

FORAGING BEHAVIOR OF *UTA STANSBURIANA* AND *CNEMIDOPHORUS TIGRIS* IN TWO DIFFERENT HABITATS

DAVID K. PETERSON AND WALTER G. WHITFORD

ABSTRACT—Foraging behavior of *Uta stansburiana* and *Cnemidophorus tigris* was studied in two different habitats in the Chihuahuan Desert. One habitat was "natural" Chihuahuan Desert dominated by shrubs. The other habitat had been modified with herbicide and was dominated by sub-shrubs and grasses. *Uta stansburiana* exhibited no preference for plant species or life forms when foraging in either habitat. Foraging *C. tigris* preferentially used mesquite (*Prosopis glandulosa*) and, to a lesser extent, creosotebush (*Larrea tridentata*) in the natural habitat. In the grass-dominated habitat, *C. tigris* used bush muhly (*Muhlenbergis porteri*). *Cnemidophorus tigris* spend more time foraging under plants with large litter accumulations. Shifts in vegetation from grassland to shrubland appear to favor *C. tigris*.

In the American Southwest, major habitat changes occurred during the late 1800's and early 1900's when desert grasslands were degraded into desert scrub (York and Dick-Peddie, 1969). Studies of lizards indicate that habitat structure affects lizard diversity and abundance. Reynolds (1979) and Wershkul (1982) noted that converting a sagebrush desert to crested wheatgrass reduced the diversity and density of lizard populations. Reynolds (1979) and Jones (1981) indicated that heavy grazing by cattle reduced the diversity and abundance of lizard populations. Ballinger and Jones (1985) concluded that moderate grazing pressure tended to increase lizard diversity in a Nebraska sandhills habitat. Germano and Hungerford (1981) reported that a reduction in the density of shrubs and an increase of grass cover resulted in a reduction in reptile sightings.

Whitford et al. (1978) reduced shrub cover in a shrub-dominated desert community in southern New Mexico by application of a defoliating herbicide which produced a marked increase in the cover of bunch grasses. This study site offered an opportunity to test hypotheses concerning the effects of habitat modification on lizard communities and the behavior of species occurring in these habitats. If habitat structure is important as a determinant of assemblages of lizard species, it is plausible to assume that changes in vegetation will result in shifts in behavior of the lizard species that occupy modified habitats.

We hypothesized that the differences in grass and shrub cover on the area affected by shrub defoliation would result in changes in the foraging behavior of lizards when compared to the behavior of the same species on a natural area. *Uta stansburiana* and *Cnemidophorus tigris* were selected for observation because of their abundance on both plots.

MATERIALS AND METHODS—The study area was located 40 km NE of Las Cruces, Dona Ana Co., New Mexico, on the U.S.D.A. Jornada Experimental Range. The area was located in the Chihuahuan Desert on the lower slopes of a bajada. The region was dominated by desert shrubs and is lightly grazed by cattle. Yearly precipitation averaged 200 mm.

A 9-ha site was sprayed in 1972 with the herbicide Dicamba. That treatment resulted in reduced shrub cover and an increase in grass cover (Whitford et al., 1978). Our study used one randomly selected hectare of this site, and another hectare, approximately 200 m west of the sprayed areas, was chosen randomly as the "natural" (untreated) plot. Shrubs (*Larrea tridentata*, *Flourensia cernua*, and *Prosopis glandulosa*) were the most visible vegetation on the natural plot. The dominant vegetation on the modified plot (treated area) appeared to be sub-shrubs (*Xanthocephalum sarothrae* and *Zinnia acerosa*) and grasses (*Muhlenbergia porteri*, *Sporobolus flexuosus*, and *Erioneuron pulchellum*).

We estimated plant cover in three 5 by 100 m belt transects by measuring the diameters of plants within each belt. To estimate the population density of lizards on the plots and to identify individual lizards, a grid of 100 pitfall traps spaced 10 m apart was placed in each plot. Lizards were captured in traps during May, July, and September 1984. *Uta stansburiana* and *Cnemidophorus tigris* were paint-marked with Testor's enamel for field identification.

A 2.4-m tall observation tower was placed in the center of each plot. The towers afforded a view of the entire plot without disturbing lizard activity. During June, July, and September 1984, lizards were observed using 7x35 binoculars, and their behavior was recorded on a portable tape recorder for later transcription. We recorded species, sex, location on the plot (including plant species at location), type of activity (e.g., feeding, basking, etc.), duration of activity, time, air temperature, date, and weather conditions. If a paint-mark was visible, the identifying color code was recorded as was any incidental information.

Behavioral observations were conducted from 0.5 h after sunrise until approximately midday, when lizard activity ceased because of high temperatures. Several attempts were made to obtain data on late afternoon activity, but inclement weather (thunderstorms) hampered these efforts.

Because the duration of activity data were skewed and inappropriate for parametric and nonparametric analyses, no statistical analysis was performed on these data, and they are presented as frequency and duration of activity under each species of plant. The durations were divided into two classes: 1) observations less than 10 s, and 2) observations 10 s or longer. We chose this division because, when *C. tigris* remained under a plant for 10 s or less, there was no searching behavior. Thus, stops of 10 s or less were interpreted as stops to use cover not to search for food. Since *U. stansburiana* is largely a sit and wait predator, duration of stay under or in a given plant provided no useable information.

RESULTS—Vegetation—Total cover differed little between plots (Table 1), but the percentage cover of *F. cernua* (tarbush) and *L. tridentata* (creosotebush) was lower on the modified plot than on the natural plot, and the percentage cover of *M. porteri* (bush muhly) and *X. sarothrae* (snakeweed) was greater on the modified plot than on the natural plot (Table 1). Bush muhly occurred at the base of shrubs on the natural plot. On the modified plot, bush muhly grew in large clumps that often had dead creosotebushes in their center. Snakeweed occurred between existing shrubs and bush muhly grass clumps on the modified plot. Few snakeweed plants were present on the natural plot (Table 1).

Percentage cover of *P. glandulosa* (mesquite) was nearly the same for both plots (Table 1). Several dead and many young mesquite were recorded on the modified plot. Of the 47 plants measured, 38 were less than 100 cm in diameter. On the natural plot, all mesquite plants were alive and, of the 18 measured, all were greater than 100 cm in diameter.

Trap Results—Pitfall trap results showed that *U. stansburiana* and *C. tigris* were the most abundant lizards on both plots. More *U. stansburiana* were captured on the modified plot (246) than on the natural plot (194). Fewer *C. tigris* were captured on the modified plot (117) than on the natural plot (153).

Behavioral Data—In most observations of *U. stansburiana*, the lizard sat under vegetation and surveyed the surrounding area. When *Uta* saw an

TABLE 1—Absolute percent cover and mean number of perennial plants per hectare on the study plots.

Species	Modified		Natural	
	Percent cover	Mean number	Percent cover	Mean number
<i>Larrea tridentata</i> (shrub)	4.2	447	21.4	1,247
<i>Prosopis glandulosa</i> (shrub)	3.5	313	2.3	120
<i>Flourenzia cernua</i> (shrub)	0.5	100	5.3	713
<i>Xanthocephalum sarothrae</i> (sub-shrub)	8.8	3,313	0.3	193
<i>Muhlenbergia porteri</i> (grass)	10.6	1,693	2.2	740
Sum, all other plants	0.6	3,357	0.5	510
Total, all other plants	28.2	9,223	32.0	3,523

arthropod it would dash from its location, capture the prey, and return to its original location. *Uta stansburiana* occasionally captured insects when moving from plant to plant. These movements frequently covered a circular area, and after visiting several plants, the lizard returned to the location where it was originally observed. *Uta stansburiana* was considered to be basking when sitting in direct sunshine or partial shade. A lizard sitting in full shade with its eyes closed was considered to be resting.

Foraging behavior of *C. tigris* on both plots invariably consisted of movement from plant to plant and around the perimeter or through the base of a plant. Some *C. tigris* travelled occasionally over 50 m in less than 10 min. Occasionally, *C. tigris* climbed into tarbush or bush muhly and crawled among the branches for several seconds. Similar behavior was reported by Echternacht (1967), Pianka (1970), and Mitchell (1979). There were nine observations of *C. tigris* digging in open areas, but only two times were these efforts rewarded by finding prey.

Uta stansburiana used plants on both plots in proportion to the available cover of perennial plants on the site with χ^2 values for observed frequency of use and expected frequency based on plant cover varying between 0.50 and 0.14 ($P > 0.05$; χ^2 critical = 9.49). On the natural plot *C. tigris* used mesquite more than expected and creosotebush less than expected in proportion to the percent cover of the vegetation present (Table 2). *Cnemidophorus tigris* used plant species in relation to the cover available on the modified plot (Table 3).

Foraging bouts of *C. tigris* under creosotebush, mesquite, and bush muhly were predominately longer than 10 s on the modified plot (Table 4). Long and short foraging bouts under tarbush and snakeweed were equally frequent. Foraging bouts of *C. tigris* on the natural plot were longer under creosotebush and mesquite than under tarbush, where there were an equal number of long and short duration bouts (Table 3). No foraging bouts under snakeweed or bush muhly were recorded on the natural plot because of the low frequency of these plants.

TABLE 2—Analysis of data for foraging behavior of *Cnemidophorus tigris* on the modified and natural plots. Expected values are based upon relative plant cover and tests the hypothesis that the number of lizards foraging under the various life forms are proportional to the relative plant cover. An asterisk indicates significances at $P < 0.05$ (χ^2 critical = 9.49, $d.f. = 4$).

Plant	Modified			Natural		
	Observed	Expected	χ^2	Observed	Expected	χ^2
<i>Larrea tridentata</i>	33	35	0.11	54	71	4.07
<i>Prosopis glandulosa</i>	35	30	0.83	20	8	18.00*
<i>Flouencia cernua</i>	3	4	0.25	23	18	1.39
<i>Xanthocephalum sarothrae</i>	77	75	0.05	0	0	0.00
<i>Muhlenbergia porteri</i>	87	91	0.18	0	0	0.00
Total	235	235	1.42	97	97	23.46*

The maximum foraging durations under snakeweed and bush muhly (modified plot) and creosotebush and mesquite (natural plot) occurred when the lizard moved to the far side of the plant while foraging and could not be seen until it left the plant. These observations may include time spent resting beneath these plants, hence the large mean and maximum durations (Table 3). The maximum duration recorded under mesquite on the modified plot (Table 3) occurred at a plant 2 m in diameter. A *C. tigris* was observed foraging beneath this plant for 240 seconds and consumed several unidentified prey at this location.

DISCUSSION—Both *C. tigris* and *U. stansburiana* are opportunistic feeders that associate with shrubs (Milstead and Tinkle, 1969; Scudday and Dixon, 1973; Parker and Pianka, 1975; Pianka, 1980). Differences in densities of *C. tigris* and *U. stansburiana* between modified and natural plots was evident. Reduction of shrub cover and increase of grass cover appeared detrimental to *C. tigris* but appeared to improve habitat for *Uta stansburiana*.

Cnemidophorus tigris is active and widely foraging, preferring open habitats (Vitt and Ohmart, 1977). The change to sub-shrubs and grasses appeared to not only reduce the foraging area available, but, more importantly, it also decreased the area visible to foraging *C. tigris* and provided fewer escape sites. Germano and Hungerford (1982) noted that grasses hindered the foraging of *C. tigris*. The large size of *C. tigris* (mean snout-vent length = 80.2 mm) hampers its crawling into a dense clump of bush muhly. Kotler (1984) showed that risk of predation and escape site

TABLE 3—Number of foraging bouts greater than 10 s (>10) and less than 10 s (<10) and maximum (max), minimum (min) and mean duration in seconds of foraging bouts >10 s by *Cnemidophorus tigris* under shrubs and grass species on natural and modified plots.

Plant	Modified					Natural				
	<10	>10	Max	Min	Mean	<10	>10	Max	Min	Mean
<i>Larrea tridentata</i>	4	17	80	10	27.7	6	13	400	15	93.8
<i>Prosopis glandulosa</i>	2	21	240	10	48.1	1	6	180	10	64.2
<i>Flouencia cernua</i>	1	1	15	15	15.0	7	5	60	10	26.0
<i>Xanthocephalum sarothrae</i>	25	30	150	10	28.0	0	0	0	0	0
<i>Muhlenbergia porteri</i>	5	37	150	10	33.0	0	0	0	0	0

TABLE 4—Maximum (max), minimum (min), and mean duration in seconds and number of foraging bouts by *Cnemidophorus tigris* under vegetation. Visits to shrubs of 9 s or less were not included in this analysis.

Plant	Modified				Natural			
	Number	Max	Min	Mean	Number	Max	Min	Mean
<i>Larrea tridentata</i>	17	80	10	27.7	13	400	15	93.8
<i>Prosopis glandulosa</i>	21	240	10	48.1	6	180	10	64.2
<i>Flourensia cernua</i>	1	15	15	15.0	5	60	10	26.0
<i>Xanthocephalum sarothrae</i>	30	150	10	28.0	0	0	0	0
<i>Muhlenbergia porteri</i>	37	150	10	33.0	0	0	0	0

availability are important factors governing the distribution of desert rodents. The same factors may affect desert lizards.

The frequency of visits and the amount of time spent under each plant species provides clues to plant characteristics important to foraging *U. stansburiana* and *C. tigris*. The results of this study indicate that foraging *U. stansburiana* are not selective in their use of plants. All plants were used at the rate that would be expected based on plant cover available. Similar conclusions also apply to basking and resting behavior. These data suggest that clumps of dense vegetation or shrubs that provide shade and possibly cover from predators are the habitat features important to *U. stansburiana*.

Mesquite was used preferentially by *C. tigris* and foraging visits to mesquite were generally longer than 10 s. A large amount of leaf litter accumulates beneath the canopy of mesquite. Average litter patch size beneath mesquite is almost equal to that of the canopy of the plant (canopy diameter = 194 ± 51 cm, litter diameter = 185 ± 54 cm). Mesquite litter harbors a higher density of arthropods than litter of any other shrub species on the Jornada (J. Cepeda, pers. comm.). *Cnemidophorus tigris*, which often forages by kicking up leaf litter and capturing insects, should forage in areas where leaf litter is most abundant. Germano and Hungerford (1981) reported a close association between *C. tigris* and mesquite on their experimental plots and that a reduction in mesquite resulted in an accompanying decrease in *C. tigris*.

The behavioral data show frequent use of mesquite by *C. tigris* on the natural plot but not on the modified plot. The failure of *C. tigris* to preferentially use mesquite on the modified plot was probably due to the following: 1) up to 30% of each mesquite bush in the modified plot was dead and plants with a large amount of dead material may have reduced abundance of arthropods at their bases, 2) most mesquite shrubs had a large amount of bush mulch around their bases which may have prevented *C. tigris* from foraging in the leaf litter, and 3) most of the mesquite were immature and had low litter accumulation.

Although creosotebush and bush mulch should produce good prey locations due to large litter patches (creosotebush diameter = 155 ± 43 cm, litter patch diameter = 111 ± 40 cm, bush mulch diameter = 92 ± 41 cm, litter patch diameter = 90 ± 40 cm), *Cnemidophorus tigris* did not utilize these plants more than expected based on their percent cover. These data suggest that the litter accumulations under these plants may not support

large populations of appropriate prey. The relationship of these lizards to the plants in the habitats suggest that sit and wait predators like *U. stansburiana* use only the cover attribute of the species. For active searching predators like *C. tigris* attributes other than cover (i.e., characteristics of the litter) are more important.

Before the introduction of domesticated livestock, the Jornada del Muerto region of New Mexico was primarily a desert grassland dominated by grasses of the genus *Bouteloua* (York and Dick-Peddie, 1979). Mesquite was limited to arroyos and the edges of playas. Creosotebush was found on well drained rocky uplands. Although the lizard species of the Jornada del Muerto prior to the arrival of European man is unknown, data from this study and Germano and Hungerford (1981) suggest that the composition of lizard communities was changed due to changes in vegetation.

The lizard community of the pre-European man desert grassland may have contained only two species in the grassland areas, *U. stansburiana* and *Cnemidophorus inornatus*, with other species restricted to arroyos and rocky areas where Chihuahuan Desert shrub vegetation was present. Our data suggest that when the desert grassland was altered to shrubland, lizard diversity probably increased as lizards that formerly had been restricted to marginal habitats were now able to exploit areas that, until recently, were of "poor quality". Data from our study suggest that *C. tigris*, which is a dominant species in the Chihuahuan desert shrublands, would have occurred at considerably reduced densities in the desert grasslands of the past.

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Address of authors: (DKP) 4357 Guilford Ave., Livermore, CA 94550; (WGW) Dept. of Biol., New Mexico State Univ., Las Cruces, NM 88003.