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TREE AND SUBSTRATE SELECTION IN THE SEMI-ARBOREAL SCINCID LIZARD *EUMECES LATICEPS*

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Broad-headed skinks occupied a range of substrates during the daily activity period. Although they foraged and engaged in social behaviour on the ground, two-thirds of individuals were initially observed on trees and other vertical surfaces. In using both trees and ground as sites for foraging and social activities, these skinks are similar in microhabitat use to trunk-ground anoles. Substrate occupation differed significantly between adults and juveniles, adults occurring more frequently on oaks and ground, juveniles on walls, pine trees, and palmettos. Adult males and females had substantially, but not quite significantly different substrate distributions. The lizards occupied oak trees much more frequently than expected by chance, strongly preferring them to palmettos and pines. There is some evidence that they may actively avoid pines. No significant differences were detected in perch height among age and sex categories during the daily activity period, but sample sizes were small and differences might occur at other times of day or in other seasons.

INTRODUCTION

Numerous studies have been published on habitat selection among arboreal lizards in the polychrid genus *Anolis* (e.g. Rand, 1964, 1967; Andrews, 1971; Schoener & Schoener, 1971*a,b*). Most of these studies have dealt with differences in habitat distribution among species. Studies of the ecological distribution of arboreal lizards in the United States are few (e.g. Vitt, Van Loben Sels, & Ohmart, 1981); these also deal with differences in microhabitat among species. A group of North American lizards that contains species that tend to be arboreal, at least much of the time, is the scincid genus *Eumeces*. Here we report preliminary data on habitat selection in the broad-headed skink, *Eumeces laticeps*, studied in the southern part of its range during the breeding season in May and later in activity season in July.

Over its wide geographical range in the eastern United States, the broad-headed skink, *E. laticeps*, occupies forests having diverse soil types and moisture conditions (Cooper & Vitt, 1987*a*). This species forages on the ground and trees (Vitt & Cooper, 1986) and uses trees to escape from terrestrial predators, for shelter sites, and for nest sites. Here we provide data showing a strong preference for oaks and a preliminary characterization of the degree of arboreality, as indicated by perch height and types of substrates occupied by broad-headed skinks when first observed during the period of maximum daily activity.

METHODS

All observations were made on Kiawah Island, Charleston County, South Carolina between 1000 and 1530 hr (EDST) on 13-14 July 1982 and on 13 and 14 May 1983. The habitat was edificarian, consisting of a mixture of buildings, forest, and edge. To find lizards we walked slowly through each area once, attempting to carefully scan all trees, walls, ground, bushes, and other substrates in the area. Substrates on which lizards were observed were categorized as trees, other vertical surfaces such as walls, ground, and other. We also recorded perch height when first sighted for many individuals.

To obtain data to test the relationship between lizards and tree types, the number of large trees (diameter $\geq$ 15 cm) were counted in an open, wooded region of unmeasured area (approximately 2 ha) supporting a dense population of lizards on Seabrook Island, Charleston County, South Carolina on 13 May 1987. This area was a disturbed, largely cleared site surrounded by climax forest. After counting the trees, one of us surveyed the area once for skinks either on trees when first observed or fleeing to trees when disturbed, noting the types of trees for each lizard.

Significance of differences in (1) substrate types among age and sex groups and (2) occupation of tree species by lizards from randomness were assessed by chi-squared tests. We examined the data on perch height for differences between sexes and age groups of lizards and between tree types by conducting Mann-Whitney *U* tests. All statistical tests were two-tailed with $\alpha=0.05$.

RESULTS AND DISCUSSION

SUBSTRATES OCCUPIED

Nearly two-thirds of broad-headed skinks were observed on trees and other vertical surfaces (sample sizes given in Fig. 1). Forty-two percent were on oaks and 22 percent were on other vertical surfaces, giving a total of 65 percent on trees and vertical surfaces during the daily activity period in May and July. The other 35 percent were on the ground. Our observations suggest that many adults spend the night in trees or logs and descend to the ground early in the daily activity period. During the day, the lizards move across the ground and climb trees other than the ones in which they spent the night. During June and early July, females spend most of their time in cavities of trees guarding their eggs (Vitt & Cooper, 1985). Broad-headed skinks are semiarboreal because much of their foraging and social behavior occurs on the ground (Vitt and Cooper, 1986; Cooper, unpublished data). However, most individuals, especially adults, spend their nights and a substantial fraction of their days in trees. *Eumeces laticeps* is similar in its relative use of ground and trees to the trunk-ground ecomorph of anoles (Williams, 1972, 1976).

Statistical association between lizards and substrate types could not be assessed because data on numbers and areas of the various types of substrates were not collected. However, it was possible to compare the distributions of substrate types occupied among age and sex groups. Comparison of the distributions of adult males, adult females, and juveniles on substrates shows an apparently greater diversity of substrate types for juveniles (Fig. 1). If the 'other' substrate category is omitted and the pine, wall and palmetto categories are pooled to meet the requirements for minimal expected frequencies, there is a significant difference among the distributions for the age and sex categories ($\chi^2=12.74$, df=4, $P<0.05$).

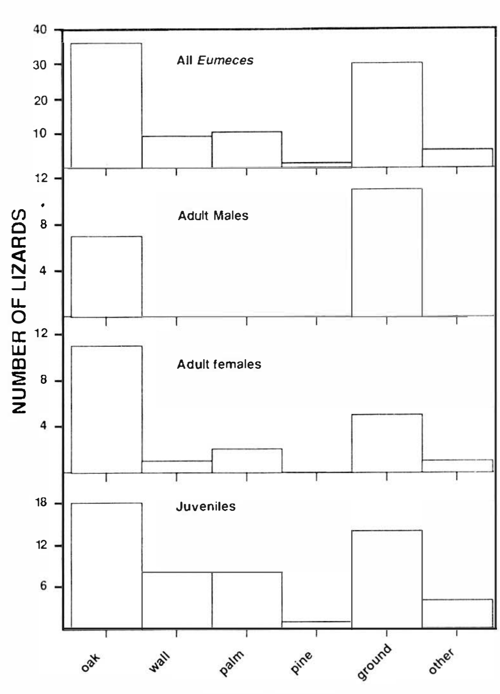

FIG. 1. Substrate types occupied by broad-headed skinks.

The major difference is between adults and juveniles, with a greater proportion of juveniles being observed on the pooled wall, palmetto, and pine category, i.e. vertical surfaces other than oaks, and lower proportions of juveniles being found on oaks and on the ground (Fig. 1). The statistical test underestimates the true difference due to the higher proportion of juveniles than adults occurring on 'other' substrates. Observations in the other category were as follows: adult males, none; adult females, one in a snake's mouth; and juveniles, two trapped in spider webs, one on a grapevine, and one on a human body (it had crawled onto a person who was standing still). Predations by spiders, in a reversal of the predator prey-relationship between spiders and older immature and adult skinks, may be a major source of mortality to hatchling skinks.

Further examination of the data required additional pooling to attain the minimal expected cell frequencies for chi-squared tests. A comparison of male and female distributions was conducted using two substrate categories, ground and a pooled vertical category (all tree types and walls). Although the distributions differ substantially, they do not differ significantly ($\chi^2=4.56$, df=1, $P=0.07$). Even using the Fisher exact test, which is sometimes preferred with small sample sizes, the difference is not quite significant ($P=0.057$). It would not be surprising if a real difference were found using a larger sample size. Females tend to be warier and more difficult to catch than males, in part because they are more often on or close to trees when first observed (Cooper, Vitt, Hedges, & Huey, 1990).

Data for adults were pooled in the three substrate categories used in the initial analysis for comparison with data for juveniles. The pooled adult and juvenile distributions differ significantly ($\chi^2=7.42$, df=2, $P<0.05$). The major source of this difference is that juveniles are much more likely than adults to be found on vertical surfaces other than oaks, especially on walls and palmetto trees. When all vertical perches are pooled, including oaks, the distributions of adults and juveniles on vertical surfaces versus the ground do not differ significantly ($\chi^2=1.78$, df=1, $P>0.10$). Thus, the primary age difference in microhabitats is that juveniles use a greater diversity of vertical surfaces than adults, not in the tendency to be on the ground or on trees and other vertical surfaces. It is also likely that hatchlings use a greater variety of substrate categories, including some atypical for adults. However, the sample size is too small to test that hypothesis.

Possible reasons for the lower diversity of substrate types in adults include ontogenetic changes in preferences based on fixed developmental programs or learning by juveniles about the suitability of available microhabitats for feeding, climbing, avoidance of predators, etc. This could result in a gradual shift in substrate distribution as the skinks grow and suitable prey and perch sizes change. Another possible contributing factor is the elimination by predators of juvenile skinks that occupy atypical microhabitats.

Tree Species Occupied

At least in the southeastern part of its range, *E. laticeps* has been stated to be closely associated with hardwood trees (Cooper & Vitt, 1987*b*; Cooper, 1988), but this obvious association has not been demonstrated previously. At the study site there were numerous live oak trees (*Quercus virginiana*), palmettos (*Sabal palmetto*), pines (*Pinus sp.*), and one magnolia (*Magnolia sp.*, Table 1). The uncleared forest contained additional species. In the cleared area the vast majority of *E. laticeps* were initially observed on or fled to live oaks. This agrees with observations made over several years on Kiawah Island and Seabrook Island in both climax forests and partially cleared areas.

However the data are categorized, association between live oaks and lizards was very strong (Table 1). If the single magnolia is dropped from the analysis, leaving three tree categories, skinks were significantly more likely to be found on live oaks than on other trees (χ^2=36.81, df=2, P<0.001). A slightly higher chi-squared was obtained when the data were analyzed with the single magnolia pooled with the live oaks (χ^2=37.84, df=2, P<0.001). Lizards were also found at a significantly greater than chance frequency on hardwoods than on palmettos (χ^2=26.79, df=1, P<0.001) or pines (χ^2=11.43, df=1, P<0.001).

Taken strictly these data establish only that *E. laticeps* preferentially occupied oaks (hardwoods) in the area observed. However, the data substantiate our strong impression based on longterm observation at numerous sites that broad-headed skinks are found in close association with hardwoods. The precise basis for the preference remains to be determined, but two factors are clearly important: tree size and presence of refuges. The palmettos in the area observed were relatively small, not much over 0.3 m in diameter, which in part may account for the low frequency of use by skinks.

Tree size may have contributed to the observed distribution because many of the live oaks and the magnolia were the largest trees on the site. In many of the largest trees there were holes that offered refuges from predators and potential nest sites. Later in the season, a skink brooding eggs was found in a humus-filled cavity in one of the oaks counted in this study. As both sexes of *E. laticeps* frequently may be observed basking, climbing, foraging, and using holes in oaks, it seems quite likely that the lizards actively select these trees. In contrast to their apparent attraction to oaks and perhaps other large hardwoods, broad-headed skinks may actively avoid pines. Only occasionally have we observed adults or juveniles on pines. On the study site were numerous pines with diameters greater than those of some live oaks frequented by skinks. An anecdotal observation provides a probable reason for the low frequency of occupancy of pines. An adult male *E. laticeps* observed on 12 May 1987 on Kiawah Island moved from the ground toward a very large pine (diameter >0.75 m) as one of us (WC) slowly approached. The pine was the only tree within 15 m. The male began to climb slowly and with uncharacteristic awkwardness. Broad-headed skinks, including the male, typically climb trees in an upward spiral in the manner of squirrels when attempting to evade pursuing birds or human beings who move around the base. As the male climbed, its progress appeared to be somewhat obstructed by the deep channels between adjacent raised areas of bark. Before the male reached a height of 1 m, its claws failed to grip the slick surface of a raised section of bark, causing the male to fall to the ground. In thousands of observations of *E. laticeps* climbing other types of trees, we have seen no other falls. It is very likely that the surface of large standing pines simply is not suitable for efficient climbing by these lizards.

The situation is less clear for palmettos. In climax forests with large palmettos, we have observed broad-headed skinks climbing large palmettos to the crown while foraging and fleeing from predators. They climb these trees with more finely grained bark normally; they find refuge and may forage among the large leaves of the crown. Undisturbed broad-headed skinks often voluntarily climb palmettos, but appear to use them much less frequently than live oaks, presumably due to the larger size and presence of cavities suitable as refuges and nest cavities in oaks.

	Number of trees	Number of lizards
Oak	178	30
Magnolia	1	1
Palmetto	171	1
Pine	66	0

TABLE 1. Numbers of trees and associated *Eumeces laticeps* in an area cleared of underbrush.

Perch Height

Perch heights for both sexes of adults and juveniles on various substrate types are presented in Table 2. Perch heights of adult males and females did not differ significantly on oaks (Mann-Whitney U=18.5; n=6, 10; P>0.10). The perch height on oaks of pooled adults was

	Oak	Wall	Palm	Pine	Ground	Other
Adult male						
$\bar{x}$	0.5	-	-	-	0.0	-
SD	0.3	-	-	-	0.9	-
Adult female						
$\bar{x}$	1.3	1.0	2.0	-	0.0	0.0
SD	1.0	-	0.0	-	0.0	0.0
Juvenile						
$\bar{x}$	1.1	1.4	0.7	1.8	0.0	0.1
SD	0.8	0.9	0.6	-	0.0	1.2

TABLE 2. Substrate types and perch heights (m) occupied by broad-headed skinks.

not significantly different from that of juveniles (U=130.5; n=16, 18; P>0.10). Perch heights of juveniles differed slightly on oaks and palms, but the difference did not quite attain significance (U=53.5; n=8, 18; 0.05<P<0.10). These small samples over a restricted time do not reveal any differences in perch height among age-sex groups, but such differences may exist at other times of day and in other portions of the activity season.

The time of day may have strongly affected the observations of perch height and substrate type because our impression is that broad-headed skinks frequently bask at greater perch height shortly after emergence in the morning before beginning to forage. Shortly after basking on warm days, broad-headed skinks climb down to the ground, where they forage. Therefore, the percentages observed in trees and on the ground vary with time of day. The limited samples also fail to reveal the entire range of perch heights at midday because we have observed adults of both sexes in trees at heights well over 10 m.

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