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Mist-Netting of Forest-Dwelling Bats in the Lazovsky State Nature Reserve, Russian Far East

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Abstract

Many bat species depend on a high value of healthy and undisturbed forests with a high ratio of roost sites in old tree stands. This investigation focused on the diversity, distribution and reproduction status of bats within the area of Lazovsky State Nature Reserve. The importance of an area for bats can be measured by the ratio of reproduction. The most important and sensitive time in a bats yearly circle is the time of hibernation in winter and the reproduction time of females. From the beginning of July to the end of August 2007, in total 139 bats of eight species were captured within the area of Lazovsky Zapovednik. For all species, evidence of reproduction could be provided. The amount of reproducing females and juvenile bats indicates the areas rele vance for the bats of the region. The distribution of the Ussuri Tube-Nosed Bat (*Murina ussuriensis* Ognev, 1913) is limited to the Far Eastern Region. 14 individuals of this species were captured during July and August, mostly female and juvenile bats, indicating the importance of the area for this species. Knowledge of the ecology, habitat conditions and distribution of the Ussuri Tube-Nosed Bat is scarce and further baseline research focussing on this species would be helpful to define conservation aims in Primorye.

Keywords: diversity, reproduction, *Murina ussuriensis*, Chiroptera, Zapovednik

1. Introduction

With the arrangement of the University of Muenster, Germany and the friendly permission and logistic support of Lazovsky State Nature Reserve, in 2007 a study on forest-dwelling bats during maternity season could be carried out. The vast, woody areas of Primorsky Krai in the Russian Far East are famous for its diversity, unique species composition and its importance for many threatened species, whose distribution is limited to the Far East (NEWELL 2004). For the area of Primorye there are 15 bat species named to occur (РОСИНА 2007). For the area of the Lazovsky State Nature Reserve there are 11 bat species mentioned. In addition, some roost sites are known. Status of bats ecology and distribution data are mostly gathered as an additional aspect of ornithological research or in autumn after the maternity season of bats (РОСИНА 2007, ХОХРЯКОВ & ШОХРИН 2002). Detailed knowledge about ecology, habitat use and the importance of the reserve for bats is scarce. The most sensitive aspects in a bats yearly circle are the winter roost sites and the maternity roosts of reproducing females in summer. In this colonies, females aggregate from some dozen to several hundred and sometimes up to more than thousand females, to give birth and raise their offspring. Bats are traditional animals and the use of roost sites and habitat is very continuous over the years (SIMON et al. 2004, DIETZ et al. 2007).

Two groups of bats can be distinguished in general - though there are exceptions (NGAMPRASERTWONG et al. 2014) - bats associated to caves or houses and forest-dwelling bats. The first species need caves or places in buildings with appropriate climate conditions for their maternity roosts, the latter are associated to woodpecker holes or cracks and bark peelings in dead wood. While cave or house inhabiting bats are mostly stable in the use of one roost site during the summer, forest inhabiting bats need up to over 20 (depending on the species) appropriate roost sites per maternity colony within their core area. They move between the roosts as gravid females as well as with their young. Therefore, they need a stable quota of such sites over the whole summer period. Habitat use and home range size of a colony depends on bat species and

habitat quality. The distance between roost site and feeding area can be between 2 km and 20 km. Reproducing females need high quality habitats to raise their offspring successfully. When the juveniles can fly, the colonies will stay together for some more time and later on, colonies will divide. Then, bats start to explore their environment intensively, look for mating partners, for winter roost sites or for those, which migrate, start migration (DIETZ et al. 2007). Focus of this investigation was gathering data on bats inhabiting forest during the summer, to evaluate the importance of the area of Lazovsky State Nature Reserve for this group of bats.

2. Study Area

Study area was Lazovsky Zapovednik, Primorsky Krai, Russian Far East (fig. 1). The current core area of the Reserve was about 121.000 ha, and the protected area about 15.000 ha in 2007. The reserve is located at the southern part of the Sikhote Alin ranges. Forest types are ussurian broad-leaved and mixed forest as well as coniferous-broad-leaved and mixed forests. A dense river system is running through the area. Climate varies from the mountain ranges to the coastal area. With temperatures between 17.4° and 23.5° C August is the warmest month of the year, the coldest month is January, with temperatures varying between -17.5° C at continental sites and -5.1° C on the coast site. Summers are characterized by high humidity (ХОХРЯ-КОВ & ШОХРИН 2002).

Fig. 1: Map overview: Far Eastern Region and study site with Kordons.

3. Methods

Per capture site, an average of 30 to 50 m mist nets was set and checked for captured bats every 10 to 15 min. simultaneously, the netting sites were controlled with an Ultrasonic Sound Detector (Petterson D 200). The additional use of an Ultrasonic Sound Detector allows to measure flight activity at the nets and to double check, if bats occur at the chosen site, even though there are no bats captured during the night (DIETZ et al. 2007, BARATAUD 2012). Nets were set from dusk to approximately 2 to 3 am, depending on the weather conditions. Captured bats were removed immediately from the net. Forearm-length and body mass were measured. Sex, age (adult or juvenile) and reproduction status, especially of reproductive females was checked (gravid/non-gravid or lactating/post-lactating/non-lactating). Post-lactating females were only regarded as belonging to a maternity colony until August 15th, and earlier than August 15th with consideration of the mammae. After marking the captured animals with nail varnish on the toenails, bats were released as soon as possible. The colour marking helps identifying recaptured animals and allows releasing the animals quickly (fig. 2).

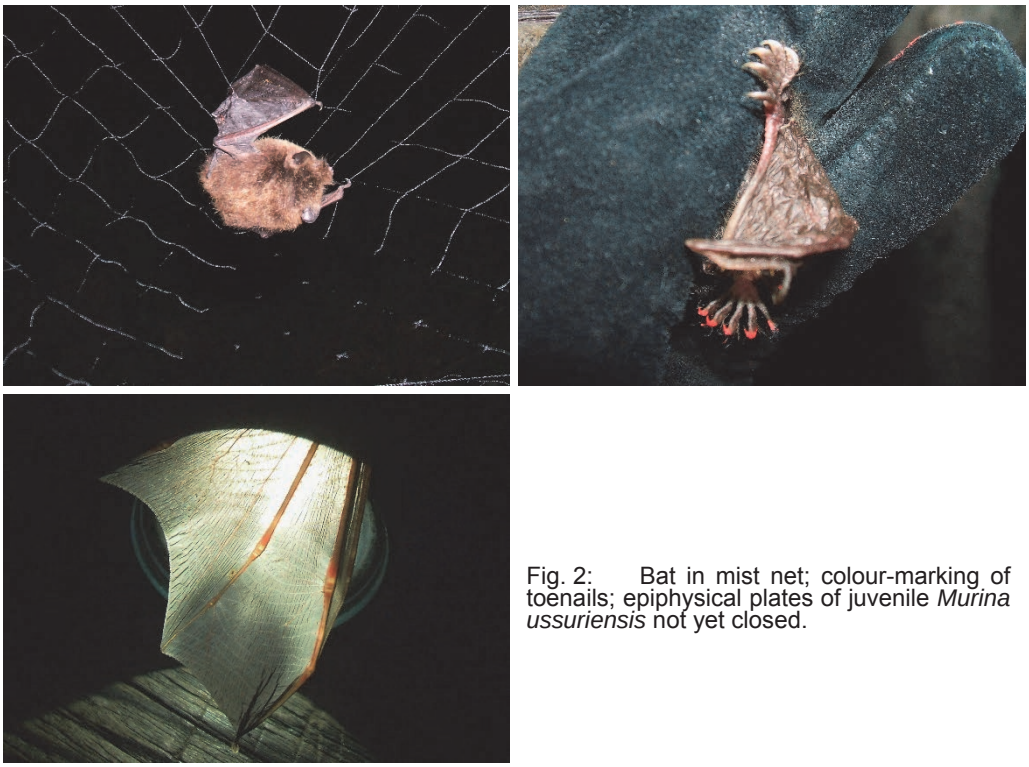

Fig. 2: Bat in mist net; colour-marking of toenails; epiphysical plates of juvenile *Murina ussuriensis* not yet closed.

28 mist-netting nights were carried out during the research period from 06.07.2007 to 29.08.2007 (table 1). Four different regions of the reserve were chosen: the areas around Kordon Korpad, Kordon Amerika, Kordon Tatshingouza and Kordon Zvyozdotshka. Though Kordon Amerika and Kordon Korpad are located near to each other (fig. 1), they are treated as two different areas because of the results.

This study follows the systematic used by the Russian Bat Research Group as is used in the Guide to Russian Bats "Большой энциклопедический словарь, Млекопитающие. Москва, АСТ, 1999". To compare the current results with former results (e.g. ТИУНОВ 1997, РОСИІНА 2007), *Myotis daubentonii* (KUHL, 1819) should be regarded as equivalent to *Myotis petax*, and

Murina hilgendorfi (PETERS, 1880) to *Murina leucogaster*. Furthermore, for the Eastern subspecies of Brandt's bat *Myotis brandtii* (EVERSMANN, 1845) the term *Myotis brandtii* is used instead of *Myotis brandti gracilis* to avoid misunderstanding with Japanese nomenclature. The term *Eptesicus nilsonii* (KEYSERLING & BLASIUS, 1839) is equivalent to *Amblyotus nilsonii* used in some publications. According to SPITZENBERGER et al. (2006) the former subspecies of *Plecotus auritus ognevi* has been upgraded to an own species, therefore the captured bats determined as *Plecotus auritus,* most probably belong to *Plecotus ognevi* (KISHIDA, 1926).

Table 1: Capture sites with date of capture and coordinates

Date	Latitude	Longitude	Date	Latitude	Longitude
Amerika (Америка)			**Tatshingouza (Тачингоуза)**		
24.07.07	43.27593°	133.98354°	06.07.07	43.01656°	134.12659°
25.07.07	43.27599°	133.98360°	07.07.07	43.01272°	134.12395°
26.07.07	43.26384°	134.04317°	08.07.07	43.01245°	134.12184°
27.07.07	43.18528°	133.99561°	09.07.07	43.01499°	134.12360°
28.07.07	43.18536°	133.99565°	17.08.07	43.01493°	134.12378°
14.08.07	43.26581°	134.04382°	19.08.07	43.01656°	134.12659°
15.08.07	43.26937°	134.04974°	21.08.07	43.01197°	134.12190°
16.08.07	43.26581°	134.04382°	22.08.07	43.01197°	134.12190°
Korpad (Корпадь)			**Zvyozdotshka (Звёздочка)**		
14.07.07	43.26720°	134.13638°	30.07.07	43.01037°	133.73132°
15.07.07	43.24096°	134.08644°	31.07.07	43.01469°	133.76039°
17.07.07	43.27284°	134.11754°	27.08.07	43.01240°	133.73201°
06.08.07	43.26948°	134.13185°	28.08.07	43.01479°	133.76028°
07.08.07	43.24096°	134.08644°	29.08.07	43.01037°	133.73132°
09.08.07	43.26568°	134.13136°	-	-	-
11.08.07	43.26697°	134.14349°	-	-	-

4. Results

During the investigation in 2007, 139 bats from eight different species were caught. Namely Northern bat, *Eptesicus nilssonii* (KEYSERLING & BLASIUS, 1839), Greater Tube-Nosed Bat *Murina hilgendorfi* (PETERS, 1880), Ussuri Tube-Nosed Bat *Murina ussuriensis* (OGNEV, 1913), Far Eastern or Bombinus Bat *Myotis bombinus* (THOMAS, 1906), Brandt's Bat *Myotis brandtii* (EVERSMANN, 1845), Ikonnikov's Bat *Myotis ikonnikovi* (OGNEV, 1912), Eastern Water Bat *Myotis petax* (HOLLISTER, 1912) and Brown Long-Eared Bat *Plecotus auritus* (LINNAEUS, 1758). One individual of the genus *Myotis* was not determinable (table 2).

Table 2: With mist-netting in Lazovsky State Nature Reserve from 06.07.07 – 29.08.07 detected bat species, their protection and reproduction status (Red Data Book Primorsky Krai (КОСТЕНКО 2005); categories: 1 = endangered, 3 = rare)

Species	Status	IUCN Red List 2008	Red List Primorye 2005
Eptesicus nilsonii	●°	least concern	3
Murina hilgendorfi	●*°	least concern	-
Murina ussuriensis	●*°	least concern	1
Myotis bombinus	●*°	near threatened	-
Myotis brandtii	●*°	least concern	3
Myotis ikonnikovi	●*°	least concern	3
Myotis petax	●*°	least concern	-
Plecotus auritus	●*°	least concern	-

* gravid or lactating females ° juveniles

Evidence of reproduction for all eight species within Lazovsky Zapovednik could be provided with gravid or lactating adult females or juvenile bats. With 45 individuals *Plecotus auritus* was the most frequently captured species, followed by *Myotis ikonnikovi* with 36 caught individuals. For *Myotis petax* and the both species of the *Murinae* - *Murina hilgendorfi* and *Murina ussuriensis* - 14 individuals each could been caught. Four individuals of *Myotis brandtii* could been caught as well as one juvenile bat of *Eptesicus nilsonii* (table 3).

Table 3: Number, sex and age of the captured bats within Lazovsky State Nature Reserve in July and August 2007 (juveniles are included in the sex determination)

Species	male	female	sex & age missing	total	number of juveniles
Eptesicus nilsonii	0	1	-	1	1
Murina hilgendorfi	7	7*	-	14	5
Murina ussuriensis	6	7*	1	14	8
Myotis bombinus	5	5*	-	10	5
Myotis brandtii	1	3*	-	4	1
Myotis ikonnikovi	17	19*	-	36	9
Myotis petax	7	7*	-	14	4
Myotis spec.	0	1*	-	1	0
Plecotus auritus	25	20*	-	45	22
total	**68**	**70 (33*)**	**1**	**139**	**55**

* gravid or lactating females

Kordon Amerika

In the area around Kordon Amerika in eight mist-netting nights 35 bats from eight species were caught. The most frequently species was *Plecotus auritus* with 16 individuals. *Myotis ikonnikovi* and *Myotis bombinus* were detected six respectively five times as well as three individuals of *Murina ussuriensis.* All of them were adult females. Two individuals of *Myotis petax* were captured, and one exemplar of *Eptesicus nilsonii, Murina hilgenorfi* and *Myotis brandtii*. 50 % of detected

bats were adult females, and 13 of these 19 females were reproducing. For the three species *Eptesicus nilsonii, Myotis brandtii* and *Myotis petax* no reproducing female was found, but reproduction was proved by catching of one juvenile from each of these species. The total number of caught adult male bats was four (table 4).

Table 4: Number, sex (adult) and age of the captured bats in the area of Kordon Amerika in July and August 2007

Species	male	female	juvenile	total
Eptesicus nilsonii	-	-	1	1
Murina hilgendorfi	-	1*	-	1
Murina ussuriensis	-	3*	-	3
Myotis bombinus	-	3*	2	5
Myotis brandtii	-	-	1	1
Myotis ikonnikovi	1	5*	-	6
Myotis petax	-	1	1	2
Plecotus auritus	3	6*	7	16
total	4	19 (13*)	12	35

* gravid or lactating females

Fig. 3: Broken trees can provide future roost sites for bats (area of Kordon Amerika).

Kordon Tatshingouza

During July and August 2007 eight mist-netting nights were carried out. For the area of Kordon Tatshingouza 73 bats of six species were caught. With 24 and 20 individuals *Plecotus auritus* and *Myotis ikonnikovi* were the most frequently caught bat species here. From *Myotis petax* nine individuals were determined, from *Murina hilgendorfi* eight, and from *Murina ussuriensis* seven. With five individuals, *Myotis petax* was the least captured bat species. From the 73 bats, 18 were adult females, and 12 of them were reproducing in this year. Evidence of reproduction for this part of the study site has been proved through reproducing females for *Murina hilgendorfi*, *Myotis ikonnikovi* and *Myotis petax*. The number of adult males was relative high, 21 males were captured totally. Juveniles could be caught from all eight species (table 5). However, capture date was between August 17 and 22 (see methods).

Table 5: Number, sex (adult) and age of the captured bats within the area of Kordon Tatshingouza in July and August 2007

Species	male	female	juvenile	total
Murina hilgendorfi	3	1*	4	8
Murina ussuriensis	1	1*	5	7
Myotis bombinus	2	-	3	5
Myotis ikonnikovi	8	7*	9	24
Myotis petax	1	5*	3	9
Plecotus auritus	6	4	10	20
total	21	18 (12*)	34	73

* gravid or lactating females

Fig. 4: Capture site around the Kordon Tatshingouza.

Kordon Korpad

In seven nights, mist nets were set in the region around Kordon Korpad. During this time 13 bats of five species could be caught. The most frequently captured species was *Myotis ikonnikovi* with five individuals. From *Myotis brandtii* three females were captured. Furthermore two individuals of *Murina hilgendorfi* and *Myotis petax* each and one of *Plecotus auritus* were determined. For every species, evidence of reproduction has been proved by reproducing females or juveniles either. Portion of adult females was more than 50 %, and portion of reproducing females nearly 50 %. Only three adult males and two juveniles were captured totally (table 6).

Table 6: Number, sex (adult) and age of the captured bats within the area of Kordon Korpad in July and August 2007

Species	male	female	juvenile	total
Murina hilgendorfi	-	1	1	2
Myotis brandtii	-	3*	-	3
Myotis ikonnikovi	2	3*	-	5
Myotis petax	1	1	-	2
Plecotus auritus	-	-	1	1
total	3	8 (6*)	2	13

* gravid or lactating females

Fig. 5: Rivers can provide flyways and foraging sites for bats (area around Kordon Korpad).

Kordon Zvyozdotshka

In the area around Kordon Zvyozdotshka mist nets were set only five times. The total number of captured bats was 18. Five different species were captured, one adult female of genus *Myotis* could not be determined. *Plecotus auritus* was the main species; eight individuals were detected. Four exemplars of *Murina ussuriensis*, three of them juvenile, were caught in late July. Three adult females of the species *Murina hilgendorfi* were captured as well as one of *Myotis ikonnikovi* and *Myotis petax* each. Two of the seven captured adult females were reproducing this year, namely one *Myotis petax* and one *Myotis ikonnikovi*. Additionally, the three juvenile *Murina ussuriensis* can be considered as proven evidence of reproduction in this area.

Table 7: Number, sex (adult) and age of the captured bats within the area of Kordon Zvyozdotshka in July and August 2007

Species	male	female	juvenile	sex & age	total
Murina hilgendorfi	-	3	-	-	3
Murina ussuriensis	-	-	3	1	4
Myotis ikonnikovi	-	1*	-	-	1
Myotis petax	1	-	-	-	1
Myotis spec.	-	1*	-	-	1
Plecotus auritus	1	3	4	-	8
total	2	8(2*)	7	1	18

* gravid or lactating females

Fig. 6: Capture site with tents (area Kordon Zvyozdotshka).

5. Discussion

The high ratio of reproduction underlines the relevance of Lazovsky Zapovednik for bats. The climate conditions are supporting insect richness and the diverse vegetation structure together with a dense river system provides ecological niches for many different bat species. Measurement of temperature, which has been taken while mist-nettings during this investigation indicates that the second part of the night is too cool in the valleys, and therefore not attractive for foraging bats. This aspect is already known from research in Europe and may be an explanation for the low number of captured bats at Kordon Korpad. Obviously, the mist-netting at the locality Izbushka

'1st Log' within the area of Kordon America was the most successful one. Six of eight bat species were captured here. Because of the climate and structure of the place the nets were set, this can be considered as a concentration effect due to high insect density.

In general, it is helpful to combine mist-netting and walking transects with a bat detector. Both methods have advances and disadvantages in their suitability for detecting different species. Due to a lack of time, intensive detector transects were not possible for this investigation. For further research it would be helpful additionally, to choose the mist-netting places independently from the locations of Kordons or Izbushkas and stay with a tent where vegetation structure seems appropriate. There are lighter sticks to set up the nets, which can be carried easier then the ones used here. With the help of telemetry roost sites of captured bats can be located and group sizes of colonies be counted. It would also give answers about habitat use, vegetation structure and home-range size. As the knowledge about *Murina ussuriensis* is still scarce (FUKUI et al. 2012, КАЗАКОВ & ГОРОБЕЙКО 2018), more information of the species ecology would help defining conservation needs.

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Portrait of *Plecotus auritus*, which according to SPITZENBERGER et al. (2006) most probably can be seen as *Plecotus ognevi.*

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