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Habitat use of four bat species in Jablonec n.N. revealed by bat detector

Wybiórczość środowiskowa czterech gatunków nietoperzy w mieście Jablonec n. N.; badania przy użyciu detektora ultrasonicznego

Abstract

The distribution of four bat species (*M. daubentonii*, *P. pipistrellus*, *N. noctula*, and *E. serotinus*) was studied in the submontane town of Jablonec n. N. in different habitats during the seasons 1998-2000 by a bat detector. *M. daubentonii* was closely related to water habitats (mainly smooth water) surrounded by closed bankside vegetation; its flying activity (FA) increased towards waterside. High FA was also recorded in suburbs with gardens. *P. pipistrellus* preferred water bodies, the surface of which was covered by bankside vegetation. High FA was further recorded along closed linear growths. No correlation was found between FA and type of buildings. Compared to other species, *N. noctula* more often foraged in urban habitats (old buildings in downtown). These habitats were represented by open spaces, contrast to habitats with gardens. *N. noctula*, however, forages high over studied habitats therefore its affiliation to a particular habitat is not explicit. FA of *E. serotinus* was higher away from water bodies, especially near semi-closed linear vegetation and tree patches. High activity was recorded in the vicinity of new buildings and around streetlamps.

Similar level of FA was found in *P. pipistrellus* and *M. daubentonii* in gardens with small water bodies. FA in a garden with a lot of streetlamps was different compared to the gardens mentioned above. Very low FA was recorded in downtown (with new buildings and without vegetation). High level of FA was observed over pools, whereas low at the canalised stream.

Key words: *Chiroptera*, urban area, flying activity, habitat use

1. Introduction

Urban habitats offer plenty of diversified foraging areas and also many suitable shelters to bats (KUNZ 1982, RYDELL et al. 1996). Their utilisation by summer nursery colonies and also by solitary individuals enables many bat species to extend their range mainly in the temperate zones (KUNZ 1982).

Bat research in towns became more intensive because of the fast development of ultrasound detector use for the monitoring of bat activity. At the beginning, most field studies dealt with the distribu-

tion of various bat species in European cities (HOOPER 1981 and MICKLEBURGH 1987 - London, HAENSEL 1992 - Berlin, SCHÖBER and MEYER 1995 - Leipzig, SPITZENBERGER 1990 - Wien). Other studies looked at ecological requirements of bat populations in urban habitats. MICKLEBURGH (1987) recorded the occurrence of 14 bat species in the agglomeration of London, where he observed foraging *P. pipistrellus*, *E. serotinus* and *M. daubentonii* particularly often. One of the first works about the ecology of bats in cities was published by GAISLER (1979), who recorded visually the initial flying activity of bats on the terri-

tory of the city of Brno. However no bat detectors were used in this study. Later, acoustic monitoring by bat detectors was conducted along the same transects (GAISLER et al. 1998). The habitat use and activity course of selected bat species were also analysed.

The main goal of this study was to assess the habitat use of four bat species in a submontane town.

2. Material and Methods

A bat detector (Pettersson D200 – heterodyning system) was used for the monitoring of ultrasound bat calls within the town of Jablonec nad Nisou (from May till October in years 1998–2000). The studied habitats were divided into three groups: parks (illuminated or non-illuminated), urban habitat (old and new buildings in suburbs and the centre), and water bodies (streams and ponds). Each of these groups was further divided based on additional habitat structures (cf. GAISLER et al. 1998).

Only the flight activity of four bat species was recorded i.e. *Myotis daubentonii* (KUHL, 1819), *Pipistrellus pipistrellus* (45 kHz) (SCHREBER, 1774), *Nyctalus noctula* (SCHREBER, 1774), and *Eptesicus serotinus* (SCHREBER, 1774). Because of the fragmentation of the studied habitats the method of detecting points was used (cf. FURLONGER et al. 1987). The monitoring started 10 minutes after sunset and continued until midnight. Each observation lasted 10 minutes and at the beginning the detector was tuned up and down between 15 and 60 kHz. Having heard the signal, the observer tuned to optimum frequency and recorded the duration of the time interval (positive minutes - +min) during which the bat signals were heard (MCANEY and FAIRLEY 1988, von ZAHN and MAIER

1997). The values of activity were converted into the relative activity (+min/1 hour of observation) (RACHWALD 1992). The activity was marked as commuting flight and/or foraging immediately in the field. Data from 14 three-day observations (3947 minutes) were used to assess the habitat use.

In general, there were no between-year differences in the level of activity and habitat use (Chi-square test, NS) and the data were pooled for the subsequent analyses. The Spearman correlation coefficient was used to compare the changes of flight activity in different habitats. The habitat use on the territory of the town was tested by contingency tables (Chi-square test). The statistic software JMP (SAS Institute, 1995) was used for the data analysis.

HABITAT FEATURES

Detecting sites (habitats) were classify by their distance to water (m) and to growth (m) as well as by closure of growth (open, semi-cluttered, cluttered). In addition, I observed level of activity in dependence on the presence or absence of trees or shrubs (forest, width of linear vegetation), homogeneity of growth (sporadic, straggly, continuous), type of buildings (old, family houses, new buildings, blocks of flats), watersides (smooth, turbulent), distance from the town centre.

The territory of the town was divided into squares of 100 x 100 m on a map (1 : 25 000) and these squares were allocated to the defined groups of habitats (parks, buildings and water bodies).

Habitat structure of studied sites

Parks

- *small park*
- *large park*
- *park with a small pond*
- *park with a stream*

Buildings

- *family houses with gardens*
- *old buildings without gardens*
- *new buildings*
- *prefabs (blocks of flats)*

Watersides

- *stream surrounded by buildings*
- *stream in open space*
- *natural stream*
- *open water surface*
- *pond with vegetation*

3. Results and Discussion

3.1. Foraging activity and habitat structure

All urban habitat types considered in this study were visited by flying bats but habitats with higher prey density were preferred (similarly WALSH and HARRIS 1996, ENTWISTLE et al. 1996). Changes in activity are influenced by the changes in prey availability. Prey density is changing during the night and the season. Therefore it also influences the bat's changes in habitat use. In most studies, watersides have been found to be preferred as rich foraging sites (RACEY and SWIFT 1985, RACHWALD 1992, RYDELL et al. 1996, WALSH and MAYLE 1991, KRUSIC et al. 1996, HART et al. 1993). VAUGHAN et al. (1997) reported almost 70% of positive records over water bodies.

The main goal of many studies was to find out about the effect of habitat features on foraging activity (von ZAHN and MAIER 1997, RACEY et al. 1998). The studied types of habitat were not randomly distributed in the town and there was a strong correlation between observed characteristics (Tab. 1).

M. daubentonii, which is closely associated with water habitats (RACEY et al. 1998), was foraging in their vicinity in the town as well. High activity of Daubenton's bat correlated to watersides surrounded by

closed bankside vegetation, with trees and shrubs (Tab. 2). This species trawls prey right from the water surface and obstacles as branches or rocks would interfere with insect detection and capture. Therefore *M. daubentonii* preferred free water surfaces. The low activity recorded over the canalised stream might be associated with the absence of growth or just with turbulent water. I found higher foraging activity over smooth water surface than over turbulent water (similarly von ZAHN and MAIER 1997). The ultrasonic noise generated by turbulent water may interfere with the bats' echolocation (MACLEY and BARCLAY 1989). High flight activity of *M. daubentonii* was also recorded in suburb gardens.

P. pipistrellus used also the surroundings of the water bodies (mainly with smooth water), while GAISLER et al. (1998) reported its highest activity in old suburbs and villa quarters both with gardens. In contrast to *M. daubentonii*, *P. pipistrellus*, foraged higher over the water along the closed canopy of trees on the bank. Pipistrelles preferred sites where dense bankside vegetation covered the water surface. Besides watersides, high foraging activity was recorded near to linear growths. *P. pipistrellus* is more sensitive to strong wind due to its smaller body size and slow hawking foraging strategy (VERBOOM 1998). Nevertheless, its activity did not increase with the width of linear growth. The width of linear growths was less important for the level of foraging activity, then their closure. A positive correlation between foraging activity of pipistrelles and high density of vegetation in the studied sites has also been found by VERBOOM (1998). No correlation was found between foraging activity and type of building (Tab. 2).

Tab. 1. **Współczynnik korelacji Spearmana i poziom istotności statystycznej** (NS – nieistotne statystycznie; * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$) pomiędzy różnymi czynnikami. A – położenie w stosunku do potencjalnego centrum miasta, B – odległość od wody, C – odległość od roślinności, D – przestrzeń otwarta/zamknięta, E – las, F – pasy roślinności, G – drzewa, H – krzewy, I – roślinność iglasta, J – szerokość pasów roślinności, K – jednorodność środowiska, L – stare budynki, M – domy rodzinne, N – nowe budynki, O – domy z prefabrykatów (plyty), P – woda (stojąca/płynąca).

I	J	K	L	M	N	O	P	Feature
-0.48 ^{NS}	-0.27 ^{***}	0.20 ^{***}	-0.47 ^{***}	0.35 ^{***}	0.04 [*]	0.15 ^{***}	-0.24 ^{***}	A
-0.02 ^{***}	-0.12 ^{***}	-0.48 ^{***}	-0.11 ^{***}	-0.06 ^{***}	0.09 ^{***}	0.01 ^{NS}	0.43 ^{***}	B
-0.40 ^{***}	0.08 ^{***}	0.04 ^{NS}	-0.41 ^{***}	0.09 ^{***}	0.04 [*]	0.05 ^{**}	0.11 ^{***}	C
-0.35 ^{***}	0.23 ^{***}	-0.21 ^{***}	-0.38 ^{***}	-0.26 ^{***}	0.15 ^{***}	0.45 ^{***}	-0.34 ^{***}	D
0.18 ^{***}	-0.60 ^{***}	0.55 ^{***}	-0.23 ^{***}	0.42 ^{***}	-0.20 ^{***}	-0.11 ^{***}	-0.34 ^{***}	E
-0.18 ^{***}	0.60 ^{***}	-0.55 ^{***}	0.23 ^{***}	-0.42 ^{***}	0.20 ^{***}	0.11 ^{***}	0.38 ^{***}	F
0.08 ^{***}	0.13 ^{***}	0.04 ^{NS}	-0.29 ^{***}	0.09 ^{***}	0.10 ^{***}	0.17 ^{***}	-0.38 ^{***}	G
-0.24 ^{***}	0.01 ^{NS}	0.08 ^{***}	0.50 ^{***}	0.19 ^{***}	-0.31 ^{***}	-0.21 ^{***}	-0.10 ^{***}	H
–	-0.22 ^{***}	-0.16 ^{***}	0.07 ^{***}	0.05 ^{**}	0.19 ^{***}	-0.12 ^{***}	0.14 ^{***}	I
	–	-0.20 ^{***}	0.28 ^{***}	-0.27 ^{***}	-0.03 ^{***}	0.07 ^{***}	-0.10 ^{***}	J
		–	-0.07 ^{***}	0.24 ^{***}	-0.34 ^{***}	0.79 ^{***}	0.27 ^{***}	K
			–	-0.29 ^{***}	-0.30 ^{***}	-0.30 ^{***}	0.35 ^{***}	L
				–	-0.25 ^{***}	-0.08 ^{***}	0.22 ^{***}	M
					–	-0.30 ^{***}	-0.52 ^{***}	N
						–	-0.17 ^{***}	O
							–	P

Tab. 2. **Correlation between particular features and activity of bats.** The value of spearman correlation coefficient and significance level are given: NS – not significant; * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$ (n – sample size).

Tab. 2. Korelacja pomiędzy poszczególnymi czynnikami a aktywnością nietoperzy. Podano wartość współczynnika korelacji Spearmana i poziom istotności statystycznej: NS – nieistotnie statystycznie; * = $P < 0.05$; ** = $P < 0.01$; *** = $P < 0.001$ (n – wielkość próby).

species feature	<i>M. daubentonii</i> n = 2806 min.	<i>P. pipistrellus</i> n = 2806 min.	<i>N. noctula</i> n = 2806 min.	<i>E. serotinus</i> n = 2806 min.
location	0.22 ***	- 0.04 NS	-0.03 NS	0.09 NS
water distance	-0.42 ***	-0.28 ***	-0.05 **	0.04 *
vegetation distance	-0.04 **	0.09 ***	0.01 NS	0.02 NS
space (open/clutter)	0.06 **	-0.14 ***	-0.10 ***	0.02 NS
forest	0.04 *	0.06 *	0.02 NS	-0.05 **
linear vegetation	-0.04 *	-0.06 **	-0.02 NS	0.05 **
trees	0.07 **	0.06 ***	0.04 *	-0.07 **
coniferous trees	0.00 NS	0.06 ***	-0.02 NS	0.08 ***
shrubs	0.12 ***	0.01 NS	0.03 NS	-0.03 NS
width of growth	-0.16 ***	-0.05*	-0.05 *	-0.10 **
homogeneity	0.13 ***	0.18 ***	0.10 ***	-0.10 ***
old buidings	-0.12 ***	0.00 NS	0.06 ***	-0.08 ***
family houses	0.20 ***	0.03 NS	0.04 NS	-0.04 NS
new buildings	0.11 ***	-0.02 NS	-0.02 NS	0.14 ***
prefabs	-0.10 ***	-0.06 ***	-0.10 ***	-0.05 **
water	-0.28 ***	-0.10 ***	0.07 ***	-0.11 ***

Riverine habitats with many trees were also attractive for all bat species studied in Brno city except *E. serotinus* studied (GAISLER et al. 1998). In Jablonec, *E. serotinus* more often foraged off watersides, especially near to linear growths. Serotines preferred small groups of vegetation or less closed linear growths. Their foraging activity differed according to the type of building, with more frequent foraging close to new buildings.

The water habitats were also frequently used by *N. noctula* (BARTONIČKA and ZUKAL 2002). On the other hand, I registered mainly commuting flights in urban habitats (similarly GAISLER et al. 1998), mainly in central parts with old houses. These habitats were represented by open spaces. *N. noctula*, however, forages high over the studied habitats. Therefore its association to a particular habitat is not explicit, compared to the other species studied.

Dense vegetation in the foraging sites is important as a wind-break, providing protection from strong wind and supplies stable microclimatic conditions in contrast to open spaces (KURTA and TERAMINO 1982). Bats foraged significantly more often along closed (dense tree and shrub growth) linear vegetation, than close to isolated trees. At watersites, bats preferred to forage in

places with tree or shrubs vegetation (von ZAHN and MAIER 1997).

Insect density may be affected by the eutrophication of many water bodies (von ZAHN and MAIER 1997). VAUGHAN et al. (1996) recorded an increase in Daubenton's bats activity downstream of sewage outlets, while foraging in *P. pipistrellus* decreased.

3.2. Habitat use in the territory of the town

Tab. 3 shows the percentages of the habitat types occurring in the study area and the level of their utilisation during the season. The level of relative flight activity differed significantly among individual habitats (contingency table, $\chi^2 = 107.663$; $P < 0.001$). Differences of expected (E) and observed (O) values indicate higher foraging activity in gardens (O-E = 19.91) and over water surfaces (O-E = 28.57), then above buildings (O-E = -48.48).

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Tab. 3. **The availability of particular habitats (number of squares) and their utilization in urban area.**

Tab. 3. Dostępność poszczególnych typów środowiska (liczba kwadratów) i ich wykorzystanie na obszarze miejskim.

habitat	<i>park</i>	<i>buildings</i>	<i>waterside</i>	total
number of squares / dominance	124 / 13.69%	614 / 67.77%	168 / 18.54%	906 / 100%
activity (+min/1h) / dominance	71.6 / 33.6%	41.1 / 19.29%	100.4 / 47.11%	213.1 / 100%

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Wybiórczość środowiskowa czterech gatunków nietoperzy w mieście Jablonec n.N.; badania przy użyciu detektora ultrasonicznego

W okresie od 1998 do 2000 roku, w podgórskim mieście Jablonec n. N., badano występowanie 4 gatunków nietoperzy (*M. daubentonii*, *P. pipistrellus*, *N. noctula* i *E. serotinus*). Nocek rudy *M. daubentonii* był silnie związany ze środowiskiem wodnym (głównie wody stojące) otoczonym przez zwarte pasy nadbrzeżnej roślinności. Jego aktywność (FA) wzrastała nad wodą. Wysoką FA odnotowano także na przedmieściach z ogrodami. Karlik malutki *P. pipistrellus* preferował małe zbiorniki i ciekły wodne, otoczone zwartą roślinnością. Wysoką FA tego gatunku zarejestrowano także wzdłuż zwartych pasów roślinności. Nie stwierdzono korelacji pomiędzy FA i typem budynków. W porównaniu z innymi gatunkami borowiec wielki *N. noctula* częściej żerował w środowisku miejskim (stare budynki w śródmieściu). Ten typ środowiska reprezentowany był przez otwarte przestrzenie, w przeciwieństwie do środowiska z ogrodami. Jednak ze względu na żerowanie *N. noctula* wysoko ponad badanymi obszarami, jego powiązanie z poszczególnymi typami środowiska nie jest wyraźne. FA mroczka późnego *E. serotinus* była wyższa w oddaleniu od cieków i zbiorników wodnych, szczególnie w częściowo zwartych pasach roślinności i zadrzewieniach. Wysoką aktywność tego gatunku zanotowano w pobliżu nowych budynków i dookoła lamp ulicznych.

W ogrodach z małymi ciekami i zbiornikami wodnymi stwierdzono podobny poziom FA karlika malutkiego *P. pipistrellus* i nocka rudego *M. daubentonii*. W porównaniu z tym środowiskiem, inny poziom FA odnotowano w ogrodach z dużą ilością lamp ulicznych. Bardzo niską FA zanotowano w śródmieściu (z nowymi budynkami i bez roślinności). Wysoki poziom FA zanotowano nad sadzawkami, podczas gdy niski nad skanalizowanymi ciekami wodnymi.

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