DIET AND SEXUAL DIMORPHISM OF THE DESERT IGUANA, *DIPSOSAURUS DORSALIS,* FROM SONORA, MEXICO

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ABSTRACT.—We examined the diet and sexual dimorphism of the desert iguana, *Dipsosaurus dorsalis,* from Sonora, Mexico. The diet consisted primarily of vegetation, with insect material contributing little to the overall volume of the diet. Plant matter was restricted to leaves and seeds. Animal prey consisted mostly of ants, termites, and beetles. Males and females did not differ significantly in snout–vent length, head length, or head width. These results confirm that in general *D. dorsalis* is herbivorous and not sexually dimorphic through much of its range.

Key words: diet, sexual dimorphism, desert iguana, Dipsosaurus dorsalis, *herbivory, insectivory.*

RESUMEN.—Examinamos la dieta y dimorfismo sexual de la Iguana del Desierto, *Dipsosaurus dorsalis,* en Sonora, México. La dieta consistió principalmente de vegetales, con insectos contribuyendo poco al volumen total de ésta. La materia vegetal estuvo restringida a hojas y semillas. Las presas animales consistieron principalmente de hormigas, termitas, y escarabajos. Machos y hembras no difirieron significativamente en longitud hocico cloaca, longitud de la cabeza, o ancho de la cabeza. Estos resultados confirman que en general *D. dorsalis* es una especie herbívora que no presenta dimorfismo sexual en la mayor parte de su intervalo de distribución.

Palabras clave: dieta, dimorfismo sexual, iguana del desierto, herbívoro, insectívoro.

The desert- and arid-scrubland-dwelling desert iguana, *Dipsosaurus dorsalis,* is mainly herbivorous but will occasionally consume insects, fecal matter, and carrion (Norris 1953, Asplund 1967, Minnich and Shoemaker 1970, Pianka 1971). However, previous studies on the diet of *D. dorsalis* have found variation among populations in the extent of omnivory. For example, in some populations adult diets are composed of >80% plant material (Norris 1953, Pianka 1971, Mautz and Nagy 1987), but in at least one population a much more omnivorous diet, composed of 54% plant material (Asplund 1967), has been observed. Thus the diet composition of *D. dorsalis* appears to show some degree of intraspecific variation. Indeed, the population with the greatest degree of omnivory is the southernmost population examined (Asplund 1967), suggesting that there may be a latitudinal gradient in herbivory in *D. dorsalis.* However, we are unaware of any reports on the diet of *D. dorsalis* from northern Mexico. We therefore examined the diet of *D. dorsalis* from Sonora, Mexico, to help determine the extent of intraspecific variation in diet composition.

We also examined sexual dimorphism in *D. dorsalis* from this population. Carothers (1984) found no sexual dimorphism in body or head size in *D. dorsalis,* but intraspecific variation in sexual dimorphism has been observed in some other lizard species (McCoy et al. 1994, Molina-Borja et al. 1997). Therefore, it is useful to examine other populations of *D. dorsalis* to determine if there is any intraspecific variation in sexual dimorphism in this species.

Dipsosaurus dorsalis individuals ($n = 56$) were collected near Ortiz, Sonora, Mexico (28°17′23.0″N, 119°43′0.8″W) during summer 2005 as part of a geographic survey of the herpetofauna of the Sonoran and Chihuahuan deserts and nearby regions (Smith et al. 2005). Specimens were humanely euthanized, fixed in formalin, and preserved in 90% ethanol. Specimens were deposited in the Colección Herpetológica of the Laboratorio de Ecología of the Unidad de Biotecnología y Prototipos of the Facultad de Estudios Superiores Iztacala-UNAM. We measured snout–vent length (SVL), head length (HL), and head width (HW) to the nearest 0.1 mm using digital calipers. Stomachs

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TABLE 1. Diet of 57 desert iguanas, *Dipsosaurus dorsalis*, from Sonora, Mexico. Because one stomach was empty, frequencies were created using $n = 56$.

Prey taxon	Stomachs		Items		Volume	
	n	%	Freq.	%	cm³	%
INVERTEBRATES						
Insecta						
Coleoptera	12	21.43	13	6.02	1.46	2.05
Larvae	2	3.57	3	1.39	0.07	0.11
Diptera	2	3.57	2	0.93	0.38	0.53
Hymenoptera						
Ants	24	42.86	154	71.29	1.14	1.60
Wasps	1	1.78	1	0.46	0.04	0.06
Isoptera	5	8.93	42	19.44	0.60	0.85
Orthoptera	1	1.78	1	0.46	0.13	0.18
VEGETATION						
Leaves	51	91.07	—	—	43.40	60.96
Seeds	36	64.28	—	—	17.75	24.93
Other	17	30.36	—	—	6.22	8.74
TOTAL	56		216		71.19	

TABLE 2. Mean snout–vent length (SVL), head length (HL), head width (HW), prey length (PL), prey width (PW), and proportion vegetation consumed (prop. veg.) of male and female desert iguanas, *Dipsosaurus dorsalis*, from Sonora, Mexico. Means are given with one standard error; sample sizes are in parentheses.

	Males	Females
SVL (mm)	98.8 ± 3.3 (29)	90.8 ± 3.4 (27)
HL (mm)	11.1 ± 0.3 (29)	10.1 ± 0.3 (27)
HW (mm)	15.9 ± 0.2 (29)	14.5 ± 0.2 (27)
PL (mm)	10.8 ± 1.1 (13)	6.4 ± 1.2 (12)
PW (mm)	3.86 ± 0.44 (13)	2.76 ± 0.46 (12)
Prop. veg.	0.932 ± 0.024 (29)	0.932 ± 0.026 (26)

were removed and prey identified to the lowest possible taxonomic level, usually order. We divided plant material into leaves, seeds, and unknown vegetation and used volumetric displacement to determine the volume of vegetation in the stomach. We measured the length and width of invertebrate prey items to the nearest 0.1 mm using digital calipers and calculated insect volumes using the expression for a prolate spheroid (Vitt et al. 2005). We calculated niche breadth based on volume (with seeds, leaves, and unidentified plant material represented as a prey category) for each individual, using the reciprocal of Simpson's Index (Krebs 1989). ANOVA was used to compare SVL and the proportion of plants in the diet between males and females, and ANCOVA with SVL as a covariate was used to compare HW, HL, prey size, and stomach volume be-

tween males and females. In all cases the interaction between sex and SVL was not significant and was not included in the final ANCOVA model. Proportion data were arcsine transformed prior to analyses. In the results, means are accompanied by one standard error.

Diets of 56 *D. dorsalis* consisted of both plant and animal material (Table 1). Plant matter composed 94.6% of the total volume of *D. dorsalis* diets, with leaves being the predominant category (43.4%). Less than half (25 of 55; 45%) of the adults had animal prey in their stomachs. Numerically, ants were the most important animal prey item (154 items in 24 stomachs) but contributed little to the total volume of the stomach contents (1.60%). We found no statistically significant relationship between adult SVL and proportion of vegetation eaten ($n = 55$, $r^2 = 0.026$, $P = 0.24$).

Mean reciprocal Simpson's index was 1.87 ± 0.09 ($n = 56$). Males and females had similar mean reciprocal Simpson's indices (males 1.91 ± 0.12, females 1.85 ± 0.13; $F_{1,53} = 0.11$, $P = 0.74$). The reciprocal Simpson's index increased with SVL ($n = 56$, $r^2 = 0.18$, $P = 0.0012$; $1/D = 0.46 + 0.015\,SVL$).

For individuals that consumed animal prey, mean prey length increased with SVL ($n = 26$, $r^2 = 0.24$, $P = 0.0103$; mean prey length = $-0.11 + 0.010\,SVL$). Similar trends were seen for mean prey width and SVL ($n = 26$, $r^2 = 0.21$, $P = 0.017$; prey width = $-0.0081 + 0.0036\,SVL$), and for total stomach volume and SVL ($n = 57$, $r^2 = 0.102$, $P = 0.015$; volume = $-0.12 + 0.015\,SVL$).

Males consumed longer insect prey than females did (Table 2; $F_{1,22} = 9.1$, $P = 0.006$). Mean prey width did not differ between males and females (Table 2; $F_{1,22} = 3.0$, $P = 0.10$). The proportion of vegetation eaten by males was not significantly different from that eaten by females (Table 2; $F_{1,53} < 0.01$, $P = 1.0$).

Snout–vent length did not differ significantly between males and females (Table 2; $F_{1,54} = 2.79$, $P = 0.10$). Male and female head size did not significantly differ (Table 2; HL: $F_{1,53} = 0.76$, $P = 0.40$; HW: $F_{1,53} = 0.87$, $P = 0.35$).

Our results indicate that *D. dorsalis* from Sonora is primarily herbivorous, with almost 95% of the diet consisting of plant material. The relatively low reciprocal Simpson's index values are consistent with a relatively narrow diet. Pianka (1971) found a similar diet composition for *D. dorsalis* from the southwestern

United States, recording 94.2% vegetative material by volume. Norris (1953) observed volumetric percentages of vegetation from 80%–95% for *D. dorsalis* from California. Mautz and Nagy (1987) found that *D. dorsalis* from California ate only 1% invertebrate prey. In contrast, Asplund (1967) found that *D. dorsalis* from southern Baja California had only 59% plant material in their diet. Taken together, these results from the literature and our observations on the diet of *D. dorsalis* from Sonora suggest that if there is a latitudinal trend in herbivory in *D. dorsalis,* it has a rather rapid shift. It seems more likely that there is something unique about the southern Baja California population of *D. dorsalis* studied by Asplund (1967), and further study of that population may elucidate why it is more omnivorous than other populations of *D. dorsalis.*

Smaller or juvenile *D. dorsalis* may consume insects and then switch to herbivorous diets as they grow (Asplund 1967, Sokol 1967, Pianka 1971). Asplund (1967) found that 68% of stomach contents from 12 juvenile (SVL < 65 mm) *D. dorsalis* was animal material, while only 41% was animal material in adults. Our specimens contained only one individual classified as a juvenile based on Asplund's criteria, and its stomach contained only insects. While our research is consistent with an ontogenetic shift in diet, the small sample size for juveniles makes conclusions tenuous. However, the increase in the reciprocal Simpson's index values with increases in SVL suggests that larger individuals do consume broader diets than smaller individuals, but SVL explains relatively little of the variation in the lizard diets.

Male and female *D. dorsalis* did not differ in body or head size in our specimens from Sonora. This is consistent with the one other study on sexual dimorphism in *D. dorsalis* (Carothers 1984). Thus it appears a lack of sexual dimorphism may be characteristic of *D. dorsalis.* Carothers (1984) offered an explanation for this lack of differences, proposing that *D. dorsalis,* an herbivorous species with low levels of male aggression, would have little selective pressure for dimorphism in head size. However, there does appear to be some male–male aggressive behavior that includes direct confrontation and fighting (Norris 1953).

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