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Live trapping design for the harvest mouse (*Micromys minutus*) in its summer habitat

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Abstract: The harvest mouse *Micromys minutus* is a very rare species in Switzerland. It has only been documented accurately since 1960. Most records are based on nest findings and there have been few direct observations or captures, mainly because live trapping of this species is not simple. Therefore, an efficient trapping technique is needed for population studies and to facilitate the management of its habitat. By combining the methods used to capture very small (*Suncus etruscus*) and climbing (*Muscardinus avellanarius*) mammals, we developed a design using Longworth traps with mouse excluders set on suspended platforms. This allowed us to trap more harvest mice in four field sessions of 60 trap-nights than have ever been caught previously since its discovery in Switzerland.

Keywords: Harvest mouse, Longworth trap, mouse excluder, prebaiting.

Resumé : La souris des moissons (*Micromys minutus*) est une espèce très rare en Suisse et peu documentée jusque dans les années 1960. La plupart des indications de présence sont indirectes, basées sur la découverte de nids. Très peu d'entre-elles font référence à des observations directes, qu'elles soient visuelles ou issues de captures d'individus vivants, car le piégeage classique n'est pas efficace. La vérification de la bonne gestion de son habitat ou la réalisation d'études populationnelles nécessitent cependant des techniques de piégeage efficientes. Quelques astuces développées pour piéger de petites musaraignes (*Suncus etruscus*) et des muscardins (*Muscardinus avellanarius*) exploitant les structures hautes de la végétation ont aidé à développer un protocole ayant permis de piéger en quatre sessions de 60 nuits-pièges, plus de souris de moissons que jamais depuis sa découverte en Suisse.

Mots-clés : Souris des moissons, piège Longworth, réducteur de la taille de l'entrée, pré-appâter.

INTRODUCTION

The harvest mouse *Micromys minutus* (Pallas, 1771) is a very rare rodent in Switzerland (Fig. 1). In older literature, it was mentioned only twice from the region of St-Gall (Fatio, 1869; Miller, 1812). Baumann (1949) and Hainard (1949) had no knowledge of its occurrence in Switzerland. In western Switzerland, it was first documented by Krapp (1964). This rare status is attributable to the altitudinal and climatic conditions, as well as the scarce occurrence of swampy habitats. This species occurring from Europe to Japan in a homogenous genetic clade (Yasuda *et al.,* 2005) is well distributed in most neighbouring countries, such as France, Germany and northern Italy (humid plain of the Po), but it is absent from the Alps, including many parts of Austria (Spitzenberger, 1986). The main habitat of *M. minutus* comprises reed beds in wetlands (Spitzenberger, 1999), approximately 90% of which have been destroyed in Switzerland since the Second World War (OFEFP, 1990) and hence only a few regions in this country harbour this species. Thirty years ago, a few small populations were recorded in the southern part of Switzerland (Lardelli, 1981), the north-western area close to Lake Constance, the region of Basel (contiguous with the population in Alsace, France), the Geneva region and the most important population along the southern shore of Lake Neuchâtel (Rahm, 1995).

Most records are based on indirect signs, i.e., the presence of its summer nests (Piechocki, 1958) woven with longitudinally spliced leaves (Juškaitis & Remeisis, 2007) within the dense vegetation of Cyperaceae (e.g., *Carex* spp.) or Poaceae (e.g. *Phragmites communis* and *Phalaris arundinacea*) species. Recent methodological developments of nest search (Blant *et al.*, 2012) were applied to potential habitats, which detected new populations in the Ajoie region (Canton of Jura, north-western Switzerland), and extinctions were suggested

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Fig. 1. Harvest mouse captured on 7 March 2014 (Photo: P. Vogel).

in many previously occupied localities where no recent observations could be obtained, e.g. southern Switzerland (Maddalena & Zanini, 2008) and Geneva (Blant *et al.,* 2012).

The more direct technique of trapping has not been used often because this species is rather difficult to catch with standard trapping designs, as mentioned in several reports (e.g., Piechocki, 1958; Trout, 1978; Rahm, 1995; Serrano Padilla, 1998). In the city of Oxford, Dickman (1986) found 26 nests but trapped only four *M. minutus* during 3858 trap nights. Data were checked at the Swiss Fauna Database (CSCF-Infofauna, www.cscf.ch) and among 201 occurrences based on known census techniques (excluding our own data), only five were captured with small mammal traps. All other records were based on nest sightings (135), owl pellet analyses (25), direct observations, mummified remains and foot prints (seven). Moreover, between 1996 and 2002, 27 individuals were collected at Lake Neuchâtel, which had drowned in the plastic buckets combined with drift fences used for regular amphibian censuses, a regrettable case of collateral damage for this rare species. Thus, in order to increase the success of live trapping, we developed a method that allowed us to capture 48 harvest mice and the present study reports the final standard trap design, which was applied to a small study of habitat management for this species (Vogel & Gander, in press). The method was inspired by trapping techniques developed for the small Etruscan shrew *Suncus etruscus* (Vogel, 2012) using long prebaiting periods with an entrance filter, and for the arboreal hazel dormouse *Muscardinus avellanarius* (Vogel *et al.,* 2012) using hanging platforms to set the traps. Live trapping may facilitate different aspects of investigation such as density, home range and optimal habitat studies, which are important for the conservation of this rare species.

MATERIAL AND METHODS

Trapping locality: A trapping census using different trapping methods was performed at three localities on the southern shore of Lake Neuchâtel where *M. minutus* nests have been found (pers. obs.): Cheyres, Font and Portalban. This allowed us to find an important population in Font (lat. 46.83674°, long. 6.810381°, at 430 m a.s.l.) at the end of the summer in 2012. Therefore, we restricted our further investigations to this locality, where we repeated the census in March 2013, September/October 2013 and February/March 2014.

Habitat: Three trap lines were set in the following habitats. Line 1 was in a habitat with a mix of *Phalaris arundinacea* and *Phragmites communi*s. Line 2 was in an adjacent field of *P. communis* in the direction of the lake between an *Alnus glutinosa* stand and a dune close to the water. Line 3 was located at a distance of 300 m in a mixture of *Cladium mariscus* and *Carex panicea* with some *P. communis* standing in part in the water. During the first winter session, only line 2 remained in exactly the same place. As the reeds on line 1 and parts of line 3 were mowed during December 2012 for habitat conservation, line 1b was set in the adjacent forest and line 3b was shifted to the closest unmown area during March 2013.

Trap design: For each line, we used 20 Longworth traps (Penlon Ltd, Abingdon, UK). They were set in alternating pairs, where one pair was placed on the ground and the next was placed at a height of about 80 cm in the vegetation (Fig. 2). We used a wooden platform (13 x 33 cm) to fix the hanging traps within the vegetation, which was usually attached to *Phragmites* or young *Alnus* to ensure easy access by mice. One trap of each pair (odd numbers) had a normal entrance whereas the second trap (even numbers) had a reduced entrance by use of a mouse excluder (Fig. 3). This accessory equipment (Penlon) originally contained a circular hole of 12 mm and it was designed for increasing trapping success of shrews by avoiding trapping larger and far more common mice and voles. In our study, we increased the diameter of mouse excluders to 14 mm. Moreover, many holes were increased in size by gnawing mice.

During the winter of 2013, the trap success on the platforms was very low demonstrating a drastic reduction of the climbing behaviour. Therefore, during

Fig. 2. Top line: hanging platforms in summer and in winter; bottom line: traps on the ground in autumn and winter (Photos: P. Vogel).

Fig. 3. Harvest mouse looking through the hole of a mouse excluder in a Longworth trap (Photo: P. Vogel).

the winter of 2014, all 10 pairs of traps in each line were placed on the ground.

The traps were prebaited for 2-4 nights (avoiding heavy rainfall) and then triggered for one night, with two or three checks per night. The bait was a mixture of seeds (sunflower, wheat and millet) and mealworms, but a small piece of apple was included during the trapping nights. Initially, some seeds were scattered around the entrances to increase interest in the traps.

The small mammals were not marked to avoid damaging *M. minutus*. Therefore, the number of controlled individuals of all species may include some recaptures. As no invasive method was used, we could not always distinguish the syntopic sibling species, *Sorex araneus* and *Sorex coronatus*.

Statistics: We used chi-squared tests (χ^2) to compare the separate effects of the entrance diameter size on the trapping of shrews, harvest mice and other rodents combined, but only significant differences are reported. The same test was used for the two trap positions. We also separated the data according to the seasons.

RESULTS AND DISCUSSION

In total, 184 small mammals were captured during the four trapping sessions (Table 1), where 60 traps were each triggered for one night after prebaiting, which corresponded to 240 trap nights. The trap success rate (77%) was higher than that reported in other studies of harvest mice, e.g. 14.3% in the total catch (50,500 trap nights) and 37.7% in a reduced set using a standard design by Trout (1976), 53% by Nordwig *et al.* (2001) and 12% by Haberl & Krystufek (2003). Among the eight species captured, *Myodes glareolus* (56 captures) was dominant, followed by *Apodemus sylvaticus* (39 captures) and *M. minutus* (34 captures). For the seasonal score, in the summer 2012 trapping session, the dominant species were *M. minutus* together with *M. glareolus* (14 captures each). The harvest mouse disappeared during the winter and none were trapped in March 2013. However during October 2013, the habitat had a similar harvest mouse population density (number caught per trap line) as that recorded in the previous year and was the dominant species (19 captures). In the very mild winter of 2014, one harvest mouse was captured.

Table 1. Summary of the four trapping sessions (the three habitats combined), which shows the numbers of rodents and shrews trapped on the ground (G) and platforms (P), and the numbers with the normal (N) and reduced (R) entrances. During the winter of 2014, all of the trap pairs were placed on the ground. This explains the twofold increase compared with the winter of 2013.

Season	Summer 2012				Winter 2013				Autumn 2013				Winter 2014	
Species/Trap type	G30	P30	N30	R30	G30	P30	N30	R30	G30	P30	N30	R30	N30	R30
Sorex araneus/coron.	3	0	2	1	10	0	5	5	6	0	4	2	2	10
Sorex. minutus	0	0	0	0	3	0	2	1	0	0	0	0	0	1
Micromys minutus	3	11	8	6	0	0	0	0	9	10	9	10	1	0
Apodemus flavicollis	2	4	6	0	0	0	0	0	0	0	0	0	0	0
Apodemus sylvaticus	2	5	4	3	2	0	2	0	5	7	8	4	16	2
Myodes. glareolus	8	6	6	8	8	2	6	4	3	1	2	2	25	5
Microtus agrestis	3	1	2	2	3	1	3	1	0	0	0	0	4	0
Total	21	27	28	20	26	3	18	11	23	18	23	18	48	18

The comparison of trap preferences, i.e., ground versus platform, showed that *M. minutus* was trapped more often in the platform traps than the ground traps during the summer of 2012 (11 versus three, respectively, but the difference was not significant), whereas the numbers were almost equal during the autumn of 2013 (10 versus nine). This is probably because the climbing activity of *M. minutus* is reduced in the autumn when a drastic change in habitat exploitation occurs. Nordvig *et al.* (2001) tested traps on the ground and attached to vegetation in September and obtained similar results (13 *M. minutus* captured in elevated traps but only three on the ground). It was concluded that the summer decline in captures by traps placed exclusively on the ground mentioned by Trout (1978) may have been a consequence of greater activity in elevated vegetation.

In the three seasons with platforms, about 2/3 of the other small mammals were trapped more often on the ground than on the platforms during summer and autumn (32 versus 24), although this difference was not significant. However, during the winter of 2013 (26 versus three), the traps on the ground captured significantly more ($\chi^2 = 9.9$, df = 1, $P < 0.001$). The sunflower seeds scattered around the traps on the platform were not touched and even birds did not visit them, except for one *Parus palustris.*

In the trap entrance size comparison, i.e., normal (N) versus reduced (R), we expected significant differences between the three categories: 1) shrews, 2) *M. minutus* and 3) other larger rodents. However, shrews (15 N, 20 R) and *M. minutus* (18 N, 16 R) did not exhibit significant preferences. It is even possible that normal (larger) entrances are preferred by *M. minutus*, but these traps were frequently occupied by larger species. Indeed, the trap occupation rate by larger rodents was much higher in traps with normal entrances (84 N) than reduced entrances (31 R) and the difference was highly significant ($\chi^2 = 11.75$, df = 1, $P < 0.001$). Trout (1976) subdivided his study area into a grid of 10 x 10 m and placed four Longworth traps in the centre of each grid cell, where two traps were normal and two contained a mouse excluder with a 13-mm hole. By recalculating his data, we found that significantly more *M. minutus* were captured in the traps with reduced entrance sizes ($\chi^2 = 17.6$, df = 1, $P < 0.001$). The trap type, trap density, small mammal species community and species density have each potential strong effects on the result. The effect of trap type was demonstrated by Serrano Padilla (1998) who used a large enclosure with an exclusively experimental harvest mouse population where Ugglan traps had a higher success (12.9%) than Longworth traps (2.7%), followed by Sherman traps (1.8%). The better capture rate of Ugglan traps may be explained by the rather "open" system and the possibility of multiple catches. In a natural environment however with a complex small mammal community Ugglan traps showed the same score for the harvest mouse compared to Longworth traps (PV pers. observation in Denmark).

In conclusion, the use of double traps with reduced and normal entrance set on platforms appears to be the optimal trap design for *M. minutus* in the summer. Traps with reduced entrances were avoided by the majority of the more frequent larger rodents so the chance of capturing *M. minutus* in an unoccupied trap was higher. In addition, the by-catches provided an idea of the other species that shared the same habitat.

The lack of *M. minutus* captures during the winter suggests that there was a drastic change in their behaviour, either by subterranean habitat exploitation or a total habitat change. Previous studies of this issue lack agreement (Piechocki, 1958; Böhme, 1978). However, the use of a drift fence to sample amphibians resulted in high number of *M. minutus* captured, which suggests that migration to other habitats may occur (Koskela & Viro, 1976). However, in contrast to frogs, the direction of dispersion was not determined. This was also not the case for the 27 kills of harvest mice in amphibian pitfall traps from lake Neuchâtel (in 27,293 traps nights, trap success 0.1%) mentioned in the introduction. Another possibility of lack of winter observation is a very high winter mortality where only a few individuals survive, but without any change of habitat use (Trout, 1978). To facilitate optimal habitat management, it would be useful to develop an adapted winter trapping technique.

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