Vegetation structure at basking sites of the adder *Vipera berus*: Implications for site management

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THE European adder *Vipera berus* (Linnaeus, 1758) has the largest geographic range of the world's terrestrial snakes (Nilson, 1980; Herczeg et al., 2007) and is arguably one of the most studied snakes in the world (Phelps, 2007). Studies of this species and its response to vegetation structure are, nevertheless, scarce. Changes to vegetation dynamics, resulting from inappropriate habitat management schemes, have been observed to influence population density (Phelps, 2007) and removal of heath vegetation by fire can increase the risk of predation due to the lack of adequate cover, especially for males during spring emergence (Phelps, 2004).

This study investigates habitat structure and use by thermoregulating adders, comparing vegetation at spring basking sites with that of adjacent heath and grassland. The analysis of the influence of vegetation structure on the local distribution of this species following emergence from hibernacula and during lying-out periods may allow site managers to take account of adder populations in habitat management plans.

MATERIALS AND METHODS

Surveys were conducted across six habitat patches, with various vegetation types, across two localities in the UK; Blackmoor Reserve (n = 1) and Quantock Common, Somerset (n = 5). Blackmoor Reserve (51º18'N, 2º44'W) covers 0.25 km^2 of the central plateau of the Mendip Hills Area of Outstanding Natural Beauty (AONB), 244 m above sea level. Habitat consists of a mosaic of calcareous grassland and limestone heath. Patches of bare ground and lead slag reflect its former use for mining. Quantock Common (51º08'N, 3º13'W) covers 18.31 km^2, 250-350 m above sea level, and is part of the Quantock Hills AONB. It compromises mostly lowland heath, acid grassland and ancient woodland.

The survey of basking sites was conducted over 56 days between late February and early May 2008, following the spring emergence of snakes and subsequent establishment of lying out areas. The six study areas were surveyed for basking sites on six separate occasions. For the purpose of this study, a basking site is a location where an adder was considered to be attempting to thermoregulate in direct sunlight. Sites were surveyed from a network of pathways established by anthropogenic activity and grazing stock. The collection of data was conducted between 1000 and 1700 hours in relatively dry conditions. Upon finding a basking site, all snakes were removed to allow for vegetation surveys to be conducted safely and for morphological measurements to be made (for another study). Snakes were returned to the point of capture after the vegetation survey.

Vegetation was assessed within four layers, defined as follows. "Ground" vegetation comprised lichens, mosses, herbaceous shoots and short swards of grass shoots. "Litter" was dead material sitting loosely on the ground layer and typically comprised dead gorse (*Ulex* spp.), heather (*Calluna* and *Erica* spp.) leaves and bracken (*Pteridium aquilinum*) leaves and stalks. "Understorey" comprised grass tussocks, and low-growing vegetation, both herbaceous and woody plants (including small heather, gorse and bracken plants). "Canopy" vegetation included established, tall (> 80 cm) woody plants, including predominantly heather, gorse and birch. Bracken is widespread on the Quantock Hills; during spring dead bracken contributed most of the vegetation in the litter layer, and young bracken shoots made up most of the ground layer.

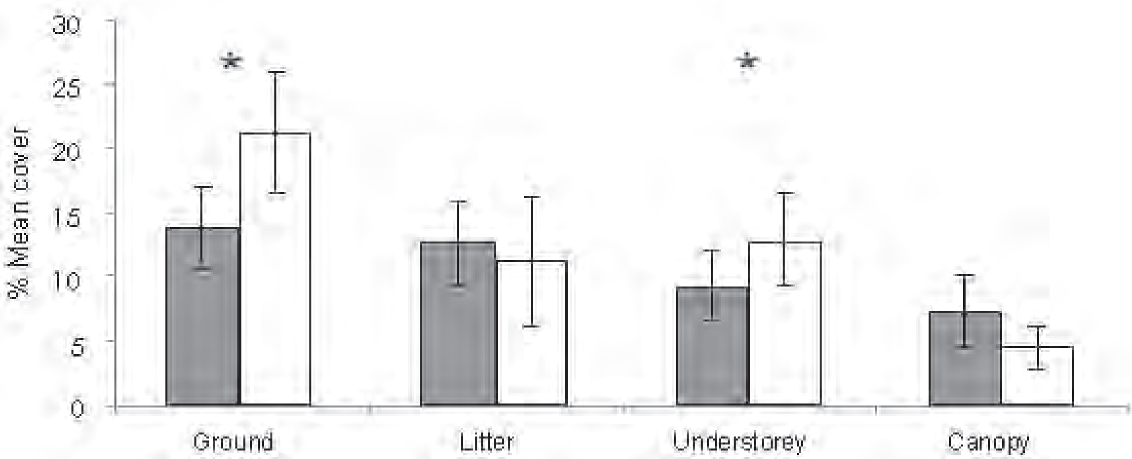

Figure 1. Extent (%) of vegetation cover (± SE), within ground, litter, understorey and canopy layers. Shaded bars signify random quadrats and unshaded bars signify basking sites. * denotes statistically significant results.

A 50 x 50 cm quadrat was centred on each basking site, and the percentage cover of each of the sward layers was estimated. General vegetation structure of each study area was assessed using the same approach, but randomly locating quadrats (twenty quadrats on the five Quantock Common study areas and forty on Blackmoor Reserve, a larger site).

A mixed-effects linear model with a binomial error structure was used to determine the factors that were significantly related to adder presence. Results with a probability of less than 0.05 were treated as statistically significant. Statistical analysis was conducted using R 2.6 software.

RESULTS

Adder basking sites were found in three of the study areas known to contain hibernacula. 202 quadrats of vegetation were sampled, of which 34.07 % (n = 62) were adder basking sites and 65.93 % (n = 140) were randomly selected. The mean percentage cover by ground vegetation was greater at basking sites than at randomly sampled locations (± SE 0.001, df 190, $P < 0.001$), as was the mean percentage understorey vegetation cover (±SE 0.001, df 190, $P < 0.001$) (Fig. 1). There was no significant difference in the extent of vegetation cover in the litter and canopy layers between basking sites and the surrounding vegetation.

DISCUSSION

Microhabitat use by basking snakes was positively associated with ground and understorey vegetation cover. Snakes must trade-off the costs and benefits associated with the selection of habitats and thermoregulation (e.g. avoiding predators and obtaining basking sites) (Howard et al., 2003). Vegetation cover at the ground layer provides a warm substrate on which some UK reptile species can thermoregulate (House & Spellerberg, 1983). Understorey vegetation cover can provide a refuge from potential predators, whilst also allowing enough light to penetrate to the ground so that snakes can thermoregulate in the litter layer below. Predation pressure on adders by foraging mammals and human persecution is most frequent during basking following spring emergence (Prestt, 1971). Often only a relatively small amount of open ground is required for basking, but from observations, dense vegetation cover is nearly always close by (House & Spellerberg, 1983).

Although the extent of canopy cover was not significantly different between basking and random sites, it was present only in small amounts. More extensive canopy cover may lead to the shading out and loss of basking sites (House & Spellerberg, 1983; Urbina-Cardona et al., 2006), yet may serve as cover, particularly against avian predators during episodes of spring basking activity (Chris Gleed-Owen, pers. comm.).

In summary, this study found differences in vegetation structure between adder basking sites and adjacent microhabitats. Basking sites had more extensive areas of low growing vegetation (ground and understorey layers). It is likely that patches of relatively low growing vegetation, within a mosaic of other vegetation structure, provide structural microhabitat suitable for both basking and as cover to escape predation.

Implications for Habitat Management

The management of understorey and canopy vegetation is important in managing habitat for snakes (Pringle et al., 2003). Unmanaged habitats with mature, tall stands of woody vegetation, and continuous canopy cover, may lack basking sites. A mosaic of vegetation heights enhances thermoregulatory opportunities and provides protective cover (Tracey & Christian, 1986; House & Spellerberg, 1983). However, habitat requires particularly careful management near hibernacula because loss of vegetation here can increase predation pressure on adders following spring emergence (Phelps 2004; 2007). Management may therefore have to include cessation of spring fires at known sites of hibernacula and adopt alternative management methods. Habitat management should seek to maintain or create a mosaic habitat at adder hibernacula, where both open basking areas and mature cover are available (House & Spellerberg, 1983).

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