

Dynamics of social organization and phenology of Nathusius' pipistrelle *Pipistrellus nathusii* (Keyserling and Blasius, 1839) (Chiroptera: Vespertilionidae) occupying bird and bat boxes – interseasonal approach

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Abstract. Changes in numbers and social structure of *Pipistrellus nathusii* inhabiting boxes were studied in two areas of the Polish Baltic Sea Coast. The timing of the peak of bat number (connected with migration and mating period) changed from the 5th pentad of August to the 5th pentad of July between 1995 and 1999. In early spring solitary individuals and transitional groups of 3-14 females dominated, in June solitary males (no nurseries were found), and from July to September – sexually active males with harems of 1-9 females. We recorded eight cases of sharing the same box by two or three adult males, which could be attributed to much weaker territoriality in the beginning and the end of mating period.

Key words: bats, migration, mating, northern Poland.

INTRODUCTION

The Nathusius' pipistrelle *Pipistrellus nathusii* is a common, forest bat species in northern Poland, frequently occupying bird and bat boxes (KOWALSKI & LESIŃSKI, 1994; JARZEMBOWSKI *et al.*, 1998) and performing regular, long-distance migrations (STRELKOV, 1969; LINA, 1990; PETERSONS, 1990; JARZEMBOWSKI, 2003a). Its mating system is characterised by polygyny with territorial males and accompanying harems of females (GERELL-LUNDBERG & GERELL, 1994; CIECHANOWSKI & JARZEMBOWSKI, 2004). The phenology of roost occupation and social organisation of this species are poorly studied. Most of the previous papers gave only a limited picture of *P. nathusii* migration and social organization dynamics, often with little attention paid on long-term or site-related variation in phenology (HEISE, 1982; PETERSONS, 1990; RACHWALD, 1992), although such variation could be expected, as even particular populations in Baltic Sea Coast seem to migrate in different directions (JARZEMBOWSKI *et al.*, 2004). The only publications comparing species' phenology in different locations, are that of BASTIAN (1998) and BARRE & BACH (2004).

The aim of this study is to describe the social organization and long-term changes in phenology of occupation of bird and bat boxes by *P. nathusii* in two forest complexes on the Polish Baltic Sea coast. Details regarding changes

in number and size of harems in the same study sites were published earlier in the separate paper (CIECHANOWSKI & JARZEMBOWSKI, 2004).

STUDY AREA

1. Vistula Spit

- a) Przebrno (54° 23' N, 19° 23' E). The study area was located about 1.2 km from Baltic Sea coast. The following forest types could be distinguished in this area: coniferous forest (about 60 years old) with 50-90% dominance of pine *Pinus sylvestris*, some spruce *Picea abies* and birch *Betula* sp., pine plantation (about 40 years old) and beech *Fagus sylvatica* forest (about 140 years old) (JARZEMBOWSKI *et al.*, 1998).
- b) Sobieszewo Island in Gdańsk (54° 20' N, 18° 47' E). There were two study plots, located about 1 km from the Baltic Sea coast, and 2.8 km from each other: Górki Wschodnie, the border of the "Ptasi Raj" nature reserve (suboceanic pine forest *Leucobryo-Pinetum* and alder *Alnus glutinosa* plantation – BULIŃSKI, 1996) and Sobieszewo (pine plantation).

2. Darżłubska Forest

Mała Piaśnica (54° 40' N, 18° 13' E). The study area was located about 17 km from the Baltic Sea coast. Suboceanic pine forest *Leucobryo-Pinetum* (about 80 years old), with absolute domination of pine.

MATERIAL AND METHODS

On the Vistula Spit 90 bat boxes of the modified Stratmann type were hung up in 1994 (30 boxes per study plot). Additionally we found 80 bird nest boxes (type A sensu KASPRZYK & RUCZYŃSKI, 2001) there – 30 in Przebrno and Sobieszewo, 20 in Górkki Wschodnie. All boxes were controlled once per pentad between May and September during 1995-1998 (every month was divided into 6 pentads, the last one (VI) lasted from the 25th day to the end of month). In years 1996-1998 boxes were not checked up in nursing period (IV pentad of June – III pentad of July).

In the Darżłubska Forest, 34 bat boxes of the modified Stratmann type were hung up on 30.04.1998. They were controlled every 10 days in July-September. In 1999 boxes were checked in May-September (May-June – every two weeks, July-September – every 10 days).

Bats captured in boxes (according to the licenses of the Ministry of Environmental Protection) were sexed and aged; sexual activity of males was determined by presence of enlarged testes (RACHWALD, 1992; GERELL-LUNDBERG & GERELL, 1994) and buccal glands, used to scent marking of mating territories (SCHÖBER & GRIMMBERGER, 1997). On the Vistula Spit *Nathusius'* pipistrelles were ringed with metal bat bands of the Hague Nature Museum. In the Darżłubska Forest, bats were marked with black alcohol marker on the fur of the dorsal side, in order to avoid erroneous repeated recording of the same bat during one control, but it did not give any recapture data.

In order to check if any trend appears in variation of species' phenology, Pearson's correlation was tested between the number of year and the number of day with summer peak of bat population.

RESULTS

The first bats were found in boxes in pentad I-III of May. In some seasons we observed the spring peak in bats' number, associated with numerous appearance of females, later leaving boxes in pentad IV-V of May. In June, the number of bats was rather stable; it started to increase in July, when females appeared in boxes again. In 1998 the summer peak of bat numbers occurred in the same period on the Vistula Spit and the Darżłubska Forest (Fig. 1b); we assumed that population dynamics in both localities was synchronised, so data from them were analysed together. The period of the summer peak of bat numbers changed between 1995 and 1999 from pentad V of August to pentad V of July (Fig. 1); the trend was nearly significant ($y = 2803.8 - 1.4 x$, $r = -0.87$, $p = 0.056$). The last bats (males) were found in boxes in pentad VI of August (Darżłubska Forest) or pentad III-V of September (Vistula Spit).

The sexual structure of *P. nathusii* aggregations changed during a season. In May, solitary males ($n = 95$ records), solitary females ($n = 29$) and (in Vistula Spit) transitional groups of females (range: 3-14 individuals, $n = 4$) occurred. In June, only solitary males were present in the controlled boxes; they became sexually active in the beginning of July. Harems of females (median: 2 individuals, range: 1-10, $n = 91$) joined them between decade I of July and decade III of September. Part of territorial males remained solitary during the whole mating period. Nine times we recorded the presence of two or three adult males in one box. Four times two sexually active males were found in one roost; they shared box with adult females in one case (Tab. 1).

Table 1: Occurrence of two or more males of *Nathusius'* pipistrelles in one and the same roost. Abbreviations: ad. – adult, juv. – juvenile, act. – sexually active, ind. – unsexed or unaged individuals.

No.	date	pentad	area	structure of a group occupying a particular box
1	25.08.1995	V August	Vistula Spit	2 ♂♂ ad. (1 act.) + 2 ♀♀ ad.
2	25.08.1995	V August	Vistula Spit	2 ♂♂ ad. (1 act.) + 2 ♀♀ ad.
3	12.06.1996	III June	Vistula Spit	2 ♂♂ ad.
4	20.08.1997	IV August	Vistula Spit	3 ♂♂ ad. + 2 ♂♂ juv. + 1 ♀ + 4 ind.
5	10.07.1998	II July	Darżłubska Forest	2 ♂♂ ad. act. + 2 ♀♀ ad.
6	30.08.1998	VI August	Vistula Spit	2 ♂♂ ad. act.
7	09.06.1999	II June	Darżłubska Forest	2 ♂♂ ad.
8	07.07.1999	II July	Darżłubska Forest	2 ♂♂ ad. act.
9	09.08.1999	II August	Darżłubska Forest	1 ♂ ad. + 1 ♀ juv.
10	17.08.2000	IV August	Vistula Spit	3 ♂♂ ad. (2 act.) + 1 ♀ ad. <i>N. noctula</i>

DISCUSSION

The phenology of box occupation by *P. nathusii* in the first part of the study period (till 1997) was similar to that described from the Vistula Spit by RACHWALD (1992). However, we found a distinct change in the period when the summer peak of bat number occurred (about a month earlier in 1999). We do not know if it is a constant trend or a fluctuation, and we did not verify any possible explanations for that. However, we suggest that it could be a result of the climate variation (milder winter, and earlier beginning of the vegetation period). A significant contribution of transitional female groups to the spring peak of bat number shows that this peak could be connected with seasonal migration. Such a transitional group (5 females) was recorded earlier in *P. nathusii* only once (RACHWALD, 1992). The absence of females in boxes during June suggests that they join nurseries. We did not find any nurseries during the study period, although they were found in bird boxes on Vistula Spit on 10.07.1993 (T. Jarzembowski, unpubl. data). Our study area is located inside of the nursing area of *P. nathusii*, as defined by STRELKOV (2000). The summer peak of Nathusius' pipistrelle number on the Vistula Spit is associated both with the mating period, but also with the peak of the 'autumn' migration, as proven by detector-based counts of bat passes (JARZEMBOWSKI, 2003a) and social calls (JARZEMBOWSKI, 2003b).

The size of harems was similar to that recorded by GERELL-LUNDBERG & GERELL (1994) in Sweden (1-9 females), and by HEISE (1982) in eastern Germany (1-11 females). However, harems recorded in 1985-1986 on Vistula Spit by RACHWALD (1992) were distinctly smaller (1-5 females). This could be a result of lower quality of mating roosts in the earlier study (only old bird boxes), however differences in habitat quality could not be excluded. FURMANKIEWICZ & SZKUDLAREK (2001) found higher density of *P. nathusii* male territories in densely afforested park, than in sparsely afforested one; they suggested an abundance of food resources as a possible reason for that difference. The study of RACHWALD (1992) was conducted in 1986-1987, so the age and structure of tree stands on Vistula Spit could significantly change since that time.

Both GERELL-LUNDBERG & GERELL (1994) and RACHWALD (1992) stated that adult males cannot share the same roost in the mating period, because of their strong territoriality. They found only juvenile males joining the harems of females and/or the territorial males. HEISE (1982) described three cases when two males occurred in one box with harems of 6-8 females, however he did not give any data about their age nor breeding status. He suggested that high number of females in harems could reduce the aggressiveness of males sharing the same shelter. Our record of only two females in a box with two adult and sexually active males does not agree with

this explanation. All 'pairs' of sexually active males were found in the beginning or in the end of mating season; we conclude that male territoriality is much weaker in that period. Groups of adult males during the mating season were described by GERELL-LUNDBERG & GERELL (1994) in *Pipistrellus pipistrellus* (Schreber, 1774) (in fact, the frequency of echolocation calls on sonograms given in that paper shows that it was *P. pygmaeus* [Leach, 1825]). Non-active and juvenile males are probably not aggressive and could utilize the same boxes or join the territorial males and their harems.

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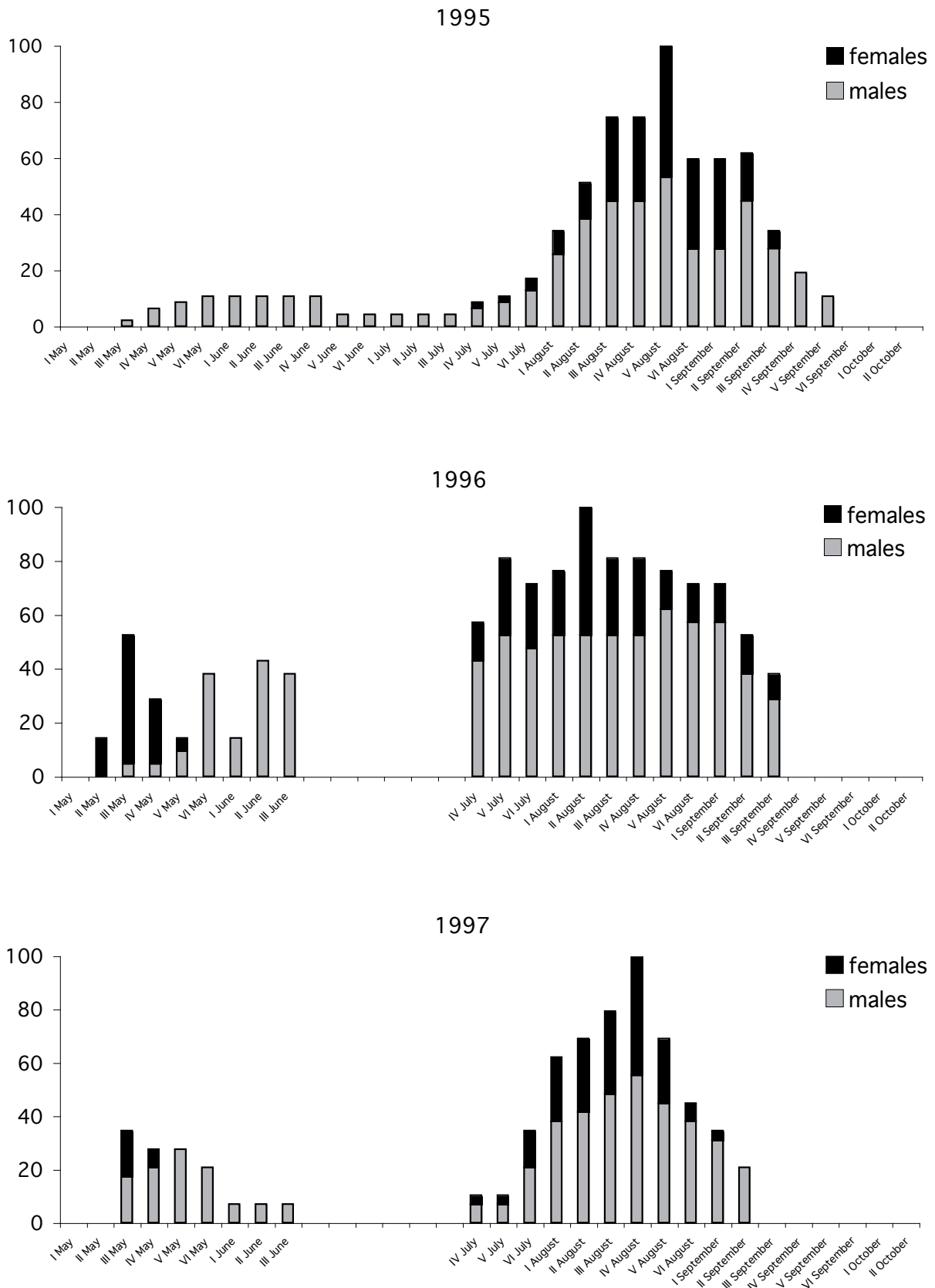


Fig. 1: Dynamics of number and sexual structure of Nathusius' pipistrelles occupying boxes : a) on the Vistula Spit in 1995 – 1997, b) on the Vistula Spit and the Darżłubska Forest in 1998 – 1999. x axis – pentad of the month, y axis - % of the maximum number of bats in season.

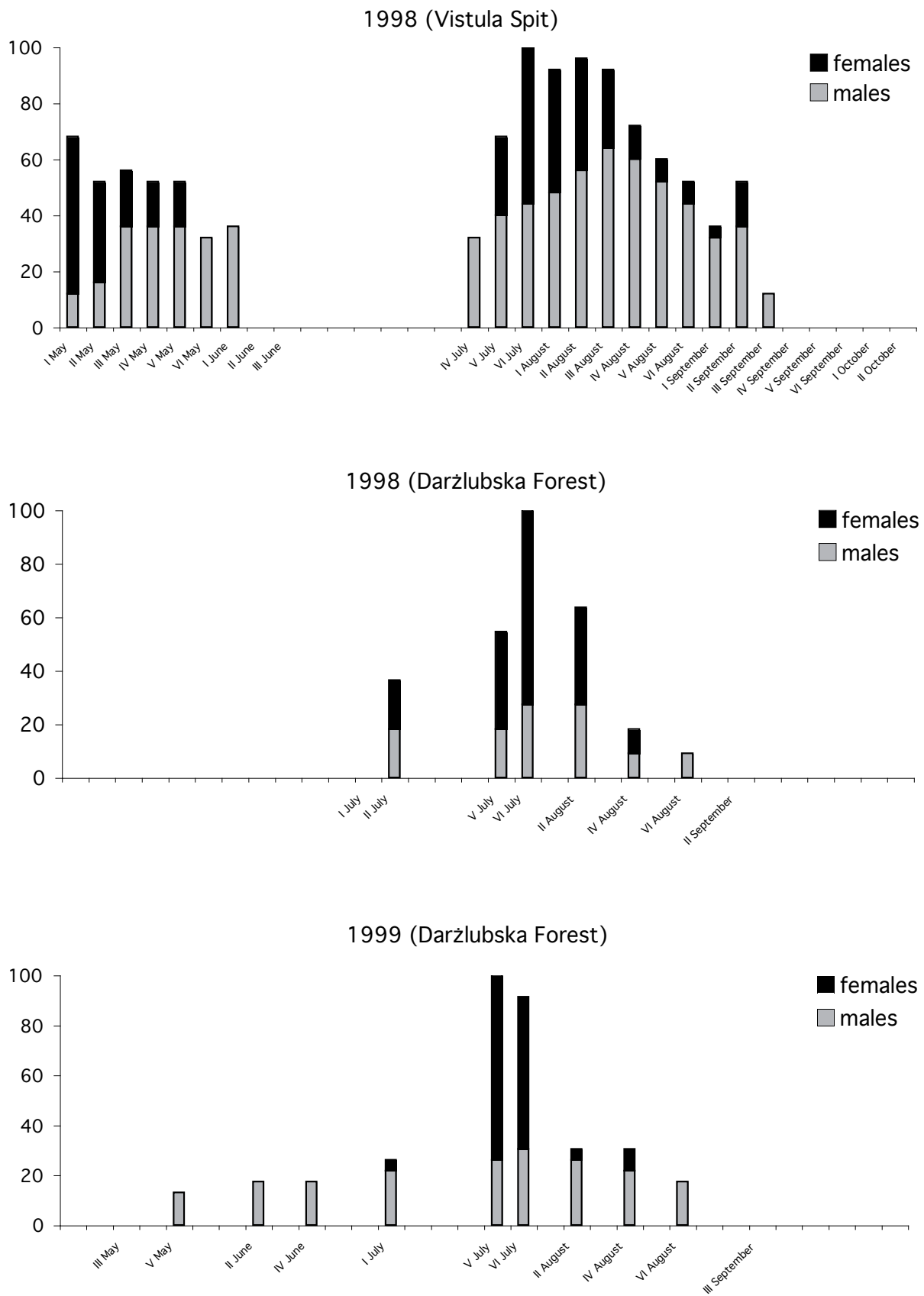


Fig. 1 b

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