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Short research contribution

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FACTORS DETERMINING THE DISTRIBUTION OF COEXISTING DORMOUSE SPECIES (GLIRIDAE, RODENTIA)

ABSTRACT: This study investigated coexistence of three dormouse species living in the same habitat, Naszály-hill, in the north-eastern part of the Danube-bend (47°49'N, 19°08'E). The vegetation of the area is very diverse, comprising a mosaic of orchards with natural forests and forest plantations. Data were collected from 1999 to 2005 with wooden nest boxes and from 2002 to 2005 also plastic nest tubes were used. Study area was approximately 6 ha.

All three species (hazel dormouse *Muscardinus avellanarius* L., forest dormouse *Dryomys nitedula* Pall. and fat dormouse *Glis glis* L.) have different ecological requirements. However, they occurred simultaneously in some microhabitats and in some places one species clearly predominated. We also observed how the ongoing succession process in the former orchards affected the distribution of dormice.

There were seasonal differences in timing of emergence from hibernation, greatly affecting spatial distribution of the different species. Hazel dormice were first to appear in nest boxes and/or tubes, in March, then forest dormice in April and fat dormice in June. As numbers of fat dormice increased the smaller species withdrew from using the nest boxes. Fat dormice reached peak numbers in summer and they entered hibernation by October.

KEY WORDS: dormouse, coexistence, habitat, environmental factors, nest box/tube

The coexistence of several dormouse species in one locality with different habitat types offers a unique possibility to study habitat preference of the species.

Our research site, the Naszály-hill, has been known as a habitat of all three dormouse species that occur in Hungary (Bakó and Gál 1999, Gál 1999). Our first studies began in 1995 using live-traps. Based on the early results we started an improved research project in 1999. The aim of our study was to find out, which environmental factors enable the coexistence of different dormouse species in one area and to observe how the adjacent vegetation types and the ongoing succession process affect the spatial distribution of the coexisting dormouse species. Research topics also included the seasonal and yearly differences in the appearance and occupancy of nest boxes/tubes by the dormice.

The study area (in total *ca*. 6 ha), Naszály-hill (652 m a.s.l.), lies near the city of Vác in the north-eastern part of the Danube Bend (47°49'N, 19°08'E). Mainly dachstein limestone, with dolomite in some places, dominates in the bedrock and contains nine caves of different size. The vegetation is extraordinarily diverse as it lies on the ranges of the distribution area of

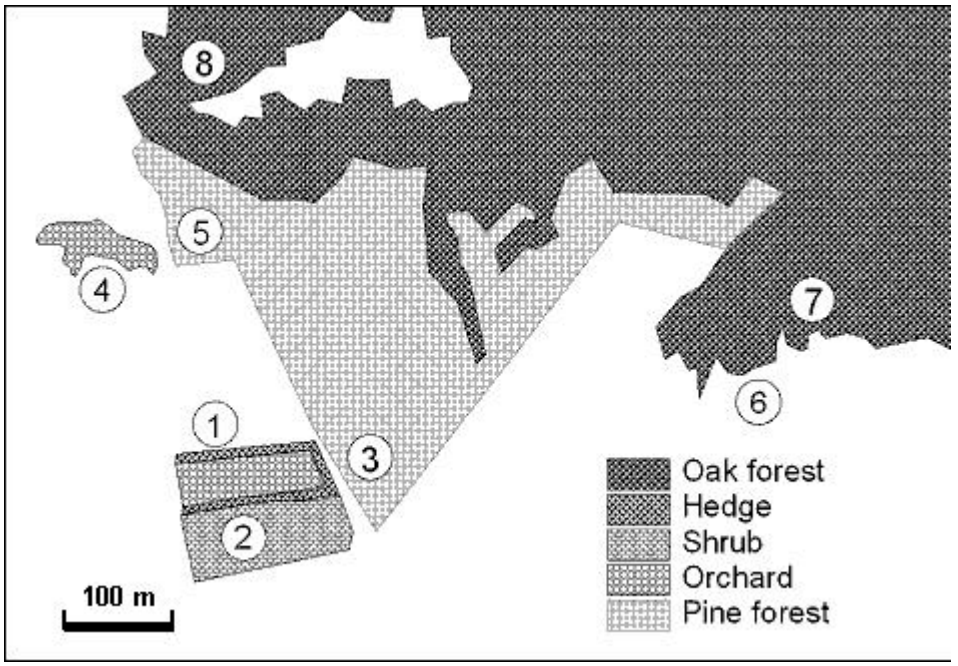

Fig. 1. Site map of the location showing the woody vegetation patches.
Legend to the numbers of patches see in Table 1.

Table 1. Main and other abundant tree and shrub species in the different vegetation types and the size of the plots where dormice were surveyed.

No.	Vegetation type	Main species	Other abundant species	Size of plot	No. of boxes 1999/2002/ 2005
1.	Hedge around abandoned orchard	dogwood (*Cornus sanguinea* L.), plum (*Prunus domestica* L.)	dogrose (*Rosa canina* L.), cherry (*Cerasus avium* /L./ Moench), privet (*Ligustrum vulgare* L.)	0.6 ha	70/50/50
2.	Shrub	dogwood	dogrose, cherry, privet	0.5 ha	–/50/50
3.	Young pine stand	Austrian pine (*Pinus nigra* Link)	privet	0.3 ha	–/50/50
4.	Abandoned orchard	plum	dogwood, common lilac (*Syringa vulgaris* L.)	0.6 ha	35/35/38
5.	Mixed pine forest	Scots pine (*Pinus sylvestris* L.)	ash (*Fraxinus excelsior* L.)	0.6 ha	–/12/35
6.	Edge of oak-hornbeam forest	sessile oak (*Quercus petraea* /Matt./ Liebl.)	hedge maple (*Acer campestre* L.), ash	0.7 ha	35/21/35
7.	Oak-hornbeam forest	sessile oak	hornbeam (*Carpinus betulus* L.), hedge maple	0.6 ha	–/50/50
8.	Turkey oak forest	turkey oak (*Quercus cerris* L.)	white oak (*Quercus pubescens* Willd.), ash	0.7 ha	–/–/70

different flora units (Füri and Sinkóné Póka 1996). Natural and planted vegetation plots also change in space and time. Beside the different types of grassland there are planted hedges and orchards, with different fruit trees (mostly apple, plum and pear). Most of the orchards have been out of cultivation for decades, but some are still in use. The mixed oak forests (*Quercus petraea* (Matt.) Liebl., *Quercus cerris* L., *Quercus pubescens* Willd.) both with dense and sparse underbrush, and planted pine forest (*Pinus sylvestris* L. and *Pinus nigra* Link) of different age occur in the area. The older pine forests are already mixed with ash (*Fraxinus excelsior* L.), some areas are monocultures of young pines. On the top of the hill a beech (*Fagus sylvatica* L.) forest (Gál 1999) occurs.

Populations of the three dormouse species: hazel dormouse *Muscardinus avellanarius*, fat dormouse *Glis glis* and forest dormouse *Dryomys nitedula* occur in the study area (Bakó and Gál 1999, Gál 1999).

From 1999 to 2005 nest boxes were used to collect data. They were placed along a transect across different vegetation types like an abandoned orchard, a hedgerow and the edge of a deciduous forest dominated by sessile oak (*Quercus petraea*) (Bakó *et al.* 2002).

The first 150 wooden bird nest boxes (height 30 cm, width 15 cm and depth 15 cm) were set up for dormice in autumn 1999, they were followed by 150 plastic nest tubes (height 10 cm, width 10 cm and depth 30 cm) in summer 2002 (Bakó *et al.* 2002). In spring 2005 additionally 70 new wooden dormouse nest boxes (20 × 20 × 20 cm) and 35 new plastic nest tubes were introduced. The boxes were fixed at 1.5–2.5 m above the ground, 5 m apart, the wooden ones faced the tree trunk, the plastic tubes were on horizontal branches. This height was found to be suitable for dormice and easy to check (Morris 2004). With this nest box density the availability of nesting places is not a limiting factor (Bright et al. 1994, Juškaitis 2003, 2006).

First observations suggested that a nest tube made mainly of smooth plastic was not fully suitable, although several nestings were recorded. So we roughened the inner surfaces with sand. Some nest boxes were lost for various reasons, but with the new ones we managed to complete the data series.

Eight vegetation types were surveyed with nest box system (Table 1), and their location can be seen in Fig. 1.

We checked the nest boxes and nest tubes monthly and cleaned them only in winter. We collected data on animals found: after sexing the animals were weighed, body and tail length and the length of the left ear and left hind foot were measured. Empty nests were also recorded, but only the new nests were included in the data processing.

The total occupation in the wooden boxes and plastic nest tubes (Figs 2 and 3) is a sum of the records on dormice, observed new nests, food remains, faeces and other signs of activity. There were differences in the use of the two different nest box types, so in spring 2005 we started a comprehensive investigation to find out how this difference influenced the results (Fig. 4). *Muscardinus* was the only dormouse species successfully breeding in plastic tubes, *Glis* and *Dryomys* were found only few times. There were 16 nest boxes and tubes (5.7%), which were never used (no nest or any sign of occupation) mainly in the area of the planted young pine stand (5 plastic tubes) and the oak forest (8 plastic tubes) with sparse underbrush.

In the years 2000–2005 we had a total of 341 records on dormice. The percentage of species can be seen in Fig. 5.

Although not all vegetation plots are adjacent to each other, there are no geographical barriers or habitat corridor gaps between them. So, theoretically all surveyed plots can be reached by the animals. Moreover, there are neighbouring vegetation types, which have different plant species composition.

Muscardinus was the only dormouse species found in every plot, and the only species in the young pine stand and the shrub (Fig. 6). We got less records from the hedge in the last three years, but at the same time the number of hazel dormice in the neighbouring pine stand and shrub increased. In the plots where *Glis* was very abundant (orchard, edge of oak-hornbeam forest, turkey oak forest), only few records of *Muscardinus* were obtained.

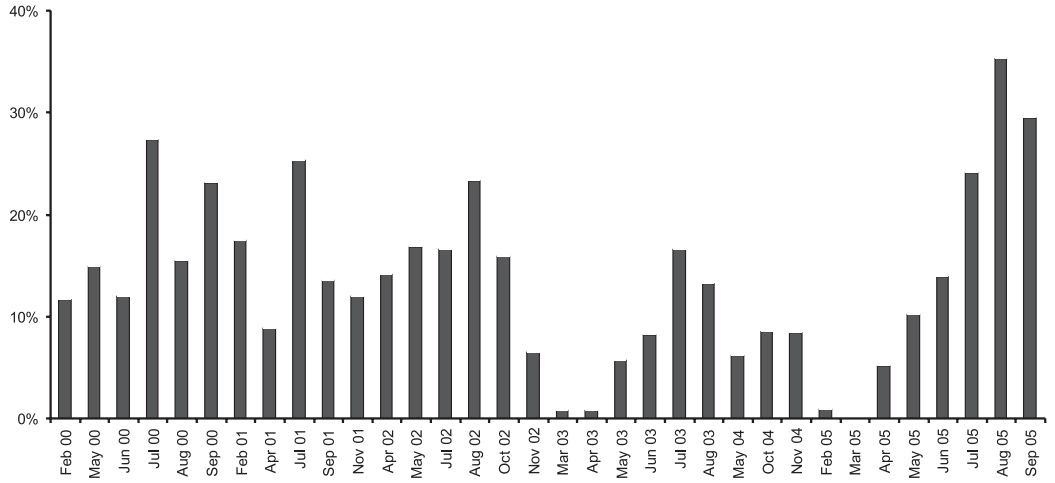

Fig. 2. Changing in the occupancy by dormice (%) of the wooden nest boxes by dormice during the whole study period (2000–2005).

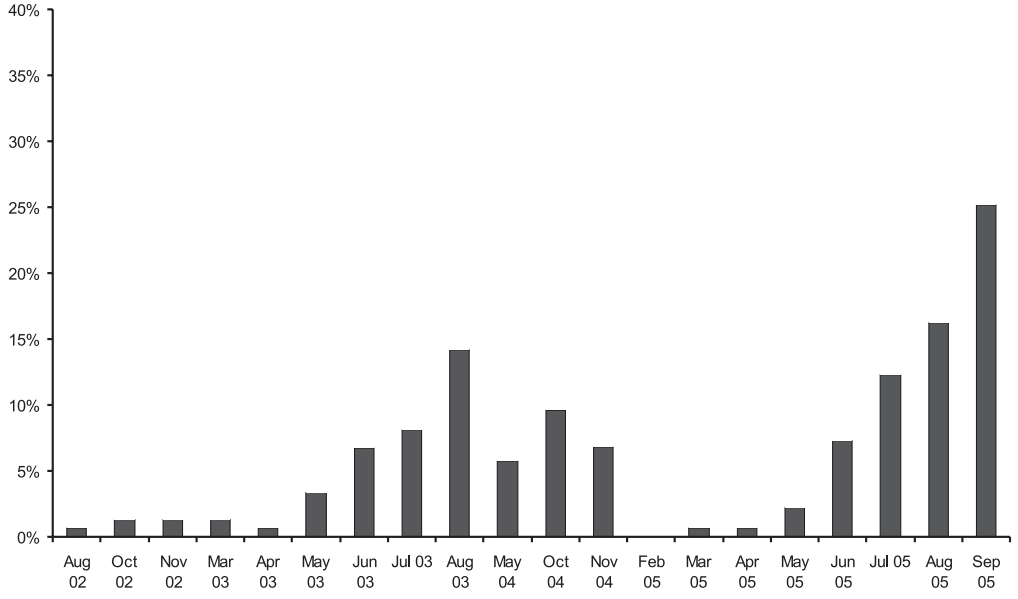

Fig. 3. Changing in the occupancy by dormice (%) of the plastic nest tubes during the study period (2002–2005).

Glis was absent from the shrub habitat and the young pine stand, as was *Dryomys* (Fig. 6). *Dryomys* was also absent from the edge of oak-hornbeam forest. *Glis* occurred in higher numbers in the hedge, orchard, edge of oak-hornbeam forest and in the turkey oak forest, while most data on *Dryomys* were collected in the abandoned orchard (Fig. 6).

All three species occurred in five out of eight plots: hedge, orchard, mixed pine forest, oak-hornbeam forest and turkey oak forest, although in the oak-hornbeam forest, we found only a single *Glis* and *Dryomys*.

The results on seasonal distribution showed (Fig. 7) that dormice used the nest boxes to a different extent. *Muscardinus* used nest boxes/tubes during the whole active season, *Dryomys* numbers peaked in May and some specimens could be found in August. *Glis* was found mostly in late summer and autumn, when they appeared to play a very dominant role.

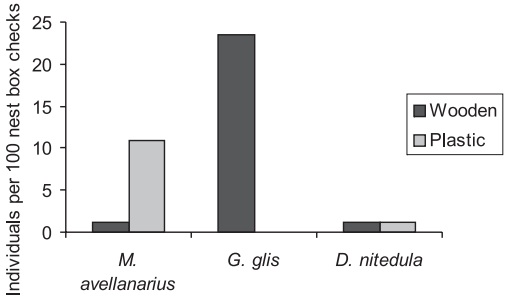

Fig. 4. Proportion of monitored animals, nests and other signs of activity in the turkey oak forest in the two different nest box types (per 100 nest box checks).

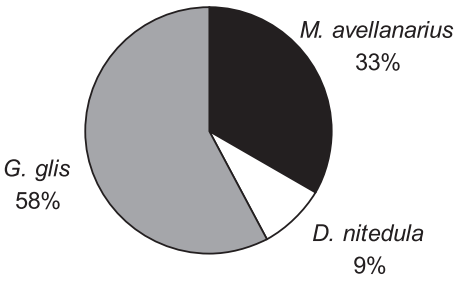

Fig. 5. Percentage of the dormouse species in the total number of caught dormice.

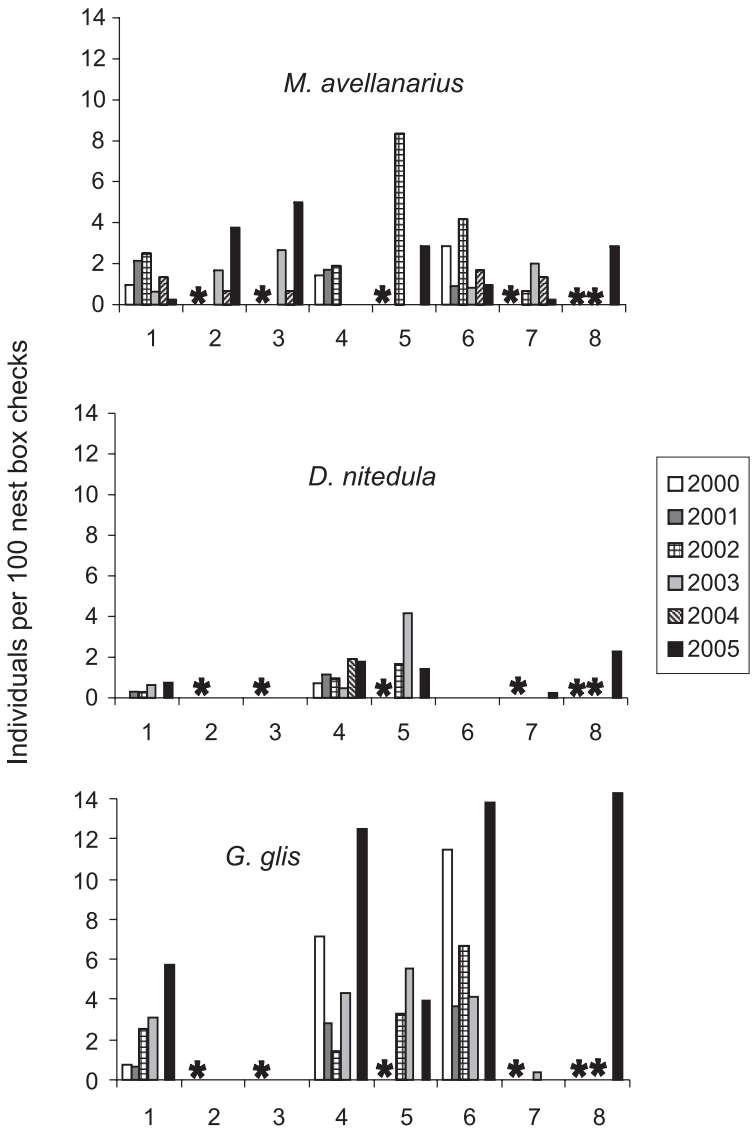

Fig. 6. Proportion of three dormouse species caught in the different vegetation types (per 100 nest box checks)

Legend:
1. hedge,
2. shrub,
3. young pine stand,
4. abandoned orchard,
5. mixed pine forest,
6. edge of oak-hornbeam forest,
7. oak-hornbeam forest,
8. turkey oak forest

* boxes placed in 2002,
** boxes placed in 2005

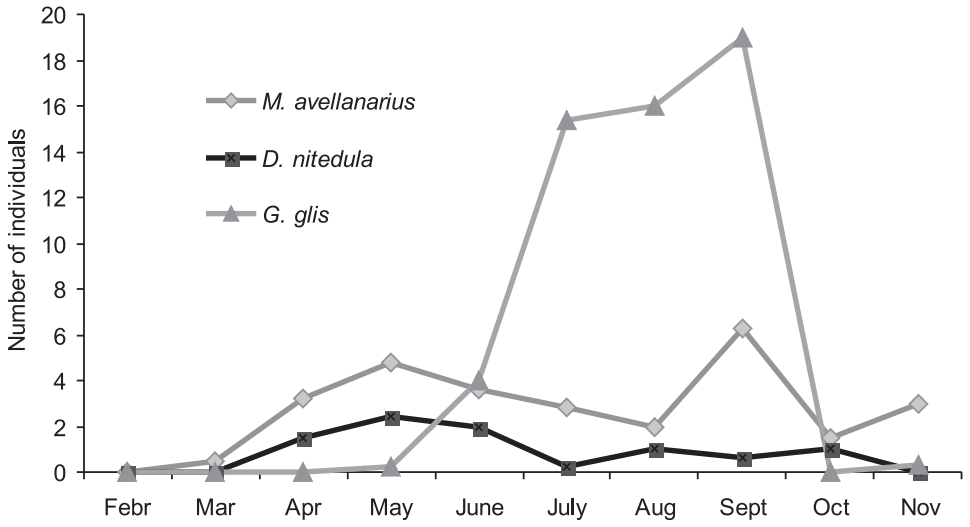

Fig. 7. The average number of dormouse individuals in all boxes in the different months of the whole survey period (2000–2005).

Other species nesting in the boxes were *Apodemus flavicollis* Melchior, *Apodemus sylvaticus* L., *Parus major* L., *Parus caeruleus* L., *Jynx torquilla* L., *Vespa crabro* L. and *Bombus terrestris* L.

The number of records on dormice collected during our survey confirms that the use of nest boxes/tubes for surveys provided a good source of data (Robel and Leitenbacher 1993, Schlund *et al.* 1993, Morris 1997, Sorace *et al.* 1998, 1999, Juškaitis 1995, 1999, 2000, Koppmann-Rumpf *et al.* 2003, Bakó *et al.* 2002). There was difference in the use of wooden boxes and plastic nest tubes. The preliminary results of the comprehensive investigation let us suppose that fat dormice avoid the plastic nest tubes, forest dormice seem to make no difference, whereas hazel dormice nested mainly in the plastic tubes. In an earlier study we found out that *Muscardinus* made no difference between the two types of nest boxes, but *Dryomys* and *Glis* had a clear preference to wooden boxes (Hecker and Bakó 2005). These observations show that records gained using wooden nest boxes are more reliable for all three species. We think this is because the inner hole is bigger in the wooden nest boxes and more suitable for *Glis,* but even for *Dryomys*, because the only two forest dormice found in the nest tubes in 2005 were juveniles. We think that *Muscardinus* used the tubes more because of the competition with the other dormouse species. However the wooden boxes are heavier and it is hard to fix them on shrubs. Probably the size is more important than the material, so it would be useful to test larger plastic nest boxes e.g. of the size of wooden nest boxes.

The species composition changed in 2005. Before that year hazel dormouse was the most abundant similarly to nationwide trends (Hecker *et al.* 2003). In 2005, 139 records were obtained on *Glis*, which made 41% of all dormouse records during whole study period. Observed increase in *Glis* numbers might have been caused by the change in acorn production, as it was observed in other studies (Schlund *et al.* 2002). However, we did not monitor acorn production to support this statement, but a lot of the nest boxes and plastic nest tubes were filled up with acorn shells much more than in previous years.

The differences in distribution of dormouse species cannot be explained only by spatial factors. All but one of the plots were adjacent to one or more plots, and all were linked together by forest patches or habitat corridors. The largest difference in species composition was found between the hedge,

with all three dormouse species present, and the neighbouring shrub and young pine stand, only with *Muscardinus.*

Those habitats where all three dormouse species occurred contained various tree and shrub species, providing food (fruits or seeds) at different times. By contrast, in the shrub where dogwood (*Cornus sanguinea* L.) dominated or in the young pine stand only few shrub species provided source of food.

Dryomys was the only species, which was not found at the edge of oak-hornbeam forest. It agrees with the results of the former survey (Gál 1999). However, in the neighbouring oak- hornbeam forest one *Dryomys* was recorded in 2005.

There are certain microhabitats where mainly or only hazel dormice appear: young pine stand, shrub, oak-hornbeam forest. The changes of the spatial distribution found during the five years of our survey suggest that the increase of *Glis* forced back *Muscardinus* to the habitats with less species-rich structures. In the last three years of the study (2002–2005) we observed a decrease in the records on *Muscardinus* in the hedge but at the same time the numbers in the adjacent shrub and young pine stand increased.

In the last years vegetation succession was very intensive, because the orchards were taken out of cultivation. The shrub vegetation (*Viburnum* L., *Prunus* L. and *Euonymus* L. species) has got thicker and formed a more continuous habitat. This is a possible reason why more fat dormice appeared in the hedgerow and numbers of *Dryomys* increased in the abandoned orchard.

Data on seasonal distribution show that nest boxes were used in the whole active season, but to different extent. The decrease in using of nest boxes by *Muscardinus* and *Dryomys* in July–August might be due to the late re-appearance of *Glis* after hibernation. *Glis* probably forced out the smaller dormouse species. In some cases we found gnawed skin of young *Dryomys* and *Muscardinus* specimens in *Glis* nests, which confirms the strong competition between the species. To answer these questions we started a field survey in a location where only *Dryomys* and *Muscardinus* occur.

Our results showed that coexistence of different dormouse species was possible in the same habitats – even in nest boxes next to each other. In our study site we found noticeable differences between the influence of the vegetation types and structures, but a more detailed field survey is needed to explore interspecies behaviour patterns.

REFERENCES

Bakó B., Gál I. 1999 – Habitat Preference of Dormouse Species in Naszály Region of Hungary – IVth International Conference on Dormice (Rodentia, Gliridae), Book of Abstracts, Edirne, pp. 4.

Bakó B., Hecker K., Kis Zs. 2002 – Using of Nest Boxes in Studies on the Vegetation Preference by the Three Dormouse Species in Hungary – Vth International Conference on Dormice (Myoxidae), Abstracts, Szent István University, Gödöllő, pp. 27.

Bright P.W., Mitchell P., Morris P.A. 1994 – Dormouse Distribution: Survey Techniques, Insular Ecology and Selection of Sites for Conservation – J. Appl. Ecol. 31: 329–339.

Füri A., Sinkóné Póka M. 1996 – Vác/Naszály-hegy [Vác/Naszály-hill] (In: Magyarországi települések védett természeti értékei [Protected natural values of Hungarian settlements] Ed. J. Tardy) – Mezőgazda Kiadó, Budapest, pp. 424–425 (in Hungarian).

Gál I. 1999 – A magyarországi pelefajok (Myoxidae) élőhelypreferencia vizsgálata [Investigation on the Habitat Preference of Dormouse Species (*Myoxidae*) in Hungary] – Thesis – Agricultural University of Gödöllő (in Hungarian).

Hecker K., Bakó B. 2005 – Life history of different nest box types occupied by dormice. 6th International Conference on Dormice (Gliridae), 20–24 September 2005, Siedlce, Poland, Book of Abstracts, pp. 31.

Hecker K., Bakó B., Csorba G. 2003 – Distribution ecology of the Hungarian dormouse species, based on the national Biodiversity-monitoring System – Acta Zool. Hung. 49: 45–54.

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-breeding passerines – Acta Zool. Hung. 49: 69–76.

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. 1999 – Mammals Occupying Nestboxes for Birds in Lithuania – Acta Zoologica Lituanica. Biodiversity, 9: 19–23.

Juškaitis R. 2000 – Abundance Dynamics of Common Dormouse (*Muscardinuis avellanarius*), Fat Dormouse (*Glis glis*) and Yellow-necked Mouse (*Apodemus flavicollis*) derived from nestbox occupation – Folia Theriologica Estonica, 5: 42–50.

Juškaitis R. 2003 – Nestbox Grids in Studies of the Common Dormouse (*Muscardinus avellanarius*) Populations: Some Methodological Aspects – Acta Zool. Hung. 49: 161.

Juškaitis R. 2006 – Nestbox grids in population studies of the common dormouse (*Muscardinus avellanarius* L.): methodological aspects – Pol. J. Ecol. 54: 351–358.

Morris P.A. 1997 – A review of the fat dormouse (*Glis glis*) in Britain – Nat. Croat. 6: 163–176.

Morris P. 2004 – Dormice – Whittet Books Ltd, Suffolk, 38 pp.

Robel K., Leitenbacher G. 1993 – Der Einfluß des Siebenschläfers *Glis glis* auf die Höhlenbrüterpopulation in künstlichen Nisthöhlen am Surspeicher [The Impact of the Fat Dormouse *Glis glis* on the Hole-nesting Bird Population in Artificial Nest Boxes at Surspeicher] – Orn. Anz. 32: 59–63.

Schlund W., Scharfe F., Ganzhorn J.U. 2002 – Long-term comparison of food availability and reproduction in the edible dormouse (*Glis glis*) – Mamm. biol. 67: 219–232.

Schlund W., Strauss M.J., Burkhardt J.F. 1993 – Siebenschläfer in Nistkästen – eine Langzeitstudie zur Habitatwahl [Fat Dormouse in Nest Boxes – a Long-term Study on Habitat Selection] – Carolinea, 51: 93–100.

Sorace A., Bellavita M., Amori G. 1999 – Seasonal Differences in Nestboxes Occupation by the Dormouse *Muscardinus avellanarius* L. (Rodentia, Myoxidae) in Two Areas of Central Italy – Ecologia Mediterranea, 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: 37–40.

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