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THE SOUTHERN BIRCH MOUSE *SICISTA LORIGER* (DIPODOIDEA) IN THE CRIMEA: DISTRIBUTION, HABITATS, SEASONAL ACTIVITY, AND ABUNDANCE

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The southern birch mouse *Sicista loriger* (Dipodoidea) in the Crimea: distribution, habitats, seasonal activity, and abundance. — I. Evstafiev. — The southern birch mouse is a rare and non-abundant species of small mammals of the fauna of the Crimean Peninsula. Its geographic range has gradually reduced during the 20th century. Initially, the southern birch mouse occupied almost the entire territory of the steppe and foothills of the Crimea. As the area of virgin and unploughed lands decreased, the species disappeared from most parts of the peninsula. Whereas the species had been recorded in 11 administrative districts in the middle of the 20th century, now it is known only in three districts, in two of which is extremely rare. Currently, the southern birch mouse exists in two isolated populations—a western (Tarkhankut) and an eastern (Kerch)—separated by 200 km of anthropogenic landscapes. Field surveys of small mammals have been carried out on trap-lines for the past 40 years. In a total of 667100 traps-nights, 144 birch mice were collected. Additionally, remains of 56 birch mouse specimens were found in 16862 pellets of the long-eared owl. The birch mouse population in the Tarkhankut Peninsula is small (12 specimens were trapped and 39 specimens were identified in pellets), and its range is largely restricted. The species' population in the Kerch Peninsula is larger (132 birch mice were trapped and 17 specimens were identified in pellets of birds of prey) and its range occupies the entire area of the Kerch Peninsula. Data of long-term epidemiological surveys showed that the ratio of trapped birch mice in the whole of the Crimea is 0.21 %, whereas their ratio in the steppe zone is 0.29 % at a relative abundance of 0.03 specimens per 100 trap-nights. Birch mice are active from mid-April to mid-November. The peak of activity is in April, when 49.9 % of animals were trapped. Among natural enemies, the red fox (*Vulpes vulpes*) can pose a real threat to birch mice, as well as the long-eared owl (*Asio otus*) to local micropopulations, especially during the breeding season. In our opinion, despite the generally low abundance of birch mice in the Crimea and the fragmentation of its geographic range, extinction does not threatens this species in the peninsula (especially its Kerch population) under the current management system. Conservation of the southern birch mice populations in the Crimea requires a detailed study of the species' ecology, especially of limiting factors.

Key words: southern birch mouse, geographic range, population abundance, seasonal activity, Crimea.

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Introduction

The southern birch mouse *Sicista loriger* (Nathusius, 1840) (formerly *S. subtilis nordmanni*) is one of the rarest and least studied species of small mammals of the Crimea, which has a fragmented a highly restricted geographic range isolated from its the mainland part (Tovpinets & Evstafiev 2002, 2005; Tovpinets & Evstafiev 2008; Evstafiev 2015). The same concerns the family Sicistidae in the whole of Ukraine, where birch mice are one of the rarest and most vulnerable group of rodents (Zagorodniuk 2015). The steppe birch mouse has been protected since 1994 and it is listed in the Red Data Book of Ukraine with the status "endangered". This species is also included into Annex II of the Bern Convention (Zagorodniuk & Filipchuk 1999). The geographic range of this species in Europe has gradually decreased and fragmented in recent decades, and the species has completely disappeared in a number of countries (Bauer 1960; Ham *et al.* 1983; Petrov 1992; Pucek, 1999; Cserkész & Gubányi 2008).

The southern birch mouse is the only species of the family Sicistidae in the Crimea. Earlier, birch mice from the Crimea had been attributed to the species *Sicista subtilis* Pallas, 1773 as a subspecies *S. s. nordmanni* (Khodykina 1965; Dulitsky 2001 and others). Due to new approaches to

species diagnostics, which include not only traditional descriptive morphological methods, but also genetic, biochemical, and several others, it was possible to revise and clarify the taxonomic position of this mouse, although scientists from different countries do not share a common view on this topic.

Several authors (Baskevich *et al.* 2005, 2010; Baskevich & Oparin 2009; Kovalskaya *et al.* 2011) consider *S. subtilis* as a complex of various sibling species or semi-species, and currently recognise 4 subspecies (Shenbrot *et al.* 1995). Of them, the subspecies *S. s. nordmanni* (= *S. s. loriger*) is distributed in the Crimea and in mainland Ukraine, as well as in Moldova and Ciscaucasia (Russia) (Pavlinov & Lisovskiy 2012). To analyse the superspecies *Sicista* "*subtilis*" and to substantiate the distinctness of separate species, a number of researchers (Lebedev *et al.* 2019) conducted genetic studies, which confirmed the independence of several geographic forms that have different chromosome numbers. Based on the obtained data, the distinctness of *S. subtilis subtilis* (Pallas, 1773), *S. subtilis severtzovi* Ognev, 1935, *S. trizona* (Frivaldszky, 1865), and *S. lorigera* (Nordmann, 1839) was substantiated.

Comprehensive studies based on the craniology and biogeography of the superspecies *Sicista* (gr. "*subtilis*") *subtilis* (Aniskin *et al.* 2003; Zagorodnik 2005) allow the form *S. s. loriger* to be considered as an independent species *Sicista loriger*, which has 26 chromosomes in the karyotype. We support I. Zagorodniuk's view to recognise the name *S. loriger* (Nathusius, 1840) as prior for the steppe birch mouse of the Crimea and an the whole of Ukraine (Zagorodniuk 2009; 2019).

The aim of this work is to revise the geographic range of the southern birch mouse in the Crimea, to analyse the specifics of ecology and habitat preferences of this species, and to explore the structure of small-mammal communities that include the southern birch mouse.

Material and Methods

The general characteristics of the studied region and the history of small mammal research in the Crimea were considered earlier (Evstafiev 2015).

The present work is based on materials collected during epizootic field studies of the Crimean Peninsula by zoologists of the Crimean Anti-Plague Station, CAPS (A. F. Alekseev, V. I. Chirniy, A. I. Dulitsky, L. S. Arutiunian, and others) and of the Department of Highly Dangerous Infections of the Crimean Republican SES, DHDI (M. M. Tovpinets, V. Kyrychenko, and others), with the participation of the author who worked at the CAPS in 1980–2001 and at the DHDI from 2001 to the present, in total for 40 years (1980–2020).

Small mammals were trapped using the standard and generally accepted census and trapping methods (Kucheruk 1952; Kucheruk & Korenberg 1964; Popov 1967; Instruction ... 1978; Karaseva & Telitsyna 1996). We analysed the generalized data on trappings of small mammals for the specified period: in 667100 trap-nights, 69067 specimens of small mammals of 13 species of two orders (insectivores and rodents) were captured, including 144 specimens of the southern birch mouse.

The pellet method of analysis of the species composition of small mammals based on bone remains (mainly of skulls) is fairly efficient when studying the distribution of rare species in a particular area (Tovpinets 1998; Tovpinets & Evstafiev 2002; Zagorodniuk, 2015). Thus, the species composition, distribution, and number of birch mice collected in pellets of birds of prey in the territory of Ukraine are considered in the survey by Igor Zagorodniuk (2015). This approach is widely used in other countries as well (Demeter & Obuch 2004; Cserkész 2007; Cserkész & Gubányi 2008; etc.).

Our analysis of the modern distribution of rare and protected species of mammals based on the comparison of trapping data with the data obtained from the study of bird pellets showed that the trapping localities of rare species (in particular, shrews and birch mice) almost completely coincide with the places where these animals were found in pellets, and their ratio in the pellets generally corresponds to their ratio in natural habitats, i.e. reflects their real portion in communities of small mammals (Tovpinets & Evstafiev 2002). In total, 16862 pellets of birds of prey were collected and analysed, in which remains of more than 38256 specimens of rodents and shrews were identified (species identification was carried out by N. N. Tovpinets).

Results and Discussion

Chorology of the species in the Crimea

Quaternary deposits from caves and rock shelters of the mountainous and piedmont part of the Crimea contain numerous the eagle owl pellets with remains of rodents, including those of (steppe?) birch mice that had already occurred in the peninsula at that time (Birulya 1930; Gromov 1961).

The first survey on the distribution and ecology of the steppe birch mouse in the Crimea was published by Z. Khodykina (1965) based on materials collected in 1956 to 1962. According to these data, the range of the "steppe" birch mouse covered not only the steppe belt, but also the piedmont zone of the Crimea. Single records of birch mice were also reported from the Third and Second Ridges of the Crimean Mountains. The ratio of the birch mouse among other small mammals trapped during this study period was 2.58 % (Khodykina 1965).

Later on, under the influence of the ever-increasing anthropogenic pressure (ploughing and reclamation of previously uncultivated lands for the needs of agriculture), there was a decrease in the abundance of birch mice followed by a significant reduction of its distribution range. While in the first study period (1956–62) this species was recorded in the territory of 11 administrative districts of the Crimea from the steppe and piedmont zones, in 1975–1980 the species was recorded only in the Kerch Peninsula (Lenino Raion), in the Crimean Sivash Region (Sovietskyi, Nyzhniohirskyi, and Dzhankoy Raions), in the Tarkhankut Peninsula (Chornomorske Raion), and in piedmont areas of Simferopol Raion (Chirniy *et al.* 1989; Tovpinets & Evstafiev 2008).

Detailed data on the geography of records of the southern birch mice in the Crimea (date, localities, coordinates, and habitats) are given in a separate paper (Evstafiev 2020), and here is given only a brief list of localities, nearby to which southern birch mice were trapped.

1) Chornomorske Raion: Zoriane (1992), Krasna Poliana (1997–96).

2) Lenine Raion (Kerch peninsula): Batalne (1984), Cheleadinove (1990), Doroshenkove (1994), Heroivske (1985), Hornostaiivka (1987), Kalynivka (2000), Kamianske (1986, 1989, 2006), Krasnohirka (1986, 2015), Leninske (1980–81, 1985, 1989, 1993, 1996, 2000), Luhove (2012), Marfivka (1981, 1985), Mysove (1998–99), Novomykolaiivka (2015), Novoselivka (1985), Ohonky (1986), Ptashkyne (1981, 1985–86, 1988), Romanove (1992), Fontan (1981, 1985), Uvarove (1986), Shcholkine (1992), Vulkanivka (1987, 1989, 1990-91, 1993, 1999), Viaznikove (1991), Yakovenkove (1982, 1985–88, 1990–93), Yarke (1985–86, 1992–94, 2015), Yerofieieve (1986), Yurkyne (2017).

3) Rozdolne Raion: Kotovske (2020).

Distribution and abundance

Since the 1980s, the southern birch mouse has been represented in the Crimea by two isolated populations. The western population is located in the far west, mainly in the Tarkhankut Peninsula, (Figs 1–2), whereas the eastern population occupies the Kerch Peninsula (Figs 3–4). The most extreme (the closest) findings of the southern birch mouse from these populations (near Kotovske, Rozdolne Raion, E 33.15, N 45.65, in the west and near Kamenka, Lenin Raion, E 35.47, N 42.29, in the east) are separated by at least 200 km of anthropogenic landscapes, which is an insurmountable obstacle (in the foreseeable future) for gene flow between the two populations (Evstafiev 2020).

Below we consider the distribution and abundance of the southern birch mouse separately for each of the two isolated populations. Data on all records localities of the southern birch mice in the Crimea with reference to coordinates are given in a separate paper (Evstafiev 2020).

The western population, Tarkhankut Peninsula

The western or Tarkhankut population of the southern birch mouse is much smaller than the eastern one and its range is more restricted. The population is represented in our collection by 12 specimens of trapped animals and 39 specimens identified by skull remains from pellets of the long-eared owl. The first southern birch mouse was trapped in a forest belt in Chornomorsk Raion, 7 km northeast from Zoryane in early June 1992 on a census line of 100 trap-nights together with a specimen of the steppe field mouse (*Sylvaemus witherbyi*).

Fig. 1. Trapping localities of southern birch mice of the western population in the Tarkhankut Peninsula.

Рис. 1. Місця вилову південних мишівок (західна Тарханкутська популяція).

Four specimens of the southern birch mouse were trapped simultaneously at the end of May 1997 in a forest belt 5 km north of Krasna Poliana. On the same census line, four other species were also trapped: *Crocidura suaveolens* (one specimen), *S. witherbyi* (nine specimens), *Mus spicilegus* (one specimen), and *Microtus socialis* (seven specimens). This indicates a high diversity of small mammals in this habitat along with their high relative abundance (22 specimens / 100 trap-nights).

At the end of April 1998, 5 km northeast of the same village (Krasna Poliana), six specimens of the southern birch mouse were trapped at once on one census line exposed in weeds, together with three other species: *S. witherbyi* (two specimens), *Microtus socialis* (eight specimens), and *Cricetulus migratorius* (one specimens). The relative abundance was also high (17 specimens / 100 trap-nights). The last specimen of the southern birch mouse was trapped in early September near Kotovske, Rozdolne Raion on unploughed land on a line of 50 traps. This locality is only a few kilometres far from the border of Chornomorsk Raion.

The obtained data show a clear tendency to aggregated distribution of the southern birch mouse despite its low general abundance. This is eloquently indicated by the fact that during the study carried out in Chornomorsk Raion, 1016 specimens of small mammals were trapped in 17400 trap-nights, of which 11 specimens belonged to the southern birch mice (1.08 % of the total number). In Rozdolne Raion, 1471 specimens were trapped in 16825 trap-nights, including only one southern birch mouse (0.07 %).

Data obtained by the pellet method on the state of the western population of the southern birch mouse are presented in Fig. 2 and Table 1.

A comparative analysis of record localities of the southern birch mouse by trapping (Fig. 1) and the collecting localities of owl pellets with remains of the species suggests a wider distribution of the southern birch mouse in the studied area (Table 1). In particular, it seems that the westernmost border of the species' range lies in vicinities of Olenivka, where in 1983 remains of 11 specimens were found in nine pellets, i.e. 50 % of their total number. This may indicate the existence of a southern birch mice settlement nearby to Olenivka.

Interesting are the finds of southern birch mice in Saki Raion. In Dobrushyno, two birch mice were found in one pellet, and tree specimens were found in another pellet, which may also indicate the existence here of a settlement of this rodent.

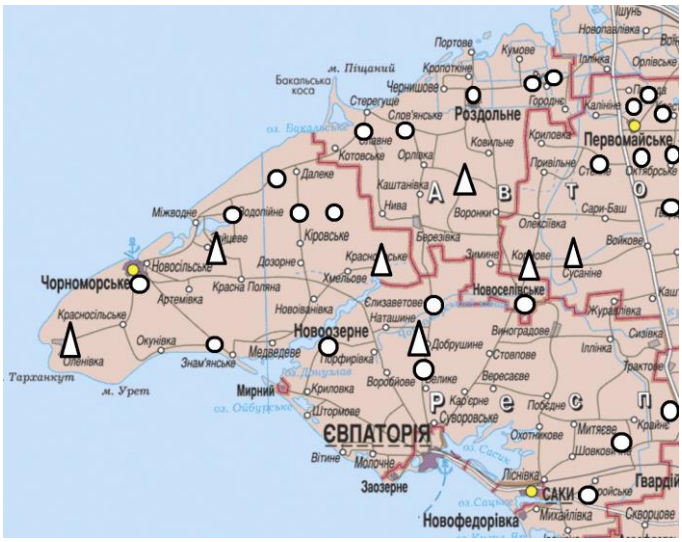

Fig. 2. Collecting localities of pellets of the long-eared owl with remains of the southern birch mouse (western population, Tarkhankut Peninsula) (circles — pellets without birch mouse remains; triangles — pellets with birch mouse remains).

Рис. 2. Місця збору пелеток вухатої сови, в яких виявлені кісткові залишки степової мишівки (західна Тарханкутська популяція) (кружечки — мишівки в пелетках не виявлені; трикутники — у пелетках виявлені останки степових мишівок).

Table 1. Analysis of owl pellets

Таблиця 1. Аналіз пелеток вухатої сови

Administrative districts	Number of collecting localities of pellets*	Number of collected pellets**	Number of animals in pellets***
Chornomorske Raion	11 / 3 (27.3 %)	967 / 9 (0.93 %)	2016 / 13 (0.64 %)
Pervomaiske Raion	11 / 2 (18.2 %)	1677 / 2 (0.12 %)	3557 / 2 (0.06 %)
Saky Raion	9 / 1 (11.1 %)	933 / 2 (0.21 %)	2279 / 5 (0.22 %)
Rozdolne Raion	7 / 1 (14.3 %)	462 / 1 (0.22 %)	1042 / 2 (0.19 %)
Total:	38 / 7 (18.4 %)	4039 / 14 (0.35 %)	8894 / 22 (0.25 %)

Note. Data in columns are given in an order as follows:

* number of trapping localities / number of localities with southern birch mice (proportion of the latter, %);

** number of pellets collected / number of pellets with southern birch mice (proportion of the latter, %);

*** number of animals in pellets / number of southern birch mice in pellets (proportion of the latter, %).

The evaluation of records of southern birch mice in pellets in Pervomaiske Raion (one find nearby to Susanino and another find near Kormove) and Rozdolne Raion (two specimens in one pellet from Serebrianka) should be more careful. Such single findings of the species in pellets could be accidental drifts, even significantly remote areas.

Firstly, all pellets were collected not in the breeding territory of long-eared owls, but in their wintering places, where the absolute majority of them are migrants from neighbouring, more northern regions of mainland Ukraine (in some wintering aggregations we counted up to a hundred or more individuals of both sexes).

Secondly, such wintering groups form gradually, and before their final formation, owls move for significant distances, sometimes tens of kilometres per day. Such local migrations are related to foraging and search for daytime shelters. Thirdly, the southern birch mouse is a hibernating species and active only during the warm season. Consequently, only the last weeks of the species' activity coincide in time with the arrival of owls for wintering and their active search flights over the territory. Therefore, southern birch mice could be caught in one place, but their remains in pellets could be found tens of kilometres away. Respectively, single records of birch mouse remains in pellets of birds of prey cannot serve as basis to delineate the boundaries of the species' range, especially when analysing pellets of wintering groups of the long-eared owl.

An interesting fact should also be emphasised: in each of three pellets of the long-eared owl, two birch mice were found, as well as three and four specimens in two other pellets, respectively.

That is, 13 of 22 specimens (59.1 %) are not single records, which may indirectly indicate that they tend to form family groups or other types of aggregations (as mentioned above), although some sources (Flint 1960; Tsvetkova 1978, and others) indicate solitary lifestyle.

The eastern population, Kerch Peninsula

The Kerch Peninsula is one of the most well-studied territories of the Crimea. Over the years of research, 16266 specimens of small mammals were trapped in 154340 trap-nights. However, the territory of military training grounds created during the Soviet era—one in the northeast and another one in southwest of the peninsula—has remained unexplored and no data on small mammals, including the southern birch mouse, are available from these territories.

The population of the southern birch mouse in the Kerch Peninsula is more abundant and stable compared to the western one, as evidenced by the larger number of records (Fig. 3).

In the Kerch Peninsula, pellets were collected in 17 localities. In 3435 pellets, 7849 specimens of small mammals belonging to eight species were identified. The southern birch mouse (17 specimens or 0.22 % of all identified animals) was found in 12 pellets (0.35 % of collected pellets) from five localities (29.4 % of collecting localities). At the same time, seven pellets contained one specimen of the birch mouse, and five pellets contained two specimens each.

Fig. 3. Trapping localities of the southern birch mouse in the Kerch Peninsula in 1980–2020.

Рис. 3. Місця відлову мишівок на території Керченського п-ва за період 1980–2020 рр.

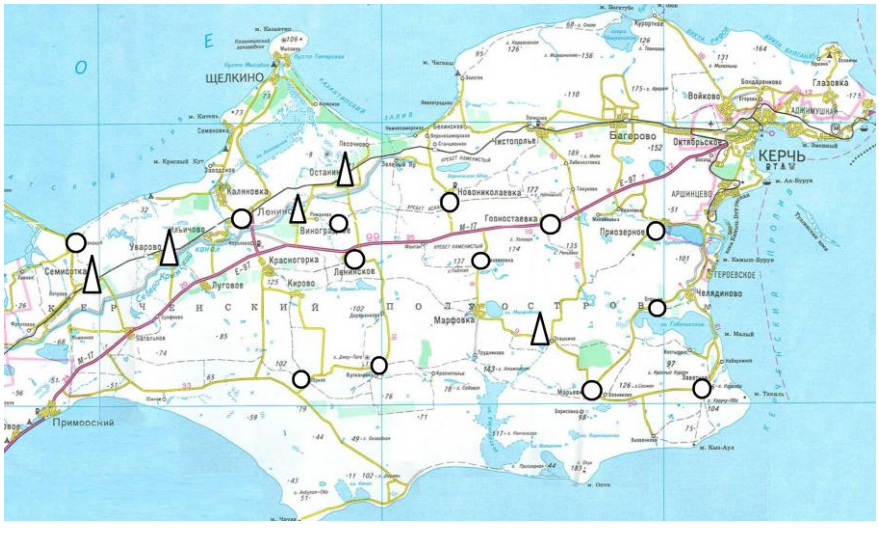

Fig. 4. Collecting localities of pellets in the Kerch Peninsula in 1980–2020 (circles — pellets without remains of birch mice; triangles — pellets with remains of birch mice).

Рис. 4. Місця збору пелеток на Керченському п-ві у 1980–2020 рр.: кола — мишівки в пелетках не виявлені; трикутники — в пелетках виявлено рештки мишівок.

The analysis of pellets with remains of birch mice showed that each pellet contains three to seven specimens of various species.

In particular, 14 specimens of *Microtus socialis* were found in eight pellets, five specimens of *Mus spicilegus* in five pellets, 11 specimens of *Crocidura leucodon* in three pellets, and three specimens of both *Sylvaemus witherbyi* and *Crocidura suaveolens* in two pellets.

The data obtained on the chorology of the southern birch mouse in the Kerch Peninsula shows that the species is widespread here, although not abundant. According to the data of long-term studies, birch mice were registered on 89 of 1763 trap lines (5.01 %). Of the 16266 small mammals trapped, 132 were identified as birch mice (0.81 %). The long-term average estimate of the species' relative abundance in the Kerch Peninsula is 0.09 specimens / 100 trap-nights.

The steppe birch mouse is characterised with a sporadic distribution within its range represented by local spots with a relatively high abundance despite a relatively low general abundance (Flint 1960). Apparently, the birch mouse is also distributed extremely unevenly in the Crimea, even within the two isolated populations, where the species are found in settlements with a small area and increased abundance and density. These spots are basically reserves for the species, as well as refugia from unfavourable weather cataclysms. This is indirectly confirmed by the presence of several birch mice in a single pellet of the long-eared owl despite its low general abundance, as well as by captures of several specimens of the species on a single trap line.

Ecology of the southern birch mouse in the Crimea

Seasonal activity

Most southern birch mice are active from April until mid-October. The southern birch mouse is a hibernating species, therefore, with the onset of stable cold weather it hibernates for about six months in average (Flint 1960; Khodykina 1965; Tsvetkova 1978; Shenbrot *et al.* 1995).

In the Crimea, most birch mice leave their winter shelters in the second half of April and begin to feed actively and reproduce. It was in April that we caught 71 birch mice, which is 49.9 % of their total number. This indicates their maximum activity associated not only with foraging, but also with searching for sexual partners.

From the middle of the summer, the activity of birch mice gradually decreases and only 23 specimens (16.0 %) were trapped in early autumn (mainly in September). The last active specimens of the steppe birch mouse were trapped in mid-October (two specimens or 1.4 %).

However, it is necessary to mention the capture of four southern birch mice in January 1987 and 1989 in the Kerch Peninsula. In the first case, three specimens were caught in a virgin area near Vulkanovka (E 35.94, N 45.14) and one specimen near Kamenskoe (E 35.47, N 45.29) in the second case, also in a virgin area. Accurate meteorological data on weather conditions of these trapping localities have not been, although archival data of the nearest meteorological stations indicate that short-terms warmings had occurred in the Kerch Peninsula during the period of surveys. The average daily temperature on some days reached + 3–4 °C, whereas the daytime average temperature was + 8–9 °C. At the same time, it is known that in sunny days the air temperature near the surface and of the surface layer of the soil and litter in well-protected microhabitats can warm up to + 12–15 °C and higher.

What made the steppe birch mouse not only wake up, but also remain active until the evening air temperature drops (in winter, traps were usually set at 13 to 16 pm) remains unclear. At the same time, the birch mice were not only active, but were also feeding as they were caught in small Gero traps with standard bait (1 x 1 cm pieces of white bread flavoured with vegetable oil).

These facts clearly conflict with all literature data known to the author, since cases of interrupted hibernation in the southern birch mouse have never been mentioned. It is possible that this phenomenon observed in the Crimea is related to the long snowless and frost-free periods, which can result in an increased consumption of accumulated fat reserves forcing the animals to leave their wintering shelters and forage for nourishment.

Population size and abundance

Long-term trends of population dynamics of the southern birch mouse in the Crimea cannot be analysed due to the scarcity of census data. The number of trapped specimens is presented in Fig. 5. The graph shows that in 1985 to 1993 birch mice were trapped regularly not as single specimens, but in a number of up to 10 or more specimens (maximum 21 specimens in 1985 and 22 specimens in 1986).

A more objective picture of the real number of birch mice in nature is given by calculating their relative abundance. At the same time, we completely excluded from the calculation the data of those catches that were carried out from mid-October to mid-April, i.e. the time when southern birch mice are inactive and hibernate in wintering nests. The graph in Fig. 6 demonstrates that the dynamics of relative abundance of small mammals in general and of the southern birch mouse does not coincide and changes differently (correlation coefficient r = -0.1), which is due to several reasons.

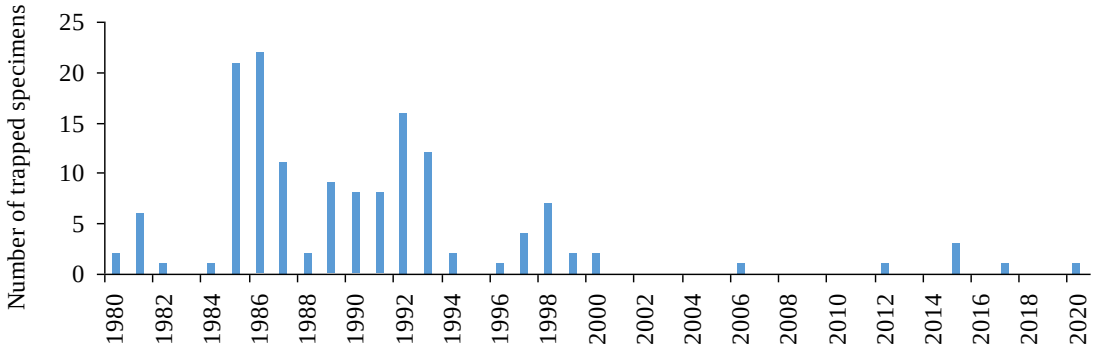

Fig. 5. The number of specimens of *Sicista loriger* trapped in consecutive years.

Рис. 5. Кількість особин *Sicista loriger*, спійманих в різні роки.

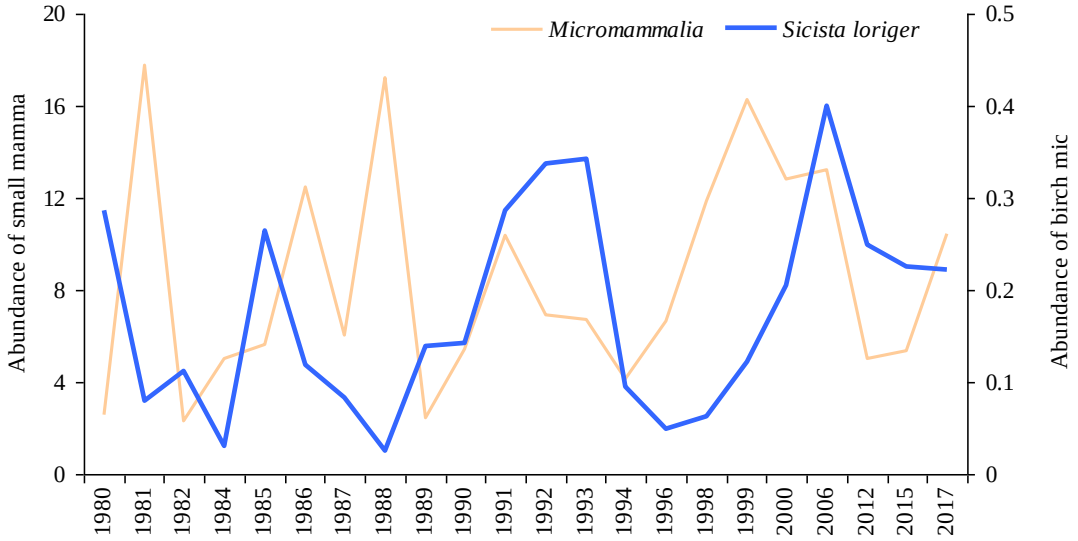

Fig. 6. Relative abundance (specimen / 100 trap-nights) of small mammals and birch mice *Sicista loriger* in consecutive years (excluding years when steppe birch mice were not trapped).

Рис. 6. Відносна чисельність (ос. / 100 л./н.) дрібних ссавців і мишівок *Sicista loriger*, за роками (на графіку не відображено дані для років, в які мишівки були відсутні у зборах).

On the other hand, the correlation analysis of long-term population dynamics of separate species revealed a positive correlation between the dynamics of *Sicista loriger* and *Cricetulus migratorius* (r = +0.59), *Sylvaemus witherbyi* (r = +0.55), and *Mus musculus* (r = +0.49), as well as a negative correlative between *Sicista loriger* and *Mus spicilegus* (r = -0.71) and *Crocidura leucodon* (r = -0.12).

Natural enemies

As the results of the study of birch mice in the Crimea showed, 144 specimens were caught during long-term epizootological surveys and 39 specimens were identified by bone remains extracted from pellets of the long-eared owl (*Asio otus*), which is 21.3 % of the total number of recorded birch mice. At the same time, the ratio of pellets containing birch mice was only 0.15 % of their total number in the Crimea (26 of 16862 specimens), while in the Kerch Peninsula it reached 0.35 % (12 of 3435 specimens) of those collected here in the peninsula. The ratio of trapped steppe birch mice to the total number of all small mammals identified in pellets was 0.1 % (39 of 38263 specimens) in the entire steppe Crimea and 0.22 % (17 of 7849 specimens) in the Kerch Peninsula.

Such small numbers seem insignificant, but two facts should be remembered.

Firstly, steppe birch mice are active only during the warm season—in April to mid-October—with a pronounced peak of activity in April.

Secondly, the analysis is based on pellets collected in groups of wintering long-eared owls, which are formed in September to mid-October (depending on the hydrothermal conditions of the current year) mainly by birds that had migrated from more northern regions, and which exist until February-March. Respectively, pellets were collected in the winter months (January–February), i.e. before these group start to scatter. Thus, the period of activity of the southern birch mouse and the period of active hunting of migrating owls overlap only slightly when the activity of the steppe birch mouse is minimal before entering hibernation. This may even indicate a certain selectivity of the long-eared owls toward this rodent species as more available and active prey compared to the more secretive shrews, voles, and mice.

Therefore, it can be assumed that in those localities where the distribution range of the steppe birch mouse overlaps with the nesting sites (or more precisely, foraging sites) of the long-eared owl, the role of the latter as predator can be significant for the local birch mouse micropopulation. This is especially important for populations of the southern birch mouse compared to populations of other mouse-like rodents, since they reproduce only once a year and the time of their highest activity and the appearance of the offspring (April–May) coincides with the breeding period of the owls and the time of nourishing of their offspring. However, to carry out a real assessment of the impact of long-eared owls and other birds of prey (short-eared owl, house owl, etc.) is possible only by studying their diet, especially during the time of nourishing their young.

The clearing of numerous forest belts in the Kerch Peninsula led not only to a significant reduction in wintering concentrations of long-eared owls, but also to the decrease of the number of pairs nesting here. With the destruction of large trees, the owls lost their convenient and protected wintering and breeding sites, which ultimately could significantly reduce their predation pressure on micropopulations of the steppe birch mouse.

The red fox, which is widespread in the Crimea and has a consistently high abundance, is another predator that can potentially affect the abundance of the steppe birch mice, but no data are available to study this topic.

Habitat preferences

An analysis of distribution of birch mice in different habitats revealed that 75.69 % of specimens were trapped forest belts (39.58 %) and in virgin lands (36.11 %), followed by fallow lands and wastelands (abandoned agricultural fields, areas with ruderal vegetation), where 18.06 % of birch mice were caught. The steppe birch mouse was less common in cultivated fields of winter cereals (3.47 %), spring cereals (1.39 %), and perennials (alfalfa) (1.39 %).

According to Cserkész & Gubányi 2008, most finds of steppe birch mice of the subspecies *S. subtilis trizona* are associated with abandoned fields overgrown with annual weeds, among which birch mice especially prefer thickets of the thistle *Carduetum acanthoidis*. An underground nest of birch mice lined with a silky bunch of thistles was discovered in thistle thickets (Méhely 1913). Birch mice were also caught in thistles in Russia, in the Volga-Kama region (Popov 1960). In Austria, birch mice were found in meadows with sandy soils, where the vegetation was dominated by *Bromus tectorum* and *Festuca vaginata* (Bauer 1960). In Serbia, southern birch mice were caught not only in natural habitats, but also in gardens and an old vineyard (Petrov 1992).

The data obtained on the biotopic distribution of birch mice shed some light on the reasons for the decrease of their abundance (of the number of trapped animals) in the last two decades. It was during this period that devastation and lawlessness began following the collapse of the Soviet Union, along with the impoverishment of the local population and large-scale uncontrolled clearing of many forest belts especially in the Kerch Peninsula. From the mid-1990s to the middle of the first decade of this century, more than 90–95 % of high-trunk forest belts were cut down, and the remaining tree and shrub vegetation degraded due to the changed conditions of their growth: some dried off, some burned down due to the more frequent summer-autumn steppe fires on abandoned fields with abundant dry ruderal vegetation.

On the other hand, over the past decades, many abandoned agricultural fields in the Kerch Peninsula have undergone succession and their vegetation has changed from ruderal to more or less restored virgin steppe. This should have had a positive effect on the state of birch mouse populations, but the absence of forest belts, which provide good protective conditions from both predators (for example, long-eared owls) and unfavourable weather conditions, did not give the expected effect.

Concluding the chorological analysis of the southern birch mouse in the Crimea, we can state the following. Despite the general low number of birch mice in the Crimean Peninsula and the fragmentation of the species' range, there is no threat of extinction of the species (especially of the eastern population in the Kerch Peninsula) under the current economic system. It is important to note that in connection with the ever-increasing urgency of the problem of biodiversity conservation, researchers are faced with the task of considering the intraspecific genetic structure of species as fully as possible, since fragmentation and reduction of the geographic range leads to the destruction of genetically unique intraspecific taxa. This issue requires further comprehensive study of the steppe birch mouse in its geographically isolated populations in the Crimea.

Conclusions

The southern birch mouse *Sicista loriger* (Nathusius, 1840) is a rare and non-abundant species of small mammals of the Crimean Peninsula that exists in two isolated populations—a western (Tarkhankut) and eastern (Kerch)—separated from each other by 200 km of anthropogenic landscapes.

The data of long-term large-scale epizootological censuses showed that the ratio of trapped birch mice among small mammals was 0.21 % in the whole of Crimea and 0.29 % in its steppe zone with a relative abundance of 0.03 specimens / 100 trap-nights.

The southern birch mouse is active from mid-April to mid-October. The peak of activity was observed in April, when 71 specimens of the species were caught (49.9 % of their total number).

Among the natural enemies, real damage to the abundance of local micropopulations of the southern birch mouse can be caused by the long-eared owl (*Asio otus*), especially during the breeding season, as well by the red fox (*Vulpes vulpes*).

Despite the general low abundance of the birch mouse in the Crimea and the fragmentation of its geographic range, there is no threat of extinction of the species under the modern system of land use. To preserve the populations of the southern birch mouse in the Crimean Peninsula, a detailed study of its biology and ecology and, especially, limiting factors, should be carried out to develop appropriate conservation measures to protects this species, which is also listed in the Red Data Book of Ukraine.

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