

ASPECTS OF THE NATURAL HISTORY OF *CROTAPHYTUS COLLARIS*
FROM CHIHUAHUA AND COAHUILA, MEXICO

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The Eastern Collared Lizard, *Crotaphytus collaris*, occurs from Missouri to Arizona and southward between the western and eastern Sierra Madres to San Luis Potosí, Mexico (Lemos-Espinal and Smith, 2007). Most of our knowledge of its natural history comes from studies on populations in the United States, especially populations in Missouri and Oklahoma (e.g., see review of studies in Sexton et al., 1992). Given that some aspects of its biology are known to vary among populations (e.g., limb morphology and behavior, Husak and Rouse, 2006; sexual dimorphism, McCoy et al., 1994; Baird et al., 1997; growth rate, Sexton et al., 1992; sexual selection, Baird et al., 1997), it is important to study more populations of *Crotaphytus collaris*, particularly those populations in relatively understudied regions of its range (e.g., Mexico), to obtain a more complete understanding of its natural history and any possible geographic variation. Here we report on several aspects of the natural history of *C. collaris* from the Chihuahuan Desert in northern Mexico. In particular, we provide information on sexual dimorphism, microhabitat use, and temperature relationships.

Materials and Methods

Study sites.—*Crotaphytus collaris* were studied at four sites in the state of Coahuila [La Cuchilla, municipality of Parras (25°36'57.7"N, 102°53'46.8"W, 1104 m); proximities of Ocampo, municipality of Ocampo (27°1'33.7"N, 102°6'13.9"W, 804 m); El Rincón, municipality of San Pedro (26°42'27"N, 102°6'53"W, 980 m); 11 km N of San Miguel, municipality of Ocampo (28°41'37"N, 102°51'39.1"W, 1064 m)], and eight in the state of Chihuahua [Ojos de Santa María, municipality of Ascensión (31°9'31"N, 107°19'27"W, 1189 m); Las Lajas, municipality of Buenaventura (29°51'46.4"N, 107°4'32.3"W, 1561 m); Estación Guzman, municipality of Ascensión (31°13'1.2"N, 107°28'4.3"W, 1219 m); Ran-

cho La Viuda, municipality of Ascensión (31°23'32.3"N, 107°48'20"W, 1285 m); near Ejido Flores Magón, municipality of Buenaventura (29°58'34"N, 107°6'19"W, 1481 m); volcanic rocky hill km 5.5 hgw Flores-Magón/Casas Grandes, municipality of Buenaventura (29°58'34"N, 107°6'19"W, 1481m); Proximities of Rancho La Bamba, municipality of Coyame (30°20'54.1"N, 105°20'20.3"W, 1550 m); Canyon near Rancho El Saucito, municipality of Coyame (29°34'14"N, 105°11'27"W, 1382 m)]. All localities fall within the Chihuahuan Desert Region, which is dominated by xerophytic shrubs such as Creosote Bush (*Larrea tridentata*), American Tarwort (*Flourensia cernua*), Mesquite (*Prosopis glandulosa*), Texas Sotol (*Dasyllirion texanum*) and Ocotillo (*Fouquieria splendens*), among other species. All study sites consisted of rocky foothills surrounded by wide valleys where these lizards found a suitable habitat.

Methods.—Lizards were captured with a noose from 0945 hrs to 1745 hrs from April to May 2007 and April to June 2008. We recorded the microhabitat where the lizard was first seen. Upon capture, we measured body temperature (T_b) to nearest 0.1°C using a quick-reading cloacal thermometer. We measured air temperature (T_a) to nearest 0.1°C one cm above substrate and substrate temperature (T_s) to nearest 0.1°C at the spot where the lizard was first seen. We measured snout-vent length (SVL) and tail length to the nearest mm using a plastic ruler. Sex was determined by checking for the presence of enlarged jaw muscles in the rear of the head in males compared with the female, and by the presence in males of one or more jet black spots on the sides of the body, between axilla and groin.

We used ANOVAs to compare SVL, T_b , T_a , and T_s between males and females. We used ANCOVA with SVL as the covariate to compare body mass and tail length between males and females (the interaction term was not significant, indicating homogeneity of slopes, and was removed from the analysis). Means are given \pm 1 SE.

Results and Discussion

Sexual Dimorphism.—Males of *Crotaphytus collaris* were larger than females in SVL (Table 1; $F_{1,100} = 37.22$, $P < 0.0001$). Males and females did not differ in body mass (Table 1; $F_{1,31} = 2.26$, $P = 0.14$). Body mass increased with SVL ($F_{1,31} = 63.5$, $P < 0.0001$). Tail length did not differ between males and females (Table 1; $F_{1,94} = 1.0$, $P = 0.31$). Tail length increased with SVL ($F_{1,94} = 206.9$, $P < 0.0001$).

Our results are consistent with previous reports that

Table 1. Means of several characteristics of male and female *Crotaphytus collaris* from northern Mexico (states of Chihuahua and Coahuila). Means are given ± 1 SE, n in parentheses. T_b = body temperature; T_a = air temperature; T_s = substrate temperature. All temperatures are Celsius.

	Males (63)	Females (39)
SVL (mm)	101.8 \pm 0.81	94.6 \pm 0.74
Body mass (g)	49.6 \pm 1.2	32.4 \pm 1.9
Tail length (mm)	316.3 \pm 1.7	289.4 \pm 2.3
T_b	38.0 \pm 0.3	38.7 \pm 0.3
T_a	27.8 \pm 0.8	28.7 \pm 0.9
T_s	35.3 \pm 0.8	36.6 \pm 1.1

males are larger than females in body size (Burt, 1928; Fitch, 1956; Best and Pfaffenberger, 1987; Sexton et al., 1992), suggesting that larger male body size is a general trait in *C. collaris*. However, the extent of the dimorphism may vary, even among geographically close populations. For example, McCoy et al. (1994) observed variation in the extent of sexual dimorphism among three populations of *C. collaris* in Oklahoma, although in all cases males were larger than females (see also Baird et al., 1997). Larger male size in *C. collaris* appears to be under intra-sexual selection (Baird et al., 1997), with male *C. collaris* defending territories from other males (Baird et al., 1996). Diet partitioning would appear unlikely to explain sexual dimorphism in *C. collaris* as males and females, while differing in diet composition, do not differ in the mean size or number of prey taken (Best and Pfaffenberger, 1987).

Microhabitat Use.—Most lizards were observed on rocks or rock piles (Table 2). Males and females used microhabitats in similar ways (Table 2). Mean SVL of lizards did not differ between microhabitats (Table 3; $F_{5,96} = 0.77$, $P = 0.57$).

Our observations are consistent with observations on *C. collaris* from other parts of their range. Fitch (1956) reviewed previous observations of habitat use of *C. collaris* and also reported observations of his own that indicate that rocky outcrops and rocks are important characteristics of *C.*

Table 2. Microhabitat use by *Crotaphytus collaris* from northern Mexico (states of Chihuahua and Coahuila).

Microhabitat	Total	Males	Females
Small rock	12	8	4
Medium rock	37	22	15
Large rock	29	20	9
Ground	6	2	4
Rock pile	16	9	7
Road	2	1	1

collaris habitats. *Crotaphytus collaris* in Missouri use rock perches throughout its activity season, with only rare use of other perches (Angert et al., 2002).

Temperature Relationships.—Mean T_b was $38.3 \pm 0.2^\circ\text{C}$ ($n = 102$). Body temperature increased with T_a ($n = 102$, $r^2 = 0.381$, $P < 0.0001$; $T_b = 31.5 + 0.239T_a$). Body temperature also increased with T_s ($n = 102$, $r^2 = 0.406$, $P < 0.0001$; $T_b = 30.4 + 0.22T_s$).

Males and females did not differ in T_b (Table 1; $F_{1,100} = 1.90$, $P = 0.17$), T_a (Table 1; $F_{1,100} = 0.59$, $P = 0.44$), or T_s (Table 1; $F_{1,100} = 0.84$, $P = 0.36$). Body temperature (Table 2; $F_{5,95} = 0.80$, $P = 0.55$), T_a (Table 3; $F_{5,95} = 2.10$, $P = 0.07$), and T_s (Table 3; $F_{5,95} = 1.65$, $P = 0.16$) did not differ among microhabitats. Body temperatures did not vary among months (Table 4; $F_{2,99} = 1.34$, $P = 0.27$). However, T_a (Table 4; $F_{2,99} = 13.2$, $P < 0.0001$) and T_s (Table 4; $F_{2,99} = 3.2$, $P = 0.044$) varied among months. This suggests that *C. collaris* are able to thermoregulate.

The range of T_b s we observed for *Crotaphytus collaris* in the Chihuahuan Desert matches the range of T_b (typically $35\text{--}40^\circ\text{C}$) found for other populations of *C. collaris* in the field (Fitch, 1956; Angert et al., 2002) or in laboratory gradients or outdoor runways (Firth et al., 1988, 1989; Sievert and Hutchison, 1989, 1991). Taken together, these results suggest most populations of *C. collaris* have similar temperature requirements.

Table 4. Monthly variation in body temperature, air temperature, and substrate temperature for *Crotaphytus collaris* from northern Mexico (states of Chihuahua and Coahuila). Means are given ± 1 SE, n in parentheses. T_b = body temperature; T_a = air temperature; T_s = substrate temperature. All temperatures are Celsius.

	April (41)	May (58)	June (3)
T_b	38.1 \pm 0.2	38.3 \pm 0.4	40.3 \pm 0.4
T_a	25.3 \pm 0.7	29.7 \pm 0.8	37.6 \pm 0.6
T_s	34.1 \pm 0.9	36.7 \pm 0.9	41.6 \pm 0.5

Table 3. Means of several characteristics of *Crotaphytus collaris* using different microhabitats. Means are given ± 1 SE, n in parentheses. T_b = body temperature; T_a = air temperature; T_s = substrate temperature. All temperatures are Celsius.

	Small rock (11)	Medium rock (37)	Large rock (29)	Ground (6)	Rock pile (16)	Road (2)
SVL (mm)	98.7 \pm 2.5	98.8 \pm 1.0	100.6 \pm 1.3	95.0 \pm 3.3	98.6 \pm 1.8	99.5 \pm 5.5
T_b	38.8 \pm 0.6	38.0 \pm 0.3	37.9 \pm 0.4	39.4 \pm 0.4	38.8 \pm 0.8	37.3 \pm 0.9
T_a	30.2 \pm 1.4	27.6 \pm 0.9	26.4 \pm 1.0	27.5 \pm 2.1	31.5 \pm 1.8	25.3 \pm 2.9
T_s	36.1 \pm 1.8	35.9 \pm 1.1	39.0 \pm 1.0	39.5 \pm 2.4	38.0 \pm 2.2	28.4 \pm 4.0

Literature Cited

- Angert, A. L., D. Hutchison, D. Glossip, and J. B. Losos. 2002. Microhabitat use and thermal biology of the Collared Lizard (*Crotaphytus collaris collaris*) and the fence lizard (*Sceloporus undulatus hyacinthinus*) in Missouri glades. *Journal of Herpetology* 36: 23–29.
- Baird, T. A., M. A. Acree, and C. L. Sloan. 1996. Age and gender-related differences in the social behavior and mating success of free-living Collared Lizards, *Crotaphytus collaris*. *Copeia* 1996: 336–347.
- Baird, T. A., S. F. Fox, and J. K. McCoy. 1997. Population differences in the roles of size and coloration in intra- and intersexual selection in the Collared Lizard, *Crotaphytus collaris*: Influence of habitat and social organization. *Behavioral Ecology* 8: 506–517.
- Baird, T. A., J. M. Hranitz, D. K. Timanus, and A. M. Schwartz. 2007. Behavioral attributes influence annual mating success more than morphological traits in male Collared Lizards. *Behavioral Ecology* 18: 1146–1154.
- Best, T. L. and G. S. Pfaffenberger. 1987. Age and sexual variation in the diet of Collared Lizards (*Crotaphytus collaris*). *Southwestern Naturalist* 32: 415–426.
- Burt, C. E. 1928. The sexual dimorphism of the Collared Lizard, *Crotaphytus collaris*. *Papers of the Michigan Academy of Science, Arts, and Letters* 10: 417–421.
- Firth, B. T., R. E. Maudlin, and C. L. Ralph. 1988. The role of the pineal complex in behavioral thermoregulation in the Collared Lizard *Crotaphytus collaris* under seminatural conditions. *Physiological Zoology* 64: 176–185.
- Firth, B. T., J. S. Turner, and C. L. Ralph. 1989. Thermoregulatory behaviour in two species of iguanid lizards (*Crotaphytus collaris* and *Sauromalus obesus*): diel variation and the effect of pinealectomy. *Journal of Comparative Physiology B* 159: 13–20.
- Fitch, H. S. 1956. An ecological study of the Collared Lizard (*Crotaphytus collaris*). University of Kansas Publications, Museum of Natural History 8: 213–274.
- Husak, J. F. and M. N. Rouse. 2006. Population variation in escape behavior and limb morphology of Collared Lizards (*Crotaphytus collaris*) in Oklahoma. *Herpetologica* 62: 156–163.
- Lemos-Espinal, J. A. and H. M. Smith. 2007. *Anfibios y Reptiles del Estado de Chihuahua, México/Amphibians and Reptiles of the State of Chihuahua, México*. CONABIO, México, xiv + 628 pp.
- McCoy, J. K., S. F. Fox, and T. A. Baird. 1994. Geographic variation in sexual dimorphism in the Collared Lizard, *Crotaphytus collaris* (Sauria: Crotaphytidae). *Southwestern Naturalist* 39: 328–335.
- Sexton, O. J., R. M. Andrews, and J. E. Bramble. 1992. Size and growth rate characteristics of a peripheral population of *Crotaphytus collaris* (Sauria: Crotaphytidae). *Copeia* 1992: 968–980.
- Sievert, L. M. and V. H. Hutchison. 1989. Influences of season, time of day, light and sex on the thermoregulatory behaviour of *Crotaphytus collaris*. *Journal of Thermal Biology* 14: 159–165.
- Sievert, L. M. and V. H. Hutchison. 1991. The influence of photoperiod and position of a light source on behavioral thermoregulation in *Crotaphytus collaris* (Squamata: Iguanidae). *Copeia* 1991: 105–110.

