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New Records of the Savi's Pipistrelle *Hypsugo savii* (Bonaparte, 1837) (Chiroptera, Mammalia) from Serbia: An Evidence for the Expansion of its Geographical Range

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Abstract: This paper presents the currently known records (84) of *Hypsugo savii* from Serbia. They were collected from 22 localities and 55 exact sites. Only three of these records were previously published. The first records were from 1981 from two localities in Eastern Serbia. Since then, new sites have been gradually recorded throughout Serbia, particularly in the last four years. According to the records , there is a noticeable expansion of the species' range, from mountainous karstic areas to valleys and plains, with human settlements being particularly favoured habitats. After the first appearance in 1994 in human settlements, a constant increase of population was recorded from these habitats. Furthermore, there was growing evidence of reproduction in settlements and lowland habitats. A significant part of summer records was from certain areas of Vojvodina Province, i.e. southern part of the Pannonian Plain, recorded often above vast arable fields. The expansion of the range and the increase of population numbers had been recorded in neighbouring countries; thus, the described situation in Serbia is a contribution to better understanding of the present distribution, bionomics and ecology of this species.

Keywords: *Hypsugo savii*, distribution, Serbia, range and population expansion

Introduction

The Savi's pipistrelle *Hypsugo savii* (Bonaparte, 1837) has a wide geographical range in the Palaearctic: it extends from Southern Europe and North Africa through the Middle East and the Caucasus to Central Asia and Northern India and Burma (Horáček, Benda 2004, Wilson, Reeder 2005; Hutson *et al*. 2008). Historically, it inhabited primarily Mediterranean and sub-Mediterranean regions within its Western Palaearctic range. Recently it has been recorded as a permanent species from some Central-European countries; it is a vagrant in the Great Britain (Hutson *et al*. 2008). Northward expansion of this species from the region south of the Alps, the Mediterranean and sub-Mediterranean countries, into Central Europe has been documented previously (Spitzenberger 1997, 2001, Gaisler 2001, Gaisler, Vlašín 2003, Lehotská 2006, Lehotská, Lehotský 2006, Bartonička, Kaňuch 2006, Danko 2007, Görföl *et al*. 2007, Reiter *et al*. 2010a, 2010b). Typically it inhabits rocky (usually karstic) areas, from the sea level to more than 3300 m a.s.l. (Mitchell-Jones *et al*. 1999, Dietz *et al*. 2009). At the western part of its geographical range, the species is widespread and abundant, with no evidence of population decline and with a population trend considered as stable (Hutson *et al*. 2008). The population size and trends are not known for the eastern part of its range (Molur *et al.* 2002). Although it generally

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occurs with low population densities and is restricted by its habitat requirements, *H. savii* is abundant in some European areas bordering the Mediterranean (Hutson *et al*. 2008). It forages along cliffs, over open woodlands, pastures and wetlands, and often feeds in the vicinity of lights in urban areas. Roosts are usually in rock crevices, sometimes in buildings or under the bark of trees, rarely in underground sites (Mitchell-Jones *et al*. 1999, Hutson *et al*. 2008, Dietz *et al*. 2009). Information about the migratory behaviour of this species is lacking (Hutterer *et al*. 2005). Migration is suspected in Europe, but the longest recorded movement of 250 km has unreliable origin (Dietz *et al*. 2009).

Hypsugo savii was firstly recorded from Serbia in the early 1980s from the highlands in the south-eastern (Dimitrovgrad) and eastern (Žagubica) parts of the country, where limestone formations rich in cliffs, gorges and underground objects are plentiful (Petrović 1983, Mirić, Paunović 1995). No other records of the species have been published from the country. However, there have been numerous records and significant spread of this species' range throughout Serbia since then, particularly toward the northern border with Hungary and Romania.

The aim of this study is to summarise new and unpublished records of *H. savii* and to determine time and pattern of its geographical range increase within the territory of Serbia. At the same time, this work may serve as a contribution to understanding the species' range spreading toward north and northeast, into the countries of Eastern and Central Europe, which is obviously ongoing (Spitzenberger 1997, 2001, Gaisler 2001, Gaisler, Vlašín 2003, Lehotská 2006, Lehotská, Lehotský 2006, Bartonička, Kaňuch 2006, Danko 2007, Görföl *et al*. 2007, Reiter *et al*. 2010a, 2010b).

Materials and Methods

Data were collected in the period 1981-2014 using several methods. Field studies started in the early 1980s, with a survey of potential underground and aboveground roosts (Petrović 1983, Mirić, Paunović 1995). Since the 1990s, bats have been captured using mist-nets. Some of the captured animals were collected as voucher specimens and stored in the Mammal Research Collection at the Natural History Museum in Belgrade, Serbia, while others were marked with wing markers, measured and released. All capture, handling and collection of bats have been done under appropriate licenses issued by the responsible national ministry. Handheld ultrasound detectors D240X (Petterson Elektronik AB, Uppsala, Sweden) were introduced at the beginning of the new millennium, always in combination with visual detection using a reflector handheld lamp. Data collected for each recorded bat flight (contact) included: (preliminary) species identification, number of individuals, time, duration and locality, habitat and remarks on observed behaviour. In order to identify species as precisely as possible, the registered bat signals were recorded on digital audio-recorders and later analysed in computer lab using the specialised software BatSound 4.03 (Petterson Elektronik AB, Uppsala, Sweden), the available literature (Russo, Jones 2002, Pfalzer, Kusch 2003, Obrist *et al*., 2004, Boonman *et al*. 2009, Limpens 2010) and authors' comparative collection of ultrasound records. The combination of audio and visual detection also gave information about bat behaviour: whether they were only flying over or using a particular site (route) for feeding. In case of feeding activities, "feeding buzz" was clearly audible and recorded during detection. Field studies were systematic and intense in Western and Eastern Serbia, in the Belgrade area and in the northern part of the country (Vojvodina Province, including Srem, Banat and Bačka regions). In central, South-western and Southern Serbia bat research was not systematic and data had been collected only occasionally.

All records were listed chronologically in the Appendix. Each record included informtion about the time or period of sampling, locality, geographic coordinates (WGS84), altitude, position within the Universal Transverse Mercator grid (UTM), and habitat description. Finally a description of type of detection and, if applicable, a description of behaviour and/or condition of *H. savii* individuals were included. The records were presented on the map of Serbia in the grid of UTM squares 10 x 10 km, where periods of detection were presented by different patterns of black and white together with the year of the first record in a particular region (Fig. 1). Habitat type preferences and bionomics of this species were analysed afterwards. Habitat types were classified in accordance with the IUCN Habitats classification scheme (IUCN 2012).

Bat activity surveys were conducted within different monitoring schemes and for different purposes. However, during the research period comparable data sets were collected from three localities (Belgrade, Novi Banovci, Dolovo) and used for the calculation and discussion of relative abundance and activity index of the species. Data were obtained during bat activity surveys, using a manual bat detector as explained above. Only data sets collected in the same seasons of different years (September) and in the same period of night (from dusk until three hours

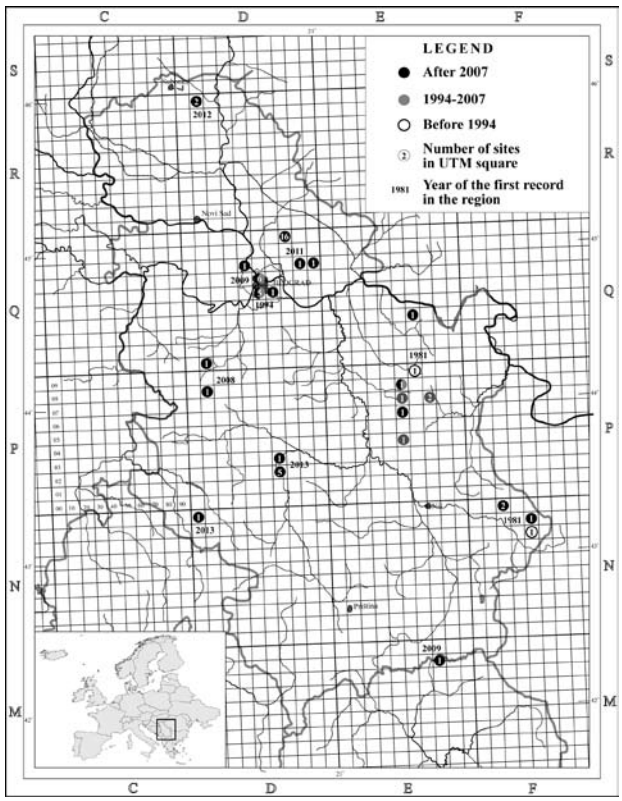

Fig. 1. Map of records of *Hypsugo savii* in Serbia; 10 x 10 km UTM grid with the year of the first record in particular region

afterwards) were used for the current study. Surveys were conducted in very similar weather conditions that were optimal for bats' activity: temperature about 20ºC, without precipitation and wind (or very light one). The relative abundance of the species was calculated as the percentage of positively identified contacts of *H. savii* specimens out of total registered contacts. Activity index of the species was calculated as the number of positively identified contacts of *H. savii* specimens per hour of survey.

Results

There were 84 records of this species in Serbia (Appendix), collected at 22 localities and 55 sites, located in 24 UTM squares 10 x 10 km^2 (Fig. 1). By April 2010, there were 19 known sites (Karapandža, Paunović 2010) with 39 records, and after that, with the intensification of the use of acoustic detection methods, the number of records and sites increased more than twice (Appendix). The use of audio detection yielded 40 records (48% of overall records), mostly in agricultural plains (63%). It gave valuable information on sites where mist-netting was not an efficient sampling method. In total, 33 voucher specimens were collected for the Mammal Study Collection of the Natural History Museum in Belgrade. Nine captured individuals were marked and released, but so far there were no recaptures. On two occasions, the captured individuals were just photographed for identification and documentation and then released.

Table 1. Review of records and record types of *Hypsugo savii* by habitat types. Habitat types are given after IUCN Habitats classification scheme (IUCN 2012)

Habitat types	Number of localities	Number of sites	Number of records
Dry Caves (7.1)	7	7	12
Urban Areas (14.5)	5	16	18
Permanent Rivers, Streams, Creeks (5.1)	8	13	29
Arable Land (14.1)	4	19	25
Total	22*	55	84

*Two of the localities include sites of two different habitat types

Table 2. Relative abundance (% of positively identified contacts of the species out of total registered contacts) and activity index (contacts per hour) of *Hypsugo savii* in September of different years at 3 localities with comparable data sets

Locality	Habitat	Year	Relative abundance	Activity index
Belgrade	Urban, park	2001	0.1%	0.7
		2010	18.0%	13
Novi Banovci (Srem region)	Urban, suburban	2006	0%	0
		2012	8.1%	3.7
Dolovo (Banat region)	Arable fields	2010	0%	0
		2011	1.2%	0.1
		2013	2.2%	0.4

Since the number of sites was very much dependent on the sampling technique (i.e. localities surveyed with bat detectors had many sites while mist-netting sites were usually the only within the locality), localities and records were more suitable for analysing species' habitat preference (Table 1). Most of the localities (33%) were in the vicinity of rivers and similar water bodies, somewhat fewer (29%) at cave entrances, 21% in urban habitats and 17% in arable fields (Table 1, Fig. 2). Furthermore, the most of the records (35%) were also from the vicinity of rivers, fewer (30%) were from above arable fields, 21% from urban habitats, and the smallest number (14%) was from the vicinity of caves (Appendix, Table 1).

The average altitude of locality was 371 m a. s. l. (Fig. 3). The vast majority of localities (82%) were at altitudes lower than 500 m and most of the

Fig. 2. Preferred habitat types of *Hypsugo savii*: a) limestone; b) urban area; c) arable field. Photos taken by B. Karapandža (a, c) and M. Paunović (b)

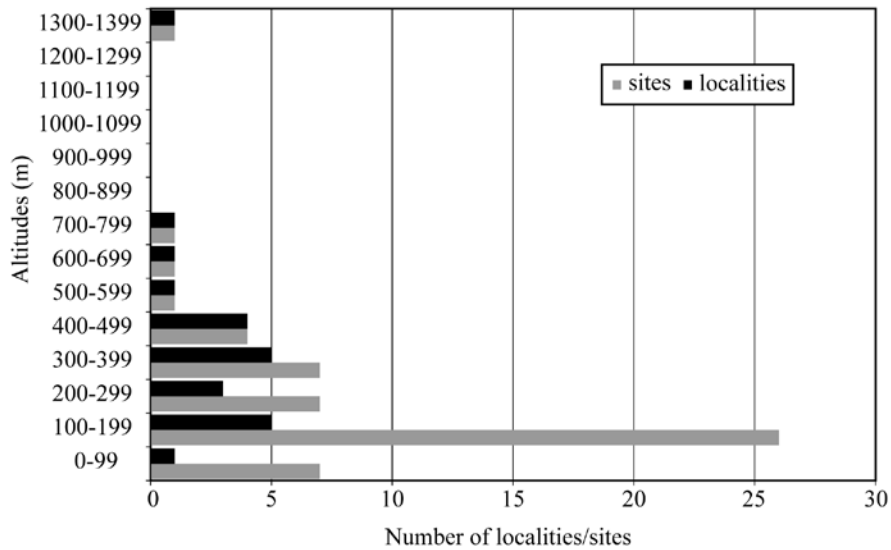

Fig. 3. Altitudinal distribution of sites (N=55) and localities (N=22) of *Hypsugo savii* in Serbia

sites within the range of 100-199 m (47%). The lowest altitude record of *H. savii* was from Banat region of Vojvodina, in the vicinity of the Padina village (DQ79, 86 m) and the highest altitude record of this species in Serbia was from a cave at Ćetanica (DN09, 1334 m) in south-western Serbia near Sjenica.

The analyses of the relative abundance and activity index revealed prominent differences among different years (Table 2). There was an obvious increase in abundance and activity at all three analysed localities.

Discussion

The first three records of the species from Serbia, and the only ones published so far were from two localities in Eastern Serbia from 1981. The record from Žagubica had been published with some ambiguity, since the first collected specimen was misidentified (Stamenković, Kovačić 1982) but this mistake was corrected after the later re-examination of the material deposited in the National History Museum in Belgrade (Mirić, Paunović 1995). The corrected data are finally recognised and included in this paper. The first specimen of *H. savii* from Belgrade was recorded in 1994 and at that time it had the status of an exceptional record, i.e. that was the first record of this species from urban areas from Serbia. At the same time, the number of records in the eastern parts of the country had increased significantly by the turn of the century. In spite of the intense research since the early 1990s, the species was recorded from Western Serbia in 2008 for the first time (Fig. 1, Appendix). During the last four years, the number of the recorded localities increased by a third, while the total number of records doubled (Appendix). In that period, there were numerous and relatively common records from Eastern Serbia, and also from the broader region of Belgrade where the population increase was definite (Table 2). Surprisingly, there were also numerous records from Vojvodina Province (southern part of Pannonian Plain), particularly from Banat region.

An interesting fact was that these records were from plain habitats at low altitudes (about 100 m). Moreover, these habitats were altered severely owing to human activities and intensive agricultural production, which was quite unexpected concerning the biology of *H. savii* (Hutson *et al*. 2008, Dietz *et al*. 2009). The distribution of the records (Fig. 1) and the presence of the species in all of the regions throughout all seasons clearly indicate that the species' distribution range and its occurrence (IUCN 2001) currently include the entire territory of Serbia. Therefore, current continental-scale distribution maps of *H. savii* (Hutson *et al*. 2008, Dietz *et al*. 2009) should be corrected.

After the first records from hilly areas in Eastern Serbia, individuals of this species started to appear in urban environments in 1994, coinciding with a similar phenomenon regarding the species *Pipistrellus kuhlii* (Paunović, Marinković 1998, Karapandža, Paunović 2010). The examination of the collections of mammals at the Natural History Museum in Belgrade shown that in the period 1954-1978, when bat fauna of Serbia was studied very intensively, individuals of *Pipistrellus pipistrellus* were dominant and most commonly recorded from urban habitats, particularly from Belgrade (Paunović, Marinković 1998, Karapandža, Paunović 2010). After 1994, there were the first records of *P. kuhlii* and *H. savii* from urban environments, where the dominance establishment by the former species had almost an invasive character. In contrast, *H. savii* has started to be more abundant only during the last several years (Table 2). After the increased presence of *H. savii* in Belgrade, it appeared in Western Serbia and in Vojvodina, and the number of records gradually increased. In Western Serbia, according to the number of records (Appendix), the range expansion and population increase have not been fast or intensive so far, but in Vojvodina they have an accelerated character (Appendix, Table 2). Surprisingly, in Vojvodina records of foraging activity became common above the agricultural plains, especially above arable fields of various crops. It was noted that linear landscape elements (alleys, hedgerows along roads, overgrown cairns between the plots) did not play crucial role in foraging activity, but that they were mostly used as flight paths between the roosts in settlements and foraging areas in agricultural fields. In areas where woody and shrubby vegetation, as a key part of linear landscape elements (Limpens *et al*. 1989; Limpens, Kapteyn 1991), was missing, the role of the flight paths was taken over by infrastructure elements including roads and tracks. We observed that specimens of *H. savii* often used rough tracks, with or without linear vegetation along, as flight paths in the Banat region of Vojvodina Province.

Concerning the habitat preference, numerous records were documented from karstic formations in mountain region of Eastern and Western Serbia, often in proximity of both flowing and still water. Specimens were sometimes found at entrances of caves or their immediate vicinity, but never within the caves. The urban environment primarily provides a wide choice of roosts, but also a source of prey. Patches of vegetation in urban ecosystems, such as parks, cemeteries and other surfaces under woody vegetation are important foraging areas. Foraging around street lights was recorded occasionally. Rivers and other smaller water bodies have great importance for bats, as the bank vegetation may be crucial for the presence of food for many bat species, including *H. savii*. Arable fields have the primary role of foraging areas in the plains, while various natural and/or artificial linear landscape elements act as flight paths. Habitats of this type are characterised by sporadic swarming of certain insect species, particularly in spring and summer, leading to increased number of records of foraging bats, including *H. savii*.

Regarding the annual dynamics, individuals of *H. savii* complete the whole annual life cycle in Serbia, including hibernation and reproduction. The winter roosts were rarely recorded, but single individuals or small groups of animals were found hibernating close to cave entrances and in the walls of buildings in urban areas. Reproduction was documented with six proof juvenile specimens (Appendix) during summer months, in urban and limestone areas likewise. Most of recorded summer roosts were found in urban environments where they were more accessible than in the natural habitats.

Within a relatively short period, *H. savii* in Serbia has shown very turbulent changes in its ecological preferences, as indicated through collected records (Appendix) and data from monitoring of overall bat fauna in certain localities (Table 2). In Serbia, there was an evident population size increase and range expansion which had not only horizontal but also a vertical aspect; *H. savii* in Serbia has spread from mountainous regions to lower elevations. These changes resulted in modification of ecological characteristics, even initiating name change for this species in the Serbian standard nomenclature. Due to the previously determined ecological characteristics, the Serbian standard name was "planinski slepi mišić" (Paunović 1999), literally translated "mountain pipistrelle". As the available data now showed that individuals of this species were increasingly recorded from human settlements, river valleys and plains of

Serbia, there are initiatives that the species' name in Serbian should soon be changed and based on morphological criteria which are obviously more stable and more appropriate than the ecological ones.

Analysing relative abundance and activity index, we observed that both values increased in time from all three localities. The increase was slightest and the values of relative abundance and activity index were lowest in Dolovo, Banat region. At that locality, the interval between surveys was shortest, but also the species' presence was discovered most recently (in 2011; Fig. 1, Appendix), although comprehensive and systematic monitoring of bats during the whole activity season at that locality started two years earlier. The values of relative abundance and activity index were highest in Belgrade, where the species presence has been known for the longest time, since 1994 (Fig. 1, Appendix).

Although population increase and range expansion of *H. savii* toward the north and east of Europe has been known for some time (Spitzenberger 1997, 2001, Gaisler 2001, Gaisler, Vlašín 2003, Lehotská 2006, Lehotská, Lehotský 2006, Bartonička, Kaňuch 2006, Danko 2007, Görföl *et al*. 2007, Reiter *et al*. 2010a, 2010b), knowledge on historical and present distribution of the species in Serbia may complete and clarify the current situation, primarily in the region but also on the whole continent. After the zoogeographic and ecological changes are recognised based on the presented observations, the next stage in understanding of this phenomenon may be at the level of taxonomic-molecular studies which have already been initiated.

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References

Bartonička T., P. Kaňuch 2006. Savi's pipistrelle (*Hypsugo savii*): bat species breeding in the Czech Republic (Chiroptera: Vespertilionidae). – *Lynx n. s.*, **31**: 19-21.

Boonman A., C. Dietz, K. Koselj, V. Runkel, D. Russo and B. Siemers 2009. Limits of echolocation calls of European bats. English version May 2009. <http://www.batecho.eu/afbeeldingen/callcurvatureMay2009.pdf>. Downloaded on 5 October 2010.

Danko Š. 2007. Reprodukcia *Hypsugo savii* a *Pipistrellus kuhlii* na východnom Slovensku: ďalšie dôkazy o ich šírení na sever [Reproduction of *Hypsugo savii* and *Pipistrellus kuhlii* in eastern Slovakia: further evidence of their spreading northwards]. – *Vespertilio*, **11**: 13-24. (In Slovak, English summary).

Dietz C., O. von Helversen and D. Nill 2009. Bats of Britain, Europe and Northwest Africa. A & C Black Publishers Ltd, London, UK.

Gaisler J. 2001. A mammal species new to the Czech Republic – Savi's pipistrelle *Hypsugo savii*. – *Folia Zoologica* **50**: 231-233.

Gaisler J., M. Vlašín 2003. Second record of the Savi's pipistrelle *Hypsugo savii* in the Czech Republic. – *Vespertilio* **7**: 181-182.

Görföl T., I. Dombi and S. Zsebők 2007. Az alpesi denevér (*Hypsugo savii* Bonaparte, 1837) Magyarországon – a faj hazai adatainak áttekintése, új eredmények [Savi's pipistrelle (*Hypsugo savii* Bonaparte, 1837) in Hungary – review of Hungarian data and new results]. – In: Molnár V. (Ed.): Proceedings of the 5th Conference on the Bat Conservation in Hungary (Pécs, 3-4 December 2005) and the 6th Conference on the Bat Conservation in Hungary (Mártély, 12-14 October 2007). CSEMETE Egyesület, Szeged, Hungary, 85-97. (In Hungarian, English summary).

Horáček I., P. Benda 2004. *Hypsugo savii* (Bonaparte, 1837) – Alpenfledermaus. In: Krapp F. (Ed.): Handbuch der Säugetiere Europas. Band 4: Fledertiere. Teil II: Chiroptera II. Vespertilionidae 2, Molossidae, Nycteridae, Aula-Verlag, Wiebelsheim: 911-941. (In German).

Hutson A. M., F. Spitzenberger, J. Juste, S. Aulagnier, J. Palmeirim, M Paunović and A. Karataş 2008. *Pipistrellus savii*. In: IUCN 2013. IUCN Red List of Threatened Species. Version 2013.2. <www.iucnredlist.org>. Downloaded on 22 May 2014.

Hutterer R., T. Ivanova, C. Meyer-Cords and L. Rodrigues 2005. Bat migrations in Europe: A review of banding data and literature. Naturschutz und biologische Vielfalt 28. Federal Agency for Nature Conservation, Bonn, Germany.

IUCN 2001. IUCN Red List Categories and Criteria (Version 3.1). Gland, Switzerland and Cambridge, UK: IUCN Species Survival Commission. IUCN.

IUCN 2012. IUCN Habitats classification scheme (Version 3.1). <http://www.iucnredlist.org/documents/June_2012_Guidance_Habitats_Classification_Scheme.pdf>. Downloaded on 5 January 2013.

Karapandža B., M. Paunović 2010. National Report on the Implementation of the Agreement on the Conservation of Bats in Europe 2009 - Serbia. Inf.EUROBATS.AC14.18, UNEP/EUROBATS Secretariat, Bonn.
<http://www.eurobats.org/sites/default/files/documents/pdf/National_Reports/nat_rep_Ser_2009.pdf>. Downloaded on 2 February 2014.

Lehotska B. 2006. Second record of the Savi's pipistrelle (*Hypsugo savii*) in Slovakia. *Vespertilio*, **9-10**: 225-226.

Lehotská B., R. Lehotský 2006. First record of *Hypsugo savii* (Chiroptera) in Slovakia. – *Biologia, Bratislava*, **61**: 192.

Limpens H. J. G. A., W. Helmer, A. Van Winden and K. Mostert 1989. Bats (Chiroptera) and linear landscape elements: a review of our present knowledge of the importance of linear landscape elements to bats. – *Lutra*, **32** (1): 1-20.

Limpens, H. J. G. A., K. Kapteyn 1991. Bats, their behaviour and linear landscape elements. – *Myotis*, **29**: 39-48.

Limpens H. J. G. A. 2010. Educational material for 3 day/night Workshop on Identification of bats in flight and the survey of bats with a bat detector. Stichting Vleermuis-Onderzoek / NABU Projektgruppe Fledermauserfassung Niedersachsen / Eco Consult & Project Management.

Mirić Đ., M. Paunović 1995. Novi nalaz planinskog slepog miša *Pipistrellus savii* (Bonaparte, 1837) (Chiroptera, Mammalia) u Srbiji [A new record of the Savi's pipistrelle *Pipistrellus savii* (Bonaparte, 1837) (Chiroptera, Mammalia) in Serbia]. – *Proceedings „Naša ekološka istina '95" Borsko jezero, Serbia,* **II-17**: 367-370 (in Serbian, English summary).

Mitchell-Jones A. J., G. Amori, W. Bogdanowicz, B. Kryštufek, P. J. H. Reijnders, F. Spitzenberger, M. Stubbe, J. B. M. Thissen, V. Vohralik and J. Zima 1999. The atlas of European mammals. Academic Press, London, UK: 128-129.

Molur S., G Marimuthu, C. Srinivasulu, S. Mistry, A. M. Hutson, P. J. J. Bates, S. Walker, K. Padma Priya and A. R. Binu Priya 2002. Status of South Asian Chiroptera: Conservation Assessment and Management Plan (C.A.M.P) Workshop Report., Coimbatore, India: Zoo Outreach Organization, CBSG South Asia and WILD.

Obrist M. K., R. Boesch and P. F. Flückiger 2004. Variability in echolocation call design of 26 Swiss bat species: consequences, limits and options for automated field identification with a synergetic pattern recognition approach. – *Mammalia* **68** (4): 307-322.

Paunović M., S. Marinković 1998. Kuhl's pipistrelle *Pipistrellus kuhlii* Kuhl, 1817 (Chiroptera, Vespertilionidae) - A new species in the mammal fauna of Serbia, with data on its Balkan distribution range, status and ecology. – *Proceedings on the fauna of SR Serbia, vol 5, SANU, Dept of natural-mathematic sciences, Belgrade, Serbia:* 167-180.

Paunović M. 1999. Predlog srpske nomenklature evropskih slepih miševa (Chiroptera Blumenbach, 1779, Mammalia) [A proposal for the standard Serbian nomenclature of bats (Chiroptera Blumenbach, 1779, Mammalia) of Europe]. – *Bulletin of Natural History Museum Belgrade, B*, **49-50**: 237-243 (in Serbian, English summary).

Petrović P. 1983. Nova vrsta sisara za faunu SR Srbije – Savijev netopir *Pipistrellus savii* Bonaparte, 1837 (Chiroptera, Mammalia) [A new mammal species in the fauna of the Socialistic Republic of Serbia: the Savi's pipistrelle Bonaparte, 1837 (Chiroptera, Mammalia)]. – *Proceedings on the fauna of SR Serbia, vol 2, SANU, Dept of natural-mathematic sciences, Belgrade, Serbia:* 263-266. (in Serbian, English summary).

Pfalzer G., J. Kusch 2003. Structure and variability of bat social calls: implications for specificity and individual recognition. – *Journal of Zoology*, **261**: 21-33.

Reiter G., T. Bartonička, R. K. Lučan and Z. Řehák 2010a. New records of *Hypsugo savii* in the Czech Republic. – *Vespertilio*, **13-14**: 121-125.

Reiter G., S. Wegleitner, U. Hüttmeir and M. Pollheimer 2010b. Die Alpenfledermaus, *Hypsugo savii* (Bonaparte 1837) in Mitteleuropa. – *Nyctalus (N. F.)*, **15**: 158-170 (in German).

Russo D., G. Jones 2002. Identification of twenty-two bat species (Mammalia: Chiroptera) from Italy by analysis of time-expanded recordings of echolocation calls. – *Journal of Zoology*, **258**: 91-103.

Spitzenberger F. 1997. Distribution and range expansion of Savi's bat (*Hypsugo savii*) in Austria. – *Zeitschrift für Säugetierkunde*, **62**: 179-181.

Spitzenberger F. 2001. Die Säugetierfauna Österreichs. Wien, Austria: Grüne Reihe des Bundesministeriums für Land- und Fortswirtschaft, Umwelt und Wasserwirtschaft (in German).

Stamenković S., D. Kovačić (1982). Prilog poznavanju faune sisara okoline Žagubice [Contribution to the knowledge of mammal fauna in surroundings of Žagubica]. – *Rezultati bioloških istraživanja "Homolje '81", Mladi istraživači Srbije, Beograd:* 7-15 (in Serbian).

Wilson D. E., D. M. Reeder 2005. Mammal Species of the World. A Taxonomic and Geographic Reference (3rd ed), Johns Hopkins University Press.

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Appendix

List of all records of *Hypsugo savii* from Serbia

(**Ordinal number**; sex; age; date; locality: site; latitude N; longitude E; altitude; UTM; habitat; detection type; NHM collection/ring number; remark; source/reference: NHMBeo – Natural History Museum, Belgrade, CAM – Centre for Animal Marking, Natural History Museum, Belgrade, BK – B. Karapandža, IB – I. Budinski)

1; m; -; 1981/2/21; Dimitrovgrad: Petrlaška Pećina cave; 43.07; 22.80; 700; FN47; cave entrance (crevice), limestone area, shrubs; manually collected; PP 3/81; -; Petrović, 1983; private collection.

2; f; -; 1981/2/21; Dimitrovgrad: Petrlaška Pećina cave; 43.07; 22.80; 700; FN47; cave entrance (crevice), limestone area, shrubs; manually collected; PP 7/81; -; Petrović, 1983; private collection.

3; m; adult; 1981/7/20; Žagubica: elementary school; 44.20; 21.79; 315; EP69; urban, building (window); manually collected; 093/95; -; Mirić and Paunović, 1995; NHMBeo.

4; m; adult; 1994/9/4; Beograd: Lekino Brdo hill, Deli Radivoja street 4; 44.79; 20.47; 120; DQ55; urban, building (school); manually collected; 047/94; -; NHMBeo.

5; m; adult; 1995/7/5; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, collected; 030/95; -; NHMBeo.

6; m; -; 1995/7/8; Bor: Zlot, Lazareva Pećina cave; 44.03; 21.96; 303; EP77; limestone cliffs, river, broadleaf forest; mist-netted, collected; 033/95; -; NHMBeo.

7; m; adult; 1996/7/2; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, collected; 062/96; -; NHMBeo.

8; f; adult; 1996/7/2; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, ringed; B1973; large embryo at the left branch of uterus; CAM.

9; m; adult; 1996/7/5; Bor: Zlot, Lazareva Pećina cave; 44.03;

21.96; 303; EP77; limestone cliffs, river, broadleaf forest; mist-netted, collected; 066/96; -; NHMBeo.

10; f; juvenile; 1996/7/23; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, collected; 098/96; -; NHMBeo.

11; f; adult; 1996/7/23; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, collected; 099/96; -; NHMBeo.

12; m; adult; 1996/8/25; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, collected; 125/96; -; NHMBeo.

13; m; -; 1998/5/21; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, collected; 560/98; -; NHMBeo.

14; m; -; 1998/7/22; Bor: Zlot, Lazareva Pećina cave; 44.03; 21.96; 303; EP77; limestone cliffs, river, broadleaf forest; mist-netted, collected; 162/98; -; NHMBeo.

15; m; -; 2000/7/19; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, collected; 043/01; -; NHMBeo.

16; -; -; 2001/9/23; Beograd: Kalemegdan; 44.82; 20.45; 110; DQ56; urban, park; bat detector survey; -; -; BK.

17; m; juvenile; 2002/8/28; Beograd: 29. Novembra street; 44.82; 20.46; 105; DQ56; urban (street, bellow the roost in a wall crevice); collected (found dead); 076/04; -; NHMBeo.

18; f; adult; 2002/8/28; Beograd: 29. Novembra street; 44.82; 20.46; 105; DQ56; urban, street; collected (after unsuccessful rehabilitation attempt); 077/04; -; NHMBeo.

19; m; adult; 2003/7/7; Ražanj: Skorica, Pećina Pećurski Kamen cave; 43.78; 21.66; 470; EP54; cave entrance, limestone cliffs, broadleaf forest; mist-netted, collected; 134/08; -; NHMBeo.

20; m; adult; 2003/7/9; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, ringed; C00020; -; CAM.

21; m; subadult; 2003/7/9; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, ringed; C00021; -; CAM.

22; f; adult; 2003/7/9; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, ringed; C00022; -; CAM.

23; m; adult; 2003/7/9; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, ringed; C00025; -; CAM.

24; f; adult; 2003/7/9; Bor: Zlot, Lazareva Reka river; 44.03; 21.96; 295; EP77; limestone cliffs, river, broadleaf forest; mist-netted, ringed; C00028; -; CAM.

25; m; adult; 2004/7/20; Despotovac: Lisine, Resava river; 44.09; 21.64; 350; EP58; river, broadleaf forest, limestone cliffs; mist-netted, collected; 010/04; -; NHMBeo.

26; m; juvenile; 2004/7/21; Beograd: Kanarevo Brdo hill, Adžine Livade street.; 44.76; 20.46; 140; DQ55; urban, building; collected (after unsuccessful rehabilitation attempt); 071/04; -; NHMBeo.

27; m; adult; 2004/7/23; Despotovac: Lisine, Resava river; 44.09; 21.64; 350; EP58; river, broadleaf forest, limestone cliffs; mist-netted, collected; 012/04; -; NHMBeo.

28; m; adult; 2004/7/24; Despotovac: Lisine, Resava river; 44.09; 21.64; 350; EP58; river, broadleaf forest, limestone cliffs; mist-netted, ringed; C00038; -; CAM.

29; m; adult; 2004/7/24; Despotovac: Suvaja river, Pećina Bela Sala cave; 44.07; 21.64; 550; EP57; cave entrance, limestone cliffs, broadleaf forest; mist-netted, ringed; C00039; -; CAM.

30; m; subadult; 2004/7/24; Despotovac: Lisine, Resava river; 44.09; 21.64; 350; EP58; river, broadleaf forest, limestone cliffs; mist-netted, ringed; C00023; -; CAM.

31; m; -; 2004/8/12; Bor: Zlot, Lazareva Pećina cave; 44.03; 21.96; 303; EP77; limestone cliffs, river, broadleaf forest; mist-netted, collected; 085/04; -; NHMBeo.

32; m; juvenile; 2005/7/31; Beograd: Banjica, Miladina Popovića street; 44.76; 20.48; 180; DQ55; urban, building; collected (found dead); 088/05; -; NHMBeo.

33; f; -; 2005/7/31; Beograd: Banjica, Borska street 92; 44.76; 20.47; 185; DQ55; urban, building; collected (found dead); 089/05; -; NHMBeo.

34; m; adult; 2008/8/1; Paraćin: Grza river by mountain lodge; 43.90; 21.65; 405; EP56; limestone area, river, broadleaf forest; mist-netted, collected; 178/08; -; NHMBeo.

35; m; adult; 2008/8/18; Valjevo: Lastra, Pećina Tmuša cave; 44.15; 19.88; 420; DP18; cave entrance, limestone cliffs, river, broadleaf forest; mist-netted, collected; 170/08; -; NHMBeo.

36; m; adult; 2008/8/19; Valjevo: Lastra, Pećina Tmuša cave; 44.15; 19.88; 420; DP18; cave entrance, limestone cliffs, river, broadleaf forest; mist-netted, collected; 168/08; -; NHMBeo.

37; f; adult; 2008/9/4; Beograd: Dedinje; 44.78; 20.45; 130; DQ55; urban, backyard; collected (found dead); 091/08; -; NHMBeo.

38; m; juvenile; 2009/7/17; Beograd-Zemun: Miće Radakovića street 8; 44.84; 20.39; 95; DQ56; urban, building; collected (found dead); 041/09; -; NHMBeo.

39; -; -; 2009/7/22; Trgovište: Pčinja river, Prohor Pčinjski monastery; 42.33; 21.89; 443; EM78; river, broadleaf riparian forest; mist-netted, photographed; -; -; Released.

40; m; adult; 2010/3/28; Beograd-Zemun; 44.84; 20.41; 90; DQ56; urban; collected (caught by cat); 001/10; -; NHMBeo.

41; m; adult; 2010/4/29; Beograd: Vračar, Smiljanićeva street 4; 44.80; 20.47; 110; DQ56; urban, building; collected (after unsuccessful rehabilitation attempt); 002/10; -; NHMBeo.

42; -; -; 2010/6/29; Beograd: Kalemegdan; 44.82; 20.45; 110; DQ56; urban, park; bat detector survey; -; foraging + commuting; BK.

43; -; -; 2010/7/11; Pirot: Temska village; 43.26; 22.54; 388; FN29; urban, street light; bat detector survey; -; foraging; IB.

44; f; adult; 2010/7/13; Pirot: Temska village, Temštica river; 43.26; 22.54; 382; FN29; river, village edge; mist-netted, photographed; -; -; IB.

45; -; -; 2011/8/2; Valjevo: Petnica village; 44.25; 19.93; 203; DQ10; crop fields, close to lake; bat detector survey; -; -; IB.

46; -; -; 2011/9/30; Deliblato sands: Dolovo village area; 44.95; 20.92; 150; DQ97; rough track, crop fields, some forest-steppe elements; bat detector survey; -; commuting; BK.

47; -; -; 2012/5/29; Kanjiža: Male Pijace villag area; 46.04; 19.88; 99; DR19; rough track, crop fields; bat detector survey; -; commuting; BK.

48; -; -; 2012/6/20; Despotovac: Lisine, Resava river; 44.09; 21.62; 366; EP58; river, broadleaf forest; bat detector

survey; -; foraging; IB.

49; -; -; 2012/9/28; Kovačica: Padina village area; 45.11; 20.71; 100; DQ79; rough track, crop fields, some linear broadleaf shrub/forest vegetation along and some forest-steppe elements, by village edge; bat detector survey; -; commuting; BK.

50; -; -; 2012/9/28; Novi Banovci; 44.95; 20.29; 89; DQ47; urban, suburban; bat detector survey; -; foraging + commuting + social calls; BK.

51; -; -; 2012/9/30; Kanjiža: Male Pijace village area; 46.03; 19.89; 100; DR19; rough track, crop fields, some linear broadleaf shrub/forest vegetation along, by village edge; bat detector survey; -; foraging + commuting + social calls; BK.

52; -; -; 2013/4/12; Kučevo: Duboka village, Dubočka Pećina cave; 44.55; 21.77; 365; EQ63; cave entrance, limestone cliff; bat detector survey; -; -; IB.

53; -; -; 2013/4/23; Kovačica: Padina village area; 45.10; 20.73; 111; DQ79; rough track, crop fields, some linear broadleaf shrub/forest vegetation along, by the village edge; bat detector survey; -; commuting; BK.

54; -; -; 2013/4/25; Kovačica: Padina village area; 45.10; 20.69; 100; DQ79; rough track, crop fields, forest edge; bat detector survey; -; commuting; BK.

55; -; -; 2013/4/26; Kovačica: Padina village area; 45.10; 20.72; 112; DQ79; rough track, crop fields, some linear broadleaf shrub/forest vegetation along, by the village edge; bat detector survey; -; commuting; BK.

56; -; -; 2013/5/4; Despotovac: Lisine, Resava river; 44.09; 21.64; 375; EP58; river, broadleaf forest; bat detector survey; -; foraging; IB.

57; -; -; 2013/5/14; Pirot: Visočica river, Rsovci village area; 43.17; 22.77; 667; FN48; river, riparian broadleaf shrubs; bat detector survey; -; -; IB.

58; -; -; 2013/5/20; Kovačica: Padina village area; 45.10; 20.69; 100; DQ79; rough track, crop fields, broadleaf forest edge; bat detector survey; -; -; BK.

59; -; -; 2013/5/24; Kovačica: Padina village area; 45.09; 20.71; 110; DQ79; rough track, crop fields, linear broadleaf shrub/forest vegetation along; bat detector survey; -; foraging + commuting; BK.

60; -; -; 2013/5/27; Kovačica: Padina village area; 45.11; 20.70; 100; DQ79; rough track, crop fields, some forest-steppe elements ; bat detector survey; -; foraging + commuting; BK.

61; -; -; 2013/5/27; Kovačica: Padina village area; 45.10; 20.70; 110; DQ79; rough track, crop fields; bat detector survey; -; foraging; BK.

62; -; -; 2013/5/27; Kovačica: Padina village area; 45.09; 20.70; 105; DQ79; rough track, crop fields; bat detector survey; -; foraging + commuting; BK.

63; -; -; 2013/5/28; Kovačica: Padina village area; 45.11; 20.72; 100; DQ79; rough track, crop fields, some linear broadleaf shrub/forest vegetation along and some forest-steppe elements, by the village edge ; bat detector survey; -; commuting; BK.

64; -; -; 2013/5/28; Kovačica: Padina village area; 45.10; 20.72; 112; DQ79; rough track, crop field, some linear broadleaf shrub/forest vegetation along, by the village edge; bat detector survey; -; commuting; BK.

65; -; -; 2013/5/28; Kovačica: Padina village area; 45.09; 20.73; 112; DQ79; rough track, crop fields, some linear broadleaf shrub/forest vegetation along; bat detector survey; -; commuting; BK.

66; m; adult; 2013/6/2; Novi Beograd: Arsenija Čarnojevića boulevard 51; 44.81; 20.43; 90; DQ56; urban, building (top 12th floor of apartment building); collected (caught by cat); 015/13; -; NHMBeo.

67; -; -; 2013/6/14; Kovačica: Padina village area; 45.07; 20.67; 86; DQ79; rough track, crop fields; bat detector survey; -; foraging; BK.

68; -; -; 2013/6/14; Kovačica: Padina village area; 45.08; 20.68; 92; DQ79; rough track, crop fields, power lines intersection, lone broadleaf tree by the road; bat detector survey; -; foraging + commuting; BK.

69; -; -; 2013/6/20; Kovačica: Padina village; 45.10; 20.73; 111; DQ79; urban, village edge, street light; bat detector survey; -; foraging (around the street light); BK.

70; -; -; 2013/7/13; Kraljevo: Ibar river; 43.56; 20.60; 280; DP62; limestone cliffs, river, roadult, broadleaf riparian forest and shrub; bat detector survey; -; commuting; BK.

71; -; -; 2013/7/14; Kraljevo: Ibar river; 43.61; 20.55; 270; DP62; limestone cliffs, river, roadult, broadleaf riparian forest and sparse shrub; bat detector survey; -; -; BK.

72; -; -; 2013/7/14; Kraljevo: Ibar river; 43.61; 20.55; 260; DP62; limestone cliffs, river, road, street light, broadleaf riparian forest; bat detector survey; -; commuting; BK.

73; -; -; 2013/7/14; Kraljevo: Ibar river; 43.62; 20.55; 260; DP62; limestone cliffs, river, road, broadleaf riparian forest; bat detector survey; -; commuting; BK.

74; -; -; 2013/7/14; Kraljevo: Ibar river; 43.63; 20.54; 240; DP63; river, broadleaf riparian forest; bat detector survey; -; commuting; BK.

75; -; -; 2013/7/16; Kraljevo: Ibar river; 43.56; 20.61; 300; DP62; limestone cliffs, river, road, bridge, broadleaf riparian forest and shrub; bat detector survey; -; commuting; BK.

76; -; -; 2013/7/19; Kovačica: Padina village area; 45.11; 20.70; 100; DQ79; rough track, crop fields, some forest-steppe elements ; bat detector survey; -; commuting; BK.

77; -; -; 2013/7/21; Kovačica: Padina village area; 45.10; 20.70; 110; DQ79; rough track, crop fields, some forest-steppe elements ; bat detector survey; -; commuting; BK.

78; -; -; 2013/7/21; Kovačica: Padina village area; 45.11; 20.70; 100; DQ79; rough track, crop fields, some forest-steppe elements ; bat detector survey; -; foraging + commuting; BK.

79; -; -; 2013/7/22; Kovačica: Padina village area; 45.08; 20.70; 100; DQ79; rough track, crop fields, power line parallel and close to the road; bat detector survey; -; commuting; BK.

80; -; -; 2013/7/23; Kovačica: Padina village area; 45.09; 20.72; 111; DQ79; rough track, crop fields, power line parallel and close to the road; bat detector survey; -; foraging; BK.

81; m; adult; 2013/7/29; Sjenica: Pećina na Ćetanici cave; 43.32; 19.82; 1334; DN09; cave entrance, limestone cliffs, coniferous forest; mist-netted, collected; 002/14; -; NHMBeo.

82; -; -; 2013/9/26; Deliblato sands: Dolovo village area; 44.90; 20.84; 115; DQ87; rough track, crop fields; bat detector survey; -; foraging + commuting; BK.

83; -; -; 2013/10/21; Deliblato sands: Dolovo village area; 44.90; 20.84; 115; DQ87; rough track, crop fields; bat detector survey; -; commuting; BK.

84; f; adult; 2014/2/3; Beograd: Mirijevo, Vladislava Bajčevića street 15; 44.79; 20.53; 170; DQ65; urban, building; collected (found dead); 003/14; -; NHMBeo.