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Small mammals in natural and agricultural lands of Slobozhanshchyna (eastern Ukraine): results of a five-year-long survey

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abstract

The study of the species composition, biological and ecological features of small mammals was carried out for five years (2018–2022) in the surroundings of the village of Rozsohuvata (Kharkiv Oblast, Ukraine). During the study period, nine species of mouse-like rodents and three species of insectivorans were detected. The research area is represented by a ravine-beam system, agrocoenoses, field-protecting forest strips, riparian vegetation around artificial reservoirs and streams, dry meadows, and pastures. Trappings of small mammals were carried out on thirty lines of traps. During the entire period of trapping, the dominant species was *Sylvaemus uralensis* and in some seasons *Sylvaemus sylvaticus* dominated. Starting from 2018, the relative abundance increased in autumn, reached a peak in 2020 and declined in the following years. In general, 2019 was the year of maximum abundance and most species were recorded in the summer of this year. The greatest number of species was found in the ecotone between riparian vegetation and field (10 species), as well as in the area of the multi-grass steppe in the beam (8 species). The eurytopic species include *Sylvaemus uralensis* and *Sylvaemus sylvaticus*, whereas the stenotopic species is *Mus spicilegus*. According to the obtained abundance scores, only one species—*Myodes glareolus*—occurs randomly, whereas the rare species here are *Mus spicilegus, Sorex minutus*, and *Crocidura suaveolens*. Six species are non-abundant: *Apodemus agrarius, Sylvaemus tauricus, Mus musculus, Microtus levis, Cricetulus migratorius,* and *Sorex araneus*. Only *Sylvaemus sylvaticus* belongs to common species, and only *Sylvaemus uralensis* is abundant. It should be mentioned that *Cricetulus migratorius*, which usually belongs to the category of random or rare species, turned out to be non-abundant in the study region, and it was recorded regularly in almost half of the studied biotopes. *Myodes glareolus*, which usually prefers oak forest, was extremely rare. The abundance of *Apodemus agrarius*, which usually belongs to common species in river valleys, was also low. *Sylvaemus* showed greater ecological valence, dominated in abundance and inhabited most biotopes, except for *Sylvaemus tauricus*, which began to occur only in the last two years and mainly in forest strips.

Дрібні ссавці природних та агроландшафтів Слобожанщини (східна Україна): результати п'ятирічного моніторингу

Оксана Марковська

Резюме. Дослідження видового складу, особливостей біології та екології дрібних ссавців в околицях с. Розсохувата проводили протягом п'яти років (2018–2022 рр.). За період дослідження було виявлено дев'ять видів мишоподібних гризунів та три види комахоїдних. Територія досліджень представлена яруго-балковою системою, агроценозами, полезахисними лісосмугами, прибережно-водною рослинністю навколо штучних водоймищ та струмків, суходільними луками та пасовищами. В околицях с. Розсохувата було відпрацьовано 30 ліній пасток. Протягом всього періоду лову, домінуючим видом був мишак уральський і в окремі сезони домінував мишак європейський. Починаючи з 2018 року восени відносна чисельність зростала, досягла піку в 2020 році і в наступні роки пішла на спад. Загалом, 2019 рік був роком максимальної чисельності і більшість видів була зафіксована саме влітку цього року. Найбільша кількість видів виявлена в екотоні прибережно-водної рослинності та поля (10 видів), а також на ділянці різнотравно-типчакового степу в балці (8 видів). До евритопних видів належать мишаки уральський та європейський, до стенотопних – миша курганцева. Відповідно до отриманих балів рясноти, до випадкових видів належить лише один вид – нориця руда; до рідкісних відноситься три види – миша курганцева, мідиця мала та білозубка мала; до категорії нечисельних потрапило шість видів – житник пасистий, мишак жовтогрудий, миша хатня, полівка лучна, хом'ячок сірий та мідиця звичайна; до звичайних видів належить лише мишак європейський, як і до чисельних – лише мишак уральський. Варто зазначити, що хом'ячок сірий який зазвичай входить до категорії випадкових або рідкісних, на дослідженій території потрапив до категорії нечисельних, адже дійсно зустрічався регулярно і майже в половині досліджених біотопів. Нориця руда, яка зазвичай надає перевагу дібровам, зустрічалася вкрай рідко. Низькою була і чисельність житника пасистого, який в долинах рік зазвичай належить до звичайних видів. Мишаки показали більшу екологічну валентність, домінували за чисельністю і заселяли більшість біотопів, окрім мишака жовтогрудого, який почав траплятися лише останні два роки і переважно в лісосмугах.

Ключові слова: дрібні ссавці, відносна чисельність, біотопічна преференція, видовий склад, багаторічний моніторинг, категорія рясноти.

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Introduction

In recent years, agriculture has increasingly affected biodiversity [Bullock *et al.* 2007, Kostyushyn & Kostyushyn 2012]. Farmers reclaim every free piece of land from nature, reduce the width of the field protection forest strips to a minimum, plough up beam slopes and pastures. Pesticides kill many non-target animals every year [Patyka *et al.* 2003; Dudley *et al.* 2017]. The norms of land use have changed—immediately after harvesting, the fields are ploughed and prepared for the next sowing thus neither stubble nor crop residue remains in the fields. Haystacks, which used to serve as a shelter for many small mammals in the winter, have not been located in the fields for a long time [Naglov & Tkach 1998].

The study of areas with a considerable agricultural load is of great importance [Barral *et al.* 2015]. Often in such places we can find a number of rare species that have survived in fragmented pieces of natural lands, or have adapted to the anthropogenic environment [Fischer *et al.* 2008]. It is no less interesting to research the usual widespread species, the features of their use of available habitats, the influence of agricultural crops on their diet and abundance [Naglov & Tkach 2002]. In addition, the monitoring of small mammals in such areas has considerable epidemiological significance for predicting a number of epizootics [Naglov 2010; Zorya 2015]. After all, when their abundance increase, mouse-like rodents often flood granaries and human dwellings.

The aim of this research was to study the species composition of small mammals in natural and agricultural lands of eastern Ukraine, the biotopic preferences of species and fluctuations of their populations.

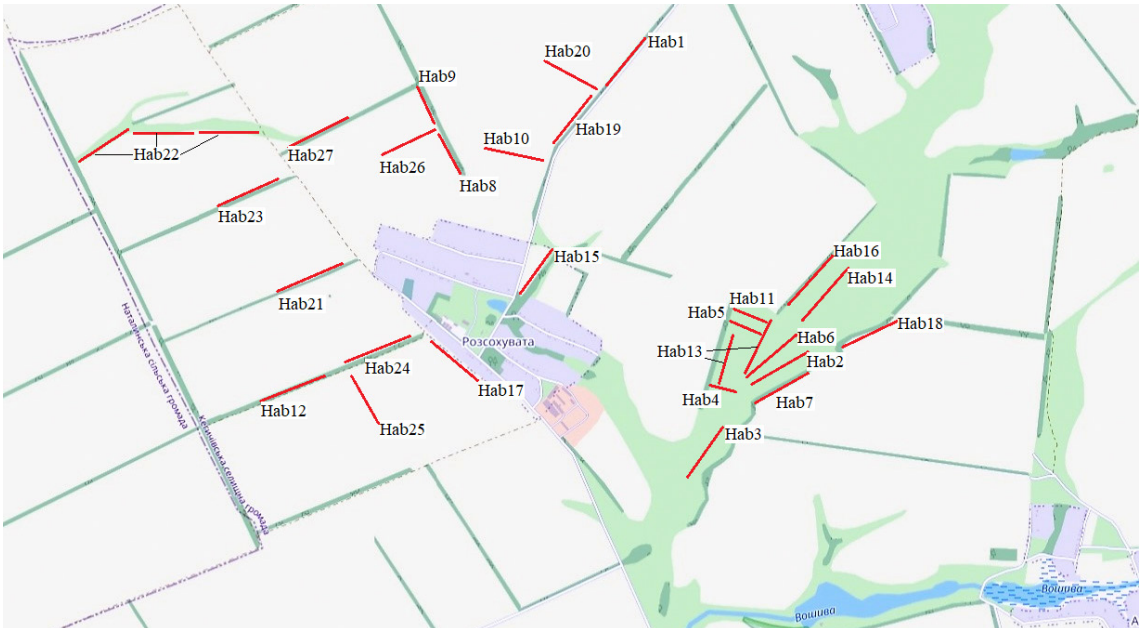

Fig 1. Studied habitats in the surroundings of Rozsohuvata: Hab1, Hab7, Hab12—field protection forest strip; Hab2—dry meadows; Hab3—riparian vegetation/floodplain meadows; Hab4—a ravine on a clay slope; Hab5—multi-grass steppe/field; Hab6—bottom of beam; Hab8, Hab9, Hab17, Hab18, Hab19, Hab21, Hab23, Hab24, Hab27—field protection forest strip/field; Hab10, Hab11—field; Hab13, Hab14—multi-grass steppe; Hab15—dry meadows/field; Hab16—field protection forest strip/multi-grass steppe; Hab20, Hab25, Hab26—on the border of fields and different crops; Hab22—riparian vegetation/field.

Рис. 1. Досліджені біотопи в околицях с. Розсохувата: Hab1, Hab7, Hab12 — полезахисна лісосмуга; Hab2 — суходільні луки; Hab3 — прибережно-водна рослинність/заплавні луки; Hab4 — яр на глинистому схилі; Hab5 — різнотравно-типчаковий степ/поле; Hab6 — дно балки; Hab8, Hab9, Hab17, Hab18, Hab19, Hab21, Hab23, Hab24, Hab27 — полезахисна лісосмуга/поле; Hab10, Hab11 — поле; Hab13, Hab14 — різнотравно-типчаковий степ; Hab15 — суходільні луки/поле; Hab16 — полезахисна лісосмуга/різнотравно-типчаковий степ; Hab20, Hab25, Hab26 — на межі полів з різними посівами; Hab22 — прибережно-водна рослинність/поле.

Materials and Methods

The research was conducted over a period of five years, from the spring of 2018 to the autumn of 2022. Field studies were carried out in vicinities of the village of Rozsohuvata, in Krasnograd Raion, Kharkiv Oblast, Ukraine. The surveyed habitats included a ravine–beam system, agrocoenoses, field protecting forest strips, riparian vegetation around artificial reservoirs and streams, dry meadows, and pastures.

Trappings were carried out on 30 trap-lines in various habitats (Fig. 1) using spring-loaded bar traps [Numerov *et al.* 2010]. 25/50/75/100/150 traps were placed in a line, trapping was carried out for one night in each habitat. Trapping was carried out, if possible, three times a year—in spring, summer, and autumn. In total, 30 trap-lines were placed, and with a trapping effort of 4900 trap-nights (Table 1) 380 individuals of small mammals were caught. The taxonomy and nomenclature of species follows [Zagorodniuk & Emelianov 2012].

Table 1. **Surveyed habitats in various seasons in 2018–2022**
Таблиця 1. **Досліджені біотопи у різні сезони 2018–2022 рр.**

Date	Surveyed habitat	Type of habitat	Trapping effort
Spring, 2018	Hab1	field protection forest strip	100
	Hab2	dry meadows on the steep beam slope	50
	Hab3	riparian vegetation/floodplain meadow ecotone	50
Autumn, 2018	Hab4	gradual clay beam slope	25

Date	Surveyed habitat	Type of habitat	Trapping effort
	Hab5	harvested wheat field/multi-grass steppe ecotone	50
	Hab6	floodplain meadows at the bottom of the beam	25
	Hab7	field protection forest strip	25
	Hab8	field protection forest strip/beet field ecotone	25
	Hab9	field protection forest strip/sunflower field ecotone	25
	Hab10	maize filed	25
Spring, 2019	Hab2	dry meadows on the steep beam slope	25
	Hab4	gradual clay beam slope	25
	Hab5	harvested wheat field/multi-grass steppe ecotone	25
	Hab6	floodplain meadows at the bottom of the beam	25
	Hab11	harvested wheat field	25
	Hab12	field protection forest strip	100
	Hab13	multi-grass steppe	25
	Hab14	multi-grass steppe	50
Summer, 2019	Hab2	dry meadows on the steep beam slope	100
	Hab3	riparian vegetation/floodplain meadow ecotone	50
	Hab13	multi-grass steppe	100
	Hab14	multi-grass steppe	100
	Hab15	wheat field/dry meadow ecotone	50
	Hab16	field protection forest strip/multi-grass steppe ecotone	50
	Hab17	field protection forest strip/harvested wheat field ecotone	50
	Hab18	field protection forest strip/harvested wheat field ecotone	50
Autumn, 2019	Hab2	dry meadows on the steep beam slope	50
	Hab5	harvested sunflower field/multi-grass steppe ecotone	25
	Hab13	multi-grass steppe	75
	Hab14	multi-grass steppe	25
	Hab18	field protection forest strip/harvested wheat field ecotone	25
Summer, 2020	Hab13	multi-grass steppe	100
	Hab17	field protection forest strip/sunflower field ecotone	100
	Hab19	field protection forest strip/harvested barley field ecotone	50
	Hab20	harvested barley field/sunflower field ecotone	50
Autumn, 2020	Hab21	field protection forest strip/beet field ecotone	100
	Hab22	riparian vegetation/harvested wheat field ecotone	400
Spring, 2021	Hab2	dry meadows on the steep beam slope	50
	Hab5	harvested wheat field/multi-grass steppe ecotone	50
	Hab13	multi-grass steppe	50
	Hab17	field protection forest strip/wheat field ecotone	100
	Hab21	field protection forest strip/harvested beet field ecotone	50
	Hab22	riparian vegetation/harvested wheat field ecotone	50
	Hab23	field protection forest strip/harvested wheat field ecotone	50
	Hab24	field protection forest strip/wheat field ecotone	50
Summer, 2021	Hab2	dry meadows on the steep beam slope	50
	Hab13	multi-grass steppe	50
	Hab17	field protection forest strip/wheat field ecotone	100
	Hab21	field protection forest strip/maize field ecotone	100
	Hab22	riparian vegetation/maize field ecotone	50
	Hab24	field protection forest strip/wheat field ecotone	50
	Hab25	wheat field/maize field ecotone	50
Autumn, 2021	Hab2	dry meadows on the steep beam slope	75
	Hab5	harvested maize field/multi-grass steppe ecotone	75
	Hab13	multi-grass steppe	150
	Hab17	field protection forest strip/harvested wheat field ecotone	75
	Hab21	field protection forest strip/harvested maize field ecotone	300
	Hab22	riparian vegetation/harvested maize field ecotone	150
	Hab24	field protection forest strip/harvested wheat field ecotone	75
	Hab26	harvested maize field/sunflower field ecotone	150
Summer, 2022	Hab13	multi-grass steppe	50
	Hab14*	multi-grass steppe	150
	Hab21	field protection forest strip/wheat field ecotone	100
Autumn, 2022	Hab8	field protection forest strip/harvested sunflower field ecotone	100
	Hab17	field protection forest strip/harvested wheat field ecotone	50
	Hab21	field protection forest strip/harvested wheat field ecotone	100
	Hab24	field protection forest strip/maize field ecotone	50
	Hab27	field protection forest strip/sunflower field ecotone	100

Note: * In 2020, a large part of the slope of the surveyed beam was ploughed, so Hab14 bordered a wheat field in the summer of 2022.

Results and Discussion

Species composition

In the course of the study, 12 species of small mammals belonging to 4 families were found in the surveyed habitats:

- Family Muridae Illiger, 1811: striped field mouse (*Apodemus agrarius* Pallas, 1771), Ural wood mouse (*Sylvaemus uralensis* Pallas, 1811), European wood mouse (*Sylvaemus sylvaticus* Linnaeus, 1758), yellow-necked wood mouse (*Sylvaemus tauricus* Pallas, 1811), house mouse (*Mus musculus* Linnaeus, 1758), mound-building mouse (*Mus spicilegus* Petenyi, 1882);
- Family Arvicolidae Gray, 1821: bank vole (*Myodes glareolus* Schreber, 1780), southern vole (*Microtus levis* Miller, 1908);
- Family Cricetidae Fischer, 1817: grey hamster (*Cricetulus migratorius* Pallas, 1773);
- Family Soricidae Fisher, 1821: lesser white-toothed shrew (*Crocidura suaveolens* Pallas, 1811), common shrew (*Sorex araneus* Linnaeus, 1758), Eurasian pygmy shrew (*Sorex minutus* Linnaeus, 1766).

Dominance structure and relative abundance of species

The monitoring of small mammals in the surroundings of Rozsohuvata was carried out from the spring of 2018 to the autumn of 2022, but in the summer of 2018, the spring of 2020 and the spring of 2022, no trapping was carried out (Tables 2–3).

During the entire trapping period, the dominant species was *Sylvaemus uralensis*, and in some seasons *Sylvaemus sylvaticus* dominated (Tables 2–3). The system of dominance remained unchanged, despite the annual fluctuations in the abundance of small mammals. If we consider only the autumn relative abundance, when the abundance of rodents is usually the highest, we can see that starting from 2018 it increased, reached a peak in 2020 and declined in the following years (Fig. 2). In general, 2019 was the year of maximum abundance and most species were recorded in the summer of this year (Table 2). In the autumn of 2020, shrews, which were found in most habitats, made up a large part of the individuals caught.

Table 2. **Dynamics of trapping of small mammals by seasons in 2018–2020 in the surroundings of Rozsohuvata**

Таблиця 2. **Динаміка відлову дрібних ссавців за сезонами у 2018–2020 рр. в околицях с. Розсохувата**

Species	Spring 2018		Autumn 2018		Spring 2019		Summer 2019		Autumn 2019		Summer 2020		Autumn 2020	
	n	*N*	*n*	*N*	*n*	*N*	*n*	*N*	*n*	*N*	*n*	*N*	*n*	*N*
Apodemus agrarius	–	–	–	–	–	–	6	1.1	1	0.5	–	–	–	–
Sylvaemus uralensis	–	–	5	2.5	15	5.0	43	7.8	15	7.5	8	2.7	24	4.8
Sylvaemus sylvaticus	1	0.5	1	0.5	5	1.7	13	2.4	11	5.5	1	0.3	29	5.8
Sylvaemus tauricus	–	–	–	–	–	–	–	–	–	–	–	–	–	–
Mus musculus	–	–	–	–	–	–	2	0.4	–	–	1	0.3	6	1.2
Mus spicilegus	–	–	–	–	3	1.0	3	0.5	–	–	1	0.3	–	–
Microtus levis	–	–	–	–	–	–	2	0.4	5	2.5	–	–	1	0.2
Myodes glareolus	–	–	–	–	–	–	2	0.4	–	–	–	–	–	–
Cricetulus migratorius	–	–	–	–	1	0.3	2	0.4	–	–	1	0.3	1	0.2
Sorex araneus	–	–	1	0.5	–	–	8	1.5	–	–	–	–	6	1.2
Sorex minutus	–	–	–	–	–	–	2	0.4	–	–	–	–	6	1.2
Crocidura suaveolens	–	–	–	–	–	–	–	–	–	–	–	–	10	2.0
Total	1	0.5	7	3.5	24	8.0	83	15.1	32	16.0	12	4.0	83	16.6

Note: *N*—relative abundance; $N = n \times 100/D$, where *n*—number of trapped individuals, *D*—trapping effort [Numerov *et al.* 2010].

Table 3. **Dynamics of trapping of small mammals by seasons in 2021–2022 in the surroundings of Rozsohuvata**
Таблиця 3. **Динаміка відлову дрібних ссавців за сезонами у 2021–2022 рр. в околицях с. Розсохувата**

Species	Spring 2021		Summer 2021		Autumn 2021		Summer 2022		Autumn 2022	
	n	*N*	*n*	*N*	*n*	*N*	*n*	*N*	*n*	*N*
Apodemus agrarius	–	–	–	–	2	0.2	–	–	3	0.8
Sylvaemus uralensis	3	0.7	6	1.3	37	3.5	9	3.0	5	1.3
Sylvaemus sylvaticus	2	0.4	2	0.4	10	1.0	5	1.7	7	1.8
Sylvaemus tauricus	–	–	4	0.9	4	0.4	3	1.0	3	0.8
Mus musculus	–	–	1	0.2	13	1.2	–	–	–	–
Mus spicilegus	–	–	–	–	1	0.1	–	–	–	–
Microtus levis	–	–	–	–	3	0.3	–	–	1	0.3
Myodes glareolus	–	–	–	–	–	–	–	–	1	0.3
Cricetulus migratorius	1	0.2	–	–	5	0.5	1	0.3	–	–
Sorex araneus	–	–	–	–	2	0.2	–	–	–	–
Sorex minutus	–	–	–	–	3	0.3	–	–	–	–
Crocidura suaveolens	–	–	–	–	1	0.1	–	–	–	–
Total	6	1.3	13	2.9	81	7.7	18	6.0	20	5.0

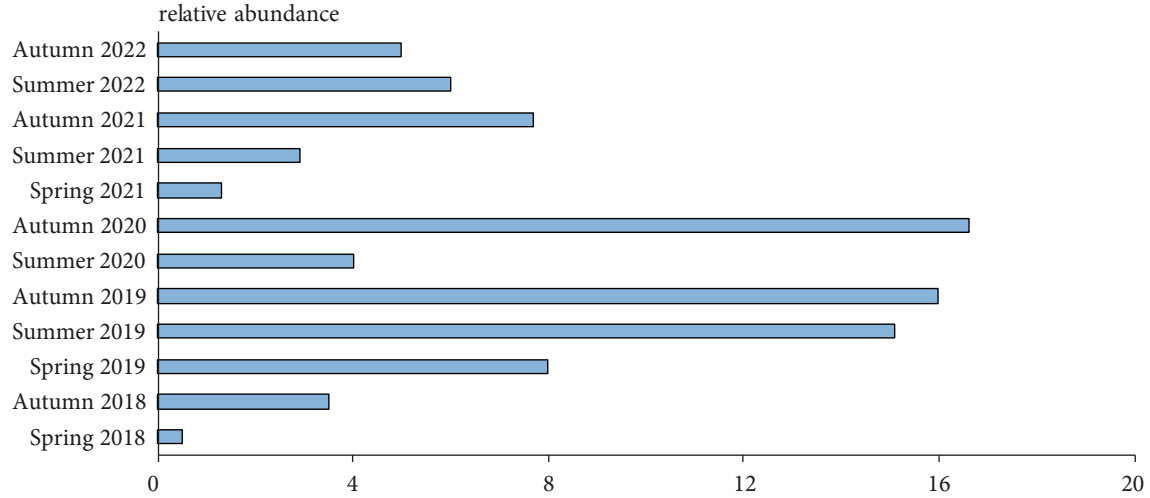

Fig. 2. The relative abundance (individuals/100 trap-nights) of small mammals during 2018–2022.
Рис. 2. Динаміка чисельності дрібних ссавців протягом 2018–2022 рр.

Distribution of small mammals in the studied habitats

The relative abundance in the spring of 2018 was minimal (Table 4), only one *Sylvaemus sylvaticus* was found in the field protection forest strip.

In the autumn of 2018, the abundance was still low, not a single individual was recorded in Hab9 and Hab10, and only three species occurred in other habitats, mainly *Sylvaemus uralensis*.

In the spring of 2019, not a single individual occurred in Hab6, in other habitats *Sylvaemus uralensis* prevailed. In wheat filed harvested in the previous year, two mounds were found and three *Mus spicilegus* were captured, and *Cricetulus migratorius* was found in the steppe.

In the summer of 2019, ten species were recorded, with the dominance of *Sylvaemus uralensis*. Shrews *Sorex* dominated the floodplains. Two *Cricetulus migratorius* were found in Hab15 and Hab16. In Hab18, *Myodes glareolus* was recorded, and in Hab2—*Microtus levis*. Also in Hab2, Hab13, and Hab15, *Apodemus agrarius* was recorded. *Mus spicilegus* was recorded lower down the slope in the steppe.

In the autumn of 2019, the dominant species were *Sylvaemus uralensis* and *Sylvaemus sylvaticus*. In total, only four species were recorded compared to the summer. In Hab13, down the slope from the field, a mound was found (Fig. 3).

Fig. 3. A mound of *M. spicilegus* in multi-grass steppe (Hab13).

Рис. 3. Курганчик *M. spicilegus* у різнотравно-типчаковому степу (Hab13).

In the summer of 2020, compared to the summer of last year, the relative abundance was much lower, and, as in the previous year, *Sylvaemus uralensis* prevailed. Only three species were recorded in the steppe. In Hab17, only two individuals were captured against the twenty trapped in the previous year. No individual were recorded in Hab20.

In autumn 2020, the dominant species were *Sylvaemus sylvaticus* and *Sylvaemus uralensis*. All three species of shrews were found in large numbers. *Cricetulus migratorius* was recorded in Hab22.

The relative abundance in the spring of 2021 was very low (Table 4); only three species occurred—*Sylvaemus uralensis* and *Sylvaemus sylvaticus*, and *Cricetulus migratorius* was recorded in Hab17. No individuals were captured in Hab21, Hab22, Hab23, and Hab24.

In the summer of 2021, the relative abundance remained low, only four species were recorded, *Sylvaemus uralensis* dominated. *Sylvaemus tauricus* was recorded in the field protection forest strips, which did not occur in previous years. No individuals were recorded in Hab2, Hab22, and Hab25.

Table 4. **The relative abundance (*N*) of small mammals in the studied habitats in the surroundings of Rozsohuvata**

Таблиця 4. **Відносна чисельність (*N*) дрібних ссавців в досліджених біотопах в околицях с. Розсохувата**

Habitat	Spr 2018	Aut 2018	Spr 2019	Sum 2019	Aut 2019	Sum 2020	Aut 2020	Spr 2020	Sum 2021	Aut 2021	Sum 2022	Aut 2022
FPFS	0.5	0.5	3.0	–	–	–	–	–	–	–	–	–
DM	–	–	0.3	4.2	4.5	–	–	0.4	–	0.8	–	–
RV	–	–	–	2.0	–	–	14.6	–	–	0.7	–	–
BB	–	1.5	0.3	–	–	–	–	–	–	–	–	–
MGS	–	0.5	3.3	4.9	9.0	1.0	–	0.7	0.7	4.0	2.7	–
FPFS/F	–	1.0	–	4.0	2.5	3.0	2.0	0.2	2.2	0.7	3.3	5.0
F	–	–	1.0	–	–	–	–	–	–	1.6	–	–

Note: FPFS—field protection forest strip (Hab1, Hab7, and Hab12); DM—dry meadows (Hab2, Hab15); RV—riparian vegetation (Hab3, Hab22); BB—bottom of the beam (Hab4, Hab6); MGS—multi-grass steppe (Hab5, Hab13, Hab14, and Hab16); FPFS/F—field protection forest strip/field (Hab8, Hab9, Hab17, Hab18, Hab19, Hab21, Hab23, Hab24, and Hab27); F—field (Hab10, Hab11, Hab20, Hab25, and Hab26).

In the autumn of 2021, eleven species were recorded, *Sylvaemus uralensis* dominated, and *Mus musculus* was found in large numbers in the fields surrounding the village. In Hab5, compared to previous years, six species were captured, including *Sorex minutus* and *Cricetulus migratorius*. Compared to the previous autumn, there were almost no *Sylvaemus* in Hab22. *Cricetulus migratorius* was recorded in four habitats—Hab5, Hab13, Hab24, and Hab26. Most of *Sylvaemus uralensis* were captured in the steppe. In Hab21, compared to the previous year, only one species was recorded. In Hab13, *Crocidura suaveolens* was found.

In general, the relative abundance in the summer of 2022 was not high; only four species were recorded, of which *Sylvaemus uralensis* dominated. *Cricetulus migratorius* was captured in Hab21.

Compared to the previous year, only six species were recorded in the autumn of 2022; the dominating species were *Sylvaemus sylvaticus* and *Sylvaemus uralensis*. Five species occurred in Hab27, including *Myodes glareolus*. In Hab24, compared to the previous year, only one species was captured. All three species of *Sylvaemus* were recorded in Hab21.

In general, during the trapping period, the largest number of species was recorded in the ecotone with riparian vegetation (Hab22) and in the multi-grass steppe (Hab13) (Table 5).

Biotopic preferences

The degree of biotopic preferences is calculated according to the formula

$F_{ij} = (n_{ij} \times N - n_i \times N_j) / (n_{ij} \times N + n_i \times N_j - 2n_{ij} \times N_j)$,

where n_{ij}—the number of individuals of *i* species in *j* sample (habitat) with a volume of N_j; n_i—the number of individuals of the species in all captures with a total volume of *N* [Zagorodniuk & Naglov 2017]. The data necessary for calculating the degree of biotopic preference are summarised in a table (Table 5).

The value of F_{ij} ranges from –1 to +1:

–1—the species is absent in the habitat;

+1—the species occurs only in this habitat;

0—the species is indifferent to this habitat (neither prefers nor avoids).

Thus, if the value is less than zero, the species avoids the studied habitat; if it is greater than zero, the species prefers the studied habitat, and the closer the value is to 1, the greater the preference of the species to this habitat.

Table 5. **The number of trapped individuals and species in the studied habitats for the entire research period (2018–2022)**

Таблиця 5. **Кількість зловлених особин та видів в досліджених біотопах за весь період відлову (2018–2022 рр.)**

Habitat	Ap-Agr	Sy-Ura	Sy-Syl	Sy-Tau	Mu-Mus	Mu-spi	Mi-Lev	My-Gla	Cri-Mig	So-Ara	So-Min	Cr-Sua	Sum	Sum
	n	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	*n*	sp
Hab1	–	–	1	–	–	–	–	–	–	–	–	–	1	1
Hab2	3	17	7	–	–	–	5	–	–	1	–	–	33	5
Hab3	–	1	–	–	–	–	–	–	–	8	2	–	11	3
Hab4	–	2	1	–	–	–	–	–	–	–	–	–	3	2
Hab5	–	16	2	–	–	1	1	–	1	–	1	–	22	6
Hab6	–	–	1	–	–	–	–	–	–	–	–	–	1	1
Hab7	–	–	–	–	–	–	–	–	–	1	–	–	1	1
Hab8	2	4	–	2	–	–	–	–	–	–	–	–	8	3
Hab11	–	–	–	–	–	3	–	–	–	–	–	–	3	1
Hab12	–	5	4	–	–	–	–	–	–	–	–	–	9	2
Hab13	2	48	13	–	–	4	3	–	3	–	1	1	75	8
Hab14	–	9	6	–	–	–	1	–	–	–	–	–	16	3
Hab15	2	2	4	–	1	–	–	–	1	–	–	–	10	5
Hab16	–	–	1	–	–	–	–	–	1	–	–	–	2	2
Hab17	–	17	7	1	1	–	–	–	1	–	–	–	27	5
Hab18	–	3	2	–	–	–	–	2	–	–	–	–	7	3
Hab19	–	6	–	–	1	–	–	–	–	–	–	–	7	2
Hab21	–	8	3	6	7	–	–	–	1	–	–	2	27	6
Hab22	2	24	28	1	1	–	1	–	1	7	7	8	80	10
Hab24	–	5	1	4	–	–	–	–	1	–	–	–	11	4
Hab26	–	1	2	–	12	–	–	–	2	–	–	–	17	4
Hab27	1	2	4	–	–	–	1	1	–	–	–	–	9	5
Total	12	170	87	14	23	8	12	3	12	17	11	11	380	12

Note: Ap-Agr (*Apodemus agrarius*), Sy-Ura (*Sylvaemus uralensis*), Sy-Syl (*S. sylvaticus*), Sy-Tau (*S. tauricus*), Mu-Mus (*Mus musculus*), Mu-spi (M. spicilegus), Mi-Lev (*Microtus levis*), My-Gla (*Myodes glareolus*), Cri-Mig (*Cricetulus migratorius*), So-Ara (*Sorex araneus*), So-Min (*S. minutus*), Cr-Sua (*Crocidura suaveolens*), Sum *n*—total individuals, Sum sp—total species.

Also, this value allows to determine the eurytopy or stenotopy of the species. If a species occurs only in one habitat (+1), or it gives it a greater preference (>+0.7) with a negative or indifferent (close to zero) 'attitude' to other habitats, then it is a *stenotopic* species. If the value preference in all studied habitats are equal to zero or deviate slightly (within ± 0.3) from zero, then the species should be classified as *eurytopic*. An intermediate position is occupied by species that have sufficient ecological valence (plasticity) and occur in several habitats [Zagorodniuk & Naglov 2017].

The obtained values of biotopic preferences are presented in Table 6. During the monitoring period, *Apodemus agrarius* did not occur often, and it preferred ecotones with field protection forest

strips, especially areas in descent and with developed vegetation cover. *Sylvaemus uralensis* dominated in abundance and occurred in almost every habitat—it belongs to the eurytopic species of the studied area. *Sylvaemus sylvaticus* was the second most abundant species, occupying a large number of habitats, and similarly to *Sylvaemus uralensis* is a eurytopic species. *Sylvaemus tauricus* was recorded for the first time in the summer of 2021; it prefers field protection forest strips with an old stand of oak (*Quercus robur* L.), linden (*Tilia cordata* Mill.), and black locust (*Robinia pseudoacacia* L.). *Mus musculus* occurs in habitats closest to the village, in particular in fields and field protection forest strips. Mounds of *Mus spicilegus* were found only in two habitats—in a field located on a gradual beam slope and in an adjacent section of a multi-grass steppe on the same slope; it can be considered a stenotopic species. *Microtus levis* occurred rarely and mostly in dry meadows on the steep slope of the beam. *Myodes glareolus* was extremely rare, recorded in ecotones with oak field protection forest strips. *Cricetulus migratorius*, which belongs to the rare species of the region [Zorya 2008], was captured in almost half of the habitats; on the beam it occurred mainly in the steppe, whereas in the surroundings of the village—in ecotones of field protection forest strips and wheat or maize fields. Shrews *Sorex* preferred moist ecotones with riparian vegetation, while *Crocidura suaveolens* occurred near field protection forest strips.

Table 6. **Values of the biotopic preference index (F_{ij})**
Таблиця 6. **Показники ступеня біотопної приуроченості (F_{ij})**

Habitat	Ap-Agr	Sy-Ura	Sy-Syl	Sy-Tau	Mu-Mus	Mu-spi	Mi-Lev	My-Gla	Cri-Mig	So-Ara	So-Min	Cr-Sua	Sp in hab with $F_{ij} > 0$
Hab1	–1.0	–1.0	0.6	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	1
Hab2	0.6	0.1	0	–1.0	–1.0	–1.0	**0.8**	–1.0	–1.0	–0.2	–1.0	–1.0	3
Hab3	–1.0	–0.7	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	**0.9**	**0.8**	–1.0	2
Hab4	–1.0	0.2	0.2	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	2
Hab5	–1.0	0.3	–0.4	–1.0	–1.0	0.4	0.2	–1.0	0.2	–1.0	0.2	–1.0	5
Hab6	–1.0	–1.0	0.6	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	1
Hab7	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	**0.9**	–1.0	–1.0	1
Hab8	**0.8**	0.1	–1.0	**0.8**	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	3
Hab11	–1.0	–1.0	–1.0	–1.0	–1.0	1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	1
Hab12	–1.0	0.1	0.3	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	2
Hab13	–1.0	0.2	–0.2	–1.0	–1.0	0.6	0.2	–1.0	0.2	–1.0	–0.4	–0.4	4
Hab14	–1.0	0.1	0.3	–1.0	–1.0	–1.0	0.3	–1.0	–1.0	–1.0	–1.0	–1.0	3
Hab15	**0.8**	–0.4	0.3	–1.0	0.3	–1.0	–1.0	–1.0	0.5	–1.0	–1.0	–1.0	4
Hab16	–1.0	–1.0	0.4	–1.0	–1.0	–1.0	–1.0	–1.0	**0.9**	–1.0	–1.0	–1.0	2
Hab17	–1.0	0.2	0.1	0	–0.3	–1.0	–1.0	–1.0	0.1	–1.0	–1.0	–1.0	4
Hab18	–1.0	0	0.1	–1.0	–1.0	–1.0	–1.0	**1.0**	–1.0	–1.0	–1.0	–1.0	2
Hab19	–1.0	0.3	–1.0	–1.0	0.4	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	–1.0	2
Hab21	–1.0	–0.2	–0.4	**0.8**	**0.7**	–1.0	–1.0	–1.0	0.1	–1.0	–1.0	0.5	4
Hab22	–0.1	–0.2	0.3	–0.6	–0.7	–1.0	–0.5	–1.0	–0.5	0.4	**0.7**	**0.8**	4
Hab24	–1.0	0	–0.4	**0.9**	–1.0	–1.0	–1.0	–1.0	0.5	–1.0	–1.0	–1.0	3
Hab26	–1.0	–0.8	–0.3	–1.0	**0.9**	–1.0	–1.0	–1.0	0.6	–1.0	–1.0	–1.0	2
Hab27	0.6	–0.3	0.3	–1.0	–1.0	–1.0	0.6	**0.9**	–1.0	–1.0	–1.0	–1.0	4

Note: Sp in hab—the number of species, which are occur in the habitat.

Distribution of small mammals by categories of abundance

According to Zagorodniuk and Kyseliuk [Zagorodniuk 2002], there are six categories of species presence: absent, 0—the portion in the sample is zero; rare (very rare), 1—from 0 to 1%; occasional, 2—from 1 to 3%; frequent, 3—from 3 to 10%; common, 4—from 10 to 30%; and abundant, 5—from 30 to 100%.

Thus, according to the obtained abundance scores (Table 7), only one species belongs to rare species—*Myodes glareolus*; occasional are three species—*Mus spicilegus*, *Sorex minutus*, and *Crocidura suaveolens*; six species are categorised as frequent—*Apodemus agrarius*, *Sylvaemus tauricus*, *Mus musculus*, *Microtus levis*, *Cricetulus migratorius*, and *Sorex araneus*; only *Sylvaemus sylvaticus* belongs to common species, and only *Sylvaemus uralensis* belongs to abundant species.

Table 7. **Estimates of the number and abundance of small mammals in the surroundings of Rozsohuvata for the period of trapping 2018–2022**

Таблиця 7. **Оцінка чисельності та ряснота дрібних ссавців в околицях с. Розсохувата за результатами обліків 2018–2022 рр.**

Species	Relative abundance (*N*)	% in the sample	Abundance scores	Presence category
Apodemus agrarius	0.24	3.16	3	frequent
Sylvaemus uralensis	3.47	44.74	5	abundant
Sylvaemus sylvaticus	1.78	22.89	4	common
Sylvaemus tauricus	0.29	3.68	3	frequent
Mus musculus	0.47	6.05	3	frequent
Mus spicilegus	0.16	2.11	2	occasional
Microtus levis	0.24	3.16	3	frequent
Myodes glareolus	0.06	0.79	1	rare
Cricetulus migratorius	0.24	3.16	3	frequent
Sorex araneus	0.35	4.47	3	frequent
Sorex minutus	0.22	2.89	2	occasional
Crocidura suaveolens	0.22	2.89	2	occasional

It should be mentioned that *Cricetulus migratorius*, which is usually included in the category of rare or occasional [Zorya 2008], fell into the category of frequent species in the studied area, because it occurred regularly and in almost half of the studied habitats. In addition, it reproduces successfully—5 to 7 placental scars were found in the captured females. *Myodes glareolus*, which usually prefers oak forest, was extremely rare. The abundance of *Apodemus agrarius*, which usually belongs to common species in river valleys, was also low. The absence of forests and rivers in the studied area could affect the abundance of these two species. *Sylvaemus* showed greater ecological valence, dominated in the abundance and occurred in most habitats, except for *Sylvaemus tauricus*, which began to occur only in the last two years and mainly in field protection forest strips.

Conclusions

1. Nine species of mouse-like rodents and three species of insectivorans were found in the course of the study of small mammals in natural and agricultural lands of eastern Ukraine carried out in the period from 2018 to 2022.
2. In the study period, the wood mice *Sylvaemus uralensis* and *Sylvaemus sylvaticus* turned out to be the predominating species in the surveyed habitats.
3. The largest number of species was found to occur in ecotone habitats, particularly those between riparian vegetation and field (10 species), as well as in patches of multi-grass steppe on the beam (8 species).
4. Among the recorded species, according to the estimated values of their biotopic preferences, *Sylvaemus uralensis* and *Sylvaemus sylvaticus* are the most eurytopic species, whereas the most stenotopic species in the studied area is *Mus spicilegus*.
5. Of the twelve species of small mammals found in the studied area, one species was categorised as rare, three as occasional, six as frequent, one as common, and one as abundant species.

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