THE SOUTHWESTERN NATURALIST 32(4):415-426 DECEMBER 9, 1987

AGE AND SEXUAL VARIATION IN THE DIET OF COLLARED LIZARDS (*CROTAPHYTUS COLLARIS*)

TROY L. BEST AND GARY S. PFAFFENBERGER

ABSTRACT—This study presents the first examination of relationships among morphologic variation and diet and the first food habit assessment for collared lizards (*Crotaphytus collaris*) inhabiting the Pedro Armendariz lava field, New Mexico. Coleoptera, Orthoptera, Hymenoptera, and Aranae formed the major portion of the diet during the two activity seasons studied. The 145 lizards consumed 63 categories of arthropods as well as eight individual lizards of the genera *Cnemidophorus* and *Phrynosoma*, one snake (*Sonora semiannulata*), an unidentified bird nestling, plant tissues, and small pebbles. Analyses revealed that adults and non-adults differed in body size and in size of food items ingested, but the kinds of food did not differ significantly between age classes. Males and females differed morphologically and in the kinds of foods eaten, but the size and numbers of food items were similar among sexes. Variables separating months were probably a reflection of insect phenology. Size and diet differences between sexes may act to reduce intraspecific competition for food resources.

Though widely distributed in New Mexico, the only data on food habits of collared lizards (*Crotaphytus collaris*) for the state were presented by Ruthven (1907) and Little and Keller (1937). There are no data on foods of populations that occur on lava fields in New Mexico, although *C. collaris* occurs on three large lava fields in southern New Mexico (Lewis, 1949, 1951; Best et al., 1983).

Studies of *Crotaphytus* food habits from throughout the range of the genus have usually been based upon examination of fewer than 20 specimens (e.g., Hallowell, 1856; Ruthven, 1907; Ruthven and Gaige, 1915; Camp, 1916; Cowles, 1920; Pack, 1923; Force, 1925; Burt, 1928*a*, 1933; Springer, 1928; Knowlton and Thomas, 1936; Little and Keller, 1937; Johnson et al., 1948; Fitch, 1956; Banta, 1960; Whitaker and Maser, 1981; McAllister and Trauth, 1982). However, the studies of Knowlton (1938) in Utah, Blair and Blair (1941) in Oklahoma, and McAllister (1985) in Arkansas and Missouri were based on 93, 91, and 238 specimens, respectively, and have provided insight into variation in the diet of *C. collaris*. McAllister (1985) evaluated seasonal, sexual, and age variation in his Arkansas-Missouri specimens, but no previous studies have evaluated food relationships as related to body size, age, and sex for a single population of *C. collaris*.

Burt (1928*b*) found males of *C. collaris* were larger than females in snout-vent length and head width. Otherwise, relatively little attention has been paid to describing sexual size variation in this species (e.g., Greenberg, 1945; Fitch, 1956, 1981). Morphologic studies have lumped sexes (e.g., Ingram and Tanner, 1971; Axtell, 1972) or used only males in analyses (e.g., Montanucci et al., 1975). No statistical tests have been conducted to assess the degree of secondary size dimorphism in this species. Perhaps size or species of food items ingested is related to body size of *C. collaris*.

Is sexual dimorphism reflected in size of prey items consumed? Are there differences in diet among sexes and ages? These relationships could give considerable insight into determining the degree of intraspecific segregation of food resources. The purposes of our study were to determine the food items consumed by *C. collaris* and to examine body size differences among age classes and sexes, age and sexual variation in diet, seasonal variation in diet, and relationships between body size and size and number of food items ingested.

MATERIALS AND METHODS—The 760,000 year old (Bachman and Mehnert, 1978) Pedro Armendariz lava field is located in Socorro and Sierra counties, New Mexico. It is 15-20 km in diameter and has one large crater near its center (elev. 1,566 m). The 3- to 5-m high edge of the black lava abruptly meets the sandy-soiled plains on all sides. The field is well vegetated with shrubs and grasses, and in many areas small lava pebbles form desert pavement between the plants. The herpetofauna has previously been described (Best et al., 1983; Best and James, 1984).

During April, July, and August of 1981 and May and June of 1982, 145 *C. collaris* were collected with .22 caliber no. 12 shot. All specimens were preserved in the field with 10% formalin, stored in 40% isopropanol, and deposited in the Eastern New Mexico University Natural History Museum, Portales. Stomach contents were later removed, placed into individual vials, and identified to family when possible. Araneae, Chilopoda, Lepidoptera, and Trichoptera not identified to family were entered into the data set as Araneae, Chilopoda, etc. Arthropod taxonomy follows Borror et al. (1981).

To estimate the largest prey items consumed, length and width of the largest food item in each stomach was measured to the nearest mm with dial calipers; in most cases, these measurements were on nearly intact bodies of prey taxa. Snout-vent length (SVL), greatest width of head, and length of head (from snout to the constriction behind the auditory openings) were measured with dial calipers to the nearest mm for each preserved collared lizard. Specimens were divided into adult and non-adult age groups by body size, and sex was verified by dissection. We followed Ingram and Tanner (1971) and assigned those with SVL less than 80 mm as non-adults. However, specimens up to 90 mm SVL have been considered non-adults (e.g., Montanucci et al., 1975). Though intraspecific geographic variation probably exists, examination of the reproductive organs indicated that the 80 mm length used by Ingram and Tanner (1971) was a reliable separation of age groups.

Means, sample sizes, and standard deviations of each morphologic character for each age group of males and females were determined. A single-classification analysis of variance (ANOVA) was used to compare age groups and sexes. Product-moment correlation coefficients were calculated between each of the prey size and number characters and each of the lizard body size characters for each sex and age. All statistically significant relationships referred to in the text have P values less than 0.05. Discriminant analyses were used to test for age, sexual, and seasonal variation in food habits. Best and Gennaro (1984) presented a summary and explanation of the use of discriminant analysis in food habit studies of lizards. Analyses were conducted using the IBM computer system at The University of New Mexico and SPSS (Nie et al., 1975) and UNIVAR (D. M. Power, pers. comm.) computer programs.

RESULTS—*Composition of Diet*—The kinds and numbers of food items in stomachs of 145 *C. collaris* are presented in Table 1. Arthropods represented by highest frequencies of occurrence (number of lizards containing a food category/total number of lizards × 100) were: Coleoptera, 79%; Orthoptera, 74%; Hymenoptera, 52%, Araneae, 40%; Hemiptera, 27%; Diptera, 21%; and Lepidoptera, 16%. In addition, 42% of the stomachs contained one or two small pebbles (ca. 5 mm diameter), and 17% contained plant material in the form of pieces of stems, leaves, flowers, or seeds. Although Coleoptera was represented by at least 16 families, there were more than three times as many Curculionidae as all other Coleoptera combined. Their frequency of occurrence was 66%, with 428 of these beetles counted. Orthoptera also was represented in greatest numbers by one family, Acrididae, which occurred in 71% of the stomachs. The most common hymenopteran family was

Table 1—Food items found in the stomachs of 145 collared lizards (*Crotaphytus collaris*) from the Pedro Armendariz lava field, New Mexico. Sample sizes are given in parentheses and occurrence data are presented as number of lizards containing a food category; total items of that category in the stomachs.

	1981				1982					
	Males	Females			Males		Females			
Food category	Adults (31)	Adults (37)	Non-adults (6)	Year total	Adults (35)	Non-adults (4)	Adults (18)	Non-adults (14)	Year total	Study total
ARTHROPODA										
Arachnida										
ARANEAE	11;23	12;18	2;5	25;46	18;34	2;2	7;12	6;10	33;58	58;104
Chilopoda	1;1	2;2		3;3	1;1		2;2	1;2	4;5	7;8
Insecta										
ORTHOPTERA										
Acrididae	25;47	31;62	4;5	60;114	18;34	4;4	11;20	10;20	43;78	103;192
Blattidae					1;1	1;1			2;2	2;2
Gryllidae	1;1	1;1	1;1	3;3	1;1			1;1	2;2	5;5
Mantidae	3;4			3;4	1;1				1;1	4;5
Tettigoniidae	2;2	2;3	1;1	5;6	2;2			1;1	3;3	8;9
HEMIPTERA										
Aradidae	1;3	1;1		2;4	2;2			1;1	3;3	5;7
Coreidae					1;1				1;1	1;1
Lygaeidae	2;2		1;7	3;9		1;1	1;1	1;1	3;3	6;12
Miridae					3;3		1;1		4;4	4;4
Pentatomidae	1;1			1;1				1;1	1;1	2;2
Phymatidae							1;1		1;1	1;1
Reduviidae		2;4		2;4	3;3	1;2	5;7	1;3	10;15	12;19
Scutelleridae	2;6			2;6	7;8		4;5	1;1	12;14	14;20
Thyreocoridae						1;1			1;1	1;1
HOMOPTERA										
Cicadidae							1;3		1;3	1;3

TABLE 1—*Continued.*

NEUROPTERA										
Myrmeleontidae	1;1			1;1	2;4		2;2	2;2	6;8	7;9
COLEOPTERA							1;1		1;1	1;1
Bruchidae	1;1	2;3	1;1	4;5			2;2		2;2	6;7
Buprestidae	1;1	3;4		4;5	4;4		3;5	4;4	11;13	15;18
Cantharidae							1;1		1;1	1;1
Carabidae		1;1		1;1	3;18		3;3	1;1	7;22	8;23
Chrysomelidae	4;4	2;2		6;6	2;2		1;1	1;1	4;4	10;10
Cicindelidae		1;2		1;2						1;2
Clambidae		1;1		1;1						1;1
Coccinellidae							1;1		1;1	1;1
Curculionidae	18;115	16;34	1;1	35;150	30;162	3;11	16;71	12;34	61;278	96;428
Elateridae					1;1	1;1	2;8	1;16	5;26	5;26
Histeridae		1;1		1;1						1;1
Meloidae		2;4		2;4	1;1		1;2		2;3	4;7
Melyridae	1;1			1;1	1;2				1;2	2;3
Scarabaeidae					1;1				1;1	1;1
Staphylinidae		1;1		1;1		1;1			1;1	2;2
Tenebrionidae	14;24	3;3		17;27	1;1			1;1	2;2	19;29
TRICHOPTERA								1;1	1;1	1;1
LEPIDOPTERA	2;4			2;4	1;1	1;1	1;1	2;4	5;7	7;11
Geometridae	2;2			2;2			1;1		1;1	3;3
Microlepidoptera		2;3		2;3	2;2		1;1		3;3	5;6
Noctuidae		1;1		1;1			2;2	1;1	3;3	4;4
Nymphalidae	3;7			3;7	1;1				1;1	4;8
Sphingidae		1;1		1;1						1;1
DIPTERA	1;1			1;1			1;2		1;2	2;3
Asilidae	11;12	11;11		22;23	2;3		1;1	1;1	4;5	26;28
Calliphoridae							2;2		2;2	2;2
Cuterebridae	1;1			1;1						1;1
Tipulidae								1;1	1;1	1;1

TABLE 1—*Continued.*

HYMENOPTERA							1;1		1;1	1;1
Andrenidae	1;3			1;3			1;1		1;1	2;4
Anthophoridae	1;1			1;1	2;4		1;1	1;1	4;6	5;7
Apidae	1;1			1;1						1;1
Braconidae	1;1			1;1	1;2		2;3		3;5	4;6
Chrysididae	1;1			1;1	1;1	1;1			2;2	3;3
Colletidae								1;1	1;1	1;1
Formicidae	2;23	2;4	1;11	5;38	2;3	1;10	2;20	1;1	6;34	11;72
Halictidae	1;1			1;1						1;1
Ichneumonidae							1;1		1;1	1;1
Megachilidae	1;1		1;1	2;2						2;2
Mutillidae							2;2		2;2	2;2
Pompilidae					1;1		2;2		3;3	3;3
Sphecidae	9;12	13;20	1;1	23;33	18;47	2;3	11;107	9;15	40;172	63;205
Tiphiidae					3;3			1;1	4;4	4;4
Vespidae		1;1		1;1			1;1		1;1	2;2
MISCELLANEOUS										
Lizards	2;3		2;2	4;5	1;1		1;1	1;1	3;3	7;8
Snakes					1;1				1;1	1;1
Birds	1;1			1;1						1;1
Plant tissue	5;5	3;3		8;8	13;13	1;1	6;10		20;24	28;32
Pebbles	11;14	14;18	4;6	29;38	20;30	2;8	5;5	6;9	33;52	62;90
Empty		1;1		1;1						1;1
Number of kinds of items/stomach	4.7	3.7	3.3	4.8	4.9	5.8	6.2	5.1	5.3	144;4.7
Total number of items/stomach	10.7	5.8	7.0	8.0	11.4	12.0	17.5	9.7	12.6	144;10.2

Sphecidae (44%) followed by Formicidae (8%). Hemiptera was represented by nine families at frequencies less than 10%; Reduviidae and Scutelleridae were more common. Diptera was represented by Asilidae, at 18% frequency, with only seven other individuals of at least three families. All categories of Lepidoptera were represented at frequencies less than 5%. Lizards found in the stomachs were six *Cnemidophorus* sp. and two small *Phrynosoma modestum*. The one snake, which was lacking its head, was 185 mm in length and appeared to be a fully adult *Sonora semiannulata*. The bird remains were of a nestling similar in size to a horned lark (*Eremophila alpestris*), an avian species that is common on the study area. For the 144 *C. collaris* with stomach contents, the average number of kinds of items in each stomach was 4.7. The average number of items per stomach was 10.2.

Age Differences—Results of the ANOVA between age groups (as defined by body size) are presented in Table 2. Since we separated adults from non-adult animals on the basis of snout-vent length, significant differences in this character were expected. In addition, there were statistically significant differences between ages for width and length of head. This established that adults are larger than non-adults, but is body size difference reflected in diet? ANOVA showed that length, width, and length x width of the largest food item were also significantly different between age groups. The size of the largest food items in non-adults was smaller than for adults. Thus, there is an indication that body size is related to size of the food items ingested.

The results of discriminant analyses between ages (sexes combined) are shown in Table 3. Almost 87% of the specimens were correctly classified, implying substantial differences between adult and non-adult lizards. Only 7% of the adults were misclassified, but about 50% of the non-adults were misclassified. Among the variables contributing most to the separation of age groups by discriminant analysis were Lygaeidae, Thyreocoridae, Trichoptera, Colletidae, and Elateridae. When age differences for males were analyzed separately, 100% of the specimens were correctly classified with Thyreocoridae, Staphylinidae, Reduviidae, Elateridae, and Lygaeidae being among the variables that contributed most to the separation. For females, 89% of the specimens were correctly classified with lizards, Lepidoptera, Braconidae, Myrmeleontidae, and Trichoptera contributing the most. All food categories separating age groups were represented by very low frequencies. Thus, discriminant analyses selected categories that were incidential in occurrence to separate age groups. If real differences existed between ages, the analyses should have shown separation by some of the more frequently occurring food categories for one or both age groups. Thus, age groups were not separated in subsequent analyses.

Sexual Differences—ANOVA also indicated statistically significant differences between males and females in SVL and width and length of head (Table 2). Males were larger than females in these characters, but similar analyses between sexes revealed no differences in the number of kinds of food items, the number of food items, and length, width, and length x width of food items. Thus, males and females exhibited significant sexual size variation, but there were no differences in size and number of food items ingested between sexes.

TABLE 2—Age and secondary sexual variation in *Crotaphytus collaris* from the Pedro Armendariz lava field, New Mexico.

Character	Character-state means[1]		Analysis of variance[2]	
			d.f.	*F*-ratio[3]
Age variation				
	All Adults	All Non-adults		
Snout-vent length	90.40	68.57	1,142	217.833***
Width of head	22.71	16.78	1,142	83.952***
Length of head	28.28	21.17	1,142	95.737***
No. kinds of food items	4.64	4.79	1,143	0.091
No. food items	10.38	9.42	1,143	0.261
Length of largest food item	19.99	11.71	1,143	4.574*
Width of largest food item	6.27	4.88	1,143	7.535**
Length x width of largest	145.76	62.50	1,143	4.125*
Secondary sexual variation				
	All Males	All Females		
Snout-vent length	93.80	86.33	1,119	75.386***
Width of head	24.64	20.40	1,119	139.138***
Length of head	30.42	25.71	1,119	135.103***
No. kinds of food items	4.82	4.42	1,119	0.869
No. food items	11.08	9.55	1,119	0.904
Length largest food item	21.29	18.44	1,119	0.698
Width largest food item	6.52	5.98	1,119	1.503
Length x width largest item	163.58	124.38	1,119	1.167

[1]Dimensions are in mm.
[2]One-way analysis of variance, groups compared pairwise for each character.
[3]Minimally significant difference assumed where $P \leq 0.05$ (*), $P \leq 0.01$ (**), and $P \leq 0.001$ (***).

Discriminant analyses correctly classified 82% of specimens to sex (Table 3), with Curculionidae, plant tissue, Tenebrionidae, Mantidae, and Mutillidae contributing most to the separation. Because the first three of these variables are among the most common food items found in the stomachs, we believe this separation is valid. An examination of Table 1 reveals that males ate more curculionid beetles, plant tissue, and tenebrionid beetles than did females. Thus, males and females differed in diet composition.

Seasonal Differences—Discriminant analysis between months correctly classified 66% of the animals (Table 3). Separate analyses of data for males and females increased the correct classification of specimens to above 80% for both sexes. Curculionidae contributed the most to the separation of months in the three analyses. As noted previously, the samples from May and June were collected in 1982, and those from April, July, and August were collected in 1981. Though monthly differences are present, they cannot be separated from annual variation. There are changes in the available insect fauna from one month to the next, but this needs study.

Correlations Among Characters—Because of significant differences in body size for adults and non-adults of both sexes, Pearson product-moment correlation coefficients between morphologic characters (SVL, width and length of head) and food number and size characteristics (number of kinds of items, number of items, length and width of largest item, length x width of the largest item) were calculated separately for each of these groups of

TABLE 3—Discriminant analyses among *Crotaphytus collaris* from the Pedro Armendariz lava field, New Mexico.

Actual group	N cases	Predicted group membership				
Between ages						
All specimens[1,2]			*Adults*		*Non-adults*	
Adults	121		113 (93.4%)		8 (6.6%)	
Non-adults	24		11 (45.8%)		13 (54.2%)	
Between sexes						
All specimens[3]			*Males*		*Females*	
Males	70		51 (72.9%)		19 (27.1%)	
Females	75		7 (9.3%)		68 (90.7%)	
Between months						
All specimens[4]		*April*	*May*	*June*	*July*	*August*
April	6	6 (100%)	0	0	0	0
May	53	0	36 (67.9%)	7 (13.2%)	9 (17.0%)	1 (1.9%)
June	18	0	2 (11.1%)	8 (44.4%)	8 (44.4%)	0
July	53	0	4 (7.5%)	2 (3.8%)	41 (77.4%)	6 (11.3%)
August	15	0	1 (6.7%)	0	9 (60.0%)	5 (33.3%)
All males[5]		*April*	*May*	*June*	*July*	*August*
April	6	6 (100%)	0	0	0	0
May	30	0	24 (80.0%)	1 (3.3%)	5 (16.7%)	0
June	9	0	0	8 (88.9%)	1 (11.1%)	0
July	18	0	0	0	16 (88.9%)	2 (11.1%)
August	7	0	3 (42.9%)	0	1 (14.3%)	3 (42.9%)
All females[6]			*May*	*June*	*July*	*August*
May	23		19 (82.6%)	0	4 (17.4%)	0
June	9		0	7 (77.8%)	2 (22.2%)	0
July	35		0	0	33 (94.3%)	2 (5.7%)
August	8		0	0	5 (62.5%)	3 (37.5%)

[1]The data in subsequent footnotes are given as: percent of the specimens that were correctly classified; in decreasing order of importance, the variables accounting for most or all of the differences.

[2]86.9%; Lygaeidae, Thyreocoridae, Trichoptera, Colletidae, Elateridae, pebbles, Lepidoptera, Megachilidae, Curculionidae, Asilidae.

[3]82.1%; Curculionidae, plant tissue, Tenebrionidae, Mantidae, Mutillidae, Chilopoda, snakes, Scutelleridae, Hymenoptera, Miridae.

[4]66.2%; Curculionidae, Nymphalidae, Lepidoptera, Cuterebridae, Aradidae, Scarabaeidae, Coreidae, pebbles, Tiphiidae, plant tissue.

[5]81.1%; Curculionidae, Nymphalidae, Lepidoptera, Cuterebridae, Scarabaeidae, Chrysididae, Megachilidae, Halictidae, Aradidae, pebbles.

[6]82.7%; Curculionidae, Asilidae, Myrmeleontidae, Meloidae, Noctuidae, Elateridae, Cicadidae, Braconidae, Geometridae, Andrenidae.

lizards. For adult males, adult females, and non-adult females the three morphologic characters were highly significantly correlated, but for non-adult males the only significant relationship was between SVL and length of head.

Among the food number and size characteristics (listed in Table 2), adult males had significant relationships among all characters, except between number of items and width of largest food item ($P > 0.07$). Non-adult males had a significant relationship only between length of largest food item and length x width of largest item. For adult females, total number of items and length of largest food item were correlated, as well as length and width of largest food item, and length and width of largest food item with length x width of largest food item. Non-adult females had significant correlations between number of kinds of items and number of items, as well as length and width of largest food item, and length and width of largest food item with length x width of largest food item.

When comparisons were made between morphologic characters and food number and size characteristics adult males had significant correlations between SVL and number of kinds of items and number of items; non-adult males had significant correlations between width of head and number of items, and length of head and number of items. For adult females, SVL was correlated with number of kinds of items and number of items, and length of head was correlated with number of kinds of items and number of items; non-adult females had significant correlations between SVL and number of kinds of items and number of items, width of head and number of items, and length of head and number of kinds of items and number of items.

DISCUSSION—There is a paucity of food habit data available for *C. collaris* in New Mexico. Little and Keller (1937) reported a *Phrynosoma modestum*, cicadas, a grasshopper, and insect fragments from a specimen collected in Dona Ana Co., and Ruthven (1907) noted that the diet near Alamogordo consisted exclusively of insects, including grasshoppers, beetles, and locusts. In spite of its widespread distribution and conspicuous nature in New Mexico, food habits of this species have not been studied in detail until now. In other parts of its range *Crotaphytus* has been reported to consume a wide variety of prey species, including grasshoppers, beetles, and other insects (Hallowell, 1856; Ruthven, 1907; Ruthven and Gaige, 1915; Camp, 1916; Pack, 1923; Force, 1925; Burt, 1928*a*; Woodbury, 1928; Springer, 1928; Knowlton and Thomas, 1936; Little and Keller, 1937; Knowlton, 1938; Blair and Blair, 1941; Johnson et al., 1948; Fitch, 1956; Ruppert, 1980; Whitaker and Maser, 1981; McAllister, 1985). More unusual items include *Lycium* berries (Banta, 1960), other lizards (Cowles, 1920; Burt, 1928*a*, 1933; Woodbury, 1928; Little and Keller, 1937; Klauber, 1939; Johnson et al., 1948; Fitch, 1956; Banta, 1960; McAllister, 1985), snail shells (Blair and Blair, 1941; McAllister, 1985), and a small mammal (McAllister and Trauth, 1982). We found a similar diversity of foods ingested by collared lizards: spiders, centipedes, more than 60 taxa of insects, lizards, a snake, a bird, plant tissue (stems, leaves, flowers, seeds), and pebbles.

Sand grains and small rocks were found in the stomachs of lizards examined by Pack (1923), Burt (1928*a*), Knowlton and Thomas (1936), and McAllister (1985); Johnson (1966) indicated that such particles may function as abrasive agents to aid in the maceration of arthropod exoskeletons. Because of their frequency, rather uniform size, and occurrence of either one or two pebbles, we agree that they are probably useful in breaking up food items.

McAllister (1985) pointed out that availability, rather than preference, dictates the numbers and kinds of prey species eaten by *C. collaris*. Collared lizards seem to be opportunistic feeders, as they take such a wide variety of prey taxa and size classes. However, they consistently consume orthopterans, coleopterans, arachnids, lepidopterans, and hymenopterans.

McAllister (1985) found the diet of hatchling and juvenile collared lizards was less varied than that of adults, and their stomachs contained only small grasshoppers, true bugs, and jumping spiders. He attributed differences between age groups to the synchronous timing of hatching and increased availability of certain prey, especially grasshoppers. We also found the diet of non-adults was less varied than that of adults, but we attribute some of this difference to the smaller sample size for non-adults. To separate ages, discriminant analyses tended to select uncommon items that were found in only one age class. While this gave a high level of separation, it did not truly reflect relationships among age groups. The major food categories consumed by adults were also consumed by non-adults, and in about the same numbers of kinds and items. When size of food items were compared, however, there were significant differences between adult and non-adult lizards. Non-adults ate statistically significantly smaller food items than adults. This is to be expected since they do not have the body size to handle larger prey. Thus, non-adults and adults ate the same prey taxa, but significantly different size classes. Our findings agree with McAllister (1985) in regard to diversity and size of prey, indicating that *C. collaris* may have a similar relationship among age groups throughout its range.

Burt (1928*a*) and Fitch (1981) found secondary sexual size difference in collard lizards; we found males were significantly larger than females in SVL and width and length of head. No previous studies have attempted to relate secondary sexual size variation in *C. collaris* to food habit data. McAllister (1985) found no preference for prey items between sexes in his Arkansas-Missouri study. We found no differences between sexes in number of kinds of food items, number of food items, and size of food items. However, we did find differences in prey items eaten by each sex. Thus, males and females eat the same numbers and sizes of food items, but the kinds of food items differ somewhat. We did not find evidence that males were consuming items that were totally different from females, but the two sexes ate different proportions of various food categories, i.e., Curculionidae, plant tissue, Tenebrionidae, Mantidae, Mutillidae, etc., that were used to separate sexed by discriminant analyses. Perhaps the sexes forage differently and are exposed to different food typed, or males and females may actually prefer different foods. There is considerable overlap in food habits between sexes.

Seasonal variation in diet was observed by Fitch (1956) and McAllister (1985). Our study suggests seasonal changes in diet of *C. collaris* that are related to seasonal changes in abundance of insect taxa. Data on seasonal abundance of insects need to be collected and compared to diet variation to properly assess this relationship.

In summary, we have provided the first detailed listing of foods consumed by a population of *C. collaris* in New Mexico, determined that adults and non-adults eat different sizes of the same food items, shown that there is secondary sexual size variation in collared lizards, found that males eat different proportions but the same numbers and size of prey items as females, and that there is seasonal and possibly annual variation in the diet of this species. Additional studies are needed to determine food availability, relationships with other species, and the selective advantages to separation of food types consumed (whether food taxa, sizes, or numbers) among ages and sexes. Age and sexual differences in diet may act to reduce intraspecific competition for food in this species.

W. R. Barber, D. G. Beard, F. H. Best, H. C. James, H. F. Pearson, and F. W. Weckerly gave valuable assistance in the field. B. N. Best assisted in recording data. N. J. Scott, Jr., and J. D. Stuart verified our identifications of the vertebrate remains in the stomachs. C. Intress and T. E. Garrison assisted in proofreading. F. W. Judd, J. O. Whitaker, Jr., and an anonymous reviewer provided numerous suggestions that greatly improved the manuscript.

Literature Cited

Axtell, R. W. 1972. Hybridization between western collard lizards with a proposed taxonomic rearrangement. Copeia, 1972:707-727.

Bachman, G. O., and H. H. Mehnert. 1978. New K-Ar dates and the late Pliocene to Holocene geomorphic history of the central Rio Grande region, New Mexico. Geol. Soc. Amer. Bull., 89:283-292.

Banta, B. H. 1960. Notes on the feeding of the western collared lizard, *Crotaphytus collaris baileyi* Stejneger. Wasmann J. Biol., 18:309-311.

Best, T. L., and A. L. Gennaro. 1984. Feeding ecology of the lizard, *Uta stansburiana*, in southeastern New Mexico. J. Herpetol., 18:291-301.

Best, T. L., and H. C. James. 1984. Rattlesnakes (genus *Crotalus*) of the Pedro Armendariz lava field, New Mexico. Copeia, 1984:213-215.

Best, T. L., H. C. James, and F. H. Best. 1983. Herpetofauna of the Pedro Armendariz lava field, New Mexico. Texas J. Sci., 35:245-255.

Blair, W. F., and A. P. Blair. 1941. Food habits of the collared lizard in northeastern Oklahoma. Amer. Midland Nat., 26:230-232.

Borror, D. J., D. M. DeLong, and C. A. Triplehorn. 1981. An introduction to the study of insects. Saunders College Publ., New York, 827 pp.

Burt, C. E. 1928*a*. Insect food of Kansas lizards with notes on feeding habits. J. Kansas Entomol. Soc., 1:50-68.

——. 1928*b*. The sexual dimorphism of the collared lizard, *Crotaphytus collaris*. Papers Michigan Acad. Sci. Arts Letters, 10:417-421.

——. 1933. Some distributional and ecological records of Kansas reptiles. Trans. Kansas Acad. Sci., 36:186-208.

Camp, C. L. 1916. Notes on the local distribution and habits of the amphibians and reptiles of southeastern California in the vicinity of the Turtle Mountains. Univ. California Publ. Zool., 12:503-544.

Cowles, R. B. 1920. A list and some notes on the lizards and snakes represented in the Pomona College Museum. J. Entomol. Zool., 12:63-66.

Fitch, H. S. 1956. An ecological study of the collared lizard (*Crotaphytus collaris*). Univ. Kansas Publ., Mus. Nat. Hist., 8:213-274.

——. 1981. Sexual size differences in reptiles. Misc. Publ. Mus. Nat. Hist., Univ. Kansas, 70:1-72.

Force, E. R. 1925. Notes on reptiles and amphibians of Okmulgee County, Oklahoma. Copeia, 141:25-27.

Greenberg, B. 1945. Notes on the social behavior of the collared lizard. Copeia, 1945:225-230.

Hallowell, E. 1856. Notice on a collection of reptiles from Kansas and Nebraska, presented to the Academy of Natural Sciences, by Dr. Hammond, U.S.A. Proc. Acad. Nat. Sci., Philadelphia, 8:238-253.

Ingram, W., III, and W. W. Tanner. 1971. A taxonomic study of *Crotaphytus collaris* between the Rio Grande and Colorado Rivers. Brigham Young Univ. Sci. Bull., Biol. Ser., 13:1-29.

Johnson, D. R. 1966. Diet and estimated energy assimilation of three Colorado lizards. Amer. Midland Nat., 76:504-509.

JOHNSON, D. H., M. D. BRYANT, AND A. H. MILLER. 1948. Vertebrate animals of the Providence Mountains area of California. Univ. California Publ. Zool., 48:221-376.

KLAUBER, L. M. 1939. Notes on some lizards of the southwestern United States. Bull. Zool. Soc. San Diego, 14:80-100.

KNOWLTON, G. F. 1938. Lizards in insect control. Ohio J. Sci., 38:235-238.

KNOWLTON, G. F., AND W. L. THOMAS. 1936. Food habits of Skull Valley lizards. Copeia, 1936:64-66.

LEWIS, T. H. 1949. Dark coloration in the reptiles of the Tularosa malpais, New Mexico. Copeia, 1949:181-184.

——. 1951. Dark coloration in the reptiles of the malpais of the Mexican border. Copeia, 1951:311-312.

LITTLE, E. L., JR., AND J. G. KELLER. 1937. Amphibians and reptiles of the Jornada Experimental Range, New Mexico. Copeia, 1937:216-222.

MCALLISTER, C. T. 1985. Food habits and feeding behavior of *Crotaphytus collaris collaris* (Iguanidae) from Arkansas and Missouri. Southwestern Nat., 30:597-600.

MCALLISTER, C. T., AND S. E. TRAUTH. 1982. An instance of the eastern collared lizard, *Crotaphytus collaris collaris* (Sauria: Iguanidae) feeding on *Sigmodon hispidus* (Rodentia: Cricetidae). Southwestern Nat., 27:358-359.

MONTANUCCI, R. R., R. W. AXTELL, AND H. C. DESSAUER. 1975. Evolutionary divergence among collared lizards (*Crotaphytus*), with comments on the status of *Gambelia*. Herpetologica, 31:336-347.

NIE, N. H., C. H. HULL, J. G. JENKINS, K. STEINBRENNER, AND D. H. BENT. 1975. Statistical package for the social sciences (SPSS). McGraw-Hill Book Company, New York, 675 pp.

PACK, H. J. 1923. Food habits of *Crotaphytus collaris baileyi* (Stejneger). Proc. Biol. Soc. Washington, 36:83-84.

RUPPERT, R. M. 1980. Comparative assimilation efficiencies of two lizards. Comp. Biochem. Physiol., 67A:491-496.

RUTHVEN, A. G. 1907. A collection of reptiles and amphibians from southern New Mexico and Arizona. Bull. Amer. Mus. Hat. Hist., 23:483-603.

RUTHVEN, A. G., AND H. T. GAIGE. 1915. The reptiles and amphibians collected in northeastern Nevada by the Walker-Newcomb Expedition of the University of Michigan. Occas. Papers Mus. Zool., Univ. Michigan, 8:1-33.

SPRINGER, S. 1928. An annotated list of the lizards of Lee's Ferry, Arizona. Copeia, 169:100-104.

WHITAKER, J. O., JR., AND C. MASER. 1981. Food habits of seven species of lizards from Malheur County, southeastern Oregon. Northwest Sci., 55:202-208.

WOODBURY, A. M. 1928. The reptiles of Zion National Park. Copeia, 166:14-21.

Address of authors: (TLB) *Dept. of Biol. and Mus. of Southwestern Biol., The Univ. of New Mexico, Albuquerque, NM 87131;* (GSP) *Dept. of Life Sci., Eastern New Mexico Univ., Portales, NM 88130.*