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The distribution of the Northern Bat *Eptesicus nilssonii* (Keyserling & Blasius, 1839) in Romania

Csaba JÉRE[1], László SIMON[2], Szilárd-Lehel BÜCS[1], István CSŐSZ[1],
Levente BARTI[1], Farkas SZODORAY-PARÁDI[1], Annamária DÓCZY[1]

1. Romanian Bat Protection Association, 440014 Satu Mare Str. I.B. Deleanu Nr. 2, Romania.
2. "Gyilkostó Adventure" Association, 535500 Gheorgheni Str. M. Eminescu Nr. 29, Romania.
Corresponding author, C. Jére, E-mail: jerecsaba@yahoo.com

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Abstract. The northern bat (*Eptesicus nilssonii*) is one of the Romanian bat species with largely unknown distribution and conservation status. Due to its habitat use and hardly accessible roosts (e.g. underground roosts and rock crevices in high altitude mountain areas) only a few historical records are available about the Romanian distribution of the species. In the present paper, in addition to a literature review, we discuss eleven new occurrence data which contribute to a better understanding of the species distribution and conservation status in Romania. Most of the presented original data refer to specimens observed in hibernacula located at altitudes between 652–1,650 m above sea level, in the Eastern Carpathians and in the Apuseni Mountains. A summer observation of the species in the Rodnei Mountains at an altitude of 2,200 m currently represents the altitudinal record for the distribution of the species in Romania. The conservation status of the species is ambiguous, due to the natural protection provided by its roost choice and, at the same time, due to the deforestation in mountain areas, which represents a major threat for species' foraging habitats. The presented data suggest that *E. nilssonii* is not as rare as previously suggested, and, on the contrary, in some high mountain areas of the Romanian Carpathians can be relatively well represented.

Key words: *Eptesicus nilssonii*, Romanian Carpathians, occurrence data, winter roosts, altitudinal distribution.

Introduction

The northern bat (*Eptesicus nilssonii*) is a widely distributed species in Northern, Central, and North-Eastern Europe (Rydell 1993, Dietz et al. 2009), being also present in Eastern France and Switzerland (Stubbe et al. 2008, Dietz et al. 2009), and in Northern Italy (Agnelli et al. 2006, Toffoli et al. 2016). In Northern Europe it is one of the most abundant bat species (Rydell 1993, Stubbe et al. 2008) with a northern distribution border of 70°N, and proven to have breeding colonies even above the Arctic Circle (Rydell et al. 1994). The northern bat is a typical species of boreal and mountain forest areas, occurring in Northern Europe also in the lowlands (Dietz et al. 2009), while in Central and South-East Europe it is connected with mountain areas (Piksa & Nowak 2002, Benda et al. 2003, Pavlinić & Tvrtković 2003, Kryštufek & Režek Donev 2005, Kaňuch & Krištín 2006, Lučan 2007, Pocora et al. 2008). It can be present even in high mountains at altitudes over 2,000 m (Spitzenberger 1986, Piksa & Nowak 2002, Benda et al. 2003).

Summer roosts of the species are in buildings, in roof spaces, in wall linings or in crevices, rarely in tree holes (Rydell 1993, Dietz et al. 2009), but in Northern Europe it can occasionally be found also in bat boxes (Baranauskas 2010). As it is highly resistant to low temperatures, it usually hibernates alone or in small groups in cold cellars, bunkers, mines and caves (Rydell 1993, Dietz et al. 2009), where it can tolerate temperatures down to -5.5 °C (Masing & Lutsar 2007). The preferred habitats of the species are coniferous and hardwood forests, but the proximity of summer roosts to wetlands, lakes and streams is also essential (De Jong 1994, Dietz et al. 2009). The northern bat can be considered relatively well adapted to anthropogenically altered habitats, and it has a remarkable flexibility in seasonal habitat use (Haupt et al. 2006). It is one of the few bat species capable to take advantage from street lamp foraging (Rydell 1992, Stone et al. 2015).

E. nilssonii is usually considered to be sedentary, but is able to perform long distance flights of more than 100 km, the longest recorded distance in Europe being 450 km (Hutterer et al. 2005). Several records of the species on offshore platforms in the North Sea (Boshamer & Bekker 2008), on the Faroe Islands (Dietz et al. 2009) or flying over the open sea, at considerable distances from the coast, in the southern Baltic Sea (Ahlén et al. 2009) indicate at least occasional migratory behaviour or the ability of relatively long distance dispersal flights. The populations of the species are considered stable, with no major threats at European level and it is included in the Least Concern (LC) IUCN Red List category (Stubbe et al. 2008). A recent European study, based on monitoring data from underground hibernation roosts, collected in several countries across Europe in the 1993-2011 period concluded that no European trend could be determined for *E. nilssonii*, probably due to high between-year variation (Van der Meij et al. 2015). The reason for this is probably the extreme cold tolerance of the species, being found in higher numbers in classic underground hibernacula only during severe winter periods (Dietz et al. 2009).

Romania is situated at the southern edge of the species European distribution (Stubbe et al. 2008, Dietz et al. 2009, Battersby 2010). South to Romania the species' occurrence is only confirmed from two European countries. In Bulgaria a dead specimen was found in summer in the Rila Mountains, in the south-western part of the country, at an altitude of approximately 2.200 m (Benda et al. 2003). In addition to an uncertain historical data, relatively recent records are available also from Croatia (Pavlinić & Tvrtković 2003), where a few individuals were mistnetted in the Velebit Mountains, in the 1,058-1,351 m altitudinal range.

The main goal of this work was to compile the published

data on the Romanian occurrence of the northern bat and completing it with own, unpublished data to get a better understanding of the distribution and conservation status of the species at its southern distribution range.

Materials and methods

The paper presents the Romanian records of *E. nilssonii* from published data, papers and conference abstracts, and also original, unpublished data of the authors. We considered only occurrence data based on visually identified or captured specimens, or those identified from osteological materials. In the case of ultrasound recordings of the species with high quality material and experience the identification of the species is possible (Barataud 2015). Nevertheless, in some circumstances (certain habitat types, low quality recordings) the characteristics of the ultrasound emitted by the northern bat can show considerable overlap with other bat species (Pocora & Pocora 2012), thus leading to misidentification. In some Romanian publications even data based on automated recording systems are taken into consideration and accepted as facts, without clear description of acoustic discrimination methods and any possibility of validation. However, this method of data collection and species identification based on automated software needs a much more critical approach (Russo & Voigt 2016). Due to this uncertainty, data based on ultrasound recordings were not taken into account for the present paper.

The presented original data is a result of bat survey and monitoring work carried out during the last decade across Romania, without a special study designed to focus on *E. nilssonii*. For morphological identification of the observed specimens we used external characteristics described in Dietz et al. (2009) and Jére et al. (2010). Collected osteological material was identified according to Topál (1969). Field work was done based on permits 01/2012, 33/2013, 119/2014, 210/2014, and 01/2015 issued by the Speleological Heritage Committee.

Results

Literature review

The first two Romanian reports on the occurrences of *E. nilssonii*, dating from the 19th century and cited for decades by Romanian researchers (e.g. Dumitrescu et al. 1963, Gheorghiu et al. 2001, Valenciuc 2002, Murariu 2005) are in fact erroneous and are the results of an inaccurate localization and a misidentification. In the first case, the data referring to two specimens collected at Oravicz in 1883 and presented by Méhely (1900) and Paszlavszky (1918) are adopted erroneously by Romanian researchers and placed in the Romanian Banat area, at Oravița locality. In fact, the mentioned location (Oravicz, Árva County) is situated on the western slopes of the High Tatra Mountains, on the current territory of the Slovak Republic. The inaccurate nature of this data is already discussed in detail and corrected by Barti (2001). In the second case, the specimen collected by Méhely (1900) near Baziaş in 1899, a female with worn teeth, was, after redetermination, proved to be in fact *Hypsugo savii* (Topál, 1959). It must be noted that Méhely in his monograph already expressed a concern with regard to the certainty of the correct identification of this specimen. The first valid occurrence data of *E. nilssonii* from Romania are from the 1960's, concerning a specimen captured in the Bucegi Mountains (Rauschert 1963) and on osteological material found in the south-western Romanian Popovăț cave (Negrea et al. 1967), both data indicating the presence of the species in the Southern Carpathians. More than a decade later the presence of the species was also proven in the Eastern Carpathians, where two specimens were found in 1978 among the vertebrate victims of carbon dioxide intoxication in caves on the Ciomad-Puciosu Mountains (Molnár, 1983).

After 1990, in accordance with the increasing number of bat researchers and chiropterological studies, the available amount of distributional data for different Romanian bat species also started to show an upward tendency, this being also true for *E. nilssonii*. Between 2000 and 2015 several scientific papers presented data on the Romanian distribution of the northern bat (Table 1.). Most of the sites presented in these papers are located in the Eastern Carpathians, but the presence of the species was also proven in the Apuseni Mountains, where specimens were observed or captured at two caves, situated at altitudes over 1,000 m (Lucan 2007). A remarkable hibernation roost of the species is located in an

Table 1. Literature data on the distribution of the northern bat (*Eptesicus nilssonii*) in Romania. Abbreviations: cs - captured specimen (with no specified method or other than mistnetting), om - osteological material, ds - dead specimen, op - specimen found in owl pellet, vo - visual observation, mn - mistnetting.

Roost/location	Mountain/area	Specimen number	Method	Date/period	References
Piatra Arsă	Bucegi Mts.	1	cs	June-July 1961	Rauschert (1963)
Popovăț cave	Domanului Mts.	1	om		Negrea, Botoșăneanu, Negrea (1967)
Ucigaşă cave	Ciomad-Puciosu Mts.	2	ds	28.07.1978, 28.08.1978	Molnár (1983), Barti (2001)
		1	ds	07.07.2001	Barti (2001)
Sâncraiu (church)	Covasna county	1	op	16.02.2002	Barti (2001)
Pietrele Doamnei	Rarău Mts.	1	cs	July 1997	Valenciuc, Chachula (2001)
Mine nr. 1 from Rarău	Rarău Mts.	17-18	vo	February 2003	Valenciuc, Done, Chachula (2007), Done (2007)
		18	vo	December 2003	Done (2007)
		6	vo	February 2004	Done (2007)
		2-12 (total: 71)	vo	26.02.2004-03.01.2008	Pocora, Pocora, Baltag (2008)
Mine nr. 2 from Rarău	Rarău Mts.	1	vo	February 2003	Valenciuc, Done, Chachula (2007)
Padiş cave	Bihor Mts.	2	mn	14.10.2000	Lucan (2007)
Focul Viu ice cave	Bihor Mts.	1	vo	14.10.2000	Lucan (2007)
Mine from Abruptul Rarăului	Rarău Mts.	1	vo	16.10.2001	Chachula, Valenciuc, Done (2008)
Mare pothole	Ceahlău Mts.	1	vo	December 2004	Pocora, Pocora, Baltag (2008)
Liliecilor cave	Rarău Mts.	2	mn	Aug. 2005 – Sept. 2008	Pocora, Pocora, Baltag (2012)
Ciobănuş valley	Ciucului Mts.	1	mn	31.08.2013	Uhrin et al (2014)

Table 2. Original data on the distribution of *E. nilssonii* in Romania. Abbreviations: vo - visual observation, ds - dead specimen.

Roost/ location	Mountain/ area	Altitude (m)	Specimen number	Method	Date/period	Observations
NW from Pietrosul Rodnei	Rodnei Mts.	2200	1	vo	15.08.2001	observed after the displacement of some rocks in a rocky slope
Ucigaşă cave	Ciomad-Puciosu Mts.	1109	1	ds	18.07.2003	male
Damoklész cave	Ciomad-Puciosu Mts.	1090	1	vo	14.12.2005	male, forearm length 42,6 mm
Büdös cave	Ciomad-Puciosu Mts.	1090	1	ds	16.10.2010	male, subadult, forearm length 37,8 mm
Cu Apă din Valea Leşului cave	Pădurea Craiului Mts.	652	1	vo	18.11.2011	at a height of 2 m above ground
Likas pothole	Hăşmaş Mts.	1650	1	vo	03.12.2011	at a height of 1 m above ground
Súgó cave	Giurgeu Mts.	1063	1	vo	19.03.2013	at a height of 1,2 m above ground
			1*	vo	06.12.2014-10.01.2015	in the entrance area, height <2 m
			1	vo	06.12.2014-28.03.2015	at 6-8 m distance from the entrance, height <2 m
			1*	vo	14.02.2015-21.03.2015	at 19-20 m distance from the entrance, height <2 m
Coiba Mare cave	Bihor Mts.	1043	1	vo	20.12.2013	at a height of 1,5 m above ground
De Sus din Piatra Ciobanului pothole	Hăşmaş Mts.	1560	3	vo	12.11.2014	
Nagy-Teleki pothole	Hăşmaş Mts.	1640	6	vo	27.11.2014	
Cohárd cave	Hăşmaş Mts.	990	1	vo	25.01.2015	at a height of <1 m above ground
			1	vo	20.02.2015	at a height of <1 m above ground

*possibly the same specimen

abandoned mine gallery (Mine nr. 1) from Rarău Mountains (Eastern Carpathians), situated at an altitude of 1,504 m, where the northern bat is a representative member of the wintering bat fauna, with up to 18 specimens present (Valenciuc et al. 2007, Done 2007, Pocora et al. 2008).

Original data

During survey and monitoring work carried out in the period of 2003-2015, we observed *E. nilssonii* in 10 roosts, situated in the Eastern Carpathians and the Apuseni Mountains. These data are based primarily on bats observed during hibernation and those found as victims of the carbon dioxide emanations, in caves of the Ciomad-Puciosu Mountains (Table 2.). The number of specimens in the presented locations varies between 1 and 6. The data set is completed with an accidental observation from Rodnei Mountains (Eastern Carpathians), where during a field trip in summer of 2001 a northern bat was observed at an altitude of 2,200 m, after the displacement of some rocks in a steep rocky slope (Lengyel, Sighetu Marmației, pers. comm. 2016). Species identification was subsequently verified based on the photographs about the specimen in question. The external characteristics of the species, well distinguishable on the photographs (dark brown dorsal fur with golden-yellowish tips, yellowish hair tufts at the inner edge of the ears, dark-brown coloured skin areas) make the results of the species identification indisputable. According to the current state of knowledge, the data from Rodnei Mountains is the altitudinal record for the Romanian distribution of *E. nilssonii*.

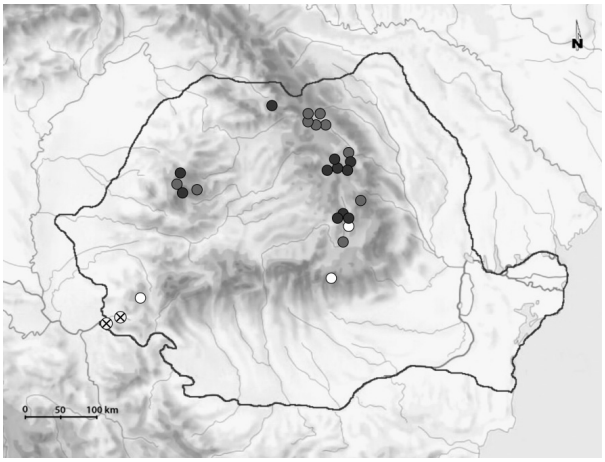

Figure 1. The distribution of *E. nilssonii* in Romania. White circles with X – erroneous data from the 19th century, white circles – literature data until 1990, light grey circles – literature data after 1990, dark grey circles – original data.

Discussion

In addition to literature data which describes the occurrences of *E. nilssonii* from 13 locations, we present here original distributional data from 11 sites, located in the Eastern Carpathians and Apuseni Mountains (Fig. 1). With one exception, all these sites provide new occurrence data to the Romanian distribution of the northern bat. Most of the data rely on hibernating specimens identified in underground roosts and in lesser extent, on dead specimens. The altitudinal range of the winter roosts covers 652-1,650 m a.s.l.; most of the observed specimens were hibernating in roosts situated at altitudes between 1,000-1,650 m. Since we did not find it during subsequent visits in the same winter, the specimen observed at the lowest altitude, at 652 m (Cu Apă din Valea Leşului Cave, Pădurea Craiului Mountains, 18.11.2011), probably used the cave only as a transition roost during autumn migration. *E. nilssonii* is one of the most cold-tolerant bat species (Masing & Lutsar 2007, Dietz et al. 2009).

Its winter roost choice is following a relatively well-defined typology: in most cases it hibernates in underground roosts (but probably also in rock crevices) situated at high altitudes (usually above 1,000 m), in the entrance areas of caves, sometimes with descending galleries or in potholes, where cold air accumulates. Inside the hibernacula the specimens often are located on the lower part of cave walls, frequently at heights between 1-1.5 m above the ground level, or even lower (Table 2.), occupying probably the coldest sections of the roost. The majority of the occurrence data collected in the summer period is from the 1,000-1,800 m distributional range. The summer observation of the species in the Rodnei Mountains at 2,200 m currently means the altitudinal record for the distribution of the species in Romania and together with the Bulgarian data (Benda et al. 2003), also for Eastern and Southern Europe.

After the two historical records from literature (Rauschert 1963, Negrea et al. 1967), no further observations of the species are available from the Southern Carpathians, despite surveys carried out during the last 15 years in different mountain ranges (e.g. Piatra Craiului, Retezat, Făgăraş Mountains; unpublished data of authors). Future studies, focusing on underground roosts situated at high altitudes in the Southern Carpathians, and particularly on the winter period, probably will be able to demonstrate the presence of the northern bat also in this area of the Romanian Carpathians.

Distribution is an essential question when assessing the conservation status of the species, especially when trying to establish the level of isolation of populations from different mountain ranges. When we take into consideration the sedentary character of the species (Hutterer et al. 2005, Dietz et al. 2009) the arguments are in favour of isolation. However, at the same time, several literature sources suggest at least occasional migratory behaviour of the species or the capacity of relatively long distance dispersal flights (Boshamer & Bekker 2008, Dietz et al. 2009, Ahlén et al. 2009). In addition, in a radio telemetry study carried out in Germany (Haupt et al. 2006) the authors found that some northern bat males displayed exploratory flights of up to 70 km per night. In most cases the distances between sites from various mountain ranges, where the occurrences of the northern bat are indicated by recent literature and our data, are shorter. In the Apuseni Mountains the sites from Pădurea Craiului and Bihor Mountains are located at distances between 30 and 60 km. Also in the Eastern Carpathians the distances of sites from different mountains are well below than the suggested flight capacity of *E. nilssonii*: sites from Ciomad-Puciosu and Ciucului Mountains are located approximately at 35 km distance from each other; between Ciucului Mountains – Giurgeu and Hăşmaş Mountains at 45-65 km; between Hăşmaş Mountains – Ceahlău Mountains at 20-35 km; and between Ceahlău Mountains – Rarău Mountains at 60-70 km. The presented arguments suggest that the populations from different mountain areas of the Eastern Carpathians and Apuseni Mountains are not isolated from each other; on the contrary, connections probably exist and can result in a functional metapopulation.

In addition, the species is also present in some of the neighbouring countries. In Hungary, situated approximately at the same latitude with Central and Northern Romania there are two available records of the species. One hibernating specimen was found in the Bakony Mountains, western part of Hungary (Paulovics 1998), and an adult female was observed during summer in the Aggtelek Karst area, Northern Hungary (Boldogh, Jósvafő, pers. comm. 2016, Vidovszky & Boldogh 2011). Probably the main reason for this scarcity of data, despite the intense bat research in Hungary, is the fact that the country is mostly situated at low altitudes, with unfavourable habitats and climatic conditions for the northern bat. The presence of the northern bat is also indicated from the Ukrainian sector of the Eastern Carpathians (Pokynchereda et al. 1999, Dietz & Kiefer 2016). Based on these records the possibility of connection, at least with the Ukrainian population, cannot be excluded.

When we try to judge the conservation status of the species, two factors are obvious. On one hand, the ecological requirements of the species and the roost choice offers a good natural protection. The situation is further improved by the facts that, at latitudes in Romania, the northern bat rarely forms large aggregations in roosts and in many cases sites are difficult to access. These circumstances reduce to a minimum the possibility of human disturbance in roosts and even if these disturbances exist, they affect a small percentage of the population, due to reduced number of specimens in single roosts. On the other hand, the coniferous and deciduous forests of the mountain areas are exposed to high anthropogenic pressure, mainly due to the deforestation affecting large areas with valuable habitats. This results in habitat loss and fragmentation, as well as loss of connectivity between roosts and foraging habitats. These factors constitute an important negative impact and can seriously affect the survival of northern bat populations, and, at the same time, represent a large-scale threat for an important number of bat species.

The presented data suggest that *E. nilssonii* is not as a rare species, as suggested previously, but, on the contrary, in some high mountain areas of the Romanian Carpathians it can be relatively well represented. The ecological requirements of the species, its restricted distribution to higher altitudes, the low detection probability and the difficulties in identification with acoustic methods are probably the main reasons for the limited number of occurrence data.

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