

The small mammals (Eulipotyphla, Rodentia, Lagomorpha) of the Sarnena Sredna gora Mts

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Abstract. As a result of a large-scale study on the small terrestrial mammals (Eulipotyphla, Rodentia, Lagomorpha) of the Sarnena Sredna Gora Mts., through various methodological approaches and methods, we collected data about 2460 individuals, belonging to 30 species. The established species composition represents about 70% of the small terrestrial mammals of Bulgaria, which indicates the presence of a rich faunal complex. Of the established species, 6 are protected, 2 are defined as conservationally significant, with a limited distribution for the area, 3 species are synanthropic. For the first time we confirmed the presence of *Sorex araneus*, *S. minutus*, *C. glareolus* in the Sarnena Sredna Gora Mts. The nutria (*Myocastor coypus*), the European hare (*Lepus europaeus*), and the Red squirrel (*Sciurus vulgaris*) are hunting objects, and the nutria is also included in the list of invasive alien species in Europe. For the first time, the mountain habitats of the small mammal fauna of Sarnena Sredna Gora have been studied, typified, and mapped, and the species richness, zoogeographical structure, nature conservation status, and regularities in its distribution and origin have been analyzed.

Key words: Micromammalia, diversity, distribution, Sarnena Sredna Gora Mts.

Introduction

The terrestrial small mammal fauna of Bulgaria includes representatives of three orders and 43 species, of which 38 are autochthonous (Peshev *et al.* 2004). The great species richness, relatively high density of individuals and numerous methods of collecting biological information make the group suitable for faunal, zoogeographical, ecological, and monitoring studies (Peshev *et al.* 2004, Popov *et al.* 2007).

The available data on the distribution of small terrestrial mammals in the region of the Sarnena Sredna Gora Mts. (Sarnena Gora) are being collected incidentally, during regional surveys of neighbouring territories (Markov 1964, Hristov 1974), from separate localities in settlements and border areas of the mountain (Simeonov 1985, Milchev 2012, Milchev & Gruychev 2015, Mikov & Georgiev 2018), as well as during studies on the distribution, ecology and parasites of individual species or groups (Markov 1957, 1960, Christov 1964, 1966, Tuleschkov 1964, Skuratowics *et al.* 1982, Genov 1984), or studies of the feeding spectrum of diurnal and nocturnal birds of prey (Simeonov 1985, Georgiev 2009,

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Milchev 2012). Information about the fauna of the relatively high parts of the mountain and the territories remote from populated areas is completely lacking. Probably the high degree of urbanization of the lower parts of the mountains and the strong degradation of the peripheral areas with intensive agriculture and livestock farming have led to a neglectful attitude towards the present biodiversity and its conservational importance.

On the territory of the mountain, there are 3 protected sites from NATURA 2000 network: Chirpanski vazvishenia (BG0000628), Reka Tundzha 1 (BG0000192), and Zhrebchevo Reservoir (BG0002052). They cover insignificant areas of the mountain – the extreme peripheries of the Chirpan Heights and the southeastern foothills of the Korten Lobe. There are no reserves declared under the Protected Areas Act.

The diversity of the life forms of the terrestrial small mammal fauna and the specific requirements of the species to the various factors of the environment necessitate the application of a complex of methods for collecting of biological information, requiring different approaches for establishing, mapping and inventorying (Peshev *et al.* 2004, Popov *et al.* 2007). Commonly used methods for assessing the faunal diversity of terrestrial small mammals are: analysis of the components of the food remains of birds of prey, traces of life activities, as well as registration of victims of car accidents or direct observations of living individuals (Popov *et al.* 2007, Taylor *et al.* 2022). Different methodological approaches have different success rates in registering individual species, which necessitates their mandatory complex application (Popov *et al.* 2007). The study of rare, economically and conservationally important species requires long-term and targeted surveys, the purpose of which is the protection and sustainable management of their habitats, guaranteeing their survival, favourable conservation status or economic efficiency (Popov *et al.* 2007).

In this study, the distribution and the preferred habitats from the small terrestrial mammals (Eulipotyphla, Rodentia, Lagomorpha) registered in the Sarnena Sredna Gora Mts are presented.

Material and Methods

The materials used to map the small mammal fauna of the Sarnena Gora were collected through various methods: analysis of food remains and pellets from owls – mainly Barn owl (*Tyto alba*) and Little owl (*Athene noctua*) (2002 – 2020), catch with pitfall traps (March 2019 – May 2020), establishment of traces of life activities (for hedgehogs, moles, mole rats, squirrels, water rats, sousliks, nutria and hares), identification of road kills (mainly for hedgehogs, rats and hares), as well as catches with live traps (for shrews, dormice, voles, mice) or direct observations (hedgehogs, red squirrels, sousliks, nutria, hares, etc.).

The pitfall traps were made of cut plastic bottles with 2 l volume and diameter of the entrance hole of about 12 cm, buried at the level of the substrate and filled with formaldehyde. Six traps were set in each of the selected 22 sampling sites (Table 1). The traps were checked seasonally, i.e. three times a year. The sampling sites were located in three main areas – two in the Bratan region and one in the Chirpan Heights region. When deploying the traps in the Bratan section, the zoning, geographical exposure, naturalness and landscape structure of the habitats were taken into account.

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Table 1. List of the sampling sites, with their code, average altitude, coordinates (GPS), description and dates of visiting.

Code	Locality and altitude a.s.l.	GPS	Habitat	Sampling dates [period]
Pitfall traps 2019–2020				
Svezhen Region				
I	E Svezhen vill. 865 m	42°29'48"N 25°02'54"E	Actively grazed pasture at the southern foot of the Chatal Darvo Peak, with single bushes and trees	22.III–7.VII [1], 7.VII–11.XI.2019 [2], 11.XI.2019–9.V.2020 [3]
II	E Svezhen vill. 863 m	42°29'50"N 25°02'57"E	Old coniferous Scots pine and Norway spruce plantation at the southern foot of the Chatal Darvo Peak, with single trees of beech, birch and black locust	22.III–7.VII [1], 7.VII–11.XI.2019 [2], 11.XI.2019–9.V.2020 [3]
III	E Hut Svezhen 1100 m	42°30'35"N 25°03'51"E	Mesophilous ridge beech forest with many old trees	22.III–7.VII [1], 7.VII–11.XI.2019 [2], 11.XI.2019–9.V.2020 [3]
IV	E Hut Svezhen 975 m	42°30'36"N 25°04'26"E	Old beech forest , near large non-drying up puddle on the mountain road	22.III–7.VII [1], 7.VII–11.XI.2019 [2], 11.XI.2019–9.V.2020 [3]
V	W Svezhen vill. 860 m	42°30'31"N 24°59'59"E	Mesoxerothermic oak forest on the road to Hadzhi Dimitar's Grave Place	22.III–7.VII [1], 7.VII–11.XI.2019 [2], 11.XI.2019–9.V.2020 [3]
VI	1 km NW Hut Svezhen, 1022 m	42°31'03"N 25°02'40"E	Ridge beech forest with many old trees	22.III–7.VII [1], 7.VII–11.XI.2019 [2], 11.XI.2019–9.V.2020 [3]
VII	1 km NW Hut Svezhen 1015 m	42°30'60"N 25°02'38"E	Ridge coniferous plantation of Scots pine, spruce and Douglas-fir, with single trees of beech, overgrown with eagle fern	22.III–7.VII [1], 7.VII–11.XI.2019 [2], 11.XI.2019–9.V.2020 [3]
VIII	NW Hut Svezhen 1008 m	42°31'03"N 25°02'31"E	Actively grazed ridge pasture , surrounded by forests	22.III–7.VII [1], 7.VII–11.XI.2019 [2], 11.XI.2019–9.V.2020 [3]
IX	5 km NW Hut Svezhen 898 m	42°31'59"N 25°02'05"E	Mixed forest of oak, beech and hornbeam, at the upper limit of the oak and the lower limit of the beech	22.III–7.VII [1], 7.VII–11.XI.2019 [2], 11.XI.2019–9.V.2020 [3]
X	S Osetenovo vill. 670 m	42°32'43"N 25°02'32"E	River bank of Turiyska Reka River near dank glade with oaks, cornels and white willows	22.III–7.VII [1], 7.VII–11.XI.2019 [2], 11.XI.2019–9.V.2020 [3]
XI	S Osetenovo vill. 633 m	42°34'12"N 25°01'36"E	Oak forest with numbers of large tufts of butcher's-broom (<i>Ruscus aculeatus</i>)	22.III–7.VII [1], 7.VII–11.XI.2019 [2], 11.XI.2019–9.V.2020 [3]
Chirpan Heights Region				
XII	NW Veren vill. 366 m	42°21'33"N 25°10'37"E	Black locust plantation on sandy soil	23.III–8.VII [1], 8.VII–10.XI.2019 [2], 10.XI.2019–12.IV.2020 [3]
XIII	NW Veren vill. 353 m	42°21'19"N 25°10'47"E	Pasture with Jerusalem thorn (<i>Paliurus spina-christi</i>) and many tufts of prickly pear (<i>Opuntia</i> sp.), near cedar (<i>Cedrus</i> sp.) plantation	23.III–8.VII [1], 8.VII–10.XI.2019 [2], 10.XI.2019–12.IV.2020 [3]
XIV	S Saedinenie vill. 386 m	42°21'01"N 25°17'47"E	Mixed riverine forest of poplars, elms, black pine and black locust, with <i>Ruscus</i> , <i>Viburnum</i> sp., wild vine and ivy	23.III–8.VII [1], 8.VII–10.XI.2019 [2], 10.XI.2019–12.IV.2020 [3]
XV	S Saedinenie vill. 487 m	42°20'39"N 25°17'44"E	Linden forest with tufts of butcher's-broom	23.III–8.VII [1], 8.VII–10.XI.2019 [2], 10.XI.2019–12.IV.2020 [3]
XVI	S Saedinenie vill. 449 m	42°20'44"N 25°17'41"E	Mixed forest of oak, linden, and maple, with <i>Ruscus</i> , <i>Viburnum</i> sp. and ivy	23.III–8.VII [1], 8.VII–10.XI.2019 [2], 10.XI.2019–12.IV.2020 [3]
XVII	N Sredno Gradishte vill. 418 m	42°19'21"N 25°17'39"E	Dry forest on shallow stony soil with oaks, Oriental hornbeam, Jerusalem thorn, cornel, hawthorn and <i>Ruscus</i>	23.III–8.VII [1], 8.VII–10.XI.2019 [2], 10.XI.2019–12.IV.2020 [3]
XVIII	NW Stoyan Zaimovo vill. 435 m	42°21'13"N 25°20'46"E	Abandoned pasture with single bushes and trees – pear, apple, cherry plum, oaks, blackthorn and blackberry	23.III–8.VII [1], 8.VII–10.XI.2019 [2], 10.XI.2019–12.IV.2020 [3]
XIX	NW Stoyan Zaimovo vill. 406 m	42°21'02"N 25°20'40"E	On the edge of alfalfa field , bordering with belt of bushes and trees	23.III–8.VII [1], 8.VII–10.XI.2019 [2], 10.XI.2019–12.IV.2020 [3]
XX	S Stoyan Zaimovo vill. 363 m	42°20'16"N 25°21'28"E	Ecotone between wheat field and small river, overgrown with walnuts and blackberry	23.III–8.VII [1], 8.VII–10.XI.2019 [2], 10.XI.2019–12.IV.2020 [3]
Bratan Region				
XXI	E Zelenikovo vill. 344 m	42°24'46"N 25°05'13"E	Scots pine plantation with lush undergrowth of hawthorn, rosehip, blackberry and butcher's-broom, near	24.III–9.VII [1], 9.VII–9.XI.2019 [2], 9.XI.2019–12.IV.2020 [3]

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walnut and linden plantations				
XXII	S Turiya vill. 583 m	42°31'35"N 25°11'59"E	Riverine forest at the lower limits of the beech, with alder, hazel and hornbeam	24.III-9.VII [1], 9.VII-9.XI.2019 [2], 9.XI.2019-12.IV.2020 [3]
Pellets 2017-2020				
	Gorno Belevo vill. 192 m	42°15'23"N 25°14'16"E	Abandoned buildings in settlements at the southern mountain slopes	22.XII.2019
	Rumanya vill. 223 m	42°30'15"N 25°52'30"E	Abandoned buildings in settlements at the southern mountain slopes	16.XII.2019
	Bratya Kunchevi vill. 225 m	42°29'41"N 25°50'45"E	Abandoned buildings in settlements at the southern mountain slopes	16.XII.2019
	E Brezovo town 254 m	42°20'48"N 25°05'17"E	Abandoned industrial base (factory)	19.VI.2020
	Zapalnya 269 m	42°38'15"N 25°53'07"E	Settlement on Zhrebchevo Dam (8 km east from Nikolaevo town)	18.VI.2020
	Staro selo vill. 295 m	42°34'51"N 26°08'54"E	Abandoned buildings in settlements at the southern mountain foothills	22.XII.2019
	Shanovo vill. 299 m	42°32'60"N 25°36'39"E	Abandoned buildings in settlements at the northern mountain slopes	19.VI.2006
	Yulievo vill. 299 m	42°32'60"N 25°36'39"E	Abandoned buildings in settlements at the northern mountain slopes	21.III.2017
	Medvena – hunting farm 200 m	42°28'30.2"N 25°44'11.0"E	Abandoned buildings in settlements at the northern mountain slopes	20.VI.2018
	S Kolena 200 m	42°27'28"N 25°44'05"E	Abandoned buildings in settlements at the southern mountain foothills	2002
	Hrishteni 200 m	42°27'11"N 25°42'05"E	Southern mountain foothills	2002

Owl pellets are a good and reliable tool in studying small mammal communities and detecting rare species and they have many advantages over traditional trapping methods (Heisler *et al.* 2016). In this respect, barn owl pellets were collected from ten different locations (Table 1), of which seven are on the southern mountain slopes (Brezovo town and the villages of Gorno Belevo, Kolena, Bratya Kunchevi, Rumanya, Staro selo, Hristheni), and three are on the northern ones (Yulievo, Shanovo, Zapalnya). Some records of small mammals were obtained from the electronic public database Smartbirds (Popgeorgiev *et al.* 2015).

The collected data from observations from traces of life activity, carcasses of animals killed in car accidents and directly observed live individuals were from transects along the routes of forest roads to our sampling sites or along the main roads between settlements. Hedgehogs, moles, blind mole rats, sousliks, red squirrels, water voles, nutria and European hare have been registered by this method. To supplement the information on the species which are hunting objects, we have surveyed local hunters and fishermen, and subsequently supplemented and verified the reliability of the information. In total, 52 traces of life activities of small mammals, 9 hedgehog corpses, 8 live European hares and about 15–20 nutria were observed.

The presence of the sibling vole *Microtus rossiaemerdionalis* was confirmed by cariological examination.

The zoogeographic categorization of the small mammal fauna from Sarnena Gora and the evaluation of the faunal complexes are according to Popov (2007).

Results and Discussion

In total, 121 individuals of 9 species, of which 5 species of insectivores and 4 species of rodents, were caught with pitfall traps. From the collected owl pellets, skeletal remains of at least 2275 individuals (minimum individual numbers) were identified, belonging to 21 species, of which 5 insectivores and 16 rodents. The overall results from the study revealed that in the Sarnena Sredna Gora Mts 30 species of small mammals occur. They belong to 22 genera, and this represents, respectively, 70% of all established Bulgarian micromammalian species, 73% of the genera and 92% of the families (Peshev *et al.* 2004).

For the first time we confirmed the presence of *Sorex araneus*, *S. minutus*, *C. glareolus* in the Sarnena Sredna Gora Mts.

Species list:

Northern white-breasted hedgehog (*Erinaceus roumanicus* Barret-Hamilton, 1900)

It is a quite common species throughout the country distributed up to 1800 m a.s.l. (Peshev *et al.* 2004). It has been found common and recorded in numerous localities in the study area, as the highest altitude record comes from 1082 m a.s.l. It often becomes a victim of road accidents. Previously the species has been reported from Milkini Skali Site (2,5 km west from Moruley hut) (Georgiev 2009), Bedechka city park in Stara Zagora), Hrishteni Vill. (Mikov & Georgiev 2018), Mezhdzenik ridge (MH01, MH11) (Milchev & Gruychev 2015). We recorded the hedgehog from the following sites: Sampling sites III and XIII, Dolno Sahrane vill., between Zelenikovo vill. and Brezovo town, Granit vill., south of Varben vill., Domlyan vill., Pavel Banya town, north of Rozovets vill (Fig. 1).

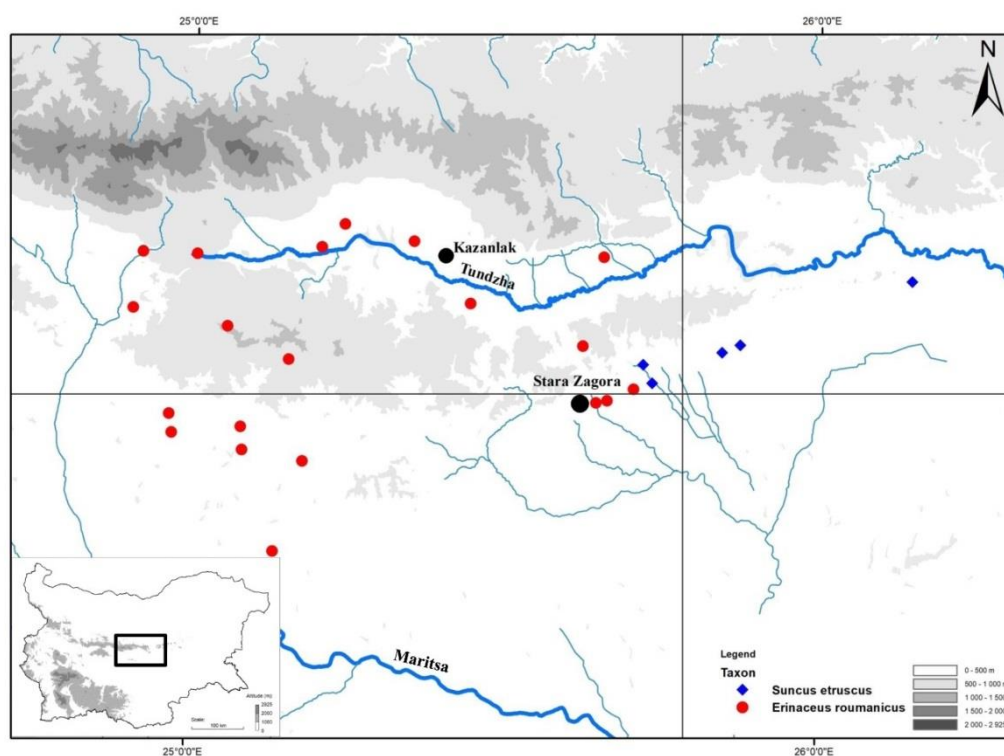


Fig. 1. Records of the Hedgehog (*E. roumanicus*) and Etruscan shrew (*S. etruscus*) in Sarnena Gora.

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European mole (*Talpa europaea* Linnaeus, 1758)

It is a common species in Bulgaria (Peshev *et al.* 2004). It prefers wet meadows and pastures, gardens and river banks where it finds its preferable food – earthworms. Previously the species has been reported from Slivenski mineralni bani (Markov 1951), Bedechka city park in Stara Zagora, Mezhdzenik ridge – UTM squares MH11 (Milchev 2012) and MH01 (Milchev & Gruichev 2015). We registered its presence in numerous localities in the study region – south of Varben vill., Srednogorovo vill., south of Razhena vill., northeast from Lyuliak vill., nearby the Moruley hut.

Common shrew (*Sorex araneus* Linnaeus, 1758)

It is a mesophilic species inhabiting mainly the mountains in Bulgaria but is also recorded from the lowlands (Peshev *et al.* 2004). Milchev (2012) reported *S. araneus* from the southwestern most part of the Kazanlak valley, at the foothills of the Sarnena Gora (UTM – LH14). We recorded the common shrew between 254 and 1100 m a.s.l., as most of the records are above 1000 m in the vicinities of Svezhen Hut (Sites II, III, IV, V, VII, XII). Other new localities are: near the villages of Veren and Zapalnya (owl pellets) (Fig. 2).

Pigmy shrew (*Sorex minutus* Linnaeus, 1758)

It is a mesophilic species inhabiting mainly the mountains, but there are some records from the lowlands of southeastern and northern Bulgaria (Peshev *et al.* 2004). Milchev (2012) reported *S. minutus* from the Kazanlak valley (UTM – LH14). It is a new record for the region, found between 230 and 850 m a.s.l. (Fig. 2): both, on southern and northern slopes – in the vicinities of Svezhen hut, (Sites I, II, IV, V) and near Osetenovo Vill. (Site X), respectively, as well as at the Chirpan Heights (XIX).

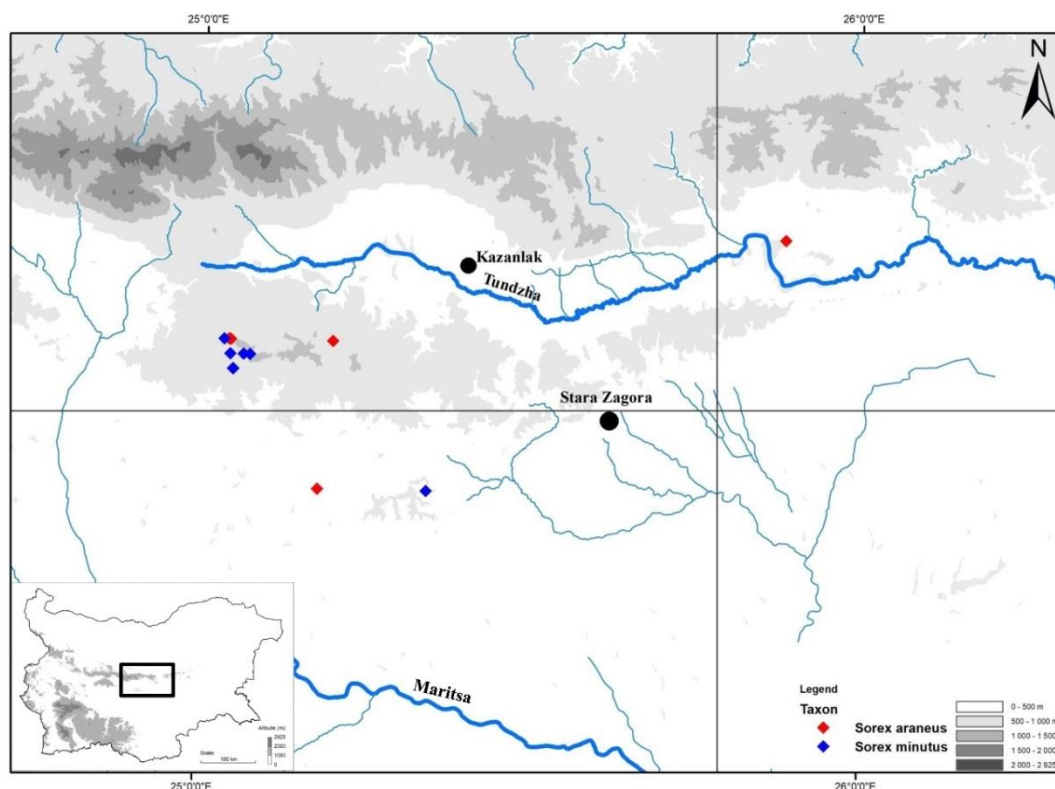


Fig. 2. Records of the Common (*S. araneus*) and Pigmy shrew (*S. minutus*) in Sarnena Gora.

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Mediterranean water shrew (*Neomys milleri* Mottaz, 1907)

It is widespread in Bulgaria and inhabits different wet habitats, sometimes even far from water, up to 2000 m a.s.l. in the mountains (Peshev *et al.* 2004). The species was reported from Stara Zagora and Malka Vereya Vill. (Markov 1964). We found it in the following locations: Sites III and VIII, and near the villages of Staro selo, Rumanya, Yulievo, Shanovo, Hrishteni, Kolena and Zapalnya.

White-tooted shrews (genus *Crocidura*)

They are presented by two species – **bicoloured white-tooted shrew (*C. leucodon*, Hermann, 1780)** and **lesser white-tooted shrew (*C. suaveolens* Pallas, 1811)**, as both species are quite common among small mammal communities on low altitudes (Peshev *et al.* 2004). They are opportunistic species inhabiting a variety of habitats in lower to middle altitudes (1000 m a.s.l.), as it seems *C. suaveolens* prefers more open and human modified habitats, on the other hand, *C. leucodon* is a more mesophilic species and is often caught in forest habitats (*Quercus* sp.). We found these species in numerous localities, as they are the most common and abundant shrews in the barn owl pellets, consisting of about 34% of all small mammals. Previously the species are reported from Stara Zagora city and Starozarorski mineralni bani (Markov 1964, Tuleshkov 1964). We found *C. suaveolens* in Site XVIII and *C. leucodon* was collected in Sites II and XIII; both species were also detected in pellets from the villages of Rumanya, Medvena, Staro selo, Yulievo, Bratya Kunchevi, Shanovo, Gorno Beleva, Hrishteni, Kolena, Zapaliya and Brezovo town.

Etruscan shrew (*Suncus etruscus*, Savi 1822)

The species was firstly reported for the Bulgarian fauna in 1985 from Burgas (Vohralik 1985), since than it was found in many places in SE Bulgaria (Popov *et al.* 2004). Recently, Milchev (2012) reported *S. etruscus* from the Kazanlak valley with two records south of Tvarditsa. We found it only in barn owl pellets collected from the southern foothills of the mountain – Brezovo, Kolena, Bratya Kunchevi, Staro selo and Rumanya (Fig. 1). *Suncus etruscus* consisted of a negligible part of all small mammals found in the diet of the barn owl – 0.75% (out of 2275 prey items).

Brown (European) hare (*Lepus europaeus* Linnaeus, 1758)

The distribution of the brown hare includes almost the entire Palaearctic – the unforested parts of northern Africa, Europe without the extreme north, east to Central Asia (Peshev *et al.* 2004). It is widespread in our country but with very large differences in its density in individual regions. It prefers natural and semi-natural habitats with a relatively low intensity of the agriculture. Over the last 50 years, the species has declined catastrophically and, despite being a major hunting target, in most of the country it is actually not been hunted (Zhelev *et al.* 2013). Estimated density for the studied area in the first decade of the 21st century was about 1 to 2 individuals per 100 hectares – a relatively low density (Zhelev *et al.* 2013). According to Zhelev *et al.* (2013), similarly to the situation in the neighbouring territories, its numbers in Sarnena Gora fell sharply at the end of the 1980s, after which it never recovered. In the studied area, the hare was reported without specific localities by Starozagorski Mineralni Bani (Hristov 1966), Mezhdzenik Ridge (Milchev & Gruichev 2015); Milkini Skali area (2.5 km west of the Morulei Hut) (Georgiev 2009). The presence of the European hare in the region of the Sarnena Gora is very common in our expert opinion, but specialized and targeted research is needed to establish its current status. The natural and semi-natural habitats in the foothills and mountain areas, as well as in the abandoned vineyards, orchards and fields bordering settlements, are especially preserved. During our research, the species was recorded in the area of the following places: Grave of Hadzhi Dimitar – xerothermic oak forest at 860 m a.s.l. (07.07.2019); near Svezhen

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vill., northeast of the village, on the road to Svezhen at 865 m a.s.l., pasture and conifer plantation (22.03.2019); SE of Svezhen (42°29'26.5"N 25°03'17.3"E, 840 m, 20.06.2020); east of hut Svezhen, under the peak Chatal Darvo at 1100 m a.s.l.(7.07.2019); the village of Varben (42°24'05"N, 24°58'16"E, 291 m, on 29.05.2019), in a pasture above Varben (42°25'42"N, 24°58'27"E, 380 m, 1.06.2019), south of Varben (42°23'43.1"N 24°58'14.0"E , 281 m, 20.06.2020); east of the village of Babek (42°26'10.1"N 25°05'32.8"E, 367 m, 18.06.2020) , crossing the road around Babek (42°26'16"N 25°05'34"E, 374 m, 18.06.2020) ; around the village of Drangovo (42°24'43"N, 24°58'51"E, 256 m, 11.11.2019); north of Brezovo town (42°21' 28.4"N 25°03'47.2"E, 257 m, 18.06.2020) ; around Brezovo town (42°20'49.0"N 25°05'14.6"E, 255 m, 19.06.2020 and 42°20'46"N 25°05'14"E, 554 m, 19.06.2020); east of the village of Veren (42°21'05.8"N 25°10'58.2"E, 315 m, 19.06.2020 and 42°21'13.2"N 25°10'49.4"E, 341 m, 19.06.2020); crossing the road near Granit vill. (42°15'57"N, 25°08'07"E, 176 m, 31.05.2019); around the village of Lyulyak (42°32'16.7"N 25°42'34.6"E, 650 m, 19.06.2020), west of Lyulyak (42°29'20.6" N 25°38'18.7"E, 483 m, 19.06.2020); north of Korten vill. (42°34'17.0"N 25°59'48.9"E, 344 m and 42°34'15.6"N 25°59'51.5"E, 337 m) on 18.06.2020; east of Panicherevo (42°36'55.8" N 25°53'47.4"E. 500 m, 18.06.2020). On 7.07.2019 north of Rozovets two bunnies crossed the road in front of the car. It is interesting that we observed a young hare (2-3 months old) on 23.03.2019, which shows an early breeding. Also, on 9.07.2019, at a very short distance, on the road near Veren vill. we registered 4 hares, which indicates relatively high concentration of individuals.

Red squirrel (*Sciurus vulgaris*, Linnaeus, 1758)

The species occurs throughout the country, from the sea level up to the timberland, as it is more common in the mountains. This species has always been rare in the area of Sarnena Gora, which we found both from our research and from the monograph by Markov (1960) on the species. We recorded the red squirrel in Site XVII, near Pavel Banya (42°36'12.97"N, 25°12'12.80"E, 406 m a.s.l. and 42°35'55.33"N, 25°12'30.90"E, 410 m), Stara Zagora, Srednogorovo vill., Sredno Gradishte vill., Kolena vill. and Borilovo vill., but probably the species has broader distribution in the region.

European souslik (*Spermophilus citellus*, Linnaeus, 1766)

Once being common and numerous, now its populations are fragmented and declining because of different human activities and practices (Koshev 2008). It inhabits open grassland habitats – mainly pastures and steppe-like habitats up to 2500 m a.s.l. in the mountains (Peshev *et al.* 2004). The souslik has been previously reported from Zagore vill. (Tuleshkov 1964), Stara Zagora (Markov 1964) and Starozagorski mineralni bani (Hristov 1964). We sighted its presence mainly on pastures, in the vicinities of the villages of Veren (Site XIII), Rozovo, Dolna Mahala, Ivan Vazovo, Drangovo, Sadiysko pole, and Tsenovo (Fig. 3).

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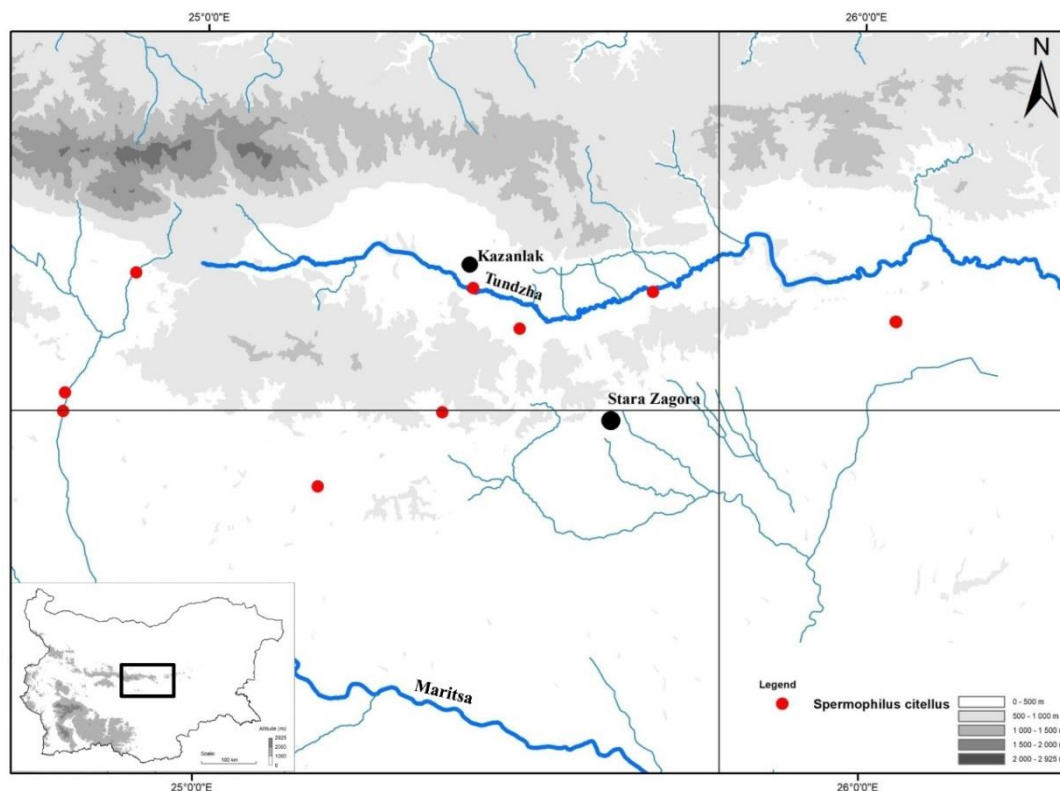


Fig. 3. Records of the European souslik (*S. citellus*) in Sarnena Gora.

Edible dormouse (*Glis glis* Linnaeus, 1766)

It is a quite common species in Bulgaria, inhabiting beech and oak forests on different elevations (Peshev *et al.* 2004). Previously the species is reported for the Sarnena Gora only from Starozarorski mineralni bani (Skuratowics *et al.* 1982). We found it only in barn owl pellets collected from Yulievo vill. and Kolena vill.

Hazel dormouse (*Muscardinus avellanarius* Linnaeus, 1758)

It is quite common in the mountains, rather than lowlands (Peshev *et al.* 2004). Milchev (2014) found it in 8 locations in the Kazanlak valley, and it was presented in a relatively low number (0.16% of 18.314 small mammals) in the diet of the barn owl. We found this species at altitudes from 270 to 870 m a.s.l. in the following locations – Sites X (cathod in pitfall trap), I and V (nibbled hazelnuts found), near Brezovo town (in pellets) and south of Varben vill. (1 ad. female caught in an old walnut garden, 20.VI.2020, 42°24'248"N, 24°58'11"E, 300 m) (Fig. 4).

Forest dormouse (*Dryomys nitedula* Pallas, 1773)

It is the commonest glirid in Bulgaria, inhabiting different forest habitats, orchards and shrubs up to 1850 m a.s.l. (Peshev *et al.* 2004). The species is reported from Malka Vereya vill., Morozovo vill. and Srednogorovo vill. (Markov 1964, Hristov 1974). We got one subadult male in an old walnut garden nearby Varben vill. (together with the hazel dormouse female, on the same tree, 20.VI.2020, 42°24'248"N, 24°58'11"E, 300 m). Also, we found *D. nitedula* in barn owl pellets from the Rumanya vill., Straro selo vill. and Kolena vill. (Fig. 4).

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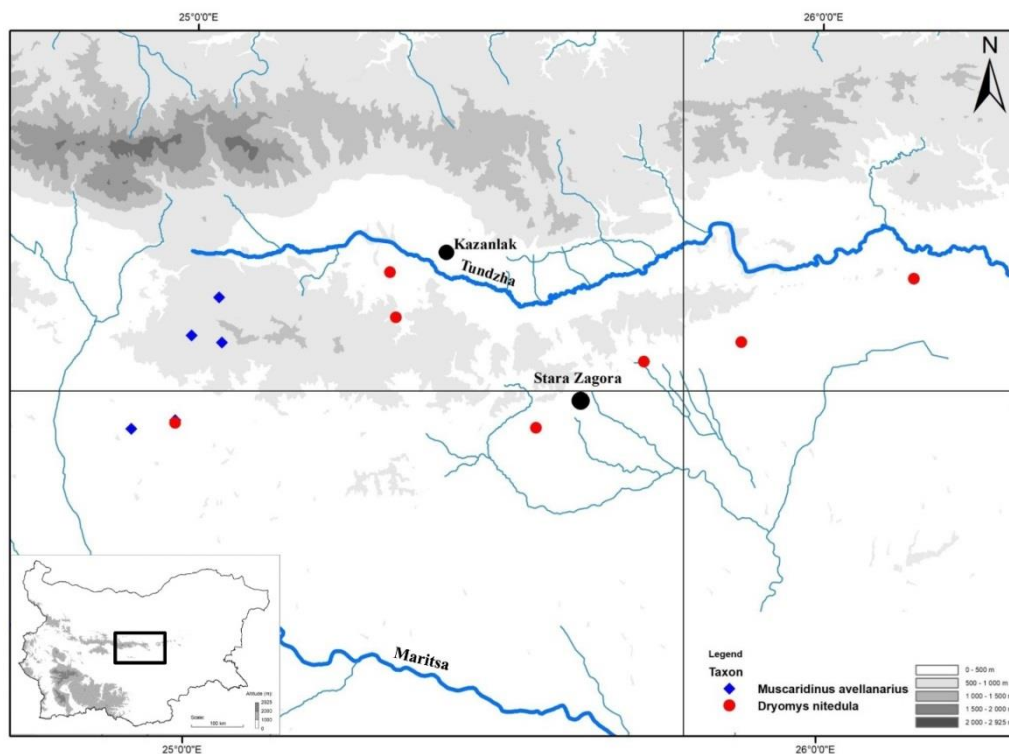


Fig. 4. Records of the common (*M. avellanarius*) and forest dormouse (*D. nitedula*) in Sarnena Gora.

Wood mice (*Apodemus* sp.)

The **yellow-necked mouse (*Apodemus flavicollis* Melchior, 1834)** and **wood mouse (*A. sylvaticus* Linnaeus, 1758)** are one of the most common and numerous rodents across Europe. They inhabit a variety of habitats, but it seems that the wood mouse prefers more open fields than the yellow-necked mouse which is restricted to woodlands. In Sarnena Gora, the species have been reported from Stara Zagora, Starozagorski bani and Srednogorovo (Tuleshkov 1964, Hristov 1964, Skuratowics *et al.* 1982). We trapped *A. sylvaticus* south of Varben vill. and also found it in pellets from Rumaniya vill., Staro selo vill., Yulievo vill., Bratya Kunchevi vill., Gorno Belevovo vill., Zapalnya and Brezovo town. *A. flavicollis* was collected in Sites I, II, III, IV, V, VII, IX, X, XI, XIII, XIV, XV, XVI, XVIII, XX and XXII, and found in pellets from Yulievo vill.

Field mouse (*Apodemus agrarius* Pallas, 1771)

It is a mesophilic species with intrazonal distribution in Bulgaria, preferring wet habitats – river and channel banks, rise fields, etc. Hristov (1974) found this species in numerous locations in the Kazanlak valley. Previously the species has been reported for the mountain from Rozino vill., Srednogorovo vill. and Starozagorski bani (Hristov 1974, Skuratowics *et al.* 1982). During this study we found the field mouse only in the food remains of barn owl collected from the following locations: Brezovo town, Bratya Kunchevi vill., Rumaniya vill., Yulievo vill., Shanovo vill. and Zapaliya.

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Harvest mouse (*Micromys mimutus* Pallas, 1771)

Such as the previous species, it prefers wet habitats in lowlands, and is rarely recorded above 500 m a.s.l. (Peshev *et al.* 2004). In Sarnena Gora, Hristov (1974) reported this species from Rozovo vill. We found it in barn owl pellets from Brezovo town, Gorno Belevu vill., Rumanya vill., Yulievo vill., Shanovo vill. and Zapalnya.

House mouse (*Mus musculus* Linnaeus, 1758)

It is a synanthropic species whose distribution is strictly associated with human activities and settlements. It is a common pest with worldwide distribution. The house mouse is reported for the region by Markov (1964) (under the name *M. m. azoricus*) and Touleshkov (1964). We found it only in owl pellets from Rumanya vill., Yulievo vill. and Shanovo vill.

Macedonian mouse (*Mus macedonicus* Petrov & Ružić, 1983)

It is a common species in the lowlands of south Bulgaria and, in contrast to *M. musculus*, it lives outside human settlements (Peshev *et al.* 2004). Markov (1964) reported this species (under the name *M. musculus hispaniscus*, a form with relatively shorter tail) from Stara Zagora and Starozagorski bani. It was quite common in the study area, found in numerous locations: in a trap south of Varben, and in all nine localities where pellets were collected – Bratya Kunchevi, Kolena, Staro selo, Gorno Belevu, Rumanya, Yulievo, Shanovo, Brezovo and Zapalnya.

Rats (*Rattus* sp.)

The black rat (*Rattus rattus* Linnaeus, 1758) and the brown rat (*Rattus norvegicus* Berkenhout 1769) are commensal species inhabiting human settlements. It seems that *R. rattus* is more common in southern Bulgaria, in contrast to *R. norvegicus* which is more common in northern Bulgaria. *R. rattus* is strictly associated with human settlements, but *R. norvegicus* could live outside them temporarily (seasonal infestations in cereal and corn fields) or form wild populations (along rivers, channels, or water reservoirs). We found these species only in barn owl pellets: *R. rattus* from Yulievo vill, Brezovo town and Zapalnya, and *R. norvegicus* – from Yulievo vill.

Gray dwarf hamster (*Cricetulus migratorius* Pallas, 1773)

This is a rare species in our country. Bulgaria lies on its westernmost edge of distribution (Kryštufek *et al.* 2016). Recently Nedyalkov (2016) reported several records from SE Bulgaria, as one comes not far from the study area – near the town of Sliven. Markov (1964) reported this species from the region of Malka Vereya vill. and Starozarorski bani, and Tuleshkov (1964) reported it from the vicinity of Stara Zagora. During our study, the species has not been registered, but it is likely to occur since potential habitats do exist.

Bank vole (*Clethrionomys glareolus* Scheber, 1780)

It is a quite common and numerous rodent in our mountains, especially in the beech forests, usually above 500 m a.s.l. (Peshev *et al.* 2004). The species has been previously reported from Bogdan Hut (Sashtinaska Sredna Gora) (Hristov 1974), and also found quite common in the neighbouring Balkan (Stara planina) mountain (Markov 1974). It is a new species for the Sarnena Sredna gora. We caught 22 individuals in the region of Svezhen Hut and above Osetenovo vill. (Sites II, III, VI, VIII and XI).

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Grey voles (subgenus *Microtus*)

In Bulgaria they are presented with two morphologically similar species – *M. arvalis* Pallas, 1778 and *M. rossiaemeridionalis* Ognev, 1924 (Peshev *et al.* 2004). Their distribution is still not fully studied, but it seems that *M. rossiaemeridionalis* occurs in SE Bulgaria and lowlands, as both species co-occur in northern Bulgaria, south of the Balkan Mountain. *M. arvalis* is found mainly in mountain areas (above 600 m a.s.l.) (Peshev *et al.* 2004, N. Nedyalkov unpubl. data). We found the complex *M. arvalis/rossiaemeridionalis* in pellets from the following localities: Rumaniya vill., Medvena, Staro selo vill., Bratya Kunchevi vill., Brezovo town, Gorno Belevo vill. vill., Rumaniya vill., Yulievo vill., Shanovo vill. and Zapaliya. We also proved the presence of *M. rossiaemeridionalis* on the base of a single karyotyped individual (karyological examination done by Vanya Koleva) from Varben vill. (20.VI.2020, 42°23'46.8"N, 24°58'16.6"E).

European pine vole (*Microtus subterraneus* de Selys Longchamps, 1836)

It is common and numerous in our mountains but it is also found at lower altitudes (Peshev *et al.* 2004). Milchev (2014) found this vole in 13 localities in Kazanlak valley. We caught this species north of Veren vill. and found its remains in barn owl pellets from Yulievo vill. and Zapaliya. These two records, from 269 and 366 m a.s.l., are the first evidence for the presence of the pine vole in Sarnena Sredna Gora.

Water vole (*Arvicola amphibius* Linnaeus, 1758)

It is a semi-aquatic rodent widespread in Bulgaria, from the sea level up to 2000 m a.s.l. (Peshev *et al.* 2004). We found it along the river of Tundzha – near Panicherevo and Banya villages, at the river of Sazliyka near Starozagorski Mineralni Bani, and in owl pellets from Hrishteni vill., Yulievo vill. and Brezovo town.

Lesser mole rat (*Nannospalax leucodon* Nordman, 1840)

It is a common species found across the country up to 2000 m a.s.l. It is represented by several karyological forms, at least 10 found in Bulgaria (Peshev *et al.* 2004). We sighted its presence in the vicinities of Bratya Kunchevi, Borilovo, Hrishteni, Medvena, Stoiyan Zaimovo, Veren, Sredno Gradisthe, Rozovo, at the river of Tundzha near Banya vill..

Coypu (*Myocastor coypus* Molina, 1782)

This is an alien species originated from South America, but it has been introduced worldwide – In North America, Europe, Asia, and North Africa. In Bulgaria, the species is introduced first in the Sherba game farm in 1948, and in 1953 it is released in the wild in Lake Mandra and Arcutino Reserve (Peshev *et al.* 2004). Recently Koshev *et al.* (2022) showed that the coypu is widely distributed in SE Bulgaria and quite common in Maritsa and Tundzha rivers basins. During our survey in the region, we observed the species in 4 localities along the Tundzha river: nearby Pavel Banya (a group of 10 individuals of different ages, in October 2021; and 2 individuals on 10.03.2022); Viden village, “Potopenata tzarkva” (Zapalya) (numerous observations in the autumn of 2021); in the vicinity of Razhena and Yagoda villages (numerous observations in 2021–2022). According to local hunters and fishermen, the coypu settled in this part of the river and established populations in the last 10-12 years.

The coypu has been listed as an invasive species by the European Community since 2019, and the management of the species is regulated by EU Regulation 1143/2014. The species is included in the Low for Hunting and Protection of the Game and its hunting is legally permitted annually in the period 1 November – 27(28) February. The presence of nutria in the Bulgarian nature is not fully understood, but it is very likely to be a function of

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three factors – introduction, displacement of animals escaped from fur farms, and displacement from neighbouring countries, via river systems and water networks.

Zoogeographical structure, specificity of habitats and distribution of the small mammal fauna from Sarnena Gora Mts

Here we follow the zoogeographical classification proposed by Popov (2007), who alleged Bulgarian mammal fauna to 4 faunal complexes divided into several subclasses (faunal elements). In the area of the Sarnena Sredna Gora we found 30 species of small mammals. They belong to the following faunal complexes:

1. Boreal faunal complex (5 species):
 - Eurosiberian forest element: *Sorex araneus*, *S. minutus*, *Clethrionomys glareolus*, *Arvicola terrestris*
 - Eurosiberian forest-steppe element: *Lepus europaeus*
2. Nemoral complex (15 species):
 - Transpalearctic elements: *Sciurus vulgaris*, *Micromys minutus*, *Apodemus agrarius*
 - South (East) European and West Asian element: *Erinaceus roumanicus*, *Crocidura leucodon*, *Dryomys nitedula*, *Microtus rossiaemeridionalis*
 - European element: *Talpa europaea*, *Neomys mileri*, *Glis glis*, *Muscardinus avellanarius*, *Apodemus flavicollis*, *Ap. sylvaticus*, *Microtus subterraneus*
3. Mediterranean faunal complex (3 species):
 - Widely distributed in southern areas: *Suncus etruscus*
 - Submediterranean element: *Crocidura suaveolens*
 - East Mediterranean element: *Mus macedonicus*
4. Eurasian Steppe complex (3 species):
 - East European-West Asian element: *Cricetulus migratorius*
 - Balkan (Southeast European) element: *Spermophilus citellus*, *Nannospalax leucodon*

In the area 4 non-native (introduced and synanthropic) species are found – *Myocastor coypus*, *Mus musculus*, *Rattus rattus* and *R. norvegicus*.

As shown, the small mammal fauna in Sarnena Gora is presented by diverse faunal elements, as it is obviously dominated by species of the Nemoral complex (thermotolerant species associated with mesophilous broad-leaved forests across the temperate area of the Palaearctic) which encompass ½ of all known species of the area. In the same time, elements from the Mediterranean faunal and Eurasian Steppe complex are also present. The results of the study show the presence of a relatively rich and diverse small mammal fauna for such a small territory. The main reason for the formation of this unique fauna is the geographical location, the unevenness of the relief and the variety of landscape forms and micro-habitats.

The strong dominance of the mesophilous forest faunal type (73%, while the average for the whole territory of Bulgaria is slightly over 60%) indicates the prevailing mountain microclimate and its main biotic elements – mostly forest species with extensive Holarctic, Transpalearctic and European ranges. The relatively high proportion (15%) of the cold-tolerant Eurasian species further emphasises the general montane character of the area, despite the strong landscape alterations that have occurred with the land-use change and deforestation. Typical mountain species as *Neomys fodiens* (Pennant, 1771) and *Chionomys nivalis* (Martins, 1842) are not presented here, which is logical given the altitude of the mountain, which only in its very small ridge in the western part of the Bratan Lobe barely exceeds 1000 m a.s.l. Gruev & Kuzmanov (2007) place the boundary between mountain and lowland regions at about 700 m, and Popov (2007) shows that it well corresponds for

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mammals presence too, as the majority of the mountain species occur above 900 m. Despite the lack of a well-formed mid-mountain and high-mountain belt (Gruev & Kuzmanov 1994), a montane small mammal fauna is present. The bank vole (*C. glareolus*) in combination with the two mesophilic brown-toothed species (*S. araneus* and *S. minutus*) and the European pine vole (*M. subterraneus*) can be taken as a reliable indicator for the presence of the mountain faunal element.

Although with a relatively small percentage compared to the whole territory of Bulgaria, the presence of thermophilic species such as the Etruscan shrew (*S. etruscus*), eastern Mediterranean mouse (*M. macedonicus*) and the lesser white-toothed shrew (*Cr. suaveolens*) in the low areas of the mountain shows the importance of climatic conditions for the spread of wide-spectrum thermophilic faunal elements characteristic of the Upper Thracian Plain. The absence of the typical Mediterranean species such as the Mouse-tailed dormouse (*Myomimus roachi* Bate, 1937), Harting's vole (*M. hartingi* Barrett-Hamilton, 1903) and Martino's mole (*Talpa martinorum* Krystufek et al., 2018), which are characteristic of the lower reaches of the Tundzha River, Strandzha Mts., Sakar Mt. and the Southern Black Sea coast, shows a kind of a limit in the distribution of Mediterranean (*sensu stricto*) species, the main reason for which is probably in the climatic factors.

An interesting fact is the distribution of the Etruscan shrew (*S. etruscus*) in Sarnena Gora, which was recorded by analysis of *Tyto alba pellets*, both by us and by other authors (Milchev 2012). All the localities of the species are on the southern side of the mountain, and along the Tundzha River the species reaches the Mezhdzenik ridge, while it is absent on the northern slopes and in the Trans-Balkan Valleys. Another interesting fact is the absence of the species in previous studies of the diet of owls from the same or nearby territories (Simeonov 1985), as well as the absence of the species in the large-scale studies of the Upper Thracian Plain (Markov 1964, Tuleshkov 1964, Hristov 1964, 1966) and of the Rose Valley (Hristov 1974). It is likely that the expansion of the species from the east and south began in the period after the 1970s and 1980s, and is very likely resulting from the global climate changes. Due to its very small size and probably its low relative density, the Etruscan shrew falls very rarely in pitfall traps and relatively often, but with a small relative share of all victims – in an analysis of the diet of owls.

The Eurasian steppe small mammal biota established in Sarnena Gora is also relatively poor represented. Of the steppe faunal elements widespread in Bulgaria, in the region of Sarnena Gora are found the blind mole rat (*N. leucodon*) and the souslik (*Sp. citellus*), and of the specific ones – only the grey dwarf hamster (*Cr. migratorius*).

The lack of new data on the distribution of the grey hamster (*C. migratorius*) raises serious concerns about its presence in the region of Sarnena Gora, where it was recorded in the middle of the last century (Markov 1964, Tuleshkov 1964, Hristov 1966). The catches are one-time and from the immediate vicinity of the populated areas (Stara Zagora – the Bobov Dol locality, and the villages of Starozagorski Mineralni Bani and Malka Vereya), and the relative density of the species when caught with live traps was 5 individuals for 8200 trap nights or 0.06% of the total catch of small mammals (710 individuals). The data for its presence in Sarnena Sredna Gora remained unconfirmed for more than 60 years. Current data on the distribution and status of this species (Georgiev 2004, Milchev 2009, Nedyalkov 2016) show that its registration is possible by systematic processing of large quantities of owl pellets collected in the eastern part of Bulgaria.

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Conservation status

The established small mammal terrestrial fauna of Sarnena Gora includes 6 species included in Appendices 2 and 3 of the Biodiversity Act, 5 of which are protected (Table 2). Priority for the area species are the Etruscan shrew (*S. etruscus*), the gray hamster (*C. migratorius*), the hazel (common) dormouse (*M. avellanarius*) and the European souslik (*S. citellus*). The hedgehog and the forest dormouse are species with a wide distribution on the territory of Bulgaria.

The Etruscan shrew is a species whose appearance in Bulgaria was recorded in the 1980s and it quickly spread in the southern Black Sea coast up to the town of Obzor (Lyubomirova 2012) and the Upper Thracian Plain to its westernmost points (Milchev *et al.* 2006). It is likely that global climate changes underlie the northward expansion of the thermophilic biota, a process that is also observed with many other groups of the Bulgarian fauna (e.g. Teofilova 2017).

The grey hamster is a species of very high conservation importance for the region and is one of rarest mammals in Europe. Its known localities around the town of Stara Zagora are the most north-western for the distribution of the species in Bulgaria, and the lack of records over the last 60 years may be due to both the lack of targeted research and the disappearance of the species from these territories as a result of the strong degradation and synanthropization of its specific habitats.

A similar trend of limitation of suitable habitats in the area of the Sarnena Gora is observed for the souslik. The decrease of grazing areas due to ploughing and reduction in the number of grazing animals are the cause of habitats degradation (cultivation or ruderalisation). Particularly valuable and rapidly declining in area are the old mesophylic beech and mixed deciduous forests, which are habitats for both protected and relatively rare species of small mammals, which determines their conservation importance.

Table 2. Conservation status of small mammals found in Sarnena Sredna Gora Mts.

№	Species	BA 200 2	RDB	IUCN	Bern	92/43	Registration method
		1	2	3	4	5	6
1	<i>Erinaceus roumanicus</i> Barret-Hamilton, 1900	III	LC	LC	III		DO
2	<i>Talpa europaea</i> Linnaeus, 1758		LC	LC			DO
3	<i>Sorex araneus</i> Linnaeus, 1758		LC	LC	III		PT, OP
4	<i>Sorex minutus</i> Linnaeus, 1766		LC	LC	III		PT
5	<i>Neomys milleri (anomalous)</i> Mottaz, 1907		LC	LC	III		LD, PT, OP
6	<i>Suncus etruscus</i> Savi, 1822	III	LC	LC			OP

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7	<i>Crocidura suaveolens</i> Pallas, 1811		LC	LC	II		LT, PT, OP
8	<i>Crocidura leucodon</i> Hermann, 1780		LC	LC	III		LT, PT, OP
9	<i>Lepus europaeus</i> Pallas, 1778		NT	LC	III		DO
10	<i>Sciurus vulgaris</i> Linnaeus, 1758		NT	LC	III		DO
11	<i>Spermophilus citellus</i> Linnaeus, 1766	II	VU	EN	II	II, IV	LD, DO
12	<i>Glis glis</i> Linnaeus, 1766		LC	LC	III		LD, OP
13	<i>Muscardinus avellanarius</i> Linnaeus, 1758	II, III	NT	LC	III	IV	LD, PT, LT
14	<i>Dryomys nitedula</i> Pallas, 1778	II	NT	LC	III	IV	LD, OP, LT
15	<i>Myocastor coypus</i> Molina, 1782		NE				DO
16	<i>Nannospalax leucodon</i> Nordmann, 1840		LC	LC			DO
17	<i>Micromys minutus</i> Pallas, 1771		NT	LC			LD, OP
18	<i>Apodemus agrarius</i> Pallas, 1771		LC	LC			LD, OP
19	<i>Apodemus sylvaticus</i> Linnaeus, 1758		LC	LC			LD, OP, LT
20	<i>Apodemus flavicollis</i> Melchior, 1834		LC	LC			LD, OP, LT, PT
21	<i>Mus macedonicus</i> Petrov, Ruzic, 1983		LC	LC			LD, OP, LT, PT
22	<i>Mus musculus</i> Schwarz, Schwarz, 1943		NE				LD
23	<i>Rattus norvegicus</i> Berkenhout, 1769		NE	LC			OP
24	<i>Rattus rattus</i> Linnaeus, 1758		NE	LC			OP
25	<i>Cricetulus migratorius</i> Pallas, 1773	II, III	VU	LC			LD
26	<i>Clethrionomys glareolus</i> Schreber, 1780		LC	LC			PT
27	<i>Arvicola amphibius</i> Linnaeus, 1758		LC	LC			LD, DO, OP

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28	<i>Microtus arvalis</i> Pallas, 1778			LC			LD (need confirmation)
29	<i>Microtus rossiaemeridionalis</i> Ognev, 1925		LC	LC			Cariological examination
30	<i>Microtus subterraneus</i> Selys, 1836		LC	LC			PT, OP

Legend:

BA 2002 – Biodiversity Protection Act (State Gazette, No.77 from 9 August 2002), Appendix 2 and Appendix 3 – protected species on the territory of Bulgaria.

92/43– Directive 92/43/EU or Recommendation No.43 on the conservation of threatened mammals in Europe (1995) and its Amendment (1996) adopted by the Standing Committee of Council of Europe; Annex II – species whose conservation requires the designation of special areas of conservation, Annex IV – species of community interest in need of strict protection;

Bern - Bern Convention on the conservation of European wildlife and natural habitats, adopted by the Council of Europe in 1998: Appendix II – strictly protected fauna species, Appendix III – protected species;

IUCN – The 2013 IUCN Red List of Threatened Species (IUCN 2013); **Categories:** (EX) Extinct or possible extinct (?EX); (CR) – Critically Endangered; (EN) – Endangered; (VU) – Vulnerable; (NT) – Near Threatened; (LC) – Least Concern; (DD) – Data Deficient; (NE) – Not Evaluated;

RDB (Red Data Book of Bulgaria, Vol. 2 Animals, 2015, Golemansky 2015) **Categories:** (EX) Extinct or possible extinct (?EX); (CR) – Critically Endangered; (EN) – Endangered; (VU) – Vulnerable; (NT) – NearThreatened; (LC) – Least Concern; (DD) – Data Deficient; (NE) – NotEvaluated;

Methods of registration - literature data (LD), pitfall traps (PT), live traps (LT), owl pellets (OP), direct observation of animals or signs of its live (DO).

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