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The vocal activity of *Pipistrellus nathusii* (Vespertilionidae) in SW Poland

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Vocal activity of Nathusius' pipistrelle (*Pipistrellus nathusii*) was studied between April–October 1998 in Wrocław, SW Poland. This activity (nocturnal and seasonal), measured as the number of social and echolocation calls recorded along a 2 km convoluted transect, was lowest in April, May and June. In July, vocal activity increased to reach its highest level during August and September. Throughout the study, calls were emitted in the early part of the night from May through June, then switched to the latter part of the evening in August. Seasonally, the number of calls correlated positively with the air temperature; no significant relationship was found between the level of social and echolocation calls, and relative humidity or atmospheric pressure. It is considered that these changes in vocal activity in July were associated with the onset of the mating period, when the males emitted social calls during an advertisement display or from the roosts, performed to attract females for harem formation. The calls of *P. nathusii* emitted outside the mating period may also have played another social function.

Key words: *Pipistrellus nathusii*, social activity, social calls, advertisement calls, echolocation

INTRODUCTION

Several species of European bat produce low frequency (12–20 kHz), species-specific advertisement calls readily audible to humans (e.g., Ahlén, 1981; Limpens and Roschen, 1995). During the mating season these calls attract females to males while repelling rival males. When vocalising, male pipistrelles (*Pipistrellus pipistrellus*) perform songflight displays as they fly near their day roosts (Lundberg and Gerell, 1986; Lundberg, 1989). Similar displays also are performed by particoloured bats (*Vespertilio murinus*) and brown long-eared bats (*Plecotus auritus*; Ahlén, 1981, 1990; Weid, 1988; Limpens and Roschen, 1995; author's unpubl. data). Male Leisler's bats (*Nyctalus leisleri*) vocalise predominantly from trees (Helversen and Helversen, 1994), while male noctules (*Nyctalus noctula*) vocalise only from the openings of mating roosts (Ahlén, 1981, 1990; Lundberg, 1989; Weid, 1994; Limpens and Roschen, 1995).

Male Nathusius' pipistrelles (*Pipistrellus nathusii*) emit advertisement calls during songflights and while sitting at the entrances of their day roosts (Sosnovtzeva, 1974; Lundberg, 1989; Barlow and Jones, 1996; Szkudlarek and Paszkiewicz, 2000), establishing territories near nursery colonies while waiting for the females to arrive (Lundberg, 1989; Schmidt, 1994). During the mating period from the end of July

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through August, large harems are most often observed and males spend most of the night vocalising (Lundberg, 1989; Rachwald, 1992).

If the calls made during songflights and from roosts are associated with mating, they should be most often heard during the mating season. But some species of bats (e.g., *Pipistrellus pipistrellus, P. pygmaeus* and *P. nathusii*) also emit social calls outside of the mating period suggesting another function for the vocalisations. Barlow and Jones (1997) proposed that the social calls of two phonic types of *P. pipistrellus*, heard before the onset of mating, play a rule during defence of food patches.

In this paper I describe the calling pattern of *P. nathusii* from April to October in Southwest Poland to determine whether social calls are emitted during the whole season and wheather vocal activity changes during the year. I supposed that in the midsummer the calling should increase, because of the onset of mating period and mating function of the social calls (e.g., in attracting the females, and higher activity of bats in defending their territories). I predicted that in mating areas there would be more social than echolocation calls, compared to foraging, maternity roosts or migration areas (Schmidt, 1994). Strong territorialism and vocalisation of males could confirm that *P. nathusii* establishes mating territories in SW Poland.

Material and Methods

The study was carried out from April to October 1998, in the Szczytnicki Park (113 ha) in Wrocław (51°07'N; 17°03'E). The study plot covered 26 ha in which approximately 50 mating roosts of *P. nathusii* are known (Furmankiewicz and Szkudlarek, 2001). Common oak (*Quercus robur*), common beech (*Fagus sylvatica*) and hornbeam (*Carpinus betulus*) dominated the study area. Other abundant tree species included the common alder (*Alnus glutinosa*), small-leaved lime (*Tilia cordata*), Norway and field maples (*Acer platanoides* and *A. campestre*) and false acacia

Fig. 1. Map of the study area in the Szczytnicki Park, Wrocław. Transect line with its terminal points (A and B) is shown

(*Robinia pseudacacia*). A 2 km-long convoluted transect was established on the study plot and took about 40 minutes to travel at 3 km/h (Fig. 1). The transect line was chosen to bring it close to a maximum number of known mating roosts.

To determine the seasonal changes in vocal activity I walked the transect line 3–4 times a week, four hours after sunset. While walking I recorded continuously advertisement and echolocation calls emitted by *P. nathusii*. I assessed changes in nocturnal vocal activity on the basis of all-night surveys, which were conducted weekly across the study period. I performed seven surveys during the long night periods from April to June, and from mid-July to September, and six surveys from mid-June to mid-July. On all-night surveys I was walking the transect line (Fig. 1) 6–7 times, and recording the social and echolocation calls of Nathusius' pipistrelle. The start time of the three transect walks was fixed: the first survey began 20 minutes after sunset, the fourth (the main one) four hours after sunset, and last one (sixth or seventh) 20 min before sunrise. The remaining surveys were distributed evenly between these transect walks.

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I used two ultrasonic heterodyne detectors (Pettersson D-140 and D-100) tuned to 40 kHz and 20 kHz respectively, connected to a stereo cassette recorder (Sony WM-D6C). The choice of these frequencies was related directly with the chacteristics of calls emitted by *P. nathusii.* The narrowband portion of its echolocation calls ranges from 36 to 41 kHz with an average at about 40 kHz (Ahlén, 1991; Jones, 1993; Limpens and Roschen, 1995; Barlow and Jones, 1996). The social calls of this species are population-dependent (e.g., Ahlén, 1991; Gerell-Lundberg and Gerell, 1994; Limpens and Roschen, 1995; Barlow and Jones, 1996) and consist of undulating and V-shaped sweeps between 14 and 45 kHz (Fig. 2). Nevertheless, the maximum energy of these calls (at ca. 20 kHz) is consistent (Gerell-Lundberg and Gerell, 1994). In the present study I used the number of advertisement calls as a measure of vocal activity, and the number of echolocation calls as an additional variable to assess bat activity in the study

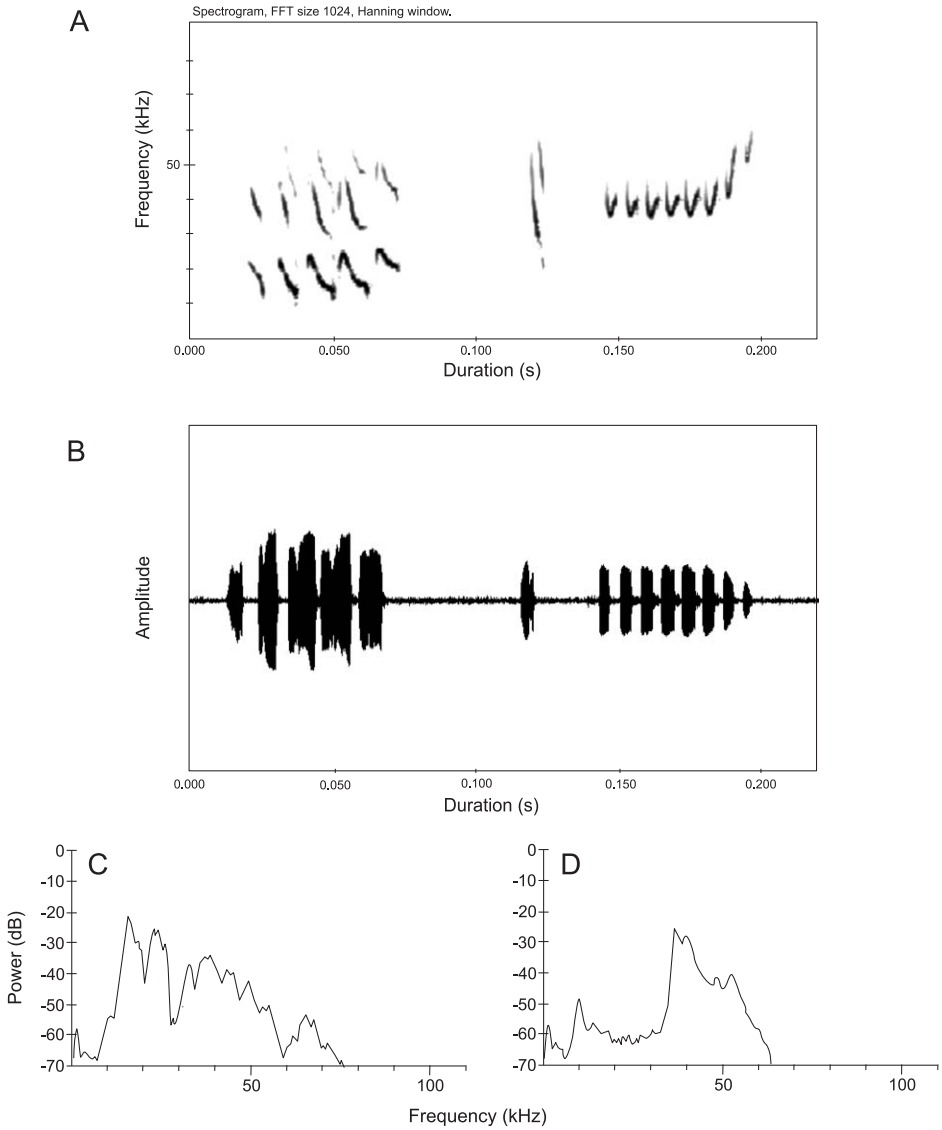

FIG. 2. Spectrograph (A), oscillograph (B) and power spectrum of the first part (C — from 18 to 74 ms) and last part (D — from 144 to 197 ms) of an advertisement call of *P. nathusii* recorded in the Szczytnicki Park in Wrocław

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area (Rachwald and Labocha, 1994; Park *et al*., 1999; Řehák and Baroň, 2001). I recorded air temperature and atmospheric pressure, before the first and main transect walks, as well as after the last nightly transect, using the data of the Institute of Meteorology and Water Economy, Wrocław (automatic measurement equipment situated about 200 m from the park). Data on relative humidity were obtained from the Institute of Meteorology and Climatology, Wrocław University. During rainy nights, observations were not conducted due to the bad quality of recordings (the sound of falling raindrops could mask bat calls) and the need to protect measurement equipment.

To look at seasonal patterns in the vocal activity of *P. nathusii* in details, I divided the season into six homogenous periods in terms of the number of advertisement calls produced. Differences in the vocal activity of bats between the periods were analysed with the Kruskal-Wallis test. A similar procedure was applied to study seasonal changes in production of echolocation calls. The pattern of nocturnal vocal activity of this species changed during the observation season. Therefore I divided all-night observations into two periods: (1) between 9 April and 21 July, and (2) between 22 July and 9 September. Differences between the periods were tested using a Mann-Whitney *U*-test. The pattern of changes in number of echolocation calls was obtained from all nights of the season without dividing them into periods. Changes in overnight activity were analysed using a one-way ANOVA. Spearman rank correlation was used to study the relationships between the air temperature, relative humidity and atmospheric pressure, and the level of bat activity. The statistical analysis was made using SIMSTAT for Windows (Peladeau, 1996).

Results

Seasonal Vocal Activity

I recorded the first social calls in four different places in early April, and by 23 April a total of 16 calling sites had been located only tens of meters from one another. I heard vocalisations from an additional 10 new sites by the end of April. By comparison, in August I heard social calls almost everywhere along the transect. The numbers of calls and calling sites began to decline early in September so that by the beginning of the third week I could locate only seven calling sites.

The activity of bats changed significantly over the season whether measured by social calls (Kruskal-Wallis test: $\chi^2 = 77.6$, $d.f. = 5$, $P < 0.001$; Fig. 3A) or by echolocation calls ($\chi^2 = 49.6$, $d.f. = 5$, $P < 0.001$; Fig. 3B). In April low vocal activity (≤ 60 social calls) and only a small number of echolocation calls (several to around a dozen) were recorded. At the end of April the number of social calls increased on average about 8.5 times, and echolocation calls by a half. Nathusius' pipistrelles were most active from 25 July to 9 September. A peak of activity was recorded in mid-August, when numbers of both social (17 August) and echolocation calls (24 August) reached the highest values. Thereafter the number of echolocation calls rapidly declined (3 times), while the overall vocal activity remained at a relatively high level till early September. From mid-July bats started to vocalise from their roosts. In August most of the social calls were produced when bats were sitting at their roosts. In mid-September vocal activity and the number of echolocation calls started to decrease rapidly. No vocalisations were noted at some places and the last day on which social calls ($n = 145$) were recorded was 23 September. During the whole season I recorded many more social calls than echolocation calls (Fig. 3).

The number of calls produced by bats correlated significantly only with the air temperature (social calls: $r_s = 0.52$, $n = 93$, $P < 0.001$; echolocation calls: $r_s = 0.56$, $n = 93$, $P < 0.001$). No relationship was found between the level of social and echolocation calls and relative humidity or atmospheric pressure.

Nocturnal Vocal Activity

Nightly vocal activity of *P. nathusii* changed throughout the season. Considering these seasonal changes I distinguished

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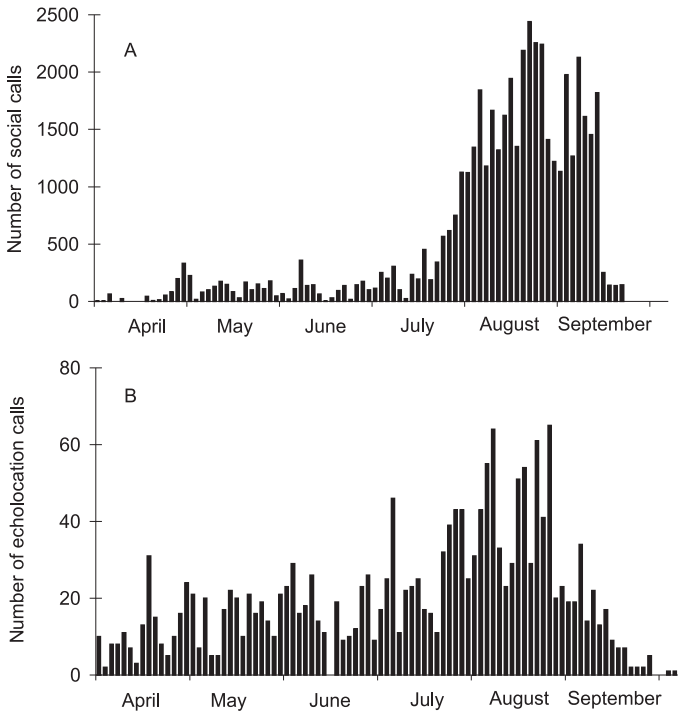

FIG. 3. Changes in number of social (A) and echolocation (B) calls of *P. nathusii* four hours after sunset. Each bar represents one day of observation

two periods: first — from 9 April to 21 July, second — from 22 July to 9 September (Fig. 4A and B). The intensity of social calling changed significantly throughout the night, but different patterns of vocalisation were observed in these two periods (Mann-Whitney *U*-test, $Z = -2.64$, $P < 0.01$). In April–July, at the beginning of the night bats produced few social calls. They became more active in the second hour of the night. During the next three hours the activity remained relatively stable, declining slightly in the morning (ANOVA, $F_{6, 84} = 3.69$, $P < 0.01$; Fig. 4A). This pattern of activity changed at the end of July, when the level of social calls was very low at the beginning of the night, then gradually rose to reach a peak in the latter part of the night, when bats called intensively from their shelters (Fig. 4B). Differences between successive hours of the night were highly significant ($F_{6, 49} = 3.99$, $P < 0.01$).

Nocturnal changes in number of echolocation calls obtained from all observation nights ($n = 20$) seemed to be the same over the whole season and showed that the number of echolocation calls did not change significantly over the night ($F_{6, 140} = 1.39$, $P > 0.05$; Fig. 4C). Of the weather factors, the number of echolocation calls was positively correlated with air temperature ($r_s = 0.55$, $n = 59$, $P < 0.001$) and negatively correlated with relative humidity ($r_s = -0.48$, $n = 59$, $P < 0.001$).

DISCUSSION

The results of my study confirm the existence of *P. nathusii* mating territories in SW Poland and the prediction that the vocalisation of this species increases at

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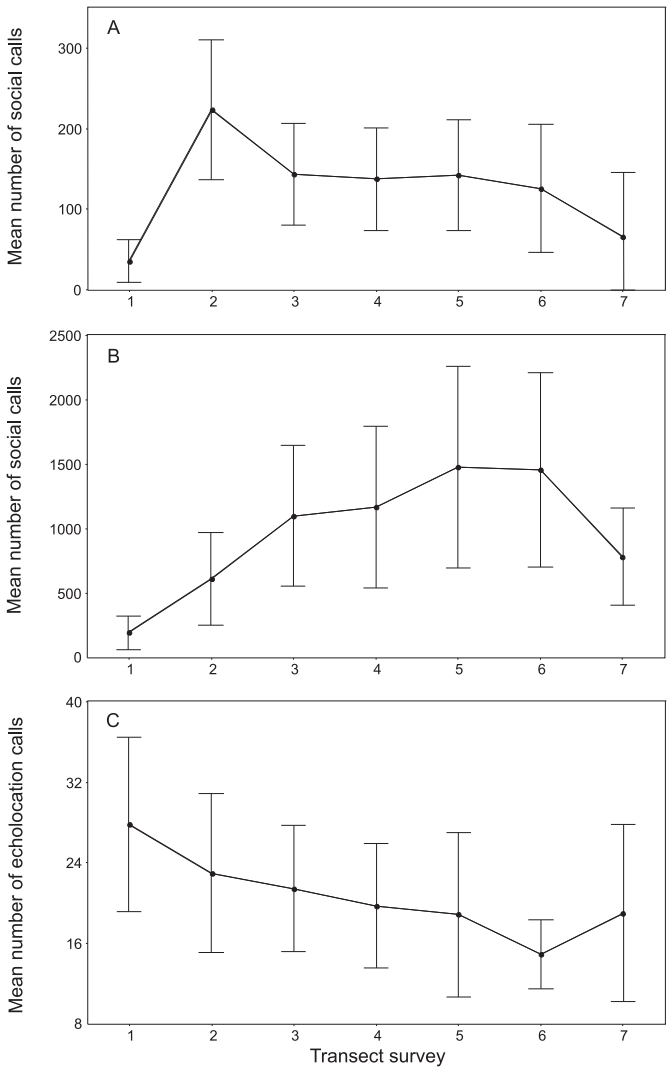

FIG. 4. Changes in number of social (A, B) and echolocation (C) calls of *P. nathusii*. (A) — 14 nights from 9th April to 21st July, (B) — 6 nights from 22nd July to 9th September, (C) — 20 nights from 9th April to 9th September. First transect survey began 20 min. and fourth — 240 min. after sunset and the last one — ended 20 min. before sunrise. Means and 95% confidence limits are given

the onset of their mating period. In late summer (August–beginning of September) 55 mating roosts of *P. nathusii* were found on the study plot (Furmankiewicz and Szkudlarek, 2001). From the inside of these shelters intensive advertisement calls were emitted and, outside, songflight displays were performed. The males of *P. nathusii* exhibit strong fidelity to the roosts from year to year, during the season (Heise, 1982; Schmidt and Heise, 1988; Rachwald, 1992; Furmankiewicz and Szkudlarek, 2001), and after arrival they frequently roost singly in their territories (Schmidt, 1994). The increase in vocalisation places at the end of April, and then in July, could also be a result of the arrival of new males in the study area. However, it is more likely that in mid-July the increase in vocal activity could be associated with the beginning of the mating

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period, which is observed between late July and early September (Sosnovtzeva, 1974; Hackethal and Oldenburg, 1984; Gerell-Lundberg and Gerell, 1994; Schmidt, 1994). Hence the intensive vocalisation of males from late July until the middle of September (with a peak in late August) demarcates the mating period for this species. The cessation of social calling and decrease in calling places in September resulted most likely from the decline in the number of individual bats (Rachwald, 1992; Schmidt, 1994; Gerell-Lundberg and Gerell, 1994) due to the onset of autumn migration (Oldenburg and Hackethal, 1989; Brosset, 1990).

The social calls emitted by *P. nathusii* in Wrocław have a similar structure to the advertisement calls of this species described in the literature (e.g., Ahlén, 1981; Barlow and Jones, 1996; Gerell-Lundberg and Gerell, 1994). I consider then, that the social calls on my study plot emitted from late July to September are the advertisement calls of the males, which are emitted during songflight or from the roosts, and play a role during mating in late summer (see Gerell-Lundberg and Gerell, 1994). Barlow and Jones (1996) also recorded social calls of *P. nathusii* in April and May. Nevertheless, during this time males and females are rarely found together and they do not form harems (Heise, 1982; Rachwald, 1992; Schmidt, 1994; Gerell-Lundberg and Gerell, 1994). Therefore, calls at that time of year probably are not emitted in advertisement display, but could play another role. Social calls, especially beyond the mating period, might be emitted by two sexes. In fact, there is no evidence against vocalisation by females — social calls of young *Nyctalus noctula* females are very similar to the advertisement calls of territorial male noctules (Helversen, 1989; Kozhurina, 1996). *Pipistrellus nathusii* social vocalisation could be used by both sexes if we consider its non-mating (non-advertising) function, as suggested for *P. pipistrellus* and *P. pygmaeus*, whose social calls are produced throughout the year at foraging sites. In their structure, these calls are similar to songflight signals and are thought to be used in a defence of feeding areas (Barlow and Jones, 1996).

The low vocal activity of *P. nathusii* at the beginning of the night was probably associated with foraging behaviour, observed nearly exclusively just after dusk (T. Jarzembowski and J. Sawicka, in litt.). Therefore, the relatively high number of echolocation calls recorded during the first hours of the night may be linked to foraging activities or flying to feeding grounds. After having fed, bats spent more time vocalising. Period II co-occurs with the mating period, when males call most intensely in the latter part of the night. They remain at their shelters and from there produce advertisement calls to attract females (Lundberg, 1989). Sosnovtzeva (1974) recorded most intense calling between 01:00 and 03:00 a.m. The increased calling rate during the last three hours of the night was observed also in *Nyctalus leisleri* (Helversen and Helversen, 1994). The authors suggest that this is a response to the arrival of females from feeding grounds; males try to encourage them to visit their shelters.

Two reasons for significantly more social than echolocation calls being emitted during whole season could be given. First, the frequency of echolocation calls is higher and therefore has a shorter range than social calls. It is therefore possible that the equipment can detect social calls more easily and from a greater distance. Second, the social calls of *P. nathusii* modulate between 14 and 45 kHz (Ahlén, 1991; Gerell-Lundberg and Gerell, 1994; Limpens and Roschen, 1995; Barlow and Jones, 1996), reaching echolocation frequencies. Therefore individuals of *P. nathusii* are able

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to orientate during flight, using only social calls. Additionally, they could forage in other sites and at this time I was not able to note their activity. The changes in number of echolocation calls in July and August was probably associated with the mating period, during which many more animals appeared in the mating ground (Rachwald, 1992; Schmidt, 1994; Gerell-Lundberg and Gerell, 1994).

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Literature Cited

Ahlén, I. 1981. Identification of Scandinavian bats by their sounds. Swedish University of Agriculture Sciences, Department of Wildlife Ecology, Uppsala, Report 6, 56 pp.

Ahlén, I. 1990. Identification of bats in flight. Swedish Society for Conservation of Nature and The Swedish Youth Association for Environmental Studies and Conservation, Stockholm, 55 pp.

Barlow, K. E., and G. Jones. 1996. *Pipistrellus nathusii* (Chiroptera: Vespertilionidae) in Britain in the mating season. Journal of Zoology (London), 240: 767–773.

Barlow, K. E., and G. Jones. 1997. Function of pipistrelle social calls: field data and a playback experiment. Animal Behavior, 53: 991–999.

Brosset, A. 1990. Les migration de la pipistrelle de Nathusius, *Pipistrellus nathusii*, en France. Ses incidences possibles sur la propagation de la rage. Mammalia, 54: 207–212.

Furmankiewicz, J., and R. Szkudlarek. 2001. The mating roosts of Nathusius' pipistrelle males *Pipistrellus nathusii* (Keyserling et Blasius, 1893) in Wrocław (SW Poland). Pp. 47–57, *in* Proceedings of the VIIIth EBRS, Volume 2 (B. W. Wołoszyn, ed.). Chiropterological Information Center, Kraków, 315 pp.

Gerell-Lundberg, K., and R. Gerell. 1994. The mating behaviour of the pipistrelle and Nathusius' pipistrelle (Chiroptera) — a comparison. Folia Zoologica, 43: 325–330.

Hackethal, H., and W. Oldenburg. 1984. Beobachtung und Überlebungen zur Fortpflanzungsbiologie der Rauhhautfledermaus, *Pipistrellus nathusii* (Keyserling und Blasius, 1839). Nyctalus, 2: 72–78.

Heise, G. 1982. Zu Vorkommen, Biologie und Ökologie der Rauhhautfledermaus (*Pipistrellus nathusii*) in der Umgebung von Prenzlau (Uckermark), Bezirk Neubrandenburg. Nyctalus, 1: 281–300.

Helversen, O. von. 1989. Sozialrufe eines Abendsegler — Weibschens (*Nyctalus noctula*). Myotis, 27: 23–26.

Helversen, O. von, and D. Helversen. 1994. The 'advertisement song' of the lesser noctule bat (*Nyctalus leisleri*). Folia Zoologica, 43: 331–338.

Jones, G. 1993. Flight morphology, flight performance and echolocation in British bats. Pp. 59–78, *in* Proceedings of the First European Bat Detector Workshop (K. Kapteyn, ed.). Netherlands Bat Research Foundation, Amsterdam, 128 pp.

Kozhurina, E. I. 1996. What may the 'song' of noctule bats disclose to an observer? Myotis, 34: 5–15.

Limpens, H., and A. Roschen. 1995. Bestimmung der mitteleuropäischen Fledermausarten anhand ihrer Rufe. NABU-Umweltpyramide Bremervörde, Bremervörde, 46 pp.

Lundberg, K. 1989. The influence of body mass, wing morphology, and call characteristics between three vespertilionid bat species. Pp. 51–66, *in* Social organization of the pipistrelle bat *(Pipistrellus pipistrellus)*, and a comparison of advertisement behaviour in three polygynous bat species (K. Lundberg). Ph.D. Thesis, University of Lund, Lund, 82 pp.

Lundberg, K., and R. Gerell. 1986. Territorial advertisement and mate attraction in the bat *Pipistrellus pipistrellus*. Ethology, 71: 115–124.

Oldenburg, W., and H. Hackethal. 1989. Zur Migration von *Pipistrellus nathusii* (Keyserling und Blasius, 1839). Nyctalus, 3: 13–16.

Park, K. J., G. Jones, and R. D. Ransome. 1999. Winter activity of a population of greater horseshoe bats (*Rhinolophus ferrumequinum*). Journal of Zoology (London), 248: 419–427.

Peladeau, N. 1996. Simstat for Windows. Provalis Research, Montreal, Canada.

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Terms of Use: https://staging.bioone.org/terms-of-use

RACHWALD, A. 1992. Social organization, recovery frequency and body weight of the bat *Pipistrellus nathusii* from northern Poland. Myotis, 30: 109–118.

RACHWALD, A., and M. LABOCHA. 1994. Differences concerning bats' occurrence in a natural and cultivated forest in Białowieska Forest (eastern Poland). Pp. 111–112, *in* The actual problems of bat protection in Poland. Proceedings of the 9th National Chiropterological Conference (B. W. WOŁOSZYN, ed.). Publication of the Chiropterological Information Center, Kraków, 244 pp. [in Polish with English abstract].

RAJTER, J. 1999. The social and feeding activity of Nathusius' pipistrelle *Pipistrellus nathusii* (Keyserling et Blasius, 1839) (Chiroptera) in the Szczytnicki Park in Wrocław. Unpubl. M.Sci. Thesis, University of Wrocław, Wrocław, 74 pp. [in Polish].

ŘEHÁK, Z., and I. BAROŇ. 2001. Detectoring of flight activity of lesser horseshoe bats, *Rhinolophus hipposideros*, at a cave entrance over a year. Nietoperze, 2: 201–212.

SCHMIDT, A. 1994. Phänologisches Verhalten und Populationseigenschaften der Rauhhautfledermaus, *Pipistrellus nathusii* (Keyserling und Blasius, 1839), in Ostbrandenburg. Nyctalus, 5: 77–100.

SCHMIDT, A., and G. HEISE. 1988. Bemerkungen zum Höchstalter der Rauhhautfledermaus (*Pipistrellus nathusii*). Nyctalus, 2: 381–385.

SOSNOVTZEVA, V. A. 1974. Phenomenon of autumn mating in *Pipistrellus nathusii* (Keis. et Blas.). Pp. 100–101, *in* Conference materials on the bats (P. P. STRELKOV and A. P KUZJAKIN, eds.). Zoological Institute of USSR Academy of Sciences, Leningrad, 182 pp. [in Russian].

SZKUDLAREK, R., and R. PASZKIEWICZ. 2000. Mating social calls of Polish bat species. Nietoperze, 1: 55–62. [in Polish with English summary].

WEID, R. 1988. Occurrence of the particoloured bat *Vespertilio murinus* (Linné, 1758) in Greece and some observations on its display behaviour. Myotis, 26: 117–128.

WEID, R. 1994. Sozialrufe männlicher Abendsegler (*Nyctalus noctula*). Bonner zoologische Beiträge, 45: 33–38.

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