Vespertilio 17: 103–114, 2014
ISSN 1213-6123

Contribution to the knowledge of the Macedonian bat fauna

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Abstract. So far, twenty seven species of bats are known to occur in Macedonia, and here we present numerous additional locations for 20 species: *Rhinolophus ferrumequinum*, *R. hipposideros*, *R. euryale*, *R. blasii*, *Myotis myotis*, *M. emarginatus*, *M. mystacinus*, *M. capaccinii*, *Vespertilio murinus*, *Eptesicus serotinus*, *Hypsugo savii*, *Pipistrellus pipistrellus*, *P. pygmaeus*, *P. nathusii*, *P. kuhlii*, *Nyctalus noctula*, *N. leisleri*, *Plecotus auritus*, *Miniopterus schreibersii*, and *Tadarida teniotis*. *Vespertilio murinus* was confirmed for the first time after the 1930s.

Bats, distribution, Macedonia, Dojran, Prespa, Štip, Mavrovo NP, roosts, foraging habitats

Introduction

Macedonia is a country with few published faunistic records of bats. Before World War II, the first data were published by Karaman (1929, 1931), Martino (1934, 1939) and Petrov (1940), who documented presence of altogether 16 bat species. After the year 1960, further records were provided by Đulić & Mikuška (1966), Dimovski (1968), Felten et al. (1977), Stojanovski (1994), Hackethal & Peters (1987), Kryštufek & Petrov (1989), and Bogdanowicz (1990). For details, see the overview papers by Kryštufek et al. (1992, 1998) and Kryštufek & Petkovski (2003), who reported on 24 bat species, but this was still far from a comprehensive list of expected bat species in Macedonia. In the last decade, several bat inventory surveys have been conducted (e.g. Boshamer et al. 2006, Micevski et al. 2011a, c, 2012, Micevski & Micevski 2012a, b, 2013a, b, Micevski 2013, Presetnik 2012) but very few have been, at least partially, properly published (e.g. Boshamer & Bekker 2006, Bekker & Boshamer 2007). The majority of this literature has been hidden from the general public in various technical reports, as well as in student camp reports and personal notes. This research increased the number of recorded bat species in Macedonia to 27 from the previous count of 24 stated by Kryštufek & Petkovski (2003). The aim of this paper is to present all the data gathered during the above mentioned studies.

Material and Methods

In all presented studies, bats were surveyed using visual inspection of potential over- and underground roosts, mistnetting of bats in their foraging habitats, and especially with the help of ultrasound detectors (Pettersson D240x, Pettersson Elektronik AB, Sweden and Batlogger M, Elekon AG, Switzerland), and a subsequent computer analysis of the recorded ultrasound calls. The captured bats were determined following the determination keys by Dietz & Helversen (2004), Dietz et al. (2009) and MacDonald & Barrett (1993), and ultrasound recordings were determined according to Ahlen 2004, Ahlen

& Baggøe (1999), Barataud (1996, 2002), Obrist et al. (2004), Russo & Jones (1999, 2002), Waters & Jones (1995), and Skiba (2009). In the results we do not present most of the ultrasound observations of "small *Myotis* species", since their calls are very similar between species (e.g. Barataud 2002, Skiba 2009), and could not be determined unambiguously to the species level or at least to a couple of species.

The results presented in this publication are based on the following studies:
(a) Data collected during the spring research camp for Slovene biology students held in SE Macedonia in the period 25–30 April 2010, covering mainly the regions of Dojran and Gevgelija (Fig. 1, region a), as well as Demir Kapija (Presetnik 2012).
(b) Results of a pre-construction survey of bat fauna in the area of a planned wind farm site south of Štip (Fig. 1, region b), carried out in the vicinity of the Štip town, along the Kriva Lakavica and Bregalnica rivers, and around the villages of Ljuboten, Dolani and Čiflik in the period 2011–2012 (Micevski et al. 2011 a, b, c; Micevski et al. 2012).
(c) Results of a pre-construction survey of bat fauna regarding the hydropower plant of Boškov Most, in the valley of the Mala reka river, in the vicinity of the Selce and Tresonče villages and in the Gorna Alilica cave (Fig. 1, region c) (Micevski & Micevski 2012 a, b; Micevski & Micevski 2013 a, b).
(d) Occasional observations of bats in Skopje and its surroundings (Fig. 1, region d).
(e) Data collected during the workshop organised by the Bat Study Group Macedonia, supported by DEFRA (UK) and UNEP/EUROBATS, in the villages of Asamati, Kurbinovo, Nakolec and at the Prespa lake shore (Fig. 1, region e) in the period 28 June – 4 July 2013 (Micevski 2013).

Overview of localities

(a) Dojran, Gevgelija & Demir Kapija regions (SE Macedonia)
These regions are characterized by the Vardar river flowing from north to south (Demir Kapija – Gevgelija) and the large Dojran lake. It is an intensively used agricultural landscape, with many small streams dammed for water reservoirs, although some parts still remain more or less in a natural state. The remaining natural vegetation includes sub-Mediterranean evergreen shrubs, with true forests located W of the Gevgelija town.
Locations: **a1** – Dojran lake bank and Dojran town, 41.181° N, 22.723° E, 175 m a. s. l.; **a2** – Nov Dojran villlage and vicinity (Dojran), 41.221° N, 22.702° E, 160 m a. s. l.; **a3** – Nikolič village and vicinity (Dojran), 41.260° N, 22.749° E, 185 m a. s. l.; **a4** – Crničani village and vicinity (Dojran), 41.236° N, 22.659° E, 200 m a. s. l.; **a5** – Bogdanci village and vicinity (Gevgelija), 41.203° N, 22.579° E, 95 m a. s. l.; **a6** – Luda Mara stream, 2 km SW of Crničani (Gevgelija), 41.224° N, 22.637° E, 155 m a. s. l.; **a7** – E part of reservoir on Luda Mara stream at the Kramedište hill, 2.4 km NE of Bogdanci (Gevgelija), 41.209° N, 22.603° E, 100 m a. s. l.; **a8** – Gjavato (Gevgelija), 41.191° N, 22.539° E, 60 m a. s. l.; **a9** – St. Nedela cave, 1.2 km NW of Gjavato (Gevgelija), 41.200° N, 22.528° E, 65 m a. s. l.; **a10** – Bogorodica village and vicinity (Gevgelija), 41.141° N, 22.548° E, 55 m a. s. l.; **a11** – Gevgelija, 41.144° N, 22.507° E, 55 m a. s. l.; **a12** – Konjska reka stream, 1.1 km W of Novo Konjsko (Gevgelija), 41.155° N, 22.426° E, 200 m a. s. l.; **a13** – gorge and town of Demir Kapija, 41.403° N, 22.256° E, 110 m a. s. l.; **a14** – Bela voda cave (Demir Kapija), 41.405° N, 22.266° E, 110 m a. s. l.

(b) Štip region (Central Macedonia)
This region is a typical steppe area in Macedonia. Large areas of crop fields and lowland as well as hilly pastures are the typical landscape features. The Bregalnica river passes through the Štip town, and 4 km downstream the Kriva Lakavica river flows into the Bregalnica river. Very old and large poplar trees are common along both rivers. On the right side along the asphalt road from Štip to Radoviš, near the Kriva Lakavica river, there is a fishpond used for carp production (Baltalija). Villages along the road, on the left side, are little inhabited, and abandoned and ruined old houses are very common. The villages are surrounded by hilly pastures and agricultural fields mainly with crops.
Locations: **b1** – Bregalnica river at Novo Selo (Štip), 41.737° N, 22.183° E, 269 m a. s. l.; **b2** – Bregalnica river, bridge at the Štip-Radoviš crossroad (Štip), 41.713° N, 22.154° E, 256 m a. s. l.; **b3** – Kriva Lakavica river, close to a petrol station in Dragoevo (Štip), 41.692° N, 22.164° E, 264 m a. s. l.; **b4** – Dolani (Štip), 41.693° N, 22.201° E, 372 m a. s. l.; **b5** – Ljuboten (Štip), 41.670° N, 22.244° E, 556 m a. s. l.; **b6** – Čiflik (Štip), 41.670° N, 22.273° E, 652 m a. s. l.; **b7** – Baltalija fishpond (Štip), 41.634° N, 22.245° E, 313 m a. s. l.; **b8** – Kežovica spa (Štip), 41.733° N, 22.176° E, 264 m a. s. l.; **b9** – Gorni Lozja-Gjupski Rid hill above Ljuboten (Štip), 41.690° N, 22.242° E, 648 m a. s. l.

(c) Mavrovo National Park (W Macedonia)
The studied area is located along the upper part of the Mala Reka river close to the villages of Tresonče, Selce and Rosoki, where a hydropower plant is planned to be built. It is a forested area with oak woods. In the vicinity of the villages, forest clearings and open areas with pastures and meadows are found. The Mala Reka and its tributaries pass through open areas with dense vegetation of willow trees and other mainly deciduous riparian bushes.
Locations: **c1** – Selce (Debar), 41.573° N, 20.712° E, 1109 m a. s. l.; **c2** – old house in Tresonče (Debar), 41.5600° N, 20.724° E, 1067 m a. s. l.; **c3** – bridge over the Tresonče river – church (Debar), 41.565° N, 20.716° E, 991 m a. s. l.; **c4**

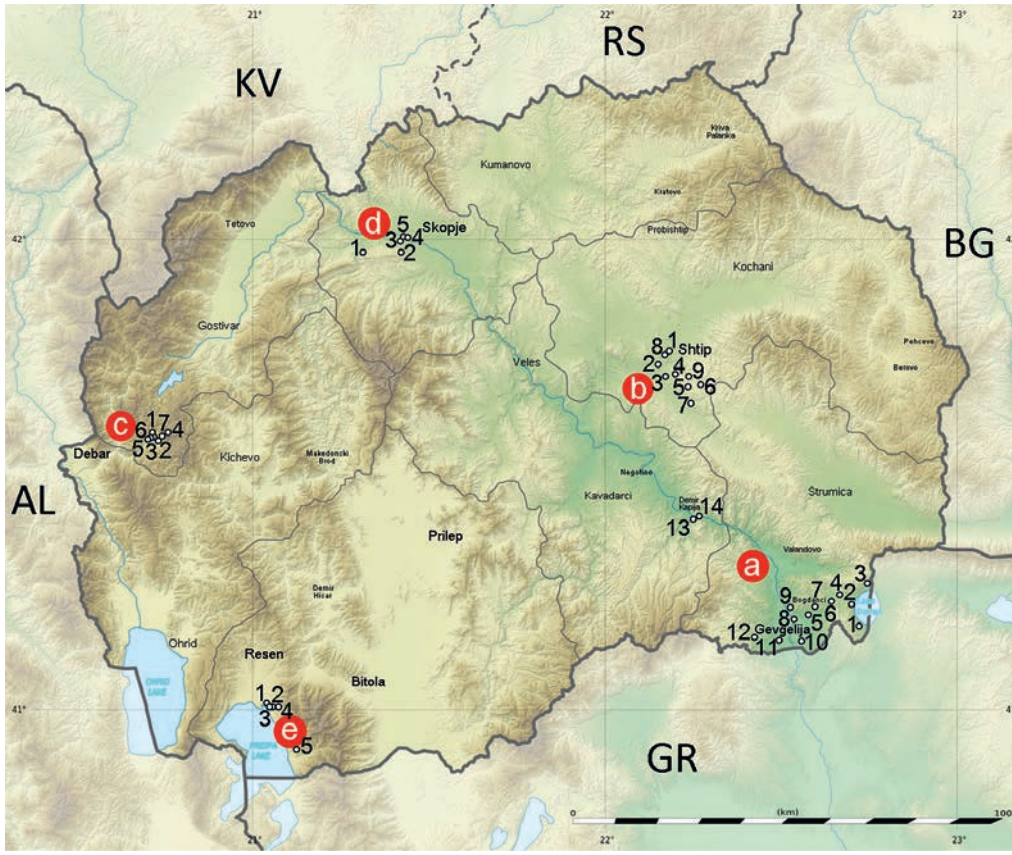

Fig. 1. General locations of the presented studies. Legend: a – Dojran, Gevgelija and Demir Kapija region, b – Štip region, c – Mavrovo National Park, d – Skopje, e – Prespa lake.

– Alilica cave, E of Tresonče (Debar), 41.567° N, 20.754° E, 1321 m a. s. l.; **c5** – bridge in Rosoki (Debar), 41.564° N, 20.699° E, 934 m a. s. l.; **c6** – Mala Reka river below Selce (Debar), 41.565° N, 20.712° E, 980 m a. s. l.; **c7** – Tresonče intake, E of the village (Debar), 41.564° N, 20.738° E, 1087 m a. s. l.

(d) Skopje (N Macedonia)
In the vicinity of Skopje, the Matka Gorge, the Skopje city park (with many old trees and old bushes and several pools), the area along the Vardar river and the Skopje city centre were surveyed.
Locations: **d1** – Dolna Matka (Skopje), 41.950° N, 21.299° E, 347 m a. s. l.; **d2** – Sopište (Skopje), 41.951° N, 21.417° E, 568 m a. s. l.; **d3** – Skopje, 41.997° N, 21.402° E, 256 m a. s. l.; **d4** – Vardar river in Skopje (Skopje), 42.009° N, 21.422° E, 246 m a. s. l.; **d5** – Skopje city park (Skopje), 42.009° N, 21.418° E, 253 m a. s. l.

(e) Prespa lake (SW Macedonia)
The Prespa lake is situated in the SW part of Macedonia on the border with Greece and Albania. This is a region famous for apple production, therefore the surrounding areas are mainly orchards. The studied area is close to the lake shore which is rich in reed-beds, and covers the inside of the Asamati village (located on the lake shore) and vicinity of the Nakolec village (lake shore is close to a small passing brook), enriching the habitats with riparian vegetation. Only the village of Kurbinovo is nearly 2 km from the lake, located in the foothills of the Baba Mountains. In this village we worked in the St. George Monastery (above the village), and in the vicinity of the village close to a small brook in the forest.

Table 1. Overview of registered bat species in the particular studied regions in Macedonia. Legend: a–e … study areas, see Fig. 1; d … ultrasound detector, m … mist-netting, o … visual observation, – … species not recorded

no.	species	SE MK (a)	C MK (b)	W MK (c)	N MK (d)	SW MK (e)
1	*Rhinolophus ferrumequinum*	m, o	–	o	–	–
2	*Rhinolophus hipposideros*	d	–	d, m, o	–	d
3	*Rhinolophus euryale*	d, m, o	–	–	–	–
4	*Rhinolophus blasii*	m	–	–	–	–
5	*Myotis myotis*	–	–	m	–	–
–	*Myotis myotis* or *M. blythii oxygnathus*	–	–	d	–	–
6	*Myotis emarginatus*	m, o	–	–	–	–
7	*Myotis mystacinus*	m	–	m	–	–
8	*Myotis capaccinii*	m	–	–	–	m
–	*Myotis daubentonii* or *M. capaccinii*	–	d	d	–	–
9	*Vespertilio murinus*	–	–	d, m	–	d
10	*Eptesicus serotinus*	d	d	d	d	d
–	*Vespertilio murinus* or *E. serotinus*	–	d	–	–	d
11	*Hypsugo savii*	–	d	d	d	d, m
12	*Pipistrellus pipistrellus*	d	d	d, m	d	–
13	*Pipistrellus pygmaeus*	d	d	d	d	d
14	*Pipistrellus nathusii*	–	–	–	–	d
15	*Pipistrellus kuhlii*	d, m	d	–	d, m	d
–	*Pipistrellus kuhlii* or *P. nathusii*	d	d	d	d	d
16	*Nyctalus noctula*	d	d	d	d	d
17	*Nyctalus leisleri*	–	–	m	–	d, m
18	*Plecotus auritus*	–	–	m	–	–
–	*Plecotus* sp.	–	–	–	–	d
19	*Miniopterus schreibersii*	d, m, o	d	d, m, o	–	d, m
20	*Tadarida teniotis*	d	d	–	–	–
	total no. of species	14	10	16	6	12

Locations: **e1** – Prespa lake shore at Asamati (Resen), 40.989° N, 21.046° E, 845 m a. s. l.; **e2** – park in Asamati (Resen), 40.986° N, 21.053° E, 872 m a. s. l.; **e3** – Asamati (Resen), 40.986° N, 21.051° E, 859 m a. s. l.; **e4** – Kurbinovo (Resen), 40.985° N, 21.069° E, 957 m a. s. l.; **e5** – Nakolec (Resen), 40.897° N, 21.117° E, 862 m a. s. l.

Results and Discussion

Our investigation confirmed the presence of 20 bat species (Table 1) and five more taxa which could not be identified to the species level, however, in our opinion those records are most probably related to already registered species. At the total of 40 sites, 14 bat species were confirmed by mist netting or visual observation in their roosts, the rest – 6 species - were recorded only by bat detectors (Table 1). Since the research was carried out in different regions of the country from lowlands in the south-east (less than 100 m a. s. l.) to highlands in the west (up to 1,100 m a. s. l.), and using a combination of several research methods, the number of recorded bat species is not surprising. We confirmed the presence of 20 out of 27 so far recorded species (Kryštufek & Petkovski 2003, Boshamer et al. 2006, Bekker & Boshamer 2007), but even more bat species can be expected with further research. The presented data represent a major contribution to the knowledge of distribution of the particular species, and in some cases they also give vital information on their roosting and foraging habitats, which is necessary for effective conservation of bat fauna in Macedonia.

In the following list, we give the locations and if possible the details on the numbers, sex and reproductive status of the particular species or taxa, with short comments on more interesting findings.

Legend: locations: a1–14, b1–9, c1–7, d1–5, e1–5 – for exact description of the locations see Methods; methods of detection: d – ultrasound detector, m – measurement/mist-netting of bats, o – visual observation; ad – adult, subad – subadult, juv – juvenile, i – individuals, s ex. – several bats.

Rhinolophus ferrumequinum (Schreber, 1774)

Locations: **a9** – 27 April 2010, o: s ex., m: 1 ♀ ad parous; **c4** – 23 October 2012, o: 20 ex.

The observation of several individuals of *Rhinolophus ferrumequinum,* including one parous female, in the St. Nedela cave on the Vardar river banks near the town of Gevgelija (loc. a9) is only the second possible reproduction site of this species known in Macedonia (see also Kryštufek et al. 1992). The Alilica cave (W Macedonia) at the elevation of 1,370 m is a possible hibernaculum of a smaller group.

Rhinolophus hipposideros (Borkhausen, 1797)

Locations: **a12** – 27 April 2010, d: 1 ex.; **c2** – 21 May 2013, o: 100 ex.; **c3** – 27 April 2013, m: 1 ♂ ad; **c4** – 23 October 2012, o: 1 ex.; **e1** – 28 June 2013, d: 1 ex.; **e4** – 30 June 2013, d: 1 ex.

Our observations of *Rhinolophus hipposideros* almost double the number of locations given by Kryštufek et al. (1992). Of special interest is the finding of a big maternity colony in an old house attic (loc. c2), which is also the first known nursery colony of the species in Macedonia. Using mistnets and ultrasound detectors, we recorded individual bats in their foraging areas along river banks (loc. a12, c3) and lake shore (loc. e1), as well as in villages close to their possible daytime roosts (loc. e4).

Rhinolophus euryale Blasius, 1853

Locations: **a6** – 26 April 2010, d: 1 ex.; **a9** – 27 April 2010, o: 100 ex., m: 4 ♀ ad parous, 1 ♀ ad gravid, 1 ♂ ad, 1 ♂ subad.

Our finding of at least 100 individuals of *Rhinolophus euryale,* including parous and gravid females, in the St. Nedela cave (loc. a9) is so far the second biggest known colony in Macedonia. It is surpassed by a colony of approximately 300 adults and 200 juveniles from the cave near Trpejca in SW Macedonia (Boshamer et al. 2006).

Rhinolophus blasii Peters, 1866

Locations: **a6** – 26 April 2010, m: 1 ♂ ad; **a14** – 25 April 2010, m: 1 ♂ ad.

We confirmed presence of the species in the Bela voda cave near the Demir Kapija town (loc. a14), where it was previously found in the years 1965, 1987, and 1989 (for details see Kryštufek 1992). At the time of our visit, only one male *Rhinolophus blasii* and one female *Myotis emarginatus* were inside the cave, but numerous sizable piles of fresh bat guano suggest that this cave remains a very important bat roost. A new location (loc. a6), where we mist-netted one male above a stream in the forest, is also interesting. In its vicinity there were rock cliffs where a cave-like shelter of this primarily cave-dwelling species could be found. The total of only four sites of this species is now known in Macedonia.

Myotis myotis (Borkhausen, 1797)

Location: **c3** – 23 August 2012, m: 1 ♂ ad.;
Location of bats identified as *Myotis myotis* or *M. blythii*: **c3** – 18 June 2013, d: 1 ex.; **c6** – 18 June 2013, d: 1 ex.

One male was mistnetted in W Macedonia at 990 m a. s. l. (loc. c3), and we heard single individuals from the taxon *M. myotis/M. blythii oxygnathus* foraging in the same area. Boshamer et al. (2006) also reported *Myotis myotis* from a similar elevation in SW Macedonia, and even a large colony of about 2,000 individuals from a cave near Velmej. However, they could have also observed a mixed colony with *M. blythii*, as suggested by their mist-netting of both species at a pond in the same village. On the other hand, judging by the measurements of forearm and ear length given in the report by Boshamer et al. (2006), some records of the two species could be dubious, since they are too big or small for the particular species – especially in comparison with the measurements of Macedonian *M. myotis* and *M. blythii* by Kryštufek et al. (1992).

Myotis emarginatus (Geoffroy, 1806)

Locations: **a9** – 27 April 2010, o: app. 15 ex., m: 2 ♀ ad parous; **a14** – 25 April 2010, m: 1 ♀ ad parous.

A small colony observed in the St. Nedela cave (loc. a9) is the third possible nursery colony of *Myotis emarginatus* in Macedonia. The largest colony of 500–1000 bats was recorded in the Bela voda cave (Kryštufek et al. 1992), where (loc. a14), possibly because of the slightly earlier date, we observed only one individual. The second biggest colony of approximately 50 animals was reported by Boshamer et al. (2006) from the cave near the village of Trpejca (SW Macedonia).

Myotis mystacinus (Kuhl, 1817) s.l.

Locations: **a12** – 27 April 2010, m: 1 ♂ ad; **c3** – 19 September 2012, m: 1 ♂ ad.

Our records support the widespread distribution of *Myotis mystacinus*, as suggested by Kryštufek & Petkovski (2003). However, we believe that the presence of the sibling species *M.* cf. *aurascens*, as noted by Boshamer et al. (2006), still needs to be confirmed. Their observations most probably refers to the form *M. mystacinus bulgaricus* as Mayer & von Helversen (2001) and Mayer et al. (2007) have with the results of mtDNA analyses co-identified the morphotype *aurascens* with the former subspecies.

Myotis capaccinii (Bonaparte, 1837)

Locations: **a7** – 30 April 2010, m: 1 ♀ ad gravid; **e5** – 2 July 2013, m: 1 ♂ ad.
Location of bats identified as *Myotis daubentonii* or *M. capaccinii*: **b1** – 3 May & 30 June 2011, o & d: s ex; **b2** – 2 & 3 May, 14, 29 & 30 June, & 6 October 2011, o & d: s ex; **b3** – 29 & 30 June 2011, o & d: s ex; **b7** – 3 May 2011, o & d: s ex; **b8** – 3 May & 30 June 2011, o & d: s ex; **c3** – 22 & 23 August 2012, o & d: s ex.

According to Kryštufek et al. (1992) and our records, *Myotis capaccinii* is common in lowlands along rivers and streams in the Vardar valley, but is also present at the more elevated Prespa lake and its vicinity. *M. daubentonii* has been recorded only once in Macedonia, however, we expected it to be a common species. Unfortunately, it cannot be reliably distinguished from *M. capaccinii* using a bat detector, therefore many observations of *M. daubentonii/capaccinii* foraging above water surface remained undetermined to the species level.

Vespertilio murinus Linnaeus, 1758

Locations: **c3** – 19 September 2012, m: 1 ♂ ad; **c5** – 23 October 2012: d: display calls.

Up to now *Vespertilio murinus* has been included in the list of Macedonian mammals (Kryštufek & Petkovski 2003) only on the basis of the Karaman's (1931) report from Skopje. We mist-netted an adult male in western Macedonia at 990 m a. s. l. (loc. c3), and recorded its characteristic display calls also by the riverside at 934 m a. s. l. (loc. c5), both in the autumn period. We also recorded possible *V. murinus* ultrasound echolocation calls at three other locations (loc. b1, e1, e2). Even though the echolocation calls showed the maximum frequency of around 24–25 kHz, duration 11–12 ms, and interpulse interval from 130 to 260 ms (all parameters that fall in the range of the echolocation calls of *V. murinus*), *E. serotinus* could not be entirely dismissed as sometimes (when flying in the open habitat) they have the same call characteristics (Skiba 2009). On at least two locations (loc. b1, e2), *E. serotinus* was also simultaneously recorded, therefore further research is needed to unquestionably confirm the summer occurrence of *V. murinus* in Macedonia.

Eptesicus serotinus (Schreber, 1774)

Locations: **a2** – 29 April 2010, d: 1 ex.; **a3** – 29 April 2010, d: 1 ex.; **b1** – 3 May 2011, d: 1 ex.; **c3** – 18 June 2013, d: 1 ex.; **d5** – 27 June 2013, d : 1 ex.; **e2** – 28 June 2013, d: 1 ex.; **e4** – 30 June 2013, d: 1 ex.; **e5** – 2 July 2013, d: 1 ex.;

We recorded *Eptesicus serotinus* in SE, SW, W, N and Central Macedonia in the approximately same altitude range as Kryštufek et al. (1992), from lowlands up to 1,015 m a. s. l. However, Boshamer & Bekker (2006) reported several individuals mist-netted at the elevation of 1,470 m in the Galičica National Park (SW Macedonia).

Location of bats identified as *Vespertilio murinus* or *Eptesicus serotinus*: **b1** – 3.5 2011, d: 1 ex.; **e1** – 28 June 2013, d: s: ex., **e2** – 28 June 2013, d: 1 ex.

Hypsugo savii (Bonaparte, 1837)

Locations: **b4** – 3 May 2011, d: 1 ex.; **b5** – 2 May 2011, d: 1 ex.; **c1** – 22 August 2012, d: 1 ex.; **c1** – 23 August 2012, d: 1 ex.; **c5** – 18 September 2012, d: 1; **d5** – 27 June 2013, d : s ex.; **e1** – 28 June 2013, d: s ex.; **e5** – 2 July 2013, m: 1 ♂ ad.

Hypsugo savii is clearly widespread in Macedonia, since we recorded it from lowlands up to 1,100 m a. s. l., and Boshamer et al. (2006) reported an ultrasound observation from the Galičica National Park (SE Macedonia) even at 1,470 m a. s. l.

Pipistrellus pipistrellus (Schreber, 1774)

Locations: **a3** – 29 April 2010, d: 1 ex.; **a5** – 29 April 2010, d: 1 ex.; **a8** – 29 April 2010, d: 1 ex.; **a11** – 29 April 2010, d: 1 ex.; **a13** – 25 April 2010, d: 1 ex.; **b3** – 19 September 2011, d: 1 ex.; **c1** – 22 & 23 August, & 18 September 2012, d: 1 ex.; **c3** – 27 April 2013, m: 2 ♂ ad, 18 September 2012, 23 August 2012, d: 1 ex.; **c5** – 18 September 2012, d: 1 ex.; **c6** – 18 September 2012, d: 1 ex.; **d5** – 27 June 2013, d : s ex.

Pipistrellus pipistrellus was found mainly using bat detectors, often foraging along rivers and streams, as well as in the villages and towns of SE, W, N and Central Macedonia, and Boshamer et al. (2006) reports it from SW Macedonia. Distribution records and the gathered material given by Kryštufek et al. (1992) should be re-examined, since at that time its sister cryptic species *P. pygmaeus* was not separated from the monotypic species *P. pipistrellus*.

Pipistrellus pygmaeus (Leach, 1825)

Locations: **a13** – 25 April 2010, d: s ex.; **b1** – 3 May 2011; d: social calls; **b2** – 2 &3 May, 14 June & 1 September 2011, d: s ex.; **b3** – 2 May, 29 June & 19 September 2011, d ex.: 2; **b4** – 15 & 29 June 2011, d: s ex.; **b8** – 3 May & 6 october 2011, d: s ex.; **c3** – 23 August 2012, d: 1 ex.; **e3** – 28 June 2013, d: s ex.; **d5** – 27 June 2013, d : s ex.; **e5** – 2 July 2013, d: 1 ex.

Pipistrellus pygmaeus was first reported in Macedonia by Boshamer et al. (2006), who recorded it with bat detectors three times in SW Macedonia at the altitudes between 937 and 1,065 m a. s. l. We also recorded it in that area, and in SE, W, N and central Macedonia at 10 additional sites between 185 and 991 m a. s. l. It was observed foraging predominantly close to rivers and lake shores, as well as in villages and city parks.

Pipistrellus nathusii (Keyserling et Blasius, 1839)

Locations: **e2** – 28 June 2013, d: social calls; **e4** – 28 June 2013, d: social calls.

Pipistrellus nathusii was reported from E Macedonia and the Vardar valley by Kryštufek et al. (1992, 1998), both in the autumn period (September, October) and in summer (June). Our ultrasound observations of its characteristic social calls in the villages on the banks of the Prespa lake (SW Macedonia) also come from June.

Pipistrellus kuhlii (Kuhl, 1817)

Locations: **a3** – 29 April 2010, d: social calls; **a7** – 30 April 2010, m: 1 ♂ ad, **a12** – 27 April 2010, m: 1 ♀ ad, gravid; **d3** – 25 November 2011, m: 1 ♂ ad; **d5** – 27 June 2013, d: social calls; **e2** – 28 June 2013, d: social calls.

It is a common species, found foraging in towns and villages close to street lamps, but also along forest edges at streams and artificial lakes. Unfortunately, *Pipistrellus kuhlii* cannot be separated from *P. nathusii* without the presence of characteristic socials calls (Barataud 1996), therefore the majority of observations made using ultrasound detectors remained in the very commonly heard calls of *P. kuhlii* or *P. nathusii*.

Location of bats identified as *Pipistrellus kuhlii* or *P. nathusii*: **a1** – 29 April 2010, d: 4 ex.; **a2** – 29 April 2010, d: 8 ex.; **a3** – 29 April 2010, d: 6 ex.; **a4** – 26 April 2010, d: s ex.; **a4** – 29 April 2010, d: 5 ex.; **a5** – 29 April 2010, d: 11 ex.; **a8** – 29 April 2010, d: 2 ex.; **a10** – 29 April 2010, d: 6 ex.; **a11** – 29 April 2010, d: 5 ex.; **b1** – 2 & 3 May, 15 June, 1 & 19 September, & 6 October 2011, d: s ex.; **b2** – 2 & 3 May, 1 & 19 September 2011, d: s ex.; **b3** – 14, 15, 29 & 30 June, 1 & 19 September, & 6 October 2011, d: s ex.; **b4** – 3 May, 15 June, 1 & 19 September 11, & 6 October 2011, d: 1 ex.; **b5** – 2 May, 14 June, 1 & 19 September, 6 & 28 October 2011, d: 1 ex.; **b7** – 3 May & 19 September 2011, d: 1 ex.; **b8** – 30 June, 1 &19 September, & 6 October 2011, d: 1 ex.; **c1** – 22 August 2012, d: s ex.; **c3** – 18 September 2012, d: s ex.; **d2** – 18 & 20 August 2011, d: 1 ex.; **d3** – 5 May 2011, d: s ex.; **d5** – 27 June 2013, d s ex.; **e1** – 28 June 2013, d: s ex.; **e5** – 2 July 2013, d: s ex.

Nyctalus noctula (Schreber, 1774)

Locations: **a1** – 29 April 2010, d: 3 ex.; **a2** – 29 April 2010, d: 2 ex.; **a4**: 29 April 2010, d: 1 ex.; **a6** – 26 April 2010, d: 1 ex.; **b1** – 3 May & 15 June 2011, d: s ex.; **b2** – 2 May, 1 & 19 September 2011, d: s ex.; **b3** – 3 & 22 May, 14 June, 1 September, & 6 October 2011, d: s ex.; **b4** – 3 May & 19 September 2011, d: s ex.; **b7** – 3 May 2011, d: s ex.; **b5** – 2 May, 14 June & 19 September 2011, d: s ex.; **b7** – 3 May 2011, d: s ex.; **b8** – 30 June 2011, d: 1 ex.; **c1** – 22 August 2012, d: 1 ex.; **c3** – 18 September 2012, d: s ex.; **c6** – 18 September 2012, d: s ex.; **d1** – 5 May 2011, d: 1 ex.; **d4** – 5 May 2011, d: 1 ex.; **d5** – 27 June 2013, d: s ex.; **e1** – 28 June 2013, d: s ex.; **e3** – 28 June 2013, d: s ex.

All alternating ("plip-plop") ultrasound CF parts of the recorded calls which were never lower than 19 kHz, and sometimes combined with visual observation of flying bats, gave us sufficient confidence that we had observed *Nyctalus noctula*, rather than its larger relative *N. lasiopterus* (with its CF signal tails at around 15–16(17) kHz; Barataud 2002, Skiba 2009). *N. noctula* seems to be a fairly common species in Macedonia, recorded by ultrasound detectors in all studied regions, and found foraging in cities, towns and villages, at river and lake banks. We recorded it from 150 up to 1,100 m a. s. l., which doubles the altitudinal distribution given by Kryštufek et al. (1992).

Nyctalus leisleri (Kuhl, 1817)

Locations: **c1** – 22 April 2012, m: 3 ex.; **c3** – 19 September 2012, m: 1 ex.; **e1** – 29 June 2013, d: s ex.; **e4** – 30 June 2013, m: 1 ♂ ad, d : 1 ex.

Kryštufek et al. (1992) reported one site of *Nyctalus leisleri in* SE Macedonia (app. 200 m a. s. l.) and Boshamer et al. (2006) gave 3 locations between 1,400–1,473 m a. s. l. in SW Macedonia. Our records from W and SW Macedonia fall between that elevation range, and hint that *N. leisleri* is widespread in Macedonia.

Plecotus auritus (Linnaeus, 1758)

Locations: **c3** – 23 August 2012, m: 1 ♂ ad.

Based on examination of museum material, Kryštufek et al. (1992) corrected the Karaman's (1929) determination of the individual from the Štip region from *Plecotus auritus* to *P. austriacus*. Therefore, the Boshamer at al. (2006) and Bekker & Boshamer (2007) reports should be considered as the first records of this species from Macedonia, which was made at 963 and 1,481 m a. s. l. in the Galičica Mountains, east of Lake Ohrid (SW Macedonia). Our record of *P. auritus*, mist-netted under the bridge over the Tresonče river at 991 m a. s. l. (W Macedonia), supports the idea that this species might be more common in woods and their surroundings at higher altitudes. And perhaps *P. austriacus* is more common in lowlands, as Kryštufek et al. (1992) gives its locations up to 333 m a. s. l. However, much more research on presence of *Plecotus* spp. is needed as Bekker & Boshamer (2007) also noted *P. macrobullaris* for Macedonia, and also the possible presence of *P. kolombatovici* should be investigated.

Miniopterus schreibersii (Kuhl, 1817)

Locations: **a1** – 29 April 2010, d: 3 ex.; **a3** – 29 April 2010, d: 7 ex.; **a4** – 26 April 2010, d: 1 ex.; **a4** – 29 April 2010, d: 2 ex.; **a5** – 29 April 2010, d: 4 ex.; **a6** – 26 April 2010, d: 1 ex.; **a9** – 27 April 2010, o: 3 ex., m: 2 ♀♀ gravid, 1 ♂ ad; **a13** – 25 April 2010, d: 1 ex.; **b1** – 3 May , 6 October 2011, d: s ex.; **b2** – 21 April, 3 May & 14 June 2011, d: s ex.; **b4** – 3 May 2011, d: 2 ex. (feeding buzz); **b5** – 2 &4 May & 29 June 2011, d: 1 ex. (feeding buzz); **b6** – 4 May & 14 June 2011, d: s ex.; **b9** – 4 May 2011, d: 1 ex.; **c1** – 23 october 2012, m: 1 ex.; **c4** – 23 October 2012, o: 100 ex.; **c7** – 23 October 2012, d: s ex.; **e1** – 28 June 2013, d: s ex.; **e3** – 28 June 2013, d: s ex.; **e4** – 30 June 2013, m: 1 ♂ ad; **e5** – 2 July 2013, d: s ex.

Kryštufek et al. (1992) found *Miniopterus schreibersii* to be common and widespread in Macedonia, roosting in underground natural or artificial roosts, which is also confirmed by our observations. We found a small group in its probable migratory roost in the St. Nedela cave (loc. a9) and in its possible hibernaculum in the Alilica cave at 1,370 m a. s. l. (loc. c4), which is also the so far highest elevation of the roost of this species recorded in Macedonia. Boshamer et al. (2006) also reports two additional summer roosts in caves near the villages of Velmej and Trpejca, where

approximately 2,000 and 220 *M. schreibersii* individuals roosted, respectively. Our numerous observations show that *M. schreibersii* also commonly forages in the proximity of street lamps.

***Tadarida teniotis* (Rafinesque, 1814)**

Locations: **a2** – 29 April 2013, d: 1 ex.; **a13** – 25 April 2010, d: 1 ex.; **b1** – 3 May & 6 October 2011, d: 1 ex.; **b3** – 2 May & 1 September 2011, d: 1 ex.; **b4** – 3 May 2011, d: 1 ex.

We have confirmed one of the locations of *Tadarida teniotis* given by Kryštufek et al. (1992, loc. a13), and with other new locations according to Kryštufek et al. (1998) we have doubled the known sites of this species in Macedonia. Even though our observations were all made under 400 m. a.s.l., *T. teniotis* is obviously also present at higher altitudes, as Boshamer et al. (2006) found it three times at the altitudes between 1,465 and 1,482 m a. s. l. in SW Macedonia.

Acknowledgements

The spring research camp for Slovenian biology students was organised by Društvo študentov biologije – Societas Studiosorum Biologiae Universitatis Labasensis, with Lea Likozar, Katja Šporar and Simon Zidar participating in the field work.

The Seasonal Survey of Bats in the Štip Area was supported by Invall – Spain, due to the Wind Farm Project Štip, in the Mavrovo NP by ELEM (Macedonian Power Plants) regarding the Hydropower Plant Project (Boškov Most), and in the Prespa Region the activities were a part of the "Project for capacity building of the Bat Study Group Macedonia" supported by the Eurobats Secretariat and DEFRA (UK) to whom we express our deep thanks.

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received on 15 December 2014