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A Technique for Quantitative Estimation of Small Mammals Traversing Water Obstacles

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Abstract—A new method for quantitative study of small mammals swimming across water obstacles was developed. A line of 25 traps was installed on either poles or boards ("rafts") with anchors at a distance of 20–25 m from the bank and with 10-m distances between the items. The study was performed upstream along the Ilych River in August 2013. A total of 300 trap/day were accumulated. Twenty-four small mammal individuals of 8 species were captured. Their relative abundance was estimated as the number of individuals per 100 trap/day. It was found experimentally that floating poles neither repel nor attract animals. When an individual accidentally finds a floating pole, it climbs up and explores it for some time. The number of animals per total length of rafts per time unit can be suggested as an index of intensiveness of migration across a water obstacle. In the area studied, the number of small mammals of various species crossing the river was estimated at 26.7 individuals per 1 km/day. A length of 5 m for floating poles/boards and installation of two traps at the ends of an item is suggested to be used.

Keywords: small mammals, methods of catching, water obstacles, migration

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INTRODUCTION

Water obstacles are a significant barrier to the migration of small mammals. The habitat borders of species are often confined to large rivers. However, small mammals are capable of traversing various water obstacles as a manifestation of their migration activity. They cross water obstacles at times when they disappear (e.g., on ice during the winter period) and by swimming over large water areas. Even large rivers may not hinder the distribution of small mammals. It has been shown that the borders of hybrid zones between the chromosome races of the common shrew in European Russia are not associated with rivers and cross them in many cases (Shchipanov and Pavlova, 2013). If the contact zone between chromosome races coincides with the water obstacle, hybrids are regularly found on both sides of the river. Small mammal invade even islands located a significant distance from the bank (Hanski, 1999). The study of 108 islands in three Finnish lakes demonstrated that the distribution and abundance of three shrew species can be explained by periodic extinction on the islands and secondary invasion from the continent (Peltonen and Hanski, 1991). As is known, small mammals can be present in large number in the stomachs of predatory fish, such as in the grayling (Teplov, 1943), the feeding intensity of which depends on the migration activity of animals (Kalinin and Kupriyanova, 2010). Swimming animals were not captured directly.

The purpose of this paper is to develop a technique for capturing small mammals in an aqueous environment at a distance from the bank that will allow us to obtain the qualitative and quantitative characteristics of the distribution and traversing of water obstacles by small mammals.

MATERIALS AND METHODS

The material was collected in the upper reaches of the Ilych River in Pechora-Ilych State Nature Reserve, from the area where the Bol'shaya Lyaga tributaries flow into the Uk'ya River, in August 2013. The width of the river in the investigated area is about 80 m.

Capturing was performed by ladder-type traps (Shchipanov, 1986) and break-back traps with ladders. Traps were installed (tied) on either poles or boards (3 m long) with anchors at a distance of 20–25 m from the bank (Fig. 1). Poles preventing overturning were tied in pairs and installed in a line with 10-m distances between the items. On the whole, 25 traps were used. A total of 300 trap/day were accumulated. Break-back traps were installed inside halves of plastic bottles to

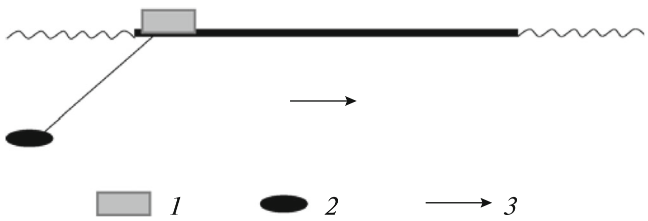

Fig. 1. Scheme for installing traps on floating poles: *1,* trap; *2*, anchor; *3*, flow direction.

prevent the entry of birds. Traps were inspected two times a day, in the morning and evening.

RESULTS

During the period of capturing (300 trap/day), 24 small mammal individuals of 8 species were captured (see table). Their relative abundance was estimated as one capture per unit of effort (individuals per 100 trap/day). The total capture efficiency was 8.0 individuals per 100 trap/day. Four shrew species (the common shrew (*Sorex araneus* L. 1758), Laxmann's shrew (*Sorex caecutiens* Laxmann 1788), even-toothed shrew (*Sorex isodon* Turov 1924), and Eurasian pygmy shrew (*Sorex minutus* L. 1766)), 3 vole species (the northern red-backed vole (*Clethrionomys rutilus* Pallas 1779), bank vole (*Clethrionomys glareolus* Schreber 1780), gray red-backed vole (*Clethrionomys rufocanus* Sundevall 1846)), and a wood lemming (*Myopus schisticolor* Lilljeborg 1844) were captured. *C. rutilus* was the most dominant species (41.7% of all captures). Shrews comprised 33.4% of all captures. Adult individuals constituted a significant proportion of the captures in water. In particular, overwintered females of *S. araneus* and *S. caecutiens* were captured. Among voles, an adult female of *C. rutilus* and an adult male of *C. glareolus* were captured. Furthermore, an adult male of *M. schisticolor* was registered. Therefore, water obstacles can be crossed not only by migrating young individuals, but also by mature animals. Among all captured small mammals, adult individuals made up 20.8%. Both adult males and females were caught at a significant distance from the bank.

Reactions of small mammals to floating poles. When calculating the abundance of animals per trap/day, we deal only with relative characteristics, which enable comparison of samplings obtained using similar methods. As traps were placed on boards having a fixed length, the absolute parameters of the migration intensity of small mammals within a particular river site were determined. The effective distance of capturing by each trapping device remains unknown. Swimming animals can see them on 3-m long poles and turn to the trapping device from different distances. In this case, the territory of capture would be the pole length + two average distances from which animals notice floating items and swim towards them. The reaction of small mammals to floating poles was studied experimentally.

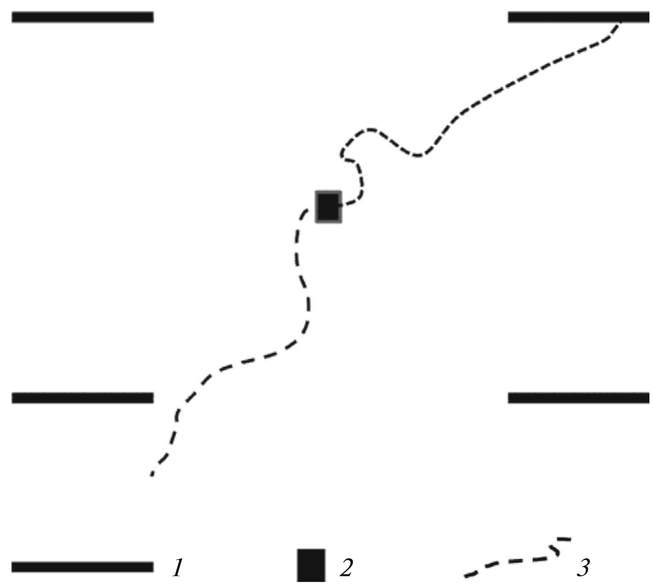

Fig. 2. Scheme for the experiment on reactions of small mammals to floating poles: *1,* floating poles with a length of 2 m; *2*, floater, place of release of animals; *3*, track variants of animal movements.

Methodology of the experiment. Animals in the experiment were caught using live traps installed in close proximity to the area for the experiment. The captured animals were placed in containers with food and nest material. Animals in the bottomless separation tank were transferred to a wooden floater (20 cm) and kept for 10 min. Then, the separation tank was removed to a distance of 4 m from the floater. The observation area was changed every time. The floater was in the center of a square (5 m), on the edges of which were floating poles with a length of 2 m (Fig. 2). The released animals moved independently into the water and selected the direction of swimming. The experiment was considered complete when the animals came out to one of the poles or left the site. After finishing the experiment, the animals were caught, placed in a container, and then released. The experimental site was located 15 m from the bank, the depth at the experimental site was 40–50 cm, and the flow rate was about 10 m/min. The trajectory of movement of animals was registered on a card. A total of 24 experiments were performed. The experiment involved 13 forest voles (1 individual of *C. glareolus* and 12 individuals of *C. rutilus*) and 11 shrews (3 individuals of *S. araneus* and 8 individuals of *S. caecutiens*).

Experimental results. As a result of the experiment, only four individuals (two voles and two shrews) climbed on the poles. Since the angle from the area of release to the ends of one pole is 16°, 17.8% of animals moving randomly should reach the poles. After 24 experiments, the expected number of positive results

Species composition and abundance of small mammals captured in water

Species	Number of individuals	Per 100 trap/day	Per 1 km	Proportion of species, %
Sorex araneus	2	0.7	2.2	8.3
S. caecutiens	4	1.3	4.4	16.7
S. minutus	1	0.3	1.1	4.2
S. isodon	1	0.3	1.1	4.2
Clethrionomys rutilus	10	3.3	11.1	41.7
C. glareolus	2	0.7	2.2	8.3
C. rufocanus	1	0.3	1.1	4.2
Myopus schisticolor	3	1.0	3.3	12.5
In total	24	8.0	26.7	100

(animals climbing on the pole) was 4.3 individuals, which is quite consistent with the results obtained. Therefore, animals occur on the floating poles in a random way. Such items neither repel nor attract animals. It is proved by the visual observations of and analysis of tracks. It was shown that animals did not turn to the floating poles even from a very close distance (15–20 mm), but they climbed up when accidentally coming across them. Then, they spent some time running and exploring the floating pole.

Therefore, the area of capture can be determined by using only the length of the poles on which traps are installed. In our variant, each trap covered 3 m (pole length). Thus, it is possible to calculate the migration intensity within this site of the river. For 300 trap/day, animals were captured from a site of 900 m. The number of animals swimming across the river during the day within an area of 100 m or 1 km can be determined. The results are given in the table. In our study, the total number of small mammals found at a distance of 20–25 m from the bank during the day was 26.7 individuals per 1 km.

DISCUSSION

The suggested methodology allows us to obtain quantitative data on the intensity of traversing water obstacles by many species of small mammals. During the study with the use of the standard pitfall traps in the same area, 16 species (including moles and water voles, which could not have been captured by our traps) were registered over 10 years. During the captures in water, eight species were registered over 300 trap/day. All dominant species were registered. Meadow mice were not found, as their abundance in this region is not high, nor were two rare shrew species (tundra and lesser pygmy shrews), the brown-toothed water shrew, and the northern birch mouse. The data obtained indicate that traversing water obstacles can be a widespread phenomenon, which is common for almost all small mammals. In 2013, the abundance and mobility of small mammals in the region of study were high. This is particularly proved by the high abundance along the bank line, which, as has been shown previously, correlates with the mobility of animals (Kalinin and Kupriyanova, 2010). When capturing was performed along the edge of the water in August 2013, the total abundance of small mammals was 31.5 individuals per 100 trap/day, and the average abundance was 20.9 ± 15.7 (for 6 years). The most dominant species, in the water as well, were *S. caecutiens* (39.7% in the captures) and *C. rutilus* (27.0%).

The ability to swim in small mammals is limited. According Sergeev (1981), swimming duration in common shrews is about 7.4 min at a water temperature up to 10°C, 10.2 min at 10–15°C, and 14.4 min at 15–19°C. In the same paper, there are data on the swimming speed determined in the areas of directional movement of shrews in the water, which averaged 13.5 ± 0.3 m/min in shrews. Thus, they can cross water obstacles of up to 150 m in width.

Despite the fact that animals traverse water obstacles in large numbers, it is difficult to observe them on the surface of water bodies. Only solitary cases of small mammals noticed in the water have been registered (Bobretsov et al., 2004). Swimming animals are easily visible, but we managed to notice only two cases when animals were crossing the river during the entire period of our study. This difficulty is associated with the fact that the mobility of animals increases after dark. Even species with polyphasic activity during the day, such as shrews and forest voles (Shchipanov et al., 2000), move significant distances at night. During the captures on the bank and along the edge of the water, all animals were trapped only in the night period.

Calculation of the migration intensity per unit of distance allows us to use trapping devices of various length if their sizes are known. In our experiment, we used boards and poles with a length of 3 m. Based on the experimental results, it can be suggested that the optimal size of poles would be 5 m. In this case, more materials will be obtained with the same efforts for installing traps. It is less convenient to work with trapping boards longer than 5 m. We suggest using boards and poles with a length of 5 m and traps on both sides. This would eliminate the effect of occupancy of the traps, which is especially important during a high intensity of migration processes. Furthermore, if the trapping board is too long, animals that climbed up can jump off into the water earlier. Two traps on the edges of the trapping board solve this problem.

The suggested methodology allows us to describe quantitatively the intensity of migration processes and to estimate the role water obstacles as a factor of isolation between populations.

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