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Steep altitudinal gradients can benefit lowland bats

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Abstract. This is a report on a post-lactating female soprano pipistrelle, *Pipistrellus pygmaeus*, which in autumn exploited habitats from sea level to the transition zone between alpine and sub-alpine areas. It travelled more than 12.3 kilometres from its roost and returned to its roost at sea level on all four nights when it was tracked. In addition to the telemetry bat, several soprano pipistrelles utilized high altitudes during the days of tracking as heard on ultrasound detector.

Key words: altitude, habitat, home-range, Norway, *Pipistrellus pygmaeus*, topography

Introduction

In central and southern Europe, large mountain chains provide a gradient of different vegetation and climate from lowlands to alpine areas, thus yielding a high bat diversity over even relatively short distances in these regions (Stutz 1989, e.g. Hausser 1996, Holzhaider & Zahn 2001, Kaňuch & Krištín 2006, Ulrich et al. 2007). In some species, there seems to be altitudinal segregation between the sexes in summer (e.g. Senior et al. 2005), where the lower ranges in general are most attractive to females. At northern latitudes in Europe, females of most species are confined to lowlands during reproduction and are found in the boreonemoral and south boreal vegetation zones. In much of south-western Norway, lowlands are found in only a small area along the hillsides of fiords or in the lower parts of valleys. Thus, most species will only utilize a small portion of the total land area during pregnancy and lactation and populations are correspondently small. However, the species that do occur here still have the potential to exploit the complex topography by utilizing different altitudinal gradients during their active season.

Radio-telemetry and ultrasound detectors were used to explore habitat use of soprano pipistrelles, *Pipistrellus pygmaeus*, in western Norway in a landscape with complex topography. Here, this species is only found in a narrow plain in lowlands during summer.

Material and Methods

We fitted a transmitter (LB2N, 0.35 g from Holohil Systems Ltd., Canada) to one post-lactating female soprano pipistrelle on 4 September 2004, just after midnight. It was caught at sea level in broad-leaved boreonemoral forest when hunting under street lamps (common at this time of year in the study area) in the village of Tafjord, Norddal municipality, Møre og Romsdal county, western Norway at 62° N, close to the northern limit of its distribution. The village is located in the east end of one of Norway's longer fiords that incises into the massive mountain chain. Here mountains rise from sea level to more than 1000 m a.s.l. over only a few hundred meters as the crow flies. The bat was tracked using a TRX 48S receiver (Wildlife Materials, UK) combined with a three element Yagi antenna. Distance to the transmitter was estimated using the attenuator switch on the receiver. When signals were low on the pulse meter on the receiver when the attenuator was set to ON, it was not possible to give an accurate estimate of distance to the bat. By tilting the antenna to a vertical position, a better estimate of the bat's position in the hillsides could be made, but the estimate would still be crude. Elements of the topography (ridges, plateaus) provided useful cues, as signals would be either heard or lost around these landscape elements. The bat was not tracked this first night, since the handling of it is likely to affect its behaviour for some time after release. Both a car and a boat was standing by so that it would

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be possible to track the bat if it would undertake long movements or if it chose to hunt in parts of the fiord without roads. In addition to track the transmitter bat, a D240X ultrasound detector (Pettersson Elektronik AB, Sweden) was fixed to the window of the car.

Daily normal temperatures referred to in this note were provided by The Norwegian Meteorological Society from Tafjord weather station located in the study area (30 y normal from the period 1961 to 1990). Mean daily temperatures from the days of tracking come from the same weather station. On location temperature measurements were carried out using a simple in-outdoor thermometer, where the outdoor sensor was fitted to the rear end of the car.

Results and Discussion

During daytime on 4 September, the bat was found roosting in a rock crevice less than 10 m a.s.l., 2.4 km from where it was captured. It left the roost between 20.40–20.45 h and flew to the hillside just east of its roost and gained altitude. The signals became weak and the bat started to move eastwards towards the valley where the fiord ends. The bat was lost at times, but periodically heard to the east and up the valley. The bat was finally found at short distance (determined using the attenuator switch) at 22.20 h at appr. 510 m a.s.l., 8 km from its day roost near a freshwater with regulated discharge. It started a rapid descent towards the fiord at 01.50 h and returned to its day roost. It had a second feeding bout this night and hunted for a short period along the shoreline of the fiord before returning to its roost. The following day (5 September), it repeated its route to elevated areas and moved even further up the valley. The road ended at 640 m a.s.l. The bat was heard in the steep hillside at some distance from this observation point (no signal when the attenuator was on, but strong signals in off-position at intermediate volume settings), suggesting a rough estimate of altitude around 700 m a.s.l. The bat did not hunt over a plateau starting at around 780 m a.s.l., where it would be lost behind a ridge. It had now moved from the warm boreonemoral vegetation zone with broad-leaved forest at sea level, to the transition between subalpine woodland and the low alpine zone dominated by man-high bushes and treeless patches. Distance from its day roost was above 12.3 km as the crow flies. It started the descent from the mountains just around 03.55 h. The bat was still active in the vicinity of the day roost at 04.25 h when the observer reached the lowlands, but was confirmed at ease sometime between 04.30 and 04.35 h. Thus, it is likely to have spent a short period hunting in lowlands before ending the activity in the morning.

On 6 September, rain stopped the activity and on 7 September the bat was not tracked. Again, tracking the bat for a short period on 8 and 9 September to see if it would still hunt at high altitudes revealed that it continued its long movement to elevated areas and hunted at elevations from 500 to around 700 m a.s.l. The soprano pipistrelle returned to the same day roost throughout this study (roost was confirmed during daytime). In addition to the telemetry bat, several soprano pipistrelles and *Myotis sp.* (probably whiskered bats *M. mystacinus*) were heard and seen in sub-alpine woodland, suggesting that many lowland bats will exploit these altitudes in autumn.

Mean daily temperatures on the first two days of tracking were 19.9°C (+8.2°C compared to normal) and 17.6°C (+6.0°C compared to normal) respectively, whereas the two last days had temperatures at 11.1°C and 9.9°C, just below the normal (-0.1°C and -1.1°C respectively). On location measurements in elevated areas the night 5–6 September varied between 8.3 and 11.0°C, still suitable for insect activity. Wind conditions were calm on all nights except for the night when the bat was captured, thus this factor would neither benefit nor yield additional costs to the bat in terms of energy on the nights it was tracked.

Car transects using ultrasound detectors carried out bi-annually during summer and over several years in this area through the Norwegian Zoological Society's Bat Surveillance Programme as well as visits and surveys reported by various authors (summarized in Michaelsen et al. 2003) have only recorded northern bats in woodlands at high altitudes. In the valley where we tracked the soprano pipistrelle, maximum altitude where we have recorded the species during summer was 140 m a.s.l., but it is the most common bat at sea level. Unlike in much of the European range of the soprano pipistrelle, in western Norway with its complex topography, the bats have potential to exploit all vegetation types available in the region by travelling short distances. In this fiord – valley landscape, mountains rise from sea level to more than 1000 m a.s.l. over only a few hundred meters as the crow flies, thus bats will not have to undertake long horizontal movements to reach high altitudes, as was the case in the telemetry bat in this study.

Insects have a delayed seasonal peak at high altitudes compared to lowlands, even within insect groups or within species (Chironomidae; Armitage et al. 1995, e.g. Lepidoptera; Gutierrez & Menendez 1998), and some species found in the subalpine forests and the low alpine zone in these parts of Norway (e.g. some Bibionidae spp.) can have their main flight periods in late summer and early autumn (e.g. Greve 1984). Further, a complex

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topography yields different vegetation types over shorter distances (conifer versus deciduous woodland), which again can influence insect phenology and its predators (van Balen 1973). Temporal patterns in habitat use related to insect densities have also been well documented in bats to the north in Europe (de Jong & Ahlén 1991, e.g. de Jong 1995). On the first day of tracking, insects (dark flies, possibly Bibionidae spp.) were numerous and covered the car lights at high altitudes. The abundance of insects and thus feeding potential could very well explain the long movements of this bat. No such mass occurrence of insects was observed in the lowlands, thus supporting this assumption. This delayed peak in insect densities could be a welcome additional source of energy intake for bats prior to hibernation at northern latitudes. The autumn-addition of vast land areas in higher altitudes suitable for soprano pipistrelles (and probably other lowland species) would also reduce intra-specific competition at a time when population size is at its highest. During pregnancy and lactation the soprano pipistrelle has a small home-range, and will usually travel less than 2 km from its roost (e.g. Nicholls & Racey 2006), and an ongoing telemetry project in the study area suggest similar home ranges here (unpublished). The coverage of vegetation zones, diversity in habitats used, altitudinal range and the extended home-range found in this post-lactating female soprano pipistrelle lack precedence in the literature. This could in part be explained by scientists' focus on bats during reproduction when females may have to return to their roost one or several times to feed their young, but ultimately also by the potential given bats to exploit different vegetation zones and their insect faunas in areas with complex topography and a steep altitudinal gradient.

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