Roost use by two sympatric species of *Scotophilus* in a natural environment

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Roost use by African bats is poorly known, particularly for those using cavities in trees. Two sympatric species of *Scotophilus* were fitted with transmitters and tracked to their respective roosts in a natural savanna site in Swaziland. Both species roosted exclusively in trees, apparently preferring *Combretum imberbe* trees with large girths. The conservation of such roosting trees may be critical to the continued persistence of cavity-nesting insectivorous bats in African savannas.

Key words: *Scotophilus,* roosts, *Combretum imberbe,* radio-tracking.

INTRODUCTION

Roosts play an important role in the ecology of bats, with different species often selecting different types of roosts (Kunz & Lumsden 2003). Insectivorous bats can be differentiated into those that use: large spaces, such as caves or mine adits; small cavities, usually in trees; and crevices, in cliffs or anthropogenic structures such as buildings (Kunz & Lumsden 2003).

Roost selection by African insectivorous bats is poorly known. The roosting requirements of some species have been characterized (McDonald *et al.* 1990; Churchill *et al.* 1997; Bronner *et al.* 1999; Monadjem 2005), but these are typically cave- or crevice-dwelling bats. By contrast, for most species roosting in tree cavities little more than a broad description of the roost exists (Monadjem *et al.* 2010). Radio-tracking studies, however, have assisted in identifying the roosts of tree-dwelling African bats (Fenton 1983; Fenton *et al.* 1985; Fenton & Rautenbach 1986; Obrist *et al.* 1989; Jacobs *et al.* 2005).

One group of African bats whose roosting habits are relatively well-known are the house bats of the genus *Scotophilus.* Two closely related species occur sympatrically over much of eastern South Africa and southern Mozambique. The larger species, *S. dinganii,* is distinguishable from the smaller species by genetics, size and echolocation call (Jacobs *et al.* 2006). There is currently confusion over the naming of the smaller species which has been variously called *S. viridis* (Rautenbach 1982) and more recently *S. mhlanganii* (Jacobs *et al.* 2006; Jacobs & Barclay 2009). The name *S. mhlanganii* is a *nomen nudem* and we therefore refer to this species as *S.* cf. *viridis* (see Monadjem *et al.* 2010 for more details). Whereas *S.* cf. *viridis* is known to roost in tree cavities (Fenton *et al.* 1985; Jacobs & Barclay 2009), *S. dinganii* has only been known to use anthropogenic roosts in the form of roofs of houses (Taylor *et al.* 1999; Jacobs & Barclay 2009). In fact, this difference in roost selection has been suggested as a key to niche separation in these two sibling species (Jacobs & Barclay 2009).

The aim of this study was to determine whether roost use by these two species would show similar segregation in a natural setting. We did this by describing both the characteristics of the roosts themselves as well as the habitat surrounding the roosts used by *S.* cf. *viridis* and *S. dinganii* in a natural setting, i.e. devoid of anthropogenic structures.

METHODS

The study was conducted at Mlawula Nature Reserve (26°14′S; 32°00′E, 150 m above sea level). The climate is subtropical with hot, wet summers and dry, cool winters. Mean daily temperatures for January and July are 26°C and 18°C, respectively, while mean annual rainfall ranges from 550–725 mm. The dominant vegetation is microphyllous savanna bisected by riverine vegetation. Characteristic tree species associated with the savanna are: *Acacia nigrescens, A. tortilis, Ziziphus mucronata, Sclerocarya birrea* and *Dichrostachys cinerea;* and large evergreen trees such as *Ficus sycomorus* and *Schotia brachypetala* are characteristic of the riparian forest (Monadjem & Reside 2008; Monadjem *et al.* 2009).

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Table 1. Measurements of the nine *Scotophilus dinganii* and *S.* cf. *viridis* individuals fitted with transmitters in northeastern Swaziland. The roost labels (A–E) correspond to those in Table 2.

Species	Sex	Mass (g)	Forearm (mm)	Date transmitter fitted	Time tracked (days)	Roosts used
Scotophilus cf. *viridis*	M	21	49.5	7 Jan 2009	3	A
Scotophilus cf. *viridis*	M	20	48.4	7 Jan 2009	3	A, B
Scotophilus cf. *viridis*	M	22	47.6	9 Jan 2009	1	A
Scotophilus cf. *viridis*	F	24	48.9	7 Jan 2009	3	A
Scotophilus cf. *viridis*	F	23	47.0	8 Jan 2009	1	E
Mean ± S.E.		21.9 ± 0.640	48.28 ± 0.447			
Scotophilus dinganii	M	25	54.2	8 Jan 2009	–	
Scotophilus dinganii	M	25	53.5	8 Jan 2009	–	
Scotophilus dinganii	M	26	52.3	7 Jan 2009	2	C
Scotophilus dinganii	M	23	51.2	7 Jan 2009	3	D
Mean ± S.E.		24.8 ± 0.629	52.80 ± 0.662			

A, B, C, D = *Combretum imberbe*; E = *Acacia nigrescens.*

Bats were trapped with mist nets and harp traps in January 2009. Captured individuals were sexed, weighed, forearm length measured and aged based on ossification of the epiphyses. Transmitters (LB-2N from Holohil Systems, Carp Ontario, Canada), each weighing 0.37 g, were attached between the shoulder blades with surgeon's glue. The bats were then released, usually within an hour of capture.

The roosts of tagged bats were located each morning after sunrise. The following characteristics of the roosting site were measured or recorded: the tree species, the diameter at breast height (DBH), and the habitat surrounding the roost. The size and spacing of trees surrounding the roost was quantified by measuring the distance to, and DBH of, the nearest tree in each of four quarters around the roost tree. In addition, we sampled the vegetation at 1 m intervals along four transects, 10 m in length, in each cardinal direction away from the roost tree, scoring the height of woody, and herbaceous/grass cover at each point. To compare the characteristics of the roosting tree with that of trees generally available in the same patch of habitat, we randomly selected a tree (of similar height to that of the roosting tree) by walking a random distance of between 100 and 300 m, in a random cardinal direction from the roost tree. The closest tree to this point was taken as the random tree and measured in exactly the same way as for the roost tree.

We used stepwise discriminant functions analysis (DFA) to test whether any of the measured characteristics of the roost and random sites could be used to distinguish between these sites. Additionally, we tested whether *Combretum imberbe* was used significantly more than expected as a roosting tree by applying a binomial test. All statistical analyses were performed in SPSS version 12.

RESULTS

A total of five *S.* cf. *viridis* and four *S. dinganii* individuals, all adults, were fitted with radiotransmitters and released (Table 1). The two species differed significantly in mass (t = 3.17, d.f. = 7, P = 0.019) and forearm length (t = 5.66, d.f. = 7, P = 0.002). There was marginal overlap in mass, but forearm length was clearly different in the two species with *S. dinganii* >51 mm and *S.* cf. *viridis* <50 mm (Table 1).

Two of these individuals (both *S. dinganii*) disappeared immediately after release and were not relocated during this study. The remaining six individuals were tracked to five different individual trees over 1–3 nights (Table 1). Four of these roosts were located in large *Combretum imberbe* (leadwood) trees, the fifth one in a large *Acacia nigrescens* (knobthorn) tree. All the bats except for a single *S.* cf. *viridis* roosted exclusively in *Combretum imberbe.* The two *S. dinganii* roosted in separate *Combretum imberbe* trees, which they did not leave during days that they were tracked (Table 1). Four of the five *S.* cf. *viridis* individuals roosted simultaneously in the same *Combretum imberbe* tree on a single night, and then one of the bats switched roosts to a different *Combretum imberbe* tree for two nights. The remaining three

Table 2. Characteristics of roost sites used by *Scotophilus* cf. *viridis* and *S. dinganii* in natural habitat in northeastern Swaziland. The roost labels correspond to those in Table 1.

Tree species	Label	DBH (cm)	Distance to neighbouring tree (m)	DBH of tree (cm)	Height of forb & grass cover (cm)	Height of woody cover (cm)
Roost						
Combretum imberbe	A	223	10.8	98	83	0
Combretum imberbe	B	233	10.6	110	20	0
Combretum imberbe	C	300	4.5	59	20	0
Combretum imberbe	D	100	7.2	41	38	28
Acacia nigrescens	E	10	3.3	30	30	0
Mean ± S.E.		173.2 ± 116.33		67.6 ± 35.06		

S. cf. *viridis* continued to roost together in the same tree. The final *S.* cf. *viridis* was tracked to a relatively small *Acacia nigrescens* tree where it roosted for one night.

The trees in which the bats roosted had significantly larger girths (DBH) than those of their nearest neighbours (Generalized Linear Model, dependent = DBH, predictor = roosting tree/nearest neighbouring tree: Wald χ^2 = 4.72, n = 10, P = 0.03, Table 2). The DFA identified one variable, DBH, that separated roosting trees from those selected randomly (Wilks' lambda: F = 6.345, d.f. = 1, 12, P = 0.027, Fig. 1). *Combretum imberbe* were significantly disproportionately used as roosting trees (binominal test, P = 0.003).

DISCUSSION

At our study site, the two species of *Scotophilus* were clearly identifiable based on forearm length alone, which matched closely those presented in Jacobs *et al.* (2006).

Although the scope of our project was limited by our small sample size there was a clear pattern to our data. Both species of *Scotophilus* used trees of similar size and species as roost sites in a natural savanna setting, casting doubt on the role that roosts may play in niche separation on a coarse scale, in these two species (*cf.* Jacobs & Barclay 2009). Similarly, Ruczynski & Bogdanowicz (2008) did not find any significant differences in the preferred roosts of two closely related species of *Nyctalus.* Niche separation in the two *Scotophilus* species may still occur on a fine scale, for example by differential use of cavities of different sizes, something that was not measured in this study. It is interesting that the smaller *S.* cf. *viridis* has not been recorded roosting in roofs of houses (Jacobs & Barclay 2009), which may be due to competitive exclusion by the larger sympatric *S. dinganii.* Future studies would do well do measure the size of the cavity used by these two species.

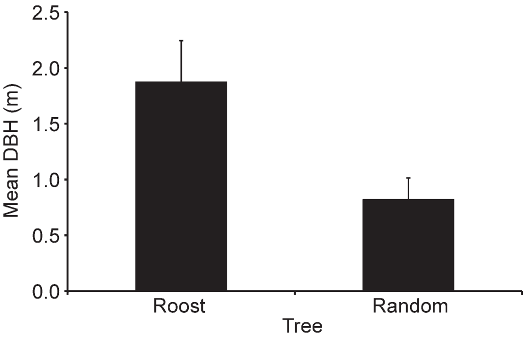

Fig. 1. The mean DBH (m) ± S.E. of random and roosting trees used by *Scotophilus* species at Mlawula Nature Reserve, Swaziland.

We witnessed roost switching in one of the *S.* cf. *viridis* individuals tracked in this study. Roost switching was not recorded in either *S.* cf. *viridis* or *dinganii* in a suburban environment in St Lucia, South Africa (Jacobs & Barclay 2009). By contrast, Fenton *et al.* (1985) noted frequent roost switching in *S. viridis* in a hot, subtropical savanna in northern Kruger National Park, a habitat similar to our study site. In the latter study, the longest residency of the same roost was four days, and all eight radio-tracked individuals changed roosts at least once during the 4–10 days that they were followed (Fenton *et al.* 1985). Roost switching in bats appears to be associated with a fission–fusion model of social interactions (Kerth & König 1999) and may be common amongst bats (Willis & Brigham 2004).

Combretum imberbe appears to be an important roosting tree for both *Scotophilus* species in our study area. The fact that DBH was a significant variable in the DFA, suggests that trees with large trunks are being selected by these bats, and is probably mediated by cavity formation. DBH increases with age, and older trees have had more time for cavities to form. Radio-tracked *Scotophilus leucogaster* in Zimbabwe used *Colophospermum mopane* trees exclusively and selected those with larger trunks (Fenton 1983; Fenton *et al.* 1985). Thus, large trees may be critical for the continued existence of cavity-roosting bats in savanna habitats (Fenton *et al.* 1998), and the conservation of such trees, including *Combretum imberbe* needs to be highlighted. The fact that *Combretum imberbe* is slow-growing and long-lived (Vogel & Fuls 2005), but is utilized for fuelwood and furniture by local communities (Shackleton 2005) underscores the importance of this species in conserving savanna bat roosts.

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