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Testing the use of two types of nest box by the common dormouse *Muscardinus avellanarius*

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Abstract

British mammalogists have used two different systems for surveying the common dormouse *Muscardinus avellanarius*: a modified bird nest box with the entrance facing the tree trunk, and a smaller, cheaper model called a 'nest tube'. However, only few data comparing different nest box systems are currently available. To determine which system is more efficient, we compared the use of the large (GB-type) and small nest boxes (DE-type, a commercial wooden mouse trap without a door) in three Swiss forests. The presence of *Muscardinus*, potential competitors, and any evidence of occupation were examined in 60 pairs of nest boxes based on 2,280 nest box checks conducted over 5 years. Mean annual occupation and cumulative numbers of *Muscardinus* present were both significantly higher for the DE than for the GB boxes (64.6% versus 32.1%, and 149 versus 67 dormice, respectively). In contrast, the annual occupation by competitors including *Glis glis*, *Apodemus* spp. and hole-nesting birds was significantly higher in the GB than in the DE boxes in all forests (19–68% versus 0–16%, depending on the species and forest). These results suggest that smaller nest boxes are preferred by the common dormouse and are rarely occupied by competitors. These boxes hence appear to be preferable for studying *Muscardinus* populations.

Keywords: Nest tube*, Glis glis*, *Apodemus*

1. Introduction

Many biologists using nest boxes to study birds have noted the occasional or regular presence of small mammals, including the common dormouse *Muscardinus avellanarius*, the fat dormouse *Glis glis* and the yellow-necked mouse *Apodemus flavicollis*. Some researchers collected data on these mammals based on these numerous occasional observations (Kahmann & von Frisch 1950, Löhrl 1960, Pielowski & Wasilewski 1960 Gaisler et al. 1977, Schulze 1986, Gatter & Schlütt 1999). In a further step, Morris et al. (1990) developed a specific type of nest box, referred to here as the GB-box that hampered their use by birds by having the entrance directed to the tree trunk. The success of this system encouraged the use of this type of nest box by mammalogists in many countries (e.g. Tvrkovic et al. 1996, Büchner 1997, Minato et al. 1997, Milazzo et al. 2003, Kryštufek et al. 2003, Vilhelmsen 2003). In contrast, other studies continued to use normal bird-type nest boxes, compensating for the presence of competitors by using large numbers of boxes (Juškaitis 1994, 1995, 1999a, Nowakowski & Boratynski 2001). Other researchers, however, developed different designs (e.g. Catzeflis 1983, 1984), initially using small, flat bat boxes that were colonised by the common dormouse, and finally switching successfully to 6-cm diameter, 30-cm long drainage pipes that were closed at one end.

The great success of Catzeflis (1984) as well as unpublished observations of H. Müller-Stiess on common dormouse nesting in blocked German mouse traps (unpublished data presented at

the first Dormouse Colloquium in Grafenau, 1990) incited one of us (PV) to start in 1997 a study testing the classical nest box against that German mouse trap (J. Duplain, unpublished Master thesis 2003). Since, a comparative study with so-called nest tubes demonstrated a low success of the smaller model (Chanin & Gubert 2011) which is in contradiction with our results. It is therefore worthwhile to present and discuss our data.

2. Material and methods

As classical nest box, we used the GB-type, a nest box developed in Great Britain by Bright & Morris (1989) and Morris et al. (1990). Its internal dimensions were 12 × 12 cm at the base and 15–20 cm height, constructed out of 15-mm thick wood. The circular entrance hole had an initial diameter of 30 mm, but this is often enlarged, especially by edible dormice. This nest box was placed on a tree with the hole directed towards the trunk with a gap between the trunk and the nest box of about 3 cm, thus discouraging entry by birds (Fig. 1). However, birds were still able to use them in many cases due to the irregular shape of many tree trunks.

As much smaller nest box, we used the DE-type, a small-mammal trap built in Germany by DeuFa (article number 406006, Neuburg, Germany). It comprised a long wooden box with internal dimensions of 4.5 cm width × 27 cm length × 7 cm height (Fig. 2), covered with wire mesh and a moveable metal cover. The front was left open, without the door of the closing mechanism. The trap was placed in a drainage pipe (35 cm long × 15 cm diameter) to protect it from heavy rain. The pipes were suspended under branches.

Twenty pairs of both nest box types were set along a transect of approximately 500 m, close to the forest edge, in each of three experimental forests of western Switzerland (46.5 N, 6.5 E). To avoid behavioural competition, the GB and DE type were spaced about 3–8 m and set at a height of 2–3.5 m [see Fig. 2 in Vogel et al. 2012 (this volume)].

Nest boxes were visited at irregular intervals of at least 30 days over 2–5 years, between 1998 and 2002, depending on the forest, during the activity season. At the first visit of the year, the nest boxes were cleaned. Bird nests were extracted from the boxes after the bird breeding season.

During the visits, each nest box was opened and every animal present was recorded with minimal disturbance. Exceptionally, animals were placed in a plastic bag, e.g. to identify *Apodemus* sp., but were then immediately released into the nest box. To avoid stress, no animal was marked. Indirect activity was noted, faeces, nest material, leftover food, and stored food. Presence of animals together with signs of indirect activity allowed the yearly occupation of each nest box to be determined. The same nest box may have been used in turn by a dormouse, a field mouse and a tit, and may therefore appear in the statistics for all three taxa.

2.1. Description of the forests

All three forests were enlarged gallery forests, situated along a small stream, with a high frequency of hazel (*Corylus avellana*), especially at the edges. According to Delarze et al. (1998), the forest at Forel [at 710 m above sea level (a.s.l.), 12.5 ha] was a Galio-Fagenion with beech (*Fagus sylvatica*), accompanied by ash (*Fraxinus excelsior*), sycamore (*Acer pseudoplatanus*), oak (*Quercus robur*) and spruce (*Picea abies*). The forest of Échichens (470 m a.s.l., 1.7 ha) was a Fraxinion with a predominance of ash, accompanied by oak, alder (*Alnus glutinosa*), sycamore and poplars (*Populus alba* and *P. nigra*). The forest of Lonay (380 m a.s.l., 1.1 ha) was also a Fraxinion with the same species. However, it differed by having recently been partly felled and therefore contained a high density of growing bushes, as in a coppiced forest.

Fig. 1 GB nest box with hole towards the trunk.

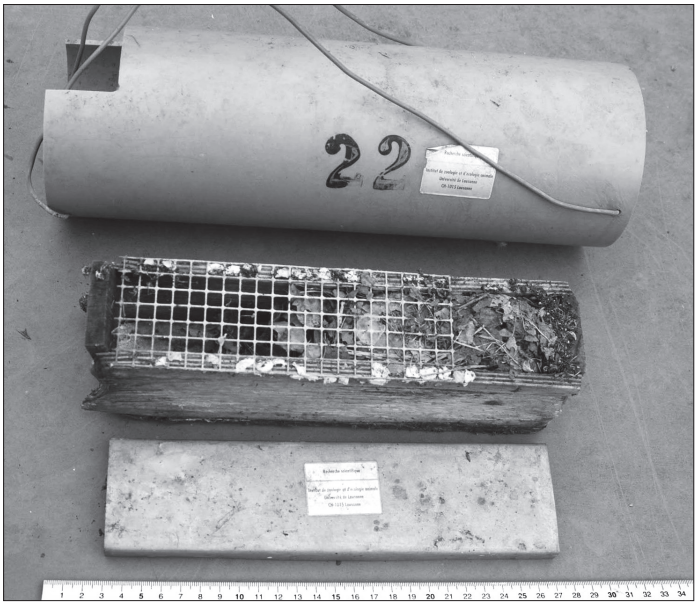

Fig. 2 DE nest box with an old *Muscardinus* nest, metal cover and drainage pipe.

3. Results

3.1. Nest box occupation

A total of 2,480 nest box checks were performed (on average, 20.7 per box). Yearly occupation by *Muscardinus* based on the indices of activity (Tab. 1) fluctuated between 10 and 50 % in GB boxes, depending on the year and the forest. Occupation of the DE boxes varied between 40 and 75 %. The annual variation did not deviate by more than 20 %, except in one case. Overall, the yearly occupation was significantly higher in the DE than in the GB boxes for all years (Pearson Chi-square tests, $\chi^2 > 4.8$, df = 1, $p < 0.03$), with a mean occupation of 32.1 % in the GB boxes and 65.6 % in the DE boxes. Considering each forest separately, although differences between the two types of nest boxes occurred in other years, the differences were only significant for Forel in 2000 and 2001 (2000 and 2001: $\chi^2 > 12.60$, df = 1, $p < 0.001$).

The number of common dormice found in the nest boxes and the relative frequencies were also higher in the DE boxes (7.1–16.2 %) compared to the GB boxes (2.6–7.3 %) for all three sites (Tab. 2). Significantly more *Muscardinus* were found in DE boxes (149 sightings, 13 %) compared to GB boxes (67 sightings, 6 %) in each forest (Pearson Chi-square tests, $\chi^2 > 6.3$, df = 1, $p < 0.02$). Only 10 females with pups were observed, eight in DE and two in GB nest boxes. They tended to reproduce more frequently in DE boxes (Fisher exact test, $p = 0.11$).

Tab. 1 Annual occupation rate (%) of GB and DE nest boxes by *M. avellanarius* at the three study sites during the whole observation period.

Site	Nest box	1998	1999	2000	2001	2002	Annual mean
Échichens	GB	45	40	35	35	40	39
Échichens	DE	75	70	75	65	65	70
Forel	GB	-	15	10	10	20	14
Forel	DE	-	40	75	70	45	58
Lonay	GB	-	-	-	50	40	45
Lonay	DE	-	-	-	75	55	65

- = nest box pairs not yet set.

Tab. 2 Total number of *M. avellanarius* present and relative frequencies in GB and DE nest boxes at the three study sites.

Site	Nest box	Visits (N)	Checks (N)	Presence (N)	Frequency
Échichens	GB	26	520	38	7.3 %
Échichens	DE	26	520	84	16.2 %
Forel	GB	19	380	10	2.6 %
Forel	DE	19	380	27	7.1 %
Lonay	GB	12	240	19	7.9 %
Lonay	DE	12	240	38	15.8 %

3.2. Phenology of occupation

The monthly occupation in the three forests (Fig. 3) showed increasing occupation in spring, with the highest numbers in autumn, except for Forel, which showed an important drop in late summer and autumn. This was probably the result of disturbance by the increasing activity of juvenile edible dormice, which were absent in the other investigated forests.

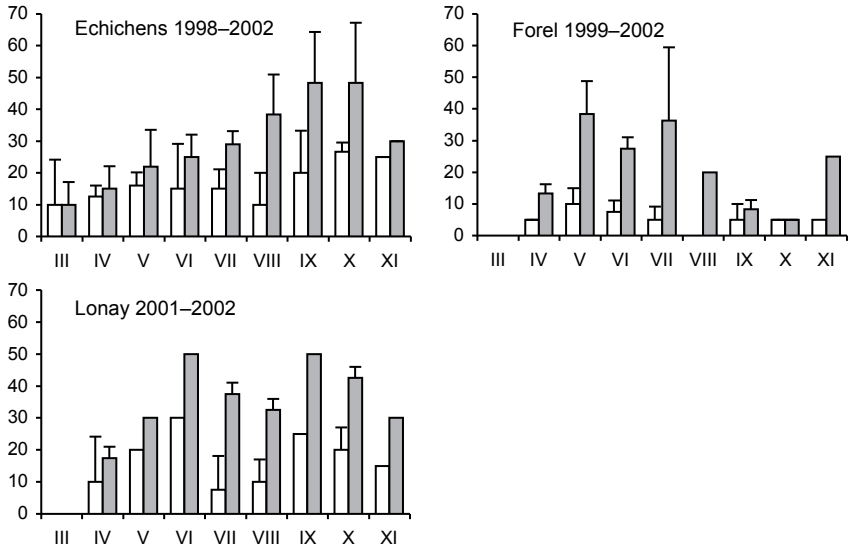

Fig. 3 Phenology of percentage monthly nest box occupation (white = GB model, grey = DE model) for the three study sites (Échichens, Lonay and Forel). Data for the different years are pooled. For March, only the forest of Échichens was checked.

3.3. Other species observed in nest boxes

Four other mammal species were observed in the nest boxes (Tab. 3), with *Apodemus flavicollis* and *A. sylvaticus* being the most frequent. Species assignment was not possible based on the nest alone, and the *Apodemus* spp. were therefore pooled. *Glis glis* was the most frequent competitor in Forel, whereas *Apodemus* spp. were relatively rare. A single bank vole (*Myodes glareolus*) was observed in a nest box. Among the hole-nesting birds, only tits were regularly found. Colonisation by eusocial insects, including wasps, bumblebees, or ants remained rare.

Regarding occupation by *Apodemus* spp., the pooled data from Échichens and Lonay showed a significantly higher occupation for GB boxes in all years (Fisher exact test: $p < 0.003$). The edible dormouse was only found in Forel, where individuals occupied significantly more GB boxes (50–75%) than DE boxes (0–5%) in all four experimental years (Fisher exact test: $p < 0.001$). *Apodemus* (4) and *Glis* (9) families with pups were only found in GB boxes.

Data for tit species (great, blue and marsh tits) *Parus* spp. were pooled because the eggs and young could not always be distinguished. The annual occupation by tits was 10–70% in GB boxes and only 0–5% in DE boxes. This difference was significant for all forests in most years (Fisher exact test: $p < 0.05$). In GB boxes, 74 broods were observed while in DE boxes one single tentative occurred.

Tab. 3 Mean percentage annual occupation of GB and DE nest boxes by vertebrates and eusocial invertebrates at the three study sites.

Site	Nest box	*M. avellanarius*	*Apodemus*	*G. glis*	*C. glareolus*	Tits	Insects
Échichens	GB	39	68	0	1	19	3
Échichens	DE	70	16	0	0	1	0
Forel	GB	14	4	64	0	59	0
Forel	DE	58	0	2	0	0	0
Lonay	GB	45	70	0	0	33	8
Lonay	DE	65	8	0	0	0	0

Apodemus = *A. flavicollis* and *A. sylvaticus* pooled; Tits = *Cyanistes caeruleus*, *Parus major* and *Poecile palustris*; Insects = eusocial insects including wasps (*Vespula* spp.), Bumblebees (*Bombus* spp.) and ants (Formicidae).

4. Discussion

4.1. Overall nest box use

Overall nest box use in the three experimental forests was comparable to the occupation rates found in Britain (Morris et al. 1990) and Lithuania (Juškaitis 1999a), where nest box techniques were applied. We found only slight fluctuations of around 20% occupation between years. This contrasts strongly with results of individual censuses in boxes, which show increases of up to four-fold between the worst and best years (Catzeflis 1984, Coppa 1991, Juškaitis 1994). The fact that one individual may use several nest boxes situated in its home range may explain our relatively stable occupation rates.

4.2. Difference in the use of the GB and DE nest boxes

Muscardinus has two main types of nests during its active period. The first is a spherical structure of leaves and other vegetable material with a lateral entrance. This is generally fixed in forks of twigs, very often in well-protected places such as in large thorny bushes of *Rubus* sp. (Kahman & von Frisch 1950, van Laar 1984). The second type of nest is also spherical, but placed in different kinds of holes, e.g. in the trunk of a tree as used by tits. These can be replaced in the experimental situation by classical vertical nest boxes, such as those used for birds or GB-type boxes or even asbestos cement drainage pipes (Catzeflis 1984). For studying edible dormouse, Morris & Temple (1998) developed a new type of nest box referred to as a 'nest-tube', 60-cm long. The use of large numbers (about 2,000) of a smaller model (5 × 5 × 25 cm, Bright et al. 2006) allowed the presence of common dormouse to be demonstrated in unusual habitats (Woods 2004). Comparative statistical results between the GB type and British nest tubes have shown a very bad score for the smaller tubes (Chanin & Gubert 2011).

In contrast, the current multi-annual comparison between the GB and DE nest boxes demonstrated significantly higher occupation of the DE type, in terms of both the number of common dormice encountered, as well as in terms of occupation derived from indirect activity signs. Regarding other vertebrate species, the rates of occupation differed: tits, field mice and edible dormice occupied the GB boxes significantly more often and never reproduced successfully in the DE boxes. This suggests that the DE boxes are too small to provide nesting sites for all these species. These species are either very aggressive or larger than *Muscardinus*, and are therefore dominant (Juškaitis 1995, Juškaitis 1999b, Juškaitis 2008) and have priority

over *Muscardinus* in the GB boxes. They used between a third and a half of the GB boxes, thus reducing their availablity to *Muscardinus*. We believe that the higher occupation of DE nest boxes by *Muscardinus* was the consequence of competition for nest sites from *Apodemus, Glis* and tits rather than the result of a preference by *Muscardinus* for this type of box.

However, Marsh & Morris (2000) found no evidence of interspecific competition in England, possibly because the nest box density was higher or because there were fewer competitors [low density of *Apodemus flavicollis* and practical absence of *Glis* (Morris 1997)]. Interestingly, a comparative study of bigger nest boxes in Sicily by Sarà et al. (2005) came to a reverse conclusion. The common dormouse was not only dominant over blue tits, but was moreover a serious predator of tit nests. At many places tit egg predation was never observed and as noted by Juškaitis (2006, 2008), opinions (and facts) regarding competition and predation behaviour vary, and different conditions may result in different reactions and adaptations.

In conclusion, and in contradiction to the study of Chanin & Gubert (2011) the results of this study indicate that smaller nest boxes are more suitable for *Muscardinus*. The potential disadvantage of the smaller size is compensated for by the reduction in interspecific competition from other nest box-using vertebrates. Moreover, the smaller nest boxes may be cheaper to produce. Although DE traps used as nest boxes are less durable than the GB box with thicker walls, they can easily be replaced. Despite their smaller size, DE-type nest boxes thus appear to offer a significant advantage over larger boxes for the study of *Muscardinus*.

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