

## SEASONAL CHANGES IN THE SEX RATIO OF *NYCTALUS* SPECIES IN NORTH-EAST HUNGARY

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The sex ratios of *Nyctalus noctula*, *N. leisleri* and *N. lasiopterus* were studied in North-East Hungary between 1994 and 2006. Significant seasonal changes were found in the sex ratios of *N. noctula* and *N. leisleri*. *N. noctula* females were not present during nursing time, which means that the species do not form maternity colonies in the region. Females were observed in the spring and autumn which suggests considerable migration. In the cases of *N. leisleri* and *N. lasiopterus* females were dominant during nursing time.

Key words: *Nyctalus*, sex ratio, Hungary

### INTRODUCTION

Bats show complex and very diverse reproductive behaviour. Mating and nursing characteristics differ significantly between species (WILKINSON & MCCrackEN 2003). Seasonal segregation of the two sexes often occurs, females form nursery colonies from which matured males are excluded in many cases (TOPÁL 1962). Males are more mobile and often live alone or in smaller, loose groups in the summer. Sometimes, females are totally absent from parts of different sizes of the species area during nursing (STRELKOV 1997*a, b*, GOMBKÖTŐ 1998). After raising the newborn bats, females migrate to mating places and to hibernating sites, where the two sexes are found together. Females often migrate longer distances between their summer (nursery) roost and hibernaculum than males, representing sex-biased migration (FLEMING & EBY 2003). *Nyctalus* species are fast (aerial) hawking bats with very good flying ability, which makes them able to migrate very considerable distances. Females of *N. noctula* stick to the nursery colonies where they were born (PETIT & MAYER 1999). They can migrate from the nursery roosts to hibernating places more than 1000 kilometres away (GEBHARD & BOGDANOWICZ 2004). *N. leisleri* is also one of the most vagrant European bats (BOGDANOWICZ & RUPRECHT 2004), and probably *N. lasiopterus* also has an outstanding capability for migration (IBÁÑEZ *et al.* 2004). These features can result in significant seasonal changes in sex ratio which can be connected to a very large geographical area.

In Hungary, all three European *Nyctalus* species are present. *N. lasiopterus* and *N. leisleri* are forest-dwelling bats, which are quite understudied, resulting in very little information on the life cycle and sex ratio of the species. *N. leisleri* is a frequent species in the woodlands of the Northern Hungarian Mountain Range, while *N. lasiopterus* is a rare bat species in Hungary (TOPÁL 1959, 1976, VÁSÁRHELYI 1964, DOBROSI 1993, GOMBKÖTŐ *et al.* 1996, CZÁJLIK & HARMOS 1997, CSERKÉSZ 1998, MATIS *et al.* 2003), with only one considerable locality. There are nursery roosts of the species, where females with signs of lactation were mist-netted. *N. noctula* is also primarily a woodlander bat, but in the last decades it has showed a preference for inhabiting the crevices in the walls of blocks of flats (BIHARI 2004). Although *N. noctula* is one of the most common bat species in Hungary, there are only very few published records of the reproductive characteristics and the sex ratio of the species (TOPÁL 1962).

The aim of this paper is to analyse the sex ratio of these three species in order to clarify the reproductive status of the members of *Nyctalus* genus in North-East Hungary.

## MATERIALS AND METHODS

To examine the sex ratio of the *Nyctalus*-species, specimens of *Nyctalus leisleri*, *N. noctula* and *N. lasiopterus* were captured with mist-nets from May to October, between 1994 and 2005. Bats were mist-netted at 39 sites of the study area on 299 nights altogether (Bükk Mts – 31 sites, 183 mist-nettings, Mátra Mts – 2 sites 13 mist-nettings, Heves Borsodi Hilly Country – 3 sites, 7 mist-nettings, Medves Mts – 2 sites, 5 mist-nettings and Eger – 1 site: a 14 hectare park named Érsekkert, in the city of Eger, 91 mist-nettings). The nets were placed near different water bodies before sunset and kept erected for a minimum of 3 hours after sunset, maximum till sunrise. Additionally, data of *N. noctula* specimens, which were rescued during the felling of old, dangerous trees in the Érsekkert in 2006 (GOMBKÖTŐ & ESTÓK unpublished) were also used.

### *Statistical analysis*

To perform statistical analysis data of captured bats were separated into different groups according to the reproductive terms of the bats. Data of *N. leisleri* were arranged into two groups: specimens captured (1) from May to the first half of July, during nursing period and (2) from the second half of July to September, during mating period. In the case of *N. noctula* three groups were separated: specimens observed (1) in April, before the nursing period, (2) from May to the end of July, during nursing time and (3) from August to the end of September, in the mating period. Regarding to the very few data of *N. lasiopterus* all data were treated together.

Chi-square test for goodness of fit was used for statistical comparison. Observed values were the numbers of specimens of each sex in the same terms, expected values were calculated on the base of 1:1 male-female sex ratio.

## RESULTS

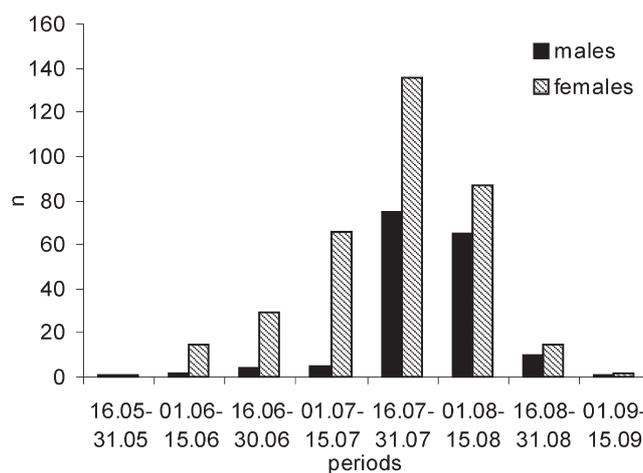
1485 specimens belonging to the *Nyctalus*-genus were sexed during mist-nettings between 1994 and 2005. 154 *N. noctula* of the rescued bats were sexed at Érsekkert in April 2006. Altogether the data of 1639 *Nyctalus* specimens were collected for comparison.

*Nyctalus leisleri*

The sexes of 514 specimens were identified. Data grouped into 15 day periods and arranged chronologically are shown in Figure 1. During nursing, from 1 May to 15 July, 90.2% of the specimens were females. This strong female dominance differed from equilibrium significantly ( $n = 123$ ;  $\chi^2 = 79.682$ ,  $df = 1$ ,  $p < 0.001$ ). From 15 July to 15 September the ratio of females reduced to 61.4%, the dominance of the females was also significant ( $n = 391$ ;  $\chi^2 = 20.258$ ,  $df = 1$ ,  $p < 0.001$ ).

*Nyctalus noctula*

During the research period, this species was mist-netted in the greatest numbers ( $n = 916$ ). A considerable number ( $n = 601$ ) of these specimens were sampled in the Érsekkert (Eger city). These bats inhabit either the crevices of prefabricated houses in the city or the hollows of trees. In forested habitats *N. noctula* were mist-netted in smaller numbers than *N. leisleri*. 154 bats were sexed during their rescue from old trees which were cut down later.



**Fig. 1.** The numbers of males and females of *N. leisleri* grouped into 15 day periods

The data of 1070 sex identified specimens of *N. noctula* were used for comparisons. Data grouped into 15-day periods and chronologically arranged are shown in Figure 2.

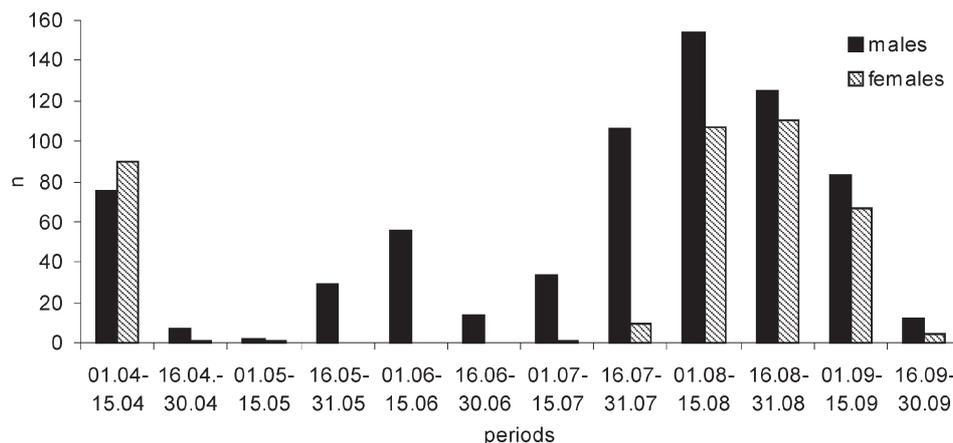
In April, before the nursing period, there was no significant difference between the representation of the two sexes ( $n = 173$ ;  $\chi^2 = 0.468$ ,  $df = 1$ , n.s.). In the nursing period, from May to the end of July, there was a strong, significant dominance of males ( $n = 251$ ;  $\chi^2 = 208.928$ ,  $df = 1$ ,  $p < 0.001$ ), with an exclusive presence of males from the second half of May till the beginning of July. Very few ( $n = 10$ ) females occurred in July. After nursing, in August and September, females were observed in considerable numbers ( $n = 288$ ), but males were dominant, the sex ratio differed significantly from the equilibrium ( $n = 646$ ;  $\chi^2 = 9.417$ ,  $df = 1$ ,  $p < 0.005$ ).

### *Nyctalus lasiopterus*

The rareness of the species resulted in very few data, only 55 specimens were sexed from July to the first half of August (Fig. 3), when females were far dominant with a 85.5% relative frequency, the sex ratio differed significantly from the equilibrium ( $n = 55$ ;  $\chi^2 = 27.654$ ,  $df = 1$ ,  $p < 0.001$ ).

## DISCUSSION

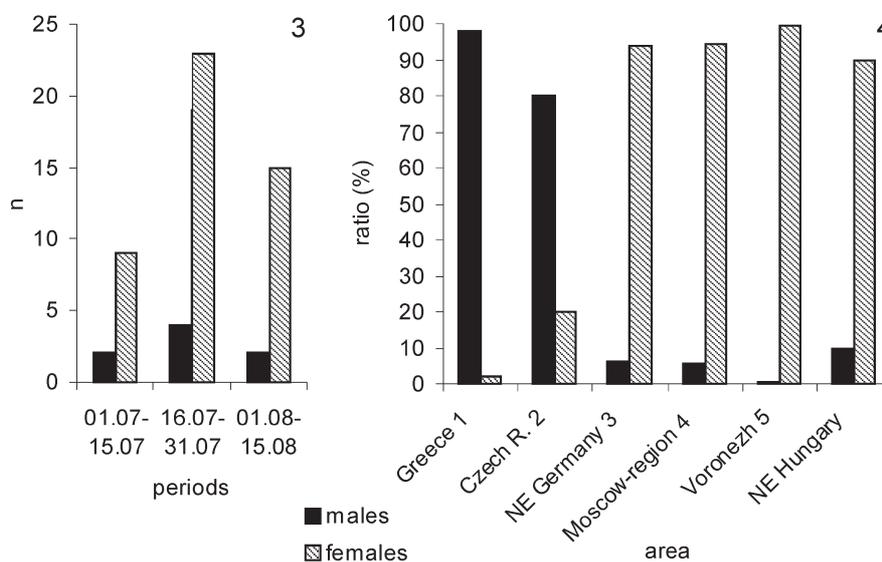
The sex ratio of *N. leisleri* and *N. noctula* showed characteristic seasonal changes. Females of *N. noctula* were observed in spring and after the nursing period, in the latter case the first females were mist-netted in the second half of July,



**Fig. 2.** The numbers of males and females of *N. noctula* grouped into 15 day periods

with only one exception: a female (with no signs of lactation) was captured on 4 July 1994. In the nursing period no females of *N. noctula* were captured. It suggests that nursing colonies of the species are not present in the research area, *N. noctula* uses the region only for mating, migrating and hibernating. These results meet the statements made by STRELKOV (1997a, b) who put the main European breeding area of the species to the eastern parts of Europe. Females arrive in larger numbers to North-East Hungary from an unknown area in August. The possible nursing area of these females may be situated in north-eastern direction from Hungary, on the basis of the average direction of migration noted by PETIT and MAYER (2000). There is a known breeding colony of *N. noctula* in the neighbouring South Slovakia (KAŇUCH & CELUCH 2004), so it is possible that sporadic breeding of the species will be detected in the Northern Hungarian Mountain Range in the future.

In the case of *N. leisleri* the opposite of the sex ratio of *N. noctula* was observed during nursing time. The researched region is important for the species as a nursing place too. The ratio of males started to increase in the first half of July, which was mainly due to the appearance of flying juveniles, but adult males were also more active with enlarged testes. *N. leisleri* also showed extreme differences in sex ratio in other European countries, with significant female dominance in North and East Europe (Fig. 4).



**Figs 3–4.** 3 = The numbers of males and females of *N. lasiopterus* grouped into 15 day periods. 4 = Sex ratios of *N. leisleri* in different parts of Europe [source: 1 (HELVERSEN & WEID); 2 (GAISLER 1975); 3 (HEISE 1982); 4 (LICHACEV 1980); 5 (ABELENEV et al. 1956) in BOGDANOWICZ & RUPRECHT 2004]

The data of *N. lasiopterus* verified that the species have nursing colonies in Hungary. The observed sex ratio is in contrast with data noted in Greece, where only males were sampled during nursing time, while both sexes were present during the mating period (HELVERSEN & WEID 1990). In Hungary, females dominated in nursing time, males were quite rarely mist-netted. In October no specimens were mist-netted, it is possible, that the known colonies migrate to unknown, likely transboundary mating and hibernating places.

The significant seasonal changes in the proportions of females support the sex-biased migration of the *Nyctalus*-species, with a bigger migrating potency of females (FLEMING & EBY 2003).

The two extremely sensitive seasonal aggregations of bats, the hibernating and nursing populations are often situated at significant distances in the case of *Nyctalus* species. Nursery roosts can be absent from considerable parts of the species area, like in the case of the most common Hungarian bat species, *N. noctula*. The study of characteristic changes in sex ratios can help to understand the regional status of the species, and raises the attention of the necessity of identifying “nursery hot spots” in order to make conservation more effective.

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