *Mammalia* 54: 377–389.

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Supplemental information

Additional Supplemental Information may be found in the online version of this article:

- Images showing progress of drey construction.
- Film sequences of the red squirrel constructing the drey.