Apodemus

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No. 14 - September 2017

Proceedings from the 9th International Dormouse Conference 2014

DANISH MAMMAL SOCIETY

The 9th International Dormouse Conference was organized by Dormouse Consult, University of Aarhus, The Danish Nature Agency, Naturama and the Danish Mammal Society and sponsered by the 15th of June Foundation.

Two publications have emerged from the conference: a special volume of the international journal Folia Zoologica vol. 64 no. 4 in 2015 edited by Thomas B. Berg and the present volume of the Danish Mammal Society Newsletter vol. 14 in 2017 also edited by Thomas B. Berg. Hanna Zaytseva-Anciferova, who did not attend the conference in 2014 due to the situation in Ukraine has been given the opportunity to present her contribution to the conference in the proceedings. In order to compile the whole picture from the conference, the editor in cheif of Folia Zoologica has granted us the permission to publish all abstracts from Folia Zoologica vol. 64 no. 4. These are placed in section 2 of this newsletter.

On behalf of the 9th International Dormouse Conference Scientific Committee I will like to thank all contributors.

Thomas Bjørneboe Berg
Ph.D. Senior scientist at Naturama,
Chair of the Danish Mammal Society

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Preface from Folia Zoologica vol. 64 no. 4

Every third year since 1990 an International Dormouse Conference has been held. Scientists from different biology branches regularly meet for this exchange of new research results. This is an event that for most of the participants is regarded as a dormouse family meeting which gathers colleagues from many countries around the world. For a detailed review of the history of the International Dormouse Conferences see the Preface, by Pat A. Morris, in the Proceedings of the 8th International Dormouse Conference, PECKIANA vol. 8, 2012. 276pp.

The 9th International Dormouse Conference was held in September 2014 at the Natural History Museum NATURAMA in Svendborg. Why choose Denmark for an International Dormouse Conference? Denmark is situated at the northern border of the dormouse family's (Gliridae) distribution. The only resident dormouse species, the hazel dormouse (Muscardinus avellanarius) most likely arrived at this northern frontier some 11,000 years ago along with the deciduous forest, which for several thousand years covered Denmark until agriculture arrived 5,000 years later. Despite a record low forest cover in 1800 (approximately 4%) the Danish hazel dormouse population succeeded in keeping a foothold in this intensively farmed land. The status of the Danish population of hazel dormouse is endangered on the national Red List. Situated in the central area of the Danish hazel dormouse distribution it was highly appropriate for NATURAMA to house The 9TH International Dormouse conference and to have all the delegates visit the fauna bridge just north of Svendborg, a bridge that has been subject to intense debate about its value to the local wild life.

The 9th International Dormouse Conference was attended by 82 participants from 16 countries. Forty three oral presentations were given during three days of presentations and an additional 15 posters were presented during the poster session. All in all, this represented an incredible amount of new insights and knowledge on the world of dormice . The book of abstract can be ordered as a PDF file by sending an e-mail to the conference secretariat thomas@naturama.dk. By the end of the conference it was agreed to arrange two outputs (in addition to the book of abstracts) from the conference. We split the output into two categories, those for the international peer-reviewed journal, Folia Zoologica, and those for the Conference Proceedings. Eleven papers have been accepted for the present special volume of Folia Zoologica which I am happy to present here. This special volume covers a valuable review paper on northerly dormouse populations, papers on habitats, dispersal, threats, field methods, phylogeography and analytical tools.

On behalf of the 9th International Dormouse Conference Scientific Committee:
Pat Morris (England), Rimvydas Juškaitis (Lithuania), Boris Kryštufek (Slovenia), Sven Büchner (Germany), Peter Sunde (Denmark), Morten Elmeros (Denmark), Hans Baagøe (Denmark) and Thomas Bjørneboe Berg (Denmark) we thank all the anonymous referees who made highly relevant and valuable contributions to this special volume.

Editor of this volume:
Thomas Bjørneboe Berg (NATURAMA, Denmark)
October 2015.

Common Dormouse Project – UK - The Beginning 1982 – 1994

Dot Eaton

1982
The Common dormouse captive breeding and re-introduction movement in the UK was started by Dot Eaton, which is now brilliantly organised by The People's Trust for Endangered Species.

The idea of breeding a species of rare British animals and re-introducing them into safe select habitats, evolved in 1982, whilst Dot was working as an animal keeper in Scotland. By 1983 the decision was made to focus on the Common dormouse, Muscardinus avelinarius . The first dormice were trapped under licence by Owen Newman, a BBC wildlife cameraman, and other dormice were added. The initial breeding took place at Chessington Zoo (now Chessington World of Adventures). At that time, no dormice were held in captivity and there was only one small book by Elaine Hurrell, on dormice.

The original intention was always to build up a captive breeding stock and once sufficient animals were available to begin re-introducing them into safe select habitats in order to re-establish a species facing a declining population.

1988
By 1988 Dot had designed a breeding unit that could hold eight groups of dormice in a comfortable space where the behaviour of the animals could be observed, without undue disturbance. This breeding unit consisted of two large wooden sheds, joined in the middle. A viewing corridor running the length of

Breeding unit at Windsor Safari Park.

the building had infra red lights which shone into each compartment. Each of the eight compartments was separated by clear perspex to prevent infection being passed between animals and also to prevent fighting, between males. Each compartment had branches added twice a week and nest boxes were fixed in each enclosure. The dormice had access to large outside runs, which were planted out with suitable food plants, such as hazel, honeysuckle rosebay willow herb etc.

Observed Behaviour

When dormice sense danger their initial reaction is to freeze, and crouch down behind a leaf or just stay still until they jump or run away.

Dormice do not feed together. If one is feeding and another approaches, the dominant animal will remain on the food source while the other runs away.

When stripping honeysuckle bark, to prepare for nest building, the bark will be held firmly in the teeth, while the front paws push on the branch, and the dormouse' head is jerked backwards, so stripping the honeysuckle bark.

When taking a leaf for nest building, the leaf is bitten at the base and a portion of the leaf is crammed into the dormouse' mouth, then the leaf is carried up towards the nest box.

There was never an observation of a nest being built, as the nesting material was always carried into the nest boxes.

Pre-mating behaviour consists of the male chasing the female persistently for three consecutive nights, until mating occurs. If the female does NOT become pregnant at this time this behaviour will be repeated in ten days time.

If mating is successful, thirty days after mating, the female will disappear into the nest box for the arrival of the young.If the female runs onto the front partition of the inside enclosure the observer can clearly see, whether she is feeding young.

Thirty days after the presumed arrival of the young, the juveniles emerge from the nest box. At this time they are very inexperienced, and often make mistakes, such as not “freezing”, when danger threatens, or falling from a branch onto the floor of the enclosure. For several days after the juveniles started leaving the nest, the adult female and sometimes the male also accompany the youngsters. At this time, in the wild, the juveniles would be very vulnerable to danger. However, it is a good learning time for the young.

Late litters are often born. At this time, it was found that on three separate occasions when the air temperature decreased and the lactating female was fat enough, she went torpid and began to hibernate, and therefore was unable to care for the young. Although on each of these three occasions the juveniles appeared to be only days away from emerging from the nest - they died.

The adult dormice begin eating excessively and gaining weight, sometimes as early as mid August and the juveniles some weeks later. Once they have gained sufficient weight a shallow nest is built at ground level, and hibernation begins. In early September, nest boxes in the breeding unit would be moved to ground level and covered with soil mix and straw to maintain a level temperature.

In 1991 the infra red lights were left on, resulting in the air temperature not falling below 10 degrees for three weeks. Immediately, the number of dormice lost, dropped. The shaded columns show the numbers of re-introduced dormice - eleven animals to Hailey Wood in 1992, six more females from different blood lines to the same wood, in 1993 and twenty to English Nature in 1994.

1992
The Haileybury Re-introduction 1992.

The re-introduction team consisted of:-
Martin HIcks
Ecologist at Hertfordshire's Environmental Records Centre. Researched old records for records of dormice. Checked Hailey Wood for suitability for a re-introduction. Helped with behaviour observations.

Dr John Lewis
International Zoo Veterinary Group.
Advised on husbandry of captive dormice.
Post mortem of dead animals.
Vet checked pre released animals.

Julian Ford-Robertson
Senior Science Master at Haileybury College, Hertfordshire.
Organised sixteen A level students assist behaviour observation
Organised the maintenance team to build the release cage.

Professor John Gurnell
Queen Mary University, London.
Behaviour advisor.
Designed and analysed observation sheets.

Steve Whitbread
Southampton University.
Radio tracking of dormouse.

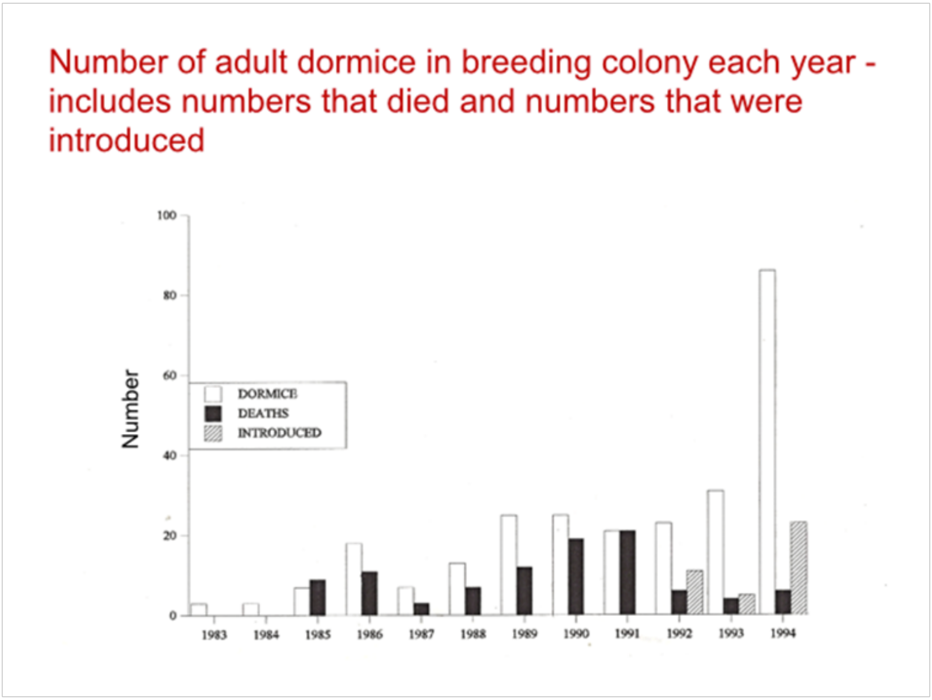


Figure 1. Numbers of dormice kept and bred 1983 – 1994. Number of adult dormice in breeding colony each year – includes numbers that died and numbers that were introduced into the wild. The clear columns show the numbers of adult dormice in the breeding unit, at the beginning of each year. The black columns show the numbers of dormice lost.

Dot Eaton
Initiator and dormouse breeder.

IUCN Guidelines
The International guidelines for re-introducing any captive bred species into the wild.

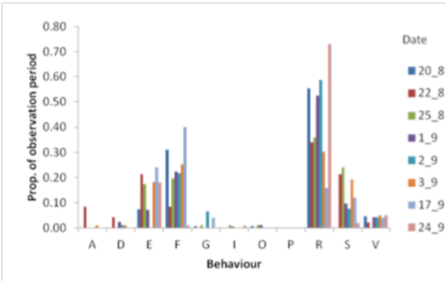
1. Good historical evidence of former natural occurrence. Martin Hicks had found this to be true.
2. Clear understanding of why a species has been lost to an area. Only those lost through human agency and unlikely to re-colonise naturally should be regarded as suitable candidates for re-introduction. A hundred years or so ago, most woods were managed. As men moved off the land, to fight in the wars, or to work in industry, woods became overgrown, dark and unsuitable for dormice.
3. Factors causing extinction should have been rectified. Hailey Wood had many areas of coppice, which had grown to provide suitable habitat for dormice.
4. Suitable habitat of suitable extent should be present. As the wood was only seven hectares this was a contentious issue. However, two large, thick hedgerows led from Hailey Wood, onto extensive woodland.

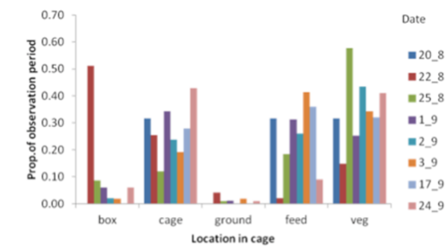
Findings of Observed Behaviour.
Initially the dormice were running and exploring their new environment. Their preferred activities were running in the vegetation, feeding and exploring. Occasionally they were grooming. They spent a minimal amount of time on the ground.

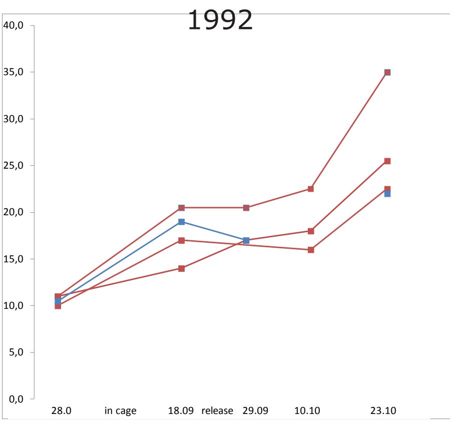
On the 23rd September 1992 the hatch was opened at 7.30 pm. It was 11 pm before

On the 18th August 1992 eleven dormice were put into the release cage which had been built over thick undergrowth, in Hailey Wood. The dormice were of two family groups, one male and two females with their two juveniles, and one female with her five youngsters. Juveniles were used, due to the initial learning that had been observed at the breeding unit.The two family groups were given nest boxes and feeding shelves on opposite sides of the cage.Sacking was hung on either side of the cage to prevent the dormice being disturbed by the observers.The dormice were observed on eight separate nights whilst in the release cage.

one dormouse was observed leaving the opened hatch, and immediately returning into the cage. Unfortunately, as the observation light was fading, the battery needed changing. At 11.30 pm the observers returned, and at that time the release cage was completely empty and silent. It had taken three and a half hours for one dormouse to find the opened hatch, but only less than half an hour for all the other dormice to leave the cage. It is highly likely that communication took place between the exploring dormouse and the others in the cage.







One juvenile male was radio tracked, and it was found that he ranged 35 m the first night and returned to his nest box in the morning. Nest boxes and milk cartons, fixed in trees had been distributed throughout Hailey Wood to check the post released animals. These were checked fortnightly. It was found that the adults were not re-caught, and it was thought they had begun to hibernate. The juveniles continued to be found until 23rd October when their weights ranged between 18g and 30g.

1993

Six female dormice of different bloodlines were added to the previously released animals. During Spring checks in 1993 fresh nests were found and one female with young in the nest.

1994

In 1994 Windsor Safari Park went into receivership which necessitated the dormouse breeding unit moving to Burnham Beeches, owned by the Corporation of London.

A contract was drawn up between Dot Eaton and Martin Hicks with Helen Read and Mark Frater of Burnham Beeches to offer joint ownership of the breeding unit with Dot and the Corporation of London. Contact was made with others working with dormice and re-introductions and English Nature, in order to maintain the future of captive breeding and re-introductions.

1995

A meeting was initiated by Dot Eaton and Burnham Beeches, and held at the Mammal Society rooms in Battersea. As a result of this meeting the Common

Figure 2. Juvenile body weight (g) before and after release. Red: Males, Blue: Females

Dormouse Captive Breeders Group was formed. Each year the CDCBG meet and each breeders donates dormice for release. These animals go to Paignton Zoo or London Zoo to be Vet checked before going to the re-introduction site. Initially they went to Dr Pat Morris and Dr Paul Bright.

2000

The People's Trust for Endangered Species, took over control of the Common dormouse project and by 2014 there have been twenty four re-introductions at nineteen sites. Woodland owners, volunteers, Trusts and the CDCBG and more are all vital components.

Many thanks to:
Owen Newman for trapping my original dormice and giving helpful advice.

Robin Page for writing an article which asked for donations for funding the breeding unit.

Tee Hesketh

The Valerie White Trust for a large donation to build the Breeding Unit

Martin Hicks huge contributions to the 1992 re-introduction

Dr John Lewis Veterinary Advisor for the breeding and re-introduction.

Professor John Gurnell Behaviour Advisor for 1992 Re-introduction

Julian Ford-Robertson organising students and release cage at Haileybury College.

Steve Whitbread supervising radio tracking

Dr Don Jeffries initial belief in the project

Nature Conservancy Council

Nigel Martin

Managing Director of Chessington Zoo for initial support and belief in the project

Maintenance Department for building work

Chessington Zoo
Windsor Safari Park

For more information, read "The Real Mad Hatter's Tea Party" available on Kindle ISBN 978-1-63068-533-1.

Evidence of social behaviour in the edible dormouse (*Glis glis*) and its implications

Patrick A. Morris & Mary J. Morris, West Mains, London Road, Ascot SL5 7DG, UK

Introduction
In 1996 we began a long-term population study of the edible dormouse (*Glis glis*) in Britain and have published the key findings (Morris & Morris 2010). The present paper discusses evidence that local populations of this species may have a relatively complex social structure, with implications in terms of the evolutionary status of *Glis* and the troublesome issue of its impact on human housing.

Vocalisations: *Glis glis* is a very vocal species, calling from secure places in the tree canopy. The calls may be a helpful way of estimating population density (Hoodless & Morris 1993, Jurczyszyn 1994) and may serve a similar function for the animals themselves. Vocalisations may be territorial signals or assist social cohesion at night. Some other species of arboreal mammals are similarly vocal, including Primates such as gibbons (Hylobates), bushbabies (Galagonidae) and lemurs (Lemuridae). However, it is unclear to what extent other species of dormice advertise themselves in this way unless they do so ultrasonically. Most appear to be silent.

Faecal deposits: Many of the 135 nest boxes at our study site were found with substantial deposits of faeces on the lid. Differences in colour suggest accumulation over a period of time and the total mass involved implies repeated depositions, not a single evacuation from one animal. Faecal deposits were usually found on the nest boxes that were most frequently occupied. The faeces could be some form of scent marking, either made by a single animal making repeated visits as a declaration of territorial possession or by multiple animals signalling common use and conveying social information concerning individual identity (and perhaps sex and age). DNA analysis would resolve how many animals were involved and hence the likely nature of any messages that the faeces convey. However, other dormouse species (*Muscardinus*, *Glirulus* and *Dryomys*) which have been studied using nest boxes appear not to engage in this behaviour.

Communal hibernation: Few Glis have been traced to their hibernacula, but Morris & Hoodless (1992) reported multiple occupancy in two out of three hibernacula that they excavated, and other examples of communal hibernation have also been reported to us (Trout pers. comm.). Dormouse trappers in Slovenia also told us that they had observed large numbers of *Glis* going underground in the same place and many animals were reported to use caves in Italy (Scaravelli & Bassi 1995) where they must have experienced total darkness and needed some form of communication (scent perhaps) in order to find their companions and the exit route.

By contrast, *Muscardinus* appears to hibernate alone (Morris 2011) and this may also be true of other species of dormouse.

Hibernation in a group implies some form of communication in order to synchronise entry to the hibernaculum, which then seems to be sealed up and not accessible from outside by later arrivals. *Glis* hibernate underground, but normally forage in the tree canopy, rarely moving about on the ground at all. So how do they know where to go in order to hibernate successfully? Our autumnal observations show that the heaviest animals disappear from nest boxes first, presumably into hibernation, followed by the smaller adults and growing juveniles a few weeks later. That still left a small number of juveniles recorded in November, apparently abandoned by the parental generation and left to find somewhere suitable to hibernate, if and when they reached a suitable size. Perhaps these unfortunate young animals suffer a greater mortality rate, whilst those that are assisted by a parent enjoy a better chance of survival than if they had been left to hibernate on their own? It is possible that a mother could lead her offspring to the sort of place to which her own mother took her at the beginning of her first winter. This would imply the existence of a type of 'social memory', passed down through the generations. However, such a mechanism might mean that a female reaching suitable size to hibernate, could lead her family to their deaths if they were not yet fat enough to survive the winter. This seems an unlikely scenario, but could be avoided by the female delaying her own hibernation until (somehow) the readiness of her family is communicated to her.

Nest box sharing: Nest boxes were frequently found with five or more occupants. This could be because nest boxes were in short supply, but actually there were more empty boxes than occupied ones. For example, in July 2002 there were 78 occupied nest boxes at our study site and 97 empty ones. Moreover, less than half of the occupied boxes contained only one animal, the rest had up to eight individuals crowded inside. But scarcity of this resource was not pressurising animals into sharing accommodation, clearly they were actively choosing to live together rather than as separate individuals. Males did not share boxes with females and their developing young, but before the breeding season males frequently lived with females or in single sex groups. After breeding had ended males often shared nest boxes with mothers and some of their well-grown families. Again, this is association by choice not necessity as plenty of empty nest boxes were also available.

Many of our sharing animals were closely related (see below) and there could be 'kinship benefits' (Pilastro 1992, Marin & Pilastro, 1994). For example, huddling together for warmth could reduce energy consumption and lead to enhanced survival, but we have not yet compared longevity of 'social animals' with those only found living alone. Nor is it clear to what extent other dormouse species behave in similar ways.

Re-association: We found many examples of young animals that returned to share a nest box with their mother long after becoming independent of her. For example, in September 2000 female 143 was found in nest box E12 with a litter of young, one of which was individually marked (with a PIT tag) as #379. They were together again in September 2001 in a nearby nest box and found again in October 2002 sharing the original box E12. Many similar examples were noted. A sample of 20 cases showed 11 re-associating in the following year, 7 coming together again after 2 years and 3 after 3 years. Since our nest box monitoring was at monthly intervals it can be assumed that such associative behaviour occurs even more frequently than we detected it. It is also apparent that this is a persistent form of social behaviour in which animals engage for much of their life.

Collectively, the observations above suggest a degree of social behaviour unexpected in a small rodent because small mammals normally have short lives and are thus unlikely to have time to develop complex social structures or benefit from them. However, significant numbers of our animals lived to be 8-10 years old (Morris & Morris 2010), and up to 15 years has now been recorded (Trout pers. comm.). There is a strong possibility that *Glis* populations have a social structure like that of badgers (Kruuk 1989) a social carnivore in which individuals use scent to recognise each other and also to which social group ('clan') they belong.

Moreover, badgers use copious amounts of faeces, deposited in strategic places to mark out their communal ('clan') territories (Neal & Cheeseman 1996). Perhaps the accumulated faeces on nest boxes perform a similar function for *Glis*?

Other species of dormice appear to live in less complex communities, although most of them have been less intensively studied. However, the speculations outlined above imply that *Glis glis* may be the most highly evolved species among the Gliridae. Moreover, there are implications for the naturalised population established in Britain since 1902 (Morris 2011). Here, progressively over the past 110 years, *Glis* have not spread far from the geographical area of release but have become very abundant within it. Crucially, they have become an increasing problem through their invasion of buildings, especially domestic housing where they cause significant disturbance and damage. If they do live in cohesive social groups, communicating via scent cues and vocalisations, this may account for the fact that some houses may be seriously troubled whilst householders living nearby report no serious issues with dormice. Fifty or more animals may be removed from some houses, while others have few or none. The edible dormice seem to be treating houses as they do nest boxes, as places of shelter and security, often with food also available within. Understanding their social behaviour and communication may be the key to effective control of *Glis* populations and the problems they cause. *Glis glis* seems to be less prone to invading human living space in Continental Europe, where complaints and accounts of damage and nuisance appear to be relatively minor and uncommon. By contrast, the British population appears to be evolving towards becoming a true commensal like the house mouse (*Mus musculus*) and brown rat (*Rattus norvegicus*). Again, this development suggests that the edible dormouse is evolving differently from most other dormice.

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Records of tree-dwelling dormice *Muscardinus avellanarius* and *Glis glis* in Central Europe.

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Abstract
Tree cavities are commonly used as nest sites by fat dormouse (*Glis glis*) and hazel dormouse (*Muscardinus avellanarius*), but little knowledge exists on physical characteristics of used tree cavities, time span as well as frequency of inhabitation. At five study sites in Germany and Luxembourg 16 nest sites of both hazel dormouse and fat dormouse in tree holes were detected between April and November. Fat dormice were found in woodpecker holes and branch brake-offs in beech, ash and oak trees at a height of 5-20 m. Hazel dormice were discovered in woodpecker holes, branch brake-offs, cracks and behind loose bark. The cavities were in oak, beech, poplar and hornbeam trees at a height of 1-20 m. Fat dormice were solitary except for one female that was observed with its young in a woodpecker hole. This female was sighted with her litter one day after a colony of Bechstein's bats (*Myotis bechsteinii*) had used the same cavity. Hazel dormice were found solitary or in groups of two to three individuals. Six discovered individuals at five nest sites were in daily torpor, while 15 individuals at eleven nest sites were active.

Key words *Muscardinus avellanarius, Glis glis*, nest site, tree cavities, endoscope

Introduction

Tree cavities are an important habitat structure for many vertebrates (e.g. bats, birds, rodents) and invertebrates (e.g. saprophylic beetles, hornets). Utilization of tree holes is species-specific and depends on life-cycle, sex, day-time and external conditions (e.g. air temperature). They are used as day or night shelter, for breeding, mating and periods of daily or seasonal torpor. Bechstein´s bats for example may compensate differences in ambient conditions by selecting appropriate tree roost types. For instance, thermally unstable tree crevices may be selected to support torpor, especially in warmer areas. To maintain high body temperature in colder areas thermally more stable woodpecker made cavities may predominantly be chosen to roost in (Dietz & Hörig 2011). Comparable to bats dormice are also able to undergo phases of torpor during periods of adverse weather and shortage of food (Fietz 2012). Currently little is known on whether dormice support thermoregulation by roost selection. Hazel dormice (*Muscardinus avellanarius*, Linnaeus 1758) build their woven ball-shaped nests both in closed cavities (tree holes) as well as in thick tangles of woody vegetation (Juskaitis 2014). Although nest sites in tree holes are commonly described for hazel dormouse and fat dormouse (*Glis glis,* Linnaeus 1766), little is known about their physical character. Nest sites in tree holes were mainly detected by radio tracking individuals (e.g. Bright & Morris, 1992; Müller-Stieß, 1996) or were discovered coincidentally. Hazel dormouse summer nests have been found under loose bark, in woodpecker holes and cracks (Möckel, 1996; Müller-Stieß, 1996; Gatter & Schütt, 1999; Verbeylen et al., 2016; Natuurpunt, 2017). These occupied cavities were located in oak, beech, spruce, fir and elder trees (Bright & Morris, 1992; Müller-Stieß, 1996; Gatter & Schütt, 1999; Verbeylen et al., 2016). Fat dormouse nests were found in woodpecker holes in beech trees exclusively (Schulze, 1970; Müller-Stieß, 1996; Sikora, 2008).

Here, we describe documented nests in tree cavities in Germany and Luxembourg used by both hazel dormouse and fat dormouse to enhance the knowledge on dormice in tree cavities.

Material and Methods

Tree-dwelling dormice were recorded at five study sites within the context of mitigation measures prior to authorized felling or within conservation projects (Fig. 1): Study site 1 is located in Luxembourg near the town of Echternach. It is composed of about 126 ha of common hornbeam oak forest with a stand age of 140-160 years. Study site 2 is a park in the suburbs of Frankfurt am Main, Germany. The park is about 18 ha in size with a stand age of 100-140 years. It adjoins allotments. Study sites 3 (stand age of 100-140 years, size of about 115 ha) and 5 (stand age of 40-60 years, size of about 910 ha) are situated within woodruff beech forests in central Germany . Study site 4 is a common hornbeam oak forest with a stand age of 140-160 years and a size of about 1000 ha in western Germany.

Tree cavities such as woodpecker holes, branch break-offs, cracks and loose bark were mapped during winter or were known as roost sites of bats. To examine tree cavities regarding nests and present animals special endoscope tree cameras (dnt Findoo ProfiLine Plus) were used. Trees were climbed using a ladder, a special rope technique or a cherry picker, depending on height and location of the cavities. Examination took place in April, July, October and November between 2006 and 2016. Two cavities inhabited by hazel dormice in October were inspected again in November (Tab. 1).

Results

In total 16 nests of tree-dwelling hazel dormice and fat dormice were found. Six nest sites of fat dormice were detected in woodpecker holes or branch break-offs in beech, ash, lime and oak trees at a height of 5- 20 m (Table 1, Fig. 2 and 3).

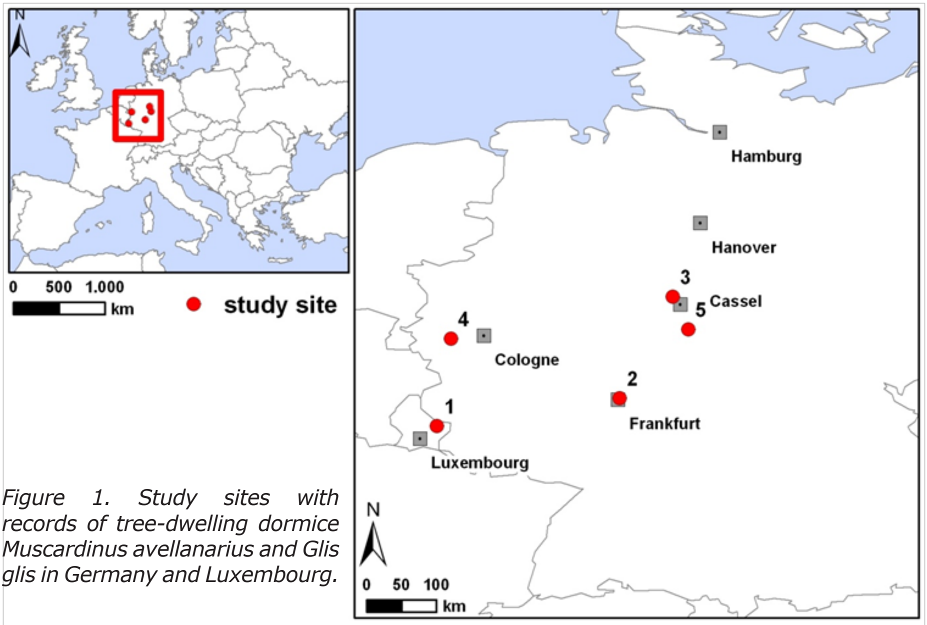

Figure 1. Study sites with records of tree-dwelling dormice Muscardinus avellanarius and Glis glis in Germany and Luxembourg.

Figure 2. Nest sites of fat dormouse in the canopy (above: overview and detail) and within a tree trunk (below: outside and inside) each in a beech (Fagus sylvatica).

Inhabited trees had a diameter at breast height of 40-100 cm. Fat dormice nesting in tree cavities were recorded at study sites 1-3 in July and October between 2006 and 2010. At the time of discovery nests were inhabited by single individuals except for one nest. In July a female was found with its newborn in a woodpecker hole that was frequently used as nursery roost by tree-dwelling Bechstein's bats, Myotis bechsteinii (Table 1, Fig. 1, Fig. 4 below, left). Discovered fat dormice were awake and curious except for one individual found in July (Fig. 3). During the observation all individuals remained within the tree cavity.

Hazel dormice were documented in ten tree cavities at study sites 4 and 5 between 2011 and 2016 (Tab. 1). Nest sites were located in woodpecker holes, branch break-offs, cracks and behind loose

Record	study site	species	No. of individuals	status	kind of nest	date	tree species	diameter at breast height [cm]	kind of tree hole	height above ground [m]	Distance to edge of the forest [m]	forest community	stand age [years]	bush/ shrubbery at ground
1	1	*Glis glis*	1 and juveniles	awake	leaves	15.07.2006	*Quercus robur*	<80	woodpecker	<20	5	common hornbeam oak forest	140-160	little
2	2	*Glis glis*	1	awake	unknown	July 2010	*Quercus rubra*	<40	woodpecker hole	<5	10	urban park/allotments	100-140	little
3	2	*Glis glis*	1	torpor	unknown	July 2010	*Tilia cordata*	<100	branch break-off	<5	35	urban park/allotments	100-140	little
4	3	*Glis glis*	1	awake	unknown	07.10.2009	*Fraxinus excelsior*	<40	woodpecker hole	<10	150	woodruff beech forest	100-140	little
5	3	*Glis glis*	1	awake	unknown	07.10.2009	*Fraxinus excelsior*	<60	crack with woodpecker hole	<20	45	woodruff beech forest	100-140	little
6	3	*Glis glis*	1	awake	unknown	07.10.2009	*Fagus sylvatica*	<80	branch break-off	<5	10	woodruff beech forest	100-140	little
7	4	*Muscardinus avellanarius*	2	torpor	grass	27.10.2011 & 17.11.2011	*Quercus robur*	<60	branch break-off	<15	10	common hornbeam oak forest	140-160	no
8	4	*Muscardinus avellanarius*	1	torpor	grass	27.10.2011	*Populus nigra*	<40	branch break-off	<5	80	common hornbeam oak forest	140-160	little
9	4	*Muscardinus avellanarius*	1	awake	leaves	28.10.2011	*Quercus robur*	<100	woodpecker hole	<20	40	common hornbeam oak forest	140-160	no
10	4	*Muscardinus avellanarius*	1	torpor	grass and leaves	28.10.2011 & 17.11.2011	*Quercus robur*	<40	woodpecker hole	<10	65	common hornbeam oak forest	140-160	yes
11	4	*Muscardinus avellanarius*	2	awake	unknown	17.10.2014	*Quercus robur*	<80	loose bark	<15	200	common hornbeam oak forest	140-160	yes
12	4	*Muscardinus avellanarius*	1	awake	unknown	17.10.2014	*Fagus sylvatica*	<80	branch break-off	<10	10	common hornbeam oak forest	140-160	yes
13	4	*Muscardinus avellanarius*	2	awake	unknown	17.10.2014	*Quercus robur*	<80	crack	<15	175	common hornbeam oak forest	140-160	no?
14	4	*Muscardinus avellanarius*	1	awake	unknown	21.10.2015	*Quercus robur*	<60	loose bark	<10	95	common hornbeam oak forest	140-160	no
15	4	*Muscardinus avellanarius*	3	awake	unknown	17.10.2016	*Carpinus betulus*	<40	crack	<10	35	common hornbeam oak forest	100-140	yes
16	5	*Muscardinus avellanarius*	1	torpor	leaves	09.04.2014	*Fagus sylvatica*	<20	crack	1	80	woodruff beech forest	40-60	no

Table 1. Overview of the characteristics of trees, tree cavities and the surroundings used by fat dormice and hazel dormice.

Figure 3. Fat dormice recorded with an endoscope tree camera. In both cases the animals were curious. The female on the left had a litter with five naked young in a leave nest. Nest material in the right picture is from seed wool of a hybrid black-poplar (Populus x canadensis).

bark. Roosts were identified in oak, beech, poplar and hornbeam trees at a height of 1-20 m. Inhabited trees had a diameter at breast height of 20-100 cm. Dormice were observed using tree cavities in April, October and November. As far as recorded, nests consisted of either grass or leaves, or a mixture of both. At the time of the survey nests were inhabited by one to three individuals. One third of the recorded individuals were in daily torpor (5/15). Most of the individuals that were awake fled from the tree hole immediately. Two nest sites which were checked repeatedly in October and November were inhabited by individuals in daily torpor during both surveys.

Ground cover in the area surrounding occupied trees was scarce in the case of fat dormouse. In the case of hazel dormouse ground vegetation varied from no shrubbery to a well-developed understorey. We recorded distances to the edge of the forest from 5 to 200 m.

Discussion

Discovered nest sites in tree cavities for both hazel dormice and fat dormice match records described in literature regarding type of tree cavity, tree species, height of cavity and time of the year animals were found. The detected nest sites show a show a wide range regarding the type of cavities inhabited by fat dormouse or hazel dormouse. Nests were built in woodpecker holes, branch break-offs, cracks and behind loose bark, while the last two were only used by hazel dormice. That might be due to the physical characteristics of cracks or loose bark that tend to provide less closed spaces in comparison to hollows produced by woodpecker. Hence, the variability of dormice selecting nest site types seems to be higher in hazel dormice than fat dormice (compare Müller-Stieß, 1996). During two telemetry studies the majority of hazel dormouse nests were discovered in cavities (natural tree holes or artificial holes, e.g. nest boxes) (84% by Bright & Morris, 1992; 72 % by Müller-Stieß, 1996). The same applies to a higher extent to fat dormice (93 % by Müller-Stieß, 1996). Further telemetry studies conducted in woodlands where natural tree holes but not artificial cavities like nest boxes are available may lead to more information on the texture of selected tree cavities and the time span as well as the frequency of use.

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The advantages of permanent marking, such as microchipping, during long term monitoring of the common dormouse (*Muscardinus avellanarius*)

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Abstract
Microchipping of small mammals has been used for a number of years. It is particularly suitable for species that have a relatively long life and for identifying individuals that may mix spatially. The common dormouse is one such species where individuals living in excess of 4 years are reported. The simple alternative of fur clipping is not practical for answering questions relating to many of the key population parameters, since fur is replaced at least twice per year. Information on an individual's capture history, nest box fidelity, survival, movements including emigration from the nest, and reproductive history can be gathered. The capture-recapture data from all the individuals can be assessed to provide demonstrably better population estimates than the monthly numbers handled. The use of microchipping is to be encouraged to answer the pressing priority questions surrounding Common dormouse conservation, woodland management and mitigation associated with built development.

Keywords: *Muscardinus avellanarius*, marking, microchipping

Introduction

Passive integrated transponders (PIT) originated from radar technology during the 1940s. Individual lifetime marking has been used for small mammals for many decades, initially involving toe clipping or leg rings, both of which are now illegal in the UK except under Licence. Ear tags or ear tattooing have also been available techniques. Each method of marking has its pros & cons and has similar levels of recapture Trout et.al. 2012a. The UK Home Office (HO) advice and recent consultation for wild animals (2014) states clearly that individual marking is not a regulated procedure if the primary reason is the individual identification of the individual. Thus there is not a welfare issue in Britain, or in Europe. In Britain, transponders available in the late 1990s were 12m long and 2mm diameter, this was considered too large for Common dormice. In 2002 the author located 8mm long microchips and these were used under licence from English Nature (now Natural England). Smaller diameter chips of 1.4mm became available more recently and have been trialled very successfully at sites in England and Wales.

The Common dormouse is a European protected species and protected in Britain under the Wildlife and Countryside Act and a Licence is required from Natural England/ Natural Resources Wales to handle or microchip Common dormice. Natural England has categorised the species as a biological action plan (BAP) species and this is translated into a number of topic areas that need information or research to assist evidence based improvement of conservation status. These include population modelling; overwinter survival; canopy use over the season; impact of woodland management; juvenile dispersal and habitat fragmentation. These require field based monitoring where medium to long term information from individuals is critical. Chanin & Gubert (2012) demonstrated dormice crossing a road in the UK using microchipping but evidence from several locations is required before Policy may be altered. This paper demonstrates by using real field data informative outcomes that only microchipping can produce. It also demonstrates how relying on fur marking leads to incorrect interpretation of results as animals moult at least twice per year. Developing future UK Policy and field practice on the basis of research based evidence is lagging behind the European advances. The advantages of this technique have recently also been extensively demonstrated in the results of many papers at the Danish Dormouse conference 2014 – of which the UK provided only one, other than this contribution.

Methods and analyses

Three hundred and fifty nest boxes were deployed in 2001 on a 12 Ha conifer site in Wyre forest, near Birmingham and were monitored monthly during the active season as described by Trout et. al. (2012b). Common dormice were microchipped (8mm x 2.0mm supplied by Pet-ID) until 2011 and released immediately under Licence from Natural England. After that date a smaller microchip of 1.4mm diameter was used. A grip handle device was used for microchip insertion into dormice as the syringe types of injector were more likely to move during insertion. Animals were held loosely (without anesthetic) on the knee by the neck scruff. Microchips were inserted subcutaneously and dorsally from just between the ears facing posteriorly. Information on recaptures of individuals up to the end of 2013 was collated. Information on capture history; nest box fidelity; movements; individual productivity overwinter and lifetime survival were gathered and minimum population estimates were made. Complete analysis of the whole data set was not attempted for this short paper as the aim is to indicate the potential of such monitoring. Instead, either the example of one long lived dormouse 340302, first caught as a juvenile in September 2010 and still alive in August 2014, was used as the demonstration or else a subsample of the dataset is shown.

The capture history of recaptured dormice was plotted on a chart to provide a calendar of captures bar chart. This enabled the available lifetime history and months between captures to be recorded. The single animal example shown in Fig.1 indicates that it may be found several times within a year. Others may not be found for over one or rarely two years before recapture.

The nest box fidelity for individuals that were recaptured at least 5 times was logged, separated by gender. The number of times the individual was subsequently, sequentially found in the same or another nest box was recorded to provide a percentage estimate of likelihood of changing nest box.

Movement data from individuals marked as juveniles and captured later were chosen from the database because they are particularly important for assessing dispersal from the nest site.

Female productivity and reproductive history can be measured over the capture lifetime using the evidence of pregnancy, presence of young, lactation and post lactation cues.

Minimum survival is based on the total duration of recaptures of an individual in nest boxes. However it is often possible to also infer the approximate month of birth prior to marking of the individual from the initial weight or time of year of first capture or tail hairiness. For example, any animal first captured in May or June at 12g or more with an adult pelage in this suboptimal conifer habitat is likely to have been born in the previous year, or earlier. For some individuals the 'Unknown but alive' value is large because at first capture it was either a large animal e.g. 30+gm in October or adult weight in June, both suggesting that birth was the previous year (or even longer ago). However, estimating how long the individual lives after the last capture is difficult.

The minimum population known to be alive is an index of population size. Constructing the calendar of captures bar chart for all marked animals and knowing that an individual was alive between capture dates, even if it was not found, the total number known to be alive in any month can be simply calculated by adding all known + captured animals. The first and last year of a graph of this data should be ignored, as the history for many individuals would be incomplete. The addition of a backwards calculation of likely birth date or birth year for each individual was as above. Such an appropriate adjustment for each individual creates a better index of minimum population size.

Results

The collated history of the individual's presence in nest boxes forms the basis for all the biological information. The capture history for dormouse 340302 is shown in Fig. 1. From the weight at first capture, it was deduced that it was most likely born in July, denoted 'U' [uncaptured but alive]. She was captured 14 times, with variable intervals between captures – those periods denoted as 'k' [known to be alive]. There were four long intervals between captures (e.g. September until May) that would have resulted, if fur clipping had been used for identification, in the supposition that 4 different

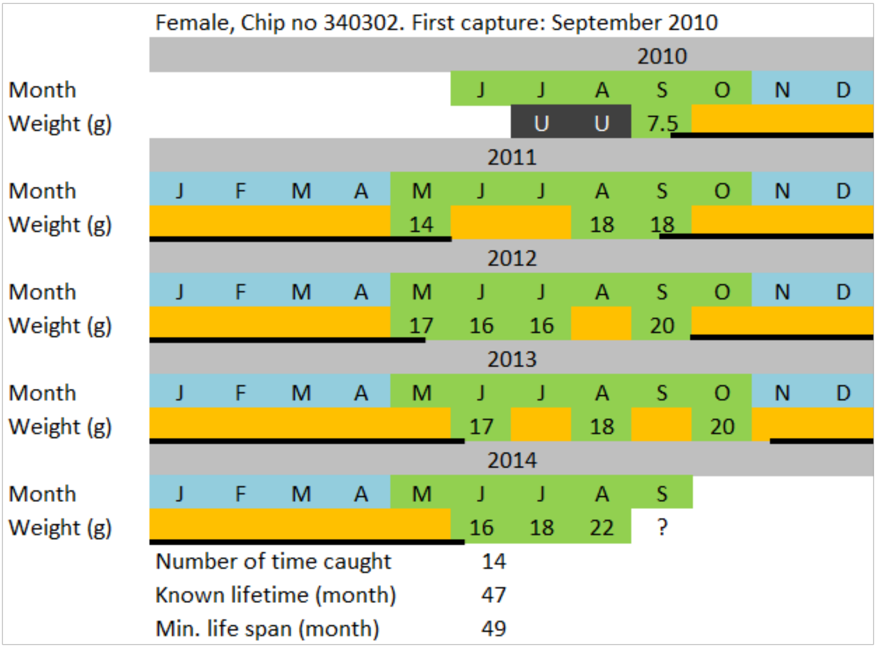

Figure 1. The 14 known lifetime captures of common dormouse 340302, >49 months old. Green month are when the common dormouse is active, blue marks the period of hibernation. Note 1. The shading and 'U' for July and August 2010 relate to retrospective estimation of the birth month. Note 2. (Black bars denote long periods overwinter between captures where moulting would erase fur clipping).

individuals were involved. From the whole dataset approximately 45% of individuals would be mis-identified.

Nest box fidelity was demonstrated by the data for 21 male and 12 females that were recaptured at least 5 times. The data in Figure 2 shows that for males or females subsequent recapture was likely (63% or 68% respectively) to be present in a different nest box. Dormouse 340302 was found in 7 different nest boxes and was recorded as changing nest boxes between captures 9 times, Fig. 3.

Movements of individuals marked as juveniles and subsequently recaptured enabled an assessment of dispersal from the nest to be made, Tab. 1. One crossed a hard track and most moved further than the normal home range diameter for this site (100m).

The minimum lifetime reproductive output of dormouse 340302 is indicated in Fig. 3. The animal produced at least 5 litters between summer 2011 and 2014 and was pregnant for the sixth time in August 2014. Nineteen young were microchipped. The animals used in Tab. 1 are either her litter mates or one from each of her four litters from 2011, 2012 and 2013.

The dormouse survival data was the minimum known and estimated known lifespan of marked individuals, Tab. 3. The first line represents dormouse 340302. When the birth month can be back-calculated this increases the accuracy of known lifetime.

The two population estimations calculated involve the number captured and the minimum number known to be alive in each month of the study, as indicated in Fig. 4. Discounting the first and last year

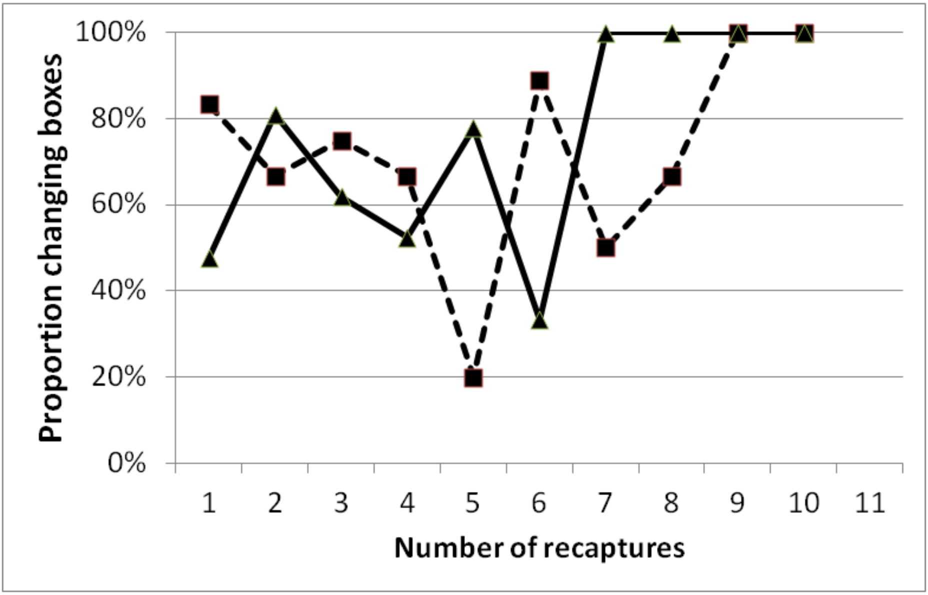

Figure 2. Box infidelity for 21 male (solid) and 12 female (dotted) common dormice at each recapture.

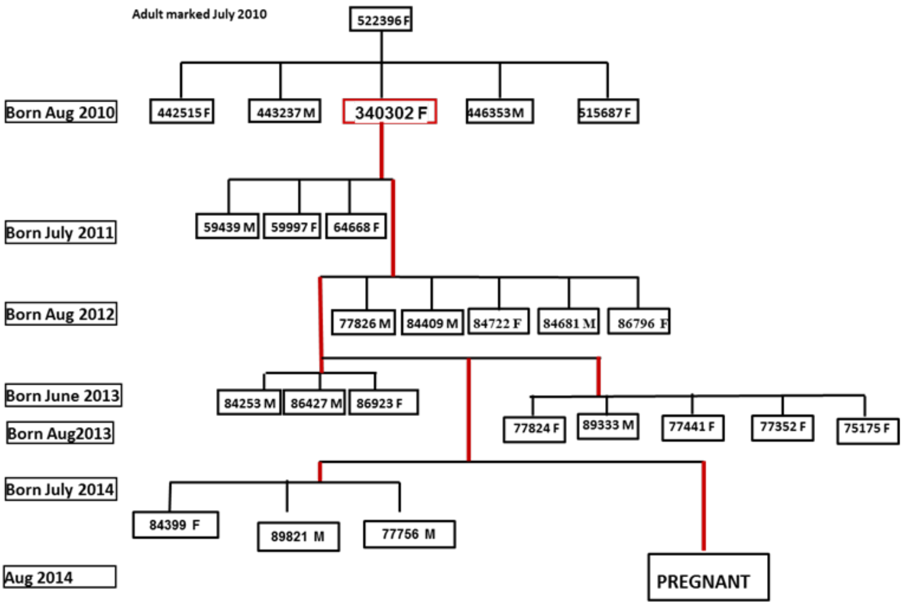

Figure 3. Lifetime reproductive output of dormouse 340302

Table 1. Nest box history of Dormouse 430302. Recaptured 13 times in 7 different nest boxes with 9 changes of nest box (bold text) between captures.

Date	Nest box ID
SEPT 2010	18C
MAY 2011	**63**
AUG	**36K**
SEPT	**51G**
MAY 2012	51G
JUN	51G
JULY	**36N**
SEP	36N
JUN 2013	**51G**
AUG	**34P**
OCT	**51G**
JUN 2014	**36N**
JULY	**31'O'**
AUG	31'O'

of data, the 11 years data indicate that captured animals in the best individual month annually (usually September or October) represent 30% -70% (mean 46%) of those known to be alive but only an average 18% when all active months are directly compared. This factor of 2.2 times as many being present as captured is because individual dormice are captured infrequently during their known lifetime.

Discussion

The technique of microchipping would clearly be inappropriate – both for welfare and progress of science - if it involved a long term impact, or life threatening injury. Evidence from different separate studies on Common dormice in Britain and Europe involving tattooing, leg rings and microchipping indicate a similar level of individuals recaptured following each method (Trout et. al. 2012a) 40%, 46% and 54% respectively). Additionally, the technique would not be applied widely

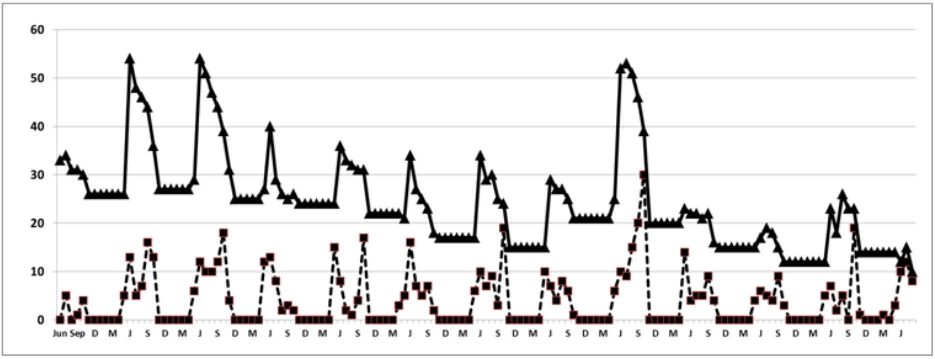

Figure 4. Numbers of dormice captured (lower dotted) compared to numbers known to be alive (upper solid) to demonstrate the advantage of individual marking.

without anaesthetic by scientists across Europe if that were the case.

The individual capture history is the basis for all the other measured parameters required to give the information required in the UK Dormouse BAP topic list. Most animals are infrequently captured in monthly nest box checks.

Table 2. Examples of distance moved by juveniles in Wyre forest from natal nest box to location of next capture.

Microchip number ID All juveniles	Born	Date recaptured	Distance moved (m) when next captured	sex
522396	Summer 2009	Aug 2010	120	F
340302	July 2010	May 2011	270 (+110m more by July 2011	F
446353	July 2010	May 2011	125	M
515687	July 2010	Oct 2010	75 across hard forest road	F
59439	July 2011	May 2012	25	M
77826	Aug 2012	May 2013	190	M
86427	Jun 2013	July 2014	260	M
77824	Aug 2013	May 2014	310	F

Table 3. Examples of estimated individual dormouse survival

Total no. times caught	Post microchip known life span	Estimated months alive before microchipping	Estimated life span (months)
14	47	2	49
1	1	12	13
1	1	4	5
9	17	11	28
2	8	4	12
4	25	4	29
2	2	4	6
9	36	3	39
2	2	11	13
1	1	16	17
2	21	4	25
4	17	11	28
3	20	4	24
1	1	11	12
6	12	15	27
2	2	7	9
5	47	16	63
3	9	4	13
1	1	13	14
2	2	4	6
1	1	11	12
11	38	11	49

The box infidelity data demonstrates that a dormouse is unlikely to be found in the same nest box the next time it is captured. It follows that the capture of a dormouse in a particular nest box in successive months is very likely to involve another animal. As one will not know, unless marked, how many times a dormouse has been captured before, only the average figure of 63-68% likelihood of change can be presumed. The obvious exception would be a female found in two successive months in the same box with her young.

Movement data from juveniles demonstrates many dispersed over halfway across the 17ha site and that marking when very young (c. 8gm) is essential to acquire this data. It also demonstrates that small areas with nest boxes within a large wood will provide a very incomplete picture of dispersal and survival over the first winter.

The reproductive history of dormouse 340302, including the pregnancy in August 2014 suggests that her productivity exceeded 20 young in 6 litters over a four year lifespan. The population estimates using the number known to be alive are of course higher than the monthly captures because of the infrequency of recaptures. However, the actual population cannot be known but could be estimated by relating the proportion marked to the total individuals captured as in the original Lincoln index (Lincoln 1930). An alternative is to visit the boxes more frequently, even daily as Brooks & Trout (2012) reported for edible dormice during 10 days and handled over 90% of all individuals captured that year. Retrospective estimation of the birth month is challenging for some individuals but for many individuals the weight, moult and tail will assist a reasonable back projection to produce a better lifespan estimate, which is essential for calculations of survival.

Each of the example results reported above indicates the usefulness of the technique of microchipping and together they indicate a powerful passive tool rarely used in the UK for this species. The longer running the dataset, the more detailed analyses can be made. The priority areas of dormouse research that have been set by the Government Agency cannot be undertaken without permanent marking and use of this technique should be encouraged to provide hard evidence. The advantages have recently also been extensively demonstrated in the results of twenty papers at the Danish Dormouse Conference 2014 – of which the UK provided only one, other than this contribution. Both passive and short active experimental manipulation projects are needed, otherwise the progress essential for pragmatic dormouse conservation and to drive future Policy will not be forthcoming via evidence based research. Instead, 'best guesses' involving demonstrably incorrect assumptions will continue to impact on Policy decisions.

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A small test with three radio-collars and their suitability for radio-tracking dormice (*Muscardinus avellanarius*)

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Introduction

In radio-tracking studies on common dormice usually radio-collars from Biotrack are used (Bright & Morris 1991, 1992, Bertolino & Cordero di Montezemolo 2007, Mortelliti et al. 2013). Since several of our colleagues (e.g. those working on bats) had problems with these transmitters (like an unstable signal), we wanted to find out if there are better alternatives.

Material and Methods

The internet was searched for radio-collars that would meet the right characteristics to be used on common dormice. Based on this we decided to buy and test three radio-collars from different companies (Tab. 1 and Fig. 1). Pulse length and rate were kept the same to allow a better comparison. Table 1 gives the adjustments that were made to improve the standard radio-collar format. The Telonics-transmitter inclusive its collar turned out to be too heavy and too difficult to fit on an active dormouse, and was not used further since we didn't want to sedate the animals. For the same reason, the Holohil-collar was replaced by a cable-tie. We had only one belt-type cable-tie available, so for the following animals we used regular cable-ties (that close under a 90° angle, so fit less good around the neck). The first two collars were fitted inside a large cage in the back of the car (Fig. 2), but after this first experience they were without any problem fitted in a small bag in the field. The dormice were tracked using the Sika-receiver and flexible 3-element Yagi-antenna from Biotrack. The receiver worked well, except for the fading of the information on the screen (e.g. signal amplitude) at low temperatures. The flexible antenna was very convenient to get through the dense thicket without elements bending or breaking off.

Results and discussion

The characteristics of the three radio-collars are compared in Tab. 1. The Biotrack-collar was fitted on an adult female from September 23rd until October 20th 2013 (battery empty), that was found with two young (12-13 g) on November 1st 2013. The Holohil-collar was fitted on a (probably) subadult female on October 5th 2013, and found on the ground on October 20th 2013 (lost collar or predated? no clear signs of predation, antenna slightly chewed but probably by the dormouse or a congener). On October 30th 2013 the Holohil-collar was fitted on a (probably) subadult male, and found on the ground at the corner of an adjacent forest on November 13th 2013 (lost collar or predated? antenna heavily damaged so predation likely). The third dormouse that was fitted with the Holohil-collar was a subadult male on November 26th 2013. On December 4th 2013 the collar was found 340 m further in an adjacent forest in a pellet of a long-eared owl (Fig. 3). The fourth and last dormouse that was fitted with the Holohil-collar was again a subadult male on December 5th 2013. It was still active during the second night that it was freezing, but was found in a hibernation nest the morning after (December 12th 2013). The battery went dead between December 16th and 23rd. The radio-collared dormouse left its nest on March 22nd 2014 but was not recaptured later.

Besides the much shorter lifespan and smaller detection range, the big disadvantage of the Biotrack-collar was that the signal quickly became unstable, making it much harder to locate. Other studies also report problems with Biotrack-collars (like stop working after 1-2 days)

Table 1. Characteristics of the three tested radio-collars.

Transmitter type	BD-2C, www.holohil.com/bd2c.htm Holohil, Canada)	PicoPip Ag317 (www.biotrack.co.uk/cable-tie-collars.php#s3, Biotrack, UK)	CHP-8P (www.telonics.com/products/vhfAvian/TMU-CHP-8P.php, Telonics, USA)
Transmitter size (length x height x width, mm)	15.1 x 6.8-7.7 x 6.7-7.3 (according to producer: 13 x 6 x 7)	13.0 x 6.2 x 4.6-6.1 (according to producer: 12 x 8 x 6)	21.1-22.9 x 4.7-8.4 x 8.5 (according to producer: 20.3 x 3.7 x 8.1)
Transmitter weight (incl. antenna, g)	1.1 (according to producer: 1.1)	1.1(1.2) (according to producer: 1.2)	2.2 (incl. collar of 7 cm) (according to producer: 1.2 excl. collar)
transmitter coating	very solid with several layers of inert waterproof epoxy	medium potting => partially bitten off by the dormouse uncovering the battery (heavy potting is possible but increases the weight with 0.15 g)	very solid waterproof polymeric coating
Collar	wire collar secured with a brass crimp and protected with flexible Tygon tubing (the antenna can also serve as wire for the collar to minimize the weight) => impossible to fit on a non-sedated dormouse, so we replaced the collar by a cable-tie protected with heath shrink tubing (first dormouse: belt-type cable-tie, second, third and fourth dormouse: regular cable-tie); weight = 0.2 g like the Biotrack collar	belt-type cable tie protected with heath shrink tubing (to avoid the sharp edges of the cable-tie wounding the animal); weight after fitting and removal of the redundant parts: 0.2 g	Tygon tubing (7 cm) that has to be cut to the right size, slid onto a brass extension, secured to this by a non-absorbent suture material to tie a knot around the grooves of the brass extension, then trim up the suture material and put some super glue on the knot => impossible to fit on a non-sedated dormouse and impossible to replace by a cable-tie since there is no tubing to put this through
Antenna	standard length 17.8 cm, coated, very flexible (doesn't get stuck in narrow crevices) => we put the first 18 mm inside the collar under the heat shrink tubing and let the remaining 16 cm stick out to the back along the longitudinal direction of the common dormouse; after the first dormouse the coating of the antenna was slightly chewed; after the second dormouse the antenna was strongly bent (by the dormouse or a predator?) and the coating was almost completely chewed off as well as part of the heat shrink tubing (probably by the dormouse or a congener) and the originally twisted wires of the antenna were disentangled which could strongly hinder the dormouse => we cut off part (12.7 cm) of the antenna and wound up the wires again and glued these together	length 3 cm, uncoated but completely internal inside the heat shrink tubing => when we removed the empty transmitter after 26 days the heat shrink tubing was chewed causing the antenna to partially stick out	length 8.0 cm of which 2.8 cm internally in the Tygon tubing, no coating
Pulse rate / pulse length / frequency	30 ppm / 20 ms / between 151 and 152 MHz		
Detection range*	ca. 1065 m (after cutting off part of the antenna: ca. 300-340 m)	ca. 295 m	ca. 470 m
Signal	very powerful and stable until at least day 50, started to weaken between day 51 and 55 because the battery was getting empty	not very powerful and didn't take long to start fluctuating around the original frequency, making the signal unclear and more difficult to locate	quite powerful when the battery was full, not tested further
Lifespan	was still working on day 60 and empty on day 66 (expected: 50-60 days), can be extended to 75 days by lowering the pulse rate to 20 ppm	worked 26 days (as expected)	not tested (expected: 30-40 days)
Price (in 2013)	radio-collar CAN$ 195.00 (+/- € 132); inclusive transport costs we paid € 200.68	radio-collar € 150.71 (excl. vat) + transport costs € 81.78 (excl. vat, but incl. transport of receiver and antenna, so real transport costs will be lower)	radio-collar USD 173.00 + transport costs USD 60.00 (together € 178.18) + vat and import duties € 57.33

** tested by putting the three radio-collars in a nest box along the railroad and then walking along the railroad until the signal could not be heard anymore (with head-phones on)*

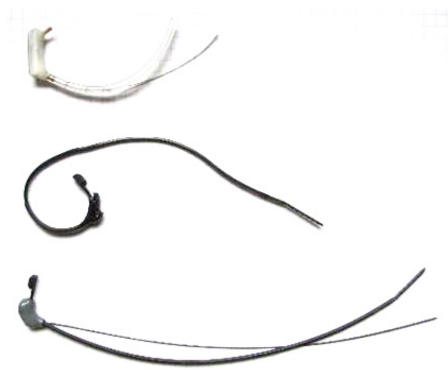

Figure 1. Three radio-collars: Holohil-transmitter with coated antenna and original collar replaced by belt-type cable-tie (bottom), Biotrack-transmitter with belt-type cable-tie and heat shrink tubing (center), Telonics-transmitter with uncoated antenna and Tygon collar secured on brass extension (top).

(Bright & Morris 1991, 1992, Bertolino & Cordero di Montezemolo 2007). Mortelliti et al. (2013) didn't have problems when using Biotrack-collars (Pip Ag376, 1,4 g) to track a limited amount of adult common dormice. In this study the subadults were fitted with smaller transmitters (Pip Ag317 backpack, ca. 0,41 g), but these had a very small detection range and were very difficult to fit (pers. comm. Alessio Mortelliti). With the Biotrack-collar that we used, the coating ('medium potting') was partially chewed off (by the animal that was wearing it or other congeners), uncovering the battery, which could have played a role in causing the instability of the signal (Fig. 4). It is not known whether a heavier potting will be sufficient to avoid damage. The advantage of the Biotrack-collar is that it is very lightweight and small and doesn't have an external antenna that may hinder the animal. This last advantage was lost though after chewing of the tubing that covered the antenna.

The Holohil-collar was slightly larger, had the same weight, a much longer lifespan, a larger detection range, a very stable and clear signal and a strong coating that wasn't damaged by the common dormice. Its weak point was the very long external antenna. As long as this flexible antenna wasn't damaged, it didn't seem to hinder the animal (shown during observations). After the second dormouse it was damaged so much that it might hinder a dormouse during climbing in dense thicket or cause the animal to get stuck. Therefore a large part of the antenna was cut off and the wires were glued together, which reduced the hinder for the dormouse but also the detection range. Replacing the Tygon tubing by a cable-tie with heat shrink tubing didn't only make the collar easier to fit, but also reduced its width, probably allowing the animals to enter holes with a smaller entrance.

Since we expected the common dormice to wear the transmitter under the chin, the first part of the antenna was

Figure 2. The first two animals were collared inside a large cage to ensure a good fit of the collars (left: adult female with Biotrack-collar, right: subadult female with Holohil-collar).

Figure 3. Holohil-collar with shortened antenna after the dormouse had been eaten by a long-eared owl.

Figure 4. Biotrack-collar after 26 days on an adult female dormouse (top). The animal in question 10 days after removing the collar, with two young and a bald neck (bottom).

incorporated in the Holohil-collar, and only after a few centimeters bent to the back, so that it would go parallel to the spine of the animal. When the collared dormice were observed, they didn't wear the transmitter under the chin though but above the right shoulder (so the antenna left the collar above the left shoulder and went along the side rather than the spine of the animal) or in the neck (with the shortened antenna under the breast). Therefore it may be better to let the antenna emerge from the center of the transmitter instead of from the collar, in a 90° angle with the collar. This way there will be only one point of the collar with something (transmitter + antenna) hanging on that may hinder the animal instead of two points (transmitter and antenna separately). Then the dormouse can wear the transmitter in the neck with the antenna trailing down the spine (Fig. 5) and will experience less hinder (e.g. when moving, washing its face or carrying food in its mouth). The suggested improvements (belt-type cable-tie collar with heat shrink tubing, antenna of max. 5 cm emerging from the center of the transmitter) can be custom-made by Holohil. The radio-collared dormice temporarily lost their fur under the collar (e.g. Fig. 4), but no substantial injuries were seen (as is also shown for other small mammals, e.g. Loughran 2007). Since the dormice chew the heat shrink tubing which exposes parts of the cable-tie, filing the edges of the cable-tie to make these less sharp is recommended.

Radio-collars can affect survival, e.g. by reducing agility, changing behavior, increasing visibility/audibility, increasing energy consumption and causing injuries, which can directly or indirectly influence predation rate, interactions with congeners and other species, reproduction, movements, dispersal etc. Few mammal studies consider an effect of being radio-collared though (Godfrey & Bryant 2003). With small mammals the presence of a radio-collar (up to 12% of

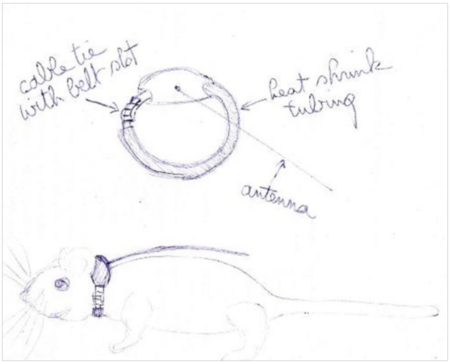

Figure 5. Suggested improvements to the Holohil-collar.

the body weight) doesn't seem to increase the daily energy consumption and the weight seems to be of less importance than the size and shape of the transmitter and the presence of external structures (like a semi-rigid external antenna) (Berteaux et al. 1996, de Mendonça 1999). Therefore it is advised to use very compact and symmetrical transmitters and at least a flexible (or better an internal) antenna. Bright & Morris (1991, 1992) were the first to radio-collar common dormice, using 1.2-1.6 g Biotrack-collars on animals of at least 14.5 g. They didn't find adverse effects on agility and energy consumption and the females kept on nursing their young. Our five radio-collared common dormice weighed between 18.75 and 21.5 g, so the radio-collars (1.4 g incl. collar) amounted to 6.5-7.5% of the body weight. Here also no exceptional weight loss was found, but only two animals were recaptured and weighed after collaring, so our information is very limited and requires further investigation. One female was wearing a radio-collar when nursing her young. For dormice the weight of the collar may even be more futile since they are used to carry much more extra weight when fattening up for hibernation. No information could be found though on possible problems with collars becoming too tight because of this fattening up (and we didn't radio-collar fattened animals).

Some studies indicate a higher predation rate during the first two days because the animals have to get used to the radio-collar (Wolton & Trowbridge 1985, de Mendonça 1999). Our five radio-collared dormice all survived longer than two days, but it wasn't always clear exactly how much longer since the animals weren't tracked daily. With the recovered radio-collars it also wasn't always clear whether the animal had lost its collar or whether it was predated. Only for the adult female with the Biotrack-collar we know that she survived the complete period (26 days) and was at least alive until two weeks after that. The first dormouse with the Holohil-collar survived until at least day 14 and then lost its collar or was predated. The second dormouse survived until at least day 5 and lost its collar or was predated between day 5 and 15. The third dormouse survived until at least day 3 and was predated between day 3 and 9. The fourth dormouse started hibernation at day 17.

When looking at possible adverse effects of radio-collars, it is important to take several factors into account, e.g. gender, age and season. Radio-tracking subadults can yield very interesting information on settlement and dispersal behavior. But subadults usually have much lower survival rates than adults, which diminishes the chance that they can be radio-tracked for a long time. Our only animal that was predated with certainty, was radio-collared very late in the season (end of November) and was probably more visible since not many leaves were left on the shrubs. So it is difficult to say whether the presence of the radio-collar increased its predation chance, or whether it was a natural seasonal effect. Future studies with much more radio-collared dormice of different gender and age and tracked during different seasons should collect information on possible adverse effects of different types of radio-collar.

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To bite, or not to bite, that is the question. Is biting distinctive for genetic lineages in the Hazel dormouse, *Muscardinus avellanarius*?

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Abstract
Genetic analyses suggest that populations of *M. avellanarius* could be split into two distinct cryptic species or at least Evolutionary Significant Units respectively distributed in South-Western and Central-Eastern Europe (Mouton et al. 2012a, b). Apart from genetic evidence other aspects such as differences in morphology or behavior are so far not known for these two lineages. For the authors it was surprising to come across to heavily biting hazel dormice during handling in north western Germany since all previous experiences with dormice in Central and Eastern Germany were different. This different behavior occurred in the only so far known population belonging to the western genetic lineage. A questionnaire among scientists regularly handling hazel dormice could not confirm the idea that the two lineages could be distinguished by different behavior. Even though, it is very obvious that hazel dormice belonging to the western lineage are regularly biting while handled, a few exceptions (some populations in Poland, Romania and Denmark) in the Eastern lineage show that there is no easily detectable pattern on a larger scale.

Key words: behavior, variation, handling hazel dormice

Introduction

Throughout its European range the observed geographic variation in Hazel dormice, *Muscardinus avellanarius* appearance lead to the characterization of different subspecies. They have mainly been described using external features like fur coloration and morphometrical differences like body size or tooth measurements (Juškaitis & Büchner 2013). Recent genetic analyses suggest that populations of *M. avellanarius* could be split into two distinct cryptic species respectively distributed in South-Western and Central-Eastern Europe (Mouton et al. 2012a, b). Today it is unclear whether these lineages represent different cryptic species or just Evolutionary Significant Units (sensu Zachos et al. 2013) that originated from adaptive differentiations among populations (Mouton et al. in prep.). Apart from genetic evidence other aspects such as differences in morphology or behavior are so far not known for these two lineages.

Regarding literature Hazel dormice are very easy to handle and unlike other small mammals do rarely bite during careful handling (Bright et al. 2006). This observation made in Great Britain was confirmed by the authors handling several hundred individuals in Central and Eastern Germany over the last few years. The only exception from this rule was found at a place in the western part of Germany close to the river Rhine. This population is so far the only one known in Germany belonging to the western genetic lineage. All other so far analyzed German samples belong to the Central European lineage (Mouton et al. in prep.). The question arose whether this very obvious behavioral difference in German *M. avellanarius* could be a feature that may be distinctive for the two genetic lineages in the rest of Europe.

Material and Methods

During the 9th International Dormouse Conference (IDC 2014) we conducted a questionnaire among the delegates and asked the ones who regularly handle M. avellanarius to note on a map where the animals a) normally bite (=use their teeth

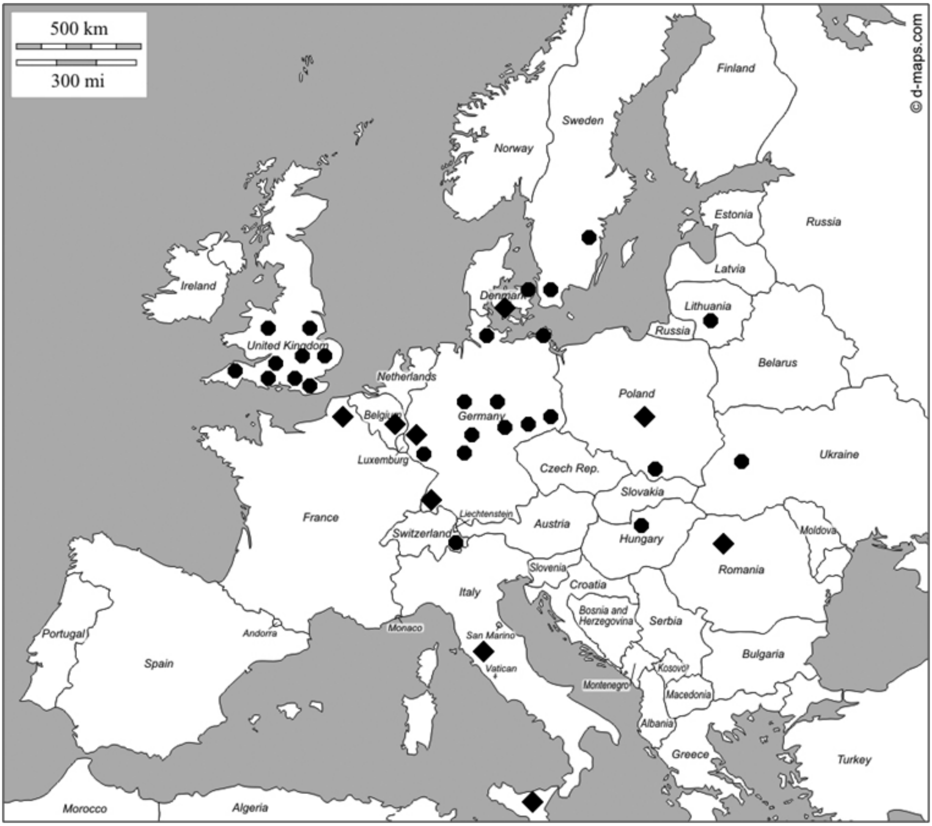

Figure 1. Observed behavior of Hazel dormice, Muscardinus avellanarius, during handling. At locations marked with dots observers stated that Hazel dormice do not (or only occasionally) bite. Diamonds mark locations where they regularly bite.

to fight against handling) or b) normally don't bite during handling. After the conference eight more dormouse specialists where asked to answer the same question via e-mail.

Results
Our questionnaire resulted in answers from 32 different researchers that submitted observations from 36 different localities all over the species range (Fig. 1). In the majority of places (27) Hazel dormice are very calm during handling and do not or only very seldom bite. The few occasions where observers mentioned that they had been bitten in areas where dormice normally don't bite have been explained by special circumstances: These animals where mostly females about to give birth or nursing their young.

Observers reported biting Hazel dormice from France, Italy, Belgium, the Danish Isle of Fyn, the upper Rhine valley in southern Germany and the Region around Cologne in western Germany. The situation in Romania and Poland is ambiguous. Researchers stated that some individuals definitely try to bite but that there are also very calm ones.

Discussion

The results of the questionnaire don't support our hypothesis that biting is a behavior that only Hazel dormice of the western genetic lineage show during handling. Animals from Poland and Romania certainly belong to the Central European lineage but show a different behavior than most of their relatives from Germany, Lithuania, Denmark and the United Kingdom also belonging to this lineage. On a smaller scale, the Dormice from the Western Baltic populations show the same differentiation: The same observers that handled Dormice without problems on the Isle of Rügen, in Schleswig-Holstein and on the Isle of Zealand got bitten by animals on the Isle of Fyn.

It is well known that high intraspecific variation of morphological features and behavior can occur in small mammals and that distinct morphological differences or utilization of different habitats don't have to correspond with genetic lineages (Kryštufek et al. 2014). This should also be true for the behavior of M. avellanarius described in this paper. Even if we found a good coincidence between behavior and genetic lineages along the edge between the western and central northern lineage described by Alice Mouton in her presentation at the IDC 2014 we have to admit that there is no easily detectable pattern on a larger scale.

For any taxonomic assessment well-controlled morphometric analyses together with mating experiments and careful observations of behavioral differences should be an integral part of future research.

Acknowledgements

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How small should the entrance be? Is it possible to let common dormice *Muscardinus avellanarius* enter nest boxes and exclude other species?

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Abstract.
This experiment with nest box entrances of different sizes and shapes shows that bank voles, wood mice and yellow-necked wood mice cannot be excluded if common dormice have to be let in. Great tits can be excluded with rectangular as well as circular entrances. If also well-fattened common dormice have to be let in, blue tits can only be excluded with a rectangular entrance, and the advised height is 15 mm.

Key words: entrance hole size and shape, competition, exclusion

Introduction

Nest boxes are often used to study or monitor common dormice, since they are readily used by this species to build nests in (Juškaitis & Büchner 2013, Juškaitis 2014). The occupation rate can be negatively influenced by other species, either competitors for nest sites (e.g. edible dormice *Glis glis*, wood mice *Apodemus* sp. or tits) or predators that enter the nest boxes (e.g. weasels *Mustela nivalis*) or take out the nests or occupants with their front paws (e.g. martens *Martes* sp. or raccoons *Procyon lotor*) (e.g. Juškaitis 1995, 1997, 1999, 2006, Sorace et al. 1998, Sarà et al. 2005; for an overview, see Juškaitis & Büchner 2013, Juškaitis 2014).

Since in our study area the aim is to capture, mark and recapture as many common dormice as often as possible, we wanted to increase occupation rates of nest boxes by decreasing the size of the entrance hole and thus excluding other species. Before this could be done, we needed to know how small the entrance hole should be to exclude as many species as possible but still let common dormice in. Scherbaum-Heberer et al. (2012) showed that tits and edible dormice can be excluded by using small nest boxes with an entrance hole of 21 mm. It was not known though whether it would be possible to exclude wood mice *Apodemus sylvaticus*, yellow-necked wood mice *Apodemus flavicollis* and bank voles *Clethrionomys glareolus*. Therefore we tested what the minimal entrance size should be to still let individuals of different species pass through.

Material and Methods

The species tested were the main nest box occupants in our study area (community of Voeren, Belgium): common dormouse, wood mouse, yellow-necked wood mouse, bank vole, great tit *Parus major* and blue tit *Cyanistes caeruleus*. No other dormouse species were present in the study area.

Wooden nest boxes were used with an inner size of 15 x 15 x 24 cm, a wall thickness of 25 mm and a circular entrance with a diameter of 45 mm. The entrance size was reduced by screwing an aluminium plate (80 x 60 x 1 mm) against the outside of the entrance hole. One series of 11 plates had a circular opening of 15 to 25 mm (with a difference of 1 mm between the plates, so 15, 16, 17, …, 25 mm). A second series of 21 plates had a rectangular opening with a width of 40 mm and a height of 5 to 25 mm.

In a first test (test 1) two to four nest boxes with entrances of different sizes and shapes were placed on the ground (Fig. 2, 3 and 4) or in the shrubs (Fig. 1). For the non-protected species (wood mice and bank voles) this test was partially conducted in captivity. Bait was put inside the nest boxes and during nightly observations was noted which small mammals entered and left the nest boxes. At first the plates with the largest entrance size were screwed on, and after the animals had entered and left a few times, the nest box entrance was made smaller and smaller until the entrance was too small and they couldn't get in anymore. From the observed animals, only those individuals were selected that could be recognized (e.g. by a broken tail, fur-clip or PIT-tag) and that were regular visitors. This way information on weight, gender and age of the animals could be linked to the size of the nest box entrance they could pass through.

In a second test the animals were put inside a nest box with the smallest entrance plate screwed on and the entrance was enlarged millimetre by millimetre until they could escape. In the first part of this test (test 2) the lid of the nest box was closed and we waited until the animals decided themselves to try to get out. In a second part of this test (test 3) the lid was left open and this opening was closed by a bag of soft mosquito-netting through which our hand could be put inside the nest box to gently encourage the animals to go out. The two tits were caught by a licensed bird-ringer (the two smallest females from a ringing session on 25/1/14 were used) and after ringing only used in the third test and released immediately after.

Results and Discussion

The bank vole, the two wood mice and the yellow-necked wood mouse could pass through similar or even smaller entrances than the common dormice (see Tab. 1). Although this experiment is based on only a few individuals, it already shows that selectively keeping out wood mice, bank voles and even yellow-necked wood mice – especially when we are dealing with young individuals – won't work if we still want to let common dormice in. One of our volunteers (Rian Pulles) observed an adult male yellow-necked wood mouse of 45 g easily passing through a rectangular entrance of 15 mm height. Some yellow-necked wood mice probably can be kept out though, since they can weigh much more (> 50 g) than the animal we observed in our tests.

The extra incentive in tests 2 and 3 yielded passages through even smaller entrances than when they were allowed to enter and leave freely (test 1). Leaving the nest box seemed to be easier than entering, probably because then they had the support of the wooden entrance on the inside of the aluminium plate and could approach the entrance in a more straight angle. Sometimes the animals seemed to learn to get through a smaller entrance. The male wood mouse for example could – even after many attempts – not pass through a rectangular entrance of 12 mm, but succeeded anyway – be it with much effort – after seeing the female wood mouse easily doing this (Fig. 2).

With the circular opening the animals always easier got through with their head than with the rest of their body and the width of their shoulders and especially their pelvis seemed to be the limiting factor. Because of this, the well-fattened common dormouse needed a quite large opening of 22 mm to get through (Fig. 4), which can also be passed by blue tits, but not by great tits.

With the rectangular entrance the size of the breast of the tits seemed to be determining whether they got through. For the mammals the size of the head was important: once the head got through, the rest of the body followed without any problem. By turning their head sideways, the animals could sometimes pass smaller rectangles. With a hazelnut in the mouth it became a whole lot more difficult to get back out, but here also turning the head helped them getting out. For the rectangular entrance, the well-fattened common dormouse (Fig. 4) didn't need a larger opening than the normal sized common dormice, which makes the rectangular entrance the best choice for

Table 1. Nest box entrance sizes that individuals of different species could pass through during the three tests (test 1 = freely entered and got back out, test 2 = put inside and freely got out, test 3 = put inside and stimulated to get out). For the circular opening the minimal diameter (in mm) that the animals could pass through is given, for the rectangular opening the minimal height (in mm) is given (width is always 40 mm). Between brackets = the animals could only pass this entrance size with some effort and almost never did this voluntarily, - = not tested.

species	age	gender	weight	hind foot length (mammals) / wing length (tits)	rectangle			circle		
					test 1	test 2	test 3	test 1	test 2	test 3
common dormouse	subadult	female	17.50 g	-	13	13	(12)	19(18)	(17)	(17, 16)
	adult	female	21.50 g	-	-	-	(13)	-	-	-
			20.50 g	-	-	-	-	-	(18)	-
	adult	female	21.50 g	-	-	-	14	-	-	-
			20.50 g	-	-	-	-	-	-	(17)
	adult	female	35.00 g	-	-	-	(14)	-	-	-
			33.75 g	-	-	-	-	-	-	(22)
yellow-necked wood mouse	adult	female	34.00 g	24 mm	14	(13)	(13)	20(19)	(18)	(18)
wood mouse	adult	male	30.00 g	23 mm	13(12)	(12)	(12)	19(18)	(17)	(17)
	adult	female	22.00 g	22 mm	12	(11)	(11)	17(16)	(16)	(15)
bank vole	adult	male	24.00 g	-	12	(11)	(11)	19(18, 17)	17(16)	(16)
great tit	2nd year	female	15.50 g	72 mm	-	-	(18, 17)	-	-	(25)
blue tit	2nd year	female	10.00 g	63 mm	-	-	(16, 15)	-	-	(22)

Figure 1. Four nest boxes with entrances of differences sizes and shapes (circle 17 and 18 mm, rectangle 13 and 14 mm) placed in a hazel tree.

Figure 2. Two nest boxes placed on the ground. The male wood mouse sees the female wood mouse leave a nest box with a rectangular entrance of 12 mm.

keeping out tits and still letting in all sizes of common dormice. A height of 14 mm seemed to be sufficient for this, but we decided to use a height of 15 mm in future field tests to make it even easier for well-fattened common dormice to get in and out. Blue tits can also pass this entrance size with some effort, but probably won't do this voluntarily, especially during the breeding season when they have to get

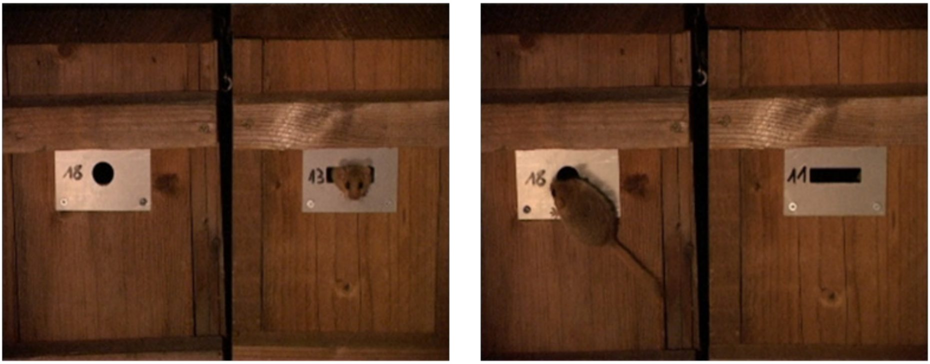

Figure 3. In test 1 the subadult female common dormouse could enter through a rectangular entrance of 13 mm and with some effort through a circular entrance of 18 mm.

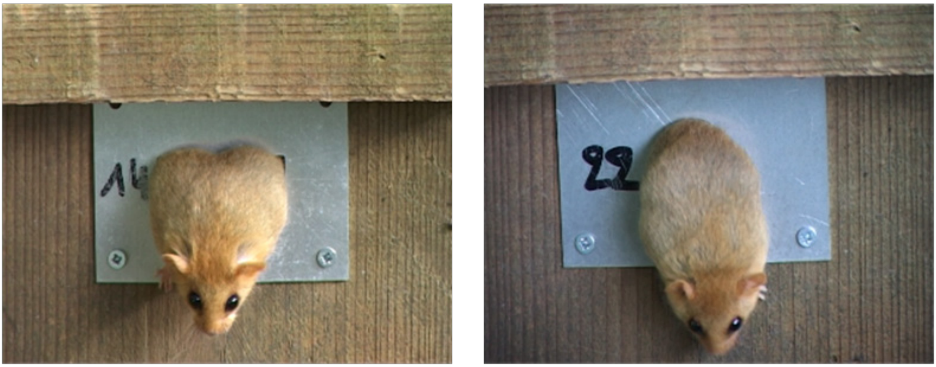

Figure 4. In test 3 the well-fattened female common dormouse could leave through a rectangular entrance of 14 mm and a circular entrance of 22 mm.

in and out very often (e.g. when feeding the young). This was confirmed in 2014 when half of our 268 nest box entrances were reduced to a rectangular opening of 15 mm and in none of these tits started building a nest (own unpublished data). Sometimes a dropping or a few feathers were found, indicating that the tits occasionally entered the nest box or left these traces while trying to do so. In 81% of the nest boxes with a normal entrance (circular, 45 mm) tits started building a nest, often followed by breeding. Also larger predators like martens and raccoons will not be able to reach with their front paws very far into the nest box when the entrance is reduced to a rectangle of 40 x 15 mm.

Based on the results of this experiment, nest box entrances can be reduced to collect information on the importance of the presence of cavities with small entrances that keep out competitors or predators. Besides that, more common dormice might be caught more often, which would improve the results of CMR studies and monitoring schemes. Our first experience with these reduced entrances in the spring of 2014 is that common dormice seemed to prefer these nest boxes and also nest tubes hanging next to a nest box with a reduced entrance (own unpublished data), which fits with common dormice avoiding tits due to their aggressive behaviour (Gatter & Schütt 1999), but these data still need to be analysed further.

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Various nest box types and their suitability for the common dormouse *Muscardinus avellanarius*

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Key words: *Muscardinus avellanarius*, nestbox, competetion

The common dormouse *Muscardinus avellanarius* is known to use nest boxes for birds and dormice throughout its distributional range. Following an initial three-year study (2009-2011) in which we found that dormouse boxes with an internal diameter of 6 cm and an entrance hole measuring 21 mm were used more intensively than bird boxes with a 26 mm entrance hole we set up a scheme comprising various combinations of dormouse boxes differing in internal diameter and sizes of entrance holes to find out which nestbox might be preferred by the species.

In the winter of 2012 a total of 120 wooden nestboxes were set up in a linear array along hedgerows in two sample areas surrounding orchards in a low mountain range near the town of Schluechtern, Germany. For every sample area we laid down a specific horizontal array of four different nestbox types attached to a fencepost that was repeated at intervals of 30 m to ensure that the dormice had the same set of choices at each of the 15 stations.

The nestboxes were set up with their entrance holes facing forward to find out which size might be limitating to other nestbox users such as hole-nesting bird species, e. g. blue tit (*Cyanistes caeruleus*, Syn. *Parus caeruleus*).

The nestboxes were checked once per week from March until the disappearance of dormice in autumn.

In August 2012 a third sample area comprising 60 nestboxes installed in yet another array was set up in the same region and hence checked as described above.
The preliminary results show that the common dormouse seems to choose larger entrance holes when not concerned with competitors such as Apodemus spec. and given the choice between different internal diameters tends to choose the smaller boxes.

Dormice and people: Ukrainian aspect

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Key words: Ukraine, dormice, ecological action.

Introduction

According to the current data four species of dormice are widespread in Ukraine: the edible dormouse *Glis glis* (Linnaeus, 1766), the common dormouse *Muscardinus avellanarius* (Linnaeus, 1758), the forest dormouse *Dryomys nitedula* (Pallas, 1779) and the garden dormouse *Eliomys quercinus* (Linnaeus, 1766). The family Gliridae is a common component of fauna of the country. However, climate arid condition and cutting of forest lead to a reduction of their abundance.

In large Ukrainian biologists tend to ignore the dormice. Thus during 20th – early 21st centuries only a small number of articles have been devoted to these arboreal rodents. For the past more than 100 years only 10 complete publications on dormouse were published in Ukraine, excluding our article. Such small number of substantial publications about Ukrainian dormice has several reasons. First, the dormice are scarce in Ukraine. Second, the research methods are difficult and require considerable work which may not always lead to positive results. Third, there is insufficient funding for dormouse research. Obviously, there is a lack of volunteers and nature lovers due to a minimal focus on dormice by the public in Ukraine.

Ukrainian dormice species are in an information vacuum despite the fact that they inhabit the most forests of the country. So dormice require considerable attention from the society in order to improve the attention of these species. The aim of this work is to highlight the relations between dormice and people in Ukraine in the past and the present. We also aim to prove that Ukrainian dormice deserve to be known and protected.

Material and Methods

The long field investigations (monitoring) were carried out in some areas of Ukraine (Tab. 1). We started to study dormice using artificial nests in 1999 and continue up to the present. Wooden nest-boxes and plastic nest-tubes made by W. Nowakowski were used (Zaytseva & Nowakowski 2012). They were positioned in trees and were monitored monthly or annually. The numerous single observations on dormice were conducted in forests.

We compiled the numerous personal communications about dormice from our colleagues and the public in different regions of Ukraine. Literature sources played an important part of our investigation. We also analysed in detail the results of ecological actions.

Results and Discussion

The role of dormice in the economy is determined by their profit or harm towards people. In different countries they are used in dishes or as beautiful fur (Carpaneto & Cristaldi 1995, Peršič 1998). In some places dormice are used as pests (Morris 2003). In Ukraine all these dormice issues are questionable. There is a lack of special tools for hunting as well as recipes of cooking or methods of keeping dormouse in captivity.

A) *Dormice and cuisine*. The use of dormouse as a food source in modern Ukraine is unknown, while in Europe dishes with dormice are considered a delicacy (Carpaneto & Cristaldi 1995). We found only one quotation from Ukraine: meat of the garden dormouse is quite tasty and good for eating and the edible dormouse is also eaten in Ukraine (Simashko 1851). According to foreign publications Ukrainians used the grease of the edible dormouse in the 19th century (Carpaneto & Cristaldi 1995) and sometimes the meat of this species was also used in food probably in 20th century (Melander et al. 1935 quoted by Rossolimo et al. 2001). At present there is a "gastronomic indifference" toward all species of dormice in Ukraine. Therefore, none of the Ukrainian names of dormice related with meals are found as in other languages, such as English or Italian (Carpaneto & Cristaldi 1995, Morris 2003). Why don't Ukrainians use dormice in food? In our opinion there are several reasons,. First, the Roman Empire, which established the tradition of using dormice in food, affected Ukrainian culture only fragmentarily. Second, low abundance of dormice in Ukrainian forests makes these animals less known to the public, in particular in rural areas.

B) *Dormice and hunting*. There is no tradition of using the dormice fur in Ukraine. Only a few records are mentioned in the literature (Korneev 1952). In some areas of Ukraine the edible dormouse is mentioned as object of trapping for skin with a soft, beautiful and fluffy fur (Korneev 1965) and is recommended to be hunted in early summer (Tatarynov 1956). The fur of the forest dormouse is of good quality and can be used for human needs (Rudyshyn 1998). The fur of the garden dormouse can also be used for fur coat and therefore these dormice species were sometimes hunted in gardens (Simashko 1851). But authors note that hunting of dormice even in areas with high population density is not widely used because of "unprofitability" (Rossolimo et al. 2001). As a result, dormice can only occasionally be classified as "fur game" and not commonly used in Ukraine.

C) *Dormice as pests*. In Ukraine dormice can be considered as a "harmful" species that cause damage in certain sectors of the economy. The edible dormouse is a pest in gardening and winemaking, but in the Ukrainian Carpathian it doesn't cause any significant damage (Sharleman 1920, Pidoplichko 1930, Korneev 1952, 1965, Tatarynov 1956). Also this species is recognized as pest in forestry. Zoologists have noted the damage of tops of young spruce (Picea sp.) and fir (Abies sp.) trees in this region (Zagaykevych & Rudyshyn 1957, Tatarynov 1973, Rossolimo et al. 2001). These rodents eat the bark of young conifers and deciduous trees (Rudyshyn, 1998). However, such records cannot be regarded as serious damage because the damages of trees are local and in small areas (Zagaykevych & Rudyshyn 1957, Rudyshyn 1998).

The forest dormouse is also considered a pest in forestry and gardening because it damages fruits and berries (Pidoplichko 1930, Korneev 1965, Rossolimo et al. 2001). The role of this species as a pest in beekeeping is emphasized by Borodin (2009): these rodents feed by bees or cells; violate the hygienic condition of beehive by leaving insects remains and own excrements; gnaw tents and clothing of beekeepers and contaminate honey (. In contrast, some authors note the forest dormouse as usefull as it eats various harmful insects to forests and bees (Korneev 1965, Rossolimo et al. 2001, Borodin 2009).

The garden dormouse can be considered a pest as it consumes fruits in orchards and chews on animal products in buildings in the forest (Sharleman 1920, Khranevych 1925, Migulin 1938).

Due to their small number the common dormouse is recognized as neutral for forestry because they don't cause significant harm, although records exixt of gnawing of needles and bark of young firs (Tatarynov 1956, Korneev 1965, Rudyshyn 1998, Rossolimo et al. 2001). However, the benefit of this species is indicated by its predation on insects that are harmful to trees (Rudyshyn 1998).

D) *Dormice and hole-nesting birds*. Several hole-nesting birds such as tits (*Parus* spp.) or flycatchers (*Muscicapidae* spp.) eat pest insects in forests. Accordingly the dormice indirectly affect trees when they destroy nests and kill individuals of these birds species. Dormice and hole-nesting birds use similar types of refuges as nests in hollows, under bark and in trunks cavities. The competition for nests by these rodents and birds are worse when using artificial nests. The edible dormouse inhabits nest boxes and is regarded as a competitor to birds (Ayrapetiants 1983, Smogorzhevskiy & Smogorzhevskaya 1990, Rossolimo et al. 2001). The forest dormouse also makes nests in nest boxes in various regions of Ukraine where it causes damage to hole-nesting birds (Matveev 1994, Lebid & Knysh 1998, Shkaran 2009). There were offered protection from dormice: banding trees by smooth paper or gauze with repellent (Rossolimo et al. 2001) or tearing off twigs near nest-box and smearing the tree trunk with solid oil (Smogorzhevskiy & Smogorzhevskaya 1990).

The common dormouse is a common inhabitant of artificial nests in various regions of Ukraine where it is considered also as a competitor to hole-nesting birds (Ayrapetiants 1983, Matveev 1994, 2006, Rossolimo et al. 2001, Shkaran 2009). Several authors even propose killing off dormouse for the protection of the birds (Gvozdak & Simochko 1977).

In our research we observed numerous interactions between hole-nesting birds and dormice in many regions of Ukraine, but significant damage to bird populations was not recorded (Zaytseva 2006, 2008, 2011, Zaytseva & Sagaydak 2011).

In general, the litterature note that all four dormice species have no significance role in the Ukrainian economy. Ukrainians don't hunt them for food nor for their fur. The records of damage to forestry, gardening, winemaking and beekeeping are local. It does not apply to the whole country and does not affect the current national economy. The competition for nest space by dormice and hole-nesting birds do never the less occurr in Ukraine. But in any cases it does not play a significant role to bird populations as inter specific interactions are common for these species. So, the dormice are neutral or indifferent to Ukrainians in economic sense.

Vulnerabilities and protection of dormice in Ukraine

There is an intense anthropogenic transformation of forest ecosystems in Ukraine and the dormice may adapt to some of these transformations of habitats. Other anthropogenic factors negatively affect dormice populations and make them vulnerable:

1 The fragmentation of forests and thus isolation into fragmented areas. The current distribution of dormice in Ukraine is a mosaic.
2 Reduction of the areas of natural forests and their replacement of artificial stands. These are not favourable habitat for reproduction and foraging by dormice.
3 The intensive forestry activities. Cutting down old trees with hollows and thinning underbrush leads to a decrease of refuges for dormice.
4 The direct human impact on forests during picking, hunting and recreation. There is a risk of disturbance of these rodents in refuges as well as destruction of their nests.

The consequence of such anthropogenic effects may reduce the abundance of dormice in different regions of Ukraine, for example, in Polissya, Prydninprovya and Podillya (Belik & Samarskiy 1987, Lozan et al. 1990, Zenina & Zhyla 2000, Zaytseva 2011). But in general most of them have low conservation status. Only the garden dormouse is included in Red Data Book of Ukraine (Akimov I.A. 2009). However, this situation doesn't reflect the stability and status of this species but only indicate the low level of observation and the lack of reliable information on their population size. Four European species of dormice are equally vulnerable and often inhabit the same biotopes. Hence, further investigation should be conducted on their population status in order to consider them for the the Red List of Ukraine This will make the public paying attention to them and perhaps help to protect the dormice.

Ukrainians and dormice

There are many aspects of relations between people and dormice. What should the Ukrainian people know about the dormice? What should they do if accidentally meeting a dormice?

In many cases when people in Ukraine see a dormouse they don't understand what they see. We collected a lot of data of such "meetings" between people and dormice. The edible dormouse is often identified as a "grey squirrel". The common dormouse is often considered as a "red mouse". The nests of dormice on branches of trees and shrubs are often considered as birds' nests. Also forestry workers tell that they see "chipmunks" in the forest. These miss-determinations are specific for dormice. In fact, dormice are unknown to many Ukrainians.

Dormice as pets.

In Ukraine the dormice can be held as pets due to their attractiveness. For example, in the 19th century individuals of the forest dormouse were easily tamed by researchers (Kessler 1851, Simashko 1851). Keeping a dormouse in captivity is a posibility for most Ukrainian families. But in Ukraine only the woodland dormouse (Graphiurus murinus Desmarest, 1822), native to southern and eastern Africa can be bought in pet stores and over internet. Nobody breeds, sells or buys Ukrainian dormice. The woodland dormice has been showen in one of the Ukrainian TV channals as an "African squirrel". Ukrainians do not keep national dormice at home and do not breed any species of dormice which are distributed across the country.

The causes of uncertainty. As a result, the causes of uncertainty of dormice in Ukraine are the following:

1 Dormice are "invisible" in the forest: they are nocturnal and go into hibernation .
2 Dormice are not easily observed.
3 Dormice are not hunted for fur or meat.
4 Dormice are not economical important as pests.
5 Interaction between dormice and hole-nesting birds is unknown to public.
6 Dormice are typical arboreal animals that visually disappear within forests.
7 Most species of dormice are not included in the Red Data Book of Ukraine.
8 Dormice are incorrectly identified by people.

There are many ways to reduce vulnerability of dormice and to minimize the uncertainty of their population status: systematic research (including monitoring) of dormice populations; implementation of habitat conservation as a method of conservation of sensitive species that have a relatively low protection status; and increased public awareness of dormice among people especially young.

Public awareness of dormice. People's understanding of the protection of species is important in the conservation of dormice. The public awareness of dormice in the context of their important role as indicator of a high biodiversity in environmental protection acts could increase their survival in Ukraine. One method of promoting the dormice is the through creation of stamps. However, in Ukraine this applies only to the rare garden dormouse. In 1997 a stamp with this rodent species was printed (Fig. 1). Also this species is shown in the Ukrainian coin collection of the series "Flora and

Figure 1. Post stamp with image of the garden dormouse

fauna". In 1999 the coin "Sonia sadova" (the garden dormouse) were put into circulation with the usual coins of two hryvnia and the silver coin of ten hryvnia (Fig. 2). Other dormice species in Ukraine could be promoted in this way .
Dormice and ecological actions. Most regions of Ukraine are areas of significant agriculture and forest management. A total protection of natural forests that supports dormice with food and refuges is impossible to accomplish. Local actions on dormice are more effective, for example, placing of artificial nests that increase the potential capacity of habitats.

In our view, dormice should be regarded as interesting to the public thanks to:

- Originality – dormice are unknown and their lifestyle is different from other Ukrainian rodents.
- Attractiveness and charisma – dormice are nice to people and have the positive "image": bright fur, fluffy tail, big eyes and the "fluffy ball appearance" when sleeping covered by its tail.
- A secret life – dormice are nocturnal and fall into hibernation.
- Indifferent to the national economy – their main roles are as indicator of a high ecosystems biodiversity.
- High conservation status in the world –dormice are one of the oldest extant rodent families and many species are protected in many countries.
- Cohabitation with humans – some of these dormice species can occur in buildings, gardens and parks.
- Uncommon but not rare – you can watch the dormice in the forest.

Figure 2. The coins with image of the garden dormouse.

In general the dormice are excellent target animal species of ecological action plans of Ukraine forests.

The ecological action "House for dormouse" in Ukraine

In 1999 our investigation of dormice was initiated. Afterward the ecological actions were carried out in different regions of Ukraine. These actions were called "House for dormouse" as the main focus was the production and placement of artificial nests for dormice and subsequently carrying out the monitoring of the species.

The nest-boxes and nest-tubes were made by pupils, students, volunteers and were placed in selected forests. The participants got interesting and useful information about dormice and were taught the technique of placing the artificial nests. Also they received the information booklets "Where do dormice sleep?" and "Dormice and people" about the life of dormice and ways to protect them. All artificial nests were checked and updated by the initiative group of researchers. Results of these actions are presented in Tab. 1.

Thus, the action "House for dormouse" had several important consequences. First, in conservation sense: artificial nest made out as a refuge reserve for dormice. Secondly, the scientific results: data were collected on different aspects of dormice life during the servey of artificial nests. Finally in the sense of ecological education: the involvement of pupils, students and volunteers in making and placing of artificial dormouse nests promote their environmental education.. Inhabitation of nest-boxes and nest-tubes by different species of dormice made a positive impression on participants. They saw the obvious results of own work and usefulness of such actions. These results are positive and confirm the relevance of using the dormice in ecological educational actions.

Table 1. The results of ecological action "House for dormice" in Ukraine

Region	The areas and dates	Co-organizers	Participants	Peculiarities	Results
Khmelnitsky region (Podillya)	45 nest boxes and 100 nest tubes were placed in the national park "Podilski Tovtry" during 2007	Employees of Kamenets-Podilskyy National University (KPNU). The Polish scientists involving PhD W.K. Nowakowski	Students of KPNU	-	The common, the forest and the edible dormice inhabited nest boxes and nest tubes. Individuals and nests were recorded. Successful reproduction of the common dormouse was recorded in these artificial nests
Chernihiv region (Polissya)	40 nest boxes and 40 nest tubes were placed in the regional landscape park "Mizhrichynskyy" during 2007–2009	Employees of the park	Volunteers from the American Chamber of Commerce (in Kiev) and pupils Kozelets district	There was a demonstration of live dormice. The nest boxes were decorated by volunteers.	The forest dormouse inhabited the nest boxes. Individuals and nests were recorded
L'viv region (Roztochcha)	50 nest boxes were placed in the national park "Yavorivskyy" and updated during 2011-2014	Employees of the park	The pupils from Yavoriv district. The teachers and students of L'viv National University (LNU)	There was a demonstration of live dormice and presentation of posters.	The common dormouse inhabited the nest tubes. Individuals and nests were recorded
Volyn region (Polissya)	20 nest tubes were placed in the national park "Shatski Ozera" and updated during 2013-2014	The teachers of LNU	The students of LNU	-	The common dormouse inhabited the nest tubes. Nests were recorded

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Section 2
Abstract from Folia Zoologica vol. 64 no. 4

Dormouse (Gliridae) populations on the northern periphery of their distributional ranges: a review

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Abstract. Geographically peripheral populations are likely to experience suboptimal conditions, and several population characteristics may be influenced. The aim of the present study was to assess characteristics of the populations of hazel, forest and fat dormice on the northern periphery of their ranges in continental Europe in comparison to populations situated in the rest of their ranges. The dormouse populations analysed were found to be distinct from other populations in many aspects of their ecology. On this northern periphery of the ranges, the dormouse activity season is shorter and ends earlier. The population density is also lower, but interannual abundance dynamics are comparatively stable. Except the shorter breeding season however, there is no clear general pattern regarding other aspects of reproduction. The composition of the vegetable food used by dormice is rather specific. Contrary to expectations, the proportion of food of animal origin is not increased in the dormouse diets. The main habitat requirements of dormice are similar to those in other parts of their ranges, though the composition of woody plant species in the dormouse habitats is different. Dormice living on the northern periphery of their ranges show a high degree of adaptability to local conditions, but factors limiting their distribution are not clear yet.

Key words: dormice, activity season, breeding, population parameters, diet,

Nest box usage by old edible dormice (*Glis glis*) in breeding and non-breeding years

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Abstract. Evidence from the only woodland study in the U.K. of the non-native edible dormouse shows (using nest boxes inspected monthly), that whilst some or much breeding occurs in most years, non-breeding years also occur. This is understood to relate to the amount of tree species flowering in spring and their level of flower production. Morris & Morris (2010) used a small sample to show that some adult animals do not appear in the nest box inspection records during the non-breeding years, but are present during the next breeding year. We have subsequently refined and increased the database, collating information on a sample of 222 glis (136 female, 86 male) known to be alive for between 5 and 13 years during a continuous study period of 18 years. The number of old animals (living to at least five years) recorded in nest boxes is significantly different between years of breeding and non-breeding with up to 90 % absent. There is no evidence that they move elsewhere in the isolated wood. Both males and females displayed this trait. The paper discusses alternative explanatory options interpreted from this. The applied science impact is that if 18 month hibernation is proven the time and cost implications for population control planning are severe. Future research is aimed at demonstrating the reality.

Key words: extended hibernation, management, long term trend, climate change

Estimation of *Muscardinus avellanarius* population density by live-trapping

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Abstract. Common dormouse (*Muscardinus avellanarius*) density in Transylvanian Plain is investigated using live-traps. Estimated population size is 39 individuals. Results using non-spatial methods combined with ad hoc calculations of the effective trapping area overestimated common dormouse density, both when using the naïve density estimation (27 ind./ha) and also when the "edge-effect" was accounted for by the addition of a boundary strip (16 ind./ha). Compared with published results using the same methods, our results are yet significantly higher. Spatially explicit capture-recapture approach yields lower density, of 13 ind./ha (maximum likelihood estimate), but still one of the highest densities reported for the species. Interspecific competition for traps was negligible at our study site.

Key words: common dormouse, population size, SECR, effective trapping area

Using integrated population modelling in conservation monitoring: a case study in the common dormouse (*Muscardinus avellanarius*)

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Abstract. Integrated Population Modelling (IPMs) is a computational method for estimating population and demographic parameters that can improve precision relative to traditional methods. Here we compare the precision of IPM to traditional mark-recapture analysis to estimate population parameters in the common dormouse (*Muscardinus avellanarius*). This species is relatively rare across its European range and field estimation of demographic parameters can be challenging, as several parts of the life history are difficult to observe in the field. We develop an IPM model incorporating dormouse nest counts and offspring counts, which is data often recorded as a standard part of dormouse nest box monitoring. We found a significant improvement in precision in the estimation of demographic parameters using IPM compared to standard mark-recapture estimation. We discuss our results in the context of common dormouse conservation monitoring.

Key words: Bayesian population modelling, IPM, population biology, population growth rate

Have feral boar significantly impacted hazel dormouse populations in Sussex, England?

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Abstract. Wild boar, *Sus scrofa* have been extinct in the wild in Britain for ca. 300 years. However, escapees from farm enclosures have been noted for over 20 years in parts of Southeast England, and populations of free-living feral boar have now established. Boar root for food on the woodland ground where hazel dormice, Muscardinus avellanarius hibernate in fragile nests and thus may impact on their population through predation. A group of twelve woodland sites assessed as suitable for supporting dormice and where wild populations of boar were known to have been present for ca. 20 years were chosen in Sussex (boar-positive sites). An additional twelve sites without boar presence (boar-negative) were chosen in the same region from the National Dormouse Monitoring Programme (NDMP). Fifty nest boxes were erected in early spring 2009 at each new site and all were inspected in June and October until the end of 2012. The numbers of individual dormice, empty nests found, and nest boxes used by dormice annually were compared between the two groups. The correlative GLM comparisons (using a negative binomial model) for all three indices were significantly higher in the boar-negative sites, suggesting that boar have negatively impacted on, but not eliminated, dormouse populations. Potential confounding variables including soils and woodland classification were investigated and were similar between the groups. Since the study was over a four year period any initial neophobic reaction to new nest boxes on the boar-positive sites would be unlikely to influence the result. We had no data for boar densities so could not evaluate boar versus dormouse density.

Key words: *Sus scrofa*, *Muscardinus avenallarius*, interspecific interaction

How often does a strictly arboreal mammal voluntarily cross roads? New insights into the behaviour of the hazel dormouse in roadside habitats

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Abstract. Roads are a threat to biological diversity. Especially the hazel dormouse (Muscardinus avellanarius) can be badly influenced by fragmentation due to its strictly arboreal activity. In this study a Northern German dormouse population living in roadside habitats and on road islands was investigated to find out if road crossing is an exceptional behaviour or if it happens regularly. With capturemark-recapture-method 30 crossings (mostly across federal highway, three of them across the federal motorway) and via telemetry 27 crossings over federal highway and smaller streets were observed. Our study gives evidence, that road crossing can be a relatively frequent behaviour, as 18 % of the mark-recaptured and 60 % of the radio marked animals crossed roads, but it remains unclear, under which circumstances road crossing takes place.

Key words: Muscardinus avellanarius, road ecology, barrier effect, motorway

The occurrence of the hazel dormouse, *Muscardinus avellanarius*, in the south-western Baltic region and its biogeographical implications

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Abstract. The occurrence of hazel dormice on some islands in the Baltic Sea raises the question about the origin of these long isolated populations. The spread of hazel dormice from their Pleistocene shelters in southern Europe to the north was facilitated by a rapid spread of hazel during the Boreal after 10800 cal. yr BP and subsequently hazel dominated woodlands in central Europe. The immigration of the hazel dormouse from central Germany to Ruegen is not supported by findings and seems to be unlikely due to habitat fragmentation in the north-eastern German mainland. This is indicated by areas of poor sandy soils with poor pine forests besides wide and sandy river valleys and wetlands. In contrast, immigration via Denmark is rather possible considering the post-glacial development of the south-western Baltic Sea region. Especially the Darss Sill could have been used as a land bridge between south-eastern Denmark and north-eastern Germany about 9800 to 8800 cal. yr BP. A further migration of the species towards the east, e.g. to Bornholm, might be prohibited by the existence of the vast Oder River valley.

Key words: Island populations, vegetation history, Denmark, Mecklenburg-Vorpommern, Ruegen

Assessment of the habitat quality of the forest dormouse (*Dryomys nitedula*) in Daghestan, Russia: role of foods and vegetation structure

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Abstract. The suitability of two forest biotopes (oak and hornbeam-beech forests) for occupation by D. nitedula in Daghestan, Russia is considered. Biotopes have been characterized according to 11 parameters. All 11 vegetation parameters were significantly different between study areas. The indices of D. nitedula success in the studied biotopes demonstrated that numbers were higher in an oak forest than in a hornbeam-beech forest. Estimates of microhabitat distribution showed that D. nitedula individuals prefer to live in shrub associations and in areas with young trees in both biotopes. The body weight of adults and reproduction rate were similar in both biotopes. We concluded that in situation when the body weight and reproduction rates of individual D. nitedula were similar but the numbers of species in the both forest biotopes significantly differ, the structure of woody-shrub vegetation becomes a significant factor.

Key words: numbers, microhabitat distribution, reproduction characteristics, diet, oak forest, hornbeam-beech forest

Phylogeography of the forest dormouse *Dryomys nitedula* (Gliridae, Rodentia) in Russian Plain and the Caucasus

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Abstract. The genetic variation of the forest dormouse *Dryomys nitedula* (Pallas, 1778) from isolated populations of Russian Plain and the Caucasus was investigated using cytochrome b gene (cytb). The genetic distance calculated between these populations of forest dormouse was 9.94 %, which corresponds to the typical distance between biological species of mammals. The genetic distance of cytb between Western and Central Caucasus forest dormouse populations is also significant, 6.0 %. Probably, there was a long-term isolation of European and Caucasian areas of *D. nitedula* during the whole Pleistocene.

Key words: mitochondrial phylogeography, mitochondrial DNA, cytochrome b, haplogroups, taxonomy, D. tichomirovi