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Thigmophilia

De thigmofiel, het verlangen naar geborgenheid [the thigmophile, longing for safety], the latest book from Dutch biologist Midas Dekkers (2015) undoubtedly created a wide recognition of the meaning of the concept of 'thigmophilia', a new term devised by the author. Dekkers defines thigmophilia as a rarely described 'love for touch'. Several readers reported almost immediately understanding exactly what this concept means, even after just reading the title. There is currently a gap in *The Oxford guide to the English language* (1984) between the words 'thigh' and 'thimble'. It will be interesting to see if 'thigmophilia' will plug it. In some Dutch dictionaries the term 'thigmotropie' has been defined as the movement of living organisms in response to their sensory nerve endings. Dekkers, in his ironic style, started his reflections on thigmophilia, after years of observing his cat, which he noticed to be most relaxed when curled–up, in an almost-too-small cardboard box with its head sticking out. Another characteristic of thigmophilia that he also mentions is hiding under an object that provides cover. While he gives many examples of thigmophilia, from the animal kingdom he also expands his reflections to concentrate on the human dimensions of the phenomenon.

Thigmophilia is part of the behaviour of almost all mammals. For example, many bat species hide in narrow crevices during the day time. They enter their roost at dawn, climbing their way into cavities, seeking to contact the surface or each other with both their belly and back. At dusk the bats crawl down to an opening and fly off again until dawn, abandoning their thigmophilia in the wide open air. The non-furred cetaceans never crawl ashore to look for a large object to hide under. While there are reports of belugas rubbing their belly over pebbles during summer in shallow waters of northern estuaries, it is still worth asking whether these sea mammals experience thigmophilia or if the surrounding water acts like a perpetual wetsuit, helping them feel comfortable? Nevertheless, the frequent outbursts of jumping, somersaulting or splashing, that lots of cetaceans engage in, also represent short moments of total non-thigmophilia.

Mammals, which move head-first, rely completely on their senses of hearing, sight, smell and taste for encountering the environment that they are approaching. Moreover, brushes of whiskers that instantaneously act to trigger the slightest movements, seem to serve as thigmophilic guides for small mammals, for example, in narrow spaces between rocks. Brown rats (*Rattus norvegicus*) have certain habits that were first described a long time ago. These can now be interpreted as partial thigmophilia. Observations show how the boldest, colonising individuals rub their flanks against the wall of a new environment, as a way of countering their tendency for neophobia, an inborn shyness for new objects in unfamiliar surroundings. At the same time these colonists leave pungent smells (urine, droppings, sebaceous secretions) as signs for subsequently visiting animals. One question to ask here is whether this behaviour – pressing their flanks against the wall or another individual – is also a common phenomenon in other mammal species.

Reflecting on these examples of partial thigmophilia, I recalled two solid observations that I have made, both during summer camps run by the Dutch Mammal Society's Field Study Group, one in Norway in 1996, the other in Macedonia ten years later.

During the second camp a lesser mole rat (*Nannospalax leucodon*) was captured and placed in a large box in order to take photos of it before releasing it. Most small mammals in this situation ran to and fro, dashing from one wall to the opposite side, before finally hiding in a corner. The lesser mole rat, however, outside its comfort zone, retreated until it came to a wall of the box and then carried on retreating until it reached the corner, where it sat still. It can be argued that, for an animal with only partial eyesight (as lesser mole rats have), dashing to and fro is ineffective. However, a common mole (*Talpa europaea*), described by Dekkers as an ultimate example of thigmophilia, placed in a terrarium begins to shovel with its front paws franticly forwards until it can hide in a hole.

When a group of hoofed animals, such as a herd of buffalos, is attacked by a group of lions, the bulls and mature cows take the 'frontline' positions, with the calves behind them. These front-liners individually make counter attacks, sometimes switching positions and do not permanently maintain physical contact with the other herd members. During an excursion at Dovre Fjell (1996, Norway) we observed a flock of musk ox (*Ovibos moschatus*). When a helicopter came in over a mountain ridge it triggered the scattered herd to cluster together. At the last moment the full-grown animals turned, while pushing their hind sides to each other, forming a complete circle around the calves in the middle. This classical, partial, thigmophilic response was to counter a threat from the outside world.

For me the classic thigmophilic mammal is the noki or dassie rat (*Petromus typicus*), which is found in the southwest of Africa. There, in the desert of Namibia it lives in rocky outcrops, sharing its habitat with the rock hyrax (*Procavia capensis*), both seeking shelter in narrow spaces between rocks. The noki has claimed its niche through a series of exceptional adaptations. Its skull is elongated and flat-topped and the ribs are extremely flexible, making it easier for the animal to squeeze its body in between rocks (Coutzee 2013a). The two pairs of anterior nipples are raised and found behind the shoulders, a peculiar physical adaptation that enables the female to feed the young in narrow crevices, well out of reach of competitors or predators (Coutzee 2013b).

From the point of animal welfare, the notion of thigmophilia can be important for handling animals. Most bat workers know that this is true for several bat species. When holding a bat in a loosely gripped fist, with the thumb under the bat's chin, the animal will soon stop its movements and slow down. However, if a bat, as sometimes is seen on photographs, is held between the pinched thumb and index of both hands, then the animal will show more signs of stress and will keep trying to escape for quite a while. Obviously the bat accepts the loosely gripped fist as a thigmophilic safe haven.

In conclusion, thigmophilia, is probably not a goal in itself. The bottom line for all thigmophilic reactions can be best understood as mutual or as reflexive stress reduction. In the end this may contribute to the fitness of individuals or groups.

Most of this volume is dedicated to a review of the results obtained during the Field Study Group summer camps of the Dutch Mammal Society between 1986 and 2014. This review highlights the foreign activities of the Field Study Group, founded forty years ago. These camps have given members the chance to study aspects of mammal life in 21 different countries.

In this issue, Van der Kooij et al. describe a study on the distribution of the masked shrew (*Sorex caecutiens*). They present new data that shows that the gap in distribution between its core range in northern Scandinavia and a population in the south of Norway is less than thought, making the latter group less isolated. Coincidentally, this article appears alongside one by Bekker et al. describing the summer camp in which an individual masked shrew was caught, although it was not identified at the time.

The outside world is constantly changing and organisms need to adapt to altered circumstances. More robust changes in biotopes and the consequences for mammals are not often studied. In this volume, Van Boekel describes the drastic changes in the small mammal community that occurred in response to a major biotope change in a Dutch nature reserve.

Research and proper reporting never ends. The study in the last issue of Lutra by Thissen et al. (2015) on the Pannonic root vole (*Microtus oeconomus mehelyi*) in Austria, near the border of Hungary and Slovakia, is extended in this volume by two new records, which confirm that the historically known range of this endemic subspecies as a whole has remained intact.

Coetzee, C.G. 2013a. *Petromus typicus* Noki (Dassie Rat). In: D. Happold (ed.). Mammals of Africa, Volume III: Rodents, Hares and Rabbits: 681-682. Bloomsbury Publishing, London, UK.

Coetzee, C.G. 2013b. Family Petromuridae Noki (Dassie Rat). In: D. Happold (ed.). Mammals of Africa, Volume III: Rodents, Hares and Rabbits: 680. Bloomsbury Publishing, London, UK.

Dekkers, M. 2015. De thigmofiel; het verlangen naar geborgenheid. Uitgeverij Atlas Contact, Amsterdam, the Netherlands.

Thissen, J.B.M., D.L. Bekker, K. Spreitzer & B. Herzig-Straschil 2015. The distribution of the Pannonic root vole (*Microtus oeconomus mehelyi* Ehik, 1928) in Austria. Lutra 57 (2): 3-22.

Jan Piet Bekker

Redactionele mededeling

Bij het afsluiten in 2010 van Deel 53 van Lutra gaf de redactie aan dat in het vervolg alleen in het Engels gestelde artikelen in Lutra zouden worden opgenomen. En dat beleid heeft de redactie sindsdien ook gerealiseerd. De redactie wilde op die wijze het internationale karakter van Lutra versterken: alles voor 'iedereen' direct leesbaar en daarmee bruikbaar. Bij het gelijktijdig handhaven van de altijd door de redactie gestelde wetenschappelijke kwaliteitseisen zou dan vroeg of laat ook de zeker toen nog zo gewaardeerde opname in *Web of Science*, en de daarbij behorende *impact factor*, behaald kunnen worden. Daarbij was de gedachte dat het zodoende voor meer onderzoekers interessant zou worden om bij Lutra een manuscript aan te bieden, zo mogelijk resulterend in publicatie van dat manuscript in Lutra. Het laatste zou natuurlijk ook en vooral voor de lezer / gebruiker van Lutra de moeite waard zijn.

Hoewel naar de mening van de redactie de wetenschappelijke kwaliteit altijd geborgd is gebleven, was een aanvraag enkele jaren later om in aanmerking te komen voor zo'n score niet succesvol. Daarbij was een teleurstellend aspect dat niet zozeer de kwaliteit van de inhoud van Lutra, als wel het argument dat er al zo veel zoogdierkundige tijdschriften zouden verschijnen voor de beoordelaar doorslaggevend. De praktijk leerde de redactie tegelijkertijd dat het aantal aangeboden manuscripten niet toenam maar juist afnam, waarbij het er, paradoxaal genoeg, op leek dat juist het nìet verkrijgen van die *impact factor* contraproductief werkte.

In de afgelopen jaren ontving de redactie regelmatig signalen van potentiële auteurs die inhielden dat zij op zich wel in Lutra zouden willen publiceren, maar dat ze dat gezien het gebruik van het Engels bezwaarlijk vonden.

Beide ontwikkelingen, 'minder ingediende manuscripten' en 'niet in het Engels willen of kunnen publiceren', leidden tot vragen binnen de redactie over het nieuwe taalbeleid. Bovendien werden er binnen en buiten de redactie steeds vaker vragen gesteld rond die *impact factor*, zoals: is het middel (wetenschappelijke punten, dat wil zeggen, status en aanzien verzamelen in plaats van wetenschappelijk nieuws brengen) niet doel op zich aan het worden?

Op basis van bovenstaande ontwikkelingen en overwegingen heeft de redactie besloten het besluit om alleen Engelstalige manuscripten te publiceren weer terug te draaien. Dit betekent dat met ingang van Deel 59 (2016) naast in het Engels gestelde manuscripten ook in het Nederlands gestelde manuscripten weer kunnen worden ingediend.

De redactie hoopt op deze wijze de stroom van ingediende manuscripten te vergroten. De behandeling van de manuscripten zal hetzelfde blijven, met name voor wat betreft de borging van de wetenschappelijke kwaliteit.

Kees J. Canters, hoofdredacteur

From meadows to marshland - response of small mammal populations

Wim H.M. van Boekel

de Westerd 12, NL-9321 AK Peize, the Netherlands, e-mail: wvanboekel@home.nl

Abstract: In January 2012, nature reserve De Onlanden, located in the northern part of the Netherlands, changed suddenly from a meadows and hayfield biotope on peat soil into a large-scale marshland biotope and water containment area. The effects of this sudden and major biotope change on the small mammal population in De Onlanden were studied. Monitoring was done by live-trapping of small mammals during the summer periods in the years before and after the biotope change. The small mammal populations changed completely as a result of the transition of relatively dry meadow biotopes with annual mowing and grazing into marshland biotopes with strong water-level fluctuations and uncontrolled vegetation development. Common vole (*Microtus arvalis*) almost completely disappeared from De Onlanden, even in the remaining grassland areas, probably as a result of high water levels in winter. Field vole (*Microtus agrestis*) numbers also declined, but the species could still be found at locations with dense vegetation and relatively low water levels. Shrew species increased their numbers in marshland biotopes. Common shrew (*Sorex araneus*) was present in high numbers before the biotope change, but was found in the marshlands in even higher numbers. Water shrew (*Neomys fodiens*) profited most of the biotope change. By the end of the study it occupied the whole study area. Locally, exceptionally high numbers were captured. Pygmy shrew (*Sorex minutus*) also started to appear at several locations by the end of the study. No evidence was found for food resource competition between the shrew species.

Keywords: De Onlanden, common vole, field vole, common shrew, water shrew, pygmy shrew, biotope change, monitoring, live-trapping, water management.

Introduction

In the Netherlands there is a growing need for capacity to store increasing amounts of surface water produced by heavy rainfall, as a result of climate change. One of the solutions for this storage problem is the transformation of rural grounds into water containment areas. This transformation often results in major biotope changes. Water levels are raised and the management regime of the area is changed. The effects of such biotope changes on nature in the area are predicted during the planning phase of the transformation project, and are sometimes monitored for certain critical species or communities after the transformation has been established. The effects can also be noticed, on a macroscopic level, by nature managers and visitors of the area. However, for many species living in the newly established water containment areas, the effects of the transformation on population size or distribution over the area are largely unknown or only poorly described.

In the northern part of the Netherlands, the nature reserve De Onlanden was also designated as a water containment area. Therefore, the largest part of the reserve has recently been transformed. From a farmland area, consisting of meadows and hayfields on peat soil with fixed surface water levels, it has turned into a marshland with much higher water levels and stronger fluctuations. The largest part of the area is now unattended, since high water levels make maintenance by mowing or grazing impossible. The resulting vegetation development in this part of De Onlanden contributed considerably to the large biotope change that has occurred.

The water shrew (*Neomys fodiens*) is adapted to wet biotopes and prefers clear, relatively deep water, like streams, large ditches, or ponds (Carter & Churchfield 2006). With its water repelling coat and fringes of stiff hairs on its back feet and tail to propel itself, it can dive up to 2.5 metres deep in search for food (like small invertebrates) in the water (Vogel et al. 1998). In the Netherlands the water shrew is a relatively rare species and is usually found in low densities during monitoring with live-traps in suitable biotopes (van Bemmel & Voesenek 1984, La Haye & Haan 1998, Bekker 2010, van der Linden & van der Weijden 2011). Before the transformation of De Onlanden, the occurrence of the water shrew was known here from a few locations through monitoring (R. Haselager, unpublished report; Bekker 2009), sightings (R. Blaauw and R. Oosterhuis, personal communication) and as prey in barn owl (*Tyto alba*) pellets (W. van Boekel, unpublished results).

The aim of this study was to monitor the changes occurring in the small mammal populations in De Onlanden as a result of the large and sudden biotope changes. It was predicted that the water shrew would clearly benefit from this change and that other species, such as common vole (*Microtus arvalis*) and common shrew (*Sorex araneus*), would be negatively affected. Since a comparable study had not been performed before, no prediction could be made about the speed of these changes.

Study area

De Onlanden is a nature reserve of about 3000 hectares, situated southwest of the city of Groningen in the northern part of the Netherlands (figure 1A). Two small rivers, Peizerdiep and Eelderdiep, run through the area from south to north. In the western part of the reserve lake Leekstermeer is situated. Until recently, most biotopes of the area consisted of extensively managed meadows and hayfields on peat soil, with fixed surface water levels, controlled by pumping stations. Management consisted of low density grazing by cattle or sheep. Mowing was done once a year, at the end of the summer period. Patches of marsh forest, dominated by black alder (*Alnus glutinosa*), grew in De Onlanden in places where in the past open water existed, like sites where peat soil had been excavated (figure 1B). These forest patches were not managed.

Between 2008 and 2012, the largest part of De Onlanden was transformed into marshland, serving as a water containment area designed to prevent flooding of inhabited areas in case of heavy rainfall. For this purpose a number of channels were dug out that connect the two small rivers to lake Leekstermeer (figure 1A). Also, much of the topsoil layer around these channels was removed to allow water to spread out over the whole area more easily. Dikes were built around De Onlanden in order to contain the water within the area. As a result of these changes, large parts of De Onlanden have turned into marshes or open water. Water level is no longer fixed, but is allowed to fluctuate depending on the amount of rainfall in the catchment area of the rivers. The higher water levels in the area serve nature conservation objectives too. In parts of De Onlanden to the south and directly east of lake Leekstermeer, water levels were raised in 2011. In the remaining area water levels were raised from the beginning of 2012.

Before 2012 the main biotope of De Onlanden consisted of the aforementioned grasslands on peat soil (figure 2A). Management by grazing and mowing resulted in low and relatively uniform vegetation, consisting mainly of grasses and herbs. At some places soft rush (*Juncus effusus*) dominated the veg-

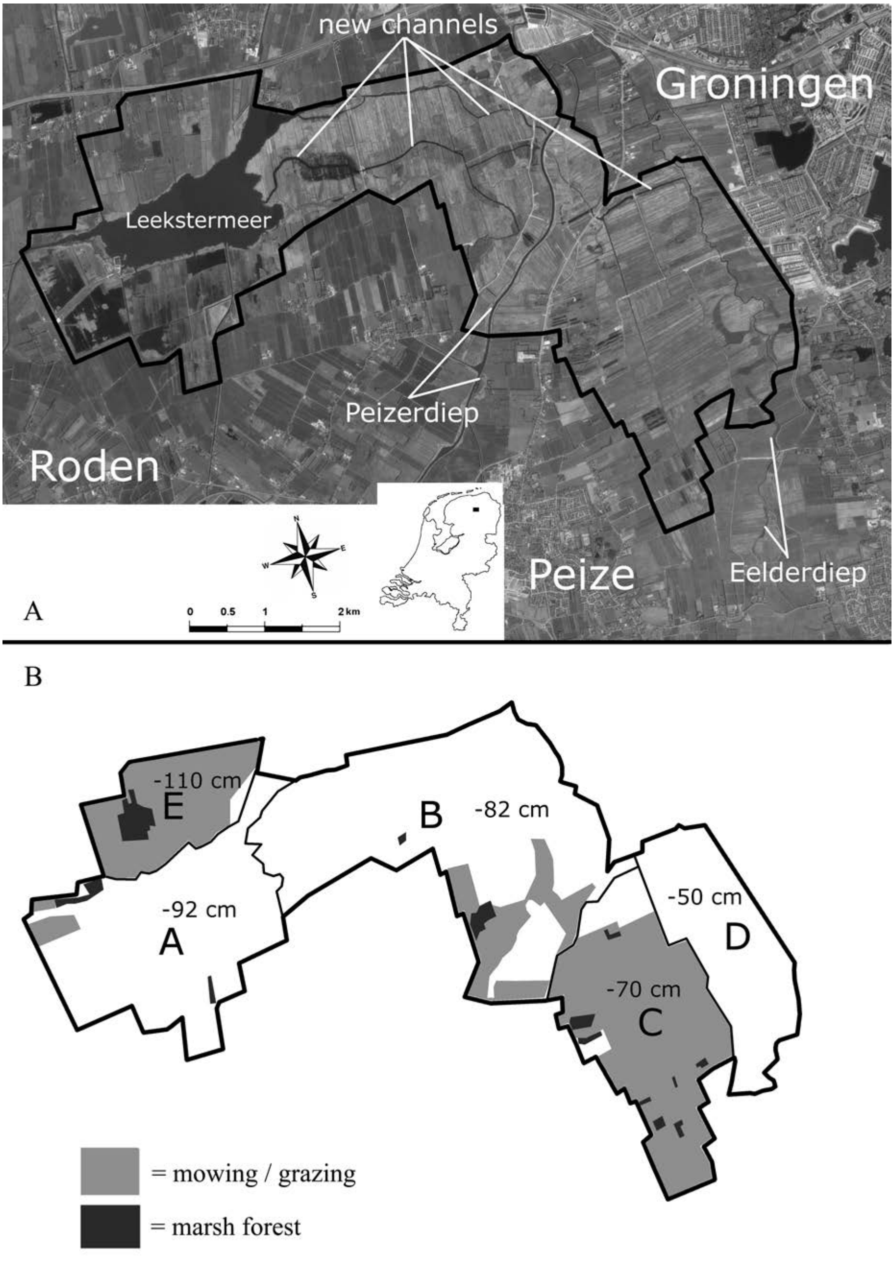

Figure 1. Location and area of De Onlanden in the northern part of the Netherlands. A. Aerial photo (with courtesy: Eurosense B.V.) of the situation in De Onlanden after the transformation into a water containment area, but before the water was let in. The newly dug channels are clearly visible. The black line marks the border of the study area. B. Parts of the study area with different surface water level regimes (in cm below standard sea level) after the biotope change (with courtesy: Waterschap Noorderzijlvest). Areas where mowing and/or grazing still occurred and the locations of the patches of marsh forest are also shown.

A

B

Figure 2. Example of the biotope change from meadow (A; photo taken in January 2009) to marshland (B; photo taken in September 2015) in De Onlanden as a result of the transformation to a water containment area. At this location (subarea B in figure 1B) the surface water level was raised by 30 cm in 2012. *Photos: Wim van Boekel.*

etation. Ditches and other water courses were cleared of excess vegetation yearly. Water level was kept constant at -110 cm NAP (i.e. 110 cm below standard sea level) in summer and -130 cm NAP in winter. Mean ground level was -80 cm NAP.

After the transition to water containment area and marshland a variety of biotopes were formed in De Onlanden, ranging from open water through marshlands with different mean water levels to grasslands with water levels just below ground level. Only the area to the north of lake Leekstermeer remained unchanged (subarea A in figure 1B). Minimum surface water levels were raised by 20 to 60 cm and varied in different parts of De Onlanden, due to several barrages in the watercourses (figure 1B). Water levels could fluctuate continuously, mostly in the range of ± 10 cm. In the winter months, water levels could rise by 20 to 50 cm over periods of weeks. In some parts of De Onlanden, management by mowing and grazing continued after the biotope change (figure 1B), but in the marshland areas this type of management was no longer possible. Here the vegetation was allowed to develop freely, with at most locations a much higher and more dense vegetation as a result (figure 2B). Reeds (*Phragmites australis*), sedges or soft rush dominated here. In marshlands with relatively low water levels, patches of grassland remained.

On 4 January 2012, De Onlanden was prematurely taken into use as a water containment area in order to prevent flooding of populated areas in the northern part of the Netherlands, caused by heavy rainfall in the preceding week. Within 48 hours the water level in De Onlanden was raised by 50-70 cm. The largest part of the area disappeared under water. After two days the water had started to run off and after a week, the water level had dropped to the new situation described above. The biotope change in De Onlanden was therefore not a slow transition, but occurred in a matter of days. Since then, water levels have been changing constantly, being relatively high in the winter period and low in summer.

Methods

The small mammal population was monitored yearly in the summer period (end of May until end of September), during the years 2009-2015. Each year 24 to 31 locations within the study area were sampled by live-trapping, except for 2009 when eight locations were sampled. Locations were chosen as to cover the whole study area in a two-year period. Locations were evenly distributed throughout the area within each trapping season. In trying to ensure that the monitoring included all small mammal species present, locations representing the variety of biotopes were chosen. For instance, after the biotope change traplines were placed in marshlands with different water levels, but also in the remaining meadows and hayfields and in the forest patches. Most locations were associated with ditches or larger channels in the area, in order to include the biotope of the water shrew, but traplines were also placed in the centre of fields or in marshes with water at ground level.

At each location a trapline was placed consisting of 20 Longworth live-traps in pairs at ten metre intervals. Traps were filled with hay, living mealworms (*Tenebrio molitor* larvae) and a piece of carrot. After two nights of prebaiting with secured trapdoors, three nights of trapping followed. Full details of the trapping method and procedure are described in van Boekel (2013). For each location a vegetation type description was made, and surface water level relative to ground level was noted.

Of all captured animals, except for water shrews, some hair on the back was clipped for recognition of recaptured animals. Water shrews were not clipped, since this might affect the water repellent properties of their coat. For recognition of previously captured water shrews their weight and the combina-

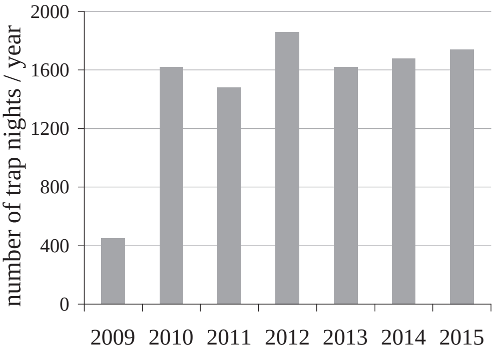

Figure 3. The total number of trap nights established during each year of the research period in De Onlanden.

tions of markings on their coat (i.e. white spots near eyes or on ear- and tailtips, black spots and stripes on belly or throat) were noted. In general, water shrews could well be recognised individually with this method, but at high densities (more than ten individuals caught in one trapline) recognition was not always certain. In cases of doubt, it was assumed that the animal had already been captured before in that trapline. At high densities of water shrews, the presented numbers are therefore minimum numbers of individuals.

Until now, there is no evidence that Millet's shrew (*Sorex coronatus*) lives in De Onlanden. In barn owl pellets from all locations in and around this area only skulls of common shrews were found (W. van Boekel, personal observations). It was therefore assumed that all captured animals of the *Sorex araneus/coronatus* group were common shrews.

Results

For the research period of 2009-2015 the number of trap nights per trapping season is given in figure 3. Some variation in trapping effort occurred between years, due to weather conditions and available time. In 2009 trapping could only be done at the end of the season, resulting in a much lower number of trap nights.

Over the study period the small mammal population showed a distinct change in the species composition (figure 4). The numbers of common voles and field voles (*Microtus agrestis*) that were caught in the traps were high in 2009 and 2011, when at some locations 20-25 individuals of common vole were trapped. From 2012 on, numbers of these voles were far lower. Compared with the period before the biotope change, common vole had disappeared almost completely from the study area (figure 5). Even in the biotopes that strongly resembled the former grasslands (mostly situated in subarea C in figure 1B), common voles could only be found in very low numbers. The total numbers of field voles caught in the last two years of the study period exceeded the numbers of common voles.

Numbers of the different shrew species increased during the study period (figure 4). This increase was most prominent for water shrew. The spatial distribution of captures of this species showed that water shrews colonised the complete area by the end of the study period (figure 6). By then, water shrews were found in high densities in the marshland biotopes. Largest number of animals (up to 15 individuals) was caught at locations with a half-open vegetation of *Juncus effusus* or reed sweet-grass (*Glyceria maxima*), with a water level at, or just above, mowing field, and with no open water at close range. At the end of the study period, water shrews were also found in low numbers along ditches in the yearly managed grassland biotopes. High numbers were also caught in some of the forest patches. In the large grove in area E up to ten individuals per trapline were caught.

Common shrews were caught in all biotopes within the study area, both before and after the biotope change. Numbers caught per location ranged from 1 to 27 individuals. The numbers of common shrew caught per 100 trap nights showed some increase over the study period, but also fluctuated between years.

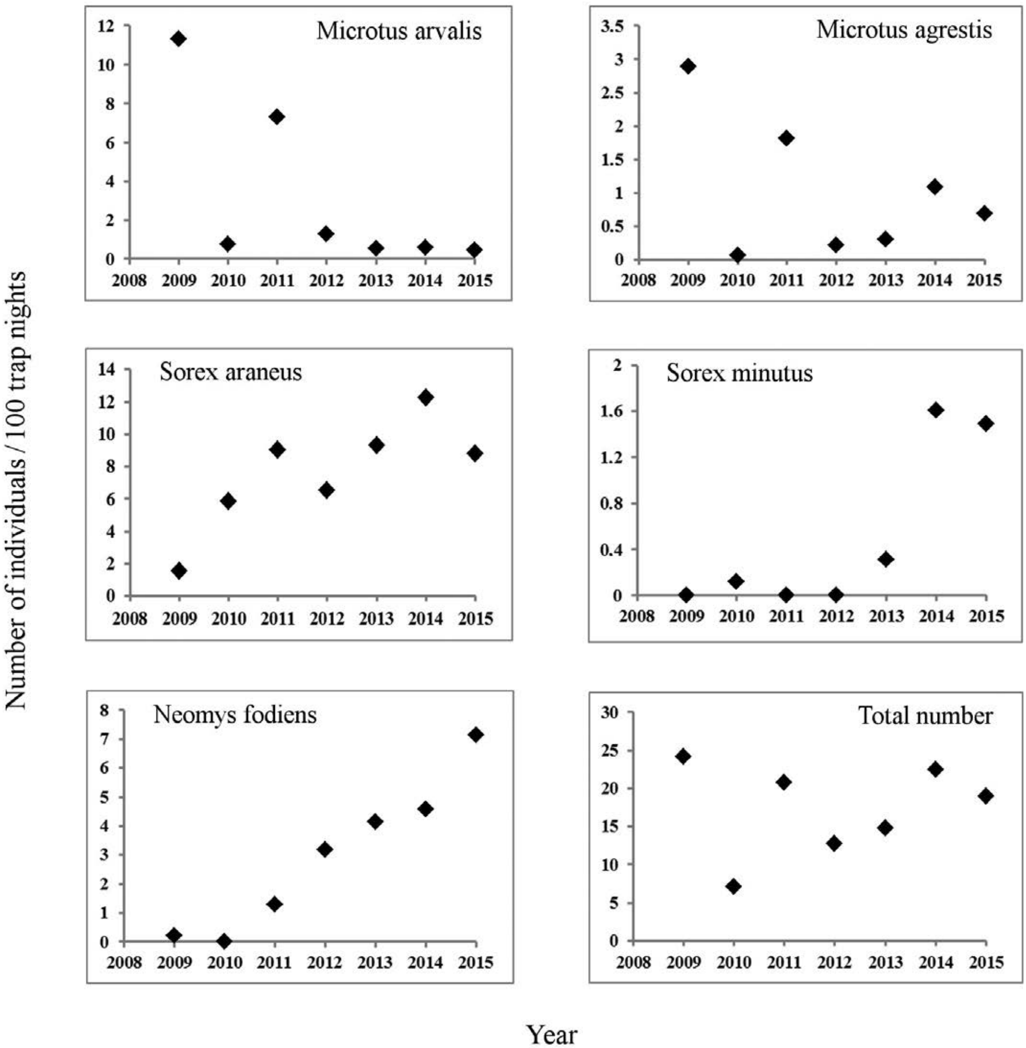

Figure 4. The numbers of individuals of common vole (*Microtus arvalis*), field vole (*Microtus agrestis*), common shrew (*Sorex araneus*), water shrew (*Neomys fodiens*) and pygmy shrew (*Sorex minutus*), and the total number of all small mammals captured per 100 trap nights, in each year of the research period in De Onlanden. Note the different scales of the y-axes.

Pygmy shrew (*Sorex minutus*) started to appear at several locations in the last two years of the study period. This species was found both in the forest patches and in marshland biotopes with dense vegetation.

Other small mammal species that were captured were bank vole (*Myodes glareolus*), wood mouse (*Apodemus sylvaticus*), harvest mouse (*Micromys minutus*), water vole (*Arvicola amphibius*) and white-toothed shrew (*Crocidura russula*). These species were captured only occasionally in very low numbers (water vole and white-toothed shrew) or locally in, sometimes, large numbers (bank vole and wood mouse in some of the forest patches). Nests of harvest mouse were found at some of the locations where the species was not captured with traps. At other locations

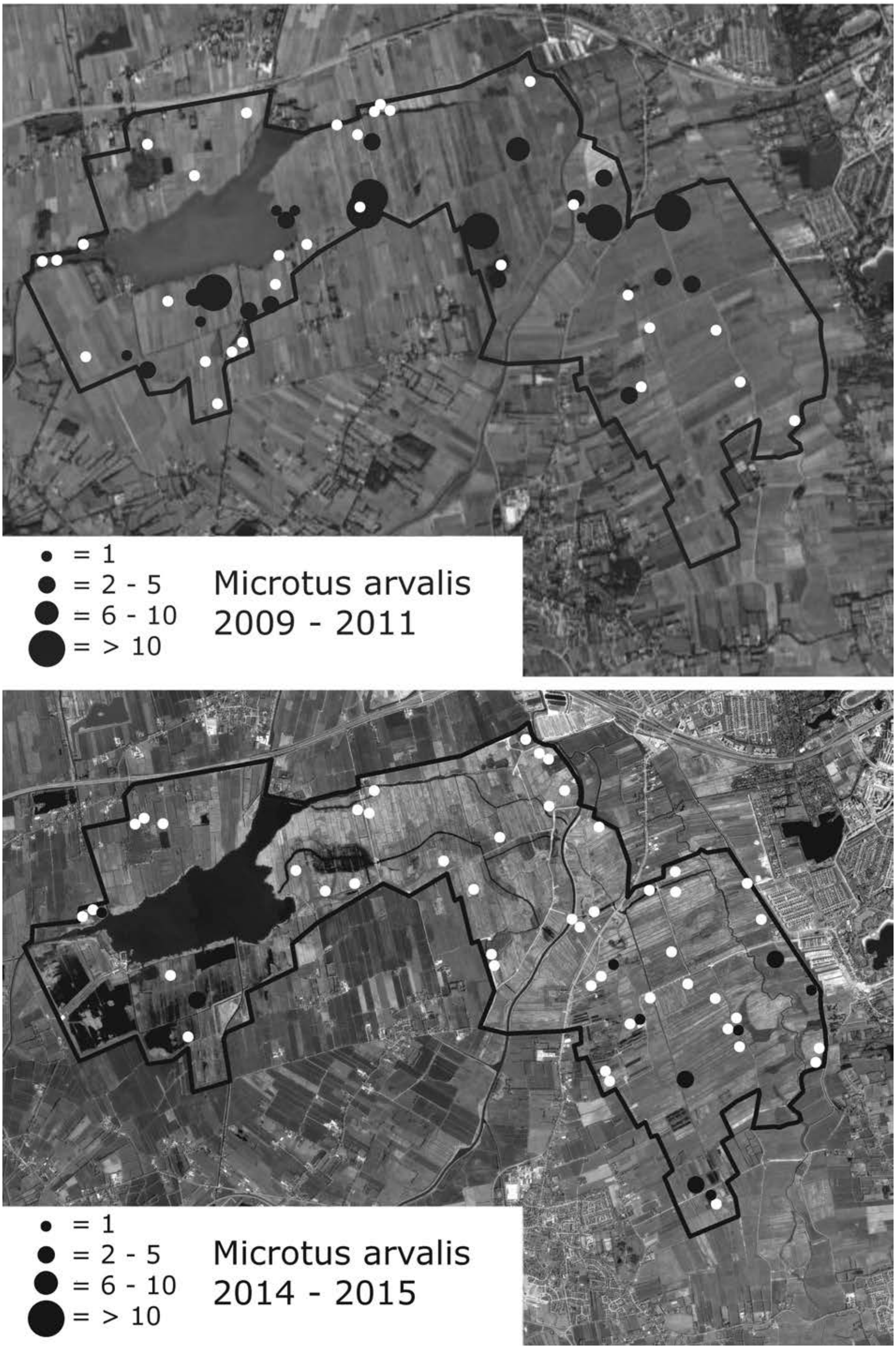

Figure 5. Distribution of trapping locations in De Onlanden and of common vole (*Microtus arvalis*) numbers captured at these locations in the years 2009-2011 (top) and 2014-2015 (bottom). White dots indicate that no common voles were captured at these locations. Note the differences in topography visible in the background aerial photos (sources: Google Earth, 2005 and Eurosense B.V., 2011).

relatively high numbers (up to twelve individuals) of harvest mouse were captured. In general, the annual numbers captured of these species were too low to show a trend during the research period.

The total number of small mammals captured per 100 trap nights fluctuated between years (figure 4). In the first years of the study the total number of captures was largely determined by voles. 2010 clearly was a year with relatively few captures, especially of voles. In the last years, the total number of captures was determined almost solely by shrews.

Discussion

As far as known to the author, this is the first time in the Netherlands that the response of small mammal populations to a large and sudden biotope change in an area of this scale has been followed over a period of years. The transition in De Onlanden of a grassland area into a marshland resulted in a rapid, major shift in small mammal species composition and relative densities. The dominant grassland species, the common vole, almost completely disappeared, even in the remaining grassland biotopes. Shrew species became dominant in the marshland biotopes, with common shrew and water shrew reaching almost equally high numbers. Both shrew species also dominated the small mammal population in the forest patches and in the remaining grassland biotopes. By the end of the study period the pygmy shrew had started to appear at several locations in the marshes. Bauer (1960) also found a dominance of shrews in the marshes surrounding the Neusiedler See in Austria. Shrews formed 62% of the total number of small mammals caught there. The common shrew was found to be most abundant, followed in numbers by the root vole (*Microtus oeconomus*), harvest mouse and water shrew.

The decline of the common vole population as a result of the biotope change in De Onlanden was larger than expected. Before 2012, the grassland biotope with its extensive management regime was found to inhabit large numbers of these voles in some years (figure 3 and Bekker 2009). Voles are known to have cycles of alternating good and poor years (van Wijngaarden 1957, Dekker & Bekker 2008). In De Onlanden, 2010 was a poor year, but in 2009 and 2011 high densities of common vole, with up to 25 individuals caught per trapline, were found at many locations in the area. In 2012, after the transition to marshland, the maximum number of common voles caught was eleven per trapline, while in the following years this number never exceeded four individuals. At many of the grassland locations common vole was not found at all. In the northern part of the Netherlands, 2014 was a year with extremely high common vole densities (c.f. Kleefstra et al. 2015, Wijnandts 2015), causing much damage to farmlands. In De Onlanden however, this common vole peak did not occur. Bauer (1960) suggested that the shortage of suitable food sources was the reason that voles and mice were almost absent from the marshes surrounding the Neusiedler See. In De Onlanden, food shortage does not explain the disappearance of the common vole, since at many locations suitable food, like grasses and herbs, could still be found. A possible explanation for the decline of the common vole population in the remaining grassland biotopes in De Onlanden may be the high surface and groundwater levels, especially in the winter period. Common voles usually live in burrows (Niethammer & Krapp 1982). From 2012 on, water levels in the remaining grassland areas in De Onlanden were mostly too high for burrowing. Shelter and nesting places for common voles were therefore scarce in the grasslands, which likely resulted in the decline of their numbers.

Like the common vole, field voles showed peak numbers in 2009 and 2011 too (figure 3), but at a smaller scale. Field vole numbers also declined after the transition. Compared to common vole, field vole is more adapted to wet biotopes with high, natural vegetation in which it often makes above-ground nests (Krapp & Niethammer 1982). After the biotope change, the highest numbers of field voles were found in the unmanaged areas of De Onlanden, where the vegetation offered more nesting opportunities. In the marshes of the Neusiedler See, root vole was found to be the most abundant vole species (Bauer 1960). This species does not live in De Onlanden, but it is found in other marshland areas in the Netherlands (La Haye & Haan 1998). It is likely that the root vole would be able to colonise the marshes in De Onlanden if it were able to migrate into it.

Even though it was assumed beforehand that water shrews would benefit from the biotope change in De Onlanden, the fast expansion of occupied area by the species and of the high numbers of individuals over the whole of the study area was not expected. At the time of writing, De Onlanden has become a major living area for water shrews in the Netherlands, with an unprecedented high population density. The number of individuals caught per 100 trap nights can be used as a relative measure for the density of the population. In other study areas in the Netherlands, with comparable marshland biotopes, like the Wieden/Weerribben (Haan 1999) and the Fochteloërveen (van der Linden & van der Weijden 2011), where the same trapping method was used, captures of water shrews were found to be 1.2-1.4 and 1.8 individuals per 100 trap nights, respectively. Numbers of 4.6 and 7.1 individuals per 100 trap nights, as found in De Onlanden during the last two years of this study, have not been mentioned in literature before. The almost linear increase of numbers caught, as shown in figure 4, suggests that the population of the water shrew in De Onlanden might even expand further over the next years. In the last year of the research period water shrews were found in biotopes that might be suboptimal for the species (Spitzenberger 1990), like grassland areas and some of the dikes, suggesting that locally the population in the optimal marshland biotope had reached its maximum density. At the same time, not all marshland territory in De Onlanden had yet been colonised by the species (figure 6), indicating that in some areas the population might still expand.

Harvest mice were only occasionally captured during the research period (at 10 out of 175 trapping locations). Usually, one to four individuals were captured, but at some locations larger numbers (with a maximum of twelve) were found. Monitoring of harvest mice with live-traps is known to be difficult, since this species lives in the top of high vegetation most of the time. In De Onlanden, this high vegetation developed in large areas of the unmanaged marshlands after the biotope change. Probably, the harvest mouse population increased in these areas, but the present study was unable to confirm this. Analyses of pellets of barn owls roosting at sites within De Onlanden showed a marked increase of the proportion of harvest mice in the yearly total of preys captured. Before 2012 harvest mice formed 2.5% (±1.36) of the prey of barn owls, increasing to 16.3% (±2.3) from 2012 onwards. Also, in the winter periods after 2012 the menu of specific barn owl individuals could exist for more than 50% of harvest mice (W. van Boekel, unpublished results). These findings indicate that the harvest mouse population has increased substantially in De Onlanden.

The three different shrew species captured in De Onlanden are often found living together in the same biotopes and are therefore potential competitors for the available food. Field and laboratory research has shown that each shrew species has its own range of food size and composition and that there is only partial overlap of food preferences between water-, common- and pygmy shrew (Churchfield 1991, Kirkland 1991, Rychlik & Jancewicz 2002, Churchfield & Rychlik 2006). Ellenbroek (1990) showed that territory size and feeding behaviour of pygmy shrews were not influenced by the presence or absence

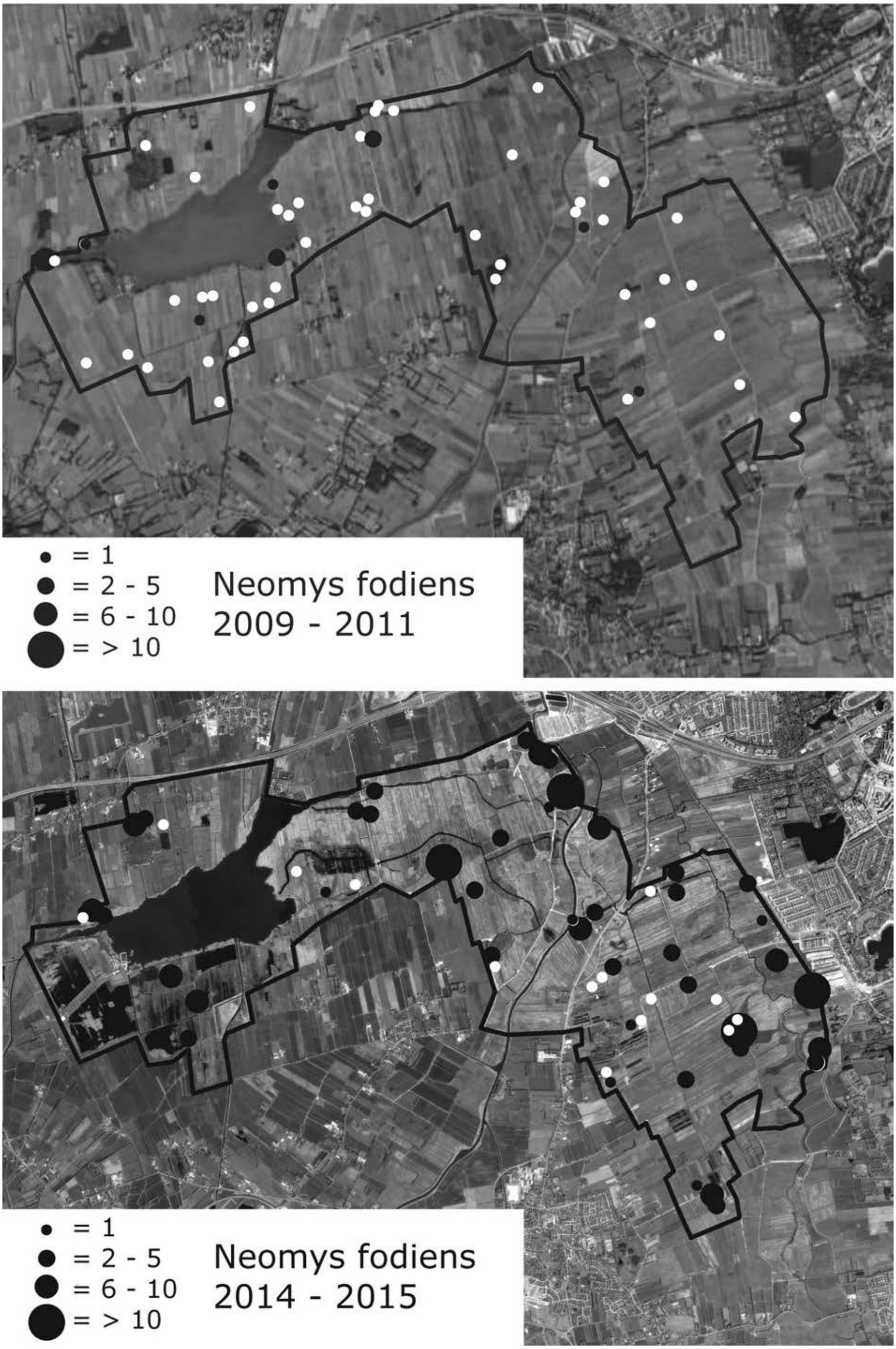

Figure 6. Distribution of trapping locations in De Onlanden and of water shrew (*Neomys fodiens*) numbers captured at these locations in the years 2009-2011 (top) and 2014-2015 (bottom). White dots indicate that no water shrews were captured at these locations. Note the differences in topography visible in the background aerial photos (sources: Google Earth, 2005 and Eurosense B.V., 2011).

of common shrews, both in laboratory situations as in field situations. He concluded that both species occupied a different niche, thereby avoiding interspecific competition. Ellenbroek (1990) suggested that intraspecific competition for the available food sources probably was more important for determining the number of individuals and territory size of each shrew species. Churchfield et al. (1997) studied seven species of shrews living together in different compositions and numbers in the Siberian taiga. They also concluded that each species occupied a specific niche and that the numbers of each species depended on the available food sources and vegetation structure, not on competition between species. During the last two years of the study in De Onlanden, large numbers of water shrew, common shrew and sometimes pygmy shrew were found living together in the same biotopes. For these locations no indications of competition could be found from the relations between their numbers. In general, with increasing total shrew numbers, all shrew species showed an increase in numbers (figure 7). Apparently, inter- or intraspecific food resource competition did not determine their numbers. The ability to find food under water is often seen as an important capacity for water shrew, enabling it to live together with common shrew (Churchfield 1984). In De Onlanden, even in biotopes without open water, where water shrew was not able to escape possible food competition with common shrew by finding food under water, both species were found living together in high densities. In these biotopes large amounts of water slaters (*Asellus* sp.) and freshwater shrimps (*Gammarus* sp.) could be found in the wet debris layer (W. van Boekel, personal observations). These Crustaceans are known to form a major part of the diet of water shrews in many biotopes (Carter & Churchfield 2006). Possibly, in De Onlanden these preys formed a major food source for both water shrews and common shrews at many marshland locations, enabling these species to live together in high densities. The populations of the shrew species, especially water shrew and pygmy shrew, in De Onlanden are probably still growing (figure 4). It will be interesting to study the future developments in these shrew populations.

Shrews are known as solitary living animals, which defend their food territory against individuals of the same species and often also against other shrew species. During the reproductive season (April-October) the females are most fierce in defending their territory. Only their young are tolerated until these are mature, while male shrews are only tolerated for mating. Males are mostly found wandering around in search of females (Saarikko 1989, Cantoni 1993, Krushinska et al. 1994). Because of this territorial behaviour of shrews, common shrews and water shrews are usually found in relatively low densities even in optimal habitats. Carter & Churchfield (2006) mention maximum densities of three to five individuals per hectare for water shrew in watercress beds (which is considered to be an optimal habitat for this species in the United Kingdom). Van der Linden & van der Weijden (2011), using live-traps, captured 1.8 water shrews and 5.6 common shrews per 100 trap nights in their study in the marshes of the Fochteloërveen in the Netherlands, which is also considered to be an optimal habitat for water shrew in the Netherlands (D.L. Bekker, personal communication). During the last year of the present study, the numbers of individuals caught per trapline of 90 metres length ranged from 0 to 27 for common shrew and 0 to 15 for water shrew. The, sometimes, extremely high shrew densities found at many locations in De Onlanden could indicate that here territories of shrews are comparatively small, due to an abundance of food resources (Ellenbroek 1990), or that the territorial system that is found in other biotopes is not present in De Onlanden. Further study on territorial behaviour of shrews in De Onlanden is needed to elude this phenomenon.

How the small mammal populations in De

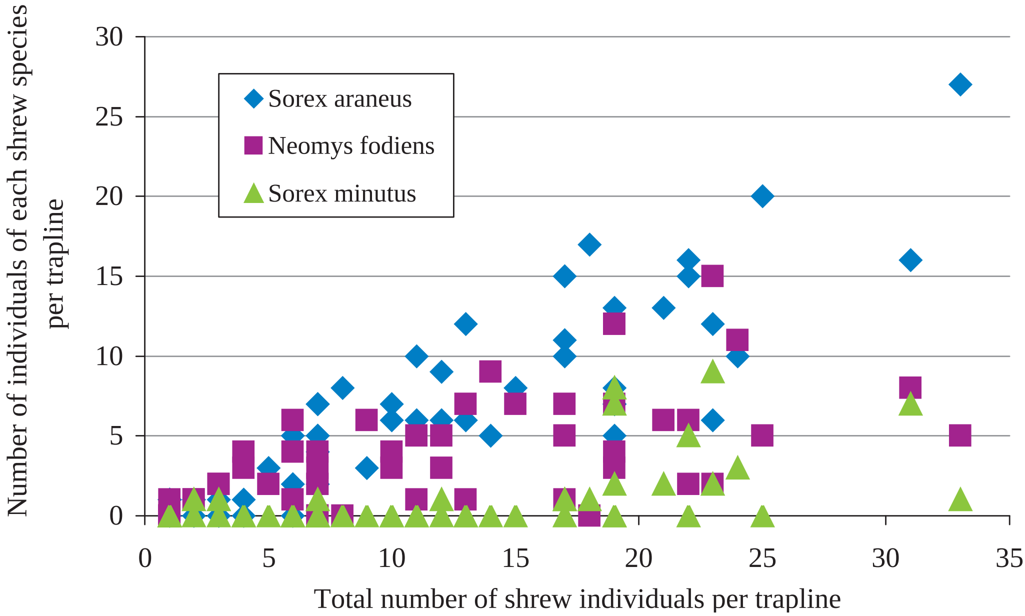

Figure 7. Relation between the total number of shrew individuals of all species, captured in traplines at different locations in De Onlanden in the years 2014 and 2015, and the numbers of individuals of common shrew (*Sorex araneus*), water shrew (*Neomys fodiens*) and pygmy shrew (*Sorex minutus*) captured in these respective traplines.

Onlanden will continue to develop in future, will depend on the developments in the marshland biotopes. In general it is expected that the vegetation in the marshes will become more dense, that the reed vegetation will spread over larger areas, and that locally new marsh forest will develop. These developments will be favourable for the shrew species, and possibly for the field vole and harvest mouse too, since these species all prefer dense vegetation. In the parts of De Onlanden that will remain under the management regime of grazing and mowing, nutrients will be removed from the soil. This will eventually result in less trophic biotopes, with possibly less available food for the shrews and other small mammals. Their numbers may decrease in these parts of De Onlanden. However, on peat soil it may take many years, if not decades, before a clear effect can be seen.

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Samenvatting

Van veenweide naar moeras in natuurgebied De Onlanden: effecten op muizenpopulaties

Natuurgebied De Onlanden, gelegen ten zuidwesten van de stad Groningen, veranderde begin 2012 van het ene moment op het andere van een veenweidegebied in een moerasgebied met waterbergingsfunctie. In de vier jaar voor deze overgang was het 3000 hectare grote gebied ingericht voor deze functie door de aanleg van dijken, het graven van verbindende slenken en het grootschalig plaggen van de toplaag. In deze studie is gekeken naar de effect dat de grote verandering van biotoop had op de samenstelling van de kleine zoogdierenpopulatie (muizen en spitsmuizen) in De Onlanden. De monitoring van deze populatie gebeurde in de periode van 2009 tot en met 2015 jaarlijks gedurende de zomerperiode met behulp van live-traps. Door de overgang van een veenweidebiotoop, met vaste waterstanden ver onder maaiveldniveau en jaarlijks beheer door maaien en begrazing, naar een grootschalige moerasbiotoop, met sterk wisselende waterstanden zonder vegetatiebeheer, veranderde de samenstelling van de muizenpopulatie volledig. De veldmuis verdween vrijwel geheel uit De Onlanden en werd zelfs in de resterende graslanden nauwelijks nog gevonden. Waarschijnlijk was het gebied vooral in de winter te nat geworden voor deze soort. Ook de aardmuis daalde in aantal, maar leek zich in de ruige, natte delen van De Onlanden wel te kunnen handhaven. De waterspitsmuis, die voor de herinrichting vrijwel ontbrak in De Onlanden, breidde zijn leefgebied sterk uit en nam in aantal toe tot plaatselijk zeer hoge dichtheden. De bosspitsmuis, die voor de herinrichting al in grote dichtheden in De Onlanden te vinden was, wist zich in de moerasbiotoop goed te handhaven en nam zelfs iets toe in aantal. De dwergspitsmuis profiteerde ook van de vernatting en verruiging van het gebied. Waarschijnlijk zullen de aantallen en de verspreiding van waterspitsmuis en dwergspitsmuis in De Onlanden in de toekomst nog groter worden.

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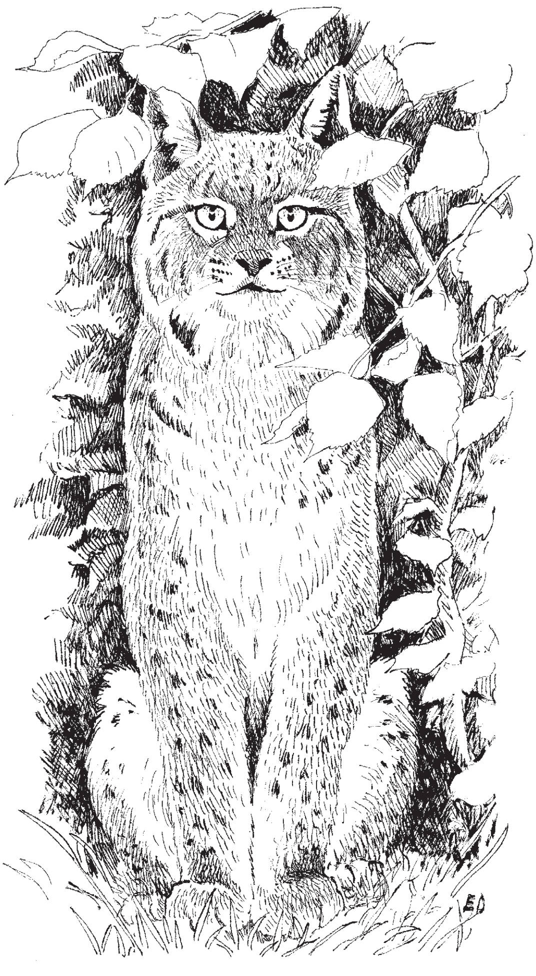

A review of the results obtained during the Field Study Group summer camps of the Dutch Mammal Society, 1986-2014

Jan Piet Bekker[1], Kees Mostert[2], Jan P.C. Boshamer[3] & Eric Thomassen[4]

[1]Zwanenlaan 10, NL-4351 RX Veere, the Netherlands, e-mail: jpbekker@zeelandnet.nl
[2]Palamedesstraat 74, NL-2612 XS Delft, the Netherlands
[3]Vogelzand 4250, NL-1788 MP Den Helder, the Netherlands
[4]Middelstegracht 28a, NL-2312 TX Leiden, the Netherlands

Abstract: The 28 summer camps of the Field Study Group of the Dutch Mammal Society organised between 1986 and 2014 are reviewed here. Over time the Field Study Group gradually spread out its activities throughout Europe, including former Eastern Bloc countries. Camp locations were found through contacts in host countries, who also assist in the preparation of camp activities. Out of a total of 160 participants from the Netherlands and Belgium, 80 attended a summer camp once and 80 joined more than once; 116 participants from local origin were active during these camps. For the 128 mammal species found, the observation techniques used are described. Overall, 7,662 small mammals were caught with live-traps and 990 bats were caught in mist nets. Among the trapped mammals, 421 casualties were counted, predominantly common and pygmy shrews in northern European countries. In pellets, predominantly from barn owls, 21,620 small mammals were found. With detectors, 3,908 bats could be identified. Caves and (old) buildings were explored for bats, and the results of these surveys made up a large part of the total number of bats found. Sightings (> 1,740) and tracks & signs (> 1,194) revealed most of all the presence of carnivora and even-toed ungulates (Artiodactyla). Since 2007, infrared camera traps were used to detect medium-sized and larger mammals; 77 individuals were detected with this relatively new technique. During seven camps, parasites were taken from 23 bat species: most of these were mites (80%) and louse flies (Diptera: Hippoboscidae) (15%). The locations where mammal species were found were compared to the existing knowledge (expressed as presence in 50x50 km UTM grid squares) on the distribution of mammal species in Europe, as presented in *The Atlas of European mammals* by Mitchell-Jones et al. (1999). The presence of mammal species was confirmed in 1,268 squares; 35 squares reaffirmed their presence after 1970, and in 218 new squares an extension of the distribution was demonstrated for a number of mammal species. The highest proportion of new squares appeared to be for Chiroptera, mostly due to the use of mist nets and the introduction of bat detectors as a new technique. Besides positive mammal observations, attention has also been paid to species that, against all odds, were not observed in specific areas. The application of newly introduced, tested, techniques during the study period are part of this review.

Keywords: fieldwork, inventory, survey, sighting, bat detector, tracks and signs, live-trap, mist netting, camera trap, mammals.

Introduction

In 1975, the board of the Society for the Study and Protection of Mammals (since 2009 named the 'Dutch Mammal Society') decided to give more attention to fieldwork and listed eight goals for the Field Study Group, established at the time, ranging from mapping the distribution of species to finding ecological key factors that could explain the species' distribution (Anonymous 1975). At that time, the Society was in a transition from a purely academic circle of mammal specialists towards an organisation that put more emphasis on basic ecological field studies (more precisely: collecting factual information about the distribution of wild mammals in the Netherlands) and on nature conservation. Three members of the new Field Study Group compiled a manual for terrestrial mammal surveys in the Benelux (Hoekstra et al. 1977).

The first surveys of the Field Study Group were organised during the autumn in the Benelux, starting in 1981 with the Oostvaardersplassen (Canters 1982), followed by Swalmdal (Bosman & Margry 1983), Kampina (Margry & Minkenberg 1984), Hollenfels (Minkenberg et al. sine anno), Dyleland (Allaerts et al. 1986), Staphorsterveld (Canters 1987) and Nijmegen (Thissen & Pelzers 1992). These early camps were aimed to teach participants some basic knowledge and skills required for mammal research. These skills turned out to be very useful for the summer camps that followed. The results were mostly published as reports (above), but some were published as regular published papers as well (e.g. Canters et al. 1983, Bosman & Margry 1984, Margry & Minkenberg 1985).

After several years of autumn camps, the first summer camp was organised in 1986 in Belgium, in the Gaume area, a favourable location for catching and observing species such as yellow-necked mouse (*Apodemus flavicollis*) and edible dormouse (*Glis glis*). From 1988 on these summer camps became a yearly event. The list of destinations (see the caption of figure 1) illustrates that the Field Study Group over time gradually spread its activities to the far corners of Europe. The geopolitical changes that took place in 1989 favoured opportunities for mammal research in former Eastern Bloc countries (e.g. Yugoslavia; photo 1).

Small mammal surveys were still performed within the Netherlands during autumn and spring focusing on small mammal live-trapping, bat detector surveys, mist netting and other activities. All of these domestic camps were good opportunities for training new participants and for trying out new techniques.

Photo 1. Biogradska Gora, Montenegro, the location of the 2014 summer camp. *Photo: K. Mostert.*

There is no user guide for preparing and organising a Field Study Group camp. Camp locations are found through contacts in host countries. The local knowledge of species and locations of these people is essential, and, as a rule, they play an important role in the preparation of a camp. Camps are usually loosely organised and participants are free to follow their interests and take initiatives. Activities requiring a group effort, such as trapping small mammals, are coordinated by the camp staff.

Some data and analysis of materials collected during the camps have been published separately (e.g. van der Kooij et al. 1997, Woutersen & Bafaluy 2001, van der Kooij 2006) or used as a reference (e.g. Twisk sine anno). In recent years, on a more or less regular basis, some highlights were described in the magazine of the Dutch Mammal Society, "Zoogdier" (e.g. Mostert et al. 2008, Mostert et al. 2009, Mostert 2012, Mostert 2015). Only occasionally, specific results were published separately, e.g. the record of a high altitude mist net capture of a serotine (*Eptesicus serotinus*) (Boshamer & Bekker 2006). The results and experiences of so many Field Study Group camps deserve a broader audience and certainly merit a review. The information collected during the camps were also important for the realisation of the (Western) European mammal field guides of Lange et al. (1994) and Twisk et al. (2010). The reports of Field Study Group camps contain many interesting details on techniques which will be summarised in a special report (Bekker et al. in prep.).

The general, repetitive objectives for the camps can be summarised as: 1. inventories of mammals in the area as an attribution to the knowledge of the existing mammals; 2. exchange of experiences and knowledge with regional and national mammal study groups; 3. gathering experience with species that are not present or rare in the Netherlands. Most of the camps also have, regionally determined, subgoals, such as observing specific species or unfamiliar ecosystems with their specific mammals. This paper aims to assess the contribution of the Field Study Group to new knowledge about the distribution of mammals in Europe; furthermore to discuss the effectiveness and results of different techniques used to establish species and /or species groups during the camps; and, finally, report on the exchange of experiences between local counterparts and Field Study Group participants.

Summer camps

Records and taxonomy

In this paper we review the 28 reports of the Field Study Group reports of the Dutch Mammal Society over the period 1986-2014. An overview of these reports is listed in section B of the References. We added information from our personal notebooks and experiences, together covering 26 of the 28 camps. A further search of the Field Study Group data, compiled by Jeroen Willemsen, was conducted through the Zoogdiervereniging website (*http://www.zoogdiervereniging.nl*).

The survey methods are specific for the three major groups of terrestrial mammals and are therefore described separately underneath. Often the various methods complement each other: sightings, tracks & signs, camera traps for larger mammals; live-traps, remains in pellets & excrements for small mammals; and bat detectors, mist nets, and exploring caves & abandoned buildings for bats.

In this review we follow the sequence of species used in *The Atlas of European mammals* (Mitchell-Jones et al. 1999). However, since its publication, the nomenclature of several species has changed. Therefore, for scientific names, except *Arvicola terrestris*, we follow the more up-to-date nomenclature by Wilson & Reeder (2005), in which *Erinaceus concolor* is replaced by *Erinaceus roumanicus*, *Lepus capensis* by *Lepus europaeus*, *Microtus pyrenaicus* by *Microtus gerbei*, *Ovis musimon* by *Ovis ammon* and *Clethrionomys* by *Myodes*. *Pipistrellus savii*, *Microtus nivalis* and *Mustela vison* have been assigned to new genera according to Wilson & Reeder (l.c.) and are now *Hypsugo savii*, *Chionomys nivalis* and *Neovison vison*.

On several locations we also traced some newly described species that were split off since 2004; in the species accounts, these recent splits directly follow the species from which they 'originated'. Recently, two new species in the *Myotis mystacinus* group were generally accepted: *Myotis alcathoe*, which was split off based on molecular-genetic characteristics (Von Helversen 2004) and *Myotis aurascens*, which was described based on morphological and morphometric characteristics (Benda 2004). The '*Myotis nattereri* complex' nowadays comprises four (sub)species: *Myotis nattereri* in most of central Europe, *Myotis escalerai* on the Iberic peninsula, *Myotis* SpA, in northern Spain and the Pyrenees, southern France and the north of Italy, while *Myotis* SpB is thought to restricted to Morocco (Salicini et al. 2013). In the 1990s, a new (sub) species was identified within the species *Pipistrellus pipistrellus* and originally described as the '55 kHz phonic type' next to the '45 kHz phonic type' (Barlow & Jones 1999). Based on the sympatric distribution of both phonic types, but different wing morphology and differences in the cytochrome sequence of the mitochondrial DNA, *Pipistrellus pygmaeus* explains the up to recently hidden identity of this species next to *Pipistrellus pipistrellus*. The genus *Plecotus* too has produced two new species relevant for the European continent and worthwhile to mention here: *Plecotus kolombatovici* and *Plecotus macrobullaris*. The characteristics of both species have been described by Kiefer & Von Helversen (2004a, 2004b).

The fossorial form of the water vole *Arvicola terrestris* has recently been split off and is here named *Arvicola scherman*, the montane water vole.

The two species described until 2005 as *Mus musculus* and *Mus domesticus* were afterwards lumped together and named as *Mus musculus*.

Locations and participants

In general the choice of a particular destination within Europe of a Field Study Group summer camp has largely been the result of three criteria: 1. the availability of one or more local contact persons with relations in national nature conservation organisations; one of these organisations is preferably located in a nature reserve and should have specific ecological, mammal-related questions regarding this area; 2. the availability of basic accommodation to suit a group of 20-25 persons in or near the research area for ca. ten days; 3. a high biodiversity of mammal species, preferably including several rare or endemic species. With some exceptions, this selection process resulted in regions in Europe, where (extensive) mammal inventories had not yet been performed.

The positions of the camp locations varied from 40° (Serra da Estrela) to 63° North

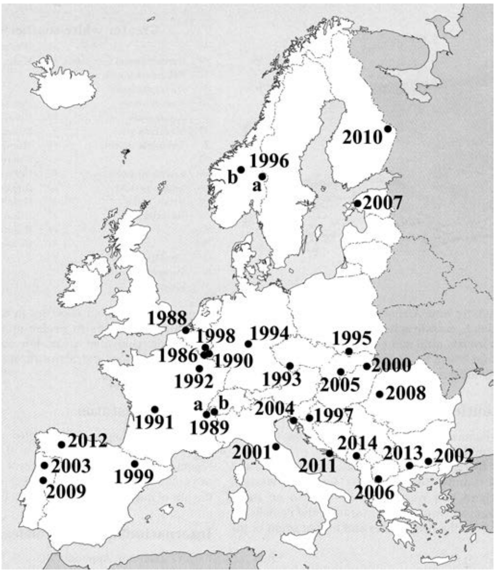

Figure 1. Map of Europe with locations of the Field Study Group summer camps held between 1986 and 2014, including the following camps (year-country (region): 1986-Belgium I (Gaume), 1988-the Netherlands (Western Zeeuws-Vlaanderen), 1989-France I (a: Culoz; b: Samoëns), 1990-Luxembourg (Wiltz), 1991-France II (Limousin), 1992-France III (Argonne), 1993-Czech Republic* (Šumava), 1994-Germany (Thüringen), 1995-Poland (Pieniny), 1996-Norway (a: Trysil; b: Dovre), 1997-Slovenia I (Podstene), 1998-Belgium II (Prelle), 1999-Spain I (Siera de Guara), 2000-Hungary (Zemplen), 2001-Italy (Onferno), 2002-Bulgaria I (Eastern-Rhodopes), 2003-Portugal I (Alvão N.P.), 2004-Slovenia II (Rakitovec), 2005-Slovakia (Pol'ana), 2006-Republic of Macedonia** (Galicica N.P.), 2007-Estonia (Matsalu), 2008-Romania (Rosia), 2009-Portugal II (Serra da Estrela), 2010-Finland (Patvinsuo), 2011-Croatia (Biokovo N.P.), 2012-Spain II (Galicia), 2013-Bulgaria II (Western-Rhodopes), 2014-Montenegro (Biogradska Gora); *: hereafter abbreviated as 'Czech R.'; **: hereafter abbreviated as 'Macedonia'.

(Patvinsuo) and from 7° West (Alvão N.P.) to 30° East (Patvinsuo). Figure 1 specifies the locations of the 28 camps between 1984 and 2014 and shows the increasing distances of the locations over the course of the years. The camps in 1989 and 1996 included two loca-

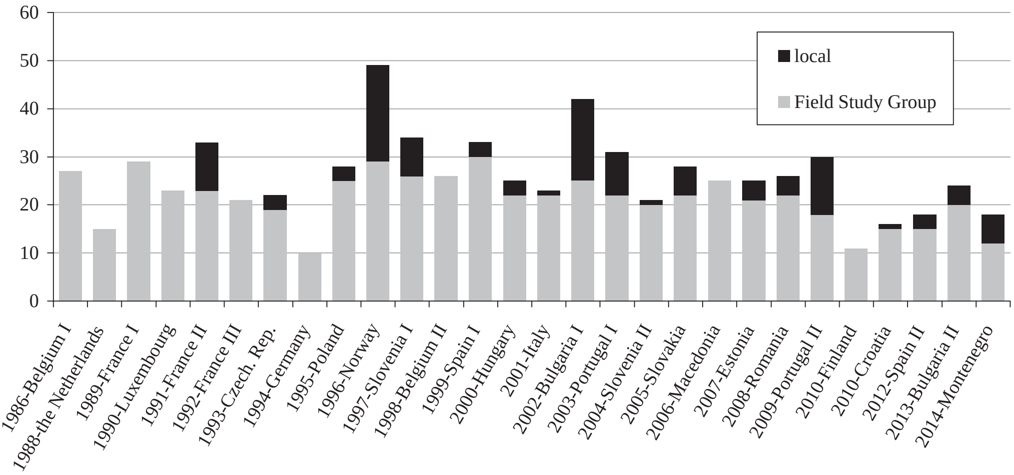

Figure 2. Number of participants in Field Study Group summer camps.
Source: Field Study Group summer camp reports, listed in Section B of References.
Local: participants of local origin.

tions (figure 1). The camp in 1989 was located in Culoz and every other day several participants moved to Samoëns, 80 km to the east and returned afterwards. The setup in Norway 1996 was different: 49 participants from Norway and the Netherlands were mixed and divided over the two camp locations in Trysil and Dovre, 190 km apart. On the fourth day the participants switched between the two sites.

From figure 1 it can be derived that there is a tendency of summer camp locations to be positioned near the borders of countries; 21 camps were located less than 50 km from the nearest border, 14 of these even less than 10 kMyotis Six camps were located between 50 till 100 km to the next nearest border, while the remaining three camps were more or less centrally located at more than 100 km off the respectively country borders (1989-France I and 1996-Norway both counted twice). An explanation for this phenomenon is the fact that interesting nature parks are often located in mountainous regions or regions with a low human population density which often coincide with country borders.

The first Field Study Group camp in 1986 began in the second half of August, while later on most camps started around (the weekends of) the 1st of August. Four camps were organised earlier in the summer, e.g. well before the onset of the migration of bats in Eastern European countries. The duration of the Field Study Group camps increased with the distance of the camp locations from the Netherlands.

The number of participants from the Netherlands and Belgium - although the Dutch Mammal Society was originally of Benelux-origin, no participant from Luxembourg ever attended - varied from 10 (1994-Germany) to 30 (1999-Spain I) (figure 2). In the first four years no local participants attended the camps, but from 1990 on local participants were present at each camp, up to 17 in 2002 (Bulgaria I). The high number of 20 local participants in Norway was due to the combined organisation by the Norwegian Zoological Society and the Field Study Group of the Dutch Mammal Society.

The presence of local mammal researchers at the camps is considered important by the Field Study Group of the Dutch Mammal Society. The board of the Field Study Group has always aimed to exchange knowledge, experiences and observation techniques

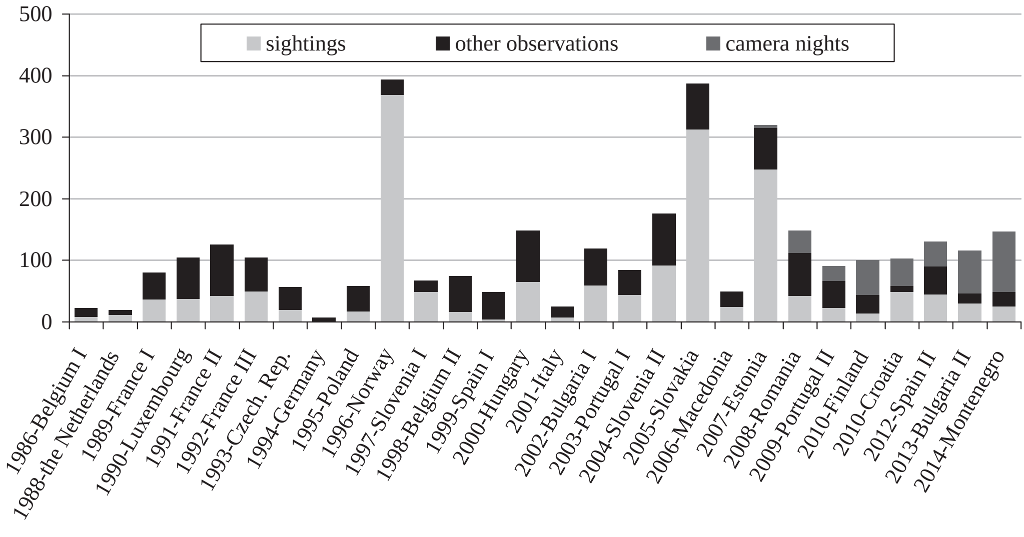

Figure 3. Sightings, tracks & signs and camera nights (predominantly of medium-sized and large mammals) in Field Study Group summer camps.
Source: Field Study Group summer camp reports, listed in Section B of References.

(including those from previous camps), both mutual and with the local participants, during the camps. Besides, locals are familiar with regional habits and peculiarities, which makes solving communication problems that may arise with local inhabitants easier.

Between 1986 and 2014, a total of 116 local participants attended the Field Study Group camps, one of whom attended a camp twice, and one three times.. For Dutch and Belgian participants the frequency of attendance is quite different: of a total of 160 participants, 80 attended once and 80 joined more than once. Seventeen persons participated ten times or more and three even more than 20 times.

Survey methods

Sightings
Direct observations, mostly sightings (visual observations), with or without the aid of binoculars, have always been a major source of information for Field Study Group camps. To a lesser extent, mammal sounds too provide information (e.g. howling wolves, barking foxes, etc.). Acoustical observations through bat detectors, however, are treated separately in this paper. In two cases acoustical and olfactorial observations (of greater white toothed shrew) are listed as 'sightings'. Since the very start of the camps, visual observations were done during night excursions with the use of searchlights (later on car-based), casting over fields or along forest trails. Figure 3 gives the number of sightings for each camp; the total number of sightings was > 1,740. For two camps, 1986-Belgium I and 1994-Germany, the number of sightings was not specified. Observations of roosting bats inside buildings and caves show a large variation and numbers are often too high (up to several thousands) to include in figure 3. These numbers are given in the species accounts.

Tracks and signs
Tracks and signs include footprints, tracks, gnawing or scratching marks and (remains of) nests or dens and droppings; these also include dead mammals or parts of mammals (e.g. skulls, antlers, hairs); for all camps

Photo 2. Preparation and baiting of the live-traps (Finland, 2010). *Photo: K. Mostert.*

> 1,652. The remains from pellets are dealt with separately. In many camp reports the number of tracks and signs are not clearly counted and separated from other observations; therefore the totals per species (figure 3) should be considered as minimum numbers. In camp reports the descriptions of tracks and signs were not always determined to species level, e.g. excrements of beech marten (*Martes foina*) or pine marten (*Martes martes*). These cases were excluded from the analyses.

Camera traps

During 2007-Estonia, the Field Study Group for the first time used an infrared camera trap for two nights, comprising a video camera (Sony®, Sony Corporation, Tokyo, Japan) in a weather proof cylinder, a separate sensor block and a battery block, all cable connected. Strong odorous lures such as peanut butter and valerian tincture, were used to attract mammals to a spot in front of the camera. The next year (2008-Romania), six camera traps (Moultrie®, EBSCO Industries, Inc., Birmingham, AL, USA), sized 27x17x10 cm, were set over 36 camera nights. From 2010 to 2014 smaller camera traps (Bolyguard®, Boly Media Communications Co, Ltd, Santa Clara, CA, USA) and Reconyx®, Holmen, WI, USA), measuring ca. 13x8x5 cm were used. The number of photographs taken each time a camera is triggered, and the reaction time after the trigger moment, can be selected and was therefore very variable. Consequently, the number of camera nights are presented to demonstrate the quantitative efforts with this method (figure 3). Since the introduction of camera traps 77 individuals were detected with this relatively new technique.

Live-traps

Since the first Field Study Group camps were held, the live-traps used were predominantly Longworth traps (photo 2). The annual use of these live-traps differed between camps, depending on the ecological questions, the landscape type, climatic circumstances and the number of camp participants with specific

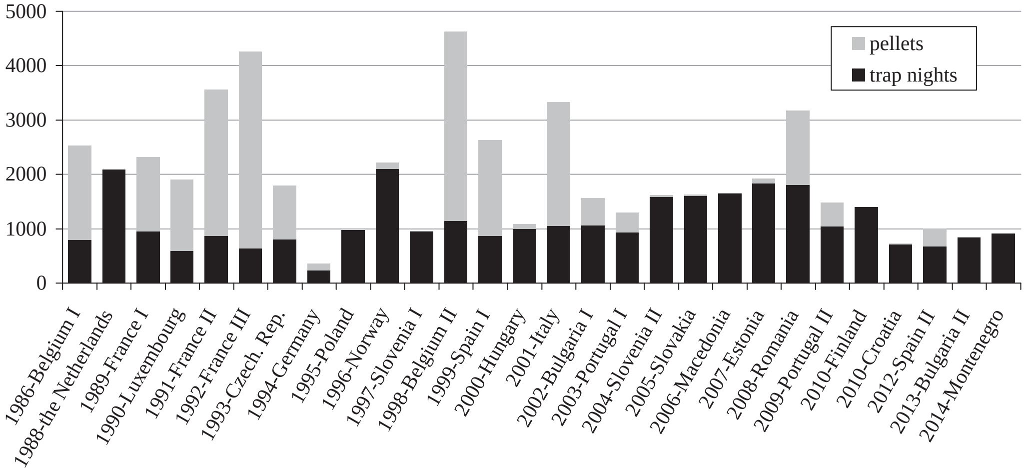

Figure 4. The number of trap nights and prey items (predominantly of small mammals) from owl pellets and excrements found at Field Study Group summer camps between 1986 and 2014.
Source: Field Study Group summer camp reports, listed in Section B of References.

Photo 3. Placing the live-traps in the verge of a dirt road (Romania, 2008). *Photo: K. Mostert.*

knowledge about small mammals and trapping techniques. Figure 4 shows the number of trap nights during the Field Study Group camps between 1986 and 2014 (a trap night being the product of the number of traps and the number of nights during which they are set).

Since the start of camp surveys in 1986, a wide range of live-traps have been used: besides the oblong aluminium Longworth® (Longworth Scientific Instruments, Abingdon, UK) and Sherman® (Tallahassee, FL, USA) traps (see e.g. Hoekstra et al. 1977), specially manufactured Czech wooden traps and metal wired Ugglan® (Grahnab AB, Hillerstorp, Sweden) traps (three different types) (Gundersen et al. 1999) have been used incidentally (photo 3). In addition, various packing materials have been modified to pitfalls e.g. yoghurt cups and PET bottles. Slovenian dormice hunters used big snap-traps fixed on a three meter long stick, suspended on a tree-branch (Anonymous 2001); a modified method which, adapted for Sherman traps, has been used since 2004 for dormice (Bekker & Bekker 2006). From 2013 on, the Heslinga® trap (Zilvermeer, Groningen, the Netherlands) came into use too. This trap has the general design of a Longworth® trap, but the treadle-mechanism is slightly altered.

Bigger traps have been employed as well for special purposes: commercially available ground squirrel traps and home made treadle traps for the common hamster (*Cricetus cricetus*) (Bekker 2001) and fyke nets for the Pyrenean desman (*Galemys pyrenaicus*) (Bekker & Hunia 2004).

Traps were usually checked three times a day: once in the morning (7 a.m.), once in the afternoon (4 p.m.) and once at night (11 p.m.), yielding an optimal compromise between control effort and the survival rate of the small mammals captured. A limited number of 256 specimens could not be determined down to species level, concerning mostly animals from the genus *Apodemus* (*Apodemus flavicollis* or *Apodemus sylvaticus*). During all camps together, 7,662 small mammals were caught with live-traps in a total of 31,097 trap nights (three hand captures included). The high trapping result of almost 25% is partly due to the usual three checks of the traps per day. Trap-happy individuals belonging to *Apodemus flavicollis* and *Apodemus sylvaticus* strongly contribute to this result, with almost 38% of the catches belonging to these species.

Remains in pellets and excrements

One of the usual questions to address to the camp hosts beforehand is whether (barn)owls are present in the area and if (barn)owl pellets are already available. Camp staff always prioritises and stimulates the search for pellets in the surroundings. During all camps together, the total of all mammalian prey items in pellets amount to 21,403 (including the not at species level determined specimens: 22,766). Numbers of mammalian prey items strongly vary between camps (figure 4). They sometimes exceed 2000 items, while on some occasions analysable material was scarce or even absent. By far the highest numbers of mammalian prey items were found in barn owls pellets (*Tyto alba*) (*n*=21,620; 95%). Other owl species contributed considerably less: tawny owl (*Strix aluco*): *n*=615 (3%); little owl (*Athene noctua*): *n*=154; long-eared owl (*Asio otus*): *n*=137; Tengmalm's owl (*Aegolius funereus*): *n*=108; eagle owl (*Bubo bubo*): *n*=26; and Ural owl (*Strix uralensis*): *n*=9. Other pellet-producing predators contributed only marginally: lesser spotted eagle (*Aquila pomarina*): *n*=46; common kestrel (*Falco tinnunculus*): *n*=17; Montagu's harrier (*Circus pygargus*): *n*=5; and common buzzard (*Buteo buteo*): *n*=7. Besides, one prey item of raven (*Corvus corax*) and one of a shrike (*Lanius* sp.) was found. Apart from the avian predators, carnivores too often have prey remains in their excrements, especially red fox (*Vulpes vulpes*): *n*=13. Mammal remains were furthermore found in low numbers in droppings of beech marten (*Martes foina*) (*n*=4), genet (*Genetta genetta*) (*n*=2) and pine marten (*Martes martes*) (*n*=1).

Bat detectors

Ever since bat detectors became available to field workers in the 1980s, they rapidly evolved into advanced, reliable and easy-to-handle devices, which are indispensible in today's bat research. Parallel to this development, sound analysis equipment and software was introduced at the Field Study Group camps, thereby greatly improving the reliability of bat identifications.

Detectors have been used during all camps, from 1986 onwards, although the level of effort differs greatly between camps. Primarily, hand-held bat detectors were used in promising locations where many hunting bats could be expected, such as ponds, lakes and

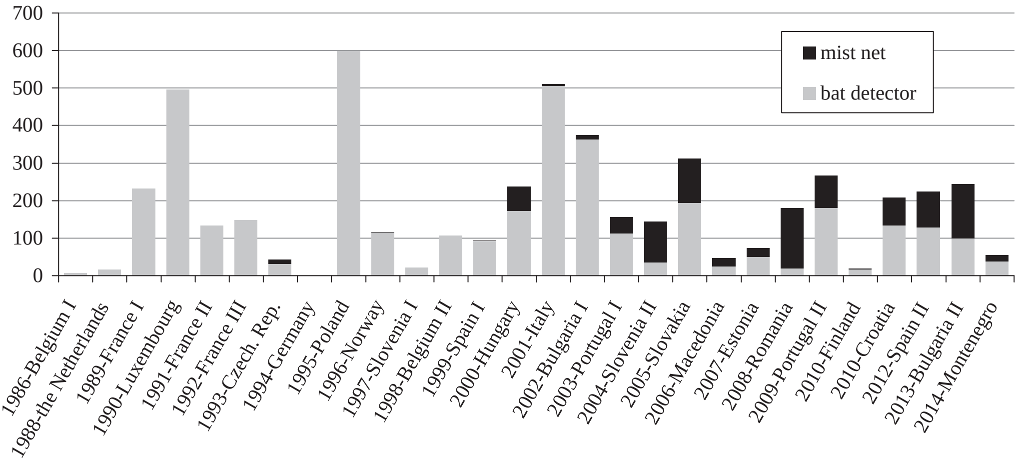

Figure 5. Bat detector observations and mist net captures of bats at Field Study Group summer camps. 1986-Belgium I and 1988-the Netherlands: exact number of bat detector observations unknown; missing numbers in 1994-Germany.
Source: Fieldwork Study Group summer camp reports, listed in Section B of References.

forests with an open structure. In addition, in recent years, detectors mounted on slow-moving cars were used on quiet roads. These car transect surveys sometimes covered considerable distances and have increased the numbers of bats identified. During all camps together, a total of 3,908 bats were identified with bat detectors, including sound analysis equipment; 165 bats could not be identified to species level. The emerging and commuting bats found during 1995-Poland (*Rhinolophus hipposideros*: 80 resp. 93 individuals) and 2001-Italy (*Miniopterus schreibersii*: ca. 5,500 individuals) are not included in these numbers.

During most camps, a considerable number of bat species were identified with the use of bat detectors (figure 5). Especially Daubenton's bat (*Myotis daubentonii*), soprano pipistrelle (*Pipistrellus pygmaeus*), noctule (*Nyctalus noctula*), Leisler's bat (*Nyctalus leisleri*), greater noctule (*Nyctalus lasiopterus*), serotine (*Eptesicus serotinus*) and free-tailed bat (*Tadarida teniotis*) were relatively easily identified with detectors (while the latter species can often be heard with the naked ear as well). Some of these species fly relatively high and fast, and are often overlooked with other survey methods. For others, especially *Myotis* and *Plecotus* species, the bat detector clearly has its limitations, as these species are virtually impossible to differentiate by sound. In recent years, however, identification of *Myotis* and *Plecotus* species could be more reliably done by computer analysis of sounds recorded with bat detectors.

Searches for colonies and other roosts during the early morning in villages and cities with the help of detectors has been a commonly used method during many camps. During twelve camps, one or more roosts or maternity colonies have been found using this method. Searching roosts was especially successful during the camps of 1989-France I, 1998-Belgium II, 2001-Italy, 2003-Portugal I and 2007-Estonia. Detectors were also used in the early morning (and sometimes in the evening) to search for swarming bats near colonies and other hides in old trees and in villages and towns. When a colony was found, the total number of bats leaving the roost on the subsequent evening was counted by stationary observers. On some occasions bat detectors were also used by observers on foot or bicycle to survey commuting or hunting

Photo 4. Putting up a mist net in front of a cave entrance (Romania, 2008). *Photo: K. Mostert.*

bats. The discovery of colonies in concrete lamp posts during 2001-Italy and 2002-Bulgaria I deserves special mention here.

Surveys with the specific aim to find maternity colonies in trees were carried out only a few times during the camps. Besides the fact that the most favourable period to do this had usually already passed, many forests in the countries visited were found to have lower accessibility (compared to the Netherlands) or seemed to be unsuitable for harbouring colonies of bats, like in many Mediterranean and north-European camp locations. Tree colonies, predominantly in old oak and beech, were found during the 2000-Hungary, 2005-Slovakia and 2007-Estonia camps.

Mist nets

In the early years of the Field Study Group camps, the use of mist nets to capture bats, was not practised regularly. The first attempts were made in 1990-Luxembourg, without success. During 1993-Czech R. and 1996-Norway a modest beginning was made with the capture of five bats and one bat respectively, but then it took four more years before a good number of captures was achieved (2000-Hungary). Later on, apart from the low numbers that were caught during the 2001-Italy, 2002-Bulgaria I and 2010-Finland camps, all other camps counted more than 30 mist netted bats, four camps even over 100 specimens. Mist netting was not part of the program during the 1995-Poland camp, because shortly before this camp, extensive mist netting had already been carried out in Pieninsky Park Narodowny, with many captures of bats. During 1998-Belgium II permission to capture bats was not granted. During 2007-Estonia and 2010-Finland bats were caught using harp traps instead of standard mist nets (one and three specimens respectively; also included in figure 5).

Ever since mist netting became an integrated part of the camps' programme, surveying bats along streams, preferably near bridges, above ponds and on trails in forests has become feasible. Besides, mist nets were frequently set up near entrances to caves and caverns, as these are regularly inspected by bats of many species (photo 4). Undoubtedly, the increased number of mist nets (or the increased total length of mist nets) that took place over the years contributed to the increased numbers of bats captured. Even so,

Photo 5. Abandoned house used by bats as a day roost (Spain, 2012). *Photo: K. Mostert.*

the increased experience of some of the regular camp participants with selecting good locations for setting up the nets undoubtedly added to the mist netting success. During all camps together, 990 bats were caught with mist nets.

Exploring caves and abandoned buildings
Caves and mines (here regarded as artificial caves), can be interesting places to check for bats. In some cases, bats had already been counted by local researchers, both inside the caves while roosting and outside while emerging. Many other caves and mines were already known to bat researchers, leaving little room to contribute new information. In addition, caves are often fenced off or inaccessible without climbing equipment.

At 14 camps, caves and mines were surveyed for bats. During 2000-Italy, 2002-Bulgaria I, 2006-Macedonia, 2008-Romania, 2009-Portugal II and 2013-Bulgaria II, this method contributed considerably to the survey. Many of these bat populations were already known.

Daytime inspection of abandoned houses and other buildings furthermore proved to be an indispensable source of information for the bat surveys, as did the investigation of bridges, tunnels, canastro's (characteristic small sheds to dry and store crops) and wine cellars (photo 5).

In depopulated agricultural areas many abandoned houses, buildings and factories are found. This is a particularly common phenomenon in parts of France, Spain and Portugal and in parts of Eastern Europe (Romania, Bulgaria, Slovenia, Poland). In the Benelux countries and in Fennoscandia it is much more difficult to find this kind of places; the few abandoned buildings that were found in these countries, however, were not inhabited by bats.

Churches were also inspected, especially church attics and sometimes bell towers. Church buildings were only surveyed in areas where churches that looked promising in terms of offering spaces potentially suitable for roosting bats. Extensive surveys of churches were restricted to areas with many, potentially suitable, churches and where surveys had not recently been carried out.

During ten camps in different regions of France, Belgium, Luxembourg and Eastern Europe (1995-Poland, 2000-Hungary, 2002-Bulgaria, 2008-Romania) and particularly at the 2004-Slovenia and 2005-Slovakia camps, churches were surveyed. During 2005-Slovakia, a remarkably high proportion (14 out of 25) of churches was found to be used by bats, while, during 2004-Slovenia, 24 churches were accessible and in eight of the church attics bats were found. During all camps together, 23,943 bats were identified while exploring caves and abandoned buildings. Groups of bats that were not identified to species level (8,515) are not included in this number.

Collecting and preserving

Casualties
In the Appendix the number of casualties of various species are presented. Most of these animals died after capture. Their death might have been related to starvation, stress, cannibalism and predation (especially shrews eating each other and eating other species), (sometimes unexpectedly) high daytime temperatures and excessive rainfall. Among the 8,652 small mammals captured, 421 casualties

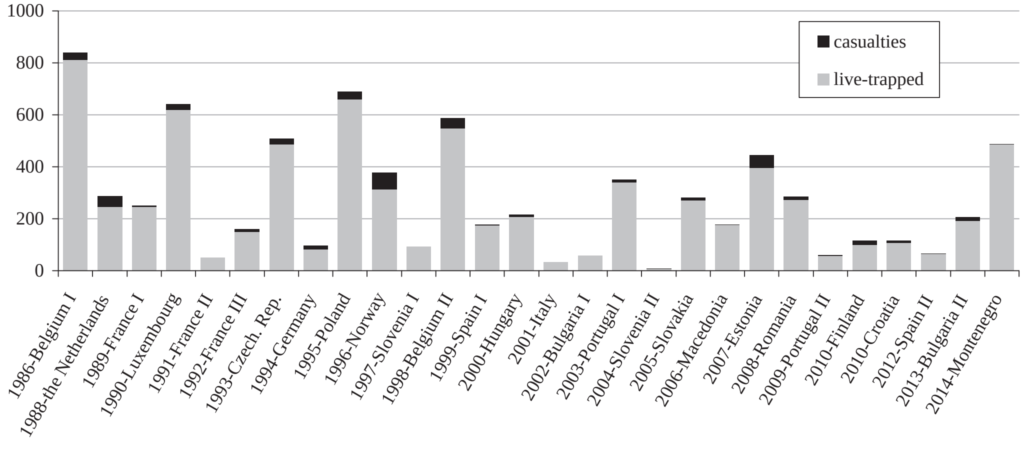

Figure 6. Small mammals caught in traps, with the number of casualties indicated in black.
Source: Field Study Group summer camp reports, listed in Section B of References.

(4.9%), were counted, mostly common shrews (*Sorex araneus*) and pygmy shrews (*Sorex minutus*). Comparing the number of casualties with the number of trapped animals, the pygmy shrew is clearly the most sensitive of all shrews, followed by the common shrew. Obviously, red-toothed shrew species (*Sorex* and *Neomys* spp.) are more sensitive than white-toothed shrew species (*Crocidura* spp.).

Casualty proportions were relatively high in northern countries (figure 6): 1996-Norway (17.2%), 1994-Germany (14.6%), 2010-Finland (14.5%), 1988-the Netherlands (13.9%) and 2007-Estonia (11.2%). These high proportions can be explained by the frequent captures in northern countries of common and pygmy shrews; these species, both of which are relatively sensitive, made up 93% of the casualties in these countries. In the past, several measures were implemented to minimise casualty rates, e.g. by placing traps at locations that are not exposed to direct sunlight, setting traps 'safe' on very hot days (e.g. during a heatwave at 1990-Luxembourg) and by the addition of mealworms (*Tenebrio molitor* larvae) to the regular bait of a peanut butter/oats-mix and apple and carrots; these were standard procedures as of 2007 (Bekker & Bekker 2008).

Preserved specimens
Casualties in traps and animals found dead were measured and labelled before they were preserved. Small mammals were preserved in alcohol or dissected to preserve the dried, flat skin and or the cleaned skull. In consultation with the local researchers the specimens were added to the collection of the Zoological Museum of Oslo (1996-Norway) or transferred to Naturalis, Leiden, the Netherlands. In all other cases specimens were added to the private collections of camp participants (details are given in the respective reports).

DNA sampling
Since 2006, biopsy tissues of bat wing-membranes and occasionally buccal smears of other small mammals were collected by the Field Study Group for DNA analysis. For collecting DNA samples, standard procedures were used, intended to avoid contact with other DNA sources (Anonymous 2012). During 2006-Macedonia a captured Alpine long-eared bat (*Plecotus macrobullaris*) was identified through DNA analysis (Bekker & Boshamer 2007) and subsequently during 2009-Portugal II a *Myotis* species was identified as *Myotis escalerai*.

Table 1. Locations of Field Study Group summer camps with the number of (partially) surveyed UTM-squares (50 x 50 km^2). The large number of UTM squares in Norway is explained by the request of the camp staff in 1996 to the participants to take different routes as they changed between camp locations in order to improve their chances to observe mammals. * Second camp location.

Year	Country	Area	UTM sq.	Year	Country	Area	UTM sq.
1986	Belgium I	Gaume	1	2000	Hungary	Zemplen	2
1988	The Netherlands	W.-Zeeuws-Vl.	1	2001	Italy	Onferno N.P.	2
1989	France I	Culoz	2	2002	Bulgaria	E.-Rhodopes	4
1989	France I	Samoëns	*	2003	Portugal I	Alvao N.P.	2
1990	Luxembourg	Wiltz	2	2004	Slovenia II	Rakitovec	2
1991	France I	Limousin	6	2005	Slovakia	Pol'ana	4
1992	France II	Argonne	3	2006	Macedonia	Galicica N.P.	4
1993	Czech. R.	Šumava	3	2007	Estland	Matsalu N.P.	3
1994	Germany	Thüringen	1	2008	Roumenia	Rosia	4
1995	Poland	Pieniny	2	2009	Portugal II	Serra da Estrela	2
1996	Norway	Dovre	22	2010	Finland	Patvinsuo	2
1996	Norway	Trysil	*	2011	Croatia	Biokovo N.P.	2
1997	Slovenia I	Podstene	4	2012	Spain II	Galicia	2
1998	Belgium II	Prelle	2	2013	Bulgaria	W.-Rhodopes	1
1999	Spain I	Siera de Guara	6	2014	Montenegro	Biogradska Gora	3

Bat parasites

Since 2004-Slovenia, ecto-parasites of captured bats were collected and identified (Boshamer 2005). Bats are known to carry large numbers of parasites with them. Although the occurrence of certain types of parasites is often genus- or even species-specific, the general knowledge of the parasite-host relationship shows many gaps. In recent years the interest in ecto-parasites on bats has greatly increased. In prehistoric times the most common bat species in Europe lived in and undoubtedly shared caves with humans for shelter and became synanthrope, in the meantime sharing each other's parasites too. This synanthropy nowadays evokes interest as to what extent these parasites carry pathogens (zoonosis) that pose a risk for people (Mühldorfer 2013).

Mist netted or otherwise captured bats were handled in a fixed sequence. The wing membrane, ears, face and coat were meticulously checked for ecto-parasites, which were removed with tweezers. The parasites collected were identified by dr Jan Kristofik and Peter Mašán of the Institute of Zoology in Bratislava, Slovakia.

Data in UTM-grid

We compared contributions by the Field Study Group to knowledge of the distribution of mammal species in Europe to known and previously known distribution patterns in *The Atlas of European mammals* (Mitchell-Jones et al. 1999). These maps are based on 2,464 terrestrial and coastal 50x50 km^2 square units in UTM projection; each square represents one of the next three categories. Bold dot: species is present, based on data since 1 January 1970. Small dot: species previously present, presumed presence based on data before 1970, but without evidence the species has become extinct locally. No dot: species absent or not observed (see: Mitchell-Jones et al. 1999 for detailed explanation). In this paper recorded mammal species in squares with a bold dot are regarded as 'confirmed', those with a small dot as 'reaffirmed' and those without a dot as 'new' (table 1).

Species accounts

The total number of mammals observed during all camps between 1986 and 2014 was well over 70,000. The different survey methods used are not evenly distributed over the mammalian orders (figure 7). For instance, for Insectivora and Rodentia, 76% and 69%, respectively, of the observations were done by owl pellet analysis, and 17% and 27%, respectively, of the observations come from live-traps. Lagomorpha and Artiodactyla, on the other hand, were predominantly observed visually (over 79% and 68%, respectively), while 14% and 30% respectively of the observations were signs and tracks. For bats, sightings in caves and abandoned buildings make up more than 83% of the records, and bat detector observations 14%. Most of the observations of Carnivora consist of signs and tracks (57%), and just over 36% of sightings. Obviously, certain observation methods are of minor quantitative importance to some orders, e.g. traps (< 0.5%) and pellets (< 0.5%) to Carnivora and pellets to Chiroptera (< 0.05%).

Of the mammalian orders Insectivora, Chiroptera, Leporidae, Rodentia, Carnivora and Artiodactyla, all species observed during the Field Study Group camps will be briefly described here. The numbers of records per species and per method are given in the Appendix. Records of former species that were split up, are assigned to the newly described species where possible (e.g. *Sorex araneus/coronatus* to common shrew *Sorex araneus* or Millet's shrew *Sorex coronatus*).

Insectivora

The presence of the Western hedgehog (*Erinaceus europaeus*) could be confirmed during 14 camps (table 2). The number of sightings exceeds the number of dead specimens (mainly found on the road). This also applies to the Eastern hedgehog (*Erinaceus rouman-*

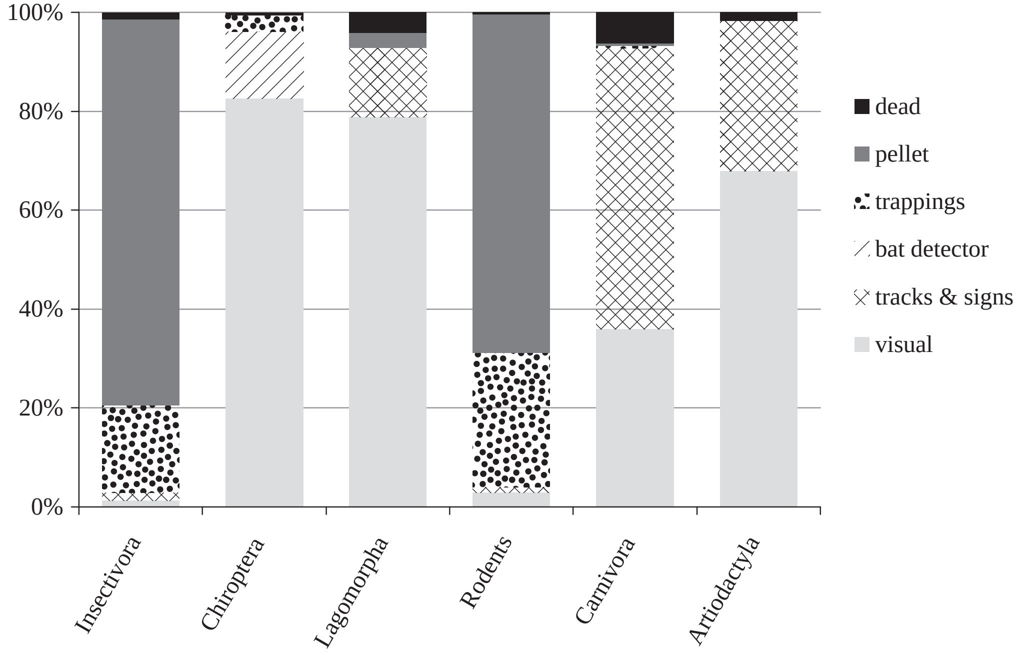

Figure 7. Relative importance of various survey methods per mammalian order. Observations of bats in caves and abandoned buildings in this figure are rendered under 'sightings' and for mist netting under 'trappings'. The observations by camera trapping (Rodents: 17, Carnivora: 34 and Artiodactyla: 7) are not included in this figure.

Table 2. The presence (black dots) of Insectivora established at the summer camps between 1986 and 2014 (all methods included).

	Species	1986-Belgium I	1988-the Netherlands	1989-France I	1990-Luxembourg	1991-France II	1992-France III	1993-Czech. Rep.	1994-Germany	1995-Poland	1996-Norway	1997-Slovenia I	1998-Belgium II	1999-Spain I	2000-Hungary	2001-Italy	2002-Bulgaria I	2003-Portugal I	2004-Slovenia II	2005-Slovakia	2006-Macedonia	2007-Estonia	2008-Romania	2009-Portugal II	2010-Finland	2011-Croatia	2012-Spain II	2013-Bulgaria II	2014-Montenegro
1	*Erinaceus europaeus*	●	●	●	●	●	●	●	●		●		●			●						●		●			●		
2	*Erinaceus roumanicus*									●		●			●		●		●	●	●		●			●		●	●
3	*Sorex alpinus*			●				●		●		●								●									
4	*Sorex araneus*	●	●	●	●		●	●	●	●	●	●	●		●					●		●	●		●			●	●
5	*Sorex caecutiens*										●																		
6	*Sorex coronatus*	●	●	●	●	●	●						●	●															
7	*Sorex granarius*																	●						●			●		
8	*Sorex isodon*										●																		
9	*Sorex minutus*	●	●	●	●	●	●	●	●		●	●	●		●	●	●			●	●	●	●		●		●		●
10	*Sorex samniticus*															●													
11	*Neomys anomalus*					●		●		●			●		●		●	●		●			●	●					●
12	*Neomys fodiens*	●		●	●	●	●	●	●	●	●		●			●				●		●						●	
13	*Crocidura leucodon*	●	●				●								●	●	●		●	●			●						
14	*Crocidura russula*	●	●	●	●	●	●		●				●	●				●						●			●		
15	*Crocidura suaveolens*							●				●			●	●	●		●	●	●		●	●		●	●	●	●
16	*Suncus etruscus*													●		●													
17	*Galemys pyrenaicus*																	●						●			●		
18	*Talpa caeca*																												●
19	*Talpa europaea*	●		●	●	●	●	●	●	●		●	●	●	●	●	●		●	●		●	●		●			●	●
20	*Talpa occidentalis*																	●						●			●		

icus), which was found at eleven camps.

The Alpine shrew (*Sorex alpinus*) was caught during four camps (1989-France I (Samoëns) (one animal), 1993-Czech R. (one animal), and 1995-Poland (two animals) and 1997-Slovenia (one animal)). Five animals were found dead during two camps, i.e. 1997-Slovenia I (two animals) and 2005-Slovakia (three animals). The most frequently caught shrews were the common shrew (*Sorex araneus*) and Millet's shrew (*Sorex coronatus*). The distinction between trapped *Sorex araneus* and *Sorex coronatus* was not always made during camps; in remains, however, this was possible. These two species were found at 18 and eight camps, respectively. The masked shrew (*Sorex caecutiens*) was caught in Dovre during the 1996-Norway camp, but was not recognised at that time. The identification of one dead individual, which was originally identified as a pygmy shrew, was revised at the Museum of Natural History in Oslo ten years later (van der Kooij 2006; see also van der Kooij et al. (2015), in this issue). During the two camps in Portugal the Spanish shrew (*Sorex granarius*) was caught in live-traps (photo 6) and was also found in owl pellets. The taiga shrew (*Sorex isodon*) was recovered once from Tengmalm's owl pellets, collected at Trysil during the 1996-Norway camp. The occurrence of the pygmy shrew was confirmed with traps during 21 camps. The impressive number of

Photo 6. Live trapped Spanish shrew (*Sorex granarius*) (Portugal, 2009). *Photo: K. Mostert.*

42 specimens found in Estonia may largely be ascribed to the large number of pitfalls used. During most camps, pygmy shrew was captured in modest numbers (1-5 animals). The presence of the Appenine shrew (*Sorex samniticus*), was restricted to 2001-Italy and was only confirmed from owl pellets.

Miller's water shrew (*Neomys anomalus*) was caught in live-traps during nine camps, while the water shrew (*Neomys fodiens*) was caught during 14 camps; both species were also recovered from owl pellets, during respectively eight and nine camps.

The bi-coloured white-toothed shrew (*Crocidura leucodon*) was only caught once outside the Netherlands, during 2008-Romania (one specimen). Three other specimens were caught during 1988-the Netherlands. The greater white-toothed shrew (*Crocidura russula)*, which has a southwest-European distribution, was captured during seven camps; with the owl pellet finds added, it was found during twelve camps. The related lesser white-toothed shrew (*Crocidura suaveolens*) was established at 14 camps and caught at five camps with a total of 28 captures. The pygmy white-toothed shrew (*Suncus etruscus*) was never caught in live-traps, despite several attempts in Mediterranean countries. This species was, however, repeatedly recovered from pellets.

During 2003-Portugal I, a Pyrenean desman (*Galemys pyrenaicus*) was caught with fyke nets set half above and half below the water surface. With the same technique, but with more traps, three specimens were caught and one entangled specimen was found dead during 2012-Spain II. Tracks and signs were only recorded at streams where the presence of the species had previously been confirmed. During 2014-Montenegro, the presence of blind mole (*Talpa caeca*) was established once only by the find of a dead specimen in the highlands. In contrast to the latter, the presence of common mole (*Talpa europaea*) was established frequently by signs and tracks and also in owl pellets, while occasionally a dead specimen was found. During three of the four Iberian Field Study Group camps (2003-Portugal I, 2009-Portugal II and 2012-Spain II) the presence of Iberian mole (*Talpa occidentalis*) was established using three observation methods, i.e. by their characteristic, relatively small, molehills, from remains in pellets and from dead animals.

Chiroptera

During the 1992-France II and 2006-Macedonia camps, several Mediterranean horseshoe bat (*Rhinolophus euryale*) colonies were visited at already known locations with estimated numbers of respectively 60 and 500 individuals (table 3). In addition, during 2004-Slovenia, II this species was found in an abandoned building. the Mediterranean horseshoe bat appeared to be present during nine summer camps (bat detector recordings included). In the Mediterranean part of Europe the lesser horseshoe bat (*Rhinolophus hipposideros*) is most commonly found in abandoned buildings, church attics and caves, which often house maternity roosts. By surveying suitable locations, at least 1072 specimens were found, mostly in small groups of up to several tens of animals. During 2014-Montenegro the largest group found inhabited an empty building where 175 animals were counted. The

Table 3. The presence (black dots) of Chiroptera established at summer camps between 1986 and 2014 (all methods included).

Species	1986-Belgium I	1988-the Netherlands	1989-France I	1990-Luxembourg	1991-France II	1992-France III	1993-Czech. Rep.	1994-Germany	1995-Poland	1996-Norway	1997-Slovenia I	1998-Belgium II	1999-Spain I	2000-Hungary	2001-Italy	2002-Bulgaria I	2003-Portugal I	2004-Slovenia II	2005-Slovakia	2006-Macedonia	2007-Estonia	2008-Romania	2009-Portugal II	2010-Finland	2011-Croatia	2012-Spain II	2013-Bulgaria II	2014-Montenegro
21 *Rhinolophus euryale*					●						●		●		●	●		●		●			●				●	
22 *Rhinolophus ferrumequinum*	●		●		●	●					●		●	●	●	●	●	●		●		●	●		●		●	
23 *Rhinolophus hipposideros*			●		●		●		●		●		●	●	●	●	●	●	●	●		●	●		●	●	●	●
24 *Rhinolophus mehelyi*																●												
25 *Myotis bechsteinii*			●										●	●				●	●			●	●				●	
26 *Myotis brandtii*										●				●					●					●				
27 *Myotis capaccinii*																●		●									●	
28 *Myotis dasycneme*		●												●							●	●						
29 *Myotis daubentonii*	●	●	●	●	●	●	●	●	●	●	●	●	●	●			●	●	●		●	●	●		●	●	●	●
30 *Myotis emarginatus*			●								●	●	●	●	●	●	●	●		●		●	●		●	●	●	
31 *Myotis myotis*			●	●	●	●	●	●	●		●		●	●		●			●	●		●	●		●		●	
32 *Myotis mystacinus*	●									●	●			●			●	●	●					●		●	●	●
33 *Myotis alcathoe*																										●		
34 *Myotis aurascens*																●				●					●			
35 *Myotis nattereri*			●	●					●				●	●		●	●	●	●				●		●			●
36 *Myotis escalerai*																							●			●		
37 *Myotis oxygnathus*					●									●				●	●	●		●	●				●	●
38 *Pipistrellus kuhlii*			●		●						●		●		●	●	●	●		●			●					●
39 *Pipistrellus nathusii*		●	●	●				●	●												●							
40 *Pipistrellus pipistrellus*	●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	●
41 *Pipistrellus pygmaeus*														●		●				●		●	●		●		●	●
42 *Hypsugo savii*													●		●	●	●	●		●			●		●	●	●	●
43 *Nyctalus lasiopterus*														●	●	●			●						●		●	
44 *Nyctalus leisleri*			●	●			●						●	●	●	●	●	●	●	●		●	●			●	●	●
45 *Nyctalus noctula*		●		●	●	●	●		●		●	●		●	●	●		●	●		●	●					●	●
46 *Eptesicus nilssonii*							●		●	●									●		●			●				
47 *Eptesicus serotinus*	●	●	●	●	●	●			●		●	●	●	●	●	●	●	●	●	●		●	●		●	●	●	
48 *Vespertilio murinus*									●	●									●			●					●	●
49 *Barbastellus barbastellus*			●								●		●	●			●		●			●	●			●	●	●
50 *Plecotus auritus*			●				●	●	●	●		●	●	●			●	●	●	●	●	●	●			●	●	
51 *Plecotus austriacus*			●										●	●		●	●		●			●	●			●	●	
52 *Plecotus kolombatovici*																									●			
53 *Plecotus macrobullaris*																				●								
54 *Miniopterus schreibersii*														●	●	●				●		●				●	●	
55 *Tadarida teniotis*			●										●			●	●			●			●		●	●	●	●

discovery of 125 animals during 2011-Croatia in an old olive oil mill is also worth mentioning. During 2003-Portugal I, a total of 15 lesser horseshoe bats were found in canastro's (see above) on three occasions, while during 2000-Hungary, 30 lesser horseshoe bats were found in wine cellars. During 1995-Poland, the use of hedgerows as commuting routes was studied (Kapteijn & van Winden 1998). Dozens of greater horseshoe bat (*Rhinolophus ferrumequinum*) roosts were found in abandoned buildings and in churches in the southern part of Europe as well, but their numbers were considerably lower than those of the lesser horseshoe bat (over 251 animals). A mixed colony of greater horseshoe bats and Geoffroy's bats (*Myotis emarginatus*) was found by inspecting a tunnel in a dam in Riglos, which was also inhabited by Natterer's bats (1999-Spain I). During 2000-Hungary a colony with ten greater horseshoe bats was discovered in a wine cellar. Using bat detectors, at eleven camps, at least 45 foraging individuals were traced, predominantly in deciduous forest. Mehely's horseshoe bat (*Rhinolophus mehelyi*) was observed and photographed only once, during 2002-Bulgaria I. At this summer camp, the species was also found to be present in five caves, together with Blasius' horseshoe bat (*Rhinolophus blasii*), in mixed colonies of the two medium-sized Rhinolophid species; both species, however, remained indiscernible (Kapteyn 2003). Several highly suggestive recordings during 2008-Romania I for the presence of Mehely's and Blasius' horseshoe bat species are mentioned by Achterkamp (2009). Because of the remaining uncertainties in identifying bats in these mixed colonies, and of the bat detector recordings made, observations of both species are not included in table 3 and in the Appendix.

A maternity colony of Bechstein's bat (*Myotis bechsteinii*) was found in an old pear tree in Haute Savoie (1989-France I) with eleven animals leaving the roost in the evening. Furthermore, Bechstein's bat was occasionally found in abandoned houses, and in nest boxes for birds in a forest. One dead animal was found on a forest path (2000-Hungary). Bechstein's bat was captured in mist nets at six camps.

During 1996-Norway and 2010-Finland Brandt's bat (*Myotis brandtii*) maternity colonies were found in wooden buildings, one at each camp. Apart from these observations, the species was captured in mist nets during 2000-Hungary and 2005-Slovakia.

In a cave near Visoka Poljana, a roost of approximately 1,000 long-fingered bats (*Myotis capaccinii*) was surveyed (2002-Bulgaria I). In addition, the species was captured in mist nets during three summer camps.

The presence of pond bats (*Myotis dasycneme*) was only established during 1988-the Netherlands and 2000-Hungary (with bat detectors) and during 2007-Estonia and 2008-Romania (with mist nets). On one occasion, a pond bat colony, housed in a farm at Hanila (2007-Estonia), was surveyed; 41 individuals were counted, in the company of three resident Northern bats (*Eptesicus nilssonii*).

The presence of Daubenton's bat (*Myotis daubentonii*) was usually established with bat detectors and, especially in recent years, with mist nets set over streams. An extraordinary discovery of Daubenton's bat was made during 2014-Montenegro, where the species had been previously unknown. During 2007-Estonia, two colonies in trees were found and surveyed (with respectively 10 and 13 animals). At other camps, roosts of Daubenton's bat with 1-10 bats each were found under stone bridges where the animals were hiding in crevices and holes between the stones. Incidentally, Daubenton's bat was observed in an attic of an abandoned house (2005-Slovakia). During 1996-Norway (Dovre) observations of Daubenton's bat were made at the extreme northern border of its range.

Geoffroy's bat (*Myotis emarginatus*) was regularly found during the day in abandoned buildings in the Mediterranean part of Europe. During 1989-France I and 2000-Hungary several colonies were found in caves and church buildings, some of which were already known. In the aforementioned inspection tunnel at Riglos (1999-Spain I), a large colony of ca. 350 Geoffroy's bats was found, together with Natterer's bats and horseshoe bats. During 1998-Belgian II in the Ardennes a dead specimen was found entangled in barbed wire, a cause of death mentioned earlier for noctules, serotines and Daubenton's bats (Voûte 1992).

Whiskered bats (*Myotis mystacinus*) were found with bat detectors during the earlier camps and more recently by mist netting. During 2003-Portugal I two colonies of respectively 46 and 11 animals were found under bridges. Whiskered bat was also found in abandoned buildings, churches and under bridges, usually in small numbers. Three specimens of a colony of 200 bats, caught in a loft in a former administration building in Malki Voden (2002-Bulgaria I), could be distinguished as *Myotis mystacinus/brandtii*, but had a back fur with clearly visible 'golden coloured' hair tips, and therefore referred to steppe whiskered bat (c.f. *Myotis aurascens*). During 2006-Macedonia and 2011-Croatia the species was also captured in mist nets. During 2012-Spain II the alcathoe whiskered bat (*Myotis alcathoe*) was caught in mist nets and recordered with bat detectors in Spain.

Greater mouse-eared bat (*Myotis myotis*) was established during 17 summer camps. In temperate Europe, (church) attics are a favourite place for nursery-colonies, while in the warmer parts of Europe caves are more commonly used (Dietz et al. 2007). The largest colony surveyed was in a church building in Očová (2005-Slovakia) with 1250 animals emerging from the roost. In other colonies in church buildings surveyed during this camp, respectively 150, 75 and 55 animals were counted. Almost 150 dead animals were found in these church attics. In some locations, such as in a church in Kovácsvágás (2000-Hungary), the roost was shared with lesser mouse-eared bats (*Myotis oxygnathus*), a sibling species. Less frequently, greater mouse-eared bats were observed in abandoned houses, whereas one specimen was discovered under a bridge. Greater mouse-eared bats were furthermore captured frequently in mist nets, as well as it was found with bat detectors. The presence of the lesser mouse-eared bat was established during nine camps, not only in church attics, but also with mist nets (five cases) and at day roosts (three cases).

Twelve camps produced Natterer's bat (*Myotis nattereri*), through bat detector observations and also through mist netting. A roost of four Natterer's bats was found in the aforementioned tunnel at Riglos (1999-Spain I), which was shared with Geoffroy's bat and horseshoe bats. A specimen caught during 2009-Portugal II was afterwards identified as Escalera's bat *Myotis escalerai*, based on a DNA sample; twelve other bats were determined as *Myotis nattereri* sensu lato. Later, during 2012-Spain II, two *nattereri*-like bats were caught; one was determined as *Myotis escalerai* , the other one was later, after DNA analysis, found to belong to a closely related species, provisionally indicated as '*Myotis* SpA' (Salicini et al. 2013).

Kuhl's pipistrelle (*Pipistrellus kuhlii*) was recorded at eleven summer camps, mostly with the use of bat detectors, but in four cases by mist nets captures. Colonies of Kuhl's pipistrelle were found several times. The most notable of these was a colony, found during 2001-Italy, in a concrete electricity pole; an evening count of this colony resulted in 31 emerging animals. In addition, during 2004-Slovenia II, Kuhl's pipistrelle colonies were found in four churches, while during 1999-Spain I a single bat was found under a bridge. The presence of Nathusius' pipistrelle (*Pipistrellus nathusii*) was established during six summer camps, with bat detectors (five camps) and, during 2007-Estonia only, through mist net captures. Also in Estonia, a large colony of Nathusius' pipistrelle was discovered near Matsalu National Park and subsequently in the evening 165 emerging bats were counted. Colonies and roosts of common pipistrelle (*Pipistrellus*

pipistrellus) were found 26 times, primarily by using bat detectors around in built-up areas. By this method many of dozens of maternity colonies were found and counted throughout Europe. One roost of 34 common pipistrelles was found in a concrete electricity pole in the village of Madzharovo (2002-Bulgaria). The species was found at all summer camps except those in Norway and Finland, the locations of which were north of the species' distribution area. In church buildings only dead animals and faeces of this species were found. The Soprano's pipistrelle (*Pipistrellus pygmaeus*) was observed during eight summer camps: seven times by bat detectors and twice (2009-Portugal II and 2014-Montenegro) by mist net captures. So far, roosts of this species were not discovered during summer camps. Savi's pipistrelle (*Hypsugo savii*) was found frequently during summer camps: in eight cases through bat detector observations and in seven through mist netting. Only one roost of Savi's pipistrelle was found, during 2001-Italy, near the village of Gemmano. Hunting animals were discovered in an abandoned potato storage building (2013-Bulgaria II). During 2011-Croatia, Savi's pipstrelle was surprisingly abundant in the coastal region.

The presence of greater noctule (*Nyctalus lasiopterus*) was established during six camps: four times with bat detectors and three times by mist netting (photo 7). During 2000-Hungary, a flight path of this species was discovered over the village of Vágáshuta; frequently passing greater noctules were taken here as an indication of a colony in the area. The roost, however, was not found. The capture of a greater noctule during 2005-Slovakia was the third capture of the species in Slovakia and was published in a local newspaper. The presence of Leisler's bat (*Nyctalus leisleri*) was demonstrated during 16 camps, with bat detectors (at twelve camps) and with mist nets (at eight camps). Only once, during 2000-Hungary, a Leisler's bat roost was discovered, in an old beech, inhabited by 50 animals. A few Leisler's bats were found in bird's nest boxes in the area as well. During 2005-Slovakia, three roosts of this species were found in an old deciduous forest. Noctules (*Nyctalus noctula*) were found during 17 camps, in most cases with bat detectors, but during six camps also with mist nets. A tree roost of this species with 27 emerging individuals was found in the village of Kloostri (2007-Estonia) and during 1991-France II and 1992-France III the flight paths of noctules commuting in a forest were tracked.

The serotine (*Eptesicus serotinus*) was found during 22 camps, mostly by bat detectors. The species was also captured in mist nets several times. Only a few day roosts of serotine were found, with 19 animals all together: four colonies were found during 1992-France III in houses; two other colonies found were located in church attics (2000-Hungary); one animal was found in the attic of a house (2003-Portugal I). The northern bat (*Eptesicus nilssonii*) was observed during six camps: five times by the use of bat detectors and three times by mist net captures, while at two camps a total of four day roosts were found in buildings (1993-Czech R. and 2007-Estonia). The particoloured bat (*Vespertilio murinus*) was found during six camps, with bat detectors (three camps) and mist nets (four camps). Before 1995-Poland known day roost in a building near the Polish village of Sromowce Niżne was surveyed, with ca. 25 animals emerging (presumably all males, as previously established by local bat workers). During this camp three (probable) parti-coloured bats were found, emerging from the same roost. During 2008-Romania, the species was discovered in a church attic in the village of Uileacu de Beiuş.

During 1997-Slovenia I, a maternity colony of eleven barbastelles (*Barbastellus barbastellus*) was found in a wooden building in a forest area (photo 8). During 1999-Spain I, an animal was found in an old tunnel, and another specimen in a cave. Eleven other barbastelle records at various camps were mist net captures and bat detector observations. During

Photo 7. Mist netted greater noctule (*Nyctalus lasiopterus*) (Slovakia, 2013). *Photo: K. Mostert.*

2014-Montenegro, the occurrence of barbastelle was established by means of sound analysis; this was the second record for this country.

Brown long-eared bats (*Plecotus auritus*) were found during 17 camps; only three times records were based on bat detector calls and seven times brown long-eared bats were captured by mist nets. Many dozens of colonies and roosts of both brown and grey long-eared bat (*Plecotus austriacus*) were found in church buildings and, to a lesser extent, in abandoned buildings. In the southern Pyrenees, both species were found frequently in old tunnels (1999-Spain I). The largest group of grey long-eared bats was located during 2005-Slovakia, in a church attic; 86 animals and one brown long-eared bat were counted. During 2000-Hungary a total of 29 grey long-eared bats were found in five church attics. During 2006-Macedonia one Alpine long-eared bat (*Plecotus macrobullaris*) was captured in a mist net, while the Balkan long-eared bat (*Plecotus kolombatovici*) was only found in Podgora (2011-Croatia), where eight animals were caught in mist nets.

Schreibers' bat (*Miniopterus schreibersii*) was found at seven camps. Three times records were based on bat detector calls and three times the species was captured in mist nets. Large colonies of this species were found during several camps in southern Europe, mostly in caves in mountainous areas. On one occasion a (previously known) colony in a column of a railway bridge was visited (1991-France II). In Onferno (2001-Italy I), 5000 Schreibers' bats emerging from a cave were counted and subsequently followed on their commuting routes by point counting passing bats in the vicinity. The outcome revealed that the vast majority of the Schreibers' bats used linear landscape elements to commute between the cave and foraging

Photo 8. Barbastelle (*Barbastella barbastellus*) colony (Slovenia, 1997). *Photo: K. Spoelstra.*

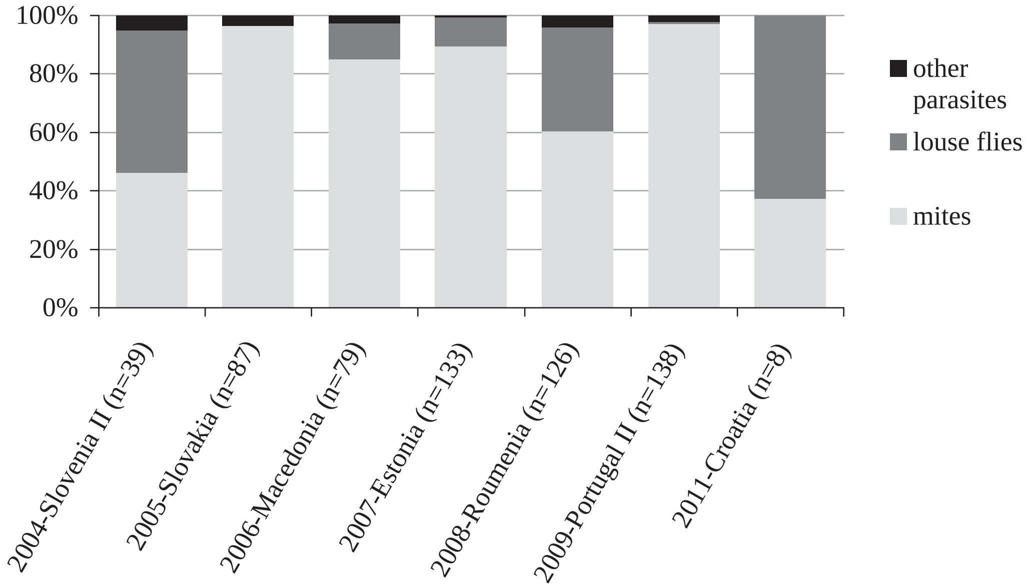

Figure 8. Proportions of different bat parasites collected during seven summer camps.
Sources: Field Study Group summer camp reports, listed in Section B of References and Jan Kristofik (personal communication).

sites (Buys 2002). During 2002-Bulgaria I this species was found roosting in an attic as well.

The European free-tailed bat (*Tadarida teniotis*) was observed during ten camps, with bat detectors and with the naked ear. In addition, a day roost was found at both 2002-Bulgaria I and 2003-Portugal I; for Bulgaria, this was the first known record.

Bat Parasites
During eight camps, 2003-Portugal I, 2004-Slovenia II, 2005-Slovakia, 2006-Macedonia, 2007-Estonia, 2008-Romania, 2009-Portugal II and 2011-Croatia, one or more parasites were collected from a total of 248 bats of 23 species. The single bat parasite taken during 2003-Portugal was not reported as identified (Kosten 2004). A total of 606 parasites were collected, consisting for more than 80% of mites of 18 different species. Louse flies (Diptera: Hippoboscidae) (eleven species) made up 15% of the parasites. Fleas (Siphonaptera) (four species), ticks (Ixodidae) (two species) and bugs (Hemiptera) (two species) were found much less frequently (figure 8). The only parasite free bats were three bats captured during the camp in Finland.

It appears that cave dwelling bats in southern Europe carry a greater number of parasites than (partly) arboreal species. Young animals too seem to be more frequently infested with parasites than older animals, probably because they cling to each other in large groups and only later in life start grooming, thereby removing parasites. Mites were found on all bats at all locations, except Finland. In addition considerable numbers of louse flies were found in southern-European countries.

Particularly, bat species belonging to the genus *Myotis* were found to be infested with large numbers of mites and louse flies. The most commonly observed mites were *Spinturnix andegavinus* and *Spinturnix myoti*, which, like all *Spinturnix* species, are bat-restricted. The, sometimes numerous, occurrence of these mites appears to be the result of a high degree of adaptation to their hosts. *Spinturnix andegavinus*, for instance, is

Table 4. The presence (black dots) of Lagomorpha established at the summer camps between 1986 and 2014 (all methods included).

	Species	1986-Belgium I	1988-the Netherlands	1989-France I	1990-Luxembourg	1991-France II	1992-France III	1993-Czech. Rep.	1994-Germany	1995-Poland	1996-Norway	1997-Slovenia I	1998-Belgium II	1999-Spain I	2000-Hungary	2001-Italy	2002-Bulgaria I	2003-Portugal I	2004-Slovenia II	2005-Slovakia	2006-Macedonia	2007-Estonia	2008-Romania	2009-Portugal II	2010-Finland	2011-Croatia	2012-Spain II	2013-Bulgaria II	2014-Montenegro
56	*Lepus castroviejoi*																										●		
57	*Lepus europaeus*	●	●	●	●	●	●	●		●		●	●		●	●	●		●	●	●	●	●			●		●	●
58	*Lepus timidus*										●														●				
59	*Oryctolagus cuniculus*	●	●	●	●	●							●	●	●	●	●	●			●			●					

known to parasitise specifically on Daubenton's bat (Lučan 2006). The exact taxonomic status of this mite species is still unclear; it is sometimes regarded as a subspecies of *Spinturnix myoti* (Haitlinger & Piksa 2012). The latter is found on several *Myotis* species, such as greater mouse-eared bat and lesser mouse-eared bat and species comprising the *Myotis nattereri* /*escalerai* /SpA/SpB complex (Baker & Craven 2003). Other host-specific mites are *Spinturnix dasycneme* which is restricted to pond bats and *Spinturnix plecotinus* which is found on both brown long-eared and grey long-eared bats. Yet another mite, *Spinturnix kolenatii,* is found to parasitise on multiple European bat species, including serotine, Northern bat, noctule and lesser mouse-eared bat (Haitlinger & Walter 1997).

Leporidae

During 2012-Spain II the broom hare (*Lepus castroviejoi*) was only observed in the Galician highlands (table 4). The brown hare (*Lepus europaeus*) was found during 21 camps, mostly through sightings, but traffic victims were also found frequently and it was also recorded by camera traps. The mountain hare (*Lepus timidus*) was only recorded in Fennoscandia (1996-Norway and 2010-Finland). The rabbit (*Oryctolagus cuniculus*) was observed during 13 camps, least often in the southeast European countries.

Rodentia

The red squirrel (*Sciurus vulgaris*), which occurs almost everywhere in Europe, was found at 24 camp locations (table 5). Its presence is usually evidenced by sightings, less often by its characteristic feeding signs too. At seven camp locations dead animals were found, mostly traffic victims. The alpine marmot (*Marmota marmota*) was only seen in the Alpine region (1989-France I), where (burrow) signs of its presence were recorded as well. Another ground squirrel, the European souslik (*Spermophilus citellus*) was encountered during three camps (2000-Hungary, 2002-Bulgaria, 2005-Slovakia). In Hungary, the typical burrows with sand in front of the entrance and perpendicular escape burrows, were also found. In Slovakia, 118 individuals were counted in a combined survey effort. During 2010-Finland, characteristic signs of beavers were found. Since only the Canadian or American beaver (*Castor canadensis*) was known from the camp location, and since the nearest European beaver (*Castor fiber*) population was ca. 350 km, these signs were linked to the Canadian beaver. This supposition is corroborated by the fact that, at sites

Table 5. The presence (black dots) of Rodentia established at the summer camps between 1986 and 2014 (all methods included).

	Species	1986-Belgium I	1988-the Netherlands	1989-France I	1990-Luxembourg	1991-France II	1992-France III	1993-Czech. Rep.	1994-Germany	1995-Poland	1996-Norway	1997-Slovenia I	1998-Belgium II	1999-Spain I	2000-Hungary	2001-Italy	2002-Bulgaria I	2003-Portugal I	2004-Slovenia II	2005-Slovakia	2006-Macedonia	2007-Estonia	2008-Romania	2009-Portugal II	2010-Finland	2011-Croatia	2012-Spain II	2013-Bulgaria II	2014-Montenegro
60	*Sciurus vulgaris*	●		●	●	●		●	●	●	●	●	●	●	●	●		●	●	●	●	●	●	●	●	●		●	●
61	*Marmota marmota*			●																									
62	*Spermophilus citellus*														●		●			●									
63	*Castor canadiensis*																								●				
64	*Castor fiber*			●							●											●							
65	*Cricetus cricetus*														●														
66	*Myopus schisticolor*										●														●				
67	*Lemmus lemmus*										●																		
68	*Myodes glareolus*	●	●	●	●	●	●	●		●	●	●	●	●	●	●				●		●	●		●		●	●	●
69	*Myodes rufocanus*										●																		
70	*Dinaromys bogdanovi*																									●			
71	*Arvicola sapidus*					●								●				●						●			●		
72	*Arvicola scherman*																			●			●						
73	*Arvicola terrestris*	●	●	●	●	●	●	●	●	●			●		●	●						●						●	
74	*Ondatra zibethicus*		●		●	●				●															●				
75	*Microtus agrestis*	●	●	●	●	●	●	●	●	●	●		●	●				●		●		●	●	●	●		●		
76	*Microtus arvalis*	●	●	●	●	●	●	●	●	●		●	●		●				●	●		●	●						●
77	*Microtus cabrerae*													●															
78	*Microtus duodecimcostatus*													●															
79	*Microtus gerbei*					●																							
80	*Microtus levis*																●											●	
81	*Microtus lusitanicus*																	●						●			●		
82	*Microtus multiplex*																		●										
83	*Microtus oeconomus*										●																		
84	*Microtus savii*															●													
85	*Microtus subterraneus*	●	●		●	●	●	●		●		●	●		●		●			●	●		●					●	●
86	*Chionomys nivalis*			●																	●						●		
87	*Nannospalax leucodon*																				●								●
88	*Micromys minutus*	●	●	●		●	●	●	●													●	●						
89	*Apodemus agrarius*									●					●				●			●	●						
90	*Apodemus flavicollis*	●		●	●	●	●	●	●	●		●	●	●	●	●	●		●	●	●	●	●			●	●	●	●
91	*Apodemus sylvaticus*	●	●	●	●	●	●	●	●	●			●	●	●	●	●	●	●	●	●		●	●		●	●	●	●
92	*Rattus norvegicus*	●	●	●	●		●	●	●	●		●	●	●	●	●	●						●			●		●	
93	*Rattus rattus*					●							●	●		●	●	●						●		●			
94	*Mus musculus*	●	●	●	●	●	●	●	●	●			●		●	●		●		●			●	●					
95	*Mus spicilegus*														●														
96	*Mus spretus*													●				●						●			●		
97	*Glis glis*	●		●		●	●			●		●			●	●	●		●	●	●		●			●	●	●	●
98	*Muscardinus avellanarius*	●		●		●	●	●		●		●			●	●			●	●	●		●						
99	*Eliomys quercinus*			●	●	●	●	●						●				●								●	●		
100	*Dryomus nitedula*																●			●								●	●
101	*Sicista betulina*																					●							
102	*Hystrix cristata*															●													
103	*Myocastor coypus*															●													

in Finland where both species were released, the Canadian beaver apparently displaced the European beaver (Tattersall 1999). During 1989-France I, 1996-Norway and 2007-Estonia the European beaver was observed visually, while numerous signs of its presence were found as well.

The lesser mole rat (*Nannospalax leucodon*) was caught by hand in the highlands near Ohrid (2006-Macedonia). The characteristic signs of its presence were found during the same camp, and also during the camp in the highlands of Montenegro (2014).

The common hamster (*Cricetus cricetus*) has only been encountered in live-traps and in pellets of lesser spotted eagle (2000-Hungary). During 1996-Norway, the wood lemming (*Myopus schisticolor*) was found in pellets of Tengmalm's owl, while during 2010-Finland one specimen was observed and signs of its presence were found (photo 9). Only during 1996-Norway, two specimens of the mountain lemming (*Lemmus lemmus*) were found in prey remains of red fox (*Vulpes vulpes*) and raven (*Corvus corax*), while signs of mountain lemming (not further specified in the concerning report) were found at least five times.

The bank vole (*Myodes glareolus*) was encountered during 21 camps. With 19% of the total number of small mammals, the bank vole is the second most trapped small mammal, but it was only rarely found in pellets (2%). By contrast, the grey-sided vole (*Myodes rufocanus*), which, within Europe, is restricted to Fennoscandia, was only found in pellets of Tengmalm's owl (1996-Norway).

The presence of the Balkan snow vole (*Dinaromys bogdanovi*) could only be demonstrated during 2011-Croatia, where it was trapped in the fringe of stones around a doline and found in eagle owl pellets (photo 10).

The southern water vole *Arvicola sapidus* has been noticed during 1991-France II and the Iberian camps by skull remains in pellets. Also, during 2003-Portugal I and 2009-Portugal II, both were found by direct observation and signs. The water vole *Arvicola terrestris* was recorded 14 times during camps, in most cases through pellet analysis, a few times by direct observation or signs, twice with traps (1986-Belgium I, 1998-Belgium II) and also twice with a camera trap (2013-Bulgaria II). Occurrence of the montane water vole (*Arvicola scherman*), which has recently been split off from *Arvicola terrestris*, was only demonstrated through signs (2005-Slovakia) and skull remains in pellets (1991-France II, 2008-Romania).

Photo 9. Runways of wood lemming (*Myopus schisticolor*) between tufts of lichen (Finland, 2010). *Photo: K. Mostert.*

Muskrats (*Ondatra zibethicus*) were found during five camps by their characteristic droppings, by tracks and by the subaquatic entrances of burrows; during two camps animals were also seen (1990-Luxembourg, 2010-Finland).

The field vole (*Microtus agrestis*) was found during 19 camps: 15 times in owl pellets and 13 times in traps. The common vole (*Microtus arvalis*), here considered together with sibling vole (*Microtus levis*), represented 25% of all prey remains in owl pellets, but no more than 10% of the small mammals trapped.

Photo 10. Balkan snow vole (*Dinaromys bogdanovi*), with its characteristic long whiskers (Croatia, 2011). *Photo: K. Mostert.*

Given its large range the species appears to be significantly under-represented in traps (see: Seasonal effects). The common vole was found during 17 camps, while the sibling vole was only caught during the two camps in Bulgaria. Cabrera's vole (*Microtus cabrerae*), which has a strictly Iberian distribution, was recorded only once, during 1999-Spain I, when three specimens were recovered from owl pellets from the southern Pyrenees. During the same camp, Mediterranean pine vole (*Microtus duodecimcostatus*) was found in large numbers in owl pellets. Not a single specimen was captured, however. Even so, the Pyrenean pine vole (*Microtus gerbei*) was only found in prolific numbers in owl pellets in the Limousin (1991-France II). During three Iberian summer camps (2003-Portugal I, 2009-Portugal II, 2012-Spain), the Lusitanian pine vole (*Microtus lusitanicus*) was frequently found in owl pellets; in addition it was trapped four times during 2003-Portugal I. One specimen of the Alpine vole (*Microtus multiplex*) was found in owl pellets (2004-Slovenia II). Root vole (*Microtus oeconomus*) was only found during 1996-Norway, with several captures and a single specimen in owl pellets. Savi's pine vole (*Microtus savii*) was never trapped during camps but its presence was confirmed during the Italian camp by a great number of remains in owl pellets. Pine vole (*Microtus subterraneus*) was found during 16 camps; it was captured in traps during twelve camps and recovered from owl pellets during six camps. Snow vole (*Chionomys nivalis*) was trapped during two camps (2006-Macedonia, 2012-Spain), and found in an owl pellet once (1989-France I).

Harvest mouse (*Micromys minutus*) was trapped once (1988-the Netherlands) and hand-captured once more (2007-Estonia). However, in owl pellets the species was found to be present at seven other summer camp locations in considerable numbers. During five summer camps the striped field mouse (*Apodemus agrarius*) was found: at four camps in traps and also at four in owl pellets, with 104 and 61 specimens, respectively. During 23 summer camps the yellow-necked mouse (*Apodemus flavicollis*) was found, at 22 camps in traps (544 specimens) and at 15 camps in owl pellets (1558 specimens). Wood mouse (*Apodemus sylvaticus)* was present during 24 summer camps, and was caught 22 times in traps (2571 specimens) and recovered 18 times from owl pellets (1319 specimens), underlining its broad ecological amplitude and trap happiness. The presence of brown rat (*Rattus norvegicus*) was demonstrated once by live-trapping during 1986-Belgium I. During eight camps (including Belgium I) the species was found in pellets; the remaining findings, mostly road kills, were from 16 camps. Black rat (*Rattus rattus*) too was trapped only once (1998-Belgium II). The species was also found in owl pellets from seven other, southern and eastern European countries. During 2002-Bulgaria I 'several' *Mus* specimens found in owl pellets probably had to be ascribed to Balkan short-tailed mice (*Mus macedonicus*). A definitive identification could, however, not be made (Mostert 2003). Even so, the live-trapped *Mus* specimens could not be identified at species level (Bekker 2003). House mouse (*Mus musculus*) was found during 16 summer camps: nine times in traps and 13 times in owl pellets.

Photo 11. Forest dormouse (*Dryomys nitedula*) (Bulgaria, 2013). *Photo: L. Soerink.*

Apart from signs, proof of the occurrence of the steppe mouse (*Mus spicilegus*) was found only once in pellets of a buzzard (2000-Hungary). During the four Iberian summer camps the Algerian mouse (*Mus spretus*) was found through trapping (three times) and pellet analysis (four times).

Edible dormouse (*Glis glis*) was found at 17 camp locations. The species was found during six camps in pellets; the predator was predominantly a tawny owl (32 specimens) and less frequently Ural owl (8) and barn owl (4); in twelve cases the predator was unknown. During twelve camps the characteristic nests of common dormouse (*Muscardinus avellanarius*) were found; its presence was also established through trapping and pellet analysis. The totals from pellets per predator species are: barn owl (26), tawny owl (5), Ural owl (1), unknown predator (1). Garden dormouse (*Eliomys quercinus*) was caught in Longworth traps and once, during 1990-Luxembourg, in a fairly large number (30 specimens) in traps placed on the ground. During other camps this species was caught as well, often in trees and also repeatedly indoors. Garden dormouse was found in pellets of barn owl, tawny owl and Ural owl and pellets of an unknown predator, with one specimen each. Forest dormouse (*Dryomys nitedula*) was found during four camps, mostly by trapping in trees (photo 11). However, one animal was trapped on the ground (2014-Montenegro). Forest dormouse was found in owl pellets during 2002-Bulgaria I only: 15 times these pellets came from tawny owl and once from barn owl. During 2005-Slovakia a nest of this species was discovered in a specially prepared nest box.

The only representative of the Dipodidae family, the birch mouse (*Sicista betulina*), was found in pitfalls as well as in owl pellets (2007-Estonia).

During 2001-Italy, a crested porcupine (*Hystrix cristata*) was briefly observed. Its presence at this location was furthermore confirmed by the large burrow entrances and quills found occasionally. During the same camp, tracks of a coypu (*Myocastor coypus*) could be established. These were the only signs of this exotic species.

Carnivora

Wolf (*Canis lupus*) could be established during four camps (table 6). During 2012-Spain II, two young animals were spotted twice, two provoked calls were heard and one camera trap recording proved the presence of wolf. In other camps only signs could be found. Red fox (*Vulpes vulpes*) was proved to be present during 25 camps; in 19 camps by signs (droppings), 17 by sightings, 10 by traffic victims and during four camps (2011-Croatia, 2012-Spain II, 2013-Bulgaria II, and 2014-Montenegro) via camera traps. Raccoon dog (*Nyctereutes procyonoides*) was observed only during 2007-Estonia, using four different observation methods. Brown bear (*Ursus arctos*) was

Table 6. The presence (black dots) of Carnivora established at the summer camps between 1986 and 2014 (all methods included).

	Species	1986-Belgium I	1988-the Netherlands	1989-France I	1990-Luxembourg	1991-France II	1992-France III	1993-Czech. Rep.	1994-Germany	1995-Poland	1996-Norway	1997-Slovenia I	1998-Belgium II	1999-Spain I	2000-Hungary	2001-Italy	2002-Bulgaria I	2003-Portugal I	2004-Slovenia II	2005-Slovakia	2006-Macedonia	2007-Estonia	2008-Romania	2009-Portugal II	2010-Finland	2011-Croatia	2012-Spain II	2013-Bulgaria II	2014-Montenegro
104	*Canis lupus*																•	•		•							•		
105	*Vulpes vulpes*	•		•	•	•	•	•	•		•	•	•	•	•	•	•	•	•	•	•	•	•	•		•	•	•	•
106	*Nyctereutes procyonoides*																					•							
107	*Ursus arctos*										•	•								•					•				
108	*Procyon lotor*				•																								
109	*Mustela erminea*	•		•	•	•					•	•	•							•									
110	*Mustela nivalis*	•	•	•	•	•	•	•			•		•	•	•	•		•			•		•				•		
111	*Mustela putorius*		•		•	•				•		•	•				•		•	•			•						
112	*Neovison vison*										•		•									•							
113	*Martes foina*	•		•	•	•	•		•			•	•	•	•	•	•		•	•	•		•	•				•	•
114	*Martes martes*			•	•	•	•	•		•	•	•	•	•	•					•		•			•		•	•	•
115	*Gulo gulo*																								•				
116	*Meles meles*	•		•	•	•	•	•			•	•	•	•	•	•	•		•	•	•		•			•	•		•
117	*Lutra lutra*					•		•			•				•		•	•		•	•	•	•	•	•		•	•	
118	*Genetta genetta*					•								•										•			•		
119	*Felis silvestris*						•										•		•							•		•	
120	*Lynx lynx*							•												•									

found during four camps, by sightings (two camps) and by various signs, including an abandoned den during 1996-Norway (Trysil). Only once signs of the raccoon (*Procyon lotor*) were found (1990-Luxembourg).

The occurrence of stoat (*Mustela erminea*) was proven with three different methods: sightings, as traffic victims and in pellets and excrements, altogether at eight summer camps. Weasel (*Mustela nivalis*) was observed during 16 camps, with the same methods. Furthermore, weasel is the only predator that was caught in traps. Western polecat (*Mustela putorius*) was found during ten camps (by sightings, signs and dead animals) while American minks (*Neovison vison*) were found by sightings and tracks during three camps (1996-Norway, 1998-Belgium II, 2007-Estonia). Beech marten (*Martes foina*) was found during 19 camps, in most cases by its signs (droppings) and also quite frequently by sightings. The presence of pine marten (*Martes martes*) was established at 17 camps, most frequently by signs (droppings) and three times by sightings and camera trapping. Wolverine (*Gulo gulo*) was observed only once; this concerned a bait-lured animal during 2010-Finland. At other locations tracks of this species were found as well. Badger (*Meles meles*) was found during 20 camps, through signs, sightings and dead animals. It was also recorded with a camera trap on one occasion. Otter (*Lutra lutra*) was seen during two camps only, while during twelve other camps signs, almost always spraints, were frequently found. On one occasion, a camera trap photograph confirmed the presence of otter (2013-Bulgaria II).

The common genet (*Genetta genetta*) was

Photo 12. Wild cat (*Felis silvestris*) recorded by a camera trap (Croatia, 2011). *Photo: camera trap.*

Photo 13. Wild boar (*Sus scrofa*), killed by traffic and already discovered by scavengers (Spain, 2012). *Photo: K. Mostert.*

Photo 14. Alpine chamois (*Rupicapra rupicapra*) spotted at the bottom of a doline (Croatia, 2011). *Photo: K. Mostert.*

found during four summer camps in south-western Europe, mostly by its characteristic droppings, and once through a sighting (1999-Spain I). On three locations, during 2009-Portugal II, pictures with a camera trap were made. The presence of wild cats (*Felis silvestris*) was confirmed during five summer camps, four times by sightings, once by a camera trap and three times by tracks (photo 12). During 2005-Slovakia, a female lynx (*Lynx lynx*) and her two cubs were spotted, while at one other summer camp tracks were discovered (1993-Czech R.).

Artiodactyla

Wild boars (*Sus scrofa*) were found during 20 camps (table 7); in all cases tracks and signs were found, while animals were sighted four times. Wild boar was furthermore confirmed by one traffic victim (photo 13), and by a camera trap recording. Moose (*Alces alces*) was found at the three northernmost camp locations, i.e. 1996-Norway, 2007-Estonia, 2010-Finland, both through sightings and signs (droppings). Red deer (*Cervus elaphus*) were found to be present during 14 camps, based in all cases on signs and in few cases also on sightings. With observations during 21 camps, the roe deer (*Capreolus capreolus*) turned out to be the most often found even-toed ungulate.

Directly after the camp in Norway (1996), one of the participants reported the sighting of reindeer (*Rangifer tarandus*) from the Dovre area; this was the only record of this species during the camps. Alpine chamois (*Rupicapra rupicapra*) was only seen in the Alps (1989-France I), the Tatra mountains (1995-Poland) and the Dinaric highlands (2011-Croatia) (photo 14). During 1996-Norway (Dovre) a small group of musk ox (*Ovibus moschatus*) was observed, the only musk oxes ever encountered during the camps. A skull of a mouflon (*Ovis ammon*) was collected during 1990-Luxembourg.

Table 7. The presence (black dots) of Artiodactyla established at the summer camps between 1986 and 2014 (all methods included).

Species	1986-Belgium I	1988-the Netherlands	1989-France I	1990-Luxembourg	1991-France II	1992-France III	1993-Czech. Rep.	1994-Germany	1995-Poland	1996-Norway	1997-Slovenia I	1998-Belgium II	1999-Spain I	2000-Hungary	2001-Italy	2002-Bulgaria I	2003-Portugal I	2004-Slovenia II	2005-Slovakia	2006-Macedonia	2007-Estonia	2008-Romania	2009-Portugal II	2010-Finland	2011-Croatia	2012-Spain II	2013-Bulgaria II	2014-Montenegro
121 *Sus scrofa*			●	●		●	●	●				●	●	●	●	●	●	●	●	●	●	●	●		●	●	●	
122 *Cervus elaphus*				●	●	●	●		●	●	●	●		●	●	●		●	●									●
123 *Alces alces*										●											●			●				
124 *Rangifer tarandus*										●																		
125 *Capreolus capreolus*	●		●	●	●	●	●	●	●	●	●	●		●	●	●		●	●	●	●	●				●	●	
126 *Rupicapra rupicapra*			●						●																●			
127 *Ovibus moschatus*										●																		
128 *Ovis ammon*				●																								

General remarks

Contribution to the knowledge of species distribution

The mammal that was most often reported during Field Study Group camps was the common pipistrelle (26 camps), closely followed by the red fox (at 25 camps) and red squirrel and wood mouse (both 24 camps). Other relatively widespread and abundant species were pygmy shrew, common mole, roe deer and hare, all of which were observed during 21 camps.

The 28 Field Study Group camps held between 1986 and 2014 have considerably contributed to the present knowledge of the distribution of mammals in Europe. The results of the camp surveys confirmed the previously known presence of a number of mammal species in 1,268 50x50 km UTM grid squares, reaffirmed their presence after 1970 in 35 squares and proved their previously unknown presence in 218 new squares (figure 9). The highest proportion of new squares was established for Chiroptera (65%), followed by Rodentia (15%), Insectivora (11%), Carnivora (7%) and Leporidae (2%). No new squares were recorded for Artiodactyla.

An explanation for the expanding knowledge of the distribution of bats seems to be the development of new equipment: bat detectors, including sound analysis tools, and mist nets. The much smaller contribution to the distribution of Leporidae, the larger Rodentia, Carnivora, and Artiodactyla is probably due to the basic knowledge and interest that already exists within the local human population and the fact that encounters with these more conspicuous, medium-sized and large mammals are relatively common.

The relatively high yield for Chiroptera is even an underestimation considering the fact that all recently described species (*Myotis alcathoe*, *Myotis aurascens*, *Myotis escalerai*, *Pipistrellus pygmaeus*, *Plecotus macrobullaris*, and *Plecotus kolombatovici*) were not included in *The Atlas of European Mammals* (Mitchell-Jones et al. 1999) and were therefore not taken into account in figure 9.

Only a handful of the mammal observations made before 1999, the year of publication of the European Atlas, were actually inserted in the atlas. Obviously, these observations were excluded from the categories 'new' or 'reaffirmation after 1970', e.g. in the case of the taiga shrew (1996-Norway, Trysil). In general, four

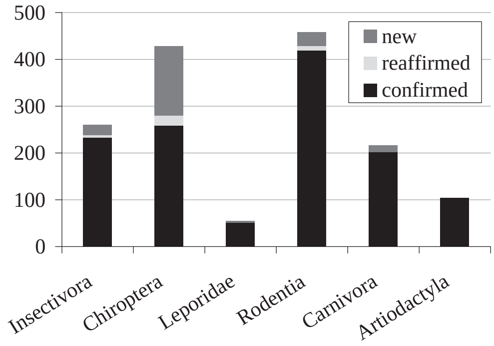

Figure 9. Confirmed, reaffirmed and new UTM grid squares (50x50 km) for each of the European mammal orders, established by the Field Study Group of the Dutch Mammal Society between 1986 and 2014.

different categories can be discerned among squares with new records of mammal species: 1. Squares filling in gaps in a more or less continuous distribution (e.g. greater noctule in 2013-Bulgaria II). 2. Squares at the edge of the known distribution of species (e.g. common mole in 1999-Spain I, 2007-Estonia, 2010-Finland). 3. Squares extending the known distribution of species (e.g. red squirrel in 2003-Portugal I, 2009-Portugal II). 4. Addition of new squares for relatively unknown species in less investigated areas or countries (e.g. small mammals in Romania).

Rare or underestimated?

In spite of the general opinion that some mammal species are extremely rare, several of those species have been trapped or otherwise observed during multiple camps. The following examples nicely illustrate this phenomenon. As mentioned earlier, Miller's water shrew was caught during nine of the 28 camps, while water shrew was caught during 14 camps. Experiences from the summer camps do support the supposition that water shrews, although usually present in low densities, are not difficult to catch (Twisk et al. 2010). The presence of Leisler's bat was demonstrated during many camps (16), in most cases with bat detectors (12) and in eight cases with mist nets. To a lesser extent this applies too barbastelle and Bechstein's bat, which were recorded during ten respectively eight camps. These observations contradict the descriptions of Leisler's bat as 'considered to be vulnerable' (Shiel 1999), of barbastelle as 'one of the rarest bats in western Europe' (Urbańczyk 1999), and of Bechstein's bat as 'considered rare nearly everywhere' (Schlapp 1999).

Missing mammal species

Some mammal species were not recorded during any of the camps, despite their known presence in the areas visited (Mitchell-Jones et al. 1999). Two of these are explicitly mentioned here. The western broad-toothed field mouse (*Apodemus epimelas*) was never trapped or otherwise observed during 2004-Slovenia II, 2006-Macedonia, 2011-Croatia and 2014-Montenegro. During the same camps, golden jackal (*Canis aureus)* was not observed either. The odds of finding a species directly depends on the survey efforts in the field (as for the golden jackal), the general success of trapping or the availability of owl pellets (as for the western broad-toothed field mouse). Although the total amounts of small mammals in owl pellets during the camps in these regions were low (62), the other survey methods used seemed to be rather promising, but clearly insufficient to meet the odds for solid observations of the golden jackal and the western broad toothed field mouse.

Effects of season

As the name 'summer camp' implies, trapping and observation during these camps are restricted to the summer months, i.e. the period around the end of July till early August. During this period, the numbers of Soricidae (shrews) and Cricetidae (voles etc.) in traps were considerably lower at camps

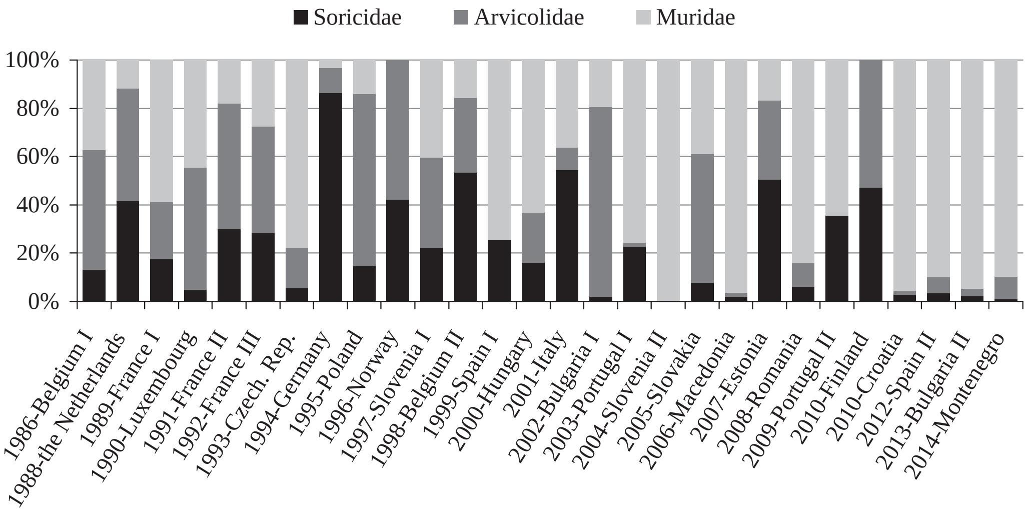

Figure 10. Proportions of Soricidae (shrews), Cricetidae (voles etc.) and Muridae (rats and mice) in live-traps. Source: Field Study Group summer camp reports, listed in Section B of References.

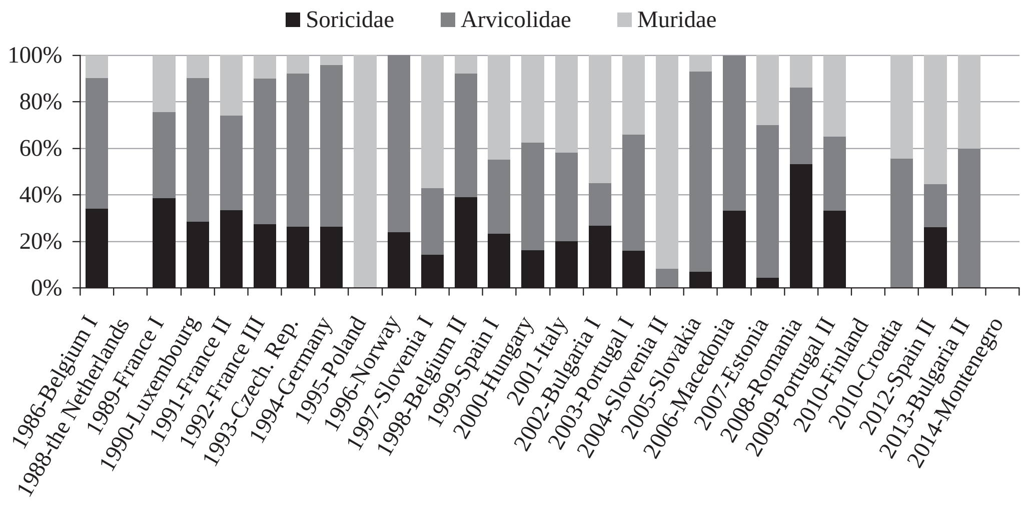

Figure 11. Proportions of Soricidae (shrews), Cricetidae (voles etc.) and Muridae (rats and mice) in pellets. Source: Field Study Group summer camp reports, listed in Section B of References.

held in Mediterranean countries (Spain I and II, Italy and Portugal I and II) than at those held in central and northern Europe (figure 10). There is no indication that these families are actually rare or absent in these regions, as shown by owl pellet analyses (figure 11). An explanation for this discrepancy for Soricidae and Cricetidae could be a possible confinement in summer of the home ranges of these rodents, which then adopt a more subsoil or even subterranean life style when food is plenty available as arthropods or juicy roots.

For the harvest mouse, there may be another explanation for the seasonal variation in capture success. This species, in spite of it having been found during nine camps, was frequently recorded in owl pellets and through signs of its presence (mainly nests), but it was captured in a live-trap only once (1988-the Netherlands) and hand-captured only once (2007-Estonia). However, harvest mouse was commonly found in live-traps during other Field Study Group camps held in autumn, (e.g. Bosman & Margry 1983, Lange et al. 1992, Bekker & van der Linden 2003). This striking difference in trapping success may be caused by the species' habit of using 'the third dimension', i.e. long leaves or stems of grasses, in summer - for 'safe' nesting and foraging on fresh seeds -, i.e. outside the reach of live-traps at ground level, as described by Paliocha & Dieterlen (2005).

Alternative inventory methods

During some of the camps, alternative methods were applied, sometimes with useful results, but often the results posed new problems. These experimental methods are nevertheless worthwhile to describe briefly as perhaps the set-up can be applied in an altered version.

In 1992 (France II), cut-open tennis balls baited with a number of sunflower seeds and fixed on bamboo poles in high vegetation were used in an attempt to attract harvest mice, in the hope of the mice eating the bait or settle in the ball, after an idea of Warner & Batt (1976). This experiment only resulted in gnawing marks of unspecified small mammals, probably due to the holes being too big and therefore accessible to wood mice. In 1996 a survey covering 13 sites throughout the UK with grids of 50 tennis balls resulted in only one of the tennis balls being occupied by a harvest mouse, despite nests being found in natural vegetation in the same area (Sibbald et al. 2006).

A method to obtain tracks of semi-aquatic small mammal was tested during the 1998 camp in Belgium II. A construction with a submersed funnel connected to a floating, tracking platform with an ink-bed was set out in the water. After passing the ink-bed, the small mammal would pass over a piece of paper and leave the contraption. Tracks of water shrew were indeed found (Bekker & Oostveen 2001), however it seems more easier to set out several small live-traps rather than this fairly large construction.

In the highlands near Ohrid (2006-Macedonia), initial attempts to positively link 'mole-hills' to lesser mole rats, by digging a jar underneath a tunnel, proved unsuccessful. Vogelaers (2006) then demonstrated how to catch lesser mole rat using a slightly adapted method described earlier by Hill et al. (1957). This method is based on the impulse of (lesser) mole rats to close any opened tunnels. The mole rat catcher opens a tunnel and waits for an animal to appear in front of the entrance. When the animal appears, the catcher drives down a hoe, directly behind the animal which can be dug out then.

During the camp in Matsalu (2007-Estonia), Spoelstra (2008) used a new, simple but effective method to identify hunting bats in the field as an extra verification of detector results. The basic principle is a digital camera with a torch perfectly aligned with the camera lens (torch beam in centre of viewfinder) and two flashes with short flash durations (e.g. 10.000 sec^{-1}). When the bat is in close range the torch is switched on by the observer and a picture is taken. The aim is to get a clear view on the tail membrane to distinguish species such as Daubenton's bat, Natterer's bat or long-fingered bat. Modern powerful and more lightweight LED lensed torches could improve the results, which are now directly visible on the display of the camera.

Closing remarks

The results presented here show that much can be achieved within the limited time frame of a summer camp aiming at the study of mammals in different European countries by using a variety of methods and techniques. A major objective of the camps were the inventories of mammals in the areas visited and their attribution to the knowledge of the extant mammals; the results of these inventories are summarised in tables 2-7. On several occasions, new mammals species were confirmed for a region or a country. During 28 Field Study Group camps a total of 128 different mammal species were found (see Appendix). The new (216), reaffirmed (38) and confirmed (1268) squares in which mammal species were recorded (as compared to the status in *The Atlas of European mammals*), is a substantial contribution to the knowledge of the distribution of mammals in Europe. Quantifying the increase of knowledge and exchange of experiences between the participants from different countries is difficult; however, there are plenty of examples showing that much has been learned by collaborating with regional or national mammal study groups. Using mist nets is one example of how Field Study Group participants learned from local counterparts. Other examples are the use of live traps on top of long sticks placed in trees to capture dormice and to place fyke nets in small Iberian streams to capture Pyrenean desman. As for getting acquainted with 'southern small mammals', the curiosity of regular attendees of the camps has been well satisfied. Not only were members of this group of mammals regularly observed, but also were mammals in Mediterranean and eastern Europe, such as the spectacular greater noctule, observed several times. For other species, in other parts of Europe, several camps were sometimes needed to established them. For instance, for the Northern birch mouse, capture attempts were already done during the 1993-Czech R. camp, but it took another camp (2007-Estonia) before the species could eventually be trapped. Even more attempts (2004-Slovenia II, 2006-Macedonia) were needed before the stenotopic Balkan snow vole could successfully be captured during 2011-Croatia.

The analyses of (owl) pellets is the most efficient method for surveying small mammals, however, sufficient numbers of pellets are not available at each location. As mentioned before, live trapping in the summer months was not very effective for shrews and voles in Mediterranean countries and for the harvest mouse. Both techniques appear to be complementary, and should be used both to maximise the results for these species. For medium-sized and larger mammals surveying the field visually (sightings) and looking for tracks and signs are still effective (standard) methods. In recent years the use of camera traps during the Field Study Group camps has proved to be a valuable addition (e.g. for common genet and wild cat).

Searching for bat roosts in places which are less frequented by humans, e.g. caves, abandoned buildings and church attics, was a standard method in bat research and during camps for a while. Bat detectors have been used since the first camps and yielded valuable information from the start. Later, sound analysis added much to the applicability and reliability of bat detector observations. Since 2000, mist netting was practised during each camp as a standard method and contributed much for the genera *Myotis* and *Plecotus*.

Tissue biopsies have proved to be valuable in validating or correcting field identifications afterwards. Therefore, DNA sampling has to be a one of the basic methods in future mammal research, including Field Study Group camps. Lastly, collecting parasites from mist netted bats during camps provided a good opportunity to increase the knowledge of these organisms.

In the oncoming years, the variety of destinations of the Field Study Group camps to choose from in Europe seems to be inexhaustible. And indeed, several countries have not yet been visited, e.g. Austria, Latvia and Sweden. Moreover, big islands such as the United Kingdom, Ireland and Iceland in the north and all the Mediterranean islands, including the Greek ones, could also be a target for a future camp. The odds are that the location will again be near a country border and indeed the 2015 summer camp location in Albania fully met this criterion (see Mostert (2015) for a first impression). Promising future destinations could also be those lacking mammal inventories, or those inhabited by rare and interesting endemic species.

Another option for future camps would be to change the time frame of 'summer' into 'autumn' to be able to study southern European shrews and voles in larger quantities and variations as well.

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Samenvatting

Een overzicht van de resultaten verkregen tijdens de zomerkampen van de Veldwerkgroep van de Zoogdiervereniging, 1986-2014

Sinds de oprichting in 1975 van de Veldwerkgroep van de Zoogdiervereniging werden er door deze werkgroep onder meer 28 zogenoemde zomerkampen georganiseerd, van 1986 tot en met 2014. Van de daarbij verkregen resultaten wordt hier een overzicht gepresenteerd.

De eerste kampen hadden België en Frankrijk als bestemming, maar in de loop der jaren heeft de Veldwerkgroep geleidelijk haar activiteiten uitgebreid naar verder weg gelegen locaties in Europa. De bestemming van een zomerkamp wordt bepaald in overleg met een internationale contactpersoon met relaties in nationale natuurbeschermingsorganisaties en daarnaast is de beschikbaarheid van een accommodatie in de omgeving van een natuurgebied, die voorziet in de basisbehoeften van een groep personen. Het aantal deelnemers tijdens de zomerkampen uit Nederland en België, varieerde tussen de tien en dertig. Van de 160 deelnemers uit Nederland en België, nam de helft eenmaal deel aan een kamp; de overige meer dan eens. In totaal waren er 116 deelnemers van lokale herkomst.

De observatietechnieken van alle 128 vastgestelde zoogdiersoorten staan vermeld. Gedurende alle kampen werden met inloopvallen 7.662 kleine zoogdieren gevangen en met mistnetten nog eens 990 vleermuizen (totaal 8.652 dieren). Deze aantallen omvatten onder meer 421 (4,9%) doodvangsten – in de noordelijke landen voornamelijk bestaande uit spitsmuizen (91%). Braakballen en andere excretieproducten van uilen, roofvogels en grotere zoogdieren bevatten 22.766 kleine zoogdieren, veruit de meeste in braakballen van kerkuilen: 21.237 (93%). Met batdetectors werden 3.908 vleermuizen waargenomen. Verder werden grotten, kerkzolders en onbe-

woonde huizen geïnspecteerd op de aanwezigheid van vleermuizen; ook oude bruggen of tunnels bleken in dit verband vaak interessante plekken te zijn, samen bijna 24 duizend exemplaren. Van de directe zichtwaarnemingen, 1.740 in totaal, zijn ook gerekend die met verrekijker of schijnwerper. De aanwezigheid van roofdieren werd voor het merendeel vastgesteld aan de hand van prenten en andere sporen, de aanwezigheid van hoefdieren vooral door zichtwaarnemingen. Ook dode dieren of delen daarvan (schedel, gewei, haren, uitwerpselen en ander zoogdier specifiek materiaal) droegen bij aan deze waarnemingen van de over het algemeen grotere zoogdieren (in totaal meer dan 1.652 waarnemingen). Sinds 2007 zijn infraroodcamera's gebruikt om vooral grotere zoogdieren te detecteren, aangetrokken met een sterk geurend kunstaas (valeriaan of pindakaas); in totaal zijn op deze wijze 77 zoogdieren geregistreerd.

De bijdrage van de Veldwerkgroep aan de kennis over de verspreiding van zoogdieren in Europa is vergeleken met de aanwezigheid van stippen op de kaarten in de atlas van de Europese zoogdieren, hetgeen resulteert in de volgende bevindingen: 1. De aanwezigheid van zoogdieren is bevestigd voor 1268 UTM-kwadranten. 2. Voor 35 kwadranten is de aanwezigheid na 1970 bevestigd. 3. Voor 218 kwadranten is de aanwezigheid voor het eerst aangetoond. Bezien we deze 'nieuwe' kwadranten op orde-niveau dan blijken Chiroptera verantwoordelijk voor het grootste aandeel (65%). Dit hoge aandeel vindt zijn oorzaak in de inzet van mistnetten en nieuwe analysetechnieken. Veel minder nieuwe kwadranten voegden Rodentia (15%), Insectivora (11%), Carnivora (7%), en Leporidae (2%) toe en de Artiodactyla voegden zelfs geen enkel nieuw kwadrant toe.

Sinds 2004 werden ecto-parasieten van vleermuizen verzameld: van 248 vleermuizen (23 soorten) werden in totaal een of meer parasieten genomen. Het totale aantal verzamelde parasieten bedroeg 606 en bestond voor meer dan 80% uit mijten (18 soorten), luisvliegen (elf soorten) vormden 15% van de parasieten.

In de Middellandse Zeegebieden is het relatieve aantal in vallen gevangen Microtidae veel lager dan in de Centraal-Europese of Noord-Europese zomerkampen, terwijl uit braakbal analyses blijkt dat Microtidae zeker niet zeldzaam of afwezig zijn in deze regio's. Dit verschil hangt mogelijk samen met de meer extreme (micro)klimaatsomstandigheden gedurende de zomermaanden, op het hoogtepunt waarvan precies de zomerkampen worden georganiseerd: deze families hebben dan mogelijk een meer teruggetrokken leefwijze in ondergrondse gebufferde (micro)milieus.

Tenslotte wordt kort ingegaan op de plussen en minnen van nieuwe onderzoekstechnieken waarmee door de jaren heen is geëxperimenteerd.

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Appendix

Total numbers of all mammals by observed methods, casualties and presence in UTM squares (confirmed, reaffirmed, new).

* recently described species not included in *The Atlas of European Mammals* (Mitchell-Jones et al. 1999).

	Species	sightings	tracks & signs	camera traps	caves & buildings	bat detector	mist net	live-trap	found dead	pellets and excrements	casualties	confirmed squares	reaffirmed squares	new squares
1	*Erinaceus europaeus*	53	13						29	1		20		
2	*Erinaceus roumanicus*	48	8						32	2		14	3	
3	*Sorex alpinus*							5	5	0		6		
4	*Sorex araneus*							849	13	922	225	31		3
5	*Sorex caecutiens*							1			1			1
6	*Sorex coronatus*							199		1998	25	11		
7	*Sorex granarius*							5		25	1	2		2
8	*Sorex isodon*									1				1
9	*Sorex minutus*							127	6	417	31	30		4
10	*Sorex samniticus*									104		2		
11	*Neomys anomalus*	1						49	1	108	8	11		3
12	*Neomys fodiens*							79	2	118	10	19		
13	*Crocidura leucodon*							4	3	443		11	1	2
14	*Crocidura russula*	2						137	3	1822	7	21		
15	*Crocidura suaveolens*							28	5	533	2	14		3
16	*Suncus etruscus*									82		5		
17	*Galemys pyrenaicus*		5					4	1		1	4		
18	*Talpa caeca*								1				1	
19	*Talpa europaea*	2	100					1	14	37		27		3
20	*Talpa occidentalis*	1	10						2	6		5		
21	*Rhinolophus euryale*				566	14	1					5	1	4
22	*Rhinolophus ferrumequinum*				251	45	11			3		17	3	5
23	*Rhinolophus hipposideros*				1169	40	15					21	2	5
24	*Rhinolophus mehelyi*				1									1
25	*Myotis bechsteinii*				39	2	16		1			4		4
26	*Myotis brandtii*				20	14	6					2		2
27	*Myotis capaccinii*				3000	35	66							4
28	*Myotis dasycneme*				41	2	6					3	1	
29	*Myotis daubentonii*				77	910	156					24		10
30	*Myotis emarginatus*				411	15	33		5			5	1	10
31	*Myotis myotis*				4959	66	79		144	1		20	1	4
32	*Myotis mystacinus*				273	5	26		1			9		5
33	*Myotis alcathoe*					5	3					*	*	1*
34	*Myotis aurascens*				200		8					*	*	3*
35	*Myotis nattereri*				9	91	20		1	2		8	1	6
36	*Myotis escalerai*						2					*	*	2*

	Species	sightings	tracks & signs	camera traps	caves & buildings	bat detector	mist net	live-trap	found dead	pellets and excrements	casualties	confirmed squares	reaffirmed squares	new squares
37	*Myotis oxygnathus*				52		41				1	7		3
38	*Pipistrellus kuhlii*				148	424	13					7		6
39	*Pipistrellus nathusii*				165	8	1					4		2
40	*Pipistrellus pipistrellus*				827	1019	40		2	2		19	4	9
41	*Pipistrellus pygmaeus*					26	2					*	*	10*
42	*Hypsugo savii*				21	206	110					8		5
43	*Nyctalus lasiopterus*					15	5					1		5
44	*Nyctalus leisleri*				50	198	43					6	1	11
45	*Nyctalus noctula*				100	173	19					9	1	9
46	*Eptesicus nilssonii*				26	102	16					18		
47	*Eptesicus serotinus*				127	295	86		1	2		20	1	7
48	*Vespertilio murinus*				4	33	21					7		3
49	*Barbastella barbastellus*				13	10	34			1		5	1	6
50	*Plecotus auritus*				137	10	24					14	2	5
51	*Plecotus austriacus*				81	31	22					5		6
52	*Plecotus kolombatovici*						8				1	*	*	2*
53	*Plecotus macrobullaris*						1					*	*	1*
54	*Miniopterus schreibersii*				10956	20	46			1		6	1	3
55	*Tadarida teniotis*				220	94						5		8
56	*Lepus castroviejoi*	6										1		
57	*Lepus europaeus*	143	20						7	1		25		2
58	*Lepus timidus*	60	1						3	1		13		
59	*Oryctolagus cuniculus*	32	22						3	7		12		2
60	*Sciurus vulgaris*	115	52						15	1		39		3
61	*Marmota marmota*	2	1									1		
62	*Spermophilus citellus*	247	3									3		
63	*Castor canadiensis*		10									2		
64	*Castor fiber*	61	26									13		1
65	*Cricetus cricetus*		10					2		18		1		
66	*Myopus schisticolor*	1	1							35		3		
67	*Lemmus lemmus*									2		4		
68	*Myodes glareolus*	5						1437	7	560	18	30	1	
69	*Myodes rufocanus*									3		1		
70	*Dinaromys bogdanovi*							2	1	5		2		
71	*Arvicola sapidus*	3	2							21		6		
72	*Arvicola scherman*		2							33		*	*	3*
73	*Arvicola terrestris*	4	4	2				4	6	544		17		
74	*Ondatra zibethicus*	8	7						2			5		
75	*Microtus agrestis*	1	2					245	2	1789	3	30		2
76	*Microtus arvalis*	1	3					750	5	5644	21	24	1	1

	Species	sightings	tracks & signs	camera traps	caves & buildings	bat detector	mist net	live-trap	found dead	pellets and excrements	casualties	confirmed squares	reaffirmed squares	new squares
77	*Microtus cabrerae*									3		1		
78	*Microtus duodecimcostatus*									505		5		
79	*Microtus gerbei*									26		1		
80	*Microtus levis*							45	2	81		1		2
81	*Microtus lusitanicus*	1	1					4	1	286		5		
82	*Microtus multiplex*									1		1		
83	*Microtus oeconomus*							15		2	3	4		
84	*Microtus savii*		1							842		2		
85	*Microtus subterraneus*							53	1	113	2	18		3
86	*Chionomys nivalis*							5		1		3		
87	*Nannospalax leucodon*		6					1		1		2		
88	*Micromys minutus*		6					2		127		11	2	
89	*Apodemus agrarius*							104	2	61	5	5		2
90	*Apodemus flavicollis*	3		4				1567	9	546	25	33	1	3
91	*Apodemus sylvaticus*	3	1	5				1319	6	2571	19	36	1	1
92	*Rattus norvegicus*	7	15	1				8	13	31		20	1	
93	*Rattus rattus*	9						1	3	18		8		2
94	*Mus musculus*							77	2	190	3	23		
95	*Mus spicilegus*		1							1		1		
96	*Mus spretus*		1					130	1	583	2	8		
97	*Glis glis*	134	15	5				59	5	58		19		7
98	*Muscardinus avellanarius*	14	40					24	4	33		17		
99	*Eliomys quercinus*	3	4					39	2	4		8	1	1
100	*Dryomys nitedula*	4	1					5		16		3	1	1
101	*Sicista betulina*							2		4		1		1
102	*Hystrix cristata*	1	2									1		
103	*Myocastor coypus*	1	0									1		
104	*Canis lupus*	8	31	2								5		
105	*Vulpes vulpes*	178	154	11					18			44		2
106	*Nyctereutes procyonoides*	22	4	2					3			2		
107	*Ursus arctos*	4	13									5		
108	*Procyon lotor*		1									1		
109	*Mustela erminea*	7	3						4	1		12		
110	*Mustela nivalis*	10	1					4	2	3	1	14		2
111	*Mustela putorius*	13	7						3			9		1
112	*Neovison vison*	7	5									7		
113	*Martes foina*	15	66	6					8			23		4
114	*Martes martes*	7	35	2					4			22		
115	*Gulo gulo*	3	1									2		
116	*Meles meles*	28	62	2					12			29		1

Species	sightings	tracks & signs	camera traps	caves & buildings	bat detector	mist net	live-trap	found dead	pellets and excrements	casualties	confirmed squares	reaffirmed squares	new squares
117 *Lutra lutra*	2	94	1					1			15		4
118 *Genetta genetta*	1	14	7								5		
119 *Felis silvestris*	5	1	1								5		
120 *Lynx lynx*	3	3									2		
121 *Sus scrofa*	7	68	1					1			21		
122 *Cervus elaphus*	15	41						1			19		
123 *Alces alces*	93	17									15		
124 *Rangifer tarandus*	1	6									2		
125 *Capreolus capreolus*	280	59	6					8			42		
126 *Rupicapra rupicapra*	25										3		
127 *Ovibus moschatus*	5										1		
128 *Ovis ammon*								1			1		
Not identified to species level	25	112	19	8515	165	10	270	18	1363	6			
Total	1740	1194	77	32458	4073	990	7662	458	22766	421	1268	35	218+ 22*

The range of the masked shrew (*Sorex caecutiens* Laxmann, 1788) extends to southern Scandinavia

Jeroen van der Kooij[1], Georg Bangjord[2], Jan Obuch[3], Bengt-Göran Carlsson[4] & Birger Hörnfeldt[5]

[1]Norwegian Zoological Society, Postboks 102 Blindern, NO-0314 Oslo, Norway, e-mail: jevader@online.no
[2]Norwegian Environment Agency, NO-7485 Trondheim, Norway
[3]Comenius University, Botanical Garden, SK-03815 Blatnica, Slovak Republic
[4]Limo Natur, Häljesund 275, SE-830 02 Mattmar, Sweden
[5]Department of Wildlife, Fish, and Environmental Studies, Swedish University of Agricultural Sciences, SE- 901 83 Umeå, Sweden

Abstract: The discovery of the masked shrew (*Sorex caecutiens*) in 2003 in southern Norway, 500 km southwest of its known range, initiated the mapping of its actual range. Through the revision of museum specimens, the analyses of owl pellets and the summarising of Swedish trapping data, the apparent gap between its northern and its southern populations could be reduced. The species' occurrence in southern Scandinavia is presumably restricted to areas above the timberline. It most likely occurs in more areas and specifically on the transboundary mountain ridge of Norway and Sweden. The species shows a distinct variation in pelage colouration, according to age and time of the year. This makes its identification difficult. Genetic research should reveal how the masked shrew colonised Scandinavia after the last glaciation.

Keywords: *Sorex caecutiens*, masked shrew, immigration history, owl pellet analysis, Scandinavia, biogeography, pelage variation, revision of museum specimens, snap trapping.

Introduction

Until the beginning of the 21st century the westernmost range of the masked shrew (*Sorex caecutiens* Laxmann, 1788) was marked by a single record from the Norwegian municipality of Hattfjelldal, approximately 100 km south of the Arctic circle (Sulkava 1990, Pucek 1999).

This view changed dramatically when in 2003 a population of masked shrews was discovered in the municipality of Vågå, southern Norway, 500 km southwest of its known distribution (Finch & van der Kooij 2005). The population was discovered through identification of 20 specimens in a considerable bycatch of small mammals from pitfall traps meant to collect epigeic arthropods (e.g. Naujok & Finch 2004). The discovery immediately raised questions about its origin and immigration history (Finch & van der Kooij 2005).

The masked shrew was recorded at Mount Blåhø from the timberline at 900-1050 m a.s.l. to the top at 1617 m a.s.l. The mountain is to the north, east and south separated by two deep valleys from other mountainous and alpine areas. Additional trapping by Finch and van der Kooij in 2004 in the nearest mountains produced no further records of the masked shrew.

Material & Methods

To investigate whether the population on Mount Blåhø in southern Norway really is isolated from the rest of the species range we made use of three different approaches. The data are presented according to the UTM coordinate system, WGS 1984, in 10 x 10 km square units. The map plots are presented as 50 x 50 km square units (figure 1).

Revision of Norwegian Museum material

As part of the Norwegian Mammal Atlas Project (Syvertsen et al. 1996) we revised in 2005 and 2006 all Soricidae in the collections of the following musea: Natural History Museum (Oslo), NTNU University Museum (Trondheim), Helgeland Museum (Mo i Rana) and Tromsø University Museum (Tromsø).

Owl pellet analysis in Sør-Trøndelag

We conducted owl pellet analyses in Sør-Trøndelag county. Mapping the distribution of small mammals from owl pellet analyses has been a well-used method in the Norwegian Mammal Atlas Project. However, the use of the method increased in 2007 when the third author demonstrated an effective way to extract bones from owl-pellets by the use of NaOH (Obuch 2014). From then on, the analyses of owl pellets have been intensified in Sør-Trøndelag county. Until the breeding season of 2014, 5700 individuals of rodents and shrews have been extracted from samples of pellets from Tengmalm´s owl (*Aegolius funereus*) nestboxes in the Røros-area.

Swedish trapping data

Swedish trapping data on small mammals were summarised. The data are part of the National Environmental Monitoring Programme (NEMP) in Sweden (Anonymous 1985). One of the prime purposes of this monitoring is to detect deviations from 'normal' density variations. The deviations could be 'early warnings' of environmental disturbances, like climate warming (Hörnfeldt 2004).

The research areas vary in size (table 1). At Vindeln (the easternmost area) the area was a 100 x 100 km square. This square contained around 60 plots of 1 ha. The mountainous areas Vålådalen/Ljungdalen, Ammarnäs and Stora Sjöfallet consisted of 40 plots of 1 ha each. The plots were normally distributed over a range of altitudes, in a way that represented different mountainous habitats.

Within each plot of 1 ha, 50 metal snap-traps were set as a diagonal transect through the plot with ten groups of traps containing five traps each, within two metres. The distance between each group was about ten metres. It is a standard trapping method, used over many decades (Hörnfeldt 1978). The method approximates to the following numbers of traps (in brackets) in the different areas: Vålådalen/Ljungdalen (2100), Ammarnäs (2200), Vindeln (3000) and Stora Sjöfallet (2050). The traps were baited with dried apple, and soaked in vegetable oil and wheat flour. They were checked once a day on three subsequent days, both in spring and fall, each year.

All animals were individually labelled, collected, and preserved at the Swedish Museum of Natural History in Stockholm. They are of great importance for future research on for example environmental pollution, pathogens or reproductional failure.

Results

Revision of museum specimens

Eleven specimens of the masked shrew were revised in the collection of the Natural History Museum of Oslo (table 2), none in the other collections. All but one individual were misidentified and listed as pygmy shrews

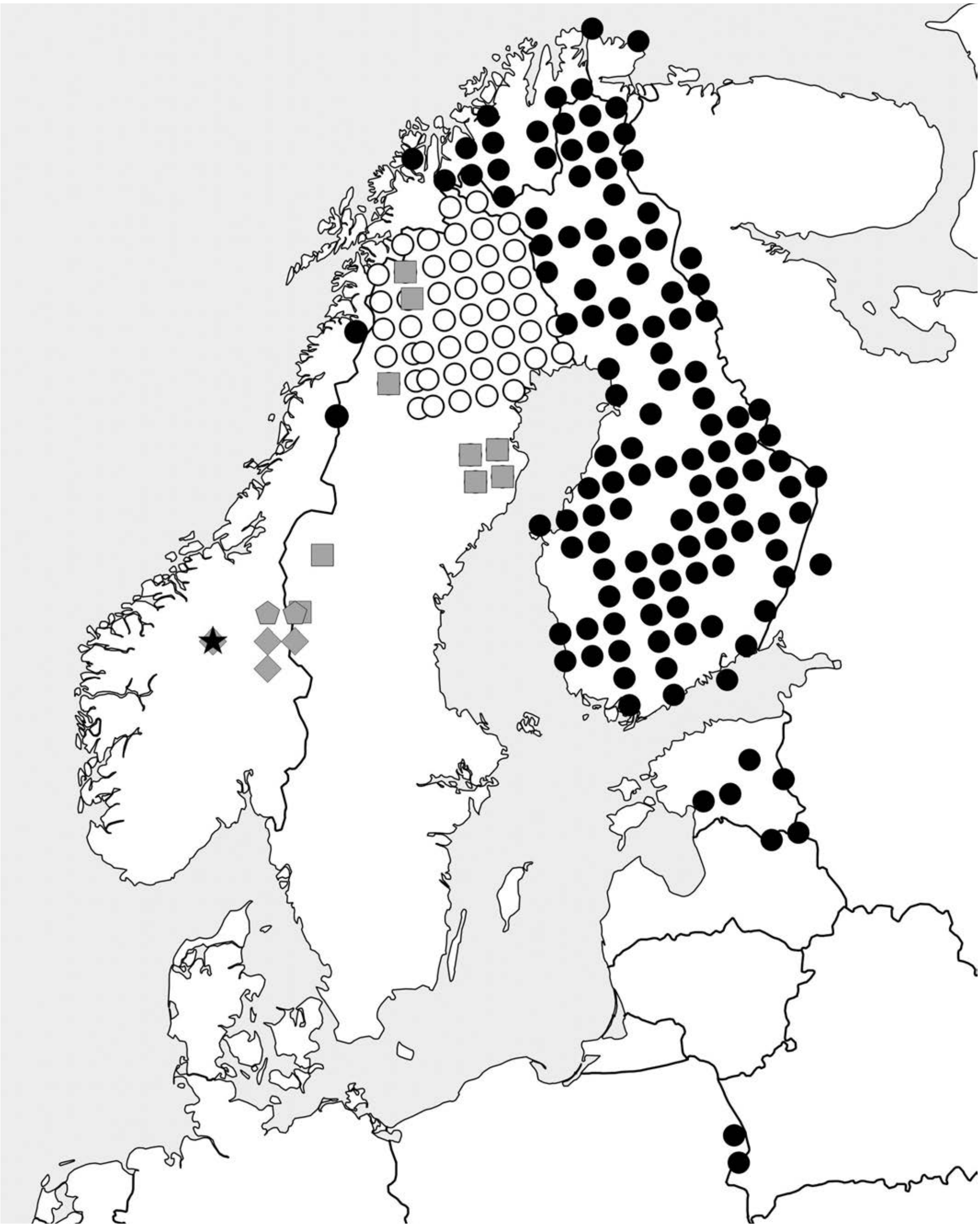

Figure 1. Occurrence of *Sorex caecutiens* in Europe exclusive of Russia and Belarus (adapted after Finch & van der Kooij 2005). The star represents the population at Mount Blåhø. The grey symbols reveal new data presented in this article: revised museum specimens (diamonds), prey items of Tengmalm's owl (*Aegolius funereus*) (pentangles) and Swedish trapping data (squares). The open circles in Sweden represent UTM-squares where the occurrence is partially based on expert judgement and not on actual records (e.g. Mitchell-Jones et al. 1999).

Table 1. The location of small mammal trapping areas in Sweden.

Area	Municipality	County	UTM 10 x 10 km square
Vålådalen/Ljungdalen	Åre/Berg	Jämtland/Härjedalen	33VUK74, 33VVL10, 33VVL20
Ammarnäs	Sorsele	Västerbotten	33WWP51, 33WWP52, 33WWP60
Vindeln	Vindeln	Västerbotten	34WCV98, 34WDS00, 34WDS03, 34WDS10, 34WDS13, 34WDS15, 34WDS18, 34WDS30, 34WDS32, 34WDS33, 34WDS35, 34WDS52,34WDS62, 34WDS65, 34WDS67, 34WDS82, 34WDS84, 34WDS87, 34WDS97
Stora Sjöfallet	Gällivare	Norrbotten	33WXR12, 33WXR20

Table 2. Revised *Sorex caecutiens* from the collection of the Natural History Museum of Oslo.

NHMO Collection nr.	Original identification	Date	UTM 10 x 10 km square	Altitude	Locality	Municipality	County	Leg.	Prep.
10419	*S. minutus*	01 Aug 1996	32VNP19	940	Storhuset (Tjernet)	Dovre	Oppland	Field Study Group VZZ	cranium, skin
10340	*S. minutus*	10 Aug 1996	32VPP24	700	Fuggsjømyrene	Rendalen	Hedmark	G. Westereng	cranium, skin
10353	*S. minutus*	15 Aug 1996	32VPP24	700	Fuggsjømyrene	Rendalen	Hedmark	G. Westereng	alcohol
10356	*S. minutus*	16 Aug 1996	32VPP24	700	Fuggsjømyrene	Rendalen	Hedmark	G. Westereng	alcohol
M 20289	*S. minutus*	23 Aug 1996	32VPP24	700	Fuggsjømyrene	Rendalen	Hedmark	B. Westereng	alcohol
10700	*S. minutus*	08 Aug 1998	32VPP24	700	Fuggsjømyrene	Rendalen	Hedmark	G. Westereng	alcohol
11183	*S. araneus*	19 Aug 1998	32VPP24	700	Fuggsjømyrene	Rendalen	Hedmark	B. Westereng	alcohol
187-74	*S. minutus*	30 July 1974	32VPP47		Bottølen, Femund	Engerdal	Hedmark	G. Westereng	alcohol
188-74	*S. minutus*	30 July 1974	32VPP47		Bottølen, Femund	Engerdal	Hedmark	G. Westereng	alcohol
28-76	*S. minutus*	13 Aug 1976	32VPP57	680	S. Femunden close to Sørken	Engerdal	Hedmark	G. Westereng	alcohol
30-76	*S. minutus*	14 Aug 1976	32VPP57	680	S. Femunden close to Sørken	Engerdal	Hedmark	G. Westereng	alcohol

(*Sorex minutus*). Only one was misidentified as common shrew (*Sorex araneus*).

Owl pellet analysis

Seventeen individuals of the masked shrew from ten different localities were found (table 3). The owl pellet analyses show that the species occurs only in low numbers in the diet of the Tengmalm's owl, at an altitude of about 600-700 m a.s.l.

Swedish trapping data

The masked shrew was trapped in low numbers within each study-area (table 4). The relative frequency in the trapping data increases from southern to northern Sweden.

Discussion

The presented data clearly show a distinctly smaller gap between the range of the masked shrew in northern Scandinavia and the record from Mount Blåhø (figure 1). It is, however, questionable whether the complete actual distribution range of the species is uncovered now. There are still vast areas in Scandinavia where no trapping has been done and no owl pellets have been analysed.

But even in areas where trapping studies or owl pellet analyses have been carried out, the species might have been overlooked by misidentification or by the use of methods which are less sensitive to smaller shrew species. For example, snap-traps are less effective than pitfalls (Hanski & Kaikusalo 1989, Sulkava 1990).

Small mammals in general, and shrews are no exception, can be difficult to identify by external traits. Field guides often fail in presenting realistic drawings of the less studied small mammals. This is presumably due to the lack of field experience with these species by the artists or by the authors. Field guides – meant for use in the field – seldom take geographic, seasonal and age variation of characters into account. To identify species correctly, extensive field experience is often needed.

Interestingly, one of the misidentified specimens from the Museum of Natural History in Oslo was collected in 1996 by a field work camp organised by the Dutch Mammal Society and the Norwegian Zoological Society (Gundersen 1999, Bekker et al. 2015). The first author (JvdK), who, at the time, had no field experience of external traits of the masked shrew, participated in this camp and collected the small mammals, which unfortunately had died in the live-traps. At that time, the species was not recognised and was confused with the pygmy shrew. It wasn´t until 2002-2003 when the first author extensively trapped small mammals in the Pasvik valley (northeastern Norway, at the Russian border) and conducted an extended study trip to the museum collection of Oulu University (Finland) that he felt confident of the external traits of the species. This was of use some years later, when he revised the museum collections.

The difficulty to distinguish the masked shrew from the pygmy shrew is also demonstrated by the publication of a supposed masked shrew from the Netherlands (van den Brink 1953). Van den Brink, author of the first field guide of the mammals of Europe, had found a shrew in 1928 in a Scots pine (*Pinus sylvestris*) plantation on inland sand dunes near Appelscha, in the province of Friesland. Although van Leeuwen (1954) proved that it was a pygmy shrew, van den Brink (1955a, 1955b) persisted that it was a masked shrew.

The masked shrew displays an extensive variation in pelage colouration. In Scandinavia one can differentiate between at least four different pelages: winter, spring and summer pelage of adults and summer pelage of subadults. The summer pelage of the subadult (figure 2) looks like the two-coloured summer pelage of pygmy shrews, whereas the summer pelage of the adults (figure 3) looks like the three-coloured summer pelage of adult common shrews (Sulkava 1990; Jeroen van der Kooij, personal observations). The skin variation led until the middle of the last century to the belief of the existence of two sympatric species: *Sorex lapponicus* and *Sorex centralis* (Sulkava 1990). With the notable exception of Twisk et al. (2010), most field guides only display the pelage of subadults.

To distinguish the masked shrew from the pygmy and common shrew it is important to consider the relative tail length, the hind foot length, the bicoloured tail with a distinct brush and the cranial characters (Sulkava 1990, van der Kooij 1999).

Our research revealed the occurrence of the masked shrew at several places in southern Scandinavia. Whether the species occurs in low densities there, as the pellet analyses and the trapping data suggest, remains unclear. Additional owl pellet analyses (25,000 small mammal prey items from tawny owl (*Strix aluco*; the Tengmalm´s owl doesn´t occur here) demonstrates the absence of the species from the lowlands in Sør-Trøndelag county. The masked shrew may therefore be confined to areas above the timberline, where

Table 3. *Sorex caecutiens* remains from samples of pellets from Tengmalm's owl (*Aegolius funereus*) nestboxes in Mid-Norway. Samples from Grøtberget and Sætra nord were analysed without the use of NaOH, which produces less prey items. The percentage is therefore not calculated here.

Number of *S. caecutiens*	% *S. caecutiens* in vertebrate prey	% *S. caecutiens* in shrews te	Sampling date	Breeding period	UTM 10 x 10 km square	Altitude	Locality	Municipality	County
1	1.3	5.1	17 Sept 2014	May 2014	32VPQ13	610	Våtstrupet	Os	Hedmark
1	-	-	Autumn 2002	2002	32VPQ23	675	Grøtberget	Røros	Sør-Trøndelag
1	0.8	0.1	1 Oct 2011	May 2011	32VPQ23	660	Påsken gård	Røros	Sør-Trøndelag
3	0.9	18.8	5 Oct 2011	May 2011	32VPQ23	640	Møllenmanns-dalen	Røros	Sør-Trøndelag
3	1.8	13.6	18 Oct 2014	May 2014	32VPQ23	630	Kvernbekken	Røros	Sør-Trøndelag
1	-	-	Autumn 2002	1985/1994	32VPQ33	650	Sætra nord	Røros	Sør-Trøndelag
3	1.5	5.1	1 July 2011	May 2011	32VPQ51	690	Røsanden	Røros	Sør-Trøndelag
2	1.1	13.6	1 Sept 2014	May 2014	32VPQ42	670	Langen	Røros	Sør-Trøndelag
1	0.3	0.8	05 Sept 2014	after 1987	32VPQ52	675	Koltjønna	Røros	Sør-Trøndelag
1	0.8	25.0	04 Oct 2011	May 2011	32VPQ53	685	Feragen øst (north off Øya)	Røros	Sør-Trøndelag

Table 4. Small mammals caught in four trapping areas in Sweden. Numbers are given in percentage of the total number of catches.

Area	Period	Number of individuals	*Sorex araneus*	*Sorex caecutiens*	*Sorex minutus*	*Myodes glareolus*	*Myodes rutlius*	*Myodes rufocanus*	*Microtus agrestis*	*Microtus oeconomus*	*Lemmus lemmus*	*Myopus schisticolor*
Vålådalen/Ljungdalen	2001-2014	9264	6.1	0.2	0.2	38.6		33.4	11.4	1.5	7.1	1.6
Ammarnäs	1995-2014	14,594	11.8	0.3	0.2	40.0		16.9	21.0		8.9	1.0
Vindeln	1979-2014	18,304	6.4	0.5	1.1	73.8		6.3	9.9			2.0
Stora Sjöfallet	2001-2014	6600	7.2	0.6	0.2		14.9	55.1	11.3	2.3	7.6	0.8

the Tengmalm´s owl does not breed and only infrequently hunts. The, from north to south, decreasing proportion of area above the timberline in the trapping areas could explain why its relative frequency in the trapping data decreases from north to south. Further analysis of the data may confirm this phenomenon.

Our work stresses once again the importance of preserving dead animals or tissue samples from fieldwork. To establish the southern border of the range of the masked shrew and to determine to what degree the different populations are isolated from each, further research is needed. The transboundary mountain ridge of Norway and Sweden, with vast areas above the timberline, probably provide the most suitable habitats to study the masked shrew's occurrence between the established northern and southern records. In addition, the occurrence in northern Norway and Sweden should be investigated further. An often referred map of its occurrence in Sweden is at least partially based on expert judgement and not on actual records (Mitchell-Jones et al. 1999, p. 21).

Whether the masked shrew, after the last glaciation, colonised the Scandinavian peninsula through the northern route alone is presumable but cannot be finally established by distribution data. For that purpose, genetic (phylogeographic) analyses are needed.

Figure 2. Subadult *Sorex caecutiens* in summer pelage (21 July 2003, Pasvik, Sør-Varanger, Norway). *Photo: Jeroen van der Kooij.*

Figure 3. Adult *Sorex caecutiens* in summer pelage (21 July 2003, Pasvik, Sør-Varanger, Norway). *Photo: Jeroen van der Kooij.*

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Samenvatting

Nieuwe gegevens over de noordse spitsmuis (*Sorex caecutiens* Laxmann, 1788) reduceren het gat in de verspreiding tussen Noord- en Zuid-Scandinavië

De ontdekking van een nieuw voorkomen van de noordse spitsmuis in Zuid-Noorwegen in 2003, 500 km ten zuidwesten van het bekende verspreidingsgebied, gaf aanzet tot nader verspreidingsonderzoek. Door het controleren van collecties, het pluizen van braakballen en het samenstellen van Zweedse vangstgegevens kon aangetoond worden dat de soort ook voorkomt op verschillende plaatsen in het tussenliggende gebied. Verwacht wordt dat de noordse spitsmuis op nog meer plaatsen voorkomt, met name in het grensgebergte van Noorwegen en Zweden. Het voorkomen in Zuid-Scandinavië is waarschijnlijk beperkt tot gebieden boven de boomgrens. Het kleurpatroon van deze spitsmuis verandert met leeftijd en tijd van het jaar, waardoor de herkenning wordt bemoeilijkt. Genetisch onderzoek moet uitwijzen hoe de soort na de laatste ijstijd Scandinavië heeft gekoloniseerd.

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Two new records of the Pannonic root vole (*Microtus oeconomus mehelyi* Ehik, 1928) in Austria

Johan B.M. Thissen[1], Dick L. Bekker[2*], Barbara Herzig-Straschil[3] & Rob M. Koelman[4]

[1]Mansberg 7, NL-6562 MA Groesbeek, the Netherlands
[2]Detail 2.0 – Faunistic Research, Rensumaheerd 73, NL-9736 AC Groningen, the Netherlands
[3]Natural History Museum Vienna, Mammal Collection, Burgring 7, A-1010 Wien, Austria
[4]Ecologisch Adviesbureau Eliomys, Kardinaal Gerardstraat 9, NL-6561 BV Groesbeek, the Netherlands

Keywords: *Microtus oeconomus*, *Microtus oeconomus mehelyi*, root vole, Austria, Neusiedler See, Waasen, Hanság

Introduction

The root vole (*Microtus oeconomus*) has a continuous holarctic distribution from eastern Germany and northern Scandinavia, throughout Russia and Alaska to north-western Canada. In addition there are isolated populations in southern Scandinavia, on Finnish islands in the Gulf of Bothnia, in the Netherlands, at Lake Balaton (Hungary) and at the point where Austria, Hungary and Slovakia meet. These isolated populations have been described as separate subspecies. The populations of the species in Austria, Hungary and Slovakia represent the Pannonic root vole (*Microtus oeconomus mehelyi* Ehik, 1928).

The Neusiedler See area, including the Seewinkel and Waasen/Hanság, is the only part of Austria where the Pannonic root vole occurs. East of the Neusiedler See, in the Seewinkel area, the occurrence of root vole has recently been confirmed (figure 1). However, apart from some records in owl pellets, the only ever record of a root vole in the field west of the Neusiedler See is the catch of five animals by Zdenek Hubálek in the reed belt near Oggau am Neusiedler See in June 1977 (Hubálek et al. 1979, no. 74 in Thissen et al. 2015). Records of two collecting localities from the west of the Neusiedler See from the period 1984-1986 have also been published (Hoi-Leitner 1989) but were later regarded as resulting from owl pellets (Spitzenberger 2001). Recently, in 2013 and early 2015, root vole remains were recovered from owl pellets collected near Oggau (nos. 73 and 73A in Thissen et al. 2015). Triggered by these recent records from owl pellets we have tried to confirm its presence in the field in that area in October 2015 by live-trapping.

There are no field records at all of root vole in the Austrian part of the Waasen/Hanság area, apart from a recent (2014) pellet record (no. 66 in Thissen et al. 2015). We visited this area during our fieldwork in October 2015 to look for habitat of the root vole. We did not set any live-traps in the Waasen/Hanság area.

Method

Because of the habitat preference of the Pannonic rootvole, we set Longworth live-traps

* Corresponding author.
e-mail: Detail2.0FO@gmail.com

Figure 1. Recent proven distribution of *Microtus oeconomus mehelyi* in Austria, before October 2015 (2011 – early 2015). White dots indicate localities of successful trapping and circles (*r* = 1 km) are drawn around the localities where owl pellets with remains of *M. oeconomus mehelyi* were collected. Source: Thissen et al. 2015.

in sedge vegetation, at six neighbouring localities in the reed belt between Oggau and Donnerskirchen. The sedge vegetation consisted mainly of great pond-sedge (*Carex riparia*) mixed with reed (*Phragmites australis*). In the 1950s large tracts of sedge beds without reed were present around the Neusiedler See. Bauer (1960) considered those pure sedge beds as the prime habitat of the root vole.

At each of the localities we set ten pairs of two Longworth live-traps, starting on 6 October 2015. The pairs of traps were up to 10 m apart. The live-traps were supplied with hay and baited with carrot and a commercial mix of rodent food. Live *Tenebrio molitor* larvae (mealworms) were added to reduce mortality of caught shrews. The traps were not pre-baited. At two localities the traps were used over two nights and at four localities over three nights. This made for a total of 320 trap nights: (40 * 2) + (80 * 3). The traps were checked twice every twenty-four hours: in the morning and in the early night.

Results

Over 320 trap nights the live-traps produced only one root vole, a subadult female of 23 grams (figure 2). It was caught at a locality with 100% cover of great pond-sedge and a low cover of reed (figure 3). The animal was collected and added to the mammal collection of the *Naturhistorisches Museum Wien* (NMW).

High numbers of other mouse and shrew species were captured in the live-traps. Overall, 44% of the traps were occupied. Striped field-mouse (*Apodemus agrarius*) prevailed at all of the six localities. This species is a recent immigrant to the Neusiedler See area. This first striped field-mouse was found near the Biological Station at Illmitz, east of the Neusiedler See, in 2003. Striped field-mouse has rapidly expanded in the last two decades from north west Hungary and north Slovenia into Austria (Herzig-Straschil et al. 2004, Sackl et al. 2007, Spitzenberger & Engelberger 2014).

Figure 2. Subadult female *Microtus oeconomus mehelyi*, caught west of Neusiedler See, 8 October 2015. *Photo: Rob Koelman*.

On 7 October 2015 we visited the Waasen/Hanság area, east of the Neusiedler See. By sheer serendipity we found a dead adult male root vole of 40 gram (figure 4) lying in an observation tower at the great bustard reserve along the road from Tadten southwards, to the Hungarian border. This reserve is an exclave of the Neusiedler See – Seewinkel National Park. We suppose that this root vole was captured by a raptor, most likely a kestrel (*Falco tinnunculus*), and carried through the air to the tower. The dead animal was collected to become added to the mammal collection of the *Naturhistorisches Museum Wien* (NMW).

Figure 3. The spot between Oggau and Donnerskirchen where one *Microtus oeconomus mehelyi* was caught on 8 October 2015. The vegetation consists of *Carex riparia* and *Phragmites australis*. *Photo: Rob Koelman*.

Figure 4. Adult male *Microtus oeconomus mehelyi* found dead in an observation tower near Tadten, 7 October 2015. *Photo: Rob Koelman*.

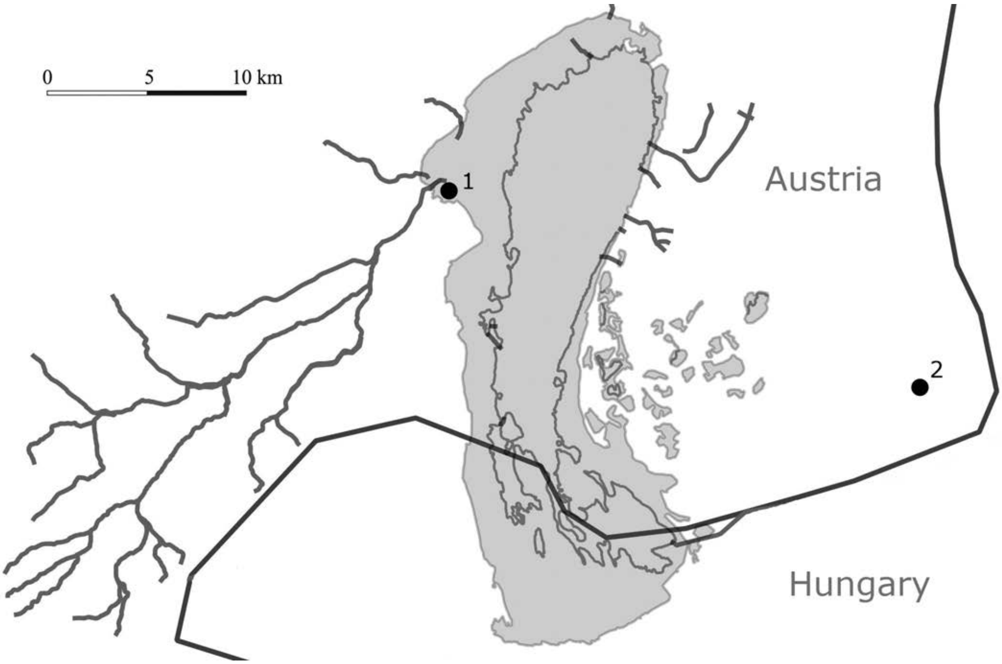

Figure 5. Map with two new records of *Microtus oeconomus mehelyi* in Austria, October 2105. 1: between Oggau and Donnerskirchen, 2: Waasen/Hanság.

Discussion

Our catch of a Pannonic root vole (no. 1 in figure 5) on 8 October 2015 confirmed that it is still present west of the Neusiedler See and our find of a dead specimen in an observation tower (no. 2 in figure 5) confirmed that it is also present in the Waasen/Hanság area. Outside of the breeding season a raptor will only transport a prey up to some hundred metres. The remains found in owl pellets, that were documented in 2013 and early 2015 west of the Neusiedler See and 2014 in the Waasen/ Hanság area (figure 1), may have been transported much further, possibly over many kilometres.

As a whole the distribution area of the root vole in Austria seems to be more or less intact, apart from a contraction in the northern part of it, between Neusiedl am See and Bruck an der Leitha or even towards Fischamend (Thissen et al. 2015). However, within parts of its distribution area it has disappeared locally, for example from wet areas with trees or grey willow (*Salix cinerea*), where it has been displaced by the bank vole (*Myodes glareolus*) (Hoi-Leitner 1989).

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Samenvatting

Twee nieuwe waarnemingen van de noordse woelmuis in Oostenrijk

Ter bevestiging van de aanwezigheid van de noordse woelmuis (*Microtus oeconomus mehelyi*) aan de westzijde van de Neusiedler See hebben wij daar recent een vangactie uitgevoerd. Sinds 1977 waren aan de westzijde geen waarnemingen meer in het veld geweest. De noordse woelmuis was daar alleen nog in braakballen aangetroffen. In oktober 2015 vingen wij aan de westzijde, in de rietgordel tussen Oggau en Donnerskirchen, een noordse woelmuis. Verder vonden wij toevallig een dode noordse woelmuis in een uitkijktoren bij het reservaat voor grote trap in het Waasen/Hanság gebied, ten oosten van de Neusiedler See. Ook in dat gebied waren geen waarnemingen bekend van noordse woelmuizen in het veld. Deze twee recente waarnemingen zijn belangrijke aanvullingen op het eerder gepubliceerde verspreidingsbeeld in Oostenrijk (Thissen et al. 2015) en bewijzen dat het areaal in Oostenrijk in grote lijnen stabiel gebleven is. Alleen ten noorden van de Neusiedler See is het areaal van de noordse woelmuis wat ingekrompen.

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