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Notes on the Movements of *Basiliscus plumifrons* (Sauria: Iguanidae) in Costa Rica

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Abstract: Three *Basiliscus plumifrons* (Reptilia: Iguanidae) were studied with radio telemetry for ten days in Costa Rica. Total activity areas for the three lizards ranged from 316-1006 m^2; core activity areas ranged from 57-114 m^2. A male and female monitored at the same site had overlapping total activity areas but non-overlapping core activity areas. Highest mean values for distances moved and changes in perch height occurred during the 1200-1600 h time period.

Lizards of the neotropical genus *Basiliscus* are distinctive, spectacular iguanids that are frequently found in high densities (Neill, 1965). Nevertheless, few studies (Fitch, 1973a; Van Devender, 1975 and 1978) have been made of *Basiliscus* ecology or, for that matter, the ecology of any basiliscine lizard. Herpetologists working in Central America have concentrated their efforts on the small species of the ubiquitous genus *Anolis* or on the larger, more easily observed iguanines and macroteiids.

In a short-term project devised primarily to determine the applicability of radio telemetry to the study of medium-sized iguanids, we chose *Basiliscus plumifrons* as our experimental animal. Although our results are only a modest contribution to *B. plumifrons* ecology, radio telemetry was found to be a useful technique for studying this little-known lizard.

Materials and Methods

The movements of three adult *Basiliscus plumifrons* were monitored with the same equipment and materials used in earlier projects [Henderson et al., (1976) and Nickerson et al., (1978)]. Each lizard was forcefed a transmitter-battery package ca. 4.0 g. ($< 10\%$ of a lizard's body weight) and then released at the original capture site within 24 h of capture. The animals were radio-located 4 times per day (0000-0210, 0600-0850, 1000-1430, 1800-2050 h).

All stations where the lizards were radio-located were plotted to scale on graph paper. Areas used by the lizards during the study period were estimated by constructing convex polygons enclosing all radio-location points and counting the number of squares enclosed by the polygon. Core activity area boundaries were subjectively determined by enclosing the outermost points of the area most frequently used by the lizard (Kaufmann, 1962). The core area was then calculated in the same manner as the activity range area.

Study Sites

The first study site was a stream-bearing ravine along Quebrade Grande at the north edge of Puerto Viejo, Heredia, Costa Rica and was designated "Creek-Site." Basilisk activity was centered within an isolated stand (10 x 15 m) of shrubs and small trees clustered around 2-3 stumps of large trees. The nearest similar stands were ca. 40 m up or down stream.

The ravine was covered with scattered shrubs (up to 2 m in height), grasses and herbs (0.1-1 m in height), bare ground, small stumps and fallen trees. The creek was 3-7 m wide and ca. 1 m at its maximum depth. The land surrounding the ravine was heavily disturbed, consisting of pasture, cultivated field, a house, and maintained lawn (Fig. 1).

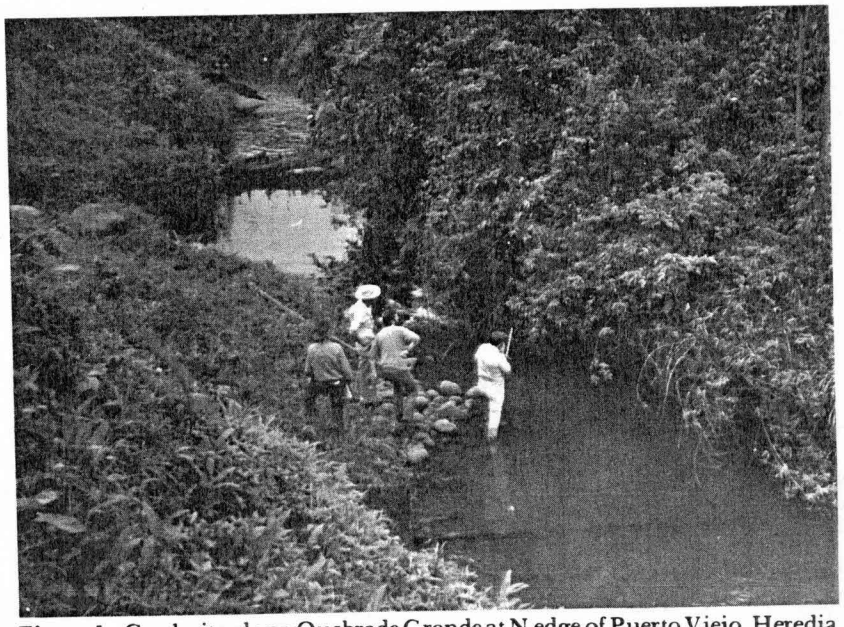

Figure 1. Creek site along Quebrade Grande at N edge of Puerto Viejo, Heredia, Costa Rica.

The second study site was a well-defined 200+ m-long forest edge between short-cropped pasture and secondary forest (10+ m canopy height) along a hillside 0.7 km north of Puerto Viejo; this was designated "Forest Edge Site." The forest edge was 5-15 m wide and consisted of a 4-8 m shrub layer with scattered taller (10+ m) trees. No standing or flowing water was present at the site (Fig. 2).

Figure 2. Forest Edge site at hillside 0.7 km N of Puerto Viejo.

Results and Discussion

One hundred twenty-one radio-locations were made on 3 adult *Basiliscus plumifrons:* a male of 15.7 cm SVL at the Forest Edge Site (FM), a male of 18.7 cm SVL (CM), and a female of 14.0 cm SVL (CF), both from the Creek Site. Observations were made between 14-25 January 1977, and movement data are summarized in Table 1.

Table 1. Summary of movement and perch height data for each animal.

	CM	CF	FM
SVL (cm)	18.7	14.0	15.7
Days monitored	14-25 Jan.	17-25 Jan.	14-25 Jan.
No. observ.	41	33	44
TA (m^2)	1006	481	316
CA (m^2)	70	57	114
No. CA observ.	29	29	37
% observ. in CA	69.0	87.9	84.1
What % CA of TA	6.96	11.85	36.08
No. arboreal observ.	39	26	27
% arboreal observ.	95.1	78.8	61.4
$\bar{X} \pm$ S.D. perch height (m)	3.39 ± 1.73	2.13 ± 2.24	2.01 ± 2.79
Range of perch heights (m)	0-8	0-9	0-17

Not all the space was equally utilized, and the more intensively used areas may represent a core activity area (CA). CM made 4 separate excursions from its core area, while the others made only 1 each.

The smaller CA's and larger total areas (TA) found in the Creek Site basilisks are possibly due to the more heterogenous habitat found at that site. This isolated stand of shrubs and trees may represent a habitat 'island' from which the basilisks disperse at various times. This is opposed to the Forest Edge Site where the habitat was much more homogenous and the basilisk's CA not confined to an 'island'.

Another indication that habitat type may influence TA and CA size is the habitat type utilized at each site. Creek site *B. plumifrons* were frequently found in grassy areas or in trees or shrubs isolated by grassy or bare areas through which the animals must have passed. CM spent 24 h and 16 h (two periods) in a solitary citrus tree growing in a cultivated field (crops ca. .1 m high); he crossed a minimum of 10 m of cultivated field to reach the tree. The FM was never found outside the forest edge shurb-tree area, although both dense secondary forest and open grassy areas with isolated trees were immediately adjacent.

A further point of interest is that the Creek site animals' combined CA's encompassed the entire habitat island, but did not overlap each other despite the considerable overlap in their TA's (Fig. 3). The CF was never found within CM's CA, but CM was once found within CF's CA. At 0000 h 16 January, CM was found within 0.2 m of CF, which resulted in CF's first capture and subsequent release with transmitter. At 2050 h 18 January, CF was found perched with another male basilisk (SVL = 16.3 cm).

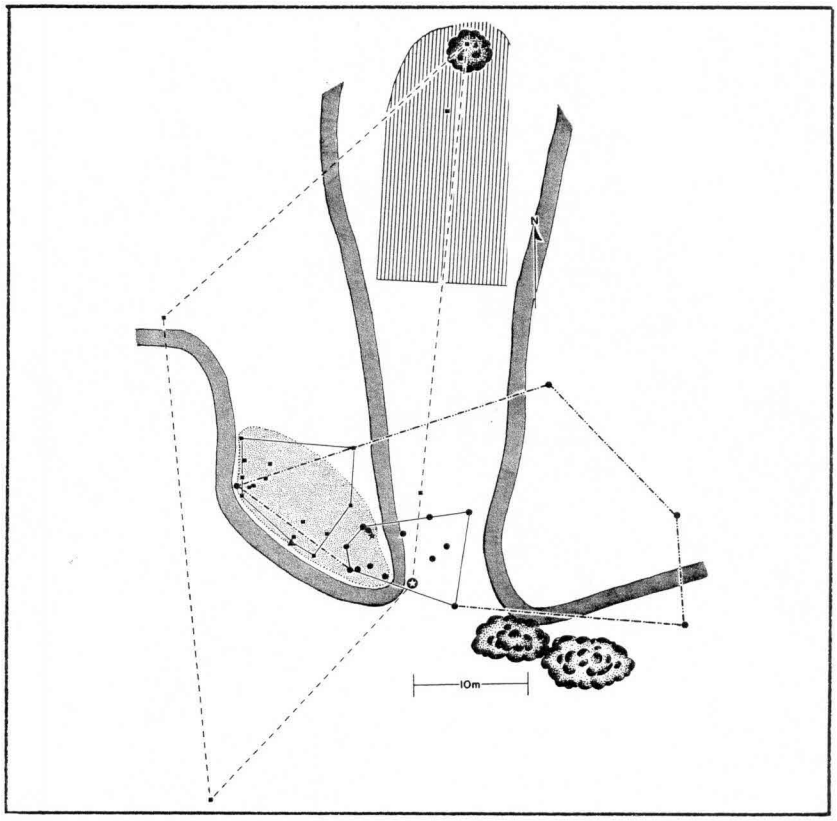

Figure 3. Points at which the CM and CF *Basiliscus plumifrons* were radiolocated. Squares = CM locations; dots = CF locations; star symbol = CF location used on two separate occasions; triangle = CM capture, release point; and star in circle simultaneous location of CM and CF and capture, release point. Dashed line delineates CM Total area; dotted/dashed line delineates CF Total area; and solid line delineates Core Areas of each animal. The path of the creek is shaded and is shown, in part, along with the cultivated field (series of parallel lines on top of figure), the habitat island (stippled area) and some vegetation.

For *Basiliscus vittatus*, Hirth (1963) calculated a mean home range value of 144.0 m^2 (range 96.0-201.6 m^2) for adult males, and 148.8 m^2 (range 96.0-225.0 m^2) for adult females. His mean home range for adult males is only 45.6% of the smallest TA observed in this study, and even the largest adult home ranges calculated are smaller than those in this study. Some possible explanations for this discrepancy include habitat differences and the smaller size (ca. 15%) of *B. vittatus* versus *B. plumifrons*.

The mean distances by each animal per 24 h period, considered as the sum of the straight line distances between sequential observations, were similar in all animals; CM $\bar{x}$ 24 h distance is 17.0 m (1.6-49.2 m), CF $\bar{x}$ = 19.1 m (0-86.3 m), and FM $\bar{x}$ = 15.8 m (0-68.3 m). Only a few other reports on movements for *Basiliscus* have been published. Fitch (1973a) reported 13 records on *B. basiliscus* movements (range 0-116 m) and 29 records of *B. vittatus* (most movements in range 4.6-23 m, with 152 maximum). Van Devender (1975) reported a maximum movement of 1500 m in *B. basiliscus*. The daily movements reported here are greater than all but the maximum movements reported in these other studies, even though the time periods involved in these other studies were greater, ranging from under a month to 293 days.

Distance moved, perch height, and change in perch height between radio locations (expressed as an absolute value, without regard to the direction of the change) were compared (Table 2) and some trends are evident. Although movements and changes in height were recorded in all four time periods, the mean values for both variables were highest during the 1200-1600 h time period, indeed, twice as high as the values for 0000-0600 h. A Kruskal-Wallis test, however, indicated no significant difference in any variable between time periods at the 0.05 level.

All three animals were strongly arboreal, and were found in trees or shrubs the majority of the time (Table 1). All three were sometimes located underground or under ground cover either at night or during inclement weather. Hirth (1963) mentions that *B. vittatus* basking on piles of coconut husks were observed to retreat into the pile as the temperature dropped and shade fell and they did not reappear.

We made 32 daytime observations on juvenile (first year) basilisks. Of these, 56% (18) were on the ground, and an additional 16% (5) were on logs over water, indicating that juveniles may be more terrestrial than adults. This is in accord with Hirth's (1963) finding that juvenile *B. vittatus* become more arboreal as they increase in size.

The creek did not serve as a barrier to movement as both animals crossed and recrossed the creek frequently. Indeed, CF's CA included both banks of the stream. Maturana (1962) stated that "They [basilisks]

are consistently found near the streams or on the seashore . . . ," but CM was never observed near water and two larger adult males were observed ca. 100 m from water.

We observed numerous juvenile basilisks and five that we measured had a mean SVL of 66.2 mm (59-74). Several females laid eggs on 28-29 January while in transit between Puerto Viejo and San Jose. This indicates that reproduction in *B. plumifrons* at Puerto Viejo is, if not aseasonal, at least not strongly seasonal and corresponds with Fitch's (1973b) Type 2 population as well as Van Devender's (1975) *B. basiliscus* study, in which reproduction is continuous but variable throughout the year. This is the prevalent pattern for most Caribbean lowland lizards (Fitch, 1973b).

Table 2. Summary of distances moved, absolute changes in perch height and perch heights at different times of day for all animals combined.

	Time	N	$\bar{X} \pm$ S.D.	Range
Distance moved	0000 - 0600	31	2.52 ± 3.86 m	0 - 13.9 m
	0600 - 1200	29	4.12 ± 8.80 m	0 - 40.5 m
	1200 - 1800	31	7.11 ± 10.03 m	0 - 36.0 m
	1800 - 0000	26	3.69 ± 6.22 m	0 - 23.7 m
Δ Perch height	0000 - 0600	31	0.89 ± 1.38 m	0 - 4.0
	0600 - 1200	30	1.56 ± 3.04 m	0 - 13.6
	1200 - 1800	31	1.65 ± 2.66 m	0 - 14.1
	1800 - 0000	27	0.9 ± 2.00 m	0 - 8.5
Perch height	0000	27	3.84 ± 4.78 m	0 - 9 m
	0600	30	2.16 ± 2.02 m	0 - 9 m
	1200	21	2.75 ± 3.26 m	0 - 17 m
	1800	32	2.44 ± 1.76 m	0 - 6 m

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