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Migrations of *Mus musculus musculus* in Danish farmland

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Abstract

Examining the migrations of *Mus musculus musculus* to and from Danish farms trappings were carried out at two farms and the surrounding field boundaries every third to fourth week for one year. The mice were captured in barns, stables and farm houses from November to March. In April, while the populations of native rodent species were low, *M. m. musculus* emigrated to grass and herb covered parts of the field boundaries. From May to July few *M. m. musculus* were captured near buildings and in field boundaries, possibly because they spend the summer in cultivated fields. In early August they reappeared in the field boundaries. From August to November during a heavy increase of native rodent populations *M. m. musculus* immigrated from field boundaries to the immediate surroundings of the buildings and further into barns and stables and finally into farm houses.

The habitat choice of *Mus musculus musculus* was examined. The mice showed a preference for traps placed in grass and herb covered areas without trees or bushes. All *M. m. musculus* captured in tree and bush covered areas were transient.

Introduction

In the nothern part of Europe *Mus musculus* movement culminates in spring and autumn (Rowe et al. 1963; Vlcek 1984; Rowe et al. 1987). *M. m. musculus* is believed to migrate from human settlements to outdoor locations, eg. arable land, in spring and back again in autumn (Stein 1955; Jensen 1966; Reichstein 1978). These seasonal migrations seem to be uninvestigated.

Choice of outdoor habitat by *Mus musculus* in Northern Europe is insufficiently described. During investigations of the small mammal fauna in stands of trees and bushes, in hedges or in dunes *Mus musculus* is caught in very small numbers (Pollard and Relton 1970; Yalden 1980; Kozakiewicz 1987; Fairley and Smal 1987). Feral populations of *Mus musculus* on arable land have been found (Southern and Laurie 1957; Zejda 1975).

Information on habitat choice by feral populations of *Mus musculus musculus* in Denmark is non-existing.

The main purpose of this investigation is to describe, temporally and spatially, the seasonal migrations undertaken by *Mus musculus musculus* in farmland of south eastern Denmark. Furthermore the outdoor habitat choice of *M. m. musculus* during migration will be described.

Material and methods

162 Ugglan live-traps were set up at two slightly disrepaired farms in the southern part of Sjælland, Denmark. The farms are situated in low altitude farmland bordering on Dybsø and Avnø Fjords. The distance between the farms is about 6 km. None of the farms are closer than 2 km to forests. The field boundaries around the two farms consist of low banks/stone fences with a mixed growth of willows *Salix* sp., poplars *Populus* sp., elders *Sambucus* sp., rowan trees *Sorbus* sp., hawthorns *Crataegus* sp., blackthorns *Prunus spinosa*, dog roses *Rosa canina* and cherry plum trees *Prunus ceresifera*. Parts of the field boundaries, however, are without any trees or bushes (Figs. 1, 2).

The undergrowth mainly consists of grasses, stinging-nettles *Urtica* sp., thistles *Carduus* sp., bindweeds *Convolvulus/Calystegia* sp., mugworts *Artemisia* sp. and dewberry *Rubus caesius*. The

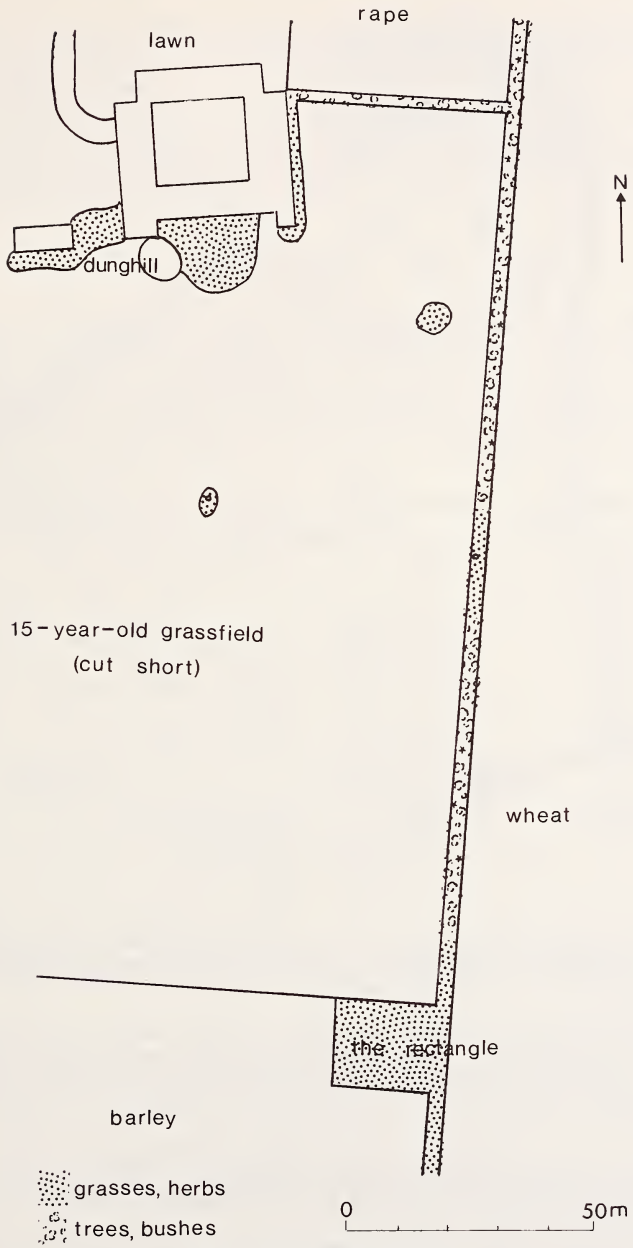


Fig. 1. Furmarksgård, Ring

cereal fields in the area were cropped from early July to early August and had all been ploughed by the end of August. The sugar beets were not cropped until late autumn.

Furmarksgård (Fig. 1) is situated in open farmland just west of the village Ring. In 1990 the stock consisted of 2 pigs, 8 to 12 bull-calfs, a dog and an unknown number of cats. During the winter 89/90 the farm was infested with rats *Rattus norvegicus*. On the request of the farmer the rats were eradicated during March 1990.

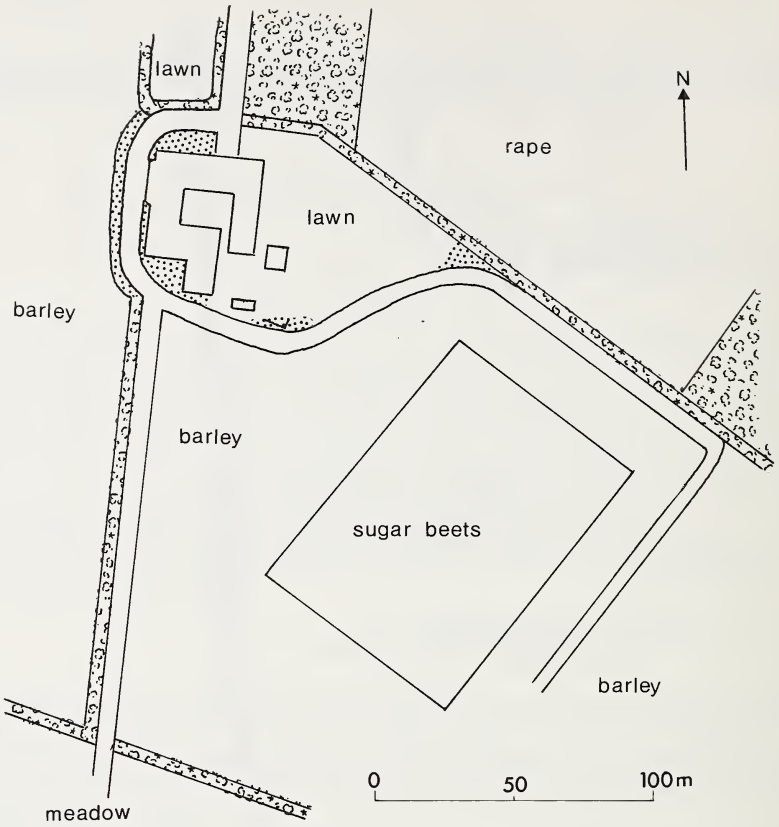


Fig. 2. Egebjerggård, Svinø

Barley and carrots were stored in the barn throughout the year. Filling of the loft with bundles of straw took place through the last half of July and into early August. From then on the amount of straw on the loft declined until it reached a minimum in June. Through June and the first half of July the loft was nearly empty.

92 Ugglan live-traps were set up on Furmarksgård: 18 in barn, stables and on the loft; 8 outdoors on the farm; 4 in the grass field; 9 in the east hedge (one every 5th meter); 1 on the 10th meter of the north hedge; 50 in the south hedge (one every 5th meter the first 250 meters) and 2 in the rectangle (Fig. 1). On a couple of occasions traps were extraordinarily set up from 250 to 500 meters in the south hedge.

Egebjerggård (Fig. 2) is in the southern end of the village Svinø. The only domestic animals on the farm were cats, 2 dogs, a few rabbits and poultry. In the stables piles of junk, such as bricks, boards and a few old bundles of straw could be found. The loft was empty. In the barn barley was stored in two silos from July 1990 and forward.

Around Egebjerggård 70 Ugglan live-traps were set up: 6 in barn and stables, 13 outdoors on the farm, 18 in the south east hedge (one every 5th meter from 0 to 80 meters and one on the 150th meter) and 33 in the south hedge (one every 5th meter). On a few occasions traps were set up from 150 to 450 meters in the south east hedge and in the farm-house.

As mentioned most traps were set up in the hedges with 5 meter intervals. Each trap was carefully placed where the chance of catch was judged to be the best. No individual trap was ever placed in the same spot during two consecutive trapping periods. This happened to eliminate as far as possible the possibility of the smell or functionality of the trap influencing the catch.

In periods of windy or rainy weather exposed traps were provided with plastic covers to keep water out.

The traps were baited with maize and coarsely rolled oatmeal. From late November 1989 to March 1990 traps were set up once a month. From April 1990 to early November 1990 traps were set up every 3rd week. However there was a 5-week-interval between the trapping period in the middle of May and the period in late June.

Trappings were carried out at both farms simultaneously. The traps were inspected once every 24 hours as early in the day as possible.

When a mouse was trapped it was individually marked by toeclipping. Species, mark, point of trapping, and if possible sex and weight were noted. The mouse was released at the point of capture immediately after the marking and weighing.

Results

3648 captures of 1154 individual small mammals distributed on 11 species were made on the two farms. The distribution on species and localities is shown in the Table.

The majority of *M. m. musculus* (98.4 %) were caught from late August to May with a peak (58.6 %) in September–November. Of 51 individuals marked in Svinø and 61 marked in Ring from November to October 27.5 % and 31.1 % respectively were caught in one trapping period only but on more than one day. 41.2 % and 29.5 % respectively were caught in more than one period. The sex ratio was close to 1:1 among all marked *M. m. musculus* as well as among the ones that were caught again.

Numbers of trapped individuals of small mammals

	Svinø	Ring
Sorex araneus	64	58
Sorex minutus	46	7
Neomys fodiens	5	–
Rattus norvegicus	1	–
Mus musculus	56	63
Apodemus sylvaticus	114	100
Apodemus flavicollis	60	85
Micromys minutus	39	96
Microtus agrestis	37	81
Clethrionomys glareolus	145	95
Mustela nivalis	1	1

During January and February *M. m. musculus* were only caught indoors. Through March and early April the majority of the mice were still caught indoors with only few individuals caught outdoors close to the farm buildings.

In the interval between the early April and late April trapping periods the mice in Ring moved from the loft to trap points in the rectangle 160 meters from the farm buildings (Fig. 1). This emigration was directly traceable. After the emigration no *M. m. musculus* were caught indoors but a few were still caught in hedges and near the buildings.

In Svinø all *M. m. musculus* captured indoors early April had disappeared by late April. An emigration could not be traced directly. The indoor mice in Svinø, however, disappeared simultaneously with the emigration in Ring. I therefore presume that the disappearance was caused by an emigration. The emigration coincided with a minimum in the populations of the other small rodent species of the area (Fig. 3).

In May 3 mice were caught in hedges, in June 1 indoors and in July 1 in a hedge.

In August *M. m. musculus* started appearing in growing numbers primarily close to the farm buildings. This immigration was most marked in Svinø. From the middle of September *M. m. musculus* were caught indoors as well, primarily in the barn and stables. From then on the percentage of the mice caught indoors increased while the outdoor percentage decreased (Fig. 4). In November 75 % of all *M. m. musculus* were caught indoors.

In Svinø the immigration was directly traceable. Several *M. m. musculus* could be traced from the south hedge to trap points near the farm buildings and farther into barn and stables and finally into the farm house (Fig. 5). A 16 g female was marked early August at a trap point in the south hedge 130 meters from the farm buildings. Late August it was

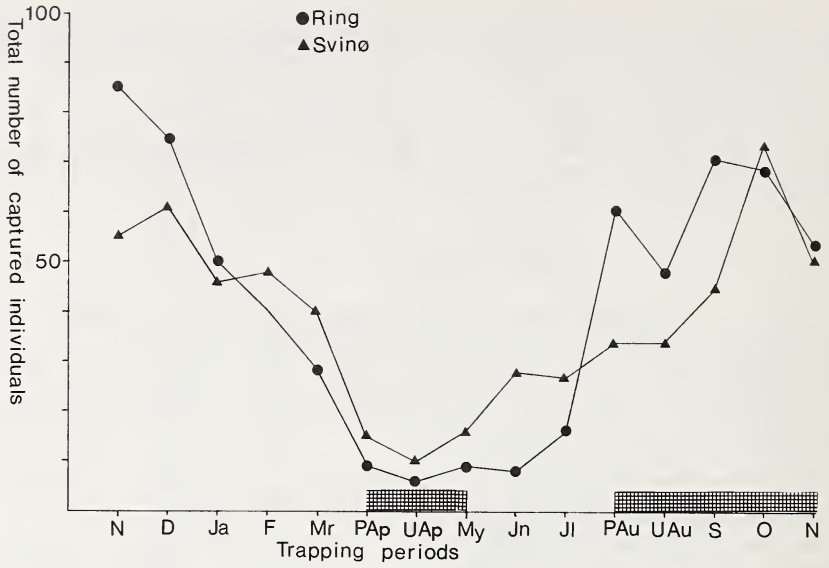


Fig. 3. Total number of captured individuals of 4 native rodent species (*C. glareolus, M. agrestis, A. flavicollis, A. sylvaticus*) each trapping period in Ring (dots) and Svinø (triangles). The shading shows the migration periods of *Mus musculus musculus*. N = November, D = December, Ja = January, F = February, Mr = March, PAp = Early April, UAp = Late April, My = May, Jn = June, Jl = July, PAu = Early August, UAu = Late August, S = September, O = October

caught close to the buildings and from September to November it was caught several times in the stables.

15 individuals were caught at more than one trap point. 13 of these had moved closer to the farm buildings or indoors between the catches.

In ring only few *M. m. musculus* were caught in the autumn of 1990. None were caught at more than one trap point.

The immigration took place from August to November, a wider span of time than the emigration. I presume that the immigration took place simoultaneously at the two farms as the mice in Ring reappeared near the farm buildings and later in the stables at the same times as in Svinø.

The immigration of *M. m. musculus* took place during a time of heavy increase in the populations of the other species of small rodents (Fig. 3).

The immigration was in 3 stages. The mice migrated from their summer quarters to the close vicinity of the farm buildings via the hedges or pherhaps directly from the fields bordering on the farm. After a short stay near the buildings the mice entered barn and stables. The farm house was entered either directly from the area immediately outside the buildings or via barn and stables.

The individual mice did not go through each particular stage simultaneously. In October, for instance, mice could be caught at all stages of immigration.

A female *M. m. musculus* marked on the loft in Ring in October emigrated in April. This indicates that individuals immigrating in autumn emigrate again in spring. None of the *M. m. musculus* which emigrated in spring returned in autumn.

Of 235 traps containing *M. m. musculus* 67.7 % held one individual and 32.3 % more than one (Fig. 6). 6 % of the traps contained 1–2 *M. m. musculus* with 1–2 individuals of other rodent species. The rodent species caught together with *M. m. musculus* were in 3 cases *Clethrionomys glareolus*, in 1 *Microtus agrestis*, in 3 *Apodemus sylvaticus*, in 1

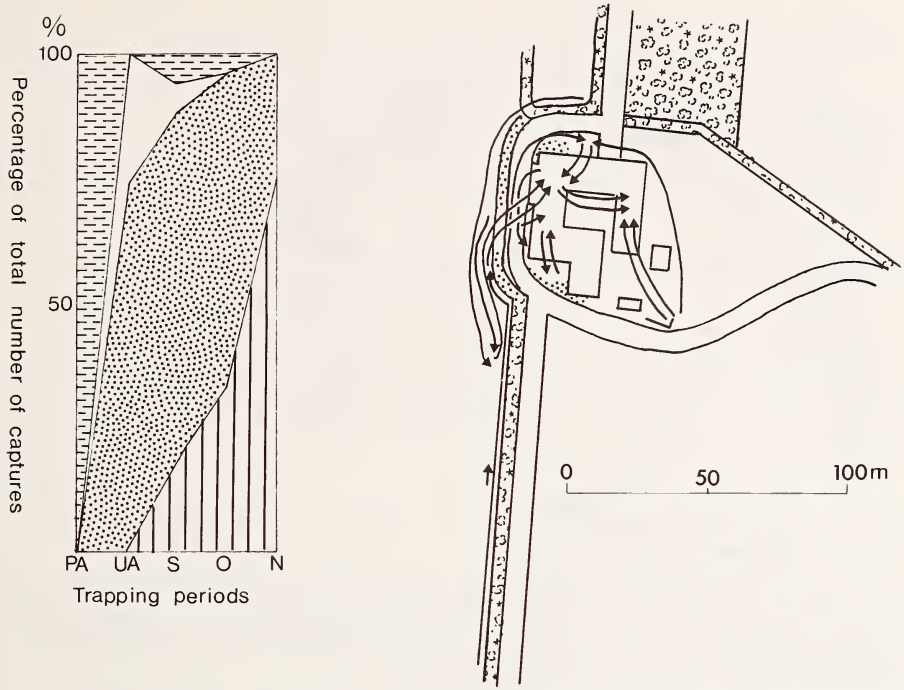


Fig. 4 (left). The immigration of *M. m. musculus*, Svinø, autumn 1990. Horizontal lines = Mice caught in hedges more than 75 m from the buildings. Blank = Hedges closer than 30 m to buildings. Dots = Immediately outside the buildings. Vertical lines = Indoors. PA = Early August, UA = Late August, S = September, O = October, N = November. – *Fig. 5 (right).* Movements of immigrating *Mus m. musculus*, Svinø, autumn 1990. Each arrow indicates the movements undertaken by one individual between two successive trap inspections

Apodemus flavicollis and in 6 cases *Micromys minutus*. In the 3 cases, however, where an *Apodemus sylvaticus* was caught together with a *M. m. musculus* these were the same two individuals.

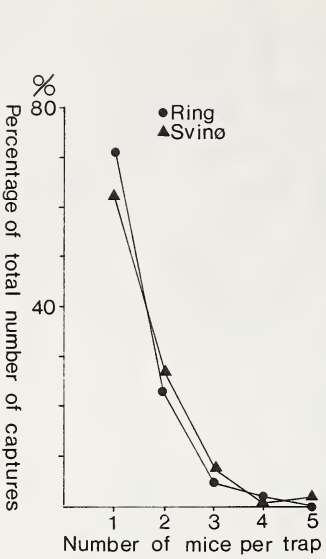
The individual trap point was rarely visited by more than one rodent species during a trapping period. From late August to November the individual outdoor trap points near the buildings visited by *M. m. musculus* were visited by a relatively steady number of mice. The total number of outdoor trap points visited by *M. m. musculus*, however, decreased. At the same time the number of trap points near the buildings visited by other small rodent species increased.

The outdoor trap points were classified as belonging to one of four categories of cover:

1. Close cover of grasses, nettles and other herbs; no trees or bushes (43 traps).
2. Piles of bricks, boards, broken concrete pipes etc. with vegetation of herbs and grasses; no trees or bushes (7 traps).
3. Trees or bushes with close undergrowth of grasses, nettles, etc. (73 traps).
4. Trees or bushes with sparse undergrowth (15 traps).

The number of catches at each category trap point were counted (Fig. 7).

The majority of *M. m. musculus* caught outdoors were caught in rather open habitats without trees or bushes. This in spite of the fact that the majority (63,8 %) of the traps were set under trees and bushes. All *M. m. musculus* caught more than once at a trap point were caught at points in categories 1 or 2.



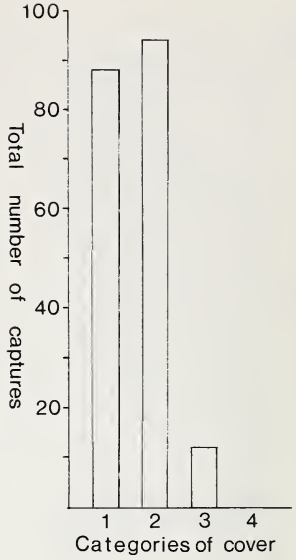


Fig. 6 (left). Captures of one or more *Mus m. musculus* per trap per trap inspection. – *Fig. 7 (right).* Outdoor habitat choice of *Mus m. musculus*. 1: cover of grasses and herbs; no trees or bushes; 2: piles of bricks, boards, etc. grass and herb cover; no trees/bushes; 3: trees/bushes; close undergrowth of grasses and herbs; 4: trees/bushes; sparse undergrowth

The 12 catches in category 3 are caused by 11 individuals. One individual only has been caught twice at category 3 trap points. The distance between the two involved trap points was more than 80 meters.

Discussion

Mus musculus are mainly caught in buildings and corn-ricks through autumn and winter (Rowe et al. 1963; Jensen 1966; Zejda 1975). Some populations spend the summer outdoors in the fields (Southern and Laurie 1974; Zejda 1975). Other populations spend all seasons indoors (Petrusewicz and Andrzejewski 1962; Pelikan 1974; Pelikan and Nesvadbova 1979; Vlcek 1984; Rowe et al. 1987).

Investigating the occurence of *M. m. domesticus* in arable land Southern and Laurie (1947) and Rowe et al. (1963) captured mice in hedges mainly in autumn but also in spring. Almost 3/4 of the mice leaving corn-ricks were noted in spring and almost 3/4 of the mice entering in autumn (Rowe et al. 1963).

In Czechoslovakia Vlcek (1984) found peaks in the intensity of *Mus musculus* movement in spring and autumn and Zejda (1975) could only catch *Mus musculus musculus* in fields from June to September and *M. m. spicilegus* from February to October.

All this indicates that yearly recurrent spring and autumn migrations between summer and winter quarters are undertaken by some *Mus musculus* populations in the northern half of Europe as suggested by Stein (1955), Jensen (1966) and Reichstein (1978).

This investigation clearly shows that populations of *Mus musculus musculus* in south eastern Denmark emigrate from human settlement in spring and immigrate in autumn. Hedges and field boundaries seem to be important migration routes.

Based on indoor trappings of *M. m. musculus* in Denmark Jensen (1966) suggests that immigration is not caused by human disturbance of the summer quarters of the mice in the fields as he does not find any surge in the immigration in connection with harvest or

ploughing of fields bordering on his house. Rowe et al. (1963), however, on the basis of trappings in corn-ricks and hedgerows found that the movements of *Mus musculus domesticus* living in the fields were largely influenced by farming practice.

Considering the multiple stages of the immigration an increase in numbers of immigrating *Mus musculus* caused by harvest or the like would not be noticed immediately in the buildings bordering on the fields but rather in the area just outside these buildings and in the hedgerows along the fields. By the time the mice reach the buildings the surge would be leveled by the intervening stages.

Mus musculus is a poor competitor with native rodent species (Caldwell 1964; Berry 1981; Fairley and Smal 1987) and interspecific competition might restrict it to disturbed areas uninhabited by native rodent species (DeLong 1966).

Stein (1955) suggests that low feral *M. m. musculus* population numbers and retreat to buildings in autumn in eastern Germany could be caused by competition with *Apodemus sylvaticus*. Apparent competition between *Mus musculus* and *Apodemus sylvaticus* has also been found by Boitani et al. (1985). The immigration of *M. m. musculus* in Svinø and Ring coincided with a heavy increase in native rodent populations, and it was mainly *Apodemus sylvaticus* which was responsible for the increase in trap points near the farm buildings in Svinø visited by other species than *M. musculus*.

I consider it possible that interspecific competition with other rodent species could be part of the cause for the immigration of *M. m. musculus*. When the summer habitat of *M. m. musculus* have been destroyed through harvest and ploughing the mice will probably be unable to find suitable uninhabited habitats away from human dwellings.

The wild forms of *Mus musculus* are typical dry area animals occuring in savannahs, steppes and even in desert country (Schwarz and Schwarz 1943). This investigation shows a preference by *M. m. musculus* when living outdoors for open habitats with dense cover of grasses, herbs, etc. but without cover of trees or bushes. This applies for spring as well as for autumn. Distribution and habitat choice of *Mus musculus* is influenced by competition more than by habitat structure (Dueser and Porter 1986). With the habitat preference in spring and autumn being the same despite apparently different competitive pressures, however, I consider the shown preference reflecting the real preference well enough.

No resident *M. m. musculus* were ever captured in the tree and bush covered part of the field boundaries. Also no *M. m. musculus* were captured in the open grass and herb covered areas bordering on the outside of the farm buildings during the summer. However, the facts that the mice emigrated in small numbers in spring and immigrated in larger numbers in autumn show that outdoor breeding populations do exist during the summer.

In Europe *Mus musculus* have been found, sometimes abundantly, in cereal and root crops during the summer (Southern and Laurie 1947; Stein 1955; Zejda 1975; Boitani et al. 1985). Information on the occurence of *Mus musculus* in open, undisturbed habitats in northern Europe seems to be scarce. Cultivated fields, meadows or other open habitats seem to suit the apparent habitat demands of *M. m. musculus*. Fields are in addition disturbed habitats with no or very low native rodent populations. This will minimize the chance of interspecific competition being a restricting factor for *M. m. musculus* populations.

I find it probable that *M. m. musculus* in south eastern Denmark spend the summer in cultivated fields.

Zusammenfassung

Saisonale Wanderungen der Hausmaus (Mus musculus musculus) im dänischen Ackerland

Um etwaige saisonale Wanderungen der Hausmaus (*Mus musculus musculus*) im dänischen Ackerland zu untersuchen, wurden auf zwei Höfen und in Flurbegrenzungen innerhalb eines Jahres jede dritte

oder vierte Woche Fallen aufgestellt. Von November bis März wurden die Mäuse in Scheunen, Ställen und Häusern gefangen. Im April, als die Populationen der wildlebenden Kleinnagetiere ein Minimum erreichten, wanderten die Mäuse zu den gras- und kräuterbewachsenen Teilen der Flurbegrenzungen. Von Mai bis Juli wurden nur wenige Hausmäuse in den Flurbegrenzungen und an Gebäuden gefangen, möglicherweise weil sie sich auf den Äckern aufhielten. Anfang August tauchten sie wieder in den Flurbegrenzungen auf. Von August bis November, als die Populationen der wildlebenden Kleinnagetiere ein Maximum erreichten, wanderten die Hausmäuse erst von den Flurbegrenzungen zu Regionen in unmittelbarer Nähe von Gebäuden, dann in Scheunen und Ställe und zuletzt auch in Häuser hinein.

Die Habitatpräferenz der Hausmaus wurde untersucht. Die Mäuse wurden vorwiegend in Fallen gefangen, die in gras- und kräuterbewachsenen baum- und buschlosen Gebieten aufgestellt waren. Alle *M. m. musculus*, die in baum- und buschbewachsenen Gebieten gefangen wurden, waren auf der Wanderung.

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