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Interactions between dormice (Gliridae) and hole-nesting birds in nestboxes

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A b s t r a c t . In Lithuania, common dormice *Muscardinus avellanarius* destroyed 6.6% of 3807 bird nests with eggs in nestboxes at two study sites. *M. avellanarius* occupied nests of pied flycatcher *Ficedula hypoleuca* without eggs or nests with incomplete clutches most often, ate unhatched eggs, but did not kill or bite nestlings and adult birds. *M. avellanarius* were very seldom found in nestboxes with nests of tits *Parus* spp. Edible dormice *Glis glis* destroyed 14.3% of 498 bird nests with eggs or nestlings at two study sites, mostly nests of *F. hypoleuca* and great tit *Parus major*. *G. glis* ate birds' eggs, killed and ate nestlings and adult birds. Forest dormice *Dryomys nitedula* made the biggest impact on birds nesting in nestboxes. They destroyed 20.5% of 171 nests with eggs or nestlings, ate eggs, killed and ate nestlings and adult birds. The most common impact of *D. nitedula* on birds in nestboxes was the killing of adults, either breeding or just looking for nest sites, and *F. hypoleuca* made a majority among birds killed. *F. hypoleuca* was most affected by all three dormice species in Lithuania, while *P. major* was impacted less and only by *G. glis* and *D. nitedula*.

Key words: *Muscardinus avellanarius*, *Glis glis*, *Dryomys nitedula*, *Eliomys quercinus*, tits, flycatchers

Introduction

Most dormice (Gliridae) species in Europe prefer closed nest sites such as tree holes (e.g. S t o r c h 1978, A i r a p e t y a n t s 1983, R o s s o l i m o et al. 2001), which are also used by hole-nesting birds. The number of trees with holes is decreasing due to felling of mature forests, but artificial nestboxes can substitute for natural tree holes for dormice (e.g. M o r r i s et al. 1990, B r i g h t & M o r r i s 1996, J u š k a i t i s 2005). However, nestboxes are also the object of competition between dormice and hole-nesting birds (e.g. J u š k a i t i s 1995, G a t t e r & S c h ü t t 1999, S o r a c e et al. 1999, V a u g h a n 2001, C z e s z c z e w i k 2004, S a r à et al. 2005).

Dormice are not only competitors of birds for nest sites but they are also predators. Many published reports (e.g. L o z a n 1970, A i r a p e t y a n t s 1983, R o s s o l i m o et al. 2001, H e n z e & G e p p 2004) indicate that common dormice *Muscardinus avellanarius* Linnaeus 1758, fat dormice *Glis glis* (Linnaeus, 1758), forest dormice *Dryomys nitedula* (Pallas, 1778) and garden dormice *Eliomys quercinus* (Linnaeus, 1758) occupy nestboxes in which they destroy nests of small hole-nesting birds, eat their eggs and nestlings and even kill adult birds. Opinions of different researchers on the impact of dormice on birds nesting in nestboxes are very different and contradictory.

Some authors consider dormice to be pests, which should even be exterminated (e.g. S e m e n o v 1956, U s p e n s k i j & L o z a n 1961, G v o z d a k & S i m o c h k o 1977) or at least dormice are recognised as a serious problem for birds (e.g. G a t t e r & S c h ü t t 1999, V a u g h a n 2001, H e n z e & G e p p 2004). Other authors speak in support of

dormice, arguing that damage inflicted by them is negligible (e.g. Airapetyants 1983, Schulze 1986a, Möckel 1988, Andresen 1989, Robel & Leitenbacher 1993).

Long-term studies of dormice carried out in Lithuania enabled the author of the present paper to collect a large amount of data on interactions between dormice and birds in nestboxes. Some previous data on relations between *M. avellanarius* and other occupants of nestboxes have published (Juškaitis 1995). However, a lot of new data on the ecology of *M. avellanarius* were collected in Lithuania later, including those on their impact on hole-nesting birds, and of the interactions of different species of dormice with tits and flycatchers.

The aims of the present study are: 1) to present data on long-term studies on interactions between dormice and birds nesting in nestboxes in Lithuania; 2) to discuss peculiarities of these interactions in different dormouse species in Lithuania and across all the distributional range of dormice.

Study Areas

Data on interactions between dormice and hole-nesting birds were collected at five dormouse study sites with nestboxes in different localities of Lithuania.

Site A (Šakiai district; 55º03'N, 23º04'E) was established for studies of *M. avellanarius*. Within the study site, mixed birch *Betula pendula* stands with Norway spruce *Picea abies* and black alder *Alnus glutinosa*, ash *Fraxinus excelsior* stands with aspen *Populus tremula*, and pure Norway spruce stands were prevalent. More detailed descriptions and schemes of the study site A are presented in earlier publications (Juškaitis 1997b, 2005). In most of the study years *M. avellanarius* was the only small mammal species occupying about 20% of all nestboxes at this site in spring. In some years, yellow-necked mice *Apodemus flavicollis* also occupied a few nestboxes in spring; other small mammal species were very rare in nestboxes (Juškaitis 1997a).

Site B (Molėtai district; 55º09'N, 25º21'E) was also established for studies of *M. avellanarius*. Mature oak *Quercus robur* stands with Norway spruce prevailed at this site. More detailed description and scheme of the study site B is presented in Juškaitis (1997b). *M. avellanarius* was the only dormouse species, which occupied 9.3% of all nestboxes at this site, and *A. flavicollis* occupied 2.0% of all nestboxes in spring during the study period (Juškaitis 1997a).

Site C (Kaišiadorys district; 54º53'N, 24º10'E) was designed for *G. glis* studies. *M. avellanarius* also inhabited this forest but occupied few nestboxes in spring. The site was dominated by mature (about 150 year-old) tree stands, mainly of oak, Scotch pine *Pinus sylvestris* and Norway spruce. More detailed description of the study site C is presented in Juškaitis (1998).

Site D (Vilnius district; 54º49'N, 24º56'E) was established for studies of *G. glis* in the valley of the rivulet Dūkšta. The valley was overgrown with deciduous trees, oaks dominating many places. *G. glis* was the only small mammal species occupying nestboxes at this site.

Site E (Šakiai district; 54º58'N, 23º30'E) was designed for studies of *D. nitedula*. The area was overgrown with a mixed forest stand containing Norway spruce with an admixture of Scots pine and birch. *D. nitedula* was the only small mammal species occupying nestboxes at this site.

Material and Methods

At all five study sites wooden nestboxes were used for dormouse studies. These were tit nestboxes with internal dimensions 12 × 12 × 23 cm and an entrance hole of 35 mm or starling nestboxes with internal dimensions 14 × 14 × 28 cm and an entrance hole of 45 mm. Their type, number and spacing were different at the various study sites and also varied during study period.

At site A, from 24 to 359 tit nestboxes were under observation in different years during 1978–1990 and 1997–2006. In 1984–1990, 262 nestboxes were spaced in a grid system with 50 m intervals between the boxes (50 × 50 m nestbox grid) in an area of 60 ha (density – 4 boxes/ha). They were inspected monthly from April until October, and twice a month in May and September. In 1999–2006, 274 nestboxes, spaced in the same grid system, were monitored twice a month from April until October. In 2001, 85 additional nestboxes were put up in the north-eastern corner of the study site, and a nestbox grid with 25 m intervals between boxes (25 × 25 m nestbox grid) was formed in an area of 6 ha (density – 16 boxes/ha). The total number of nestboxes monitored during the whole study period was 5981.

At site B, from 279 to 474 tit nestboxes were monitored monthly from April until October, with additional observations in May and September during 1984–1993. In 1985–1993, 341 tit nestboxes were placed in a grid system with 50 m intervals between the boxes in an area of 85 ha (density – 4 boxes/ha). At the same time, a number of additional nestboxes were set up within the study site, e.g. in 35 places, the same trees were furnished with three nestboxes set up at different heights. The total number of monitored nestboxes amounted to 4356.

At site C, from 27 to 97 starling nestboxes were checked twice each year: in spring (late May – early June) and autumn (early September) during 1991–2006. Nestboxes were placed in lines along rides and forest roads at 30–50 m intervals between boxes. The total number of nestboxes inspected during this period was 954.

At site D, 50 starling nestboxes were placed in lines at 30–50 m intervals between boxes. In 1999–2000, they were monitored monthly from May until September, in 2001–2002, only in early June and September. The total number of monitored nestboxes amounted to 200.

At site E, from 21 to 84 tit nestboxes were checked once or twice each month from April until September in 1999–2006. In 2001, 63 nestboxes were placed in a grid pattern at 50 m intervals between them in an area of 12 ha (in 2003–2006, 70 boxes in an area of 13.5 ha; density – 4 boxes/ha). The total number of nestboxes monitored was 485.

All nestbox occupants (mammals, birds and social insects) and signs of their activity were recorded during nestbox controls. Although nestboxes were monitored during the whole dormouse activity season in most study sites, only data from spring visits are used for the present paper.

A completed bird's nest with at least one egg was regarded as evidence of bird nesting in this study. Birds' nests with a number of eggs less than the local species average were considered to be nests with incomplete clutches. A bird's nest was considered to be destroyed by a dormouse if a dormouse itself or characteristic signs of its activity (e.g. droppings) were found. At sites A, B and C, where two small mammal species used to occupy nestboxes, characteristic signs of their activity were used for their identification (Ulevičius & Juškaitis 2005), when the mammals themselves were absent. Cases where the bird nest destroyer could not be identified were excluded from the analysis.

Results

In Lithuania, *M. avellanarius* occupied nests of pied flycatcher *Ficedula hypoleuca* most often (Table 1). It happened most often in mid-May, i.e. in the period when flycatchers built their nests and started to lay eggs. Nests occupied by *M. avellanarius* were with incomplete clutches most often, i.e. dormice occupied nests of *F. hypoleuca*, when females did not sit in their nests and eggs had not yet hatched. *M. avellanarius* also often occupied birds' nests under construction and finished nests before birds started to lay eggs (n = 68; these cases are not included in Table 1). *M. avellanarius* usually settled down under nests of *F. hypoleuca* without rebuilding or reshaping them into spherical nests. Destruction of nests with hatched eggs or with nestlings were never observed, neither was the killing or biting of nestlings or adult birds.

Table 1. Birds' nests with eggs destroyed by *M. avellanarius* in nestboxes in Lithuania (pooled data from study site A in 1978–1990, 1997–2006 and site B in 1984–1993).

Bird species	Number of nesting cases	Nests destroyed by *M. avellanarius*	
		total number	%
Ficedula hypoleuca	2053	243	11.8
Parus major	1443	4	0.3
Parus caeruleus	217	1	0.5
Parus ater	38	-	-
Parus cristatus	9	2	22.2
Parus palustris	4	-	-
Erithacus rubecula	30	2	6.7
Sitta europea	11	1	9.1
Troglodytes troglodytes	2	-	-
Total	3807	253	6.6

In most cases, *M. avellanarius* ate eggs of *F. hypoleuca* after occupying their nests with clutches, but in 65 out of 243 cases, some or even all eggs were found intact. However, dormice used to visit these nests later, and the number of intact eggs used to decrease in such nests. In several cases, *M. avellanarius* peacefully coexisted with nesting *F. hypoleuca* in adjacent nestboxes (two boxes put up in the same tree) or even in the same nestbox. In 22 cases, *F. hypoleuca* continued breeding after a single *M. avellanarius* visit to the nestbox with a bird nest. Both males and females of *M. avellanarius* (n = 137) were found in nests of *F. hypoleuca*: males were found in 49.6% of cases, females in 43.1%, males and females together in 7.3%. At site A, the percentage of *F. hypoleuca* nests destroyed by *M. avellanarius* in the 25 × 25 m nestbox grid was significantly larger ($\chi^2 = 38.98$; df = 1; $P < 0.0001$) compared with the 50 × 50 m nestbox grid (51.9% vs 19.0%).

M. avellanarius were very seldom found in nests of great tit *Parus major*, the second most abundant bird species nesting in nestboxes at sites A and B, as well as in nests of blue tit *Parus caeruleus* (Table 1). However, *M. avellanarius* destroyed two out of nine nests of crested tits *Parus cristatus* and ate their eggs. In some cases (n = 18), *M. avellanarius* occupied nestboxes with unfinished tit nests, which were deserted by birds.

In Lithuania, *G. glis* appeared in nestboxes only in the second half of May, when both bird clutches and nestlings were present in nestboxes. Not only did *G. glis* occupy bird nests and eat bird eggs, but they also killed nestlings and breeding adult birds (Table 2). *G. glis* ate killed

Table 2. Birds' nests with eggs or nestlings destroyed by *G. glis* in nestboxes in Lithuania (pooled data from study site C in 1991–2006 and site D in 1999–2002).

Bird species	Number of nesting cases	Nests destroyed by *G. glis*				
		with eggs	with nestlings	with eggs + adult birds killed	total number	%
Ficedula hypoleuca	304	32	9	12	53	17.4
Parus major	136	5	5	3	13	9.6
Parus caeruleus	1	-	1	-	1	100.0
Erithacus rubecula	31	3	1	-	4	12.9
Sturnus vulgaris	19	-	-	-	-	-
Sitta europea	4	-	-	-	-	-
Phoenicurus phoenicurus	1	-	-	-	-	-
Jynx torquilla	2	-	-	-	-	-
Total	498	40	16	15	71	14.3

Table 3. Birds' nests with eggs or nestlings destroyed by *D. nitedula* in nestboxes in Lithuania (study site E in 1999–2006).

Bird species	Number of nesting cases	Nests destroyed by *D. nitedula*				
		with eggs	with nestlings	with eggs or nestlings + adult birds killed	total number	%
Ficedula hypoleuca	57	6	3	12	21	36.8
Parus major	99	7	2	-	9	9.1
Parus ater	12	1	-	3	4	33.3
Parus cristatus	1	-	1	-	1	100.0
Parus caeruleus	1	-	-	-	-	-
Sitta europea	1	-	-	-	-	-
Total	171	14	6	15	35	20.5

birds, leaving in most cases only bones and feathers. Almost all birds killed by *G. glis* during the nesting season were *F. hypoleuca* (12 out of 15). In August, a European nuthatch *Sitta europea*, roosting in a nestbox, was also killed by *G. glis* at site D. Although *G. glis* destroyed nests mostly of *F. hypoleuca*, *P. major* also often suffered from these dormice (Table 2). *G. glis* also occupied 24 bird nests without eggs, 15 nests of which belonged to *F. hypoleuca*.

D. nitedula destroyed 20.5% of all bird nests with eggs or nestlings in nestboxes at study site E and ate eggs, killed nestlings and adult birds (Table 3). The impact of these dormice on birds was indeed much more significant. *D. nitedula* also killed adult birds in nestboxes, when birds were just looking for nest sites or building their nests (n = 22), as well as occupied bird nests before eggs were laid (n = 14; all these cases are not included in Table 3). The most common impact of *D. nitedula* on birds was killing of adults: dormice killed 37 adult birds during the study period, of which 32 were *F. hypoleuca* of both sexes. Three out of 12 nesting coal tits *Parus ater* were also killed. However, only two adult *P. major* were killed, although *P. major* was the most abundant bird species nesting in boxes at site E (Table 3), and the activity season of *D. nitedula* overlapped with the nesting season of *P. major* almost fully. All adult birds killed were eaten by *D. nitedula*, only feathers and bones being left.

F. hypoleuca and *P. major* were the two dominant bird species nesting in boxes at all study sites (Tables 1–3). However, *F. hypoleuca* was much more affected by all three dormice species compared to *P. major* (χ^2 = 4.57–172.44; df = 1; $P < 0.03$–0.0001). *P. major* was affected by *G. glis* and *D. nitedula* to a similar extent (Tables 2 and 3), while *M. avellanarius*, the smallest dormouse species, made little impact on this species (Table 1).

Discussion

In the major part of its distributional range, *M. avellanarius* most often occupied nests of *F. hypoleuca* (Yezerskas 1961, Likhachev 1971, Schulze 1973,1986a,b, Jušk aitis 1995, Vaughan 2001) and nests of the redstart *Phoenicurus phoenicurus* in Moldova (Lozan 1970). Other birds nesting in nestboxes, particularly *P. major* and *P. caeruleus*, suffered from *M. avellanarius* comparatively seldom. Sorace et al. (1998, 1999) did not mention any cases of bird nest destruction by *M. avellanarius* in Central Italy, where flycatchers were absent, and *P. major* and *P. caeruleus* occupied nestboxes frequently. However, percentages of spring nestbox occupation by *M. avellanarius* and tits were negatively related in Central Italy (Sorace et al. 1999) and Sicily (Sarà et al. 2005).

Three main reasons are proposed to explain why *M. avellanarius* affects *F. hypoleuca* much more often than tits:

a) *F. hypoleuca* start breeding later than tits, their breeding period fully overlapping with the activity season of *M. avellanarius* (Jušk aitis 1995, Vaughan 2001);

b) tits (*P. major* and *P. caeruleus*) are more aggressive than *F. hypoleuca* and are able to defend their nests from *M. avellanarius* (Lozan 1970, Jušk aitis 1995, Gatter & Schütt 1999);

c) both *F. hypoleuca* and *M. avellanarius* use almost identical material of vegetable origin for building nests, meanwhile tits line their nests with the layer of hair and wool. The latter may contain many parasites, such as fleas and mites, with the exception of early partly built nests (Vaughan 2001).

In Lithuania, *P. major* and *P. caeruleus* start laying eggs in the second half of April. At this time, males of *M. avellanarius* are already active, use nestboxes and can occupy nests of

tits unhindered, because tits do not sit on their nests until clutches are finished. However, *M. avellanarius* do not occupy nests of tits, but they destroy nests of *F. hypoleuca* in May. The main reason behind this might be that *M. avellanarius* do not like the nest building material used by tits, as it is of animal origin. In Lithuania, *M. avellanarius* most often occupy unfinished nests of *P. major*, because they contain only the moss layer and very little wool and hair or these nests are lined with vegetable fibre. Also Likhachev (1967) noted that dormice used nestboxes with old nests of *F. hypoleuca*, but very seldom nestboxes with old nests of *P. major*.

By the middle of May, *P. major* and *P. caeruleus* sitting in nests can scare away *M. avellanarius* attempting to enter the boxes. At this time, *F. hypoleuca* are still building their nests or are only starting to lay eggs. With earlier breeding and more aggressive behaviour *P. major* and *P. caeruleus* suffer less from the other two dormouse species, i.e. *G. glis* and *D. nitedula*, also (Tables 2 and 3).

Opinions of different researchers on interactions between *M. avellanarius* and hole-nesting birds are diverse, and in some cases, they differ from results obtained in Lithuania. Although Henze & Gepp (2004) affirm that dormouse males search for birds' nests with eggs, another opinion is that *M. avellanarius* enter nestboxes primarily in search of a nest site, not for food (Likhachev 1971, Juškaitis 1995, Gatter & Schütt 1999). In many cases, *M. avellanarius* occupied unfinished birds' nests without eggs, and birds' eggs were also often not eaten in nests occupied by *M. avellanarius*. Likhachev (1971) and Airapetyants (1983) expressed doubts as to whether *M. avellanarius* eats birds' eggs. However, the fact, that only egg shells without remnants of yolk and white were most often found in bird nests occupied by *M. avellanarius*, proves that eggs are really eaten (Schulze 1986b, Juškaitis 1995, Vaughan 2001, Henze & Gepp 2004).

However, several researchers also affirmed that *M. avellanarius* did not eat birds' eggs in captivity (Likhachev 1971, Lukshevich 1981, Airapetyants 1983, P. Vogel, pers. comm.). Probably, *M. avellanarius* needs first to learn that eggs contain food (Gatter & Schütt 1999). A young overwintered female started eating tits' eggs in captivity only on the third night after one egg had been broken. Later it ate unbroken eggs of tits very readily as well as hazelnut kernels and oak flowers presented together with eggs (R. Juškaitis, unpubl.).

The proposition that *M. avellanarius* can destroy birds' nests with nestlings or even eat young and adult birds (Yezerskas 1961, Lozan 1970, Gvozdak & Simochko 1971, Lozan et al. 1990, Gatter & Schütt 1999, Rossolimo et al. 2001, Henze & Gepp 2004, Sarà et al. 2005) are controversial. These actions attributed to *M. avellanarius* could have been performed by other animals occupying nestboxes (other dormouse species, *Apodemus*, birds). For example, in Moldova, three dormouse species (*M. avellanarius, D. nitedula* and *G. glis*) occupied nestboxes in the same forest (Lozan 1970), and for this reason, it is difficult to ascertain which dormouse species could have killed birds. *A. flavicollis*, inhabiting the same forests as *M. avellanarius*, can also destroy bird clutches and kill nestlings in nestboxes (Löhrl 1960, Yezerskas 1961, Henze & Gepp 2004). *M. avellanarius* were found living peacefully under nests with adult birds and clutches or nestlings in the Moscow region and Lithuania several times (Likhachev 1971, Juškaitis 1995). However, Likhachev (1971) supposed, that in exceptional cases *M. avellanarius* could destroy nestlings of *F. hypoleuca* that had just hatched.

Very doubtful and unbelievable are statements that *M. avellanarius* threw out bird nests from nestboxes, in such a way destroying bird clutches and killing nestlings

(Sidorowicz 1959, Pielowski & Wasilewski 1960). Other researchers (Likhachev 1967, Lozan 1970, Schulze 1973, Juškaitis 1995) emphasise that they have not observed such cases during long-term studies with thousands of nestboxes inspected. Airapetyants (1983) also has doubts about this statement. Polish researchers could have been misled by signs of pine marten *Martes martes* activity. These predators can shove their pads through the nestbox entrance hole and drag out bird nests (Juškaitis 1999, Ulevičius & Juškaitis 2005).

M. avellanarius influence birds indirectly also by making their nests in nestboxes in autumn. Some authors (Pielowski & Wasilewski 1960, Yezerskas 1961) indicated that birds bred only in empty nestboxes without dormouse nests. Meanwhile, Schulze (1973) wrote that birds occupied both empty nestboxes and those containing dormouse nests in the southern Harz. In Lithuania, birds roosting in nestboxes during the winter period preferred to use nestboxes without dormouse nests (Juškaitis 1995). In spring, tits avoided breeding in nestboxes containing old dormouse nests. *F. hypoleuca* preferred shallow nest sites and often built their nests over old dormouse nests. However, such nests of *F. hypoleuca* were more often destroyed by *M. avellanarius* (Juškaitis 1995).

In some cases, *M. avellanarius* themselves suffered from hole-nesting birds (Juškaitis 1995). Several times nestboxes were reported to contain dead dormice with deep wounds on their heads and other parts of the body. Such *M. avellanarius* was found in a nestbox with an unfinished nest of *F. hypoleuca* in June. Five more dead dormice with wounds to heads, paws and tails were found in nestboxes in autumn (October) and spring (April). Most probably, these animals were in torpor, and they were pecked to death by *P. major*, that at that time of the year spend nights in nestboxes (Juškaitis 1998).

In contrast to *M. avellanarius*, opinions of different researchers on interactions between other dormouse species and hole-nesting birds are similar to the results obtained in Lithuania. Many researchers (Mansfeld 1942, Vietinghoff-Riesch 1960, Lozan 1959, 1970, Schulze 1986a, Andresen 1989, Robel & Leitenbacher 1993, Gatter & Schütt 1999, Koppmann-Rumpf et al. 2003) indicated that *G. glis* occupied nestboxes, destroyed birds' nests with clutches, killed nestlings and adult birds. Airapetyants (1983) also wrote that *G. glis* willingly occupied nestboxes with bird nests, and made their own nests above them. However, she doubted whether *G. glis* occupying bird nests ate eggs and birds.

According to Vietinghoff-Riesch (1960), birds seemed to be important food source for *G. glis* in late May – early June. Lozan (1959, 1970) also noted that in Moldova, *G. glis* ate eggs, nestlings and adult birds. *G. glis* ate flesh of nestlings and adult birds leaving only gnawed bones and feathers (Vietinghoff-Riesch 1960, Andresen 1989, Henze & Gepp 2004, present paper). Sometimes dormice just bit nestlings badly and did not eat them (Schulze 1986a, Andresen 1989).

F. hypoleuca, the nesting season of which coincided with the beginning of *G. glis* activity, was the bird species that suffered most from these rodents. However, tits and other birds, which nested later, also became victims to these dormice (Vietinghoff-Riesch 1960, Petrov & Kudrova 1961 cited in Rossolimo et al. 2001, Koppmann-Rumpf et al. 2003, present paper). According to Gatter & Schütt (1999), all other small hole-nesting birds, except *S. europea*, which seldom fall a victim to *G. glis*, could have been harmed by dormice, and especially the collared flycatcher *Ficedula albicollis*.

Some authors stressed that the harm inflicted by *G. glis* to hole-nesting birds was insignificant because the activity season of *G. glis* began comparatively late, when the nesting season of most birds was already finished (Uspenskij & Lozan 1961, Schulze 1986a, Andresen 1989, Robel & Leitenbacher 1993). A long-term study carried out in Germany showed evidently how, due to the earlier appearance of *G. glis* in nestboxes, the overlap of nestbox use by hole-nesting birds and *G. glis* increased significantly (Koppmann-Rumpf et al. 2003). This caused intensified competition between *G. glis* and birds that led to the destruction of clutches, nestlings and sometimes of adult birds. A significant relationship was also established between the density of *G. glis* population in spring and the number of destroyed clutches (Koppmann-Rumpf et al. 2003). In Lithuania, such a relationship was found in *M. avellanarius*: the percentage of *F. hypoleuca* clutches destroyed by *M. avellanarius* was significantly higher in the 25 × 25 m nestbox grid, where dormouse density was two to three fold higher than in the 50 × 50 m nestbox grid (Juškaitis 2005).

Opinions of various authors about the interactions between *D. nitedula* and hole-nesting birds generally coincide (e.g. Semenov 1956, Golodushko & Padutov 1961, Angermann 1963, Lozan 1970, Lozan et al. 1990) and are similar to results obtained in Lithuania. All researchers using nestboxes noted that *D. nitedula* ate bird eggs, nestlings and adult birds. In places where *D. nitedula* lived and nestboxes for birds were present, *D. nitedula* was not only a competitor for nest sites but also a bird predator. Even Airapetyants (1983), who spoke in support of *M. avellanarius* and *G. glis*, wrote that *D. nitedula* purposely looked for food in nestboxes.

The greatest impact of *D. nitedula* on hole-nesting birds was recorded in the Voronezh reserve (Semenov 1956), Belovezha forest in Belarus (Golodushko & Padutov 1961), Moldova (Lozan 1970) and Ukraine (Lozan et al. 1990). These dormice destroyed nests of *F. hypoleuca* most often, then nests of *P. major*. *F. hypoleuca* outnumbered *P. major* in the number of adult birds killed by *D. nitedula* significantly in all cases (Semenov 1956, Golodushko & Padutov 1961, Angermann 1963, present paper).

In Lithuania, *E. quercinus* was recorded only in a single locality (Varėna district) in 1957–1959 (Yezerskas 1961). According to Yezerskas (1961), these dormice ate eggs and nestlings of hole-nesting birds in several cases and killed breeding adult starlings *Sturnus vulgaris* in three cases.

Across its distributional range, *E. quercinus* was comparatively seldom found in nestboxes (Löhrl 1960, Yezerskas 1961, Airapetyants 1983, Möckel 1986, Müller-Stiess 1996), except in some places in Germany (Mansfeld 1942, Gatter & Schütt 1999, Henze & Gepp 2004). The activity season of *E. quercinus* fully overlaps with the breeding season of birds (Gatter & Schütt 1999). Published records indicate that *E. quercinus*, occupied bird nests in nestboxes, ate eggs, nestlings and adult birds (Mansfeld 1942, Airapetyants 1983, Müller-Stiess 1996, Gatter & Schütt 1999, Henze & Gepp 2004). *E. quercinus* killed not only flycatchers and tits (Mansfeld 1942, Louarn & Spitz 1974 cited in Storch 1978, Gatter & Schütt 1999), but also starlings (Yezerskas 1961, Airapetyants 1983). According to Gatter & Schütt (1999), *E. quercinus* robbed birds' nests not only in occupied nestboxes, but also in neighbouring boxes looking for food systematically. In places where *E. quercinus* were abundant, they destroyed almost all bird clutches in nestboxes (Mansfeld 1942, Gatter & Schütt 1999).

A review of publications on interactions between dormice and hole-nesting birds in nestboxes shows that these interactions are similar across all the distributional range of dormice. Some differences may be related to different dormouse abundance, the presence of several dormouse species in the same forest, different timing of *G. glis* activity season, different bird species composition (e.g. absence of flycatchers).

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L I T E R A T U R E

Airapetyants A.E. 1983: Soni [The dormice]. *Izdatel'stvo Leningradskogo Universiteta, Leningrad (in Russian)*.

Andresen D. 1989: Über allgemeine Beziehungen zwischen Siebenschläfern und Höhlenbrütern in Nistkästen. *Der Falke 4: 118–121, 5: 156–161*.

Angermann R. 1963: Zur Ökologie und Biologie des Baumschläfers, *Dryomys nitedula* (Pallas, 1779) in der Waldsteppenzone. *Acta Theriol. 7 (18): 333–367*.

Bright P.W. & Morris P.A. 1996: Why are Dormice rare? A case study in conservation biology. *Mammal Rev. 26: 157–187*.

Czeszczewik D. 2004: Breeding success and timing of the Pied Flycatcher *Ficedula hypoleuca* nesting in natural holes and nest-boxes in the Białovieża Forest, Poland. *Acta Ornithol. 39: 47–52*.

Gatter W. & Schütt R. 1999: Langzeitentwicklung der Höhlenkonkurenz zwischen Vögel (Aves) und Säugetieren (Bilche Gliridae; Mäuse Muridae) in den Wäldern Baden-Württembergs. *Orn. Anz. 38: 107–130*.

Golodushko B.Z. & Padutov E.E. 1961: Materialy po ekologii lesnoi soni Belovezhskoi pushchi [Materials on ecology of the forest dormouse in the Belovezha forest]. In: Ges' N. D. (ed.), Fauna i ekologiya nazemnykh pozvonochnykh Belorussii. *Izdatel'stvo Ministerstva vysshego, srednego i professional'nogo obrazovaniya BSSR, Minsk: 49–70 (in Russian)*.

Gvozdak A.A. & Simochko M.D. 1977: Sonya oreshnikovaya (*Muscardinus avellanarius* L.) – konkurent melkikh duplognezdnykh ptits [The common dormouse (*Muscardinus avellanarius* L.) – a competitor of small hole-nesting birds]. *Vestnik zoologii 3: 88–89 (in Russian)*.

Henze O. & Gepp J. 2004: Vogelnistkästen in Garten & Wald. *Leopold Stocker Verlag, Graz-Stuttgart*.

Juškaitis R. 1995: Relations between common dormice (*Muscardinus avellanarius*) and other occupants of bird nest-boxes in Lithuania. *Folia Zool. 44: 289–296*.

Juškaitis R. 1997a: Diversity of nest-boxes occupants in mixed forest of Lithuania. *Ekologija 3: 24–27*.

Juškaitis R. 1997b: Ranging and movement of the common dormouse *Muscardinus avellanarius* in Lithuania. *Acta Theriol. 42: 113–122*.

Juškaitis R. 1998: Hollow birds nesting and roosting in nestboxes in mixed forests of Lithuania. *Acta Zool. Lituanica, Ornitologia 8 (2): 134–140*.

Juškaitis R. 1999: Mammals occupying nestboxes for birds in Lithuania. *Acta Zool. Lituanica, Biodiversity 9 (3): 19–23*.

Juškaitis R. 2005: The influence of high nestbox density on the common dormouse *Muscardinus avellanarius* population. *Acta Theriol. 50: 43–50*.

Koppmann-Rumpf B., Heberer C. & Schmidt K.-H. 2003: Long term study of the reaction of the edible dormouse *Glis glis* (Rodentia: Gliridae) to climatic changes and its interactions with hole-nesting passerines. *Acta Zool. Hung. 49 (Suppl. 1): 69–76*.

Likhachev G.N. 1967: Zaselenie iskusstvennykh gnezdovii oreshnikovoi sonei (*Muscardinus avellanarius* L.) [Occupation of nestboxes by the common dormouse (*Muscardinus avellanarius* L.)]. In: Arnoldi K. V. (ed.), Ekologiya mlekopitayushchikh i ptits. *Nauka, Moscow: 67–79 (in Russian).*

Likhachev G.N. 1971: K biologii oreshnikovoi soni [On biology of the common dormouse]. *Trudy Prioksko-Terrasnogo gosudarstvennogo zapovednika 5: 160–175 (in Russian).*

Löhrl H. 1960: Säugetiere als Nisthöhlenbewohner in Südwestdeutschland mit Bemerkungen über ihre Biologie. *Z. Säugetierkd. 25: 66–73.*

Lozan M.N. 1959: Materials on ecology of dormice in the Moldavian SSR. *Izviestija Moldavskogo filiala Akademii nauk SSSR 8 (62): 69–75 (in Russian with English summary).*

Lozan M.N. 1970: Gryzuny Moldavii [Rodents of Moldavia]. Vol. 1. *Redakcionno-izdatel'skii otdel Akademii nauk Moldavskoi SSR, Kishinev (in Russian).*

Lozan M., Belik L. & Samarskii S. 1990: Soni (Gliridae) yugo-zapada SSSR [Dormice (Gliridae) of the south-west USSR]. *"Shtiintsa", Kishinev (in Russian).*

Lukshevich E.V. 1981: Eksperimental'noe izuchenie izbiratel'nosti pitaniya oreshnikovoi soni (*Muscardinus avellanarius* L.) [Experimental study of food choice in the common dormouse (*Muscardinus avellanarius* L.)]. In: Krumin'sh V. K. (ed.), Priroda i muzei. *Izdatel'stvo "Avots", Riga: 53–59 (in Russian).*

Mansfeld K. 1942: Über das Auftreten von Bilchen in Vogelnistkästen und ihre Schäden an Vogelbruten. *Deutsche Vogelwelt 67: 13–20.*

Möckel R. 1986: Zum Vorkommen des Gartenschläfers (*Eliomys quercinus*) im Westerzgebirge. *Säugetierkd. Inf. 2 (10): 311–317.*

Möckel R. 1988: Zur Verbreitung, Häufigkeit und Ökologie der Haselmaus (*Muscardinus avellanarius*) im Westerzgebirge. *Säugetierkd. Inf. 2 (12): 569–588.*

Morris P.A., Bright P.W. & Woods D. 1990: Use of nestboxes by the dormouse *Muscardinus avellanarius*. *Biol. Conserv. 51: 1–13.*

Müller-Stiess H. 1996: Zur Habitatnutzung und Habitattrennung der Bilcharten (Myoxidae) Haselmaus (*Muscardinus avellanarius* L.), Gartenschläfer (*Eliomys quercinus* L.) and Siebenschläfer (*Myoxus glis* L.) im Nationalpark Bayerscher Wald. In: Müller-Stiess H. (ed.), Schläfer und Bilche. Tagungsbericht 1. Intern. Bilchkolloquium, St. Oswald 1990. *Verein der Freunde des Ersten Deutschen Nationalparks Bayerischer Wald e. V., Neuschönau: 1–20.*

Pielowski Z. & Wasilewski A. 1960: Haselmäuse in Vogelnistkästen. *Z. Säugetierkd. 25: 74–80.*

Robel K. & Leitenbacher G. 1993: Der Einfluss des Siebenschläfers *Glis glis* auf die Höhlenbrüterpopulation in künstlichen Nisthöhlen am Surspeicher. *Orn. Anz. 32: 59–63.*

Rossolimo O.L., Potapova E.G., Pavlinov I.Ya., Kruskop S.V. & Voltzit O.V. 2001: [Dormice (Myoxidae) of the World]. *Moscow University Press, Moscow (in Russian).*

Sarà M., Milazzo A., Falletta W. & Bellia A. 2005: Exploitation competition between hole-nesters (*Muscardinus avellanarius*, Mammalia and *Parus caeruleus*, Aves) in Mediterranean woodlands. *J. Zool. 265: 347–357.*

Schulze W. 1973: Untersuchungen zur Biologie der Haselmaus (*Muscardinus avellanarius* L.) im Südharz. *Arch. Naturschutz u. Landschaftforsch. 13: 107–121.*

Schulze W. 1986a: Sind unsere einheimischen Schläfer wirklich Konkurrenten der höhlenbrütenden Singvögel und auch Nesträuber? *Naturschutzarbeit in den Bezirken Halle und Magdeburg 23: 4–6.*

Schulze W. 1986b: Zum Vorkommen und zur Biologie von Haselmaus (*Muscardinus avellanarius* L.) und Siebenschläfer (*Glis glis* L.) in Vogelkästen im Südharz der DDR. *Säugetierkd. Inf. 2 (10): 341–348.*

Semenov S.M. 1956: Lesnaya sonya kak istrebitel' ptits v iskusstvennykh gnezdovyakh [The forest dormouse as a destroyer of birds in nestboxes]. In: Poznanin L.P. (ed.), Puti i metody ispol'zovaniya ptits v bor'be s vrednymi nasekomymi. Trudy soveshchanii. *Izdatel'stvo ministerstva sel'skogo khozyaistva SSSR, Moscow: 101–102 (in Russian).*

Sidorowicz J. 1959: Über Morphologie und Biologie der Haselmaus (*Muscardinus avellanarius* L.) in Polen. *Acta Theriol. 3 (5): 75–91.*

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.*

Sorace A., Petrassi F., Tanda F., Landucci G. & Ruda P. 1998: Nest-box occupation by the dormouse *Muscardinus avellanarius* L. (Rodentia, Myoxidae). *Hystrix 10 (2): 37–40.*

Storch G. 1978: Familie Gliridae Thomas, 1897 – Schläfer. In: Niethammer J. & Krapp F. (eds), Handbuch der Säugetiere Europas 1, Rodentia I. *Akademische Verlagsgesellschaft, Wiesbaden: 201–280.*

Ulevičius A. & Juškaitis R. 2005: [Tracks and other signs of Lithuanian mammals]. *Lututė, Kaunas (in Lithuanian).*

Uspenskij G.A. & Lozan M.N. 1961: Nekotorye rezul'taty izucheniya ekologii son' (Myoxidae) v Moldavii [Some results of investigations on ecology of dormice (Myoxidae) in Moldavia]. In: Voprosy ekologii i khozyaistvennogo znacheniya nazemnoi fauny. *Izdatel'stvo "Shtiintsa" Akademii nauk Moldavskoi SSR, Kishinev: 75–84 (in Russian)*.

Vaughan G. 2001: "Dormousitis" – the sequel or should tit boxes be erected for birds or mammals? *Devon Birds 54: 4–17*.

Vietinghoff-Riesch A. 1960: Der Siebenschläfer (*Glis glis* L.). Monographien der Wildsäugetiere. Band XIV. *Gustav Fischer Verlag, Jena*.

Yezerskas L.I. 1961: Postoronnie obitateli duplyanok v lesach Litovskoi SSR i ikh vlijanie na ptits-duplognezdnikov [Extraneous inhabitants of nest-boxes in the forests of the Lithuanian SSR and their influence on hole-nesting birds]. In: Lūsis J. J., Spuris Z. D., Taurinš E. J. & Vilka E. K. (eds), Ekologiya i migratsii ptits Pribaltiki. Trudy IV Pribaltiiskoi ornitologicheskoi konferentsii. *Izdatel'stvo Akademii nauk Latviiskoi SSR, Riga: 123–128 (in Russian)*.