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GOING FURTHER SOUTH: NEW DATA ON THE BREEDING AREA OF *NYCTALUS NOCTULA* (SCHREBER, 1774) IN CENTRAL EUROPE

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ABSTRACT - We collected data on the reproduction of N*yctalus noctula* in Hungary by mist-netting and monitoring bat boxes. The capture or observation of juveniles and lactating females were considered evidence of breeding. A total of 1413 *N. noctula* were mist-netted in four study areas, corresponding to 24 new breeding locations for Hungary. In southern Hungary, one breeding colony with 20-25 individuals was observed in a bat box in a protected park, while another was found in the hollow of a white poplar. Twenty lactating females and 3 juveniles were mist-netted in the Zemplén Mountains. Our data document the regular breeding of the species in Hungary, the breeding area being wider than previously reported. Further breeding colonies are likely to be located in the floodplain forests of some main rivers, such as the Tisza and the Danube.

Key words: reproduction, breeding colony, sex ratio, Hungary

RIASSUNTO - ***Sempre più a sud: nuovi dati sull'areale riproduttivo di* Nyctalus noctula *(Schreber, 1774) in Europa centrale.*** Tramite cattura con reti nebbia e il monitoraggio di cassette nido, sono stati raccolti dati inediti sulla riproduzione di N*yctalus noctula* in Ungheria. Sono stati considerati prove certe di attività riproduttiva la cattura o l'osservazione di giovani o di femmine in allattamento. Sono stati censiti 1413 esemplari, per un totale di 24 nuovi siti di riproduzione ungheresi. Nell'Ungheria meridionale sono state osservate due *nursery*, una, con 20-25 individui, in una cassetta nido posizionata in un'area protetta e una nella cavità di un pioppo bianco. Venti femmine in allattamento e 3 giovani sono stati catturati nelle Zemplén Mountains. I dati raccolti dimostrano che la specie si riproduce regolarmente in Ungheria e che il suo areale riproduttivo è più esteso di quanto precedentemente segnalato. Ulteriori colonie riproduttive potrebbero essere localizzate nelle foreste ripariali dei principali fiumi, come il Tisza e il Danubio.

Key words: riproduzione, colonie riproduttive, rapporto sessi, Ungheria

INTRODUCTION

Nyctalus noctula (SCHREBER, 1774) is a widespread Palaearctic bat, its range extending from the Iberian Peninsula to Japan and from North Africa to the southern part of Scandinavian countries (Dietz *et al*., 2007).

Within this area, the species shows different nursing behaviours: particularly, in the southern part of its distribution range where maternity colonies are missing (or can be found only sporadically), as reported for other species such as *Pipistrellus nathusii* and *Vespertilio murinus* (Strelkov, 1997a, b; Strelkov, 2000). According to Strelkov (2000), in western and central Europe the southern border of the distribution of the nursery colonies lies around 48-49° N (central France, north-western Switzerland, south-eastern Germany, Czech Republic and Poland). South of this line, there are data on the isolated breeding of *N. noctula*, in the Iberian Peninsula (Ruedi *et al*., 1998), Italy and France (Petit *et al*., 1999), Bulgaria and northern Greece (Dietz *et al*., 2007), Austria (Spitzenberger, 2007) and Slovakia (Kaňuch and Ceľuch, 2004; Ceľuch *et al*., 2006). No maternity colonies were reported by Strelkov (2000) for Slovakia, Hungary and Romania.

N. noctula is a migratory species. In Europe, there is a sex difference in its migration habits, resulting in different genetic structures. Males are genetically homogeneous throughout the continent, probably because of their dispersal behaviour, whilst females, being highly philopatric (Petit and Mayer, 1999, 2000; Petit *et al*. 2001), form distinct populations. In spring, to rear their young, females migrate north-eastwards from south and central Europe. In autumn they return to search for suitable feeding areas, mate and hibernate (Gebhard and Bogdanowicz, 2004). Their summer and winter territories may be more than 1000 km apart (Hutterer *et al*., 2005). Although *N. noctula* is the most common bat species in Hungary (Bihari, 2007), its migratory pattern is poorly known, concrete data being scarce. Only a few dozen *N. noctula* have been banded and some recaptured, but only at the same site (Görföl, unpublished data). However, most *N. noctula* that breed in Hungary are probably migratory like other *N. noctula* populations in central Europe.

The species is primarily a tree-dweller, but in the last few decades it has also been reported in considerable numbers in prefabricated houses (Bihari, 2004). Despite the significant amount of data on the distribution of this species, its sex ratio and reproductive status have been examined in details only in north-eastern Hungary, where no lactating females or nurseries were reported (Estók, 2007). There are only three published records on the reproduction of the species in Hungary. Vásárhelyi (2008) reported that Janisch collected lactating females in the Zemplén Mountains in July 1954. Demeter and Topál (1987) found pregnant females in a tree cavity in Tőserdő near the River Tisza in 1958, and Géczi (1999) mist-netted some lactating and juvenile females in the Zemplén Mountains in the 1990s and one lactating female on a backwater in the Bodrogköz in north-eastern Hungary (Géczi, pers. comm. 2007).

Strelkov (2000) reported that in many areas most breeding populations live in the valleys of main rivers. He predicted the presence of breeding colonies in the northern part of the Great Hungarian Plain, thus on the rivers Danube and Tisza.

In this paper we present our data on the

reproduction of *N. noctula* and discuss the breeding status of this species in Hungary.

STUDY AREA AND METHODS

To collect data on the sex ratio and reproduction of the species, we mist-netted in forested sites of the Zemplén Mountains (Z; North-Hungarian Mountains, north-eastern Hungary) from June to July 2002, 2006 and 2007, in Mezőföld (M) between May and September 1999, 2003 and 2005-07 and in the Lower Danube Valley (LDV) from May to August 1998-2008 (both in southern Hungary, Fig. 1). We also mist-netted in Prométheusz Park, inside the city of Szekszárd (SZD), between March and September 2001-2008. To document potential changes in the sex ratio of the species and to compare the results with those reported by Estók (2007) for a city park in north-eastern Hungary, in 2007 the park was surveyed fortnightly by standardized mist-netting.

According to Estók (2007) the first females arrive in the Bükk Mountains during the second half of July, after the nursing period. Considering this phenology, only lactating females and juveniles observed between the 1st of May and the 15th of July were considered as definitive evidence of breeding in the study areas. Mist-netted individuals are good indicators of the existence of maternity colony in the vicinity of the netting sites, because in the maternity season the females travel only 4-5 km to reach their foraging grounds (Mackie and Racey, 2007). The age of the mist-netted individuals was assigned by observing the degree of ossification of the metacarpal and phalangeal epiphyses (e.g. Kleiman, 1969; Anthony, 1988). The reproductive status of the females was determined by examination of the nipples (Hutson and Racey, 2004). Data were also collected by checking bat boxes in southern Hungary in 2007-08.

Results were divided into three groups: bats mist-netted (1) in April, before parturition; (2) from May to the end of July, during nursing time and (3) from August to the end of September, in the mating/migrating season. Data were analysed separately for the four study areas and compared by the chi-square test (χ^2) for the goodness-of-fit.

RESULTS

We mist-netted at 81 different sites on 250 nights. The yearly sampling effort varied from 10 nights in 2004 to 47 nights in 2007. A total of 1413 *N. noctula* were mist-netted in the study areas, 841 in the Lower Danube Valley, 58 in Mezőföld, 485 in Szekszárd and 29 in the Zemplén Mountains. Twenty-four new breeding locations for Hungary were identified (Fig. 1, Table 1).

During the maternity season there was no significant difference in the representation of the sexes for both the Lower Danube Valley ($N = 327$; $\chi^2 = 0.884$, $df = 1$, n.s.) and Mezőföld ($N = 19$; $\chi^2 = 0.474$, $df = 1$, N.S.). In August, in LDV females were observed in significantly greater numbers than males ($n = 514$; $\chi^2 = 7.969$, $df = 1$, $P < 0.01$), while in M the sex ratio did not differ significantly from the equilibrium ($N = 39$; $\chi^2 = 0.641$, $df = 1$, N.S.). In Bónifok, Bogyiszló (LDV), we could observe a nursery colony inside a hollow opening 2 m above the ground in a white poplar (*Populus alba*). We observed a total of 17 bats, belonging to both *N. noctula* and *N. leisleri* and including two juvenile *N. noctula*.

In one of the parks of Mezőföld we found a *N. noctula* colony in a bat box positioned 6 m above the ground on a Norway maple (*Acer platanoides*). The

Table 1 - Data of lactating females and juveniles of *Nyctalus noctula* in Hungary. (B: Bodrogköz, LDV: Lower Danube Valley, M: Mezőföld, SZD: Szekszárd, TV: Tisza Valley, Z: Zemplén Mountains, BZ: Zoltán Bihari, DI: Imre Dombi, DTp: Demeter & Topál (1987), EP: Péter Estók, GI: István Géczi, GIp: Géczi (1999), GIpc: Géczi, pers. comm. (2007), GT: Tamás Görföl, VIp: Vásárhelyi (2008), lact: lactating, preg: pregnant, juv: juvenile).

Date	Area	Locality	Latitude	a.s.l. (m)	Coll.	Specimens
07.1954	Z	no exact location	N48°24' E21°30'	-	VIp	4lact♀+8juv♂♀
06.06.1958	TV	Tőserdő	N46°51' E19°59'	85	DTp	2preg♀
07.07.1998	Z	Rudabányácska, fish-pond	N48°24' E21°36'	150	GIp	2lact♀
11.07.1998	LDV	Érsekcsanád, 47/C forest	N46°15' E18°52'	88	DI	1lact♀+ 1juv♀
10.07.2000	LDV	Őcsény, Kongresszusi-lakes	N46°19' E18°53'	90	DI	6juv♂+6lact♀+5juv♀
12.07.2000	LDV	Baja, Cserta-Duna	N46°11' E18°53'	88	DI	2juv♂+1juv♀
15.07.2000	LDV	Hercegszántó, Budzsák-bridge	N45°56' E18°52'	86	DI	1juv♂
07.07.2001	LDV	Őcsény, 54/B forest	N46°19' E18°53'	89	DI	1juv♂
09.07.2001	LDV	Baja, Cserta-Duna	N46°11' E18°53'	88	DI	3juv♂+6lact♀+1juv♀
10.07.2001	LDV	Báta, Nyéki-Holt-Duna	N46°11' E18°50'	86	DI	5juv♂+1lact♀
12.07.2001	LDV	Kölked, Slam-bridge	N45°55' E18°44'	83	DI	1juv♂+1juv♀
06.07.2002	LDV	Őcsény, Kongresszusi-lakes	N46°19' E18°53'	90	DI	1juv♀
08.07.2002	LDV	Őcsény, 1495 rkm	N46°18' E18°55'	89	DI	2juv♂+2lact♀+4juv♀
09.07.2002.	LDV	Decs, Senki-island	N46°15' E18°53'	86	DI	1juv♂+1lact♀+4juv♀
11.07.2002	LDV	Baja, Cserta-Duna estuary	N46°12' E18°53'	86	DI	4juv♂+3lact♀+5juv♀
12.07.2002	LDV	Baja, Danube bridge	N46°11' E18°55'	87	DI	1juv♂+1juv♀
22.06.2003	LDV	Bogyiszló, Bóni-fok	N46°20' E18°53'	88	DI	1lact♀
09.07.2003	LDV	Báta, Nyéki-Holt-Duna	N46°11' E18°50'	86	DI	3juv♂+1lact♀+1juv♀
10.07.2003	LDV	Baja, Danube bridge	N46°11' E18°55'	87	DI	4lact♀+1juv♀
11.07.2003	LDV	Baja, Vén-Duna	N46°12' E18°53'	88	DI	1juv♂
12.07.2003	LDV	Szeremle, Súgó	N46°08' E18°50'	87	DI	2juv♂+1juv♀
13.07.2003	LDV	Dunaszekcső, Bári-shallow	N46°03' E18°44'	86	DI	2juv♂
15.07.2003	LDV	Kölked, Nagypartos	N45°57' E18°45'	85	DI	1juv♀
15.07.2004	LDV	Kölked, II.-III. backwater	N45°54' E18°42'	86	DI	3juv♂+2lact♀+4juv♀
10.07.2005	LDV	Baja, Cserta-Duna	N46°11' E18°53'	88	DI	2juv♂+6lact♀
07.07.2006	Z	Háromhuta, István-well	N48°24' E21°24'	500	BZ&EP	3lact♀
15.07.2006	LDV	Baja, Cserta-Duna	N46°11' E18°53'	88	DI	4juv♂+2juv♀
19.06.2007	LDV	Baja, Cserta-Duna	N46°11' E18°53'	88	GT&DI	2lact♀
20.06.2007	M	Tengelic, Csapó Park, lake	N46°33' E18°42'	108	GT	5lact♀
20.06.2007	M	Tengelic, Benyovszky Park	N46°33' E18°43'	120	GT	nursery
21.06.2007	LDV	Kölked, Slam-bridge	N45°55' E18°44'	83	GT	2juv♂+1lact♀
30.06.2007	Z	Rudabányácska, Gyuszi's lake	N48°24' E21°36'	135	EP&GT	1juv♂
02.07.2007	Z	Bózsva, Koplaló, lake	N48°29' E21°25'	238	EP&GI	2juv♂+16lact♀
03.07.2007	B	Vajdácska, backwater	N48°19' E21°38'	97	GIpc	1lact♀
07.07.2007	LDV	Kölked, Slam-bridge	N45°55' E18°44'	83	GT&DI	2juv♀
08.07.2007	LDV	Baja, Cserta-Duna	N46°11' E18°53'	88	GT&DI	1juv♂+2juv♀
13.07.2007	SZD	Szekszárd, Prométheusz Park	N46°20' E18°42'	92	GT&DI	1juv♂
14.07.2007	Z	Rudabányácska, Gyuszi's lake	N48°24' E21°36'	135	EP	1lact♀
09.07.2008	LDV	Baja, Cserta-Duna	N46°11' E18°53'	88	GT&DI	3juv♀
11.07.2008	LDV	Bogyiszló, Bóni-fok	N46°20' E18°53'	88	GT	nursery

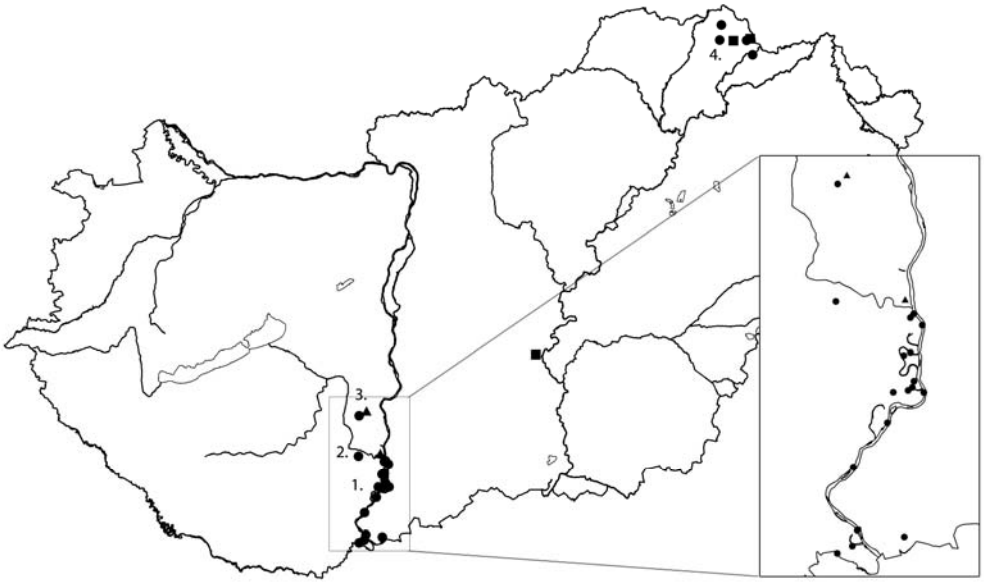

Figure 1 - Breeding records of *N. noctula* in Hungary (1. Lower Danube Valley, 2. Szekszárd, 3. Mezőföld, 4. Zemplén Mountains, ●: new records by mist-netting, ▲: nursery, ■: published old records).

colony consisted of ca. 20-25 individuals, approximately half of which were juveniles.

In the Zemplén Mountains the intensity of mist-netting was low, resulting in a small dataset that encompassed only the nursing period. During this time females predominated on males (n = 29; $\chi^2 = 4.172$, df = 1, $P < 0.05$). A total of 20 lactating females and 3 flying juveniles were mist-netted in this area.

In the city of Szekszárd females were observed before the maternity season, nonetheless a strong dominance of males was recorded (n = 142; $\chi^2 = 47.352$, df = 1, $P < 0.0001$). During the nursing period only males were mist-netted. After the nursing period females reappeared in considerable numbers, but male dominance remained significant (n = 197; $\chi^2 = 8.533$, df = 1, $P < 0.005$; Fig. 2).

During the fortnightly monitoring of Prométheusz park (SZD), females and juveniles were caught only in the post-weaning period, with the exception of one juvenile male which was mist-netted on 13th of July 2007.

DISCUSSION

In several central and south European countries (e.g. Petit *et al*., 1999; Kaňuch & Ceľuch, 2004; Ceľuch *et al*., 2006; Dietz *et al*., 2007; Spitzenberger, 2007), the breeding status of *N. noctula* has become more clear in recent years.

Our records of lactating females and juve-

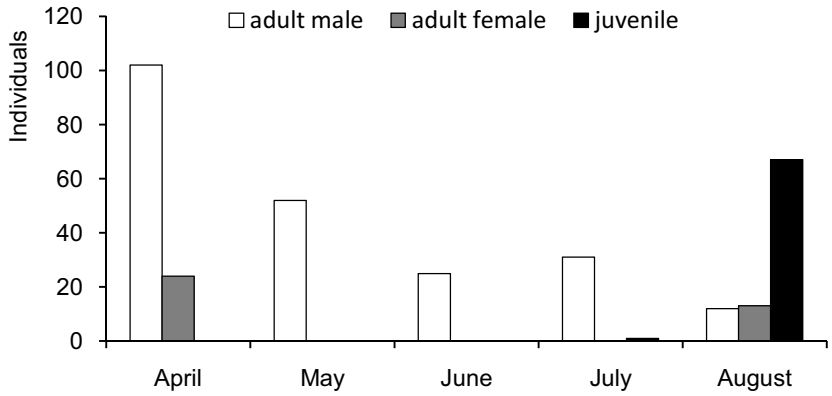

Figure 2 - Number of adult males, adult females and juveniles in Prométheusz Park, Szekszárd, in 2007.

niles clearly prove that *N. noctula* breeds in Hungary, and, based on previous studies (Strelkov 1969, 2000; Petit and Mayer, 2000), that the breeding area of this species is wider than expected. In contrast, the skewed, male-biased sex ratio recorded in the city of Szekszárd, suggests that there are no maternity roosts in this urban area, similarly to a well-studied park in north-eastern Hungary (Estók, 2007). In large settlements *N. noctula* roosts mainly in prefabricated houses, but, as yet, we have not found any breeding colony in such settlements. As Ceľuch *et al*. (2006) reported one such breeding colony in Slovakia, similar cases are likely to be found in Hungary as well.

Sampling effort was not homogeneous throughout the country, and mist-nettings were conducted mostly after the breeding season. So there are presumably other breeding populations in Hungary, most probably in the floodplain forests along the Danube and Tisza rivers. The southernmost known *N. noctula* maternity colony in Hungary is approximately 240 km south of the southernmost breeding site in Slovakia. The considerable number of records of *N. noctula* breeding in Hungary together with the sporadic records south of the Lower Danube Valley suggests that this area likely represents the southern border of the main breeding area of the species. As there are similar habitats along the River Danube also in Croatia and Serbia, further research is needed to draw the southern limits of the reproductive range of this species.

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REFERENCES

Anthony E.L.P. 1988. Age determination in bats. In: Kunz T.H. (ed.), Ecological and behavioural methods for the study of bats. Smithsonian Institution Press, Washington, D.C., 47-58.

Bihari Z. 2004. The roost preference of *Nyctalus noctula* (Chiroptera, Vespertilionidae) in summer and the ecological background of their urbanisation. *Mammalia*, 68(4): 329-336.

Bihari Z. 2007. Rőt koraidenevér - *Nyctalus noctula*. [Noctule - *Nyctalus noctula*]. In: Bihari Z., Csorba G. and Heltai M. (eds), Magyarország emlőseinek atlasza, Kossuth Kiadó, Budapest, 95-96 [in Hungarian].

Ceľuch M., Danko Š. and Kaňuch P. 2006. On urbanisation of *Nyctalus noctula* and *Pipistrellus pygmaeus* in Slovakia. *Vespertilio*, 9-10: 219-221.

Demeter A. and Topál Gy. 1987. Mammals of the Kiskunság. In: Mahunka S. (ed.), The Fauna of the Kiskunság National Park. II., Akadémiai Kiadó, Budapest, 446-452.

Dietz C., von Helversen O. and Nill D. 2007. Abendsegler - *Nyctalus noctula*. In: Dietz C., von Helversen O. and Nill D. (eds), Handbuch der Fledermäuse Europas und Nordwestafrikas - Biologie, Kennzeichen, Gefährdung, Franckh-Kosmos Verlag, Stuttgart, 267-272 [in German].

Estók P. 2007. Seasonal changes in the sex ratio of *Nyctalus* species in North-east Hungary. *Acta Zool. Acad. Sci. H.*, 53(1): 89-95.

Gebhard J. and Bogdanowicz W. 2001. *Nyctalus noctula* (Schreber, 1774) - Großer Abendsegler. In: Niethammer J. and Krapp F. (eds), Handbuch der Säugetiere Europas - Band 4: Fledertiere, AULA-Verlag, Wiebelsheim, 607-694.

Géczi I. 1999. Adatok a Zempléni-hegység és a szomszédos kistájak denevérfaunájához (Mammalia: Chiroptera). [Data to the bat fauna of the Zemplén-Mountains and the surrounding regions]. *Fol. Hist.-nat Mus. Matr.*, 23: 381-389 [in Hungarian with English summary].

Hutson A.M. and Racey P.A. 2004. Examining bats. In: Mitchell-Jones A.J. and McLeish A.P. (eds), Bat workers' manual, Joint Nature Conservation Committee, Peterborough, 49-58.

Hutterer R., Ivanova T., Meyer-Cords C. and Rodrigues L. 2005. Bat migrations in Europe - A review of banding data and literature. Federal Agency for Nature Conservation, Bonn, 94-96.

Kaňuch P. and Ceľuch M. 2004. On the southern border of the nursing area of the noctule in Central Europe. *Myotis*, 41-42: 125-127.

Kleiman D.G. 1969. Maternal care, growth rate and development in the noctule (*Nyctalus noctula*), pipistrelle (*Pipistrellus pipistrellus*) and serotine (*Eptesicus serotinus*) bats. *J. Zool. Lond.*, 157: 187-211.

Mackie I.J. and Racey P.A. 2007. Habitat use varies with reproductive state in noctule bats (*Nyctalus noctula*): implications for conservation. *Biol. Conserv.*, 140: 70-77.

Petit E. and Mayer F. 1999. Male dispersal in the noctule bat (*Nyctalus noctula*): where are the limits? *Proc. R. Soc. Lond.* B., 266: 1717-1722.

Petit E. and Mayer F. 2000. A population genetic analysis of migration: the case of the noctule bat (*Nyctalus noctula*). *Mol. Ecol.*, 9: 683-690.

Petit E., Balloux F. and Goudet J. 2001. Sex-biased dispersal in a migratory bat: a characterization using sex-specific demographic parameters. *Evolution*, 55(3): 635-640.

Petit E., Excoffier L. and Mayer F. 1999. No evidence of bottleneck in the post-glacial recolonization of Europe by the noctule bat (*Nyctalus noctula*). *Evolution*, 53(4): 1247-1258.

Ruedi M., Tupinier Y. and de Paz O. 1998. First breeding record for the noctule bat (*Nyctalus noctula*) in the Iberian Peninsula. *Mammalia*, 62(2): 301-304.

Spitzenberger F. 2007. First record of a maternity colony of *Nyctalus noctula* in Austria: does the European nursing area expand? *Hystrix It. J. Mamm*. (n.s.), 18(2): 225-227.

Strelkov P.P. 1969. Migratory and stationary bats (*Chiroptera*) of the European part of the Soviet Union. *Acta Zool. Cracov*. 14: 393-439.

Strelkov P.P. 1997a. Breeding area and its position in range of migratory bats species (Chiroptera: Vestertilionidae) in East Europe and adjacent territories Communication 1. *Zool. Zhurnal*, 76(9): 1073-1082.

Strelkov P.P. 1997b. Breeding area and its position in range of migratory bats species (Chiroptera: Vestertilionidae) in East Europe and adjacent territories Communication 2. *Zool. Zhurnal*, 76(12): 1381-1390.

Strelkov P.P. 2000. Seasonal distribution of migratory bat species (Chiroptera, Vespertilionidae) in eastern Europe and adjacent territories: nursing area. *Myotis*, 37: 7-25.

Vásárhelyi I. 2008. Borsod-Abaúj-Zemplén megye gerinces faunája. [The vertebrate fauna of Borsod-Abaúj-Zemplén County]. ANP Füzetek 6, 1-186. [in Hungarian].