Rojenie nietoperzy w Jaskini Szachownica

Swarming of bats in Szachownica cave

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Abstract

In the late summer and autumn, bats often visit underground roosts - both natural and artificial, and this phenomenon is termed as swarming (Fenton 1969). Activity of swarming is complex and its function is connected with mate-selection rituals (Kerth et al., 2003; Rivers et al., 2006; Furmankiewicz 2008), learning of young adults (Fenton 1969), identification of appropriate wintering (Thomas Et al. 1979) and feeding (Mumford and Whitaker 1974). The number of bats visiting the site of swarming is very high and can reach as many as a few thousand bats (Parsons et al., 2003a). The activity of bats is changing during the rainy season and it is species-specific (Parsons et al., 2003a; Parsons et al 2003b). Different species of bats has different length, duration and number of climax or proportion of sex (Furmankiewicz and Górniak 2002). The differences between species in the course of the activity during the swarming are usually interpreted by differences in their feeding strategies and the availability of preferred food (Anthony and Kunz 1977). Daily mass changes of bats indicate the importance of places of swarming also as feeding grounds (Šuba et al. 2011), but proper accumulation of resources occurs before hibernation (Kohyt et al., 2016). This is probably due to the fact that mating behavior (mating flights, copulation) is energetically costly (Speakman 1991; Kerth et al 2003) and significantly shortens feeding time. Autumn bat groups are characterized by uneven sex ratios - most of the activity during sex is male activity (Rivers et al 2006, Piksa 2008, Gottfried 2009). The high activity of males is highly correlated with the size of their ejaculates, which in turn confirms their swarming function (Encarnação et al 2004, Pfeiffer and Mayer 2012). In turn, the increase in the proportion of females at the site of the swarming has negative repercussions on the energy resources of males (Kohyt et al., 2016), but this association is not clear and appears to be species-specific (Gallant and Broders, 2015). The activity of bats during the rainy season can be reduced by low temperatures (Parsons et al., 2003b), due to a decrease in the activity of bats eating insects (Speakman 1991). Low temperatures can also cause lowering mating activity by inducing a torpor (Humphries et al. 2006) or even hibernation (Erkert 1982). A similar species composition of bats during swarming and wintering indicates that these two periods are closely related (Van Schaik et al., 2015).

Materials and methods

The study was conducted in Szachownica Reserve (Natura 2000 site, PLH240004). In Szachownica Cave and in its immediate vicinity there is a mass swarming of bats (Ignaczak and Lesiński 2012). In turn, the cave itself offers numerous winter roosts (cracks, fissures) and very varied microclimate. Currently, the cave is the fourth largest in Poland in terms of the number of wintering bats (2902 bats in 2009), with 11 species of bats. At only 50 km around Szachownica Cave, there are only a few small wintering places of 90 bats (Lesiński et al., 2011), and they are not significant places for bats swarming (W. Pawenta, oral comm.) Szachownica Cave is the destination of hibernation for several species of bats, migrating from up to 90 km distance (Wojtaszyn et al, 2008). The extensive chambers between the main entrances to the cave and open quarries are used by bats for intense swarming.

Bats were caught in a harp trap (size: 150 x 200 cm), located in the corridor between the Entrance Hall and the Transition Hall. The research lasted from the end of July to the end of October in 2013 (83 days). The catches were carried out every two weeks from sunset to sunrise (7 catches). The bat species, sex, age, mass (Pesola, accuracy: 0.25 g), forearm length (accuracy: 0.1 mm), and then timed with water corrector were used to identify potential re-catches during the same night (accounted for 1.4% of the total catch during the study period). To determine the reproductive status of males, a 3-point scale was adopted based on size, shape and color of the epidermis: (1) flat, not bent, (2) bold and bright (3), swollen and dark (black or brown) (Encarnação et al. 2004, Furmankiewicz et al., 2013). The air temperature was also recorded during the catch. In addition, two inspections were carried out in January and March in order to compare the composition of the fauna during swarming with the winter fauna.

Results

During the autumn was registered bat activity of a total of 2712 bats belonging to 10 species. The most commonly cited species were Natterer's bat *Myotis nattereri*, Greater mouse-eared bat *M. myotis*, Daubenton's bat *M. Doubentonia*, Barbastelle *Barbastella barbastellus* and Brown long-eared bat *Plecotus auritus*, whereas Bechstein's bat *Myotis bechsteinii* and Brandt's bat *Myotis brandtii* were less frequent. The other four species of bat were trawlally accused. The sex ratio calculated for the entire season of swarming was close to unity for Greater mouse-eared bat, Natterer's bat, Bechstein's bat and Barbastelle, while the overweight of the male was observed at Brandt's bat, Daubenton's bat and Brown long-eared bat. During winter monitoring, 11 species of wintering bats were identified, among which the three are the most numerous: Natterer's bat, Greater mouse-eared bat and Barbastelle, and Brown long-eared bat, Whiskered bat and Brand'st bat were less frequent. Other species of bats wintered slightly. The bats' turnovers during the divergence were significantly different from the wintering ones (Figure 1).

Distribution of activity is varied between species - the largest species at the beginning of the rainy season was the large one, with the first peak of activity likely occurring already in mid-July (before our research). Other species of bats started activity slightly later, which gradually declined until the end of October. The first to leave Bechstein's bat, Daubenton's bat and Barbastelle, while Natter's bat and Brown long-eared bat remained active until the end of October. In addition, females have finished their activity earlier than males, but the pattern of activity was very similar for males and females within the species, with one exception: Bechstein's bat. Species of bats can be grouped into 3 groups: i) with the highest activity at the beginning of September: Greater mouse-eared bat, Barbastelle and Bechstein's bat (females), ii) species of bats with the highest activity in September: Natterer's bat, and iii) species with bimodal activity of swarming, with the peak at the end of August, and at the end of September or October: Daubenton's bat and Brown long-eared bat (Figure 2).

Gender differences varied widely between species - four of the six species of bats were similar: the predominance of males was gradually reduced until equilibrium was reached and then increased again (Figure 3). Another pattern represented Bechstein's bat - in the population of this species were gradually increasing the share of females, followed by the return of equilibrium. On the other hand, a large pattern was noted for Greater mouse-eared bat: the predominance of females over time changed to the advantage of males. The sex ratio for the surveyed swarming season was almost equal for Greater mouse-eared bat, Natterer's bat, Bechstein's bat, and Barbastelle, while the male's superiority was found at Brandt's bat, Daubenton's bat and Brown long-eared bat.

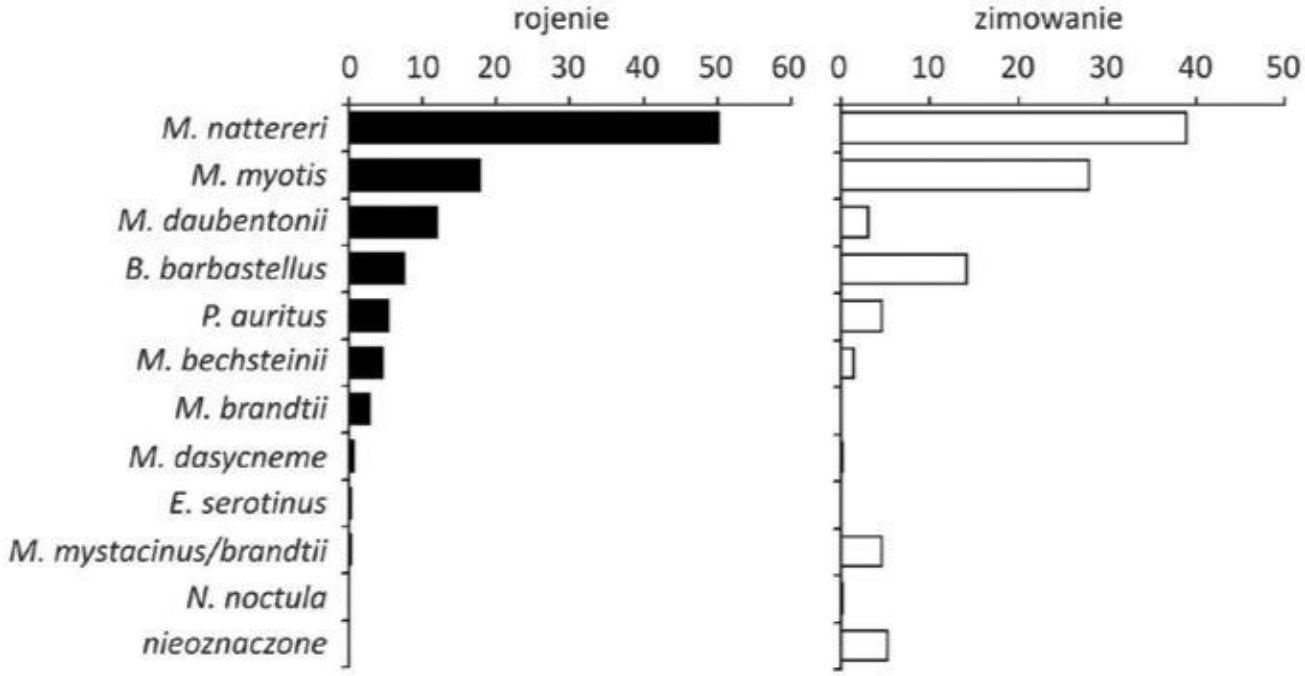
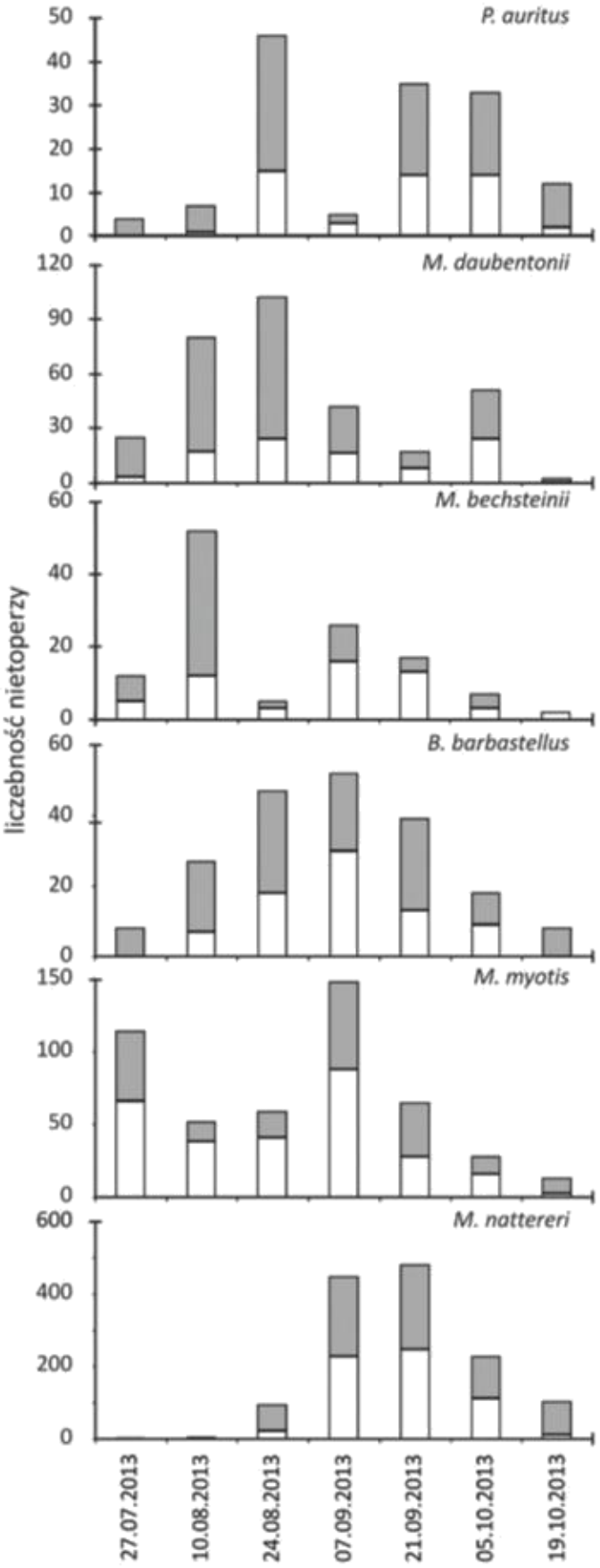


Fig. 1. Percentage of individual species of bats during the swarming season - black bars (2013) and during hibernation - white bars (winter 2013/14)



Rys. 2. Number of caught bats during individual visits in Szachownica Cave. White - female, gray - male

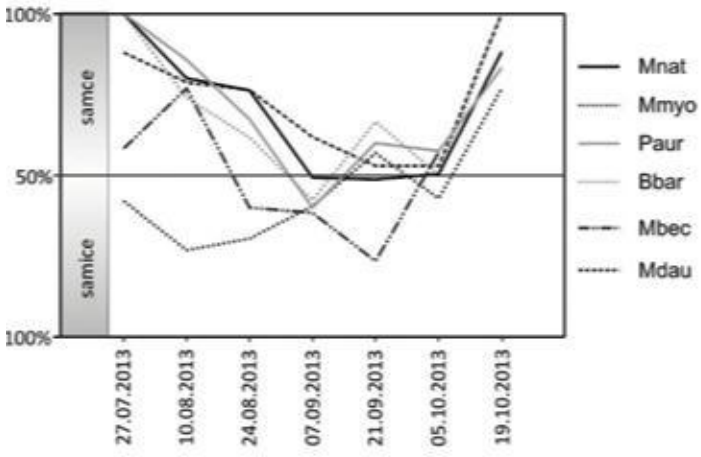


Fig. 3. Changes in sex ratios during autumn fall for individual species of bats: Natterer's bat (Mnat), Greater mouse-eared bat (Mmyo), Brown long-eared bat (Paur), Barbastelle (Bbar), Bechstein's bat (Mbec) and Daubenton's bat (Mdau)

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The similarity of fauna of bats active during swarming and wintering in a given location may indicate that both of these functions are occurring in the winter (Furmankiewicz and Górniak 2002, Piksa 2008, van Schaik et al. 2015). In case of Szachownica Cave we found differences between active and wintering fauna. This may be due to the fact that some species that are numerous during the swarming, choose winter sites hard to monitoring: deep crevices, often in the malignant zone (Brown long-eared bats, minor species of *Myotis sp.),* and even between rock in the floor (Daubenton's bat). This may lead to their underestimation during winter monitoring (Ransome 1990). In addition, some species that wintering in caves do not show such behavior as swarming.

The characteristic feature of the swarming is the high proportion of males, often up to 80% (Furmankiewicz and Górniak 2002; Parsons et al., 2003). In our study, the proportion of males and females in most species of bats was similar, not only for Greater mouse-eared bat in which there were no typical swarming behaviors (McCracken and Wilkinson 2000, Pfeiffer and Mayer 2012), but also in case of Natterer's bat, Bechstein's bat and Barbastelle it is different from earlier statements (Furmankiewicz and Górnikia 2002; Parsons et al 2003a; Rivers et al. 2006, Gottfried 2009). On the other hand, Daubenton's bat, Brown long-eared bat and Brandt's bat were characterized by typical male dominance (Piksa 2008). It is possible that in bat species for which the cave functions as both mating and wintering, the sex ratios will be similar, while for species that use the object mainly as a place of swarming, the sexes will be shifted towards one of them.

The dynamics of bat activity during the swarming is species specific, which is interpreted, inter alia, by the different arrival times for wintering (Parsons et al., 2003b) or the availability of victims and related feeding strategies (Anthony and Kunz 1977; Barclay 1991). One should expect similar patterns of activity in species with similar diets, but the association of activity with diet has not been confirmed - patterns of the activity of individual species appears to depend not only on diet but also on thermoregulation strategies - including the ability to fall into the torpor (Encarnação et al., 2012; Becker et al., 2013, Matthias et al.= or hibernation strategy (Ingersoll et al. 2010). The order in which species of bats begin hibernating in Szachownica cave (Hejduk and Radzicki 1996) to a large extent correspond to the end of the activity during the swarming: the first begins the hibernation Daubenton's bat, then Greater mouse-eared bat, Brown long-eared bat and Barbastelle, while the last for wintering was Natterer's bat.