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Selected ecological and biometrical parameters of the Daubenton's bat population (*Myotis daubentonii*) in the "Łężczok" nature reserve (S Poland)

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With 1 Figure

1 Introduction

In Poland, previous studies of Daubenton's bat have been focused on different aspects of its biology and ecology (e. g. Fedyk & Fedyk 1970, Czeczuga & Ruprecht 1982, Lesiński 1989, 1990, Bogdanowicz 1992, Kokurewicz & Bartmańska 1992, Jones & Kokurewicz 1994, Kowalski et al. 2002). However, data on habitat preferences and nocturnal activity are still scarce and limited to large forest complexes of northern Poland. In the Kozienicka Forest, Daubenton's bats were mist-netted over rivers significantly more frequently than over ponds (Kowalski et al. 1996). Similar results were noted in the Darżlubska Forest (Ciechanowski 2002). In Białowieża Primeval Forest, this species was the second most common bat flying over rivers and its nocturnal activity showed a bimodal (evening-morning) pattern (Rachwald et al. 2001). Moreover, despite numerous faunistic studies there is still little information regarding sex ratio and basic biometrical parameters of bats in Poland.

Our purpose was to assess habitat preferences and over-night activity of the Daubenton's bat in a small isolated forest patch protected as a nature reserve. We also collected data on sex ratio, body mass and forearm length of this species.

2 Study area

The "Łężczok" nature reserve was established in 1957. It is situated in southern Poland in the Silesian Lowland (50°08'10"N, 18°16'41"E), and is a part of the Landscape Park "Cistercian Landscape Compositions of Rudy Wielkie". It covers an area of 4.08 km^2.

The nature reserve is an isolated forest island surrounded by the town of Racibórz, a few villages and agricultural land. The main components of the reserve are managed fish ponds (2.47 km^2) and woods (1.34 km^2). Old oaks (*Quercus robur*) dominate the tree stand – 64 % of the area is covered by oak-stand more then 100 years old and 24 % is 61-100 years old. The average stand volume is 440 m^3/ha. Mean annual rainfall is approximately 630 mm. Mean temperature in January is 2°C and in July is 18°C. The elevation is 180-184 m a.s.l. Eleven species of bats were recorded in the reserve (Mysłajek et al. 2002, 2005, 2007), with Daubenton's bat being the most numerous.

3 Materials and Method

We conducted our studies from May to September in 2001-2003. We caught bats in mist nets in two habitats: (1) small river, on average 5 m wide and 0.5 m deep with a very slow current, which flows through old-stand oak (mist netting in two localities) and (2) large fish ponds (0.1-0.91 km^2), with old-growth trees (mainly oaks) on banks and dikes (mist netting in three localities).

We set up nets between 19.30 h and 06.00 h on 14 nights, 6 nights each in 2001 and 2002 and 2 nights in 2003, with equal effort in both habitats. Nets were installed across the river

and along its banks, and on the banks of the ponds and dikes between them. In each locality we used 2-4 mist nets (3 x 7 m, Ecotone 719/7, Ecotone, Poland) and checked them every 15 minutes. We recorded time of capture and sex for each captured Daubenton's bat, and assessed age class according to the method described by RICHARDSON (1994). We also measured forearm length of all bats and the weight of bats caught in 2002 and 2003.

To examine habitat preferences of Daubenton's bat we used: (1) total numbers of bats captured in both habitats, (2) percentage of nights when Daubenton's bats were caught and (3) mean number of captures per net-night. We analysed differences in the night activity of Daubenton's bat as a percentage of individuals captured in each hour. For statistical calculations we used Statistica for Windows 5.1. (StatSoft Inc., Tulsa, USA, 1997).

4 Results

During the study we captured 225 individual Daubenton's bats (75 in 2001, 121 in 2002, and 29 in 2003). They were caught significantly more often over ponds than over the river (205 vs. 20 individuals; $\chi^2 = 152.111$; $n = 225$; $df = 1$; $p < 0.001$). Similar differences were observed in the consistency of Daubenton's bat captures. Over ponds they were captured on every night, while over the river on only 71 % of nights. Mean number of individuals captured per net-night was 9.1 (SD 5.0, range 5.5-17.5) over ponds and 0.8 (SD 0.7, range 0-1.5) over the river. Differences in this coefficient in both habitats were significant ($U = 0.0$, $p < 0.002$, $z_1 = 7$, $z_2 = 7$).

Two visible peaks of Daubenton's bat activity were observed. The first peak followed sunset and continued for the first two hours of

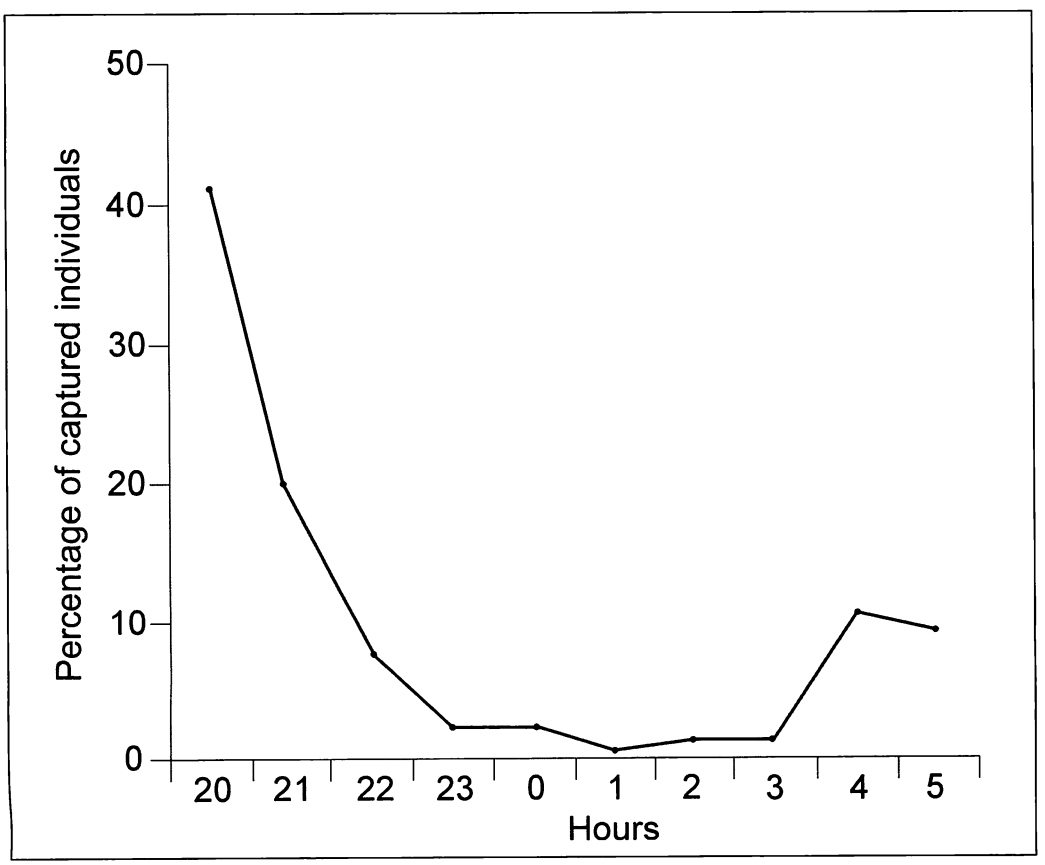

Fig. 1. Nocturnal activity of Daubenton's bats (*Myotis daubentonii*) in the "Łężczok" reserve

darkness, when 62 % of bats were mist-netted. The second, but smaller, peak was observed before sunrise (Fig 1). Differences in the activity of bats between consecutive hours of the night were significant over ponds (χ^2 = 292.707; n = 205; df = 9: $p < 0.001$), but not over the river (= 5.000; n = 20; df = 9; ns) – however, in this case only 12 bats were caught.

Females constituted 74 % of captured Daubenton's bats and males only 26 % (χ^2 = 50.884; n = 225; df = 1; $p < 0.001$). The proportion of females was larger among both adult (72 % vs. 28 %; $\chi^2 = 42.938$; n = 156; df = 1; $p < 0.001$) and young individuals (77 % vs. 23 %; χ^2 = 114.244; n = 69; df = 1; $p < 0.001$).

The mean forearm length of captured Daubenton's bats was 37.5 mm (SD 1.5, range 27.9-40.3 mm, n = 225). Females had on average longer forearms then males, 37.7 mm (SD 1.6, range 27.9-40.3 mm, n = 166) and 37.1 mm (SD 1.1, range 34.1-39.9, n = 59) respectively. This difference was statistically significant (t = 2.75299; df = 223; p = 0.01).

The mean body weight of captured bats was 9.9 g (SD 1.3, range 5.0-12.5 g, n = 150), and there was no significant difference between genders.

5 Discussion

Mist-netting is often proposed as a means to examine species structure and nocturnal activity of bats (e. g. Bell 1980, Kunz & Kurta 1990, Thomas & LaVal 1989) though as a method of studying bats it has several potential biases due to differing ability to avoid nets by each species and individual, as well as net localisation (Kunz & Kurta 1990). However, Daubenton's bat is more vulnerable to capture by mist nets than other species because it forages mostly very close to the water surface (Zahn & Maier 1997).

Daubenton's bat clearly preferred fishponds in the "Łężczok" reserve. At the river they occurred sparsely and not on all netting occasions. In contrast to this, in northern Poland in Kozienicka Forest and Darżlubska Forest, Daubenton's bats were more frequently recorded over rivers than over ponds (Kowalski et al. 1996, Ciechanowski 2002). This could be the result of differences in the size of water bodies and watercourses examined in each study. In the "Łężczok" reserve, the area of ponds ranged from 0.1 to 0.9 km^2, and the width of the river was only 5 m. Meanwhile, in Darżlubska Forest ponds were notably smaller; 0.0025 and 0.0002 km^2, but the width of the river was greater at 10 m (Ciechanowski 2002). Information on the sizes of ponds and rivers from Kozienicka Forest were not included. The authors stressed only that ponds were small, with the longer axis shorter then 25 m (Kowalski et al. 1996), which equates to an area of less then 0.0005 km^2. This suggests that the size of water bodies or width of rivers could be an important factor for Daubenton's bat. Larger areas of water could attract greater numbers of bats due to a higher quantity of insects compared to smaller areas. For Daubenton's bat a very important source of food is insects taken from the water surface, potentially constituting around 25 % of their diet (Flavin et al. 2001).

Daubenton's bat prefers crevices and hollows in trees, mostly oaks, which grow on forest margins (Boonman 2000). The warming of these trees by the heat of the sun is especially important during rearing of the young. In addition, such localisation of roosts reduces costs of flying to foraging areas. Results of studies conducted on the little brown bat, *Myotis lucifugus* (LeConte, 1831) – a North American' relative of Daubenton's bat – showed that during lactation the area travelled by females was smaller. In this period, females come back to the roost during the night to feed their young (Henry et al. 2002). In the "Łężczok" reserve, the banks of ponds and the dikes surrounding them are overgrown by old trees (mostly oaks), which are exposed to sunlight. In contrast, river banks are covered by dense forest, and trees which overhang the banks have no additional heat from sunlight. This fact could sup-

port our findings of a preference of Daubenton's bat for large ponds.

The bimodal (evening-morning) pattern of Daubenton's bat activity is similar to the results of the study in Białowieża Primeval Forest (RACHWALD et al. 2001). In both cases bats showed the lowest activity in the middle of the night and the highest after sunset. A second peak of activity, not as high as the first, occurred before sunrise. This bimodal rhythm of nocturnal activity was also reported for other species of bats (e. g. GAISLER 1979, ERKERT 1982). However, in some cases only one peak of activity (after sunset) was observed (MCANEY & FAIRLEY 1988). The highest intensity of bats foraging in the first phase of night could be due to food availability (during the night a reduction in insect activity is observed – MCANEY & FAIRLEY 1988) or by thermoregulatory factors (bats prefer foraging in the warmest part of the night – RACHWALD et al. 2001).

The sex ratio amongst new-born Daubenton's bats is close to 1 : 1 (BOGDANOWICZ 1994). An almost even ratio of the genders was also observed amongst Daubenton's bats hibernating in the undergrounds of the Modlin fortress in the central part of Poland (LESIŃSKI 1986). However, on large rivers of the Białowieża Forest (RACHWALD et al. 2001) and during our study females clearly dominated. This could be the result of competition between females and males, when larger females try to displace smaller males from richer feeding grounds, although this requires more detailed studies (SENIOR et al. 2005, DIETZ et al. 2005).

Our results support earlier observations, that amongst Daubenton's bats females are larger then males. They are usually heavier and have longer forearms and a larger skull (BOGDANOWICZ 1992, JONES & KOKUREWICZ 1994, DOLCH 1995, KOWALSKI et al. 1996). Higher body mass and a larger wingspan could be advantageous for females which, unlike males, have to carry a developing foetus during pregnancy (MYERS 1978), and later, new born young (RICHARDSON 2002).

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Summary

Habitat preferences, nocturnal activity, sex ratio, body mass and forearm length of Daubenton's bats (*Myotis daubentonii*) were studied during 2001-2003 in a small, isolated wood protected as a nature reserve in the Silesian Lowland (S Poland). Overall 225 individuals were captured by mist nets in two habitats – at large ponds (0.1-0.9 km^2) and at a river (5 m wide, 0,5 m deep), both surrounded by old oak-stands. Bats were captured more frequently over ponds than over the river (9.1 and 0.8 individuals per mist-night, respectively). They showed a bimodal pattern of nocturnal activity with the highest peak of activity two hours after sunset and a second, but smaller, peak during the two hours before sunrise. Females were more numerous then males (74 % vs. 26 %), and they were generally larger. Mean body mass was 9.4 g for females and 9.2 g for males, while mean length of forearm was 37.7 mm and 37.1 mm respectively for females and males.

Zusammenfassung

Ausgewählte ökologische und biometrische Parameter der Wasserfledermaus-Population (*Myotis daubentonii*) im Łężczok-Naturreservat (Süd-Polen)

Habitat-Bevorzugung, Nachtaktivität, Geschlechterverhältnis, Körpergewicht und Unterarmlänge der Wasserfledermaus (*Myotis daubentonii*) wurden von 2001-2003 in einem isolierten Waldgebiet, ausgewiesen als Naturreservat, im schlesischen Tiefland (Süd-Polen) untersucht. Insgesamt 225 Individuen wurden in zwei Habitaten – an großen Teichen (0,1-0,9 km^2) und an einem Fluß (5 m breit, 0,5 m tief), beide Lebensräume umgeben von alten Eichenbeständen – mit Netzen gefangen. Über den Teichen wurden mehr Fledermäuse gefangen als über dem Fluß (9,1 zu 0,8 Individuen pro Fangnacht). Die Nachtaktivität der Tiere wies zwei Aktivitätsspitzen auf, eine in den ersten beiden Stunden nach Sonnenuntergang, die andere, aber geringere, während der beiden Stunden vor Sonnenaufgang. Die ♀♀ waren häufiger als die ♂♂ (74 zu 26 %), und sie waren im allgemeinen größer. Die Körpergewichte lagen bei den ♀♀ im Mittel bei 9,4, bei den ♂♂ nur bei 9,2 g, während die Unterarmlänge bei den ♀♀ im Mittel 37,7, bei den ♂♂ dagegen nur 37,1 mm betrug.

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