

HERPETOLOGICAL JOURNAL, Vol. 7, pp. 116-118 (1997)

SUBSTRATE SHIFTS IN A POPULATION OF STRIPED PLATEAU LIZARDS, *SCELOPORUS VIRGATUS*

GEOFFREY R. SMITH*

*School of Biological Sciences, University of Nebraska,
Lincoln, NE 68588-0118, USA*

** Present Address: Department of Biology, William
Jewell College, Liberty, MO 64068, USA*

Lizards may alter their orientation to the sun, or their location relative to the sun (e.g. shuttling between sun and shade) during the day to maintain a nearly constant body temperature (Waldschmidt, 1980; Middendorf & Simon, 1988; Martin, López, Carrascal & Salvador, 1995). Other lizards change habitats on a seasonal basis. For example, Galapagos land iguanas (*Conolophus pallidus*) use a cliff face (protected from wind) in the cool season and a plateau (windier) in the hot season (Christian, Tracy & Porter, 1983). Some of these shifts involve changing the substrate or perch used (Adolph, 1990; Castilla & Bauwens, 1991) or even changing the amount of incident solar radiation (Carrascal & Díaz, 1989; Díaz, 1992; Martin *et al.*, 1995). At a larger spatial scale, shifts can involve movements between broad habitat types (Christian *et al.*, 1983; Buttemer & Dawson, 1993). In this note, I consider whether substrate use in a population of the striped plateau lizard, *Sceloporus virgatus*, shifts across the activity season. In addition, I determine if there are similar

shifts in habitat and slope use, and if striped plateau lizards change their use of sunny and shaded microhabitats during the activity season.

The study site in the Chiricahua Mountains of SE Arizona (Cochise County) (see Smith, 1996a) was a 1.2 km stretch of an east to west creek-bed with north- and south-facing slopes. In addition, two habitat types existed on the study site: a woods habitat and a slide habitat. The slide habitats were open with few trees (30% of the study area), whereas the woods habitat had several trees and relatively closed canopies (70% of the study area). Mean monthly temperatures were obtained from the Southwestern Research Station (approximately 1.5 km from the study area).

I made observations on lizard habitat and substrate use from June to August, 1992, and from April to July, 1993 and 1994. I recorded the slope (north-facing or south-facing), habitat (woods or slide), and substrate (rock, log or ground) on which an individual was first observed, as well as whether the individual was first seen in full sun, a sun-shade mosaic, or full shade. Lizards were individually marked as they were also part of a mark-recapture study (Smith, 1996b).

Because I often had several observations per individual, to maintain independence of observations I randomly selected a single observation per individual per year to use in the analysis. This is particularly important because individual *S. virgatus* appear to have different preferences for slopes, habitats, and substrates (Smith, 1996a). To examine shifts in substrate, habitat, slope use, and sun/shade use, I broke down all observations by month (e.g. June, July, August for 1992; April, May, June, July for 1993 and 1994). Each year was ana-

TABLE 1. Monthly use of slopes (proportion on north-facing slopes), habitats (proportion in woods habitat), substrates (proportion on rock substrate), and microhabitats (proportion in full sun) by *Sceloporus virgatus* in the Chiricahua Mountains of SE Arizona. Total number of individuals per month given in parentheses. Statistics reported in text conducted on raw scores, not on proportions given here. * indicates that the shift was significant at an α -value of 0.0167.

	April	May	June	July	August
Slope					
1992	—	—	0.43 (122)	0.48 (101)	0.40 (37)
1993	0.44 (85)	0.34 (91)	0.57 (86)	0.49 (45)	—
1994	0.35 (60)	0.48 (128)	0.48 (73)	0.52 (27)	—
Habitat					
1992	—	—	0.68 (122)	0.67 (101)	0.65 (37)
1993	0.70 (85)	0.72 (91)	0.70 (86)	0.58 (45)	—
1994	0.79 (61)	0.68 (127)	0.63 (71)	0.70 (27)	—
Substrate					
1992*	—	—	0.49 (120)	0.25 (101)	0.16 (37)
1993*	0.72 (85)	0.59 (90)	0.49 (84)	0.49 (45)	—
1994*	0.80 (61)	0.56 (128)	0.49 (72)	0.48 (25)	—
Microhabitat					
1992	—	—	0.38 (98)	0.31 (84)	0.57 (28)
1993*	0.63 (78)	0.49 (67)	0.18 (83)	0.28 (29)	—
1994*	0.71 (58)	0.41 (113)	0.16 (62)	0.09 (23)	—

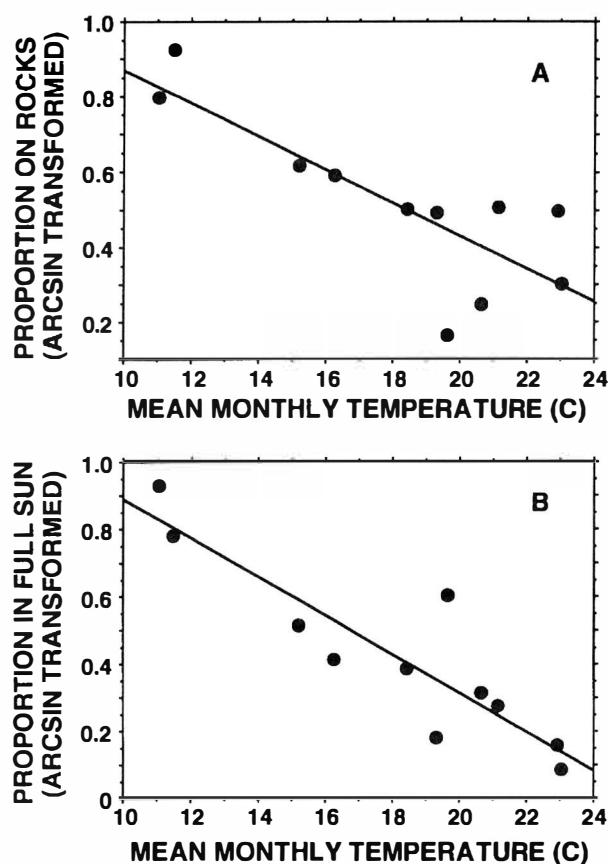


FIG. 1. (A) The inverse relationship between mean monthly temperature and the proportion (arcsine transformed) of *Sceloporus virgatus* using rock substrates. See text for statistics and equation. (B) The inverse relationship between mean monthly temperature and the proportion (arcsine transformed) of *Sceloporus virgatus* using sunny microhabitats. See text for statistics and equations.

lysed separately. Preliminary analyses of males and females separately found no significant differences between them ($P > 0.05$), thus males and females were pooled for this study. I used chi-square tests to compare lizard distributions between months within a year. I used a corrected α -value of $0.05/3 = 0.0167$ to adjust for multiple tests on each data set.

In all three years, habitat use did not shift between months (Table 1; 1992: $df = 2$, $\chi^2 = 0.13$, $P = 0.94$; 1993: $df = 3$, $\chi^2 = 3.31$, $P = 0.35$; 1994: $df = 3$, $\chi^2 = 3.86$, $P = 0.28$). In 1992 and 1994, monthly slope use did not differ (Table 1; 1992: $df = 2$, $\chi^2 = 0.92$, $P = 0.63$; 1994: $df = 3$, $\chi^2 = 3.71$, $P = 0.29$). In 1993, there was a nearly statistically significant shift, with fewer individuals using north-facing slopes than expected in May (Table 1; $df = 3$, $\chi^2 = 9.71$, $P = 0.02$).

Shifts in substrate use were apparent and significant in all three years of the study (Table 1; 1992: $df = 4$, $\chi^2 = 25.66$, $P < 0.0001$; 1993: $df = 6$, $\chi^2 = 25.44$, $P = 0.0003$; 1994: $df = 6$, $\chi^2 = 21.37$, $P = 0.002$). In all years, the use of rock substrates decreased, while the use of ground substrates – and to some extent log substrates – increased as the activity season progressed. The

proportional use of rock substrates (arcsine transformed) decreased linearly with mean monthly temperatures (Fig. 1A; $n = 11$, $r^2 = 0.65$, $P = 0.004$; $y = 1.31 - 0.044x$).

Monthly changes in the use of sun, sun/shade mosaic, and shade microhabitats were not significant in 1992, but highly significant in 1993 and 1994 (Table 1; 1992: $df = 4$, $\chi^2 = 9.60$, $P = 0.048$; 1993: $df = 6$, $\chi^2 = 41.8$, $P < 0.0001$; 1994: $df = 6$, $\chi^2 = 48.7$, $P < 0.0001$). Individuals tended to use sunny microhabitats in April and May, and shaded microhabitats in June and July. The proportional use of sunny microhabitats (arcsine transformed) was inversely related to the mean monthly temperature (Fig. 1B; $N = 11$, $r^2 = 0.80$, $P = 0.0002$; $y = 1.46 - 0.057x$).

Sceloporus virgatus show shifts in substrate and microhabitat use (i.e. amount of sun), but not in habitat and slope use. The evidence presented here suggests that substrate and microhabitat shifts are related to thermoregulation. As environmental temperatures rise there is a concomitant decrease in the use of rocks and sunny microhabitats. Different perches and microhabitats generally provide different thermal and microclimatic conditions (Bakken, 1989), and thus the *S. virgatus* in this population may change their substrate and microhabitat use to maintain a constant body temperature throughout the activity season. Indeed, *S. virgatus* in the Chiricahua Mountains maintain a relatively constant body temperature despite widely varying air temperatures (Smith & Ballinger, 1994). Using rocks during the warmer months may cause *S. virgatus* to have body temperatures higher than the preferred temperature, as individual *S. virgatus* on rocks tend to have higher body temperatures than individuals on ground substrates (Smith & Ballinger, 1994). Therefore, the decrease in the use of rock substrates is consistent with a thermoregulatory function. The shift away from sunny microhabitats is also consistent with a thermoregulatory explanation, as has been seen in other lizards (Van Damme, Bauwens & Verheyen, 1987; Carrascal & Díaz, 1989; Castilla & Bauwens, 1991). Similar shifts on an hourly basis (i.e. use sunny substrates less during the heat of the day) occur in other lizard species (e.g. Waldschmidt, 1980).

My results, while strongly suggesting a thermoregulatory explanation for the observed shifts, do not exclude the possibility that other environmental factors are driving the observed substrate and microhabitat shifts. First, the shifts may result from the lizards following their insect prey as they shift microhabitats or substrates. In this case, it would be the insects that are thermoregulating and the lizards who are following along. I do not believe this is as likely as thermoregulation to explain the shift because of the scale of the shifts and the foraging behaviour of *S. virgatus*. The shifts observed here occur over a scale of 1-2 m, much smaller than the home range of these lizards (Smith, 1995), and *S. virgatus* are sit-and-wait type foragers

that forage from a perch, and may run through other substrates or microhabitats to capture prey (*pers. obs.*). Thus, the food explanation might be more likely to explain a habitat or slope shift than a substrate or microhabitat shift. Another possibility is that these are shifts associated with mating behaviour or with females carrying eggs. While possible, the fact that males and females did not differ in their shifts in substrate or microhabitat (preliminary results mentioned above), suggests that the sexes were not behaving differently, at least as far as substrate and microhabitat use were concerned. Other non-thermoregulatory explanations exist, such as the shifts accompanying changes in anti-predator behavior, but no data exist to evaluate them.

In conclusion, *S. virgatus* alter their substrate and microhabitat (i.e. sunny vs shaded microhabitats) use throughout their activity season. These shifts appear to be closely linked to environmental temperatures and are likely tied to thermoregulation (but other factors may be involved: see above). Ultimately, the observed shifts may increase daily and seasonal activity periods with ramifications for the lizard's life history and ecology.

Acknowledgments. R. Ballinger and anonymous reviewers made helpful comments on early versions of this manuscript. The Southwestern Research Station provided the temperature data and logistic support. Financial support was provided by the National Science Foundation, the American Museum of Natural History, and the University of Nebraska. Some logistic support during manuscript preparation was provided by the Kellogg Biological Station (Michigan State University).

REFERENCES

- Adolph, S. C. (1990). Influence of behavioral thermoregulation on microhabitat use by two *Sceloporus* lizards. *Ecology* **71**, 315-327.
- Bakken, G. S. (1989). Arboreal perch properties and the operative temperature experienced by small animals. *Ecology* **70**, 922-930.
- Buttemer, W. A. & Dawson, W. R. (1993). Temporal pattern of foraging and microhabitat use by Galápagos marine iguanas, *Amblyrhynchus cristatus*. *Oecologia* **96**, 56-64.
- Carrascal, L. M. & Díaz, J. A. (1989). Thermal ecology and spatio-temporal distribution of the Mediterranean lizard *Psammmodromus algirus*. *Holarct. Ecol.* **12**, 137-143.
- Castilla, A. M. & Bauwens, D. (1991). Thermal biology, microhabitat selection, and conservation of the insular lizard *Podarcis hispanica atrata*. *Oecologia* **85**, 366-374.
- Christian, K., Tracy, C. R. & Porter, W. P. (1983). Seasonal shifts in body temperature and use of microhabitats by Galapagos land iguanas (*Conolophus pallidus*). *Ecology* **64**, 463-468.
- Díaz, J. A. (1992). Choice of compass directions around shrub patches by the heliothermic lizard *Psammmodromus algirus*. *Herpetologica* **48**, 293-300.
- Martin, J., López, P., Carrascal, L. M. & Salvador, A. (1995). Adjustment of basking postures in the high-altitude Iberian rock lizard (*Lacerta monticola*). *Can. J. Zool.* **73**, 1065-1068.
- Middendorf, G. A. & Simon, C. A. (1988). Thermoregulation in the iguanid lizard *Sceloporus jarrovi*: the influence of age, time, light conditions on body temperature and thermoregulatory behaviors. *Southwest. Nat.* **33**, 347-356.
- Smith, G. R. (1995). Home range size, overlap, and individual growth in the lizard, *Sceloporus virgatus*. *Acta Oecol.* **16**, 413-421.
- Smith, G. R. (1996a). Habitat use and fidelity in the striped plateau lizard *Sceloporus virgatus*. *Am. Midl. Nat.* **135**, 68-80.
- Smith, G. R. (1996b). Annual life history variation in the striped plateau lizard, *Sceloporus virgatus*. *Can. J. Zool.* **74**, 2025-2030.
- Smith, G. R. & Ballinger, R. E. (1994). Thermal ecology of *Sceloporus virgatus* from southeastern Arizona, with comparison to *Urosaurus ornatus*. *J. Herpetol.* **28**, 65-69.
- Van Damme, R., Bauwens, D. & Verheyen, R. F. (1987). Thermoregulatory responses to environmental seasonality by the lizard *Lacerta vivipara*. *Herpetologica* **43**, 405-415.
- Waldschmidt, S. (1980). Orientation to the sun by the iguanid lizards *Uta stansburiana* and *Sceloporus undulatus*: hourly and monthly variations. *Copeia* **1980**, 458-462.

Accepted: 1.2.97