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USE OF NESTBOXES BY THE COMMON DORMOUSE (*Muscardinus avellanarius* L.) IN LITHUANIA

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Data on the use of nestboxes by *Muscardinus avellanarius* in three areas in Lithuania were gathered in 1971-1996 during all seasons of the year including winter. More than 20 000 nestbox checks were made, finding about 5000 dormice. The numbers of dormice and their demographic composition markedly changed as the annual season progressed. The number of dormice reached maximum in September: the dormice occupying 30-40% of all nestboxes. There was a positive relationship between the occupancy of nestboxes and density of undergrowth. Dormice preferred nestboxes established at the height of 4 m. Preference was also given to wooden nestboxes. The dormice compete for nestboxes with birds, the yellow-necked mouse, fat dormouse and social insects.

Key words: *Muscardinus avellanarius*, nestboxes, Lithuania

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Podaci o korištenju kućica od strane puha *Muscardinus avellanarius* na tri područja u Litvi sakupljeni su u razdoblju 1971.-1996., tijekom svih godišnjih doba uključujući i zimu. Učinjeno je više od 20 000 provjera kućica i nađeno više od 5000 puhova. Broj puhova i njihov demografski sastav značajno se mijenjao tijekom godine. Maksimalan broj puhova zabilježen je u rujnu: 30-40% nastanjenih kućica. Ustanovljen je pozitivni odnos između naseljenosti kućica i gustoće prizemnog raslinja. Puhovi su preferirali kućice postavljene na visinu od 4 m. Radije su naseljavali drvene kućice. Za kućice puhovi se natječu s pticama, žutogrlim šumskim mišem, sivim puhom i združnim kukcima.

Ključne riječi: *Muscardinus avellanarius*, kućice, Litva

INTRODUCTION

It is well known that common dormice (*Muscardinus avellanarius* L.) willingly make use of nestboxes. This has been discussed in a number of research works and

nestboxes appear to offer a means of assisting investigations of this species (SIDOROWICZ, 1959; LÖHRL, 1960; PIELOWSKI & WASILEWSKI, 1960; LIKHACHEV, 1967; LOZAN, 1970; SCHULZE, 1973, 1986; GAISLER et al., 1977; AIRAPETJANC, 1983; CATZEFELIS, 1984; MÖCKEL, 1988; MORRIS et al., 1990; SARA et al., 1996 etc.).

The following reasons encouraged the appearance of the present paper:

- 1) Lithuania is in the north-west part of the distribution area of *M. avellanarius* where similar researches so far have not been performed;
- 2) long-term investigations, a large number of annually checked nestboxes and regular inspection of nestboxes throughout the dormice activity period enabled collection of a large data set reflecting both the mean of many years and specific character of separate years,
- 3) as well as the dynamics of nestbox use in the course of the season, data were collected on separate aspects of the use of nestboxes. Such information is scarce in the literature or absent altogether
- 4) this study offers a possibility to compare data obtained in Lithuania with those from other parts of the distribution area, including the analogous work by LIKHACHEV (1967) carried out in the Moscow and Tula regions which is not widely known in Europe.

MATERIALS AND METHODS

Data on the use of nestboxes by *M. avellanarius* were gathered in 1971–1996 in three areas of Lithuania: Šakiai district (south-west Lithuania), 1971–1990, Moletai district (east Lithuania), 1984–1993 and Kaisiadorys district (central Lithuania), 1990–1996. In the initial stage (1971–1980) hole-nesting birds breeding in nestboxes were investigated at the same time. Since 1981 checking nestboxes for dormice has become the main objective of investigation.

The main part of the data were collected in 1984–1993 at sites A and B (Šakiai and Moletai districts) where 262 and 341 nestboxes, respectively, were spaced at 50 m intervals in a grid system (JUŠKAITIS, 1994). At the same time a number of additional nestboxes were set up, both within these study sites and outside, so the total number of nestboxes inspected reached 713–745 in separate years. For the description of the study sites see JUŠKAITIS (1994, 1995).

Standard wooden nestboxes were used, intended for small hole-nesting birds e.g. Great tit (*Parus major*) and Pied flycatcher (*Ficedula hypoleuca*) with approximate internal dimensions of 12 × 12 × 24 cm and entrance hole diameter of 35 mm. Nestboxes were tied to trees and easily accessible both to birds and other box users. Most nestboxes were sited 1.5–2 m above the ground. There were dormouse nestboxes in 1985–1987 in 35 places at site B. the same trees were furnished with three nestboxes set up at different heights (1 m, 2 m and 4 m). In 1985–1990 20 trees in different places were supplied both with a standard wooden nestbox and a ceramic

one established at the same height of 1.5–2 m (the height of a ceramic nestbox being 25 cm, internal diameter of the bottom was 10 cm, entrance hole diameter 35 mm).

From April to October nestboxes were usually checked once a month with two additional inspections in May and September (a total of 9 inspections per year). In some years of the initial stage of investigations nestboxes were checked more frequently and for a longer time (e.g. from the beginning of April to the beginning of November). In 1979–1982 performing investigations of birds overwintering in nestboxes (JUŠKAITIS, 1986), boxes were also checked overwinter once a month.

Dormice found in nestboxes were marked and weighed. Their sex and age as well as the number and age of juveniles was also recorded. We also described nest materials, registered all other nestboxes users (birds, mammals, insects) and their relationship with dormice. In an attempt to establish correlation between the rate of nestbox occupation by dormice and environmental factors, an evaluation was made of the density of undergrowth, proportion of deciduous trees and Norway spruce (*Picea abies*) in the upper layer and their density. Some other factors were also recorded within a radius of 20 m around every nestbox.

Throughout the study period, in all seasons of the year, more than 20000 nestbox checks were made, with about 5000 dormice found.

RESULTS

In Lithuania *M. avellanarius* use nestboxes during all of their activity season, from April until the beginning of November. The first dormice are usually found in nestboxes in mid-April, but in early springs they can be met in the first days of April when part of the ground in the forest is still covered with snow. On April 3–4, 1983 we checked 325 nestboxes and detected 12 dormice. We guess that the first animals that year could have appeared in boxes already by the end of March. In 1985 one dormouse was detected in a nestbox on April 6. In later years, including early springs of 1989 and 1990, nestboxes were checked merely from mid-April. While cleaning nestboxes in the Šakiai district an injured *M. avellanarius* was found by O. Atkocaitis on March 2, 1991. This is the earliest record in Lithuania, but should be treated as an exceptional case.

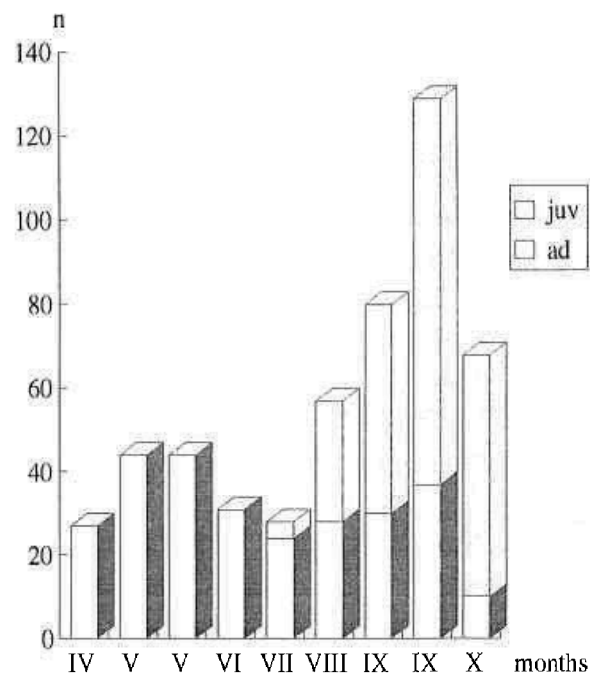
The number of dormice and their demographic composition occurring in nestboxes change considerably in the course of their activity period. In April as many as 88 % of all dormice detected in boxes ($n = 223$) were adult males. Most probably, they wake up from hibernation earlier than females. In May the number of dormice in nestboxes increases and reaches the spring maximum (Fig. 1). The number of males and females becomes similar. Dormice occupy about 10–20 % (up to 32 %) of all nestboxes (when nestbox density is 4 boxes per hectare). In June and July the number of dormice in nestboxes decreases, females with litters being more frequent. In July the first independent juveniles are also found in nestboxes.

In August the number of dormice in nestboxes increases and in the second half of September reaches the maximum (Fig. 1). At that time dormice occupy 30–40 % (up to 46 %) of all nestboxes (when nestbox density is 4 boxes per hectare). This is due to a significant rise in the number of independent juveniles which in September account for about 70 % of all dormice detected in nestboxes. A slight increase is also observed in the number of adult dormice.

In the second half of September, when the animals have accumulated a sufficient amount of fat, nestboxes start to be deserted by adult males, females without juveniles and the young of earlier litters. As a consequence, the number of dormice in boxes at the beginning of October is considerably lower. In the second half of October the only users of nestboxes are the young of later litters which have not accumulated a sufficient amount of fat. At the beginning of November only solitary juveniles can be found. The latest records in Lithuania were on November 9, 1987 and November 8, 1981. *M. avellanarius* do not use nestboxes for hibernation in Lithuania.

Quantitative dynamics of dormice in nestboxes in the second half of October and early November described above is not reflected in Fig. 1. This can be explained by the fact that Figure 1 represents the means of many years, whereas all 600 nestboxes in the second half of October were checked only in 1984 and 1986.

Dormice in nestboxes ($n = 3382$) were found singly (72 % of cases), in groups of two and more (15 %) and females with litters of young (13 %). As the season progressed the number and composition of dormice changed. In spring adult dormice



n – average number of dormice for 600 checked nestboxes

Fig. 1. Dynamics of number of *M. avellanarius* in nestboxes during their activity season in Lithuania (sites A and B, 1985–1992)

in nestboxes were usually found singly, rarely in groups (Table 1). Of 90 groups detected in spring, 80 cases were male/female breeding pairs. Groups of two or three dormice of one sex were very rare: 6 nestboxes with 2 males, one case of 3 males, one of 3 males and a female and one of a male with 2 females and a single case of 2 females. The latter cases were recorded in late April or early May before the reproductive season.

In July–October the situation slightly changed. Single users of nestboxes decreased and the proportion of dormice occurring in groups doubles (Table 1). This corresponds to the appearance of independent juveniles using nestboxes. While wandering, they seem to occur within the home ranges and nestboxes of adult dormice (JUŠKAITIS, in press, b). In autumn the composition of groups detected in nestboxes differs compared with spring. Most frequent (68 %) are pairs of different sex (juvenile male and juvenile female; male and female adults; adult male and juvenile female, male juvenile and adult female). Pairs of the same sex and groups of 3 or 4 dormice are rarer, forming 18 % and 14 %, respectively. There were some cases when a female with a litter was found in a nestbox, together with an adult male or one or two independent juveniles.

Nestboxes are often used by *M. avellanarius* for reproduction (Table 1). Females with litters may be found in boxes from mid-May to October with peak numbers in nestboxes in June and August.

Occasionally *M. avellanarius* use nestboxes for feeding and in August and September otherwise empty nestboxes may contain one or more hazel nuts gnawed by *M. avellanarius*. Occasionally other food remains are found, including buckthorn (*Frangula alnus*) berries and oak (*Quercus robur*) acorns (JUŠKAITIS, 1993). In autumn the nests of dormice in nestboxes may contain quantities of acorns. However, as far as is known, *M. avellanarius* do not store food in nestboxes and the presence of acorns is attributed to yellow-necked mice (*Apodemus flavicollis*) occupying the nests of dormice (JUŠKAITIS, 1995)

In nestboxes *M. avellanarius* usually build ball-shaped nests, similar to those built among branches of shrubs. The majority of nests found in boxes (n = 720) were made of leaves (45 %) or had a two layered structure (40 %). Combined (11 %) and

Table 1. A number of *M. avellanarius* found in one nestbox in spring and autumn (Šakiai and Moletai districts, 1982–1993)

No. of dormice	Nestboxes with dormice			
	April – June		July – October	
	n	%	n	%
1 dormouse	869	79.1	1550	67.9
Female with a litter	140	12.7	311	13.6
2 and more dormice	90	8.2	422	18.5
Total	1099	100	2283	100

grass nests (4 %) being markedly rarer (nest classifications following WACHTENDORF, 1951). The major constituents are the leaves of hazel (*Corylus avellana*), aspen (*Populus tremula*), oak (*Quercus robur*), birch (*Betula pendula*), lime (*Tilia cordata*), raspberries (*Rubus idaeus*), and other plants. The leaves of grass are used as building material for grass, layered and combined nests. Layered nests may be lined with stripped hazel bark. In spring, nests are built of last year's fallen leaves, but in the second half of summer and autumn frequently of fresh green hazel leaves. Nest type depends upon sex and age of the dormouse, and choice of nest material – upon its abundance and availability. For example, for breeding, adult females make layered nests, whereas the nests of males and independent juveniles are most frequently built of leaves. Grass nests are built in young spruce-groves where deciduous trees are absent.

Where nestboxes had been cleaned before winter, in early spring (April) dormice may often be found sleeping in empty boxes on a bare bottom. In summer and autumn such cases are rarer, but wandering juveniles may occasionally spend a day in an empty nestbox. Frequently dormice occupy the nests of hole-nesting birds (especially the pied flycatcher, *Ficedula hypoleuca*) breeding in nestboxes which they either transform into the shape of a ball or simply settle down beneath the bird nest (JUŠKAITIS, 1995). *M. avellanarius* often compete with birds for nestboxes, particularly *F. hypoleuca*, mammals (*Apodemus flavicollis*) and social insects. Relationships between dormice and other nestbox users have been analyzed in an earlier publication (JUŠKAITIS, 1995). We may merely add some new data on competition of *M. avellanarius* and *Myoxus glis* for nestboxes. In the Rumsiskes forest of the Kaisiadorys district the most suitable habitat for both species is mature mixed forest with old oak and abundant undergrowth of hazel. Normally, only *Myoxus* lives in nestboxes established in such areas and *Muscardinus* were found there only in 1994 when there was a significant decrease in the number of *M. glis*. It is still not clear whether competition between these two species occurs only for nestboxes or for territory too.

Our investigations have shown that *M. avellanarius* may live in different stands of mixed forest. Nearly the same percent of nestboxes were occupied by *M. avellanarius* in birch, spruce, ash (*Fraxinus excelsior*), aspen and oak stands (Table 2). The highest percent of occupied nestboxes was registered in the spruce stand with a mixture of deciduous trees including birch, black alder (*Alnus glutinosa*), ash and oak, where spruce made up 70–90 % of all trees. This is perhaps explained by the density of undergrowth of this spruce stand which was basically hazel. Whereas in pure spruce stands, without undergrowth (outside study site B), dormice have not occupied a single nestbox for a number of years.

The significance of the development of undergrowth for *M. avellanarius* was confirmed by the correlation analysis of environmental factors and use of nestboxes. The highest and statistically reliable correlation coefficient was established between the rate of nestbox occupation and density of undergrowth ($r = 0.46$; $p < 0.001$). The most important undergrowth shrub is hazel ($r = 0.36$; $p < 0.001$). Rate of nestbox occupation is negatively correlated with tree crown density ($r = -0.23$; $p < 0.01$). In turn it is condi-

Table 2. Use of nestboxes by *M. avellanarius* in the main forest stands (sites A and B, 1985–1987, autumn)

Stands	Stand area, ha	No. of nestboxes	Nestboxes occupied, %
Birch stand with spruce and black alder	15	60	50.6
Spruce stand with deciduous trees	8	32	61.5
Ash stand with spruce and deciduous trees	6	25	54.7
Oak stand with spruce and asp	18	72	48.1
Asp stand with spruce and oak	10.5	42	46.0

Table 3. Use of nestboxes by *M. avellanarius* and *A. flavicollis* set up at different heights (site B, 1985–1987 autumn)

Height of fixing, m	No. of nestboxes	Use of nestboxes by			
		<i>Muscardinus avellanarius</i>		<i>Apodemus flavicollis</i>	
		n	%	n	%
1	105	7	6.7	19	18.1
2	105	20	19.0	21	20.0
4	105	46	43.8	25	23.8

tioned by negative relation between the latter factor and density of undergrowth ($r = -0.35$; $p < 0.001$). There was no reliable correlation found between rate of nest occupation and proportion of deciduous trees in the canopy layer ($r = 0.11$), proportion of spruce trees in the tree canopy ($r = -0.11$) or density of grass cover ($r = -0.07$).

Erection of several nestboxes in the same tree but at different heights showed that *M. avellanarius* preferred nestboxes set up at 4m to those sited at 1 m (Chi-squared = 38.4; $p < 0.001$) and at 2 m (chi-squared = 14.9; $p < 0.001$; Table 3). By contrast, *A. flavicollis* almost equally used nests set up at three different levels.

In a comparison between wooden and ceramic nestboxes ($n = 100$), *M. avellanarius* showed particular preference for wooden one (29 % and 2 %, respectively; chi-squared = 27.8; $p < 0.001$). None of ceramic nestboxes had been used in four years, and only in the fifth year were two ceramic nestboxes found containing nests with dormice. It is interesting that in both cases the wooden nestboxes set up nearby were occupied by *A. flavicollis* which in that year were especially abundant in nestboxes.

DISCUSSION

The published literature shows that *M. avellanarius* makes use of nestboxes in all parts of the species distribution area: Russia (LIKHACHEV, 1967), Poland (SIDOROWICZ, 1959; PIELOWSKI & WASILEWSKI, 1960), Moldova (LOZAN, 1970; AIRAPET-

JANC, 1983), Germany (LÖHRL, 1960; SCHULZE, 1973, 1986; MÖCKEL, 1988), Czechoslovakia (GAISLER et al., 1977), Switzerland (CATZEFLIS, 1984), Great Britain (MORRIS et al., 1990), Italy (SARA et al., 1996) etc. These data are not easily compared because of different aims of investigation, diverse methods of study and presentation of data. Furthermore, investigations were in most cases short-term and do not reflect the mean of many years. In particular years the character of nestbox use changes depending upon natural conditions, population density, breeding intensity etc.

Almost throughout the entire distribution area of *Muscardinus*, including Lithuania, there are two peaks of nestbox use – spring and autumn. Minor differences between separate regions may be observed in timing. The spring peak may occur in May or June, autumnal – in September or October. The autumnal peak is invariably greater than the spring one, and its extent depends on the number of independent juveniles in nestboxes. In Lithuania, for example, the autumnal peak is nearly three times as in spring, whereas in the Moscow region they are nearly equal (LIKHACHEV, 1967). A decrease in the number of dormice in nestboxes during the summer months is most probably connected with microclimatic conditions inside nestboxes. Dormice desert boxes because of the heat (LIKHACHEV, 1967), whereas the litters of juveniles found at the same time in nestboxes most likely need higher temperature.

Seasonal duration of the use of nestboxes (appearance in spring and desertion in autumn) differ in separate parts of the distributional range. In this respect, the data from Lithuania resemble other northern parts of the distribution area (Moscow and Tula regions). In Great Britain and Switzerland, a considerable number of dormice are found in boxes in November (MORRIS et al., 1990; CATZEFLIS, 1984), whereas in northern parts of the range such cases are exceptional. In northern parts of the range *M. avellanarius* never overwinter in nestboxes whereas in Germany (MÖCKEL 1988) and Great Britain (MORRIS et al., 1990) this was recorded, although only in solitary cases. A quite different character of the use of nestboxes by *M. avellanarius* was observed in Sicily where the maximum nestbox occupation occurs in winter (SARA et al., 1996).

The ratio of *M. avellanarius* occurring in nestboxes alone and in groups as well as females with litters in different parts of the distribution area also differ, although nestbox sharing by dormice of one sex is rare in all regions. In this respect the data obtained in Lithuania resemble those from the Moscow region. In all parts of the range *M. avellanarius* use nestboxes for breeding, although the birth date of juveniles and number of litters differ (JUŠKAITIS, in press, a).

For nest building, *M. avellanarius* used the leaves of trees prevailing in that area: oak leaves in the Tula region and Moldova, lime leaves in the Moscow region, honeysuckle (*Lonicera periclymenum*) bark and hazel leaves in Great Britain, leaves of different trees and shrubs in Lithuania. So far we have not succeeded in elucidating why, both in Lithuania and Great Britain, *M. avellanarius* use fresh hazel leaves. In the Moscow and Tula regions (LIKHACHEV, 1967) and in Moldova (AIRAPETJANC, 1983) hazel leaves, or fresh leaves in general, were hardly ever used for nest building.

Investigations in Lithuania have revealed that dormice prefer nestboxes set up at 4 m above the ground although their natural nests in overgrowing clearings and on young spruce trees are usually found at a height of about 1 m. Radio tracking in Great Britain confirmed that *M. avellanarius* make a good use of three-dimensional space and their natural nests may be as high as at 15 m (BRIGHT & MORRIS, 1992). When a choice was offered, the mean height of nestboxes occupied by dormice in Great Britain was 3.66 m (MORRIS et al., 1990). From this we can draw a practical conclusion that nestboxes used for investigations of *M. avellanarius* should be sited at 3–4 m above the ground.

M. avellanarius successfully used both special nestboxes with the entrance hole facing the trunk (MORRIS et al., 1990) and nestboxes intended for birds. MORRIS et al. (1990) indicated that in the third year of investigation a half of special nestboxes, despite the relatively inaccessible entrance hole, were occupied by birds. In areas where *A. flavicollis* occur, they also may occupy some of the nestboxes in autumn. Thus it seems that there is no need to make special nestboxes for dormice. It is simpler to use bird nestboxes which are easy to set up on a branch at a desired height, with the help of a pole and not using a ladder.

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