ACTA THERIOLOGICA
Vol. 24, 30: 405—415, 1979

Synurbization processes in a Population of Apodemus agrarius. II. Habitats of the Striped Field Mouse in Town [1]

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Babińska-Werka J., Gliwicz J. & Goszczyński J., 1979: Synurbization processes in a population of *Apodemus agrarius*. II. Habitats of the striped field mouse in town. Acta theriol., 24, 30: 405—415 [With 2 Tables & 5 Figs.]

Trapping of *Apodemus agrarius* (Pallas, 1771) was carried out in 78 urban green areas of Warsaw during the period from 1976—1978. It is known that the species is not only the commonest, but also the most widely spread in town, of all the urban rodent community, occurring in 55% of the study areas. By means of a 0—10 point scale, proposed here, all the areas were classified in respect of 5 criteria: size of area, size of complex in which the area is included, distance from town boundaries, shelters and »quietness«. It was found that the most important factor for *A. agrarius* in urban green areas is a sufficient amount of shelters; and the »distance« is the least important one, since the rodents also occur in the city district. The habitat requirements of *A. agrarius* in town are discussed.

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1. INTRODUCTION

Apodemus agrarius (Pallas, 1771) is the commonest species in green areas of Warsaw. It also occurs in all big towns in Poland. The mouse predominates in the urban rodent community in both numbers and the quantity of habitats it occupies. Other rodents living in urban green areas — *Mus musculus* (Linnaeus, 1758), *Pitymys subterraneus* (de Selys-Longchamps, 1835) and *Microtus arvalis* (Pallas, 1779) — occur only in certain very specific habitats (Andrzejewski *et al.*, 1978).

A knowledge of the habitat requirements of the field mouse in town is important for several reasons. First of all it provides information about the new ecological niche of this species in urban areas. Secondly, it will provide the basis for proper management of green areas in order to ensure the presence of the species in adequate densities. It can be assumed that its role in urban quasi-ecosystems is highly positive as it enriches and increases the species diversity of these poor and unstable systems (Andrzejewski, 1975). Urban populations of this species

[1] Praca została wykonana w ramach problemu MR II. 6.

might, however, become too dense, as is the case observed periodically in natural and agricultural ecosystems (A n d r z e j e w s k i & W r o c ł a w e k, 1961), so that if its habitat requirements in towns are known we should be able prevent the development of too dense populations.

In this paper an analysis is made of urban green areas as habitats for *A. agrarius*, and the characteristics of habitat requirements of the species in town are given.

2. STUDY AREAS AND METHODS

The studies were carried out in green areas of all types: in parks, cemeteries, private gardens, urban forests and unmanaged areas, on stadiums and playgrounds, along the Vistula river banks etc. Seventy-eight green areas, differing in respect to size, biotic characteristics, ways of utilization and cultivation, were included in the study (Fig. 1).

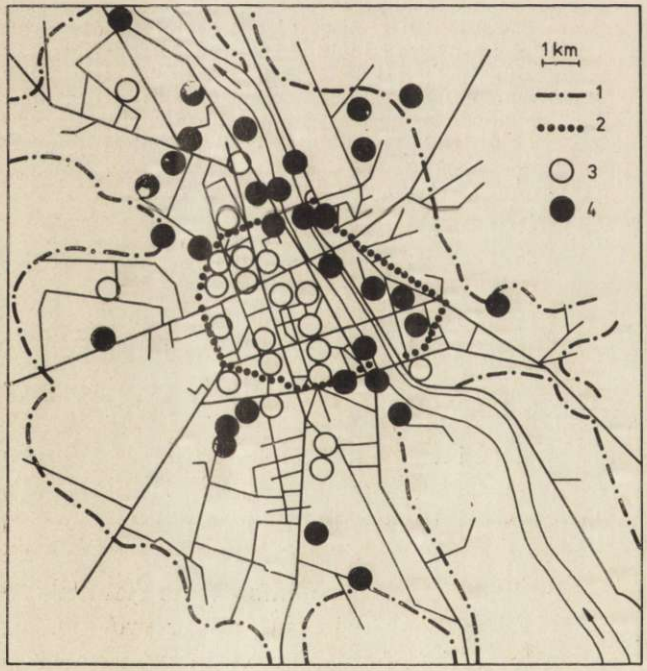

Fig. 1. Distribution of study green areas in Warsaw.
1 — town boundary, 2 — boundary of central part, 3 — areas without *A. agrarius*, 4 — areas with *A. agrarius*.
Note: In some cases one circle indicates several green areas closely situated.

From 1976 to 1978 a standard census was carried out to ascertain presence or absence of *A. agrarius* in each of these areas. The standard census included 3 days of prebaiting with oats and subsequent 3 days of snap trapping. Usually the bait

was placed on 20 sites and the traps set later on 10 of them. Prebaiting and trapping sites were situated near rodent burrows, runs and fresh footprints on the snow. If the bait was not taken, the traps were set on every second prebaiting site. The standard census lasted for a shorter time, when trapping was successful before the third day. In large and patchy areas standard trapping was carried out in 2—3 different patches of vegetation. When the negative result of trapping was somewhat doubtful (because it seemed the bait had been eaten or nearby burrows had been used) trapping was prolonged or repeated after a certain time.

A. agrarius made up over 90% of the rodents caught, while *M. musculus* predominated among the other species. It proved impossible to obtain more precise information about rodent populations from most of the urban areas, because of human activity resulting in devastation of traps.

3. RESULTS

A. agrarius was found in 43 out of 78 investigated areas (55%). Effort was made to establish major differences between areas inhabited by the species and those devoid of it. To acertain this a classification method was proposed and all investigated areas were classified in respect of the five following criteria: (1) size of the area, (2) size of the green complex of which the area forms part, (3) distance from the town centre (as the opposite of distance from town boundaries), (4) availability of shelters for rodents, (5) »quietness« as the opposite of human pressure.

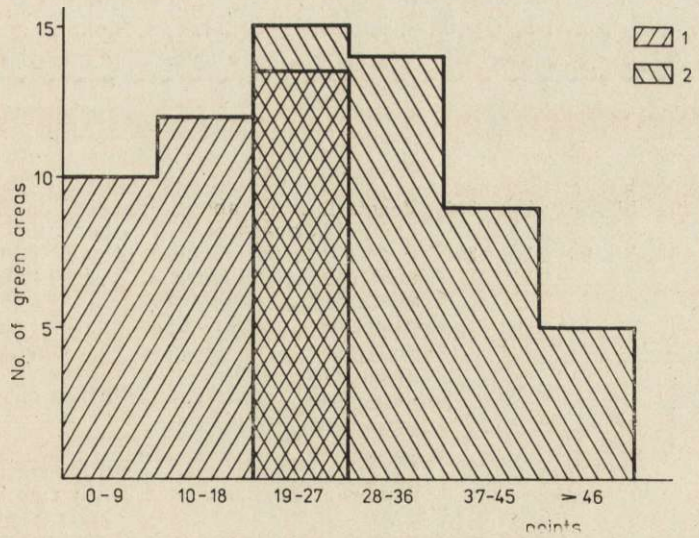

Fig. 2. Distribution of study green areas according to the sum of gained points.
1 — areas without mice, 2 — areas with mice.

The quality of each factor was evaluated according to a 0—10 point scale. The scale covers the full range of conditions met in the study

areas. The number of points increases with improving quality of habitat factors (Table 1).

The areas classified in this manner gained from 50 to 2 points. It was

Table 1

Classification of urban green areas according to five selected criteria.

Scale points	Size of area (ha)	Size of complex (ha)	Distance from town boundaries (m)	Shelters	Quietness
0	>1	>2	>2000	Lack of vegetation, lack of shelters	Greens permanently trodden; noise, car exhautions
1	1—2	3—5	1000—2000	Very scarce grass or herb layer, lack of shelters	Green areas in housing estates; permanent presence of men, dogs and cats
2	3—5	6—10	700—1000	Low and poor vegetation cover, few artificial shelters	Small green areas around factories; noise, pollutions
3	6—8	11—20	600—700	Vegetation as above, few burrows	Small green areas (squares) frequently visited by men and dogs
4	9—10	21—30	500—600	Herb layer moderately rich, few trees and shrubs, few shelters	Parks frequently visited by men and dogs
5	11—15	31—40	400—500	Vegetation as above, few burrows	Cemetaries cared for and often visited
6	16—20	41—50	300—400	Rich herb layer, clumps of trees and shrubs, few burrows	Vast areas of private gardens, moderately quiet; often cultivated
7	21—30	51—70	200—300	Vegetation as above, numerous burrows	Old vast parks, rather quiet
8	31—40	71—90	100—200	Vegetation as above, numerous burrows and artificial shelters	Neglected cemeteries, very quiet
9	41—50	91—110	50—100	Rich herb layer and undergrowth, dense canopy (forest); or: very dense grass cover (meadows); or: dense scrub	Non-park areas with rich vegeration (town forests, meadows), rather quiet
10	>50	>110	<50	Vegetation as above:, numerous burrows	Unmanagened areas with rich vegetation, rarely visited, quiet

found that field mice were present in all areas with more then 26 points, and were absent in those with less than 18 points (Fig. 2). A relatively small overlap between those two groups of areas indicates that selected criteria are of significant importance to *A. agrarius*. Exam-

ination of the relationships between the quality of each factor and the frequency of occurrence of the species gives us information about its habitat requirements in the urban environment (Fig. 3). It then appears that »distance« is not a factor limiting the occurrence of the studied species (Fig. 3c), as the mice are also present in some areas situated in the central part of town (distance = 0 points), if only they can find

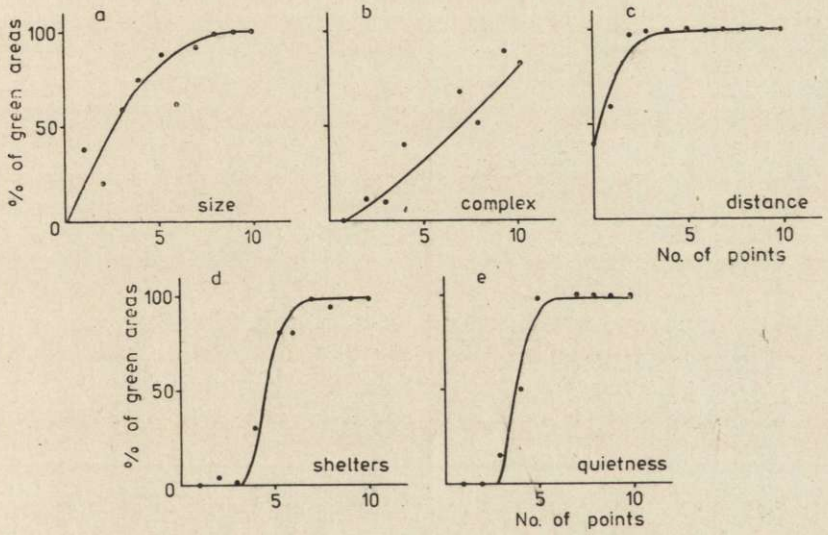

Fig. 3. Percentage of urban green areas inhabited by *A. agrarius* as a function of quality of five habitat characteristics:
a) size, b) complex, c) distance, d) shelters, e) quietness.

suitable living conditions there. However, the closer to the town boundaries the more frequently green areas are inhabited by field mice, and beginning from a distance of 1 km towards town boundaries (distance = 2 points) they are present in all green areas.

The size of an area limits the occurrence of the mice only slightly. They are absent only in areas smaller then 1 ha (Fig. 3a). Afterwards the percentage of areas inhabited by *A. agrarius* slowly increases with the size of the area. This means that in smaller green areas the animals' requirements concerning other habitat factors are greater and can be met in only a few of the areas. It was found that among the factors compensating for the small size of an area, the most important is the size of complex, of which the area forms part (Fig. 4). The mice do not occur in small areas if they do not border upon other green areas at all, or are situated in very small green complexes (Fig. 4 — quarter A),

but occur in many small areas included in vast complexes (Fig. 4 — quarter B). Of course, in these cases much depends upon the habitat quality of other complex components and if it is very low *A. agrarius* is absent even in some very large complexes (complex — 10 points). Only the vast complexes composed of large green areas are all inhabited by the species (Fig. 4 — quarter D).

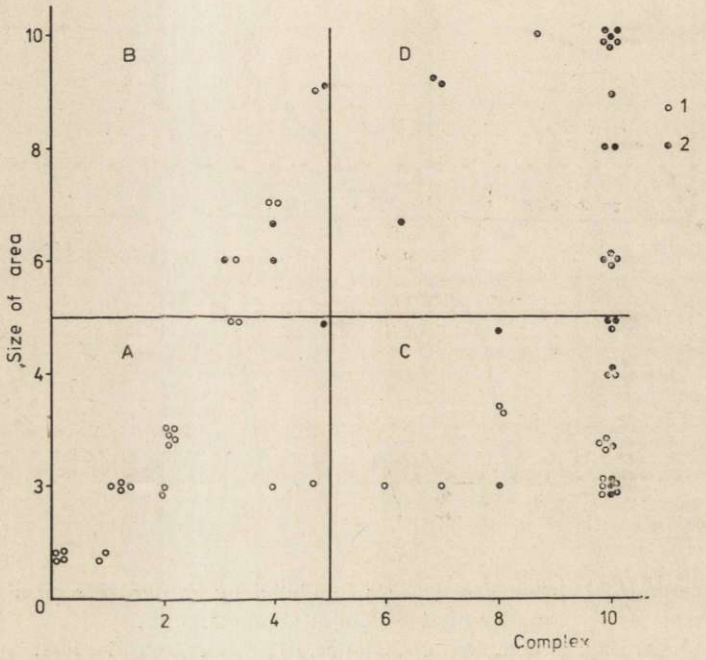

Fig. 4. Occurence of *A. agrarius* as a function of size of area and size of the complex in which the area is included.
1 — areas without *A. agrarius*, 2 — areas with *A. agrarius*.

Availability of shelters in or above ground and under vegetation cover is the most important condition for the occurrence of *A. agrarius* (Fig. 3d). Sparse vegetation cover, accompanied by lack or deficit of other kinds of shelters such as heaps of stones, mole burrows etc., prevents the rodents from inhabiting the area. They occur only on those green areas which have attained a relatively high level of biotic diversity and »microrelief« of ground surface (shelters=4 points). But when the area reaches a sufficient level of shelters availability, any other factors cease to restrict the occurrence of those rodents.

The next selected factor — quietness (meant as the opposite of human impact exerted on biocenoses of urban green areas directly and indi-

rectly) acts in a similar way. It includes information about the intensity of human, canine and feline penetration, intervention of gardeners, level of noise etc. In the areas under heavy human pressure (green areas along busy streets, around factories, in housing estates) *A. agrarius* is absent, no matter how good the other habitat conditions are, but in all relatively »quiet« areas the mice are present. Within a certain range of areas inhabited by the field mice, a compensating effect could be expected between »shelters« and »quietness« factors, as some areas providing many shelters for rodents could be inhabited despite their low »quietness« value; and when the area is very quiet its lower value of »shelters« index should suffice for mice. It was found, however, that this effect could not be established on the basis of the material available, as there is a high positive correlation between these two factors in all Warsaw green areas. We could find no areas distinguished by high biotic diversity (and rich in abiotic forms) and so providing many shelters, which were at the same time under heavy human pressure.

Comparison of five curves illustrating the relationships between rodent occurrence and the quality of each factor examined reveals the following order of importance of these factors to *A. agrarius:*

$$\text{shelters} > \text{quietness} > \text{size} \geqslant \text{complex} > \text{distance}$$

The most significant role of shelters and »quietness« factors was confirmed by results of yet another analysis. This analysis related to 28 selected green areas, very similar to each other in many aspects, but only half of them (14) inhabited by the species under study, while the

Table 2

Comparison of average values of two groups of green areas belonging to the same points class of the scale (25—18 points). Half of them are inhabited by *A. agrarius* and the other half are not.

	Size	Complex	Distance	Shelters	Quietness
A. agrarius present	4.1	7.3	0.6	5.8	4.4
A. agrarius absent	3.2	7.5	1.0	3.3	3.7
Student *t* test	0.62	0.44	0.77	3.93*	1.96

* Difference statistically significant

other half was not. These areas belong to the same class in the classification scale (18—26 points) and represent the overlapping part of distributions shown on Fig. 2. The mean values of each factor for those two groups of areas were calculated and compared by Student *t* — test to

indicate the most significant difference between areas inhabited by and devoid of the mice. It was found that the only significant difference was in the »shelters« factor, while the values for »size«, »complex« and distance factors were the same for two groups (Table 2). The »quietness« factor proved to be the second in importance (*t*— on the verge of significance).

4. DISCUSSION

The presence of *A. agrarius* in the majority of green areas of Warsaw, even in those situated in the central part of town, points to the highly advanced process of synurbization of this species, since it means that many urban populations of this species are able to maintain themselves without an inflow of immigrants from suburban populations, but to live there the species requires areas of suitable habitats, properly distributed and managed. It inhabits small green patches only when they border upon other suitable areas. It never occurs in areas smaller than 10 ha in size, if they are not part of the large complexes (Fig. 4, Table 1). The probable explanation for this is that small areas are able to maintain too few individuals to allow the population to exist continuously without an inflow of, or contacts with, mice from adjoining areas. It would appear that the most important factor limiting the carrying capacity of urban habitats for rodents is a deficit of potential shelters. *A. agrarius* uses artificial shelters such as chinks in walls, heaps of stones, spaces between roots of trees, or nests in burrows dug by itself or by other mammals. In urban parks and on lawns there is a deficit of such »artificial« shelters and the soil is often too hard and livery to allow digging of burrows, not only for mice, but even for moles *Talpa europea* (J. Goszczyński, unpubl. data). Moreover in urban areas the striped field mouse prefers to situate its burrows in places with dense vegetation cover (under bushes, in hedges etc.), which are difficult to find as higher vegetation in town is scarce and grass frequently mown. As a result of the low capacity of some habitats the rodents cannot colonize them at all, or only in very small numbers. Availability of shelters depends upon the richness of the vegetation component of the biocenosis, so it is probably positively correlated with availability of food for rodents. Therefore, only when a thorough analysis of the composition of food consumed by *A. agrarius* in urban areas is carried out will it be possible to decide which is the most limiting factor for mice in urban habitats — shelters or food.

The high threshold value found for »quietness« shown that the field mouse is not yet adapted to conditions of permanent human presence

as are other synurbic species: squirrel (*Sciurus vulgaris*, L., 1763), wild duck (*Anas platyrynhos* L.,), great tit (*Parus major* L.). On the other hand the criterion of »quietness« also includes intensity of canine and feline penetration. These two species are highly efficient predators in urban areas and can consequently act as an important factor limiting the occurrence or density of *A. agrarius* there. As, however, there is high correlation between »quietness« and shelters (Fig. 5), it is difficult to judge whether the absence of *A. agrarius* in given areas in caused by the great pressure of men and domestic animals or by simultanous lack of available shelters.

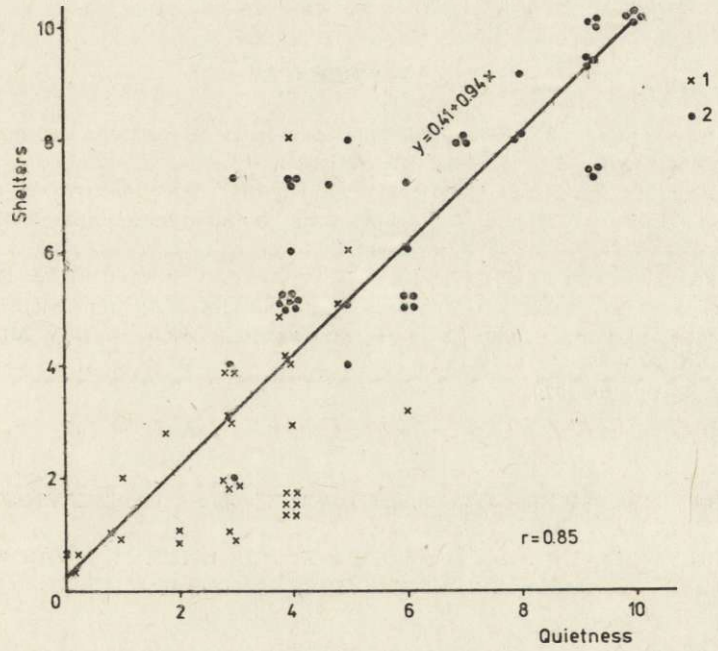

Fig. 5. Example of high correlation between selected characteristics of green areas. 1 — areas without *A agrarius*, 2 — areas with *A. agrarius*.

But not only these criteria used for our classification of green areas are correlated. Similar correlations, though not so high, exist between »distance« and »shelters« or »quietness« (in the central part of the town there are fairly small greens, squares and gardens, and in suburbs — large parks, cemeteries and unmanaged areas). Because of these interrelations between the factors it is difficult to demonstrate the compensating effect

of one factor on the other. The most useful data for such an analysis would be information about rodent density in study areas. There is probably a high positive correlation between density and total sum of points gained by the area in our classification. If this is true only about 10% of all green areas in Warsaw (allocated to the group of 40—50 points) hold high densities of *A. agrarius*.

Further investigation of urban populations should reveal whether these high densities of *A. agrarius* are advantageous or harmful for the biocenosis of green areas. This would be dependent on a yet unknown trophic and paratrophic role of the species in urban ecological systems.

Acknowledgements: We should like to express our sincere thanks to Doc. Dr. hab. R. Andrzejewski, for his scientific guidance and help, and for reviewing the manuscript. We are also indebted to Ms. J. Odolczyk and Ms. M. Sumińska for their help with fieldwork.

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Accepted, March 10, 1979.

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PROCES SYNURBIZACJI *APODEMUS AGRARIUS*. II. ŚRODOWISKA ZAJMOWANE PRZEZ MYSZ POLNĄ W MIEŚCIE

Streszczenie

Na 78 terenach zieleni miejskiej w Warszawie przeprowadzono w latach 1976—78 serię połowów *Apodemus agrarius* (Pallas, 1971). Badaniami objęto wszystkie typy zieleni miejskiej: parki, skwery, cmentarze, działki pracownicze, lasy miejskie itp. (Fig. 1). Stwierdzono, że gatunek ten występuje na 55% badanych terenów i jest najszerzej rozprzestrzenionym w mieście gryzoniem. Opracowano 10-punktową skalę waloryzującą zieleń miejską pod względem jej przydatności dla *A. agrarius* (Tabela 1). Uwzględniono w niej 5 kryteriów: wielkość terenu, rozległość kompleksu, w skład którego ten teren wchodzi, odległość od centrum (mierzona odwrotnością odległość od granic miasta), ukrycia i „spokój" (jako odwrotność wpływów antropogenicznych).

Stwierdzono, że *A. agrarius* występuje na terenach, które uzyskały w sumie po-

wyżej 18 punktów (Fig. 2). Następnie określono zależność pomiędzy częstością występowania myszy polnej a jakością każdego z kryteriów (Fig. 3). Z analizy otrzymanych krzywych wynika następująca hierarchia „ważności" poszczególnych kryteriów dla *A. agrarius*:

ukrycie > spokój > wielkość ≥ kompleks > odległość

Wysoką pozycję dwóch pierwszych kryteriów potwierdziła także analiza wybranych 28 terenów o bardzo podobnej charakterystyce, z których połowa była zamieszkiwana przez myszy a połowa nie (Tabela 2). Ponadto stwierdzono, że dla *A. agrarius* negatywne skutki zbyt małej powierzchni terenu mogą być kompensowane rozległością kompleksu i odwrotnie (Fig. 4). Należy przypuszczać, że podobne mechanizmy kompensacyjne mogą istnieć także pomiędzy innymi cechami terenów, ale stwierdzenie tego było niemożliwe, bowiem badane cechy terenów zieleni miejskiej Warszawy charakteryzują się wzajemną korelacją. Wzrost jakości jednej cechy był wysoko skorelowany z równoczesnym wzrostem pozostałych (Fig. 5). W dyskusji omówiono wymagania środowiskowe *A. agrarius* w nowych dla niego siedliskach na terenach zurbanizowanych.