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THE SOCIAL VOLE *MICROTUS SOCIALIS* (CRICETIDAE, RODENTIA) IN THE WESTERNMOST PART OF ITS GEOGRAPHIC RANGE

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Key words

population density, social vole, Black Sea seaboard steppes, population dynamics, cyclicity

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Abstract

According to the literature, there are several isolated range segments of *Microtus socialis* across the Palearctic, within which the distribution of the species has mosaic pattern. The westernmost range segment is located in the south of Ukraine covering steppe areas of the Crimea and southern Ukraine and stretching from the lower reaches of the Dnipro to Melitopol in the east and to Dnipro in the north. The social vole is represented in this centre of distribution by the subspecies *Microtus socialis nikolajevi*. The Yahorlyk Kut Peninsula in Kherson Oblast represents the westernmost edge of the subspecies' range, where local conditions have practically remained in their natural state and the social vole (*Microtus socialis*) has a substantial population density. The Yahorlyk Kut Peninsula separates Yahorlyk Bay of the Black Sea from Tendra Bay. The western part of the peninsula (5540 ha) constitutes the 'Yahorlyk Kut' protected area of the Black Sea Biosphere Reserve, where steppe habitats have been partially preserved in their natural state in contrast to the area of the former bombing range, which was attached to the reserve in 1998, where the steppe has slightly transformed. This is the only area of typical halophytic wormwood–grass steppe that has avoided continuous ploughing and irrigation. The population density of *M. socialis* depends on the microrelief, hydrological conditions, and natural spring flooding. The disturbance of vegetation and soil cover due to fires and grazing disrupt the natural population dynamics of social voles. Recovery takes 2 to 3 years. After the cessation of the impact of hydrological, pyrogenic, or pascual factors, population density of the social vole in different habitats becomes balanced. Over 30 years, the population density of *Microtus socialis* ranged from 200 to 7000 ind./ha (on average 1800 ind./ha). The amplitude of fluctuations in the value of relative abundance in the periods between peaks is about 15 units. The cyclicity in population dynamics of the social vole in the Yahorlyk Kut Peninsula is 6–8 years. The dynamics of the number of social voles is determined by abiotic and biotic factors, which are also cyclical. Disturbances in the cyclicity of population dynamics can occur due to 'force majeure' situations of both natural and anthropogenic nature.

Cite as

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Гуртова полівка *Microtus socialis* (Cricetidae, Rodentia) на західній межі свого поширення

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Резюме. За літературними даними на території Палеарктики існують декілька ізольованих осередків, в межах яких розповсюдження виду мають мозаїчний характер. Західний осередок — Південно-Український — це степова частина Криму та півдня України: від пониззя р. Дніпро до м. Мелітополя на сході та до м. Дніпро — на півночі. На території цього осередку мешкає *Microtus socialis nikolajevi*. На західній межі ареалу підвиду на півострові Ягорлицький Кут (Херсонська обл.), що знаходиться практично в природному стані, гуртова полівка (*Microtus socialis*) створює поселення зі значною щільністю населення. Півострів Ягорлицький Кут, відокремлює Ягорлицьку затоку Чорного моря від Тендрівської затоки. Це — єдина ділянка типового галофітного полинно-злакового степу, яка уникла суцільної оранки та зрошування. На ділянці «Ягорлицький Кут» (5540 га) Чорноморського біосферного заповідника цей степ зберігся частково в природному стані, а на приєднаній в 1998 році території (за рахунок ліквідованого військового полігону) — в мало трансформованому вигляді. Щільність населення *M. socialis* залежить від мікрорельєфу, гідрологічних умов, природного весняного підтоплення. Порушення рослинного та ґрунтового покриву через пожежі та випас порушують природну динаміку чисельності гуртовою полівки. Відновлення відбувається за 2–3 роки. Після припинення дії гідрологічного, пірогенного або пасквального фактору значення щільності населення гуртової полівки у різних біотопах вирівнюється. За 30 річний період щільність населення *Microtus socialis* коливалася від 200 до 7000 ос. /га (в середньому 1 800 ос./га). Амплітуда коливань значення відносної чисельності у періоди між піками дорівнює близько 15 одиниць виміру. Циклічність в динаміці чисельності популяції гуртової полівки на півострові Ягорлицький Кут становить 6–8 років. Динаміка чисельності гуртової полівки визначається абіотичними та біотичними чинниками, що також мають циклічність. Порушення в циклічності динаміки чисельності можуть відбуватися через «форс-мажорні» ситуації як природного, так і антропогенного характеру.

Ключові слова: щільність населення, гуртова полівка, приморські степи, динаміка чисельності, циклічність.

Introduction

The geographic range of the species *Microtus socialis* has a mosaic structure. There are several isolated range segments inhabited by different subspecies: *Microtus socialis nikolajevi* on left bank of the Dnieper River at its southern reaches, in the Crimea, Donetsk Oblast, and in the south-west of Rostov Oblast, Russia; *Microtus socialis parvus* in the Caucasus, Stavropol and Krasnodar oblasts and Dagestan in Russia; *Microtus socialis binominatus* in Georgia, west of Azerbaijan, and Iranian Azerbaijan; *Microtus socialis goriensis* in South Ossetia; *Microtus socialis astrachanensis* in Kalmykia and Astrakhan Oblast of Russia; *Microtus socialis socialis* in Kazakhstan, Guryev region, northern part of Ustyurt, in the north to the south-eastern borders of Volgograd region (Lake Elton); *Microtus socialis gravesi* in the northern Aral Sea region, Syr-Darya valley, Kzyl-Orda region, to the east to Chui valley and eastern Kazakhstan (Lake Alokol), to the south to Tajikistan (Kuramin ridge); *Microtus socialis bogdoensis* in China, Eastern Tien Shan, Bogdo ridge [Gromov 1995].

The western boundary of the range of *Microtus socialis nikolajevi* and the species in general is in the Kinburn Peninsula and the Yahorlyk Kut Peninsula, but the abundance of social vole reaches large values only in the Yahorlyk Kut Peninsula. The morphology of the subspecies distributed in the south of Ukraine has been studied quite in detail [Synyavska *et al.* 2015]. The social vole is a common representative of the steppe mammal fauna and an abundant rodent species of protected and little transformed southern steppes.

The Yahorlyk Kut Peninsula is located in the northern part of the Black Sea between Yahorlyk and Tendra bays of the Black Sea (in the southwest of Kherson Oblast, Ukraine). Its total area is about 10 000 hectares, of which 5540 hectares constitute the ‘Yahorlyk Kut’ protected area of the Black Sea Biosphere Reserve (Fig. 1).

Fig. 1. The Yahorlyk Kut Peninsula.

Рис. 1. Півострів Ягорлицький Кут.

The aim of this research is to study the population dynamics of the social vole in the western-most segment of its geographic range and the factors that affect species abundance.

Study area

The Yahorlyk Peninsula is a system of hypsometric terraces not separated from one another. Their surface consists of 1–3 m thick light sandy loess-like loams, on which solonetzic chernozems, dark-chestnut and chestnut soils were formed in complex with solonetzes [Umanets et al. 2007]. Desert coastal wormwood-fescue-sawdust and coastal wormwood-fescue western Black Sea complex steppes stretch along the Black Sea coast from Yahorlyk Bay to Bilosarai Spit [Lavrenko 1980].

The largest fragment of this zonal Black Sea steppe is represented on the Yahorlyk Kut Peninsula. Most of these steppes have been irreversibly transformed anthropogenically. The most destructive for the steppes and their aboriginal faunal complex were ploughing, the introduction of a network of irrigation canals, the creation of a network of rice checks, and overgrazing [Selyunina & Umanets 2006]. Untouched (or little transformed) steppes have survived only in coastal areas of the Black Sea Reserve, on the Yahorlyk Kut Peninsula, and on the coast of Yahorlyk and Tendra bays.

The complexity of the soil cover, the difference in humidity and salinity determine the complex structure of natural vegetation. The main place in its composition is occupied by wormwood-grass steppes, against the background of which are very large arrays of halophytic-steppe vegetation [Umanets 2009].

The ecological and scientific value of natural complexes of the Yahorlyk Kut Peninsula is extremely high. This is the only area of typical halophytic wormwood-grass steppe, which has survived in a slightly transformed form. Land melioration and the resulting flooding and re-salinization in the area of Krasnoznamenska and other irrigation systems, as well as ploughing of the steppe, especially for rice crops, have led to the irreversible degradation of this type of steppe everywhere. In the Yahorlyk Kut Peninsula, it has survived only due to the lack of irrigation and long-term protection [Umanets *et al.* 2007]. The natural complex is represented here by the following habitats:

• *Coastal deserted steppe.* The coastal steppe mammal assemblage is represented by typical steppe species. It consists of 18 mammal species belonging to 6 orders, 10 families, and 15 genera; 27.8% of species tend to synanthropization, 15.8% are threatened species, 22.2% are species common for desert steppe and 16.7% for steppe hollows. The other species are widespread and common for the entire mammal assemblage of the coastal steppe.

• *Meadows*, which are located in hollows of the Black Sea steppe, are characterized by the presence of the East European vole (*Microtus levis*), pygmy wood mouse (*Sylvaemus uralensis*), northern white-breasted hedgehog (*Erinaceus roumanicus*), and least weasel (*Mustela nivalis*). The lesser white-toothed shrew (*Crocidura suaveolens*) [Selyunina & Moskalenko 2020] is a common species of solonetzes and salt marshes.

• *Hollows ('pods'), solonetzes, and coastal reed thickets.*

Beside the species that are characteristic for the Black Sea zonal saline desert steppe, the mammal assemblage of Yahorlyk Kut includes such widespread species as the red fox (*Vulpes vulpes*), common raccoon dog (*Nyctereutes procyonoides*), wild boar (*Sus scrofa*), and, in recent years, also wolves (*Canis lupus*) and badgers (*Meles meles*). The stone marten (*Martes foina*), brown rat (*Rattus norvegicus*) and house mouse (*Mus musculus*) are distributed near human settlements.

Material and Methods

The material for the study was collected during stationary and route surveys, which are part of the monitoring system developed in the Black Sea Biosphere Reserve, including the annual 30 km route survey of the protected area 'Yahorlyk Kut.' Censuses have been carried out annually since 1983 in all main kinds of habitats.

Census of small mammals on trap-lines has been carried out using standard mousetraps in different habitats for more than 30 years; the annual sampling effort was 200 trap-days.

In the period of 2010–2021, additional data was obtained by using Barber traps. In general, the study material used in this research are the results of annual route surveys with a total length of about 1200 km and a total sampling effort of 5000 trap-days using standard mousetraps and more than 4500 trap-days using Berber traps.

Results and Discussion

Description of the population

The social vole *Microtus socialis* (Pallas, 1773) is an abundant species of mammals of the Black Sea steppe in the Yahorlyk Peninsula. This species is also found in other parts of the Black Sea Biosphere Reserve: in forest-steppe areas, in the Potiivka protected area and in the protected zone of Tendra Bay. All these sites are located on the western border of the species' geographic range.

In the Yahorlyk Kut protected area, the population density of *M. socialis* depends on the microrelief, hydrological conditions, disturbance of vegetation and soil cover due to fires and grazing, and natural spring flooding. Here, at the western edge of its range, *M. socialis* is represented by a population having a significant density, which in the Yahorlyk Kut Peninsula ranges in different years from 200 to 7000 individuals per hectare, on average 1800 individuals per hectare. The cyclicity of population dynamics of the social voles equals 6 to 8 years with an amplitude of fluctuation of about 15 units in the periods between peaks and is determined by abiotic and biotic factors, which also have cyclicity. Disturbances in the cycle of population dynamics can occur due to 'force majeure' situations of both natural and anthropogenic nature.

Population dynamics

To determine the population density of the social vole in different habitats, the stationary census method was used. The relative population density is determined by the number of burrows on a given with a mandatory coefficient that characterizes the number of burrows per individuals. In addition, the trap-line method was used to determine relative abundance, where spring-loaded bar traps were used. Since 2010, cones used as modified Barber traps for collecting herpetobiont invertebrates [Selyunina 2000, 2003, 2017; Nitochko 2012] have also been used.

The population dynamics determined by different methods generally coincides (Fig. 2).

Over 30 years of research, the population density of *Microtus socialis* has changed significantly (Table 1). Peak values, which include years with a density of more than 2500 specimens per hectare (sp/h), were observed five times, when density values reached 2500–7000 sp/h (in 1992, 1996, 2002, 2014, and 2020). Minimum values (less than 500 sp/h) were also observed five times, when density dropped to 150–500 sp/h (in 1990, 1997, 2005, 2010, and 2015–2016).

Analysis of cyclicity of population dynamics

The cyclicity in population dynamics of the social vole in the Yahorlyk Peninsula is 6–8 years. In one cycle, population density can change 10–12 times (Table 1). The average 30-year value of population density in the entire area is 1800 individuals per hectare. The amplitude of fluctuations in the value of relative abundance in periods between peaks is about 15 units (Fig. 3).

In low-lying areas of the steppe, the average long-term relative population density is about five times lower than the average long-term value because steppe depressions are often flooded by atmospheric or flood waters.

In areas that have experienced fire or overgrazing, the average population density of voles is two or three times higher. After the cessation of the impact of hydrological, pyrogenic, or pascual factor, the population density of the social vole in different habitats becomes balanced.

Table 1. Peak and minimum values of population density of *M. socialis* in the Yahorlytsky Kut for 30 years (ind./ha)

Таблиця 1. Пікові й мінімальні значення щільності *M. socialis* на Ягорлицькому Куту за 30 років (ос./га)

Parameters	1990	1992	1996	1997	2002	2005	2010	2014	2016	2020
Peak values (>2500 ind./ha)		4500	7000		3600			5000		2500
Minimum values (<500 ind./ha)	200			500		500	150		350	

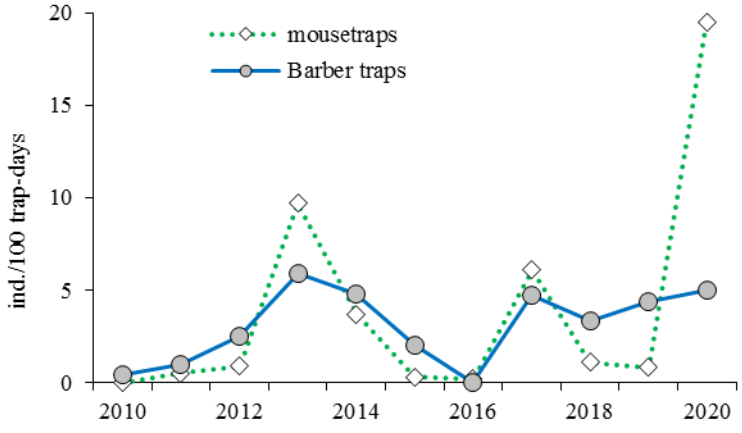

Fig. 2. Population dynamics of *Microtus socialis* according to different census methods in 2010–2020.

Рис. 2. Динаміка чисельності *Microtus socialis* за різними методами обліку 2010–2020 рр.

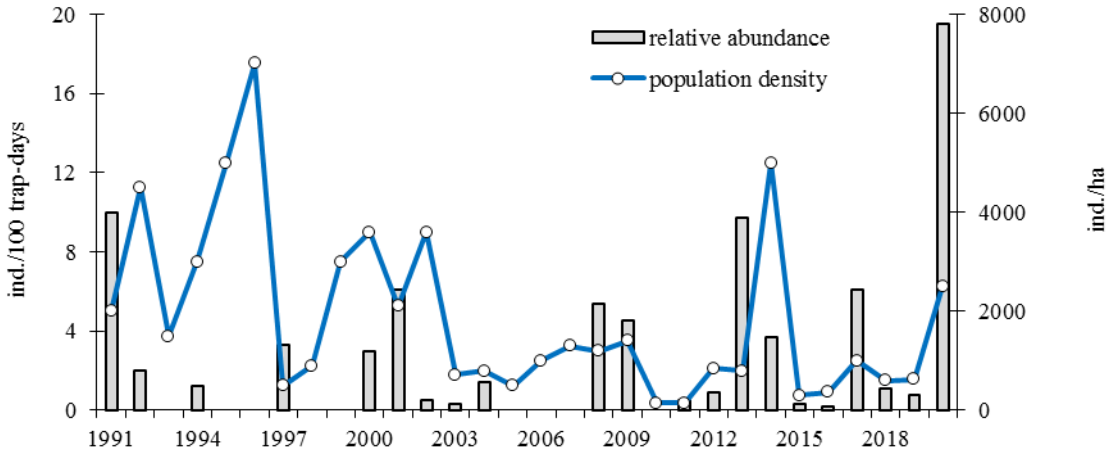

Fig. 3. Population dynamics of the social vole in the Yahorlyk Kut protected area.

Рис. 3. Динаміка чисельності полівки гуртової на ділянці «Ягорлицький Кут».

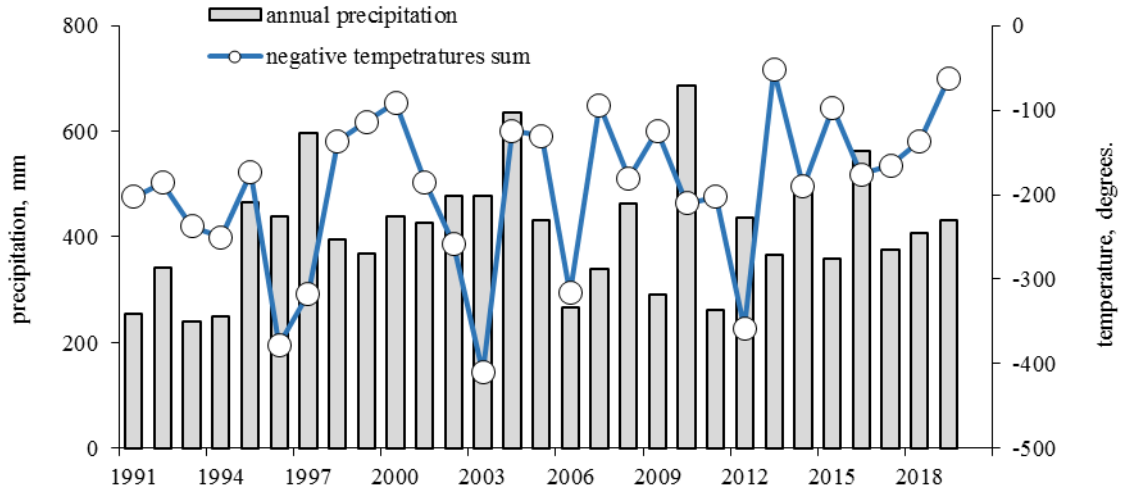

Fig. 4. Parameters of weather factors during 1991–2020.

Рис. 4. Параметри погодних факторів протягом 1991–2020 рр.

In areas that have experienced fire or overgrazing, the average population density of voles is two or three times higher. After the cessation of the impact of hydrological, pyrogenic, or pascual factor, the population density of the social vole in different habitats becomes balanced.

The cyclicity of population abundance of the social vole is also determined by weather factors. After years of maximum annual precipitation (1997, 2004, 2010, and 2016), the relative abundance of *M. socialis* decreases sharply (Fig. 4). In addition, warm snowless winters, which have been observed for six consecutive years, lead to the concentration of predators and the availability of muroid rodents for both terrestrial carnivores and birds of prey due to the lack of stable snow cover [Selyunina & Moskalenko 2020]. In dry years, the abundance of social voles increases tenfold.

Conclusions

On the western border of the subspecies' geographic range in the Yahorlyk Kut Peninsula (Kherson Oblast, Ukraine), which is characterized by the presence of steppe habitats of nearly natural state, the social vole (*Microtus socialis*) has a significant population density.

The population density of *M. socialis* depends here on the microrelief, hydrological conditions, natural spring flooding, and annual weather conditions. The cyclicity in the population dynamics of the social vole in the Yahorlyk Kut Peninsula is 6–8 years.

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