Caribbean Journal of Science, Vol. 36, No. 3-4, 258–266, 2000

Natural History of an Anoline Lizard Community in the Sierra de Baoruco, Dominican Republic

ELIZABETH E. CAST,[1], MATTHEW E. GIFFORD[2], KIMBERLY R. SCHNEIDER[3], ANDREW J. HARDWICK[4], JOHN S. PARMERLEE, JR.[2], AND ROBERT POWELL[2,5]

[1]*Department of Biology, William Woods University, Fulton, Missouri 65251, USA.*
[2]*Department of Biology, Avila College, Kansas City, MO 64145, USA.*
[3]*Department of Zoology, University of Florida, Gainesville, Florida 32601, USA.*
[4]*Department of Biological Sciences, Fontbonne College, St. Louis, Missouri 63105, USA.,*
[5]*Corresponding author (powellr@mail.avila.edu).*

ABSTRACT.—In June 1999, we examined diet, structural habitat, thermal biology, and relative population sizes in a community of *Anolis* lizards at an elevation of approximately 900 m in an agriculturally modified habitat in the Sierra de Baoruco, Dominican Republic. *Anolis bahorucoensis* was the most commonly encountered species in forest interior and edge habitats. *Anolis cybotes* was more abundant than *A. distichus* in the forest interior, but the latter was more numerous along edges. *Anolis coelestinus* was rare in both habitat situations. Structural habitats used by the species was consistent with expectations based on ecomorphology. Cloacal temperatures of the four species were significantly higher than air or substrate temperatures but varied according to ambient conditions. Temperatures of *A. bahorucoensis* were significantly lower than those of the other three species. The four species consumed mostly arthropods, and dietary niche breadths of all but *A. distichus* generally supported assumptions that most anoles are dietary generalists. A disproportionate fraction of the diet of *A. distichus* consisted of ants. Data generally conform to those of studies of communities of similar composition at lower and higher elevations, although the rarity of *A. coelestinus* at this site and the abundance of *A. bahorucoensis* along exposed edges was unexpected.

INTRODUCTION

Anoles are important components of many West Indian vertebrate communities. Of particular interest to ecologists are Greater Antillean anoline communities, which are frequently very diverse. Several studies have addressed community structure on Hispaniola (e.g., Rand, 1962; Rand and Williams, 1969; Jenssen et al., 1987), but only two other studies (Lenart et al., 1997; Sifers et al., 2001) focused on a community in the Sierra de Baoruco.

Although 90 percent of the original forests in the Dominican Republic have been destroyed as a consequence of human activity (Harcourt and Ottenwalder, 1996), extensive, albeit frequently altered, tracts remain in the Sierra de Baoruco. Because species, even congeners, can react quite differently to disturbances of natural habitats (Henderson and Powell, 1999), studies of communities in variously altered situations become increasingly timely—particularly as altered environments become the norm rather than the exception. Although data on pristine habitats in the Sierra de Baoruco are lacking, Lenart et al. (1997) examined responses of anoles to different degrees of change at moderate elevation (490-520 m) and Sifers et al. (2001) focused on an anoline community at higher elevation (1050-1150 m). This study is the first to examine community structure at an intermediate elevation (~900 m), where anoline lizard diversity is potentially the greatest (Schwartz and Henderson, 1991).

MATERIALS AND METHODS

Field work was conducted from 1-15 June 1999 at a site 18 km south of Cabral in the Sierra de Baoruco, Provincia de Barahona, República Dominicana. We conducted this study in an area characterized by Schwartz (1974) as a high mesic deciduous forest somewhat modified by the cultivation of coffee, and where native canopy

trees serve as shade cover for cultivated plants. Lianes forming dense hanging mats were present throughout the forest and the ground was almost completely covered with leaf litter. The upper canopy was about 25 m high. The extent of cultivation has increased substantially since 1974. Dramatically altered habitats extend continuously from the study site in all directions. Forest with a three-tiered canopy (Lenart et al., 1997) is occasionally simulated by cultivated species (e.g., coffee) replacing native trees of similar size, but natural forest has been almost completely eradicated in the region.

Eight species of anoles are known from the immediate vicinity of the study site, *Anolis bahorucoensis*, *A. barahonae*, *A. barbouri*, *A. coelestinus*, *A. cybotes*, *A. distichus*, *A. sheplani*, and *A. singularis* (Schwartz and Henderson, 1991). *Anolis barahonae* restricts its activity primarily to the crowns of canopy trees and *A. barbouri* is terrestrial. Neither was encountered in our surveys, although both were collected at nearby sites. We also failed to find *A. sheplani* and *A. singularis*, in spite of considerable effort; S.B. Hedges (pers. comm.) indicated that these two species were quite rare in this area. The ecomorphs (Williams, 1983) of the remaining four species, all of which were encountered frequently, are a sun-tolerant trunk-ground anole (*A. cybotes),* sun-tolerant trunk anole (*A. distichus*), sun-loving trunk-crown anole (*A. coelestinus*), and shade-loving bush anole (*A. bahorucoensis*).

The objectives of this study were to evaluate niche differences between the four focal species. Several aspects of each lizard's natural history were examined: diet, structural habitat, thermal biology, and relative population sizes. Also, because of the importance of edge habitats to anoline communities of essentially similar composition at higher elevations (Sifers et al., 2001), we compared edge and interior plots of similar composition to determine if differences in community composition existed in these adjacent areas.

We sampled lizard populations using the methods of Heckel and Roughgarden (1979). Six plots of 144 m^2 were delineated, three along forest edges and three within the forest interior. When a lizard was spotted, it was sprayed from a distance of at least 2 m with acrylic latex paint diluted with water (1:1). The individual's species, sex, perch height, perch diameter, microhabitat, and time of day were recorded. If sex could not be determined, the animal was caught after the marking period and an accurate determination was made. A different color of paint was used each day. Resultant data were used to estimate population sizes using the methods of Schnabel (1938) and Heckel and Roughgarden (1979).

After the painting period, lizards found within a two-hour period in the sampling area were captured by noose or hand. For each lizard, we recorded cloacal, substrate, and air (1 m above substrate) temperatures with a Fluke 50-Series digital thermometer equipped with K-type thermocouples (Fluke Corp. Everett, Washington). Specimens were kept on ice before being killed by lethal injection of T-61 (a veterinary drug no longer marketed) and preserved in 10 % formalin. Stomachs were later excised and contents removed for dietary analysis. Arthropodan prey items were identified to class, order, or family. Prey in other phyla were identified to class. Volumes of prey items were quantified by fluid displacement (Milstead, 1957). Importance values (Powell et al., 1990; Howard et al., 1999) were calculated for each type of prey and used to determine dietary niche overlaps (MacArthur and Levins, 1967; as modified by Pianka, 1973) between sexes, between species, and with other populations of the same species in the Sierra de Baoruco (the latter, in effect, serving as indices of similarity). Importance values also were used to calculate standardized niche breadths (Levins, 1968; Hurlbert, 1978) for each species. Specimens were deposited in the Bobby Witcher Memorial Collection, Avila College, Kansas City, Missouri.

We used StatView 5.0 (SAS Institute, Inc., Cory, North Carolina) for all statistical analyses. Means are presented ± 1 SE, except population size estimates using the Heckel and Roughgarden method (1979),

for which means are presented ± 1 SD. For all tests, $\alpha = 0.05$.

Results and Discussion

Population Sizes.—Estimates of population sizes (Table 1) indicate some interesting trends. In both areas, numbers for *Anolis coelestinus* were too small for population estimates (only five individuals were encountered during the three-day numerating period). This is in stark contrast to the abundance of *A. coelestinus* reported by Lenart et al. (1997) at a lower elevation and by Sifers et al. (2001) at a higher elevation. This discrepancy was consistently evident throughout the study period.

Shade-loving *Anolis bahorucoensis* was the most commonly encountered species in interior and edge habitats. Presumably able to find suitable conditions in both areas, it exhibited no preference for either situation. This bridges observations by Lenart et al. (1997), who found that numbers of *A. bahorucoensis* at lower elevation decreased in increasingly open sites, and Sifers et al. (2001), who found the same species at higher elevations almost exclusively along edges.

Anolis cybotes was found in much higher numbers in the interior, where low level vegetation is sparse, possibly facilitating prey location on the ground. This observation is similar to that reported by Lenart et al. (1997), but contrasts with data of Rand and Williams (1969) and Sifers et al. (2001), both of whom stated that *A. cybotes* frequented the forest edge much more frequently than its interior.

TABLE 1. Population size estimates of *Anolis* species, using the Heckel and Roughgarden (1979) procedure (±SD; top line) and the Schnabel (1938) equation (±SE; second line), in edge and interior forest habitats in the Sierra de bahoruco. Data were insufficient to make estimates for *A. coelestinus*. The dish indicates insufficient data.

Habitat	*A. bahorucoensis*	*A. cybotes*	*A. distichus*
Forest	69.7 ± 16.2	45.2 ± 27.0	24.5 ± 2.7
interior	71.7 ± 0.005	53.5 ± 0.01	24.4 ± 0.01
Forest	100.7 ± 91.5	—	55.5 ± 5.7
edge	118 ± 0.008	12 ± 0.06	25.4 ± 0.008

The greater number of *Anolis distichus* in edge plots may be related to increased insolation. Rand (1962) noted that *A. distichus* lived primarily on isolated trees and fence posts along the edges of forest and trails. Sifers et al. (2001) found very few *A. distichus* in a series of higher elevation sites and suggested that this may be due to a lower tolerance of this species for cooler conditions.

Structural Habitat.—Perch heights of the four species (Table 2, Fig. 1) differed significantly (Friedman Test, df = 3, $\chi^2 = 8.6$, P = 0.04). *Anolis distichus* was found most frequently on perches 1-2 m above the ground, *A. bahorucoensis* on bushes and vines of low to medium height, and *A. cybotes* on thick tree trunks, small bushes, and rocks. Our data were consistent with observations of Rand (1962) and predictions based on the ecomorphological characteristics (Williams, 1983) of each species.

Perch heights of *Anolis cybotes* were significantly higher in edge than in interior habitat (Mann-Whitney U, Z = −3.6, P = 0.0003). The presence of thick and visually impenetrable underbrush along the edge may cause *A. cybotes* to perch higher to visually detect prey in the upper levels of this low vegetation layer instead of prey on the ground. No differences for other species were significant.

Male *Anolis bahorucoensis* perched significantly higher than females (Mann-Whitney U, Z = −2.7, P = 0.006) (Fig. 2), but differences between male and female *A. cybotes* and *A. distichus* were not significant. For *A. cybotes*, these data agree with observations by Rand (1962), Fobes et al. (1992), and Gifford et al. (2000, for closely related *A. longitibialis*). However, Rand (1962) noted that male *A. distichus* were usually closer to the ground than females.

Overall, perch diameters did not differ significantly by species (Friedman Test, df = 3, $\chi^2 = 4.50$, P = 0.22) (Table 3). However, pair-wise comparisons indicated that perch diameters used by *Anolis distichus* and *A. bahorucoensis* (Mann-Whitney U, Z = −10.4, P = 0.0001) and *A. distichus* and *A. cybotes* (Z = −5.9, P = 0.0001) differed significantly. *Anolis distichus* had the largest average perch diameter and *A. bahorucoen-*

TABLE 2. Perch heights (mm) used by *Anolis* lizards in the Sierra de Baoruco.

Perch Height	*Anolis bahorucoensis*	*Anolis cybotes*	*Anolis coelestinus*	*Anolis distichus*
All	692.9 ± 61.5 N = 92	487.2 ± 77.1 N = 16	1725.0 ± 440.4 N = 5	1662.0 ± 100.4 N = 85
Interior	632.5 ± 82.7 N = 74	194.1 ± 68.5 N = 7	1533.3 ± 895.1 N = 3	1489.2 ± 198.9 N = 41
Edge	759.2 ± 90.3 N = 18	713.6 ± 103.6 N = 9	1916.7 ± 363.2 N = 2	1605.0 ± 118.2 N = 44
Males	849.6 ± 87.9 N = 34	615.4 ± 141.0 N = 10	2250.0 ± 250.0 N = 4	1796.5 ± 123.2 N = 52
Females	484.3 ± 68.2 N = 58	507.1 ± 109.7 N = 6	1250.0 N = 1	1485.1 ± 176.5 N = 33

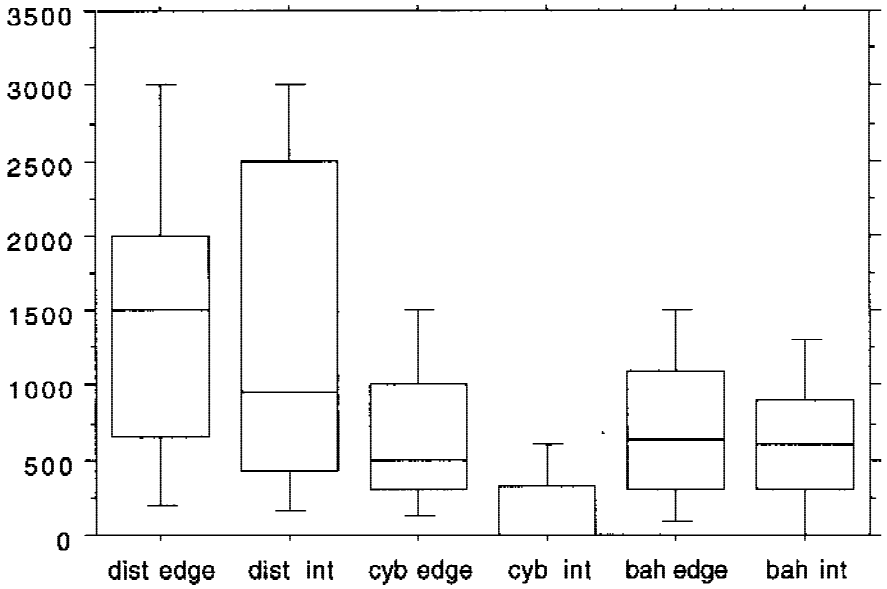

FIG. 1. Perch heights (mm) of *Anolis* lizards in edge and interior (= int) forest habitats in the Sierra de Baoruco (*A. distichus* = dist, *A. cybotes* = cyb, *A. bahorucoensis* = bah).

sis the smallest. These data are consistent with predictions based on ecomorphological characteristics (Williams, 1983). Fitch and Henderson (1987) noted that *A. bahorucoensis* often would escape by "running up a slender stem and flattening against it with legs folded" and that this behavior is typical of species that utilize small perches.

Male *Anolis cybotes* occupied significantly thicker perches than females (Mann-Whitney U, Z = −2.3, P = 0.03). Males may select more prominent perches to defend a territory, whereas females' main concerns are finding food and reproducing (Scott et al., 1976). Rand (1962) also suggested that differences in male and female perches result from territorial defenses by males. Diameters of perches selected along edge and interior sites did not differ significantly, except for *A. cybotes* (Z = −2.3, P = 0.02), for which perch diameters along the edge were larger. This is probably attributable to the scarcity of "*cybotes*-suitable" small diameter perches along the edge (where raspberrys and other small shrubs predominated) compared to the interior where trunks of numerous coffee and other small diameter trees were available.

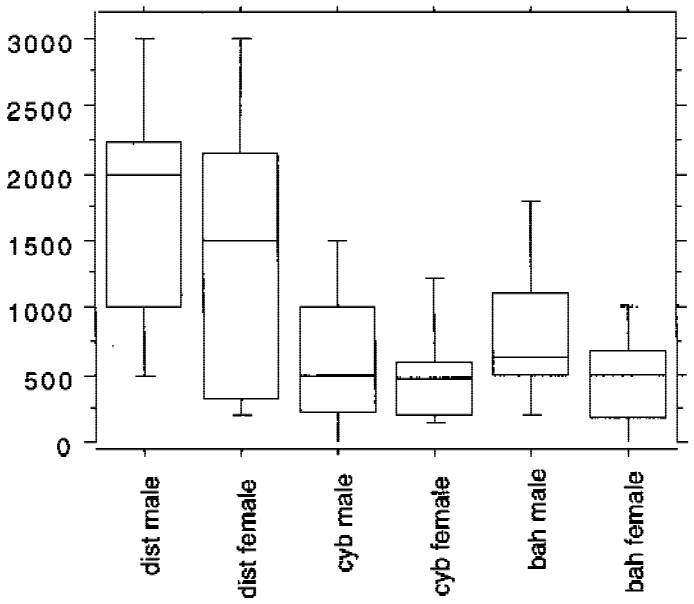

FIG. 2. Perch heights (mm) of male and female *Anolis* lizards in the Sierra de Baoruco (abbreviations as in Fig. 1).

TABLE 3. Perch diameters (mm) used by *Anolis* lizards in the Sierra de Baoruco.

Perch Diameter	*Anolis bahorucoensis*	*Anolis cybotes*	*Anolis coelestinus*	*Anolis distichus*
All	51.3 ± 6.6	87.3 ± 17.1	68.4 ± 8.9	282.7 ± 22.6
	N = 92	N = 16	N = 4	N = 85
Interior	48.0 ± 6.8	38.6 ± 8.9	101.0 ± 0.0	295.9 ± 62.7
	N = 74	N = 7	N = 2	N = 41
Edge	54.5 ± 11.4	103.5 ± 21.6	46.7 ± 17.6	278.0 ± 21.2
	N = 18	N = 9	N = 2	N = 44
Males	60.4 ± 10.2	132.7 ± 36.3	61.3 ± 11.6	302.9 ± 29.2
	N = 34	N = 10	N = 3	N = 52
Females	35.9 ± 4.9	60.0 ± 17.1	20.0	260.4 ± 37.9
	N = 58	N = 6	N = 1	N = 33

TABLE 4. Cloacal, substrate, and air temperatures of *Anolis* lizards in the Sierra de Baoruco.

Temperature (°C)	*A. bahorucoensis* males N = 12	*A. bahorucoensis* females N = 8	*A. cybotes* males N = 4	*A. cybotes* females N = 8	*A. distichus* males N = 18	*A. distichus* females N = 11
Cloacal	24.4 ± 0.6	25.3 ± 0.6	25.1 ± 1.2	28.7 ± 1.1	27.1 ± 0.7	26.4 ± 1.1
Substrate	22.1 ± 0.4	22.5 ± 0.5	22.8 ± 5.8	25.2 ± 1.0	23.9 ± 0.5	24.1 ± 0.8
Air	22.1 ± 0.5	22.4 ± 0.5	22.8 ± 0.8	24.8 ± 0.9	23.3 ± 0.5	23.1 ± 0.6

Thermal Biology.—Environmental temperatures (Table 4) did not differ significantly between males and females of the three species for which adequate data existed. Substrate and air temperatures did not differ significantly for any species; consequently, we made subsequent comparisons solely with substrate temperatures. In each species, cloacal temperatures were significantly higher than substrate tempera-

TABLE 5. Stomach contents of four *Anolis* lizards in the Sierra de Baoruco. Data are presented in an a/b/c format, with "a" representing the total number of food items, "b" the total volume in cm^3, and "c" the number of stomachs in which that item was found. The figure in the second row is the importance value of that item in the diet (Powell et al., 1990; Howard et al., 1999). Dashes indicate that a particular food item was not found.

Food Items	*A. bahorucoensis* N = 20	*A. coelestinus* N = 5	*A. cybotes* N = 17	*A. distichus* N = 29
Arachnida: Araneae	1/0.005/1 0.022	—	3/0.123/3 0.09	—
Arachnida (misc.)	3/0.055/3 0.118	—	1/0.003/1 0.015	6/0.015/5 0.038
Insecta				
Colembola	—	—	—	1/0.001/1 0.007
Coleoptera	8/0.023/7 0.144	2/0.055/1 0.195	5/0.030/5 0.084	8/0.065/8 0.064
Coleoptera (immature)	2/0.005/1 0.029	1/0.003/1 0.055	—	1/0.001/1 0.007
Dermaptera	—	—	—	1/0.010/1 0.008
Diptera	4/0.060/2 0.123	1/0.001/1 0.052	3/0.009/3 0.047	2/0.005/1 0.009
Hemiptera	8/0.019/6 0.130	—	5/0.045/4 0.082	9/0.131/7 0.068
Homoptera	1/0.005/1 0.022	—	—	—
Hymenoptera: Formicidae	9/0.029/4 0.133	3/0.003/1 0.094	13/0.073/6 0.159	158/2.198/20 0.637
Hymenoptera (misc.)	3/0.0113/3 0.061	—	1/0.001/1 0.015	1/0.003/1 0.008
Isoptera	2/0.003/1 0.025	—	—	2/0.100/1 0.021
Lepidoptera	4/0.023/4 0.091	—	7/0.103/5 0.124	—
Lepidoptera (immature)	1/0.005/1 0.022	1/0.003/1 0.055	3/0.080/3 0.074	11/0.180/7 0.077
Orthoptera: Blattidae	—	—	2/0.063/2 0.052	1/0.005/1 0.008
Orthoptera: Gryllidae	1/0.005/1 0.022	—	6/0.333/5 0.204	1/0.030/1 0.011
Orthoptera: Acrididae	1/0.003/1 0.019	4/0.023/2 0.190	—	1/0.003/1 0.007
Diplopoda	—	—	1/0.015/1 0.02	—
Isopoda	—	—	1/0.010/1 0.018	—
Unidentified arthropods	1/0.001/1 0.017	1/0.003/1 0.055	1/0.005/1 0.016	4/0.009/4 0.028
Mollusca: Gastropoda	1/0.005/1 0.022	—	—	1/0.003/1 0.007
Shed skin	—	1/0.050/1 0.164	—	1/0.080/1 0.017
Flowers	—	1/0.003/1 0.055	—	—
Fruit/seeds	—	—	—	1/0.005/1 0.023
Grit	—	2/0.005/1 0.081	—	—

TABLE 6. Dietary niche overlaps between *Anolis* lizards in the Sierra de Baoruco.

	A. cybotes	*A. bahorucoensis*	*A. distichus*
A. bahorucoensis	0.69		
A. distichus	0.53	0.57	
A. coelestinus	0.37	0.58	0.40

tures (*Anolis bahorucoensis*, Mann-Whitney U, Z = −3.5, P = 0.0005; *A. cybotes*, Z = −4.3, P < 0.0001; *A. distichus*, Z = −2.4, P = 0.02). However, body and substrate temperatures were significantly correlated (*A. bahorucoensis*, Spearman Rank Correlation, Z = 3.2, P = 0.001; *A. cybotes*, Z = 2.2, P = 0.03; *A. distichus*, Z = 2.7, P = 0.007). Although these anoles can maintain higher than ambient temperatures, body temperatures vary according to ambient, suggesting an intermediate condition between the more active thermoregulation described by Sifers et al. (2001) at higher elevation and the notation by Hertz and Huey (1981) that anoles at lower elevations are essentially thermal conformers.

Cloacal and substrate temperatures of *Anolis bahorucoensis* were significantly lower than those of other species (Mann-Whitney U, Z = −2.7, P = 0.01). This was consistent with expectations for a shade-loving bush anole. Cloacal and substrate temperatures of *A. cybotes* and *A. distichus* did not differ significantly. We had expected *A. distichus* to maintain higher body temperatures, because it is sun-tolerant and frequently associated with edges, but the similarity with *A. cybotes* was somewhat unexpected, as both species were more abundant in shaded sites. Possibly because of its greater mass (and lower surface to volume ratio), *A. cybotes* maintains higher temperatures more effectively than smaller, more gracile *A. distichus*.

Diet.—Dietary data (Table 5) indicated that these four lizard species consume a variety of predominantly arthropodan prey. Calculated dietary niche breadths for *Anolis bahorucoensis* (all, 0.60; males, 0.64; females, 0.71), *A. coelestinus* (0.73, 0.71, 0.79), and *A. cybotes* (0.59, 0.83, 0.61) generally supported prior assumptions (e.g., Henderson and Powell, 1999, and references therein) that most anoles are dietary generalists. Only for *A. distichus* does the niche breadth (0.08, 0.12, 0.22) suggest dietary specialization, specifically on ants. Pianka (1986) stated that specialization on social insects such as ants is "economically feasible because they normally occur in a clumped spatial distribution and hence constitute a concentrated food supply." However, the presence in the diet of 15 other types of prey items supported the contentions by Cullen and Powell (1994) that *A. distichus* is an opportunistic feeder, and the preponderance of ants may reflect their abundance in the microhabitat. Moermond (1979) observed differences in *A. distichus* and *A. cybotes* foraging behavior, noting that the former forages primarily on the surface of tree trunks, where ant trails are common. In contrast, *A. cybotes* uses the trunk as a "vantage point" from which to spy potential prey on the ground or lower vegetation.

Dietary overlap of males and females was high in two species (*Anolis distichus*, 0.98; and *A. cybotes*, 0.79). The very high overlap in *A. distichus* reflects the preponderance of ants in diets of both sexes. The overlap between sexes in *A. bahorucoensis* (0.34) was considerably lower. This might reflect the significant difference in perch heights chosen by males and females and the substantial difference in sizes of the sexes. Dietary overlap between species (Table 6) was greater than that between male and female *A. bahorucoensis*. Comparisons with published data for other montane populations (Table 7) reveal overlap values that range from almost complete (*A. distichus*, presumably due to the common preponderance of ants in the diets of all populations), to high (*A. bahorucoensis*), moderate (*A. coelestinus*), and low and variable (*A. cybotes*). With the exception of *A. distichus*, overlaps tended to be highest with populations in the most natural habitats (Lenart, 1997), suggesting that populations in substantially altered habitats must make adjustments due to prey availability.

Summary.—Our data generally conform to those of studies done at other low or mid-elevation sites and predictions based on ecomorphology. However, generalizations based on a few studies can be mis-

TABLE 7. Dietary niche comparisons between *Anolis* lizards in this study and other conspecific populations in the Sierra de Baoruco. Sifers et al. (2001) examined populations in a high-elevation cloudforest (1050-1150 m). Lenart et al. (1997) reported dietary data in variously altered habitats at lower elevations on the easternmost slope (490-520 m). Three values are given for these comparisons, the first representing the population in the most intensely altered habitat, the second in a more natural setting, and the third from an intermediate situation. Cullen and Powell (1994) examined the diet of *A. distichus* from a location very near that of the present study.

	A. bahorucoensis	*A. coelestinus*	*A. cybotes*	*A. distichus*
Overlap values and sources of information	0.71 Sifers et al., 2000	0.34, 0.58, 0.56 Lenart et al., 1997	0.25, 0.51, 0.15 Lenart et al., 1997	0.94 Cullen and Powell, 1994
		0.57 Sifers et al., 2001	0.46 Sifers et al., 2001	0.87, 0.96, 0.97 Lenart et al., 1997
				0.94 Sifers et al., 2000

leading (e.g., Micco et al., 1997 [1998]). For example, most anoles are generally assumed to be capable of adapting readily to many alterations in habitat (Henderson and Powell, 1999), but even common species react differently, depending on circumstances (e.g., Lenart et al., 1997; Sifers et al., 2001; this study). For instance, the relative abundance of *Anolis coelestinus* and *A. distichus* is quite different in two anoline communities of similar composition, but separated by a few kilometers and approximately 200 m in elevation. If *A. distichus* is less tolerant of cooler conditions, as indicated by its strong preference for fully insolated edge habitats and its relative rarity at higher elevation (Sifers et al., 2001), no indication would have been forthcoming based on previous studies of other populations living under different conditions. Similarly, we found *A. bahorucoensis* about equally abundant in forest interior and edge habitats. This may represent a transition from its almost exclusive use of cooler interior habitats at lower and warmer elevations (e.g., Fitch and Henderson, 1987; Lenart et al., 1997) and its equally exclusive association with insolated edges at higher and cooler elevations (Sifers et al., 2001).

Forest and other habitats on Hispaniola will continue to be altered. This will, along with other effects, establish more edge habitats, and ongoing changes in community structure are inevitable. As more and more habitats are altered ever more severely, we echo Powell et al. (1996), who recommended that "investigators working in the West Indies be encouraged to pursue studies in these less-than-pristine sites — while not neglecting efforts in [more natural] areas, currently (and appropriately) receiving the bulk of researchers' attention."

Acknowledgments.—B. L. Banbury, K. Grasela, S. E. Nelson, L. Perdomo, Y. M. Ramos, S. M. Sifers, R. A. Sosa, and M. L. Yeska helped in the field. J. A. Ottenwalder, United Nations Development Programme, and A. Schubert, Dirección Nacional de Parques, facilitated our work in the Dominican Republic. T. A. Zanoni, New York Botanical Garden, identified the plants. R. E. Glor made helpful comments on early versions of this manuscript. Permits were issued by G. Santana, Departamento de Vida Silvestre, and K. Grasela, Dirección Nacional de Parques. Field work was supported by Grant No. DBI-9732257 awarded by the National Science Foundation to RP.

LITERATURE CITED

Cullen, D. J., and R. Powell. 1994. A comparison of food habits of a montane and a lowland population of *Anolis distichus* (Lacertila: Polychrotidae) from the Dominican Republic. Bull. Maryland Herpetol. Soc. 30:62-66.

Fitch, H. S., and R. W. Henderson. 1987. Ecological and ethological parameters in *Anolis bahorucoensis*, a species having rudimentary development of the dewlap. Amphibia-Reptilia 8:69-80.

Fobes, T. M., R. Powell, J. S. Parmerlee, Jr., A. Lathrop, and D. D. Smith. 1992. Natural history of *Anolis cybotes* (Sauria: Polychridae) in an altered habitat in Barahona, Dominican Republic. Carib. J. Sci. 28: 200-207.

Gifford, M. E., Y. M. Ramos, R. Powell, and J. S. Parmerlee, Jr. 2000. Natural history of a saxicolous

anole, *Anolis longitibialis* from Hispaniola. Herpetol. Nat. His. 7: in press.

Harcourt, C., and J. A. Ottenwalder. 1996. Hispaniola. *In* C. S. Harcourt and J. A. Sayer (eds.), The Conservation Atlas of Tropical Forests, The Americas, pp. 102-111. IUCN, Gland, Switzerland.

Heckel, D. G., and J. Roughgarden. 1979. A technique for estimating the size of lizard populations. Ecology 60:966-975.

Henderson, R. W., and R. Powell. 1999. West Indian herpetoecology. *In* B. I. Crother (ed.), Caribbean Amphibians and Reptiles, pp. 223-268. Academic Press, San Diego.

Hertz, P. E. and R. B. Huey. 1981. Compensation for altitudinal changes in the thermal environment by some *Anolis* lizards on Hispaniola. Ecology 62:515-521.

Howard, A. K., J. D. Forester, J. M. Ruder, J. S. Parmerlee, Jr., and R. Powell. 1999. Natural history of a terrestrial Hispaniolan anole: *Anolis barbouri*. J. Herpetol. 33:702-706.

Hurlbert, S. H. 1978. The measurement of niche overlap and some relatives. Ecology 59:67-77.

Jenssen, T. A., D. L. Marcellini, and E. P. Smith. 1987. Seasonal micro-distribution of sympatric *Anolis* lizards in Haiti. J. Herpetol. 22:266-274.

Lenart, L. A., R. Powell, J. S. Parmerlee, Jr., A. Lathrop, and D. D. Smith. 1997. Anoline diversity in three differentially altered habitats in the Sierra de Baoruco, República Dominicana, Hispanolia. Biotropica 29:117-123.

Levins, R. 1968. Evolution in Changing Environments: Some Theoretical Explorations. Princeton Univ. Press, Princeton, New Jersey. ix + 120 pp.

MacArthur, R. H., and R. Levins. 1967. Limiting similarities, convergence, and divergence of coexisting species. Amer. Nat. 101:377-385.

Micco, S. M., et al. 1997 (1998). Natural history of *Leiocephalus barahonensis* (Tropiduridae) on the Península de Barahona, Hispaniola: an examination of two populations. Herpetol. Nat. Hist. 5:147-156.

Milstead, W. W. 1957. Some aspects of competition in natural populations of whiptail lizards (genus *Cnemidophorus*). Texas J. Sci. 9:410-447.

Moermond, T. C. 1979. The influence of habitat structure on *Anolis* foraging behavior. Behaviour 70:147-166.

Pianka, E. R. 1973. The structure of lizard communities. Ann. Rev. Ecol. Syst. 4:53-74.

Pianka, E. R. 1986. Ecology and Natural History of Desert Lizards. Princeton Univ. Press, Princeton, New Jersey. × + 208 pp.

Powell, R., J. S. Parmerlee, Jr., M. A. Rice, and D. D. Smith. 1990. Ecological observations of *Hemidactylus brookii hatianus* Meerwarth (Sauria: Gekkonidae) from Hispaniola. Carib. J. Sci. 26:67-70.

Powell, R., J. S. Parmerlee, Jr., and D.D. Smith. 1996. Evidence of spatial niche partitioning by a Hispaniolan lizard community in a xeric habitat. *In* R. Powell and R.W. Henderson (eds.), Contributions to West Indian Herpetology: A Tribute to Albert Schwartz, pp. 317-326. Soc. Study Amphib. Rept. Contrib. Herpetol., vol. 12, Ithaca, New York.

Rand, A. S. 1962. Notes on Hispanolian herpetology 5. The natural history of three sympatric species of *Anolis*. Breviora (54):1-15.

Rand, A. S., and E. E. Williams. 1969. The anoles of La Palma: aspects of their ecological relationships. Breviora (327):1-18.

Schnabel, Z. E. 1938. The estimation of the total fish population of a lake. Amer. Math. Monthly 45:348-352.

Schwartz, A. 1974. A new species of primitive *Anolis* (Sauria, Iguanidae) from the Sierra de Baoruco, Hispaniola. Breviora(423):1-19.

Schwartz, A., and R. W. Henderson. 1991. Amphibians and Reptiles of the West Indies: Descriptions, Distributions, and Natural History. Univ. Florida Press, Gainsville. xvi + 720 pp.

Scott, N., D. Wilson, C. Jones, and R. Andrews. 1976. The choice of perch dimensions by lizards of the genus *Anolis* (Reptilia, Lacertilia, Iguanidae). J. Herpetol. 10:75-84.

Sifers, S. M., M. L. Yeska, Y. M. Ramos, R. Powell, and J. S. Parmerlee, Jr. 2001. *Anolis* lizards restricted to altered edge habitats in a Hispaniolan cloud forest. Carib. J. Sci. 37: in press.

Williams, E. E. 1983. Ecomorphs, faunas, island size, and diverse end points in island radiations of *Anolis*. *In* R. B. Huey et al. (eds.), Lizard Ecology: Studies of a Model Organism, pp. 326-370. Harvard Univ. Press, Cambridge.