CORRELATES OF APPROACH DISTANCE IN THE STRIPED PLATEAU LIZARD (*SCELOPORUS VIRGATUS*)

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Animals often exhibit state-dependent behaviour, i.e. behaviour that depends on their present situation or state. In lizards, escape behaviour appears to be state-dependent and several factors affect it. Tail loss influenced escape behaviour in *Scincella lateralis*. Lizards without tails permitted a model predator to approach closer than lizards with tails (Formanowicz, Brodie, & Bradley, 1990). Snell, Jennings, Snell, & Harcourt (1988) found that *Tropidurus albemarlensis* in vegetatively complex habitats were less wary (i.e., had shorter approach and flight distances) than individuals in less complex habitats, presumably because of reduced exposure to predators. Bulova (1994) obtained similar results when comparing populations of *Callisaurus draconoides*. Similarly, Martín and López (1995a,b) found that approach distances and flight distances of *Psammodromus algirus* were shorter in more open habitats and microhabitats.

Body temperature can also influence lizard escape behaviour. *Anolis lineatopus* flee at greater distances when they are cool and allow a predator to approach closer when they are warm (Rand, 1964). Other lizards flee farther or to different microhabitats at different temperatures (Losos, 1988). Several species of lizards become more aggressive at lower body temperatures, and will attempt to flee at higher body temperatures (Hertz, Huey, & Nevo, 1982; Crowley & Pietruszka, 1983; Mautz, Daniels, & Bennett, 1992). Escape behaviour in gravid females involves crypsis (as opposed to more active behavior in non-gravid females) in *Eulamprus tympanum* (Schwarzkopf & Shine, 1992), *Lacerta vivipara* (Bauwens & Thoen, 1981), *Podarcis muralis* (Braña, 1993) and *Callisaurus draconoides* (Bulova, 1994). Lizards can also learn to avoid predators, and have been shown to flee more quickly after just one capture (Marcellini & Jenssen, 1991). Other important factors influencing lizard escape behaviour include distance to cover (Bulova, 1994), the approach behaviour of the predator (e.g., direct or tangential; Burger & Gochfeld, 1990; Burger, Gochfeld & Murray, 1991; Bulova, 1994), the physical appearance of the predator (e.g., eye size, Burger, Gochfeld & Murray, 1991; exposed face, Burger & Gochfeld, 1993), the age or size of the lizard (Martín & López, 1995b) and the presence of efficient predators (e.g., cats; Stone, Snell, & Snell, 1994). In this study, I examined the escape behaviour of the striped plateau lizard, *Sceloporus virgatus* Smith, from a population in the Chiricahua Mountains of southeastern Arizona.

Sceloporus virgatus is a common terrestrial lizard in the pine-oak woodlands of the Chiricahua Mountains. It is most often found on rock and log substrates (Smith, 1995). The study area was located in the Coronado National Forest, 2.5 km SW of the Southwestern Research Station in the Chiricahua Mountains of southeastern Arizona. The area consisted of a 1.2 km section of pine-oak woodland in a creekbed with north and south facing slopes. Two types of habitat were identified along the study site: (1) a woods habitat consisting primarily of rocks and trees, and (2) a slide habitat consisting primarily of slopes covered with bare rock or gravel with sparse grass clumps and occasional trees and larger rocks. Common predators observed on the study site include birds (Mexican Jays) and snakes (black-tailed rattlesnakes, mountain king snakes, and bullsnakes). This study took place during the third year of an intensive mark-recapture study on this population (Smith, 1995).

I measured approach distance by slowly and directly approaching a stationary and undisturbed lizard at a constant speed and estimating the distance at which the lizard first fled from my approach (to nearest 0.1 m). In addition to approach distance, I recorded the substrate (rock or log), habitat (woods or slide), and slope (north- or south-facing) the individual was initially observed on or in. Body size (SVL) from the most recent capture was used in analyses. Mark-recapture studies allowed me to assess reproductive condition of females (i.e., gravid or non-gravid), and to assess whether the individual's tail had ever been broken (i.e., freshly broken or regenerated tails), as well as to record the number of days since the last capture and how many times an individual had been previously captured in the current season. Assumptions of parametric analyses (normality and homogeneity of variances) were not violated, and therefore parametric analyses were used. Means are given $\pm$ one standard error.

A total of 71 independent observations was made (i.e., one measurement per individual). In most cases, individuals ran to the nearest cover (e.g., under a rock). Also, it appeared that the approached lizards were aware of my presence well before flight because their heads were often turned towards me as I approached.

Substrate ($F_{1,68} = 1.66$, $P = 0.20$), habitat ($F_{1,70} = 0.21$, $P = 0.64$), and slope ($F_{1,70} = 0.04$, $P = 0.84$) had no significant effects on flight distance (see Table 1 for means). Sex ($F_{1,69} < 0.001$, $P = 0.99$) and reproductive

TABLE 1. Mean (± 1 SE) approach distance for *Sceloporus virgatus* in the Chiricahua Mountains of southeastern Arizona by substrate, habitat, slope, sex, reproductive state (females only), and tail condition.

	N	Approach distance (m)
Substrate		
Rock	41	2.1 ± 0.2
Log	28	1.8 ± 0.2
Habitat		
Woods	55	2.0 ± 0.2
Slide	17	1.9 ± 0.2
Slope		
North-facing	43	2.0 ± 0.1
South-facing	29	1.9 ± 0.2
Sex		
Male	38	2.0 ± 0.2
Female	33	2.0 ± 0.2
Reproductive State		
Gravid	21	1.9 ± 0.2
Non-gravid	12	2.2 ± 0.3
Tail Condition		
Broken	21	1.4 ± 0.2
Whole	50	2.2 ± 0.2

state ($F_{1,31}$ = 0.53, P = 0.47) also had no significant effect (see Table 1 for means). Approach distance was not related to SVL (linear regression: N = 71, r^2 = 0.001, P = 0.84), and number of days since last capture (N = 65, r^2 = 0.014, P = 0.35). However, approach distance was negatively related to the number of previous captures in 1994 (N = 71, r^2 = 0.14, P = 0.002; y = 2.7 - 0.46x), but little of the variation (14%) in approach distance was explained. Individuals that had broken tails allowed me to approach closer than individuals that did not have broken tails (Table 1; $F_{1,69}$ = 11.26, P=0.001).

This study suggests that striped plateau lizards alter their escape behaviour as a function of their current state (i.e., whether the individual has broken its tail in the past or not). In cases where female sprint speed is decreased by being gravid, females often rely more on cryptic behaviour than flight responses (Bauwens & Thoen, 1981; Schwarzkopf & Shine, 1992). Tail loss can decrease sprint speed in lizards (Ballinger, Nietfeldt, & Krupa, 1979; Punzo, 1982; Dial & Fitzpatrick, 1984), thus if tail loss decreases sprint speed in *S. virgatus*, individuals with tail breaks may assume a more cryptic behavior and allow predators to approach closer before fleeing. Indeed, Formanowicz *et al.* (1990) have experimentally demonstrated this scenario in the ground skink, *Scincella lateralis*. In addition, tail loss can lead to different patterns of microhabitat use which compensate for reduced speed by decreasing the distance to refuges (Martín & Salvador, 1993). I predict then that a shift to a more cryptic anti-predator strategy among lizards that have lost their tails will be a common strategy in terrestrial lizards, such as many sceloporines and skinks. The role of tail loss in the escape behaviour of arboreal lizards is largely unknown at this time. However, in species that use their tail for balance (e.g., *Anolis carolinensis*; Ballinger, 1973), a cryptic anti-predator strategy will probably also occur.

One alternative explanation might be that individuals that allow predators to approach more closely are more likely to lose their tails, thus the relationship between tail loss and antipredator behaviour is reversed from the scenario discussed above (Burger & Gochfeld, 1990). Another alternative explanation is that individuals learn from previous encounters with predators (assuming tail loss associated with predation), and use a different escape strategy after encountering a predator. This explanation is supported by the decrease in approach distance with an increase in the number of previous captures for an individual. To differentiate between these alternative hypotheses experiments involving manipulation of tail loss, and on the effect of tail loss on sprint speed in *S. virgatus* are needed.

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