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Rimvydas JUŠKAITIS

Institute of Ecology of Vilnius University, Akademijos 2,
LT-08412 Vilnius, Lithuania, e-mail: juskaitis@eko.lt

NESTBOX GRIDS IN POPULATION STUDIES OF THE COMMON DORMOUSE (*MUSCARDINUS AVELLANARIUS* L.): METHODOLOGICAL ASPECTS

ABSTRACT: Two different nestbox grids have been used for studies of the common dormouse (*Muscardinus avellanarius* L.) populations: high-density nestbox grids in small plots (e.g. 25–30 boxes ha⁻¹ in 1 ha plots) and low-density nestbox grids in large plots (e.g. 4 boxes ha⁻¹ in areas of 60 and 85 ha). The present study aimed to compare efficiency and suitability of 25 × 25 m and 50 × 50 m nestbox grids for studies of the common dormouse population, and to show limitations of small study plots in dormouse studies. Live trapping of dormice within nestbox grids proved that all dormice captured used nestboxes placed in both 25 × 25 m and 50 × 50 m grids. Regular control of nestboxes placed in the 25 × 25 m grid gave an opportunity to register all adult dormice living in the study site during shorter periods, and average dormouse capture rate was significantly higher compared to the 50 × 50 m grid. However the 25 × 25 m nestbox grid had one substantial drawback: high nestbox density (16 boxes ha⁻¹) increased environment carrying capacity for dormice in the forest, where natural hollows were almost absent. In consequence, adult dormouse density increased two to four-fold, while their home range sizes decreased by about half. Dormice are distributed irregularly in large forest areas, and the results obtained in small study plots may not reflect the average characteristics of the population. Some results obtained in small study plots (e.g. density, mortality) can be overestimated because of dormouse movements and

edge effects. Predators, e.g. owls, can catch some dormice and substantially influence the results obtained in small plots. Because of the influence on dormouse population density and other population parameters, high density nestbox grids (e.g. 20 × 20 m, 25 × 25 m) should not be used in dormouse population studies. Small study plots (e.g. 1 ha) are completely unsuitable for estimation of such dormouse population characteristics as survival (mortality) and dispersal.

KEY WORDS: *Muscardinus avellanarius*, nestboxes, grid system, population, density

1. INTRODUCTION

Common dormice (*Muscardinus avellanarius* L.) willingly occupy bird nestboxes (e.g. Pielowski and Wasilewski 1960, Lihačev 1967, Schulze 1973, Juškaitis 1997b) or specially designed dormouse nestboxes with their entrance holes facing inwards (e.g. Morris *et al.* 1990, Woods 1996, 1997, Bright and Morris 2005). In many studies, nestboxes have been used to trap dormice and to collect data on their biology. In some cases, studies of the common dormouse populations were performed using nestboxes located in high-density grid systems in comparatively small areas. For ex-

ample, in Southwest England, 30 nestboxes per hectare were put up in a grid system over areas of approximately 1.2 ha (Bright and Morris 1990). In Sicily, nestboxes were spaced regularly at 20 m, to form grids of one hectare (Sara *et al.* 2001). In Central Italy, 50 nestboxes, 20 m apart from each other, were erected to form regular grids (Sorace *et al.* 1999, Panchetti *et al.* 2004.). In Eastern Saxony, nestboxes set in three grid systems, covering two small woods and an area of coppice, were used for dormouse studies (Büchner *et al.* 2003).

Nestbox grids have also been used for dormouse studies in Lithuania, in two study sites (e.g. Juškaitis 1997a, 2003), but in different ways. Nestboxes were placed in low-density grids (4 boxes ha^{-1} , distances between nestboxes – 50 m), but in large forest areas (60 and 85 ha, respectively). During long-term dormouse studies carried out in Lithuania, some methodological aspects emerged concerning the use of nestbox grids namely: the influence of high nestbox density on a dormouse population (Juškaitis 2005) and the advantages of large study plots compared to small study plots (Juškaitis 2002, 2004).

The aim of the present study was to review some published and unpublished methodological aspects of using nestbox grids in population studies of the common dormouse:

1) to compare efficiency and suitability of 25×25 m and 50×50 m nestbox grids for dormouse population studies;

2) to show the limitations of small study plots in dormouse studies.

2. MATERIAL AND METHODS

Investigations of the common dormouse population were carried out in south-western Lithuania, Šakiai district ($55^{\circ}03'N$, $23^{\circ}04'E$), in 1984–1990 and 1997–2005. The study site (60 ha) was delimited by the forest edge in the south and east, by a forest road in the west and border nestbox line in the north (Fig. 1). Over most of the study site, the forest was middle-aged (40–50 years old), with a great diversity of mixed tree stands. Within the study site, mixed birch (*Betula pendula* Roth) stands with Norway spruce (*Picea abies* (L.) and black alder (*Alnus glutinosa* (L.), ash (*Fraxinus excelsior* L.) stands with aspen (*Populus tremula* L.), and pure Norway spruce stands were prevalent. There was a mixed Norway spruce stand with oak (*Quercus robur* L.) at the southern edge of the site. The understorey contained many hazels (*Corylus avellana* L.) and in some places – glossy (alder) buckthorn (*Frangula alnus* Mill.).

In the whole area of the study site, 274 nestboxes were spaced at 50 m intervals (50×50 m grid, density – 4 boxes ha^{-1}) in 1999.

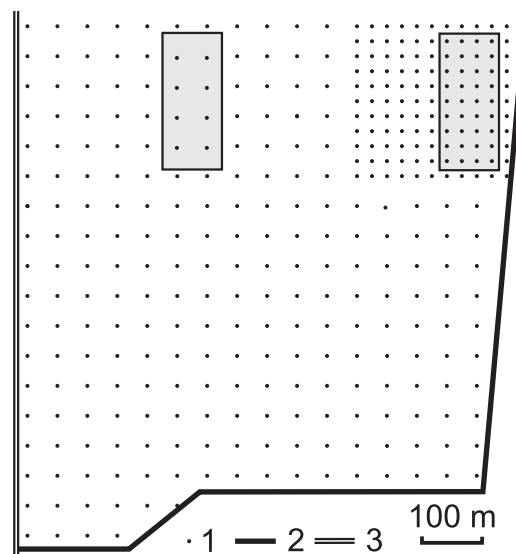


Fig. 1. Scheme of the common dormouse study site in 2001–2005. Dormouse live trapping plots in 2004 and 2005 are grey-shaded. 1 – nestbox, 2 – forest edge, 3 – forest road.

In April 2001, 85 additional nestboxes were put up in the north-eastern corner of the study site (Fig. 1), forming a 25×25 m grid (density – 16 boxes ha^{-1} , area covered by this grid – 6.25 ha). The main material for the present study was collected in 2001–2005, when all nestboxes were controlled twice each month from April until October. Some data from the first study period (1984–1990) were also used for the present paper.

All dormice caught in the nestboxes (1197 animals in 1997–2005) were marked with aluminium rings (the straightened plate was 2.5×8.0 mm). The rings were placed on the right hind leg over the ankle. All the animals were weighed and their sex and age determined. However only adult dormice were included in the analysis for the present study. Dormice were considered as the adults if they had survived at least one hibernation. Unmarked early-born young-of-the-year dormice were distinguished from adults according to lower body weight (Juškaitis 2001) and some additional indicators such as greyer fur coloration, narrower tail and earlier moulting time.

Additionally dormice were live-trapped in 2001, 2004 and 2005. Wooden live-traps ($16 \times 8 \times 8$ cm) were fixed on horizontal branches or tree trunks using sticky tape at a height of 1–2 m. Hazelnut kernels and pieces of apple were used as bait. In May, June and September 2001, traps were not set in a grid system, but were spaced over a trapping plot within the 25×25 m nestbox grid, covering approximately 4 ha. During each trapping session, 50 traps were set in 25 places for 5 nights. Two traps facing opposite directions were set at each trapping point. Trapping design was different in May 2004, when dormice were live-trapped in three plots: in the 25×25 m and 50×50 m nestbox grids (Fig. 1) and in similar habitat without nestboxes. In all three plots, 50 live-traps were placed in the 25×25 m grid system (area covered by trap grid – 2.25 ha). In May 2005, dormice were live-trapped only in the 50×50 m grid with the same trapping design. The total trapping effort was 1750 trap-nights, and 35 adult dormice were trapped in 73 captures.

Spring density of adult dormice was calculated by dividing the number of adults caught in the nestboxes during the entire

active season by the effective trapping area (Flowerdew 1976, Krebs 1999). The effective trapping area was calculated by adding a boundary strip to the sides of the area containing nestboxes, except when this area was delimited by forest edge or forest road (Fig. 1). The width of the boundary strip was equivalent to one half the mean distances moved by dormice between nestboxes. In the 50×50 m nestbox grid, this distance was 96 m ($n = 460$; pooled data for males and females), the width of the boundary strip – 50 m, and effective trapping area was considered to be 57 ha. In the 25×25 m nestbox grid, this distance was 52 m ($n = 327$), width of the boundary strip = 25 m, and effective trapping area was 8.5 ha.

3. RESULTS AND DISCUSSION

In animal population studies, it is important to register all specimens living in the area of the study site. It is desirable to do that as soon as possible with minimum effort. In this respect, two different nestbox grids were compared in the study of the common dormouse population. Results obtained have shown that the 25×25 m nestbox grid had both benefits and limitations for dormouse studies compared to the 50×50 m grid.

Live trapping of dormice in the areas of nestbox grids proved that all dormice captured in traps also used nestboxes placed in both 25×25 m and 50×50 m grids. In total, 21 adult dormice were live-trapped in the 25×25 m nestbox grid in 2001 and 2004, and all these dormice were also found in nestboxes. Live trapping results suggest that 100% of dormice, living in the area covered by the 25×25 m nestbox grid, used nestboxes placed in this plot.

Eight adult dormice were live-trapped within the 50×50 m nestbox grid in 2004 and 2005, and all of these were also found in nestboxes of this grid. However during the whole study period, three marked adult dormice were found in nestboxes of the 50×50 m grid after one year's break in observations. The obligatory fixed nestbox positions in the grid causes some nestboxes to be put up in unsuitable places for dormice (e.g. on isolated trees). For this reason, some dormice may live in the area of the

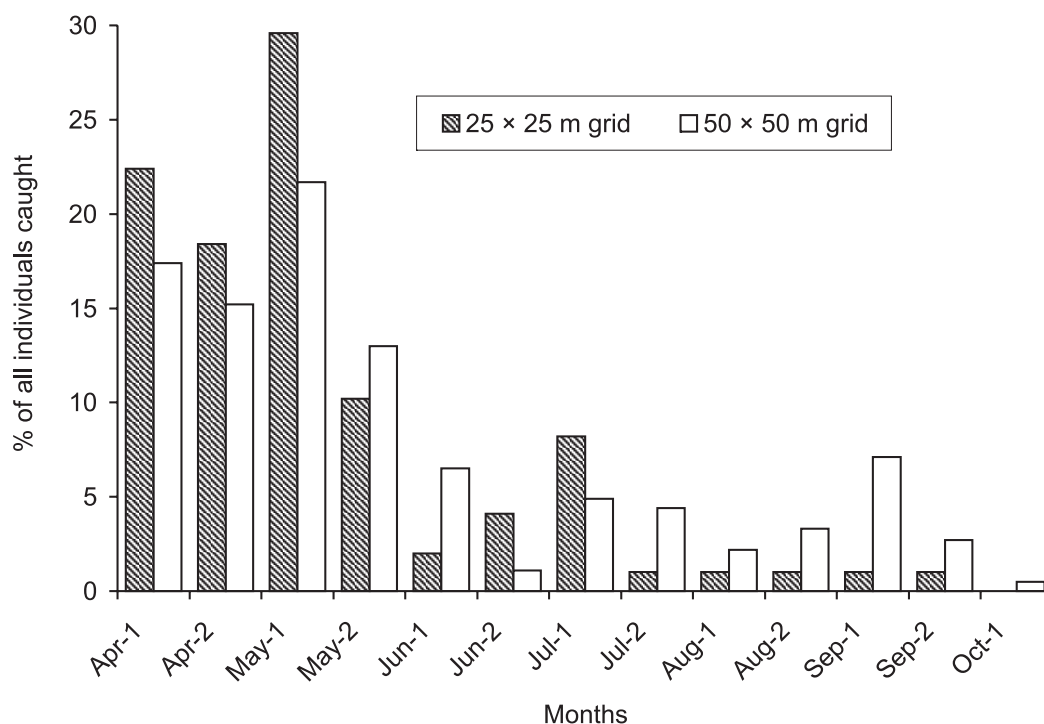


Fig. 2. Percentage of adult common dormice caught for the first time during the active season in the 25 × 25 m nestbox grid ($n = 98$) and in the rest of the study site with the 50 × 50 m nestbox grid ($n = 184$) in 2002–2005. Dormice caught in both nestbox grids are not included.

50 × 50 m grid and not use nestboxes present within their home ranges. Because of this, it is supposed that regular control of nestboxes spaced in a 50 × 50 m grid does not necessarily enable 100% of adult dormice living in this area to be found, but should find over 90% of them. More live trapping is necessary in the area of the 50 × 50 m nestbox grid to confirm this assumption. Similar numbers of dormice (5 vs. 6) were live-trapped in the 50 × 50 m nestbox grid and in the area without nestboxes using the same trapping design in 2004.

Regular control of nestboxes placed in the 25 × 25 m grid gave an opportunity to register dormice living on the study plot, during a shorter period in comparison to the 50 × 50 m grid. On average, 95% of all adult dormice ($n = 98$), found in the 25 × 25 m grid during entire active season, were caught during seven successive nestbox controls in April – early July 2002–2005 (Fig. 2). In the 50 × 50 m grid, such a result was achieved only in early September after 11 nestbox controls. The last new dormice were usually caught in border nestboxes of both grids, and

most probably the main parts of their home ranges were outside of the nestbox grids. In the 25 × 25 m grid, average dormouse capture rate was significantly higher compared to the 50 × 50 m grid ($t = 5.30$; $df = 279$; $P < 0.0001$). In the 25 × 25 m nestbox grid, one adult dormouse was captured on average 5.1 ± 3.0 times ($n = 97$), and 3.4 ± 2.4 times ($n = 184$) in the 50 × 50 m grid, during 12 nestbox controls between April and September, 2002–2005.

However the 25 × 25 m nestbox grid had one substantial drawback: the large number of nestboxes increased the carrying capacity in the forest, where natural nesting hollows were almost absent. In consequence, dormouse density increased permanently two-three-fold in the study plot compared to the former 50 × 50 m grid (Juškaitis 2005). In 2004, adult dormouse density reached 4.5 ind. ha^{-1} in the 25 × 25 m grid, but only 1.1 ind. ha^{-1} in the rest of the study site with the 50 × 50 m grid. This difference was also partially confirmed by live trapping results. Twice as many dormice (10 vs. 5) were caught with live-traps in the area of the

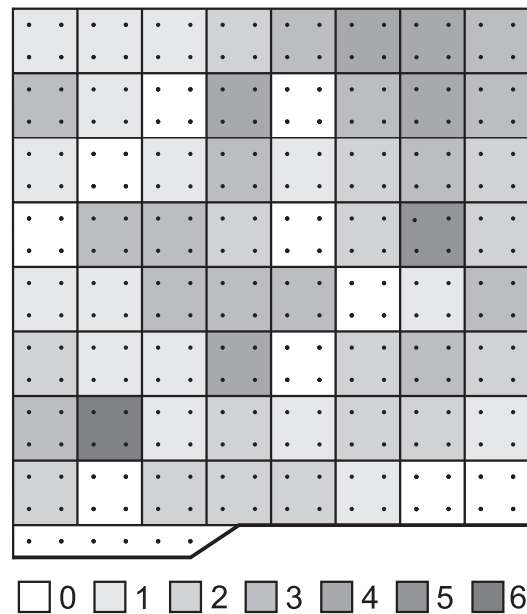


Fig. 3. Irregular distribution of adult common dormice in the area of the study site in 1985. In the legend, digits from 0 to 6 refer to the number of adult dormice found in 1 ha size squares (0 – no dormice, 1 – one dormouse, 2 – two dormice etc.).

25 × 25 m grid, compared to the 50 × 50 m grid, using the same trapping design in 2004. Dormouse home range size decreased by approximately half in the 25 × 25 m grid compared to the 50 × 50 m grid. In the 25 × 25 m grid, average home range size was 0.32 ha in males and 0.14 ha in females, but 0.73 ha and 0.25 ha, respectively in the 50 × 50 m grid (Juškaitis 2005).

One of the benefits of the 50 × 50 m nestbox grid in comparison to the 25 × 25 m grid is the possibility of using the same number of nestboxes to sample a four-fold larger forest area. It is important, because investigations carried out in large study sites in Lithuania have shown some limitations of small dormouse study plots. Dormice are distributed irregularly in large forest areas. When the area of a dormouse study site was divided into 1 ha squares, the number of adult dormice found in such squares varied from 0 to 6 individuals (Fig. 3). Habitat suitability for dormice could determine such differences in number of dormice found. For this reason, results obtained in small study plots may not reflect the average characteristics of the whole dormouse population living in the site. Data on spatial

distribution of the yellow-necked mouse (*Apodemus flavicollis* Melch.) in the same study site resulted in a similar conclusion: long-term population studies in small plots of the forest with diverse tree-stands may only reflect the situation in these specific places, but not the state of the entire yellow-necked mouse population (Juškaitis 2002).

Some results obtained from small study plots (e.g. density, mortality) can be overestimated because of dormouse movements and the “edge effect” (i.e. some animals having only parts of their home ranges overlapping the grid). According to Bondrup-Nielsen (1983), grid sizes at least 16 times larger than the average home range size should be used to minimize this effect.

Figure 4 shows movements of 16 adult dormice found in the selected 1 ha plot of the 25 × 25 m nestbox grid in 2004. Home ranges of several dormice found in peripheral nestboxes of the selected plot were evidently situated outside this plot. Different dormouse densities could be estimated in this 1 ha plot, depending on the estimation method used:

1) 16 ind. ha⁻¹, if density is calculated without adding a boundary strip;

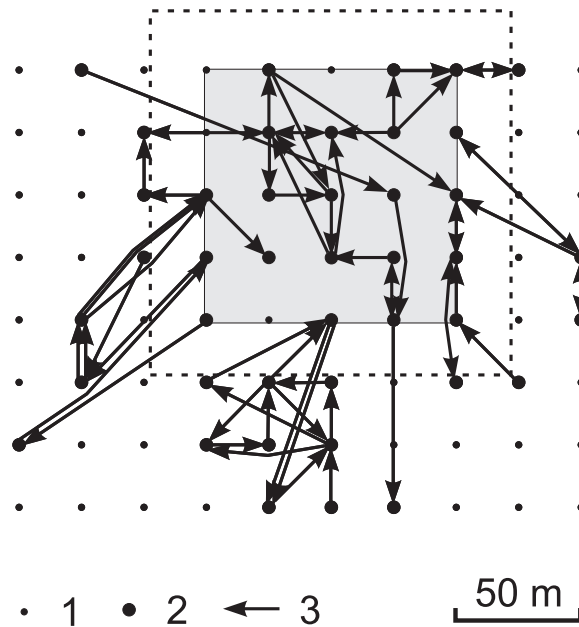


Fig. 4. Movements of adult common dormice caught in selected 1 ha plot (grey-shaded) of the 25×25 m nestbox grid in 2004. Dotted line delimits the effective trapping area, when 25 m wide boundary strip was added. 1 – nestbox, 2 – capture of dormouse, 3 – dormouse movement between nestboxes.

2) 7.1 ind. ha^{-1} , if a 25 m wide boundary strip is added (effective trapping area = 2.25 ha).

Considering that dormouse density in the 25×25 m grid was four-fold greater in comparison to the 50×50 m grid in 2004, dormouse density calculated from the selected 1 ha plot, would be less than 2 ind. ha^{-1} in the same habitat with 50×50 m nestbox grid. A similar, but probably a little lower, dormouse density should be found in the same habitat without nestboxes, assuming that dormouse density is influenced insignificantly by the nestboxes of the 50×50 m grid (R. Juškaitis - unpublished). Thus, natural dormouse density in the same habitat without nestboxes may be overestimated by up to eight-fold, if a high-density nestbox grid was used and a boundary strip was not added when calculating density. It should be noted that a boundary strip was used for estimation of population density in very few studies of dormice (Berg and Berg 1999, Bertolino *et al.* 2001, Juškaitis 2003, 2005).

Small study plots (e.g. 1 ha) are entirely unsuitable for studies of movement or survival (mortality) in young-of-the-year dormice. The majority of juveniles marked in a small study plot will disperse from it for-

ever. Mean distance travelled from the birth place by young-of-the-year born in May–July was 363 ± 28 m, maximum distances were 800–1200 m (Juškaitis 1997b).

When dormouse studies are carried out in comparatively small areas, it is necessary to pay attention to the possible local impact of owls and other predators. Tawny owls (*Strix aluco* L.) are able to catch some dormice in the small study plots and, in such a way, bias dormouse study results considerably, especially in spring before the breeding season when dormouse density is low (Juškaitis 2004). Owls can also influence other dormouse studies in small areas (e.g. faunal surveys or habitat preference studies). If dormice are absent from a particular area, it does not necessarily follow that this area is unsuitable for them and that they cannot survive there. Tawny owls can have an impact on dormice even when they nest 1–1.5 km away from the dormouse study site (Juškaitis 2004).

4. CONCLUSIONS

In the forests, where natural hollows are absent or sparse, nestboxes set up at a high density increase environment carrying capacity for the common dormouse. Thus, nest-

boxes set up at high densities can be useful for dormouse conservation where dormice are rare and threatened. However because of their considerable influence on dormouse population density and other population parameters, high-density nestbox grids (e.g. 20 × 20 m, 25 × 25 m) should not be used in scientific studies of natural dormouse population parameters. Investigations carried out in large dormouse study plots in Lithuania have also shown possible limitations of small study plots.

For all the reasons mentioned above, studies of common dormouse populations using a 50 × 50 m nestbox grid in large forest area give more accurate characteristics of dormouse populations compared to the 25 × 25 m grid in a small plot. Another quality of the 50 × 50 m nestbox grid in comparison to the 25 × 25 m grid is the possibility of spacing the same amount of nestboxes over a four-fold larger area of forest. Live-trapping in analogous habitats with different nestbox densities and without nestboxes are necessary to estimate more accurately the influence of nestbox presence on dormouse density. Methods, tested in the present study, can be also used in studies of other dormouse species and other mammals that occupy nestboxes.

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5. REFERENCES

- Berg L., Berg Å. 1999 – Abundance and survival of the hazel dormouse *Muscardinus avellanarius* in a temporary shrub habitat: a trapping study – *Ann. Zool. Fenn.* 36: 159–165.
- Bertolino S., Viano C., Currado I. 2001 – Population dynamics, breeding patterns and spatial utilisation of the garden dormouse (*Eliomys quercinus*) in an Alpine habitat – *J. Zool. Lond.* 253: 513–521.
- Bondrup-Nielsen S. 1983 – Density estimation as a function of live-trapping grid and home range size – *Can. J. Zool.* 61: 2361–2365.
- Bright P.W., Morris P.A. 1990 – Habitat requirements of dormice *Muscardinus avellanarius* in relation to woodland management in Southwest England – *Biol. Conserv.* 54: 307–326.
- Bright P., Morris P. 2005 – *The Dormouse*. 2nd edition – The Mammal Society, London, 27 pp.
- Büchner S., Stubbe M., Striese D. 2003 – Breeding and biological data for the common dormouse (*Muscardinus avellanarius*) in eastern Saxony (Germany) – *Acta Zool. Hung.* 49 (Suppl. 1): 19–26.
- Flowerdew J.R. 1976 – Ecological methods – *Mamm. Rev.* 6: 123–159.
- Juškaitis R. 1997a – Ranging and movement of the common dormouse *Muscardinus avellanarius* in Lithuania – *Acta Theriol.* 42: 113–122.
- Juškaitis R. 1997b – Use of nestboxes by the common dormouse (*Muscardinus avellanarius* L.) in Lithuania – *Natura Croatica*, 6: 177–188.
- Juškaitis R. 2001 – Weight changes of the common dormouse (*Muscardinus avellanarius* L.) during the year in Lithuania – *Trakya Univ. J. Sci. Res. ser. B*, 2: 79–83.
- Juškaitis R. 2002 – Spatial distribution of the yellow-necked mouse (*Apodemus flavicollis*) in large forest areas and its relation with seed crop of forest trees – *Mamm. Biol.* 67: 206–211.
- Juškaitis R. 2003 – Abundance dynamics and reproduction success in the common dormouse, *Muscardinus avellanarius*, populations in Lithuania – *Folia Zool.* 52: 239–248.
- Juškaitis R. 2004 – Local impact of the Tawny owls (*Strix aluco*) on the common dormice (*Muscardinus avellanarius*) in Lithuania – *Ekológia* (Bratislava), 23: 305–309.
- Juškaitis R. 2005 – The influence of high nestbox density on the common dormouse *Muscardinus avellanarius* population – *Acta Theriol.* 50: 43–50.
- Krebs Ch.J. 1999 – *Ecological methodology*. 2nd edition – Addison Wesley Longman, Menlo Park, California etc., 620 pp.
- Liháčev G.N. 1967 – Zaselienie iskusstvennyh gnezdovij orešnikovoj sonej (*Muscardinus avellanarius* L.) [Occupation of nestboxes by the common dormouse (*Muscardinus avellanarius* L.)] (In: *Èkologiâ mlekopitaûših i ptic* [Ecology of mammals and birds] Ed. K.V. Arnoldi) – Nauka Press, Moscow, pp. 67–79 (in Russian).
- Morris P.A., Bright P.W., Woods D. 1990 – Use of nestboxes by the dormouse *Muscardinus avellanarius* – *Biol. Conserv.* 51: 1–13.

- Panchetti F., Amori G., Carpaneto G.M., Sorace A. 2004 – Activity patterns of the common dormouse (*Muscardinus avellanarius*) in different Mediterranean ecosystems – J. Zool. Lond. 262: 289–294.
- Pielowski Z., Wasilewski A. 1960 – Haselmäuse in Vogelnistkästen – Z. Säugetierkd. 25: 74–80.
- Sara M., Casamento G., Spinato A. 2001 – Density and breeding of *Muscardinus avellanarius* L. 1758 in woodlands of Sicily – Trakya Univ. J. Sci. Res. ser. B, 2: 85–93.
- Schulze W. 1973 – Untersuchungen zur Biologie der Haselmaus (*Muscardinus avellanarius* L.) im Südharz – Arch. Naturschutz Landschaftforsch. 13: 107–121.
- Sorace A., Bellavita M., Amori G. 1999 – Seasonal differences in nest-boxes occupation by the dormouse *Muscardinus avellanarius* L. (Rodentia, Myoxidae) in two areas of Central Italy – Ecol. Mediterr. 25: 125–130.
- Woods D. 1996 – The use of nest boxes by the common dormouse in England (In: Schläfer und Bilche. Tagungsbericht 1. Intern. Bilchkolloquium, St. Oswald 1990, Ed. H. Müller-Stiess) – Verein der Freunde des Ersten Deutschen Nationalparks Bayerischer Wald e. V., Neuschönau, pp. 46–48.
- Woods D.E. 1997 – Nestboxes, captive breeding and re-introduction of the common dormouse (*Muscardinus avellanarius*) in England – Natura Croatica, 6: 199–204.

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