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Movements of field mice *Apodemus agrarius* (Pallas) in a suburban mosaic of habitats

A. Liro and J. Szacki
Institute of Physical Planning and Municipal Economy, Krzywickiego 9, 02-078 Warsaw, Poland

Summary. Movements of field mice (*Apodemus agrarius*) were studied using snap traps and coloured bait. The presence of coloured bait was recorded in 35% of field mice captured. Of animals with coloured bait, 60% had moved further than 100 m. The longest distances traversed by field mice exceeded 1000 m. It is suggested that live-trapping on a grid of several hectares is not an adequate method of studying small-mammal movements.

Key words: Field mice – Movements – Heterogenous environment

Over the last three decades, many studies on small-mammal movements have been carried out. Most authors assume that there are two categories of small-mammal movements: dispersal, and daily activity within home ranges. Dispersal is studied mainly as a phenomenon influencing organization and regulation of a population. In this category of movements distances are usually disregarded. Data on sizes of small-mammal home ranges are not consistent. Extreme values for a species may differ fiftyfold or more. Numerous methods are used (e.g. Mazurkiewicz 1970; Wierzbowska 1975; Don and Rennols 1983) and various numbers of observations (captures) are taken as a basis for calculations of home range sizes (e.g. Mazurkiewicz 1970; Mares et al. 1980). Several authors distinguish another category of small-mammal movements: "exploratory trips" or "sallies outside the home range" (Griffo 1961; Furrer 1973; Joslin 1977), but distances and routes of such movements have not been studied in detail. Thus, in spite of a great number of studies dedicated to the problem, we still know very little about patterns of small-mammal movements actually occurring in the wild. In view of the growing interest in landscape ecology the problem of distances and routes traversed by animals thus integrating the elements of a landscape is gaining in importance.

The aim of our study was to determine distances of small-mammal movements in a mosaic of habitats on an area larger than usual.

Material and methods

The field study was conducted in the valley of the Vistula River along the Warsaw Escarpment south of Warsaw. The area was a fine-grained mosaic of fields, meadows, patches of wood, and farm buildings. A modern urban settlement bounded the area on the north and west. Patches of wood and thicket were linked by strips of woody vegetation growing along the escarpment and dried-up streams. The largest woody areas consisted of an old park with forest relicts and woods with oaks and hornbeams on a high plain. Numerous roads and ditches ran across the study area (Fig. 1).

Trapping of small mammals took place in September 1986. Snap traps were set in two lines, with stations 50 m from each other and three traps per station. The first trapline (76 stations) was set in woody areas, the second one (39 stations) in meadows and fields. For technical reasons, there were some gaps in both lines. Therefore the distance between the first and the last station in each line was longer than the number of stations × 50 meters (4500 and 2500 m respectively). In both cases, the traps were inspected daily. Traps of the first line were exposed for 7 days and those of the second one for 5 days. Coloured bait (flour + margarine with mixed wool – Holisova 1968) was placed in several localities of both traplines. Distinct colours of wool were used for different habitats i.e. wood, strips of woody vegetation, park, meadows and fields. Distances between localities with bait were different and ranged from 250 to 1000 m (Fig. 1). The bait was laid out 4 days before the beginning of trapping and later augmented as necessary. Captured animals were autopsied. Contents of their stomachs and guts were examined microscopically to check for the presence and colour of wool threads from the bait. A total of 484 captures of 7 species of small mammals was recorded during the trappings. The most abundant species was *Apodemus agrarius* (378 individuals). 70 individuals of *Clethrionomys glareolus* were captured. Other species included *Apodemus flavicollis*, *Apodemus sylvaticus*, *Mus musculus*, *Pitymys subterraneus*, and *Micromys minutus* which were captured in very low numbers (< 20).

Results

During the study, the presence of coloured bait was recorded in 115 individuals of the field mouse *Apodemus agrarius*, or 35% of the total number of captured animals of this species. Table 1 illustrates estimated distances traversed by these animals. We assumed that a captured animal had swallowed the bait of a given colour at its nearest locality. The longest distances traversed by field mice exceeded 1000 m. Approximately 60% of the individuals with coloured bait had moved over 100 m. There is no clear

Offprint requests to: A. Liro

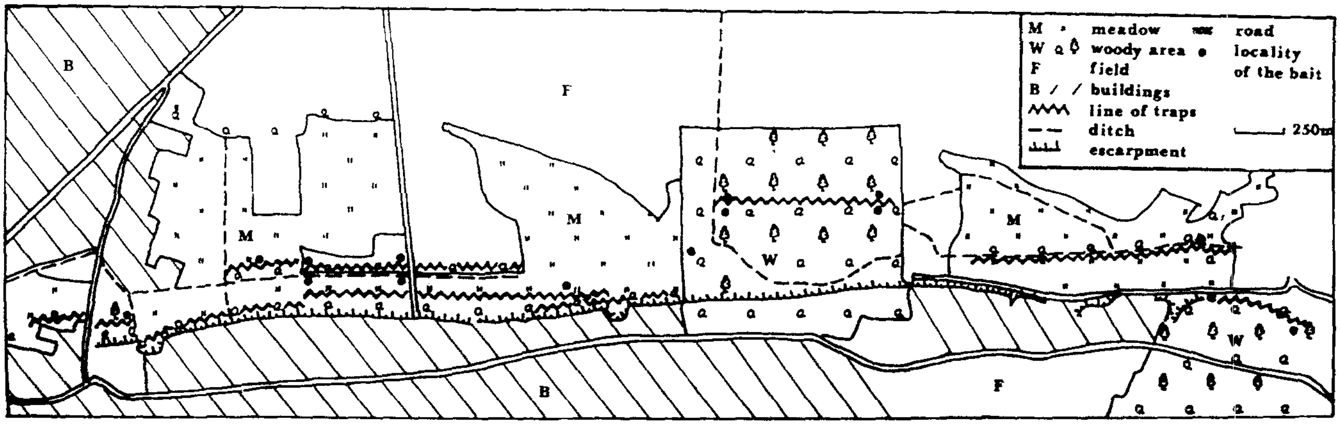

Fig. 1. A map of the study area. *W*, woody areas; *M*, meadows; *F*, fields; *B*, buildings. *Zigzags* represent trapping stations, *circles* represent localities of the bait. *Dashed lines*, ditches; *double lines*, roads

Table 1. Distances of field mouse movements in the study area

Distance [m]	Number of individuals
<100	38
101– 250	11
251– 400	20
401– 550	11
551– 700	8
701– 850	9
851–1000	14
>1000	4
Total	115

trend towards reduction of number of individuals with increasing distance. On the contrary, the number of animals which traversed distances between 700 and 1000 m is disproportionately high.

In the great majority of cases, animal stomachs contained only one colour of bait. In a few cases, however, 2 or even 3 colours of bait were found. This enabled us to establish that some animals wandered back and forth between habitats covering distances of approximately 500 m. Numerous barriers on the study area, such as ditches and roads, did not inhibit small-mammal movements.

There were no differences between groups of "long distance" and "short distance" wanderers (>300 and <300 m, respectively) in sex ratio, proportion of sexually active animals, or proportion of juveniles.

Discussion

Our data show a considerably greater range of *Apodemus* movements than generally supposed for individual daily activity in the home range. Watts (1970) assumed that 130 m is the upper limit of *Apodemus sylvaticus* movements inside the home range. Several authors (e.g. Brown 1966; Flowerdew 1977; Korn 1986) have stated that *Apodemus* home ranges are usually less than 10000 m^2, which means that diameters of the home ranges are usually shorter than 100–150 meters. Only Andrzejewski and Babinska-Werka (1986) have recently reported greater mobility of small mammals.

On the other hand, some experiments (Crawley 1969; Saitoh 1983) show that the actual range of small-mammal movements is far greater than the established diameters of their home ranges. Several authors agree that occasional "sallies" or "exploratory trips" may occur. This has inclined some authors (e.g. Furrer 1973; Joslin 1977) to use the term "life range" to distinguish between the area where such occasional sallies take place and the home range. Burt (1943), who created the definition of home range, says that such occasional long-distance movements "should not be considered as a part of the home range of the animal".

Whatever their nature, the high proportion of long-distance movements in the total small-mammal movements revealed in our study suggests that long-distance wandering is common in the lifespan of mammals and may be important for their survival at least in such a heterogenous environment as our study area. The heterogeneity of the area may contribute to the high mobility of individuals. However, possibly, our results differ in comparison with the great majority of other studies due to our system of spacing the traps. Traps are usually set in a grid of several hectares and long-distance movements cannot be noted. Moreover, a considerable number of live-traps in a small area, usually at a distance of 10 or 15 m may inhibit movements of the animals (Sheppe 1967; Andrzejewski and Babinska-Werka 1986). For technical reasons, it was not possible to set traps over a greater area. Coloured bait was placed in few localities only. Therefore we may expect that the actual number of long distance movements was much greater.

Information acquired regarding the range of small-mammal movements remains unsatisfactory. Many authors seem to forget that the home range is a concept of the human mind and it only points to some probability of meeting an animal in a given place. The distribution of this probability is different when other methods are used. It is difficult to use such terms as "sallies outside the home range" because it is not possible to define the borders of the home range. Brant (1962) seems to have been right when he avoided the term "home range" and used "movement pattern" instead. Therefore we did not intend to distinguish categories of movements. We were interested in the distances traversed during small-mammal wanderings independent of whether they were dispersal movements or "sallies outside the home range".

Unfortunately, studies on small mammal movements using methods other than live-trapping are still scarce. It is known that observed distances strongly depend on the grid size, number of traps in a grid, period of trapping and number of captures (Faust et al. 1971; Mares et al. 1980).

Other techniques (tracking, radio-telemetry) usually reveal much greater ranges of small-mammal movements (Sheppe 1967; Stickel 1968; Innes and Skipworth 1983; Cameron and Spencer 1985). Also, homing experiments suggest that animals may traverse much greater areas than their calculated home range (Joslin 1977; Bovet 1980). Thus, it seems that the use of methods other than live-trapping is obligatory in studies of small-mammal movements. The problem of long-distance animal movements so essential for further development of landscape ecology justifies the effort of applying sophisticated and laborious methods.

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