Abstract: Longworth live traps are widely used for trapping mouse-sized rodents and shrews. However, they have a number of disadvantages: some have a manufacturing defect, resulting in reduced sensitivity; smaller species of shrews can pass under the treadle, avoiding capture; captured animals can gnaw specific parts of the sidewalls and decrease the durability of the traps. To increase the efficiency of catching small shrews, we added a movable tin ramp to the treadle of the Longworth live traps and used washers to improve the design. To repair and protect traps damaged by captured animals, we used tin patches. The modified traps were shown to be significantly better than the original traps in catching small shrew species (Sorex caecutiens Laxmann 1788, Sorex minutus Linnaeus, 1766). Tin patches reliably protected live traps from further damages by animals and do not affect their catching efficiency.

Keywords: live trapping; Longworth trap; rodents; shrews

1 Introduction

Animal trapping is one of the main methods for studying the ecology of small mammals. Traps of various designs are used, including Longworth live traps (Jung 2016; Sullivan and Sullivan 2022; Thrift et al. 2022; Torre et al. 2020; Wilson et al. 2018). Constructed of aluminum, Longworth live traps (Longworth Scientific Instrument Co., Oxford, England) consist of two parts: a trapping tunnel and a detachable nest box. To activate the trap, small mammals step on a wire treadle in the tunnel, which releases the door and closes the trap. This model is intended for catching mouse-sized rodents and shrews. The advantages of Longworth live traps include an easy-to-clean collapsible design, lightness and compactness, adjustable trigger weight, corrosion resistance, and the ability to put a large amount of nesting material and bait in the nest box. Longworth live traps are considered the most reliable for catching animals weighing up to 50 g; they are less effective for catching larger individuals (Boonstra and Rodd 1982). Although those who designed the traps claim that actuation sensitivity is from 1.5 g (Chitty and Kempson 1949), in practice, the minimum actuation weight is usually approximately 3 g (Shore et al. 1995, our observations). Some traps have a faulty design, resulting in reduced sensitivity. In addition, smaller species of shrews can pass under the treadle, avoiding capture (Michielsen 1966). Therefore, some authors have noted that Longworth live traps are not effective in catching small species of shrews (Boekel 2013; Lambin and MacKinnon 1997). Additionally, since the traps are made of aluminum to reduce their weight, captured animals often gnaw specific parts of the sidewalls and decrease the service life of the traps (Boekel 2014; Lambin and MacKinnon 1997). We propose three modifications of Longworth live traps to increase their effectiveness in catching the smallest species, especially shrews, and to extend the service life of the traps.

2 Materials and methods

To increase the efficiency of catching small shrews, we added a movable tin ramp (dimensions 85 × 43 × 0.5 mm) to the treadle of the Longworth live traps (Figure 1). This detail, on the one hand, prevents the passage of animals under the treadle and, on the other hand, reduces the weight required to trigger the mechanism. We compared the results of trapping with ramps and without ramps. To do this, all the traps with ramps were set to trigger when an animal weighed 2 g (for verification, a load of that mass was put on the top of a ramp; the position of a standard sensitivity regulator could not be extreme). The original traps were set to the minimum trigger weight using the standard regulator (minimum spring tension).

Approximately half of the Longworth traps have a manufacturing defect, resulting in reduced sensitivity due to the cocking part of a treadle rubbing against the edge of a working hole (Figure 2A). We solved this problem by fitting washers to both original and modified traps where required (Figure 2B).
To repair traps damaged by captured animals, we used tin patches, gluing them with special “cold welding” glue (Figure 3). In total, 10 traps were repaired (6 original and 4 modified).

To compare the effectiveness of original and modified traps, as well as to evaluate the reliability of repaired traps, we conducted field trials. In the river floodplain (near the village Khomutovka, Sverdlovsk region, Russia: 56°51′11″, 59°48′47″), a line transect was placed in which 60 original and 60 modified live traps alternated every 5 m. We used the repaired traps on the same transect to test the catchability and strength of the patches. The study was conducted on 16–22 August 2022. Mineral wool was used as bedding material in the nesting chambers. Rye bread with unrefined sunflower oil (4–5 g) and frozen mealworms (3–4 g) was used as bait. The traps were opened at 20:00, checked at 2:00 and closed at 8:00. During the daytime, the traps were left closed. The bait should have been enough to keep the shrews alive for 6 h (Boekel 2013; Stromgren 2008). The captured animals were weighed, and their species and sex were determined. Since we were mainly interested in shrews, the rodents were removed from the transect and released 1.5 km (in a straight line) away from the experimental plot to reduce competition for traps. All shrews were released at the place of capture.

All analyses were performed using the R 4.1.2 environment (R Development Core Team 2022). Using the generalized linear model, we identified factors that influenced animal catchability. As predictors, the model included the type of trap (original or modified), the animal species, and their interaction. The dependent variable was binary. The link function was logit. Model estimation was based on the corrected Akaike information criterion (AICc) and Akaike weights (W). Likelihood ratio tests were used to evaluate the overall accuracy of the statistical model. Model building were performed using the MuMIn R package (Barton 2020). The significance of differences in the number of animals of different species caught in modified and original live traps was assessed using Fisher’s exact test (two-tailed). To compare the frequencies of “fail” cases (trap sprung with no animal capture or trap not triggered with signs of an animal visiting), their number was related to the number of nights of trapping (840 for each type of trap) and was evaluated by the chi-squared test. The same approach was used to estimate the total catches of original and modified traps. The average weight of captured rodents was compared using one-way analysis of variance.

3 Results

3.1 Trapping efficiency

The best statistical model included the trap type, species, and their interaction (Table 1). The model differed significantly from the reduced model (p < 0.001). In general, there were significantly more captures recorded in the modified (fitted with ramps) traps than in the original traps (261 versus 163 obs.; p < 0.0001). The total number and ratio of rodent species visiting both types of traps were similar (Table 2). The average weight of rodents caught by traps with and without ramps also did not differ significantly (Figure 4).

All five species of shrews were caught more often in modified traps, but the differences were significant only for Laxmann’s shrew (Sorex caecutiens Laxmann, 1788) and Eurasian pygmy shrew (Sorex minutus Linnaeus, 1766; p < 0.001 and p = 0.001, respectively). Pygmy shrews were caught exclusively with modified traps. The significant difference in the weight of the captured animals confirms the high catchability of small shrew species in modified traps (Table 2, Figure 4).
Cases where the trap failed were significantly more frequent with original live traps (p = 0.0001). The difference was due to cases when the live trap did not work and not due to false triggering, which occurred with approximately the same frequency in both types of traps (Table 1). Out of 424 captures, two rodents and five shrews died in traps (mortality was 1.2 % and 2 % respectively).

### 3.2 Repair and protection of traps from chewing

In this and another study, 120 live traps were in use for a total of 14 days. At the end of the experiment, only 14 of them had no traces of bites, and those in other cases were localized only in two spots – at the edges of the working hole in a sidewall tunnel (84 % of all traps) and on the bottom of a shutting door (75 %). In the latter case, the damage was minor and did not require repair. The working holes, on the other hand, were in many cases damaged to such an extent that there was a danger of small shrews escaping from the traps (Figure 3). Six of the ten repaired live traps had marks of gnawing on the tin patch. In all these cases, damage was limited to surface scratches. We did not find any signs of a decrease in trap effectiveness after repair; the number of catches per unrepaired trap was 2.6 for the original design and 4.3 for the modified version (3.7 and 5.3 for the repaired traps with tin patches, respectively).

### 4 Discussion

The idea of installing a ramp to prevent animals from passing under the treadle of Longworth live traps has been
suggested before but has not been tested in practice (Boekel 2013; Gurnell and Flowerdew 2006). Our study showed that the ramp increased the catchability of two shrew species. Reducing the space beneath the treadle in the trap tunnels by piece of rubber inserted above the treadle has been previously proposed to increase the efficiency of capturing small species, but it has been effective only for *S. caecutiens* and not for *S. minutus* (Boekel 2013). We did not find any effect of the ramp on the efficiency of rodent trapping (Table 2, Figure 4B). In the community of small mammals that we surveyed, no individuals weighing more than 50 g were found, so we cannot assess the effect of the ramp on the catchability of larger mammals. One more attempt to address the shortcomings of Longworth’s original trap design was the introduction of the Heslinga trap. There is an opinion that the year rape more efficient and more durable (Torre et al. 2021).

At a minimum, the pedal of these traps does not allow shrews to pass under it. However, specific comparative studies have not been conducted.

Our results confirm previous reports that animal damage to Longworth live traps is a common problem during their usage (Boekel 2014; Lambin and MacKinnon 1997). Boekel (2014) mentions that aluminum patches can potentially be used to repair traps. We consider this method to be ineffective because it cannot protect against further gnawing at the same spot. The tin patches we used provide complete protection (Figure 3). Most likely, the same method can be used to repair damage to tunnel doors. Considering the high frequency of gnawing (88 % of traps in 14 days), it seems reasonable to use tin to preventively protect traps. It is also necessary to keep in mind that the new Longworth live traps require testing and adjustment. The most common defects (rubbing of the moving elements against the bottom edge of a working hole) can be eliminated by installing washers (Figure 2).

**Research ethics:** All field methods were approved by the Bioethics Commission of the Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences (protocol #012/2022).

**Acknowledgments:** This study was performed within the frameworks of state contract with the Institute of Plant and Animal Ecology, Ural Branch, Russian Academy of Sciences (122021000082-0, 122021000085-1). We are grateful to PhD Ekaterina Malkova for her help in organizing the preliminary experiment and to Irina Tolkacheva for photographs of the traps, and Thomas Jung and anonymous reviewer for helpful comments.

**Author contributions:** All the authors have accepted responsibility for the entire content of this submitted manuscript and approved submission.

**Research funding:** None declared.

**Conflict of interest statement:** The authors declare no conflicts of interest regarding this article.
References


