Capture success of little brown bats (*Myotis lucifugus*) feeding on mosquitoes

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Abstract

A small colony of little brown bats *Myotis lucifugus* was observed feeding on mosquitoes (Culicidae) inside a barn near Fairbanks, Alaska in June 2000. Observations were made visually and with a bat detector. All capture attempts were associated with feeding buzzes, indicating that the bats used echolocation to detect and track the insects, although the light was bright and the insects were easily seen by us. The capture efficiency of the bats was 92% (n = 100). The insects did not show any defensive behaviour in response to approaching bats.

Key words: Alaska, echolocation, mosquitoes, Myotis lucifugus, predation

INTRODUCTION

Using a bat detector and a stop watch, the efficiency by which echolocating bats catch insects under natural feeding conditions can be estimated by counting so called 'feeding buzzes', i.e. sharp increases in the pulse repetition rate that is associated with the tracking and capture of an insect (Griffin, Webster & Michael, 1960). If the exploited insects can be identified and weighed, the food intake rate of the bats may be estimated. However, this technique requires either that each capture attempt can be assumed to result in a successful catch or that the error can be estimated by some other means. Unfortunately, distinguishing sucessful from unsuccessful capture attempts by acoustic means is not easy, mainly because there usually does not seem to be any reliable characteristic of the pulse sequence resulting in a successful catch (Houston & Jones, 2002).

Occassionally the outcome of interactions between bats and large insects have been estimated by direct observation in good light conditions. Generally, the capture success of aerial-hawking bats (*Lasiurus* spp., *Pipistrellus* spp. and *Eptesicus nilssonii*) hunting tympanate moths around street lights is about 30–40% (Dunning *et al.*, 1992; Rydell, 1992; Kalko, 1995) and a similar efficiency (36%) applies to *E. nilssonii* feeding on lekking ghost moths *Hepialus humuli* (Hepialidae). Ghost moths are deaf to bat calls, but the displaying males compensate for this by employing 'acoustic concealment', i.e. staying close to clutter-producing vegetation (Rydell, 1998).

We here report on the efficiency by which little brown bats *Myotis lucifugus* capture mosquitoes (Culicidae) in open air. In this situation the capture success of the bats may be expected to be relatively high, because: (1) mosquitoes fly slowly and, as far as is known, they are deaf to bat calls; (2) the detection and tracking task may be relatively easy when there is little or no interfering clutter.

STUDY SITE AND METHODS

The observations were made inside a 'Quonset Hut' at Salcha near Fairbanks, Alaska. The hut, measuring $c. 7 \times 27$ m and c. 4 m high, was previously used for storing potatoes and until recently as a garage. It was heated by a stove, near which the maternity colony of little brown bats, previously consisting of c. 200 individuals, resided. The bat colony remained in the same spot in June 2000, but apparently consisted of only a few individuals. The decline of the colony coincides with the disuse of the hut as a garage, and, most importantly, with the fact that it is no longer heated. Located at 65 °N, this bat colony is one of the most northern in the New World (Parker, Lawhead & Cook, 1997). Its feeding biology has been studied in some detail previously, and the bats were reported to feed predominantly on dipterans, including mosquitoes and moths (Whitaker & Lawhead, 1992).

As we entered the hut in the evening (10 June 2000) to observe and possibly count the bats, at least 3 bats

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emerged from inside the roof and started to hunt the mosquitoes that we had not deliberately attracted into the hut. By moving towards the open entrance of the hut, we ensured that mosquitoes were continuously attracted from the outside by our presence. At the entrance, the mosquitoes and the bats were well illuminated by the light from outside. They were thus easy to observe against the dark inner part of the hut. Remaining in this spot at the entrance for 2 h allowed us to continuously observe interactions between bats and mosquitoes at a distance of 1–3 m (between 23:30 and 01:30 Alaska summer time). Our observations were aided by a heterodyne bat detector (Pettersson D-200) tuned to 35–40 kHz.

RESULTS AND DISCUSSION

No bats were observed leaving the hut; all feeding that was observed took place inside. The bats were possibly hindered by the bright light conditions prevailing outside in clear weather. The bats typically flew back and forth inside the barn, often on figure-of-eights, attacking one insect at each turn near the entrance. There were between one and three bats flying inside the hut at the time, but usually only one, or sometimes two that were hunting actively. When more than one bat was active, much of the time was spent with one bat chasing the other or the others. This was most likely a territorial behaviour, perhaps in response to competition for the limited hunting space or to acoustic interference from the other bats (Racey & Swift, 1985; Rydell, 1986).

The outcome of 100 attacks against mosquitoes was recorded, none of which was identified to species. In 92 (92%) attacks the insect was caught by the bat, and in eight attacks it was missed. In addition, we recorded 10 attacks, all successful, against individuals of a tiny moth *Phyllocnistis populiella* (family Gracillaridae) (wingspan c. 5 mm), an outbreak species that occurred in abundance in the vicinity of the hut and which occasionally turned up at the entrance. No bats were observed feeding on other prey.

The capture attempts were always associated with feeding buzzes, indicating that the bats consistently used echolocation when tracking and catching the insects. Both the mosquitoes and the moths typically flew slowly and without any rapid changes in the flight course, and no evasive responses from any of the insects were observed when bats approached them. This was as expected, because neither culicid dipterans nor gracillarid lepidopterans are known to possess ultrasonic hearing organs or any other morphological defence against bats.

Myotis lucifugus, and other species in the genus, typically feed on small flies (Belwood & Fenton, 1976; Fenton & Morris, 1976; Vaughan, 1997). Although mosquitoes are not the dipterans most frequently eaten by these bats, they are taken when presented to *M. lucifugus* in captivity (Griffin *et al.*, 1960). They are

also known to be exploited by wild colonies of *M. lucifugus* in Alaska (Whitaker & Lawhead, 1992) and elsewhere (e.g. New Hampshire: Anthony & Kunz, 1977). Small flies seem to be caught much faster and with higher success rates than for example larger moths by aerial-hawking bats, as tentatively suggested by Kalko (1995), and this observation may help explain the apparent 'preference' for small flies even in the presence of larger insects (e.g. Swift, Racey & Avery, 1985; Barclay, 1991).

The bats observed seemed to prefer foraging inside the hut even though insects were probably more abundant outside. During this time of the year, when darkness does not occur at 65 °N, we have observed *M*. *lucifugus* forage in the shadow of willows (Salix spp.), overhanging slowflowing river channels and ponds (Parker et al., 1997). A similar behaviour is sometimes shown by northern bats (Eptesicus nilssonii) in northernmost Scandinavia (69 $^{\circ}$ N), where they either forage in the shade beneath the tree canopies or, alternatively, feed at high elevation (typically 50 m or more). Particularly in clear weather, E. nilssonii consistently avoid feeding on mountain slopes that are lit by the midnight sun, and they ususally fly straight towards the shaded side of the valley. They also concentrate their feeding activity to a short period (c. 2h)around midnight (Rydell & Strann, 1992; Speakman et al., 2000; J. Eklöf pers. obs. during July 2000). Hence, like E. nilssonii in northern Scandinavia, foraging M. *lucifugus* in Alaska typically avoid open areas near the ground, and we believe that this is a response to an increased risk of being caught by predators, particularly hawks and falcons, under bright light conditions.

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