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Cover: Fish species recorded in the Gowthami-Godavari Estuary, Andhra Pradesh: *Lutjanus johnii* (top left), *Triacanthus biaculeatus* (top right), *Acentrogobius cyanomos*, *Elops machnata*, *Trypauchen vagina*, *Oxyurichthys microlepis*. © Paromita Ray.



New records of *Nyctalus leisleri* (Kuhl, 1817) and *Myotis nattereri* (Kuhl, 1817) (Mammalia: Chiroptera: Vespertilionidae) from National Park “Smolny” and its surroundings, Republic of Mordovia

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Abstract. Protected areas in the Republic of Mordovia are still poorly studied in relation to bats. Our research of the bat fauna in the National Park “Smolny”, Republic of Mordovia was conducted in 2018–2020. A total of 573 bats of nine species belonging to the family Vespertilionidae were captured and studied. *Nyctalus leisleri* and *Myotis nattereri* were caught here for the first time. Three new sites of two rare bat species were discovered. The list of bats in the National Park “Smolny” currently includes 10 species.

Keywords: Bats, first finding, Leisler’s Bat, Natterer’s Bat, protected areas, Russia.

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Author contributions: All authors contributed equally to data collection, conceiving and designing the study. DS and AK performed the analyses. DS, NK and AK wrote the manuscript.

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INTRODUCTION

In recent years, the threat to biological diversity has increased in many countries of the world. Due to increasing anthropogenic impacts, many mammals are on the verge of extinction in different parts of the world (Bodmer et al. 1997; Bazhenov 2019; Bowyer et al. 2019; Loiseau et al. 2020; Rutovskaya et al. 2020). Protected areas are important for the protection of mammals, since regular monitoring of fauna and population density of rare species are conducted (Akpattou et al. 2018; Bowyer et al. 2019; Lebedinsky et al. 2019; Levykh & Panin 2019; Ahissa et al. 2020; Vekhnik 2020). Bats are one of the least-studied groups of mammals in protected areas, which is why increased survey efforts are required (Luo et al. 2013; Malekani et al. 2018; Barros et al. 2020; Belkin et al. 2021).

The territory of European Russia is home to 27 species of bats. Sixteen species inhabit the Volga Upland (Mammals of Russia 2020). The National Park "Smolny" is located in the central part of European Russia in the Republic of Mordovia. The fauna of Mordovia includes 12 bat species according to preliminary estimates (Artaev & Smirnov 2016). Previous studies from 2005 to 2015 established habitation of eight bat species in the National Park "Smolny" (Artaev & Smirnov 2016) which did not include *Myotis nattereri* (Kuhl, 1817) and *Nyctalus leisleri* (Kuhl, 1817). Both species are widespread in western Palaearctic. Their species ranges cover most of western, central, and eastern Europe (Juste & Paunović 2016; Smirnov et al. 2020). In most of their ranges they do not reach high population density and in some habitats they are rare. Currently, there is no information about a significant decline in the populations of *M. nattereri* and *N. leisleri*, therefore they are included in the IUCN Red List with the status 'Least Concern' (LC) (Juste & Paunović 2016; Gazaryan et al. 2020). However, these species, like other bats, are extremely vulnerable; therefore, in Europe all bat species are protected in accordance with EU directives and international agreements: The Bonn Convention on the Conservation of Migratory Species of Wild Animals and The Convention on the Conservation of European Wildlife and Natural Habitats. In European Russia, the vulnerability of bats and, in particular, *M. nattereri* and *N. leisleri* is due to the reduction and fragmentation of forest landscapes caused by the deforestation of primary forests and other anthropogenic transformations. There is also a decrease in the number of shelters caused by the cutting of old hollow trees.

In Russia, *M. nattereri*, commonly known as Natterer's

Bat, inhabits the northwestern and central parts, the middle Volga Region, and the middle & southern Urals. The southern border of distribution range runs along the southern edge of the forest-steppe (Smirnov et al. 2020). In the Volga Region, *M. nattereri* is one of the rare bat species. Rare findings are due to the low abundance and sporadic distribution of this species (Smirnov 2013). Natterer's Bat inhabits deciduous and mixed forests, has a sedentary lifestyle and hibernates in deep crevices or underground spaces (Smirnov et al. 2007, 2008; Smirnov & Vekhnik 2009, 2011, 2014). Summer habitats are closely related with trees and are confined to regions with expressed karstic landforms (Ilyin & Smirnov 2000). The bat hunts, as a rule, over bushes and near the crowns of low trees (Smirnov & Vekhnik 2012). In the territory of Mordovia, *M. nattereri* is known from the only finding made in 2013 in the Mordovia State Nature Reserve (Artaev 2014).

Nyctalus leisleri, or Leisler's Bat, is a typical inhabitant of European floodplain deciduous and mixed forests (Smirnov 2013). In Russia, the distribution of the bat covers mainly the Western and Central part, the Middle Volga Region, the South Urals, and the North Caucasus (Ilyin et al. 2002; Kozhurina 2009). *Nyctalus leisleri* has a relatively low abundance everywhere. This bat species is included in almost all regional Red Lists of the Volga Region, as well as in the Republic of Mordovia. It is a migratory species, annually making long-distance seasonal migrations.

According to observations in the Zhiguli State Nature Reserve (Samara Oblast), as well as in the Ulyanovsk and Penza oblasts, the summer season of *N. leisleri* in the middle Volga region lasts from three and a half to four months (Bezrukov & Smirnov 2012; Smirnov, 2013). Wintering places are not yet determined. Taking into account the southern direction of the migration routes of bats, most likely, the middle Volga population of Leisler's Bat spends the winter in the Northern Caucasus (Ilyin & Smirnov 2010). There is almost no information on the biology of *N. leisleri* in the Republic of Mordovia. The species is known here from only three findings (Vechkanov et al. 2006; Ruchin et al. 2014; Artaev & Smirnov 2016).

The purpose of this study was to survey *Myotis nattereri* and *Nyctalus leisleri* in the National Park "Smolny", as well as the position of these species in the structure of the bat community in this protected area.

MATERIALS AND METHODS

The materials for this work were our own field studies of bats in the National Park "Smolny", which were carried out in period 2018 to 2020 in July and August. The map of the trapping places of bats is presented in Figure 1.

Bats were caught at night with mist nets. We used the common method of stretching net between two poles (Jones et al. 1996). Telescopic fishing rods 7–9 m long were used as poles, tied to metal pegs placed into the ground. During three years of research, we carried out 43net/night: 2018 – 9, 2019 – 18, and in 2020 – 16.

In the daytime, we searched for potential bat shelters (tree hollows, underground places, and buildings). To determine the species of bats in flight, we used a D-240x detector (Pettersson Elektronik AB, Sweden) with the time expansion of 10 and memory size of 1.7 sec. The calls were recorded on a zoom H2 handy recorder (Zoom Corp., Japan) in the "wav" format with a sampling rate of 44.1 kHz and 16 bit. Processing and analysis was carried out using the BatSound 3.31 software (Pettersson Elektronik AB). For the analysis, we selected from the records series of frequency-modulated pulses with a quasi constant component at the end (FM/QCF).

They belonged to a search flight and did not include signals from the active phase of the approach and feeding buzzes, characterized by shrinking intervals between pulses. The following parameters were used as the characteristics of the calls: pulse duration (DUR), maximum (Fmax), minimum (Fmin), and peak (Fpeak) frequencies, as well as the inter-pulse intervals (IPI).

Descriptions of the three places of catching new bat species are given below (Figure 1, sites 4, 6, 10). The site in the Udalets River floodplain (54.792 °N & 45.266 °E) is a small forest glade, which is not part of the National Park (Figure 1, site 4; Image 1). The forest glade, where the animals were caught, is surrounded on all sides by the territory of the national park and is located just a few meters from its border. The forest glade with sedge-cereal forbs is bounded from north and east by a pine forest, from south and west by the floodplain forest of alders *Alnus glutinosa* (L.) and aspens *Populus tremula* L.

The Tashkinsky pond (54.747 °N & 46.263 °E) is a small reservoir (0.2 ha) located on the Chernushka River in the depth of an old pine forest (Figure 1, site 6; Image 1). Alders *Alnus glutinosa* (L.) and willows *Salix* spp. grow along the pond banks. The northern part of the pond is open with a small sandy beach. Coastal herbaceous

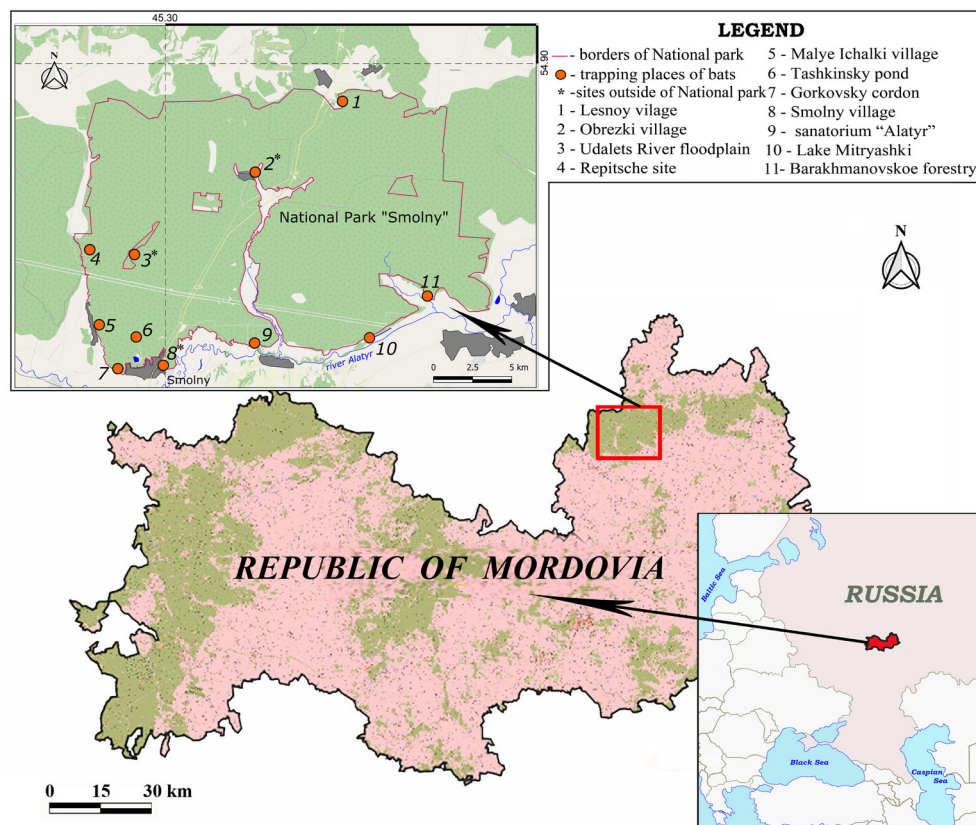


Figure 1. Trapping places of bats in the National Park "Smolny" and its surroundings in 2018–2020.



Image 1. Trapping places of *Nyctalus leisleri* and *Myotis nattereri*: A—glade in vicinity of Lake Mitryashki (inside of the National park) | B—Lake Mitryashki (boundary of the National park) | C—Tashkinsky pond (inside of the National park) | D—Udalets River floodplain (boundary of the National Park). © A—Dmitry Smirnov, B&D—Alexander Kirillov, C—Alexander Kirillov.

vegetation is represented by *Typha latifolia* L., *Carex* spp., *Bidens tripartita* L.

The site in the vicinity of Lake Mitryashki (54.745 °N & 45.503 °E) is situated in a forest glade (0.4 ha) with sedge-cereal forbs (Figure 1, site 10; Image 1). From the north and west, the glade is surrounded by a pine forest, from the east – a deciduous middle-aged forest (*Quercus robur* L., *Populus tremula* L., *Tilia cordata* Mill., *Ulmus laevis* (Pall.), and from the south there is a steep slope leading to the lake, overgrown with old alders along the shore.

The rates of occurrence and relative abundance were calculated using the previously proposed method (Strelkov & Ilyin 1990). The occurrence was estimated as the ratio of the number of findings of each species to the total number of findings of all species, given as a percentage. The relative abundance was the ratio of the number of caught and recorded individuals of each species to the total number of individuals caught from a given place of all bat species, expressed as a percentage.

RESULTS

A total of 573 bats of nine species were captured over three years of research (Table 1). We established two new species inhabiting the National Park "Smolny" – *Myotis nattereri* and *Nyctalus leisleri*.

On 9 July 2019, *N. leisleri* was observed visually and using ultrasound scanning of echolocation signals in the vicinity of Lake Mitryashki. A solitary individual was hunting along the edge of the forest for 20–30 min. Its search calls ($n = 27$) had the following characteristics: $DUR = 8.27 \pm 0.23$ (Lim 3.1–10.6), $F_{max} = 37.5 \pm 0.7$ (Lim 28.4–53.7), $F_{min} = 26.1 \pm 0.1$ (Lim 24.2–30.1), $F_{peak} = 28.7 \pm 0.2$ (Lim 24.9–35.1), $IPI = 195 \pm 53.5$ (Lim 90.1–421.6). It was not caught in the installed mist net and did not appear on subsequent evenings. However, on 27 July 2020, a post-lactating female of this species was caught on the bank of lake Mitryashki.

On 16 July 2019, on a forest glade in the Udalets River floodplain (Figure 1, site 4) 10 individuals of *N. leisleri* were caught in the mist net, including two adult post-lactating females and eight young bats: five males

Table 1. Species composition, abundance and occurrence of bats in the National Park “Smolny” and its surroundings in 2018–2020.

Species	Abundance		Occurrence	
	N ₁	%	N ₂	%
<i>Myotis brandtii</i> Eversmann, 1845	34	5.9	6	13.0
<i>Myotis daubentonii</i> (Kuhl, 1817)	58	10.1	5	10.9
<i>Myotis dasycneme</i> (Boie, 1825)	5	0.9	2	4.4
<i>Myotis nattereri</i> (Kuhl, 1817)	1	0.2	1	2.2
<i>Nyctalus noctula</i> (Schreber, 1774)	116	20.2	8	17.4
<i>Nyctalus leisleri</i> (Kuhl, 1817)	12	2.1	3	6.5
<i>Pipistrellus nathusii</i> (Keyserling & Blasius, 1839)	291	50.8	10	21.7
<i>Pipistrellus pygmaeus</i> Leach, 1825	6	1.1	4	8.7
<i>Vespertilio murinus</i> Linnaeus, 1758	50	8.7	7	15.2
Total	573	100	46	100

N₁—number of captured bats | N₂—number of occurrences.

and three females (Image 2). Several more animals, that hunted high above the tree crowns, were identified by their echolocation calls.

On 3 August 2020, one young female of *N. leisleri* was caught with a net on the bank of Tashkinsky pond (Figure 1, site 6).

On 29 July 2020 at the research base at Lake Mitryashki (Figure 1, site 10; Image 1a) one individual of *M. nattereri* was caught in a net. The captured animal was a post-lactating female (Image 3).

DISCUSSION

Before our research, the habitation of eight bat species was established for the territory of the National Park “Smolny” and its vicinity (Artaev & Smirnov 2016). In this study, we caught seven bat species from eight previously known. We were unable to find *Plecotus auritus* Linnaeus, 1758, which was recorded in the protected area earlier (Artaev & Smirnov 2016). Taking into account the newly-discovered *M. nattereri* and *N. leisleri*, the list of bats in the National Park “Smolny” currently includes 10 species. Despite the relatively high diversity of bats in this protected area, it still does not reach its maximum here, which is typical for the central part of European Russia. Thus, 15 species of bats have been established in the National Park “Samarskaya Luka” (Samara Oblast), located 300 km south-east (Smirnov & Vekhnik 2012). Five bat species: *Nyctalus lasiopterus* Schreber, 1780, *Pipistrellus kuhlii*, Kuhl, 1817, *Myotis mystacinus* (Kuhl, 1817), *Eptesicus nilssonii* (Keyserling &

Blasius, 1839), and *Eptesicus serotinus* (Schreber, 1774) were not found in the National Park “Smolny”. According to the results of long-term research, the most abundant and widespread species in the National park are *Pipistrellus nathusii*, Keyserling & Blasius, 1839 *Nyctalus noctula*, Schreber, 1774, *Myotis daubentonii*, Kuhl, 1817, *Vespertilio murinus*, Linnaeus, 1758, and *Myotis brandtii*, Eversmann, 1845 (Artaev & Smirnov 2016; this study). The high abundance of these species is common for the all territory of central Russia. For example, the results of bat studies in the National Park “Samarskaya Luka” confirm their dominance in the bat community (Smirnov & Vekhnik 2012). On the contrary, the lowest occurrence was noted for *M. nattereri*, *Myotis dasycneme* (Boie, 1825), and *N. leisleri* (Smirnov & Vekhnik 2012).

Myotis nattereri is also one of the rarest species, while *N. leisleri* only slightly exceeds *Pipistrellus pygmaeus* Leach, 1825 and *M. dasycneme* in the number of captured individuals (Table 1). At the same time, throughout the territory of Mordovia, *P. pygmaeus* and, especially, *M. dasycneme* dominate *N. leisleri* in occurrence and relative abundance (Artaev & Smirnov 2016). The widely distributed *N. leisleri* occurs sporadically, in colonies of 5 to 15 individuals (Smirnov & Ilyin 1997, Ivancheva & Ivanchev 2000, Ilyin et al. 2002, Kozhurina 2009). Therefore, findings of the species in local habitats can significantly affect the rates of relative abundance. All findings of *N. leisleri* are usually linked to reservoirs with old woody vegetation on the banks. We caught and detected *Nyctalus leisleri* during the first 60 minutes after sunset; therefore, the records of solitary animals at the Lake Mitryashki and the Tashkinskiy pond may indicate the absence of colonies in these sites. We assume that the animals used these territories as foraging places, having arrived here from more distant localities. On the contrary, the capture of post-lactating females and young bats in the Udalets River floodplain indicates the possible presence of a colony there.

The finding of *M. nattereri* in the National Park “Smolny” can be considered as unexpected and unique. The species summer habitats of this species are usually situated close to the wintering places (Smirnov & Vekhnik 2014). However, there are no karstic areas with possible underground cavities in the national park; hence the wintering places of this species are probably outside the protected area. The nearby places of the bat wintering grounds are situated in the Nizhny Novgorod region, about 150 km north-west and 100 km north (Bakka & Bakka 1999). It is possible that some individuals wintering there migrate to Mordovia for summertime. Flights over such distances for this species are possible



Image 2. Adult female of *Nyctalus leisleri*, trapped in Udalets River floodplain. © Dmitry Smirnov.



Image 3. Post-lactating female of *Myotis nattereri*, trapped in the vicinity of Lake Mitryashki. © Dmitry Smirnov.

and well known (Steffens et al. 2007).

Records of *M. dasycneme* in the National park "Smolny" need particular discussion. The species is included in the IUCN Red List as "Near Threatened" (NT). The vulnerability of *M. dasycneme* is due to its sporadic distribution, the specificity of the habitat selection (open calm water bodies with a large open water surface) and the vulnerability of its colonies, usually located in buildings (Piraccini 2016). This is a rare species for the National Park "Smolny". During three years of research, we caught only five individuals in two habitats: four bats in the vicinity of Lake Mitryashki and one bat in vicinity of the Obrezki village. Previously, *M. dasycneme* was recorded only in the vicinity of the Obrezki village (Artaev & Smirnov 2016).

CONCLUSION

As a result of our field studies for the fauna of Mordovia and the middle Volga region, three new habitats of two rare bat species, *Myotis nattereri* and *Nyctalus leisleri* were found for the first time in the National Park "Smolny" and should be recommended for inclusion in the Red List of the Republic of Mordovia. The capture of post-lactating females and juveniles indicates these species use this territory for breeding.

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