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Modified live trap increase capture success of semifossorial voles in Alpine meadows

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Abstract

Live-trapping of rodents is facilitated by their thigmotaxis (i.e. the tendency to walk along linear structures of the habitat). However, in open habitats, such as meadows and prairies, where linear structures (e.g. rocks and fallen branches) are generally absent and where densities are likely to be low, capturing rodents is often very demanding or ineffective. This applies especially to semifossorial small mammals. Therefore, we developed a technique to increase the capture success of these rodents in Alpine meadows. We applied a box in Tetrapak® with the perforated floor at the opening of Sherman traps. Semifossorial voles (*Microtus* spp.), leaving their burrows, would remain in a confined status, in the dark within the Tetrapak®, being forced to enter the trap or to go back in the tunnel. Sherman traps modified with Tetrapak® were positioned immediately upon active burrows, alternating with the same number of unmodified traps. Then, we compared the number of captures with and without this modification. Two trapping sessions were carried out, for three days/site each, in 8 sites (totally 2784 trap-days). Overall, 55 semifossorial voles were trapped; 41 (74.6%) were caught in modified traps, showing that they increase the capture success of semifossorial voles in Alpine meadows.

Keywords: altitude meadows; capture success; *Microtus*; Sherman traps.

Rodents include about 40% of mammal species (Burgin et al. 2018) and occupy a paramount ecological role in food chains, as well as for being environmental bioindicators (Bertolino et al. 2015). Therefore, they are key model species to assess evolutionary processes of ecosystems dynamics under climatic changing conditions and environmental threats (Dickman 1999; Krebs et al. 2019).

Rodent communities may include up to 15-25 species (Li et al. 2003; Shuai et al. 2017; McCain et al. 2018); hence, ecological studies on rodent community composition requires effective trapping protocols capturing as much species as possible, with an effective sampling of local populations (Thibault et al. 2004). Trap type and positioning highly influence capture success of different rodent species (Gurnell & Langbein 1983; Lambert et al. 2005; Torre et al. 2011). Therefore, it is often suggested to use more than one model of trap, to increase the possibility to effectively sample the whole rodent community (Innes & Bendall 1988; Hayes et al. 1996; Dizney et al. 2008). Together with typology, positioning of traps is another key factor affecting trap response in rodents (Gurnell and Langbein, 1983). To be successfully captured, rodents should encounter traps during their normal circadian activities. Small mammals show a remarkable tendency to move along linear structures of the environment (such as stones or fallen branches) called "thigmotaxis" (Martinez and Morato, 2004; Wang et al. 2017). Thus, traps should be preferably placed alongside roots, fallen logs and rocks (Gurnell & Langbein 1983). Accordingly, live-capture of rodents in open areas, such as farmlands, meadows and prairies (i.e. where roots and rocks are scarce or completely absent), is often challenging (Dell'Agnello et al. 2018), thus limiting the completeness of checklists (Loy et al. 2019) and, as a consequence, the reliability of global community studies (e.g. ecological, genetic and parasitological ones: Munger et al. 1983; Blaustein et al. 1996; Kosoy et al. 2004).

In agroecosystems, capture success of semifossorial voles *Microtus* spp. may be increased by placing traps directly inside the first section of active tunnel exits, digging out some soil to better position the trap (Dell'Agnello et al. 2018). This method, however, cannot be applied in Alpine meadows, where soil is hard and digging holes may be unacceptable (e.g. in pastures or in steep lands where the risk of erosion is remarkable). In the Alps, live-trapping of voles may be demanding and previous studies showed a very low capture success. For example, Patriarca & Debernardi (1997) reported 0 captures of voles in 5631 trap-days in various habitats; similarly, Bertolino et al. (2007-2008) captured only one *Microtus arvalis* in 2340 trap-days in different habitats over 1500 m asl.

Here, we developed a modified trapping method to capture semifossorial voles in Alpine meadows that we compared with unmodified Sherman traps to prove its effectiveness.

Live-trapping of rodents was conducted in the Gran Paradiso National Park (north-western Italy: 45.46°N, 7.13°E). The park covers an area of about 71,000 hectares (750-4060 m asl). We trapped semifossorial voles in three valleys: Valsavarenche, Valle Orco, and Vallone di Piantonetto, at eight sites in Alpine meadows and scree between 1400 and 2600 m asl. Alpine grasslands intermixed with scrublands composed by *Vaccinium* spp., *Juniperus communis*, *Alnus viridis* and *Salix* spp. along rivulets occur in these areas. Over 2300 m, altitude meadows intersperse with screes, whereas rocks represent the main habitat type over 2600 m.

Three species of semifossorial voles are recorded within the Gran Paradiso National Park (Patriarca & Debernardi 1997): common vole (*Microtus arvalis*), Savi's pine vole (*Microtus savii*) and Alpine pine vole (*Microtus multiplex*). All these species are typical of open areas including screes, meadows and forest glades and live most likely at low densities within the park borders (Patriarca & Debernardi 1997).

We applied a box in Tetrapak® with the perforated floor at the opening of Sherman traps so that voles, leaving their burrows, would remain in a confined status, in the dark inside the Tetrapak®, being forced to enter the trap or to go back in the tunnel. We then put a stone over the trap, to prevent it from being displaced (Fig. 1).

To increase trapping success, we exploited the voles' propensity to reopen tunnel entrances in their burrow system that were previously closed with soil (Tkadlec & Stenseth 2001; Lisickà et al. 2007). Therefore, we identified active vole holes by closing all those detected at day 0, and identifying reopened holes after 48 hours. We then alternated a total of 58 modified and unmodified Sherman traps at the entrance of successive active holes (inter-trap distance: 1-5 m), placing them horizontally, with the perforated Tetrapak ® floor directly above the entrance of vole burrows. Two trapping sessions of three days were carried out at all the 8 sites (i.e. 2784 trap-days), including 58 traps each, between June and October 2015. Traps were baited with nutcream, apple and sunflower seeds and protected from extreme temperatures with grass and leaves. Traps included raw cotton as bedding. When captured, voles were identified at the species level, sexed, weighed and marked through fur-clipping. After a brief handling phase (< 2 min/individual), voles were released at the trapping point. Trap checks occurred three times a day to reduce mortality, at dawn, at the start of the afternoon and at dusk.

To verify the effectiveness of our trap modification, we compared the number of captures with modified and unmodified Sherman traps through a Fischer exact chi-squared test, using the software R (version 3.5.1., R Foundation for Statistical Computing, Wien, Austria).

We performed this work under the approvals by the Institute for Environmental Protection and Research and the Gran Paradiso National Park.

We captured a total of 55 individuals of semifossorial voles (N = 60 capture events, including recaptures): 30 *Microtus arvalis* and 21 *Microtus multiplex* between 1700-2600 m asl, and 4 *Microtus savii* at 2600 m asl.

Among captured individuals, 74.6% (N = 41) were trapped in modified and 14 in unmodified traps and this difference was found to be significant for the total of species (Table 1). Only the comparison for *Microtus savii* was not significant, probably due to the low number of captures (N = 4).

The only other species captured with modified traps was a Valais's shrew (*Sorex antinorii*), which may have shared underground burrows with Alpine pine voles. Curiously, 6 voles were caught in unmodified traps placed near the entrance of Alpine marmot (*Marmota marmota*) burrows. Overall, a *Microtus* was captured every 99.4 trap-days in unmodified traps and in 34 trap-days in modified traps. No trap was found overthrown. Mortality was low: just two common voles and one Alpine pine vole were found dead, one in modified and two in unmodified traps.

Our work presents a cost-effective, modified trap to increase the capture success of semifossorial voles in Alpine meadows. In these habitats, trapping success with traditional live-traps has been close to zero (Patriarca & Debernardi 1997; Bertolino et al. 2007-2008) and placing the entrance of the trap directly inside the first part of the tunnel (see Dell'Agnello et al. 2018) is often not possible.

The application of a Tetrapak® box at the entry of the Sherman trap bring voles to unintentionally enter the trap, simulating a continuation of burrow system. This prevented us to force thigmotaxis by placing small fences near burrow entrances to bring voles towards the traps. Accordingly, only 14 out of 55 captured individuals of semifossorial voles were found in unmodified traps. Interestingly, six of these 14 voles trapped without the Tetrapak® modification were caught in traps located near entrances of Alpine marmot burrows, suggesting that voles may excavate their dens within burrows of larger rodent species to increase protection from predators, as already reported for rats (*Rattus* spp.) in Indian porcupine (*Hystrix indica*) dens (Mukherjee et al. 2019).

We acknowledge that our study is based on a small number of trapped animals. However, this is an indication of a probable low population densities of these species in Alpine meadows. In such a habitat, our modified traps were three times more effective in capturing semifossorial voles compared to traditional, unmodified traps.

Direct captures are required in ecological studies involving complete animal assemblies and communities (Li et al. 2003; Dreiss et al. 2015; Shuai et al. 2017), as signs of presence (e.g. burrow systems) or random detections (e.g. individuals found in discarded bottles/tins, in owl pellets or dead on the ground) may provide incomplete and qualitative-only datasets (Patriarca & Debernardi 1997; Caire et al. 2010; Gervais 2010).

Modified traps with the cost-effective method we reported in this work were proven to be near three times more effective than unmodified ones in trapping semifossorial voles, and it may be applied also to other rodents and shrews. Therefore, they should be recommended to capture semifossorial small mammals in open areas, when traditional standard methods are ineffective.

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Table 1. Comparison of capture success in modified and unmodified Sherman traps, per species and for all *Microtus* voles. *P*-value represents the result of the Fisher's exact test.: *, significant value < 0.05.

	Number of captures		P
Species	Modified traps	Unmodified traps	
Microtus arvalis	23	7	0.0218*
Microtus multiplex	14	7	0.0344*
Microtus savii	4	0	0.2143
Total	41	14	0.0065*

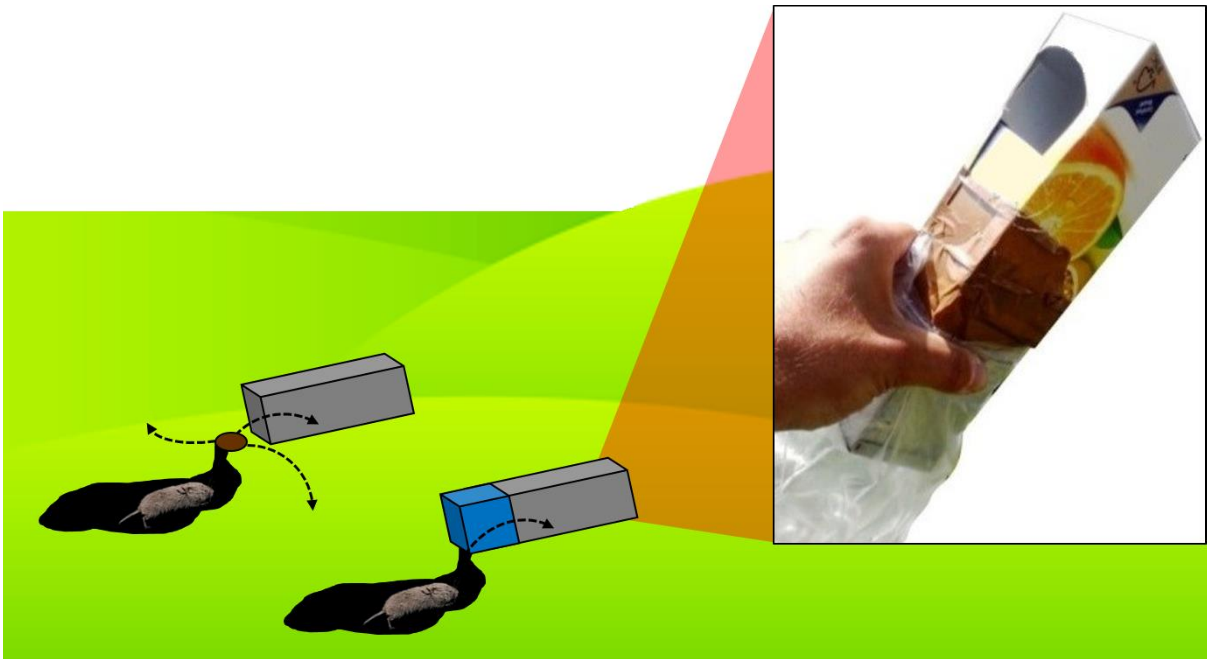

Figure 1. Functioning of modified and unmodified Sherman live traps.