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Micromammalia of the Cultivated Wizna Fen

Elżbieta MALZAHN & Stanisław FEDYK

Malzahn E. & Fedyk S., 1982: *Micromammalia* of the cultivated Wizna fen. Acta theriol., 27, 2: 25—43 [With 6 Tables and 4 Figs.]

Studies on small mammals in the Wizna fen, which is uniformly reclaimed and cultivated as meadowland, were carried out using the standard removal method on 52 trapping lines (n=1116) in the autumns of 3 years (1977—1979). Domination percentage and relative numbers were determined for 13 species of *Micromammalia* in samples from six basic types of plant habitats: various meadow habitats, shelter belts and forest reserves. The species caught in the greatest numbers were: *Microtus arvalis, Cletrionomys glareolus, Sorex araneus* and *Microtus oeconomus*. In meadow habitats the dominating species is *M. arvalis* (>70% of captures), with a considerable proportion of *S. araneus* and *M. oeconomus*. Systematic mowing of the meadow sections causes temporary local migration of these mammals to neighbouring sections and to the slopes of drainage ditches. The two vole species caught in the greatest numbers (*M. arvalis* and *M. oeconomus*) are dependent on each other in respect of the ecological niches they occupy in meadow habitats. The system of spatial relations between them depends on the population density of these two species. *Sorex araneus, Apodemus agrarius* and *Microtus oeconomus* form 80% of the captures made in shelterbelts lying between the meadow sections. The most diversified and richest in species is the fauna caught in the forest reserves not subject to management, where *Clethrionomys glareolus* or *Sicista betulina* dominates. No direct connection was found between the degree of humidity of the biotope and trappability of mammals. Comparison of the mammal fauna of the reclaimed Wizna fen with that of the adjacent natural fen habitats of the Biebrza urtal showed that fairly important changes have taken place in the fauna as the result of low peat fen reclamation.

[Mammals Res. Inst., Polish Acad. Sci., 17-230 Białowieża, Poland]

1. INTRODUCTION

The present-day landscape of the greater part of European territory has been created as the result of intensive human activity. The majority of studies on mammal fauna have been carried out on greatly changed areas, only a small number of studies of an ecological or faunistic character having been carried out in the original habitat. Among these latter studies are those undertaken for intensive examination of *Micromammalia* fauna of the Biebrza urtal, the largest and best preserved group of low peat fen in Poland and Europe, and of other bog habitats (Raczyński *et al.*, in press). It was found that the theriofauna of primeval

bogs constitutes separate formations with a specific composition of species and that it retains its original character. Natural bog habitats are the sheltering place for rare and protected species of *Micromammalia*.

The southern part of the Biebrza urtal — the low peat Wizna fen, which is uniformly reclaimed and cultivated, nowadays constitutes the pasture and meadowland group of the "Wizna" State Farm. Ecological studies have already been carried out in this area, and a detailed description made of the soil biotopes occurring there, while the connections between soil conditions and formation of grass ecosystems have been analyzed (Okruszko, 1977).

Intensive cultivation operations on the reclaimed fenland have brought about far-reaching changes in the habitat occupied by animals in relation to natural bog habitats, hence the purpose of the present study, arising from this, is to examine the *Micromammalia* fauna of this region and to obtain comparative data on the subject of the effect exerted on communities of small mammals by reclamation of bog and fenland.

2. STUDY AREA

Reclamation operations were carried out from 1960—1965 in the Wizna low peat fen area. A polder system was introduced over the whole area of 8880 ha, building a network of irrigating or drainage canals. In this way cultivated sections were created, from which the natural vegetation was removed and replaced by good quality grasses with an admixture of *Trifolium hybridum* L. (Okruszko, 1977). This area is now intensively used as meadowland by the Wizna State Farm pasture and meadow group.

Cultivation operations such as, *e.g.*, repeated mowing of the meadows during the course of the year, using mechanized plant, has brought about radical changes in the habitat. The network of canals has rendered water relations uniform, although it is known that air-water relations are not homogenous in the soils of this region. Experts on peat have distinguished three groups of soil representing different systems of biotope conditions: biotope *A* — wet soil complex, formed on poorly-decomposed moss peats, biotope *B* — moist soil complex, with moderate decomposition of sedge and tall-sedge, peats and biotope *C* — semi-arid complex, formed on strongly decomposed alderwood peats (Szuniewicz & Szymanowski, 1977).

The following elements of the habitat are typical and repeated in the study area: sections of cultivated meadows, drainage ditches separating them and shelterbelts, set up later on part of the area several metres wide, along the ditches and separating neighbouring sections of meadowland.

In addition two wooded areas have been excluded from cultivation in this area- and form reserves known as "Wizna Fen I" and "Wizna Fen II", respectively 30 and 76 ha in area. These reserves were formed in order to preserve for scientific and educational purposes parts of the low peat bog with sites of rare plants. The reserves are located on peat soils and mineral soils of varied origin, the latter have been created on mineral elevations of land above meadow level ("mineral islands").

3. MATERIAL AND METHODS

Small mammals were trapped in three consecutive years during the period of the yearly peak of population numbers, *i.e.*, in the autumn (29.9—8.10.1977, 4—14.10.1978, 15—25.9.1979).

A total of 52 trapping lines were laid out during the three-year period. The standard trapping line had 20 trap sites distributed in a line at 10 m intervals. In order to obtain the fullest possible composition of mammal fauna, two different types of trap were placed on each trapping site: one pitfall and two snap-traps, with parsnip and fried wick as baits. Trapping was carried out on each site for 5 days. Animals caught were removed from the traps once daily during the morning hours, their age and sex recorded and their skulls kept for use as specimens.

The trapping lines were laid out in the basic types of habitat in the middle of meadow sections (I): in an intermediate habitat — meadow-ditch (II); along drainage ditches, in their immediate vicinity or even on the slope of the ditch (III); in shelterbelts (IV): in the reserves on peat soils (V); in reserves on mineral soils, *i.e.*, "mineral islands" (VI).

The studies made in 1977 formed a kind of reconnaissance. The trapping lines were set up in different habitats situated within the moderately wet biotope (*B*). In 1978 and 1979, however, more attention was paid to biotope diversity as regards humidity. Trapping was carried out in all three habitats: wet soil complex (*A*), moist soil complex (*B*) and semi-arid complex (*C*).

Trappability indexes (*W*) were calculated for the various areas *i.e.*, the ratio of the number of animals caught to the number of trap-nights expressed in percentages. Significance of differences between the trappability of species in different biotopes and habitats or between successive years was checked by the χ^2 test, taking the number of trap-nights (expressed as a fraction) as probability of capture.

4. RESULTS AND DISCUSSION

4.1. Distribution of Micromammalia in the Habitats

During the three study years a total of 1116 small mammals were caught, belonging to 13 species, *i.e.*, 9 species of rodents, 3 species of insectivores and 1 carnivore species (Table 1). Species caught in the greatest numbers were: *Microtus arvalis, Clethrionomys glareolus, Sorex araneus* and *Microtus oeconomus*. The following species were far rarer: *Apodemus agrarius, Sorex minutus, Sicista betulina* and *Micromys minutus*. The remaining species: *Apodemus sylvaticus, Microtus agrestis, Neomys fodiens, Mus musculus* and *Mustela nivalis* were caught sporadically only.

Four species of mammals occur over the whole of the study area: *M. arvalis* (caught in greatest numbers, 35% of the whole of the mammals caught), *M. oeconomus* (11%) and shrews — *S. araneus* (16%) and *S. minutus* (4%). The bank vole *C. glareolus*, caught in large numbers (21% of the total of mammals) occurs chiefly in the wooded reserves.

Table 1

Results of trapping of *Micromammalia* in six study habitats of the cultivated Wizna fen. n_o — number of captures, W — trappability index. For description of habitats see text.

Biotope	I		II		III		IV		V		VI		Total	
Number of trapping lines	17		8		10		6		7		4		52	
	n_o	W	n_o	W	n_o	W	n_o	W	n_o	W	n_o	W	n_o	W
Sorex araneus	25	0.5	17	0.7	11	0.4	58	3.2	57	2.7	14	1.2	182	1.2
Sorex minutus	4	0.08	3	0.1	1	0.03	13	0.7	19	0.9	7	0.6	47	0.3
Neomys fodiens	—	—	—	—	—	—	1	0.05	1	0.04	1	0.1	3	0.01
Sicista betulina	1	0.02	—	—	—	—	—	—	—	—	37	3.1	38	0.2
Mus musculus	1	0.02	—	—	1	0.03	—	—	1	0.04	—	—	3	0.01
Micromys minutus	8	0.1	—	—	2	0.01	3	0.2	2	0.1	—	—	15	0.1
Apodemus agrarius	5	0.1	—	—	—	—	42	2.3	12	0.6	10	0.8	69	0.4
Apodemus sylvaticus	1	0.02	—	—	—	—	—	—	1	0.04	7	0.6	9	0.06
Clethrionomys glareolus	1	0.02	—	—	—	—	6	0.3	223	10.6	7	0.6	237	1.5
Microtus oeconomus	2	0.04	23	0.9	21	0.7	51	2.8	22	1.0	1	0.1	120	0.8
Microtus agrestis	1	0.02	—	—	—	—	—	—	5	0.2	—	—	6	0.04
Microtus arvalis	134	2.6	122	5.1	94	3.1	14	0.8	21	1.0	1	0.1	386	2.5
Mustela nivalis	—	—	—	—	—	—	—	—	1	0.04	—	—	1	0.01
Total	183	3.6	165	6.9	130	4.3	188	10.4	365	17.4	85	7.1	1116	7.1
Trap-nights	5100		2400		3000		1800		2100		1200		15 600	

The other species were found only in certain habitats, where they sometimes form an important component of the fauna, for instance *S. betulina*, which forms 43% of the "mineral island" fauna, but only 3% of the total number of mammals caught (Fig. 1).

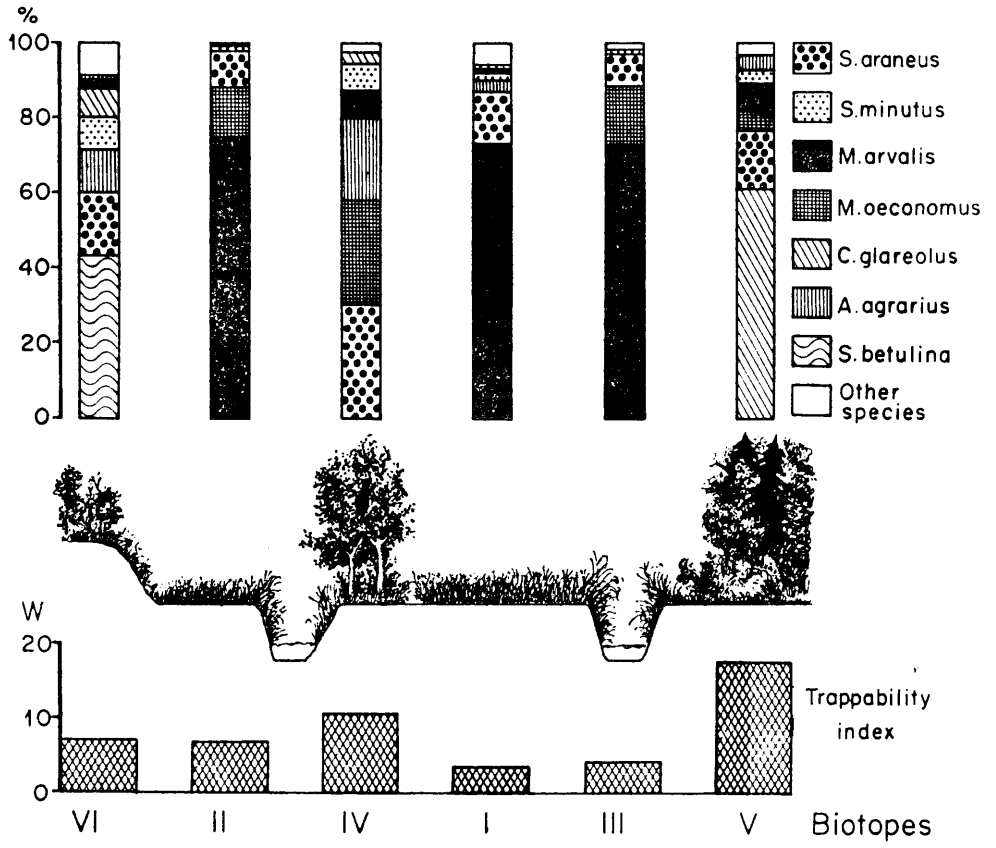

Fig. 1. Proportions of species composition and trappability indexes of *Micromammalia* in six study habitats of the cultivated Wizna fen.

4.1.1. Mammals of Meadow Habitats

M. arvalis clearly dominates among the 478 mammals caught in meadow habitats (I—III) and belonging to 11 species (Fig. 2); *S. araneus* and *M. oeconomus* were caught in far smaller numbers and the remaining eight species were only sporadically caught, particularly on the trapping lines running through the middle of the meadow sections (habitat I).

As it was expected that meadows and drainage ditches vary in value as regards ecological requirements of *Micromammalia*, and form separate

ecological niches, three variants of trapping lines were laid out: (I) through the middle of meadow sections, (II) across ditches and (III) along ditches on their slopes. In the case of variant (II) attention was always paid to differentiating between trapping sites situated near the ditch or in the meadow.

The trappability of shrews in these three meadow habitats is in proportion to the number of trap-nights, and thus does not differ to a statistically significant degree. *M. arvalis* dominates in the meadow

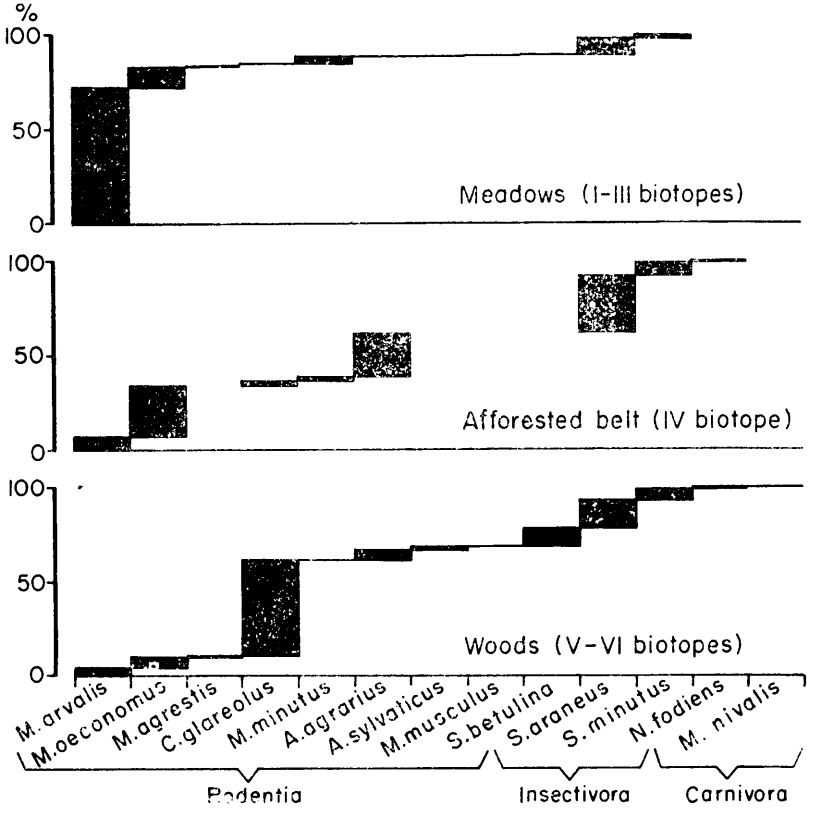

Fig. 2. Differences in the percentage of small mammals in typical habitats of the meadowland of the Wizna State Farm.

habitat, where it forms about 73% of all the mammal species caught (Fig. 2), but the trappability of this species in meadow sections (I), near drainage ditches (III) and on the dividing line between these two habitats (II) varies. A significantly differing and high trappability index occurs in habitat II, whereas in I and III trappability indexes are similar and almost half the value of that in habitat II ($\chi^2_2 = 30.147 : P \ll 0.0005$). Such differences in trappability may be due to the considerable fluctuations

in the numbers of *M. arvalis* in the three consecutive study years. As shown in Table 2, the trappability of this species varied in three meadow habitats from year to year. Data from 1977 are less reliable as only four lines were set up in that year, two of which were located in the middle of recently mown meadow sections, one near a ditch and one in an unmown meadow habitat, which is the line intersecting the drainage ditch at a right angle (line no. 9). Comparisons showed, however, a highly statistically significant difference in the trappability of *M. arvalis* between the three variants of meadow habitat and between habitats I

Table 2

Comparison of the trappability of *Microtus arvalis* in meadow habitats in three successive study years.
n_o — number of captures, n_e — number of anticipated captures on basis of proportion of trap-nights. * Difference statistically significant with $P<.05$; ** Difference statistically significant with $P<.001$ (chi-square test).

Year		Biotope I	Biotope II	Biotope III	Total	χ^2
1977	n_o (n_e)	24 (31.5)	38 (15.7)	1 (15.7)	63	47.031 **
	Trap-nights	600	300	298	1198	
	n_o (n_e)	24 (41.5)	38 (20.4)	— —	62	22.442 **
	Trap-nights	600	300	—	900	
1978	n_o (n_e)	84 (64.8)	72 (64.8)	84 (109.1)	240	12.260 *
	Trap-nights	600	900	1500	3300	
	n_o (n_e)	84 (78.0)	72 (78.0)	— —	156	0.922
	Trap-nights	900	900		1800	
1979	n_o (n_e)	26 (28.2)	12 (9.4)	9 (9.4)	47	0.908
	Trap-nights	3540	1200	1200	5940	

and II. The high trappability on the line in habitat II is undoubtedly due to the fact that it was the only trapping line situated in an unmown meadow. Comparisons are more reliable from 1978, in which 11 trapping lines were laid out, three in each of the meadow sections and the intermediate meadow-ditch habitats and five lines near the ditches. The trappability of *M. arvalis* in habitats I and II was similar that year, but was significantly lower in habitat III. In 1979, on the other hand, 20 trapping lines were laid out, but the trappability of *M. arvalis* in all three variants of meadow habitat was in proportion to the number of trap-nights. When variations in years are taken into account it may be concluded that the trappability of *M. arvalis* in meadow habitats is lowest in the vicinity of drainage ditches (habitat III).

Differences between trappability values for *M. oeconomus* in three variants of meadow habitat are highly statistically significant ($\chi_s^2 = 37.695$; $P \ll 0.0005$). The trappability index for this species is low in nabitat I, but is similar in the other two variants of meadow habitat and far higher than in habitat I.

It would seem that these two species of voles have separate ecological niches: *M. arvalis* occurs in the interior of meadow sections, and *M. oeconomus* occupies places near drainage ditches, as is particularly clear in the area set up in 1977 in the habitat intermediate between meadow and ditch (Fig. 3). The system of spatial relations between these species depends on their population density. In 1978 and 1979 *M. arvalis* was observed to spread on to the margins of drainage ditches. These were years with a drop in the numbers of the common vole in the Biebrza urtal (Raczyński *et al.*, in press). Varying proportions occur between the

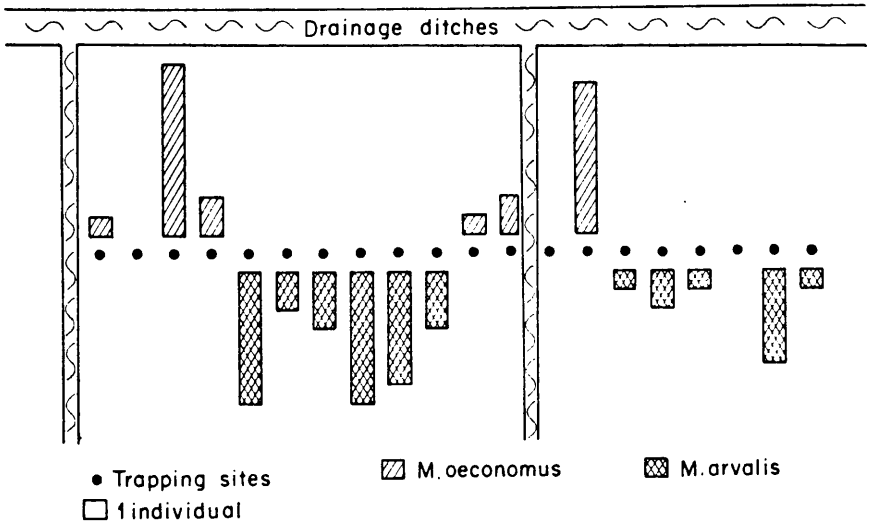

Fig. 3. Separation of ecological niches of two species of voles in meadow habitats. Captures on trapping line no. 9 laid out in 1977.

populations of *M. arvalis* and *M. oeconomus* and no equilibrium had yet been established between them, leading in consequence to the occurrence of differentiated territorial systems.

It is unfortunately not known what relations occurred in mammal fauna during the first period following reclamation of Wizna fen. There was probably an invasion of *M. arvalis*, as a species better adapted to agrocenosis conditions, and which successfullly, even though gradually, ousted *M. oeconomus* from the meadow sections. Land reclamation did not, however, bring about such drastic changes in the habitat as to make it impossible for *M. oeconomus* to persist in these areas.

Significant differences can be observed when comparing proportions in which species of small mammals were present in the meadow habitats of the cultivated Wizna fen and in the natural bog habitats of the Biebrza urtal (Raczyński *et al.*, in press). *M. oeconomus* dominates (over

60%) in the habitat typical of the lower part of the Biebrza urtal — the sedge bogs, with a considerable proportion of two species of shrews: *Sorex araneus* and *S. minutus*, and also *Micromys minutus*. In another habitat — tall-sedge peat bog occurring in the meanders of the river and the original river beds — a specific species composition was found: *M. oeconomus* dominates with a high percentage of *Apodemus agrarius*. *Micromys minutus* and the two species of shrews are also common there. *M. oeconomus*, caught in the greatest numbers in these habitats, is a species for which the optimum habitat is sedge bog of a tussocky structure (Raczyński *et al.*, in press). In the meadow habitats of Wizna fen this species occurs in the greatest numbers in the vicinity of drainage ditches, which are less exposed to human interference (cultivation operations) than the constantly mown meadow sections, and which from a wetter habitat than the sections.

Arvicola terrestris was not caught in the Wizna meadows. This species was trapped in small numbers only in the Biebrza urtal (Raczyński *et al.*, in press). It would appear that there are fairly considerable fluctuations in the numbers of *A. terrestris* in successive years, which may effect the appearance of this species in traps.

It was therefore found that the species composition of small mammals in the region of the drained meadows we examined has been altered and is poorer in species than the natural bog habitats, but is similar to the species composition of mammals occurring in the Biebrza urtal on formerly cultivated wasteland, farmed 40 years ago and then left to become wild and change into grassland. An example of this territory is the Solistowska Góra Hill in the middle basin of the Biebrza, in which *M. arvalis* dominates (over 70%) and both shrews occur (15%), while the other species form elements of the surrounding habitats. A feature of this habitat in common with the Wizna meadows is the domination of *M. arvalis*, a species connected with agrocenoses and rarely dominating in natural habitats. In the area of the Biebrza urtal the Solistowska Góra hill has non-typical fauna, but in the Wizna fen the mammal species composition found there is characeeristic of the most typical and most extensive habitat.

4.1.2. Mammals of Shelterbelts

Eight species of mammals were caught in shelterbelts (Fig. 2). Three species dominate in captures: *S. araneus*, *A. agrarius* and *M. oeconomus*, which taken together form 80% of all captures. *S. minutus* and *M. arvalis* are far less often found, while *C. glareolus*, *M. minutus* and *N. fodiens* were only occasionally found in shelterbelts (Table 1, Fig. 1).

One of the dominants in shelterbelts is the field mouse *A. agrarius*, which was encountered in greater numbers in the area of the Biebrza urtal in tall-sedge peat bogs situated near the mainstream of the river or near meanders (Raczyński *et al.*, in press). This species occupies a specific habitat in the drained bog area: the shelterbelts and edges of the wooded reserves. Most probably the presence of irrigation canals running along the edge of the reserves and the presence of shelterbelts and bushes are most important in this case, and this would explain the absence of this species near ditches of the meadow sections, although a small number of individuals of *A. agrarius* were also caught in the middle of meadow sections, which were probably migrants. It has recently been found that this is a very plastic species with considerable capacity for adapting itself to new ecological niches. This would explain the expansion of *A. agrarius* to urbanized areas (Andrzejewski *et al.*, 1978).

The shelterbelts in the Wizna State Farm land were established at different times. In 1977 and 1978 trapping was carried out in the oldest established belt in biotope *B*, and in 1978 and 1979 in the younger shelterbelts situated in biotopes *A* and *B*. Comparison of these two age categories of shelterbelts reveals a significantly higher trappability index for mammals in the younger shelterbelts ($\chi^2_1 = 8.721$; $P < 0.005$). Of the species occurring numerously in this habitat, *A. agrarius* was caught only in the younger shelterbelts. Trappability of *S. araneus*, *S. minutus* and *M. arvalis* did not exhibit any statistically significant differences in any of the shelterbelts, only the trappability of *M. oeconomus* being significantly higher in the younger shelterbelts ($\chi^2_1 = 8.569$; $P < 0.005$).

The general trappability index for mammals in shelterbelts is higher than in the meadow habitat, but lower than in the wooded reserves. Shelterbelts have a specific fauna and in addition, in our study area, form a habitat untouched by direct human interference. The high trappability index is thus not surprising, since mammals living in the meadows find a temporary shelter there during the continuous devastation of the habitat by mowing operations.

4.1.3. Mammals of the Wooded Reserves

The micromammalian fauna of different types of wooded reserves (habitats V and VI) is most diversified. A total of 13 species of mammals were found to occur (Fig. 2). The species caught in the greatest numbers is *Clethrionomys glareolus*, forming over 50% of all captures. Relatively numerous species in the forest reserves are also *S. araneus*, *M. oeconomus*, *M. arvalis*, *S. minutus*, *A. agrarius* and *S. betulina*. The remaining

species: *N. fodiens, M. musculus, A. sylvaticus, M. agrestis* and *Mustela nivalis* are only occasionally caught (Table 1).

Reserves on peat soils (habitat V) take on the character of successive growths of tree and bush species. Twelve species of mammals were caught there, of which the most numerous species is *Clethrionomys glareolus* (Table 1, Fig. 1). The species composition of the fauna in this type of reserve is thus similar to that occurring in the wooded ecosystems of the ancient Biebrza valley, except that *C. glareolus* there forms only from 30—40% in different types of treestands, that is, less than in the reserves among meadows (over 60%). The bank vole is a strongly stenotopic species and does not leave its habitat, occurring only in copses and shelterbelts in the area of Wizna State Farm.

Table 3

Trappability of *Micromammalia* in different types of wooded reserve. n_o — number of captures, W — trappability index.

Biotope	V						VI		Total	
	Thicket		Pole sized stand		Timber stand					
Number of trapping lines	1		3		1		4		9	
	n_o	W	n_o	W	n_o	W	n_o	W	n_o	W
S. araneus	3	1.0	36	4.0	8	2.7	14	1.2	61	2.2
S. minutus	1	0.3	5	0.5	5	1.7	7	0.6	18	0.7
N. fodiens	—	—	—	—	—	—	1	0.1	1	0.04
S. betulina	—	—	—	—	—	—	37	3.1	37	1.4
M. minutus	—	—	—	—	2	0.7	—	—	2	0.07
A. agrarius	—	—	—	—	—	—	10	0.8	10	0.4
A. sylvaticus	—	—	1	0.1	—	—	7	0.6	8	0.3
C. glareolus	51	17.0	75	8.3	48	16.0	7	0.6	181	6.7
M. oeconomus	—	—	2	0.2	—	—	1	0.1	3	0.1
M. arvalis	6	2.0	5	0.5	2	0.7	1	0.1	14	0.5
M. agrestis	1	0.3	2	0.2	2	0.7	—	—	5	0.2
Total	62	20.7	126	14.0	67	22.3	85	7.1	340	12.7
Trap-nights	300		900		300		1200		2700	

The high percentage of *Sorex araneus* and *S. minutus* in the treestands of the Biebrza urtal (about 60%) (Raczyński *et al.*, in press) is due to the fact that both species prefer humid areas, alder woods and bog coniferous forests. The wooded reserves of Wizna State Farm growing on peat soils can ben considered as mixed forest, in which succession of birches and willows occurs, tending towards the osier variant of bog coniferous forest. These are now treestands with three age classes: thickets, pole-sized treestand and timber stand (Table 3). It was found that the numbers of *C. glareolus*, the most numerously caught species, are similar in the thickets and timberstand. In these two age groups of

treestands capture of *C. glareolus* was in proportion to the number of trap-nights, whereas in the pole-size stand it was only half the value, the differences being highly statistically significant ($\chi^2_1 = 20.698$; $P \ll 0.0005$).

The effect of the neighbouring meadows on fauna in the wooded reserves is interesting. Comparison was therefore made of the trappability of species co-occurring on trapping lines laid out in the middle of reserves and on lines running along the edge of reserves. The general trappability indexes proved to be similar. There were no distinct differences in the numbers of *M. arvalis* and the two species of shrews on the edge and the middle of the reserve. Significantly higher trappability of *C. glareolus* was found only in the middle of the reserve ($\chi^2_1 = 4.018$; $P < 0.05$) and highly significantly higher trappability for *M. oeconomus* on the edges of the reserves ($\chi^2_1 = 43.187$; $P \ll 0.0005$). It must be emphasized that on the edge of the wooded reserves the trapping lines were laid out along the drainage ditches, that is, in a habitat preferred by *M. oeconomus*.

The fauna of the treestand on mineral soils (habitat VI) has a specific character, differing from the general picture. A total of 9 species of mammals were caught on the four trapping lines laid out in this habitat. *Sicista betulina* predominated numerically there, while species occurring fairly frequently in captures were *Sorex araneus* and *Apodemus agrarius*, whereas *C. glareolus* and *S. sylvaticus*, typically forest species, form only 8.2% of the total captures (Fig. 1). The domination of the birch mouse *S. betulina* is remarkable here, since it is a species whose existence is threatened in the larger areas altered by cultivation operations. It inhabits the alder woods, bog shrubs and pine forests growing in wet places on the edges of the Biebrza valley (Raczyński *et al.*, in press). In Poland this species still persists in less altered areas, almost exclusively in the eastern part of Poland (Pucek, in press), whereas in Europe it is in process of disappearing due to the changes taking place in the habitat. In the Wizna State Farm area the birch mouse occurs only in these places in which parts of the habitats it prefers have been preserved after draining the fen.

Among other rare species only occasionally caught in other parts of the Biebrza urtal *Muscardinus avellanarius* was never found to occur in the reclaimed Wizna fen. The occurrence of *Microtus agrestis*, an equally rare species but not included in the list of species protected by law, must be recorded. It has been found in places all over Poland, but is never a dominating species in this country. It occurs in the Biebrza urtal in places in which it encounters less competition from *M. oeco-*

nomus, that is, chiefly in bog alder and birch forests (Raczyński *et al.*, in press).

4.2. Effect of Cultivation Operations on Mammal Fauna

In order to examine the effect of the most important cultivation operation — systematic mowing of grass — trappability indexes were compared on recently mown meadows with slight regrowth of grasses, and on meadows as yet unmown with highest regrowth of grass, and near ditches surrounded by mown and as yet unmown meadows. Three species, most typical and most numerously caught in the meadow and drainage ditch habitat, were chosen for comparison (Table 4).

Table 4

Effect of mowing meadow sections on *Micromammalia* fauna. Symbols as in Tables 1 and 2. Biotope III means drainage ditches near mown or unmown meadows.

	Biotope I (meadows)					Biotope III (drainage ditches)				
	Unmown		Mown		χ^2	Unmown		Mown		χ^2
	n_o	W	n_o	W		n_o	W	n_o	W	
S. araneus	30	1.14	12	0.23	0.572	3	0.25	4	0.27	0.004**
M. oeconomus	24	0.91	1	0.02	42.826**	—	—	19	1.27	—
M. arvalis	69	2.61	187	3.67	5.832*	9	0.75	84	5.61	44.463**
All species	135	5.11	213	4.18	3.398	15	1.25	108	7.21	50.495**
Trap-nights		2640		5100			1200		1498	

The general trappability index on mown meadows is lower than on those as yet unmown, but the difference is not statistically significant. The difference in trappability on ditches surrounded by mown and unmown meadows, however, is significant and very great for ditches near mown meadows. Among the three mammal species compared it is only *S. araneus* which does not react to mowing of meadows by a drop in numbers, this applying to both meadows and ditches. Mowing meadows exerts the greatest effect on the population of *M. oeconomus* — after a meadow has been mown the numbers of this species abruptly decrease in relation to those in meadows as yet unmown. This species is caught in considerable numbers near ditches surrounded by mown meadows, but does not occur near ditches surrounded by meadows as yet unmown. Mowing meadows affects the trappability of *M. arvalis* to a lesser degree, but even so the differences between mown and unmown meadows are statistically significant. On the other hand, however, mowing the meadows results in increase in the numbers of *M. arvalis* near neighbouring ditches (Table 4).

As the slopes of ditches are not so frequently mown as the meadow sections it may be assumed that they are of importance to the community of species inhabiting the meadow areas, and that the use made of them depends on the intensity of use made of the meadows.

The fact that there are no significant differences between the general trappability index for mammals on mown and unmown meadows may be connected with the participation of *S. araneus*, a species not affected by mowing, and with the fact that mown meadows represented different stages of resettlement of the meadow sections by mammals when mowing had been completed. Systematic mowing of the meadows causes intensified local migrations. The mammals undoubtedly migrate to the

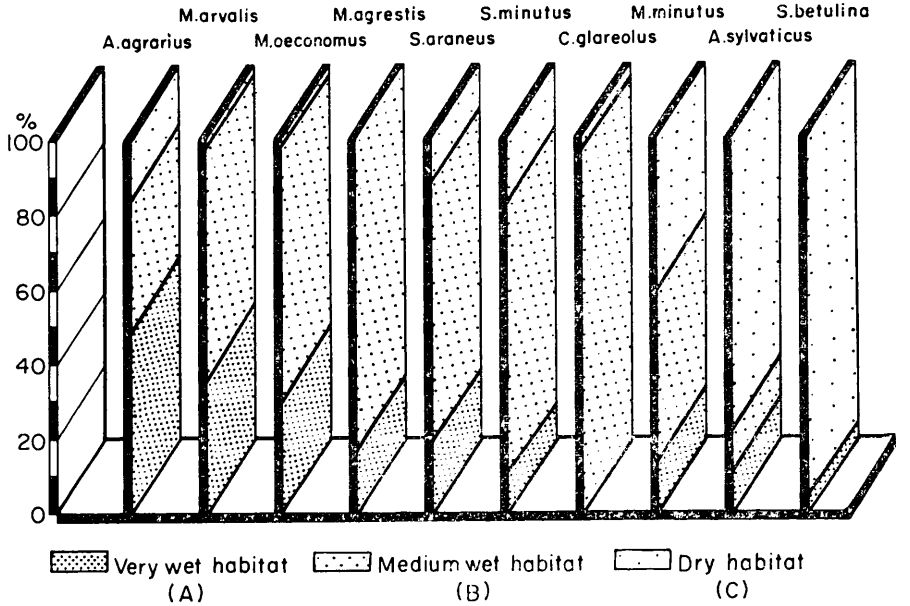

Fig. 4. Results of trapping of *Micromammalia* in six study habitats of the cultivated Wizna fen.

n_o — number of captures, W — trappability index. For description of habitats see text.

adjacent unmown sections, while the drainage ditches form a "refuge" for the animals during the period when both neighbouring meadow sections are mown.

4.3. The Effect of Biotope Humidity on Distribution of Mammals

As a whole a wet biotope (*A*) was decidedly preferred to all the other habitats by *A. agrarius* only, and the semi-arid soil complex (*C*) by two species: *A. sylvaticus* and *S. betulina* (Fig. 4). The greatest number of species prefer the habitat with intermediate humidity (*B*).

Examination was made of the trappability of mammal species caught in the greatest numbers in meadows and near drainage ditches in three biotopes. The most typical species, *M. arvalis*, occurred in practically the same numbers in biotopes *A* and *B*, whereas only 3 individuals of this species were caught in biotope *C*, with expected number of captures of 66.5. *M. oeconomus* was caught in larger numbers in biotope *B*, only 2 individuals were caught in biotope *A*, while this species did not occur at all in biotope *C*. *S. araneus*, on the other hand, inhabits all three biotopes in equal numbers. The remaining species were caught in only

Table 5

Comparison of trappability of *Micromammalia* in biotopes of differing degrees of humidity. Symbols as in Table 2.

Biotypes	Year		Very wet habitat *(A)*	Medium wet habitat *(B)*	Dry habitat *(C)*	χ^2
I Meadows	1978	n_o (n_e)	86 (83.5)	81 (83.5)	— —	0.149
		W	9.5	9.0	—	
		Trap-nights	900	900	—	
	1979	n_o (n_e)	55 (24.0)	3 (24.0)	22 (32.0)	61.542**
		W	3.7	0.2	1.1	
		Trap-nights	1500	1500	2040	
	1979	n_o (n_e)	55 (32.6)	— —	22 (44.4)	26.621**
III Drainage ditches	1978	n_o (n_e)	10 (20.4)	92 (81.6)	— —	6.627*
		W	3.3	7.7	—	
		Trap-nights	300	1200	—	
	1979	n_o (n_e)	7 (4.5)	2 (4.5)	— —	2.778
		W	1.2	0.3	—	
		Trap-nights	600	600	—	
IV Afforested shelter belt	1978	n_o (n_e)	65 (68.7)	38 (34.3)	— —	0.586
		W	10.8	12.7	—	
		Trap-nights	600	300	—	
	1979	n_o (n_e)	51 (37.5)	24 (37.5)	—	9.720*
		W	17.0	8.0	—	
		Trap-nights	300	300	—	

small numbers in the meadows. It is clear from the foregoing that the different species of mammals were caught most numerically in the meadows of biotope *B*, which is due to the greatest number of trapping lines laid out there.

Assuming that the degree of humidity of the biotope may exert a different influence on the population density of small mammals in different habitats, comparison was made of the trappability of all mammal species jointly in analogical habitats of biotopes with different degree of humidity (Table 5). It was not possible to take material from 1977 into account in these comparisons, as trapping was carried out that year only in biotope *B*. There are also no data available for comparison of wooded reserves.

Significant differences in trappability occurred in the meadows in 1979, when maximum trappability was found in biotope *A* and lowest in biotope *B*. The differences between biotopes *A* and *C* are also highly statistically significant. The same year trappability of mammals in shelterbelts was statistically significantly higher in biotope *A* than *B*, whereas trappability of mammals near ditches separating the wooded reserves from meadows did not differ that year in biotopes *A* and *B*.. Trappability of mammals near the remaining ditches was also similar in the two biotopes. In 1978 trappability of mammals near drainage ditches differed significantly — in biotope *B* it was more than twice higher than in biotope *A*. There were no differences in trappability of mammals in the other habitats compared.

The above comparisons point to the absence of a direct relation between the degree of humidity of a biotope and density of mammals. The kind of soil is certainly not a factor significantly altering the possibility of settlement of the area by mammals, whereas the character of the vegetation covering the area is of greater importance.

4.4. Variations in the Number of Mammals during the 3-year Study Period

In long-term studies it is necessary to take into consideration the effect of phases of the population cycle on the number of mammals in different habitats. Long-term studies are, however, only exceptionally carried out in a given area and for practical reasons descriptions are prepared on the basis of samples collected during short time intervals. We had at our disposal collections from three consecutive autumn seasons. In autumn the density of the mammal populations is close to the maximum values in a given year, which makes it possible to obtain more numerous series of material. Data from successive years enable conclusions to be drawn as to the phase of the population cycle of the species caught in greatest numbers.

In years when population numbers of a given species are low it must be borne in mind that the area of its occurrence may be narrowed down to optimum habitats, whereas in years of population peaks the given species becomes common and often appears in non-typical habitats (Aulak, 1970).

In the studies made the mammals were caught on standard trapping lines (with 20 trapping sites in each), with the same arrangement of traps. The results of trapping can thus be treated as a relative measure of the density of the population. In three successive years a different number of trapping lines were laid out in different habitats, and consequently species caught in larger numbers were analyzed in three

typical habitats: meadow (I, II, III), shelterbelts (IV) and in wooded reserves (V and VI) (Table 6).

In meadow habitats and in reserves the trappability of *S. araneus* varied within narrow limits, greater fluctuations in the trappability of this species being found only in shelterbelts. In successive years the trappability index decreases, but the differences are not statistically significant. The numbers of the dominating species, *M. arvalis*, are subject

Table 6

Varations in density of the mammals species caught in greatest numbers in typical habitats during successive study years.
n_o — number of captures, W — trappability index.

Species	Year	I—III biotopes		IV biotopes		V—VI biotopes	
		n_o	W	n_o	W	n_o	W
S. araneus	1977	9	0.7	3	1.0	24	2.0
	1978	18	0.5	36	4.0	—	—
	1979	26	0.4	19	3.2	47	2.6
	Total	53		58		71	
C. glareolus	1977	—	—	2	0.7	199	16.6
	1978	—	—	—	—	—	—
	1979	—	—	4	0.7	31	1.7
	Total	—		6		230	
M. oeconomus	1977	35	2.9	1	0.3	22	1.8
	1978	9	0.3	41	4.5	—	—
	1979	2	0.03	9	1.5	1	0.05
	Total	46		51		23	
M. arvalis	1977	63	5.2	2	0.7	21	1.7
	1978	240	7.3	9	1.0	—	—
	1979	47	0.8	3	0.5	1	0.05
	Total	350		14		22	
Trap-nights	1977	1198		300		1200	
	1978	3300		900		—	
	1979	5940		600		1800	
	Total	10438		1800		3000	

to considerable variations in the meadow habitat. High trappability indexes were recorded, for the first two years, after which the trappability of this species abruptly decreased in the third study year. The numbers of the second species typical of these habitats — *M. oeconomus* — gradually decreased over the 3-year study period, reductions in trappability in successive years being very great. Both these species of voles in the shelterbelts were characterized by maximum numbers in 1978, while in other years the numbers of voles in this habitat were very small. In the wooded reserves in 1977 the numbers of the dominating species, the bank vole, were very high and the numbers of the two species of vole *M. oeconomus* and *M. arvalis*, were higher than in 1979.

Distinct decreases in trappability indexes for mammals in the study

habitats over the 3-year study period show that the studies were probably carried out during a period of decrease in the population of the species caught in greatest numbers.

5. CONCLUSIONS

(1) As a consequence of reclaiming fen land degredation of small mammal communities takes place, expressed in impoverishment af the species composition in relation to the fauna of natural bog habitats. *Microtus arvalis*, a species typical of cultivated fields, appears in the fauna of meadow habitat mammals after land reclamation. The occurrence of rare and protected species of mammals is limited to marginal habitats, while the population numbers of these species are low in the central areas.

(2) Systematic mowing of meadows over large areas results in temporary increase in the density of *Micromammalia* populations in neighbouring meadow sections or near drainage ditches.

(3) Shelterbelts and wooded reserves of different types left in the state farm territory and excluded from cultivation are of importance to *Micromammalia* fauna in the study area of cultivated meadows, since they form permanent refuges for the relics of natural bog fauna.

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Elżbieta MALZAHN i Stanisław FEDYK

MICROMAMMALIA ZAGOSPODAROWANEGO BAGNA WIZNA

Streszczenie

Zbadano rozmieszczenie *Micromammalia* w sześciu podstawowych typach środowisk roślinnych na terenie jednolicie zmeliorowanego i zagospodarowanego jako łąki torfowiska niskiego Wizna. Na 52 liniach odłownych w ciągu trzech lat jesienią złowiono 1116 okazów ssaków, należących do 13 gatunków (Tabela 1). Tylko 4 gatunki występują we wszystkich badanych środowiskach (*Microtus arvalis, M. oeconomus, Sorex araneus* i *S. minutus*). Najliczniej odławianymi gatunkami są *Microtus arvalis, Clethrionomys glareolus, Sorex araneus* oraz *Microtus oeconomus*. Skład gatunkowy ugrupowań ssaków i proporcje udziału gatunków są charakterystyczne dla poszczególnych środowisk (Ryc. 1).

W środowiskach łąkowych dominuje *M. arvalis* (>70% złowień), a w pasach zadrzewień między kwaterami łąkowymi 80% złowień stanowią razem *Sorex araneus, Apodemus agrarius* i *Microtus oeconomus* (Ryc. 2). Analizowano zależność między dwoma najliczniej odławianymi nornikami — *M. arvalis* i *M. oeconomus* — pod względem zajmowania nisz ekologicznych w środowiskach łąkowych (Tabela 2, Ryc. 3). Systematyczne koszenie kwater łąkowych powoduje czasowe, lokalne migracje ssaków na sąsiednie kwatery oraz na pobocza rowów melioracyjnych (Tabela 4). W środowiskach leśnych, tj. w różnego typu rezerwatach wyłączonych spod zagospodarowania, stwierdzono najbardziej zróżnicowaną faunę ssaków, wśród których dominuje *Clethrionomys glareolus* lub *Sicista betulina* (Tabela 3). Stanowią one stałe refugia reliktów naturalnej fauny bagiennej.

Ogółem we wszystkich środowiskach większość gatunków ssaków preferuje siedlisko wilgotne (Ryc. 4), natomiast porównanie łowności ssaków w analogicznych środowiskach trzech siedlisk o różnej wilgotności wskazuje na brak bezpośredniej zależności między stopniem wilgotności siedliska a liczebnością ssaków (Tabela 5). Wyraźne obniżenie wskaźników łowności ssaków w badanych środowiskach wskazuje, że badania były prowadzone w czasie spadku liczebności populacji najliczniej odławianych gatunków (Tabela 6).

Faunę ssaków typowych środowisk gospodarstwa łąkarskiego „Wizna" porównywano z fauną sąsiednich naturalnych środowisk bagiennych pradoliny Biebrzy, wnioskując o degradacji zespołów drobnych ssaków w następstwie melioracji bagna.