HERBIVORY IN THE LIZARD *Sceloporus mucronatus mucronatus* (SAURIA: PHRYNOSOMATIDAE) IN SIERRA DEL AJUSCO, DISTRITO FEDERAL, MEXICO *

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ABSTRACT

In this paper we document the omnivorous diet of a population of *Scelopurus mucronatus mucronatus*. The study site was located in Sierra del Ajusco, Distrito Federal, Mexico, near kilometer 24.5 on the Ajusco-Tianguistenco highway, the study site was a pine forest (*Pinus hartwegii* Lindl) with a considerable amount of basaltic rocks and lava where *S. m. mucronatus* were easily observed. To ensure full stomach contents collection time was between 11:00 and 13:00 hours after the typicall morning feeding period. Using analysis of variance (ANOVA) and by Shannon-Wiener Index, diversity of stomach contents by volume and the difference in the proportion of plant material consumed between sexes were obtained. It was found a 38.7% plant material and 58.6% of arthropods, insects principally, the remaining 2.7% of the total volume was represented by a lizard *Barisia imbricata*, that was found in an adult male, that suggets incidental predation acts.

Key words: *Sceloporus mucronatus mucronatus*, herpetology, reptilians, Sierra del Ajusco, Mexico.

* Nota científica

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RESUMEN

En este trabajo se documenta la dieta omnívora de una población de lagartijas *Sceloporus mucronatus mucronatus*. El área de estudio se estableció en la Sierra del Ajusco, Distrito Federal, México, cerca del kilómetro 24.5 de la carretera Ajusco-Tianguistenco, con bosque dominante de *Pinus hartwegii* Lindl rodeado de rocas basálticas, lo que permitió observar al *S. mucronatus* con facilidad. Se capturaron especímenes entre las 11:00 y 13:00 hrs, el cual es su periodo típico de ingestión de alimentos. Mediante el análisis de varianza (ANOVA) y el Índice de Shannon-Wiener fue como se obtuvo la diversidad de contenidos estomacales por volumen y la diferencia de proporción de consumo vegetal por sexos, donde se detectó un 38.7% de materia vegetal y 58.6% de artrópodos, principalmente insectos; en el 2.7% restante, se encontraron residuos de la lagartija *Barisia imbricata* alojados en un macho adulto, lo cual supone actos depredatorios ocasionales.

Palabras clave: *Sceloporus mucronatus mucronatus*, herpetología, reptiles, Sierra del Ajusco, México.

By its direct effect on life history components (growth, reproduction, maintainance, and storage) food intake is highly important to lizard life histories. Most lizards are insectivorous, but increasing proportions of plant material are ingested by large lizard species (Abts, 1987[1], Auffenberg, 1982[2], Iverson, 1982[3], McBee *and* McBee, 1982[4]). Herbivory in lizards may have evolved in large species as a result of the low success when compiting with mammals for small vertebrates (Pough, 1973[5]), although plant ingestion has been reported for medium and small lizard species (Ballinger *et al*. 1977[6], Burquez *et al*., 1986[7], Mautz *and* Lopez-Forment, 1978[8], Méndez *and* Villagrán, 1983[9]).

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[1] Abts, M. L. 1987. Environmental and variation in life history traits of the chuckwalla, *Sauromaulus obesus*. 57: 215-232.

[2] Auffenberg, W. 1982. Feeding strategy of the Caicos ground iguana *Cyclula carinata*. pp:84-116.

[3] Iverson, J. B. 1982. Adaptations to herbivory in iguanine lizards. pp. 60-76.

[4] McBee, R. H., *and* V. H. McBee. 1982. The hindgut fermentation in the green iguana, *Iguana iguana*. pp. 77-83.

[5] Pough, F. H. 1973. Lizard energetics and diet. 54: 837-854.

[6] Ballinger, R. E., M. E. Newlin, *and* S. J. Newlin. 1977. Age specific shift in the diet of the crevice spiny lizard *Sceloporus poinsetti* in Southwestern New Mexico. 97: 482-484.

[7] Burquez, A., O. Flores-Villela, *and* A. Hernández. 1986. Herbivory in a small iguanid lizard, *Sceloporus torquatus torquatus*. 20: 262-264.

[8] Mautz, W. J., *and* W. Lopez-Forment. 1978. Observations on the activity and diet of the cavernicolous lizard *Lepidophyma smithii* (Sauria: Xantusidae). 34: 311-313.

[9] Méndez, F. R., y M. Villagrán. 1983. Contribución al conocimiento de la ecología y ciclo reproductor de la lagartija vivípara *Sceloporus mucronatus mucronatus*.

Therefore, herbivory or at least omnivory may be more important in lizards than previously believed. In this paper we document the omnivorous diet of a population of *Sceloporus mucronatus mucronatus* in Sierra del Ajusco, Distrito Federal, Mexico.

Sceloporus mucronatus mucronatus (Cope) is a medium to large phrynosomatid lizard (Frost *and* Etheridge, 1989[10]) that is distributed in parts of the states of Hidalgo, Veracruz, Puebla, and Mexico at high elevations (Smith, 1936)[11]. It is abundant on rock outcrops and ledges with crevices for refugia. Breeding activity is largely autumnal with parturition in the spring (Méndez *et al.*, 1988)[12]. Méndez *and* Villagrán, *op. cit.*, first reported the omnivorous tendencies of *S. m. mucronatus*.

The study site was located in Sierra del Ajusco, Distrito Federal, Mexico (3,500 m in elevation) near km. 24.5 on the Ajusco-Tianguistenco highway (Mex Hgw 892). Average annual rainfall is 1,340 mm with less than 5% of this occurring in the winter (García, 1973)[13]. The study site was a Pine forest (*Pinus hartwegii* Lindl) with a considerable amount of basaltic rocks and lava where *S. m. mucronatus* were easily observed. Individual *S. m. mucronatus* were captured with a noose between May and August 1991. To ensure full stomach contents collection time was between 1100 and 1300 hrs. after the typicall morning feeding period. Sex, snout-vent length (SVL) to the nearest 0.1 mm., total length (TL) to the nearest 0.1 mm, and wet body mass (BM) to the nearest 0.1 g were recorded for each lizard. Lizards were sacrificed by alcohol injection into the brain within 2-3 hrs of capture, and were preserved in 10% formalin, and later transferred to 70% alcohol. Stomach contents were examined under a dissecting microscope, and individual food items were identified. The volume of food items of a taxonomic category in a single stomach was determined to the nearest 0.001 ml by water displacement with a pipette. Difference in the proportion of plant material consumed between sexes were compared using analysis of variance (ANOVA). Diversity of stomach contents by volume were obtained by Shannon-Wiener index (1949, *in* Brower *and* Zar 1979)[14]:

$$H' = -\sum n_i / N \log n_i / N$$

where n_i = volume of food items of the same taxonomic category in a single sample, and N = volume of all food items in a single sample.

[10] Frost, D. R., *and* R. Etheridge. 1989. A phylogenetic analysis and taxonomy of iguanid lizards (Reptilia: Squamata). 81:1-65.

[11] Smith, H. M. 1936. The lizards of the *torquatus* group of the genus *Sceloporus* Weigman 1828. 24: 539-693.

[12] Méndez, F. R., L. J. Guillette, M. Villagrán, *and* G. Casas-Andreu. 1988. Reproductive and fat body cycles of the viviparous lizards, *Sceloporus mucronatus* (Sauria: Iguanidae). 22: 1-12.

[13] García, E. 1973. Modificaciones al sistema de clasificación climática de Köppen.

[14] Brower, J. E., *and* J. H. Zar. 1979. Field and laboratory methods for general ecology.

A total of 25 *S. m. mucronatus* was collected (16 males and 9 females). Snout-vent length and mass of females average 81.72 mm (range 65.1 - 87.8, SE = 2.39), and 22.69 g (range 11 - 27.5, SE = 1.768) respectively. For males, average snout-vent length was 97.11 mm (range 90.0 - 105.0, SE = 1.14), and average body mass was 40.12 g (range 32.0 - 45.0, SE = 1.154).

Average individual stomach volume was 2.15 ml $\pm$ 0.173. Summer diet for *S. m. mucronatus* was omnivorous with a total of 38.7% plant material (leaves and flower parts) and 58.6% arthropods, principally insects.

COLEOPTERA represented more than 70% of all arthropods and among other food types only LEPIDOPTERA, mostly LARVAE (6.9%) and ARACHNIDA (3.6%) exceeded three percent. The remaining 2.6% of the total volume was represented by a lizard (*Barisia imbricata*) that was found in an adult male (JLE00040, SVL = 91.0 mm, BM = 33.0 g) collected on August first, *vid., infra.*, Table Nº 1.

Plant material was minimal in specimens collected on 25 May and 3 June (4.5 and 11.6% for May and June respectively). In these same months the largest percentage of the total volume of items consumed was represented by coleopterans (93.3 amd 70.8% for May and June respectively).

Conversely, plant material on 27 July and 1 August was the most prevalent food type (41.6 and 58.3% for July and August respectively). In these later samples, coleopterans represented 28.4 and 24.5% in July and August respectively.

Perhaps the increase in relative amounts of plant material in late summer resulted from increased availability of early growth vegetation following summer rains. In early summer, rainfall is low and plant material is dry, and incidental and/or deliberate ingestion might be expected to occur when plants are more abundant and of higher quality. However, high abundance of coleopterans could result from a low foraging cost for individuals *S. m. mucronatus* in early summer.

Stomach contents of lizards collected on 25 May and 3 June, contained many small coleopterans (principally Scarabidae) that might indicate the emergence of these insects.

This agrees with Mendez *and* Villagran, *op. cit.*, who reported stomach contents from another population of *S. m. mucronatus* near our study site. They found the largest amount of plant material to be consumed in winter months and August, with the smallest amounts in May.

Taxon	Mean individual volume (%)	Total volume (%)	Frequency of occurrence (%)
Plant material	41.97±6.131 (n=24)	38.761	96
Animal material	58.57±6.270 (n=25)	61.239	100
INSECTA	52.22±5.964 (n=25)	54.995	100
COLEOPTERA	39.52±6.657 (n=25)	41.819	100
CARABIDAE	11.64±4.060 (n= 8)	4.446	32
COCCINELIDAE	3.23±0.898 (n= 4)	0.562	16
SCARABIDAE	34.44±6.900 (n=25)	35.928	100
TENEBRIONIDAE	9.18±6.492 (n= 2)	0.881	8
DERMAPTERA	4.57 (n = 1)	0.150	4
DIPTERA	6.70±3.005 (n= 2)	0.412	8
HEMIPTERA	18.28 (n = 1)	0.600	4
PENTATOMIDAE	18.28 (n = 1)	0.600	4
HYMENOPTERA	13.51±3.380 (n= 5)*	2.851	24
AMPULICIDAE	6.12±4.135 (n= 2)*	0.281	12
APIDAE	11.32±4.311 (n= 3)	1.125	12
FORMICIDAE	10.68±4.751 (n= 2)	1.444	8
LEPIDOPTERA**	10.02±4.148 (n= 9)	4.033	36
ORTHOPTERA	11.01±4.377 (n= 2)	0.487	8
GRILLACIDIDAE	11.01±4.377 (n= 2)	0.487	8
Unidentified insect parts	6.91 (n= 10)	4.596	40
ARACHNIDA	11.09±1.686 (n= 8)	3.639	32
VERTEBRATA	77.90 (n = 1)	2.645	4
REPTILIA	77.90 (n =1)	2.645	4

Table N° 1. Mean individual volume percentage ± one standar error, total volume percentage, and frequency of occurrence in stomach samples of *Sceloporus m. mucronatus*. *Plus one untracked individual, **LEPIDOPTERA were represented only by larvae.

The size of the ingested *B. imbricata* (ca. 45.0 mm SVL) suggests predation rather than incidental ingestion. In addition, we have observed *S. m. mucronatus* to ingest small *Sceloporus grammicus* in lab conditions.

Minimal diversity of prey items occurred in the 25 May sample (H' = 0.124). This could be the result of small sample size for this date (n = 2). Diversity values of the other samples (June 3 = 0.621, July 27 = 0.708, and August 1 = 0.639) confirmed that *S. m. mucronatus* has a generalist diet consuming plant and animal matter in similar proportions.

No significant difference was detected on the percentage of plant material consumed between sexes ($F_{1,21} = 0.01$, $P > 0.05$). There was no significant relationship between lizard SVL and the proportion of ingested plant material ($r = 0.376$, $N = 25$, $0.05 < P < 0.065$). However, the range of body sizes was very narrow in both sexes.

The near significant P-value suggests a relationship between these variables might exist although this conclusion is contingent upon larger sample sizes over a larger range of body sizes.

Pough, *op. cit*, proposed that lizards could be classified as carnivores, omnivores primarily carnivores, omnivores primarily herbivores, and strict herbivores. Lizards weighing less than 50-100 g are usually carnivorous, with a few exceptions (*e.g. Dipsosaurus dorsalis* body mass = 25.0 - 75.0 g) representing lizards with ecological specializations as tolerance to high temperatures at which few predators and competing lizards are present but at this temperatures there are also few insect active for it to eat, resulting in a herbivorous diet despite their small body size. However, *S. m. mucronatus* in this study was found to consume large amounts of plant material (38.7%) despite its small body mass.

According to Pough small lizards feeding on vegetation might be the result of high energetic cost of foraging for insects. However, we observed that at this site individual *S. m. mucronatus* were highly active during the summer between 1,000 and 1,400 hrs. In this time interval, lizards were observed moving among rocks in excess of 10 m. often engaging in behavioral displays. We assume that aerobic metabolic cost for these activities are be high.

Predation may also constrain feeding activity areas to vegetation (Pough, *op. cit.*). We observed several individual rattlesnake in the summer (*Crotalus triseriatus*, N = 14) in this study site. Four individual *C. triseriatus* were found under basaltic rocks, and two were basking on these rocks in close proximity to *S. m. mucronatus*. Although we did not observe *C. triseriatus* to feed on *S. m. mucronatus* such predation likely occurs and may restrict feeding activities of these lizards.

A third possibility is that *S. m. mucronatus* could be constrained by phylogeny. *Sceloporus m. mucronatus* is in the *torquatus* group of the genus *Sceloporus* of the 12 species in the *torquatus* group three are know to have herbivorous tendencies (*S. mucronatus*, Méndez *and* Villagrán, *op. cit.*, *S. poinsetti*, Ballinger *et al.*, *op. cit.*; Smith *and* Milstead (1971)[15]; Stebbins (1954)[16]; and *S. torquatus*, Burquez *et al.* 1986) and others (*e.g. S. cyanogenus*) are likely to be partly herbivorous, but at least one (*S. jarrovi*, Ballinger *and* Ballinger, 1979)[17] species consumes little vegetation (1.7 - 13.9% by volume). Evolution of herbivory in this group of *Sceloporus* may have occurred early in the evolution of the group. Thus, phylogenetic history rather than ecology may explain plant consumption by *S. m. mucronatus*.

REFERENCES

Abts, M. L. 1987. Environmental and variation in life history traits of the chuckwalla, *Sauromaulus obesus*. Ecol. Mong. 57: 215-232. USA.

Auffenberg, W. 1982. Feeding strategy of the Caicos ground iguana *Cyclula carinata*. *In*: Burghardt, G.M., *and* S. Rand (eds), Iguanas of the world, their behavior, ecology, and conservation. pp:84-116. Noyes Publ. Park Ridge, N.J. USA.

Ballinger, R. E., M. E. Newlin, *and* S. J. Newlin. 1977. Age specific shift in the diet of the crevice spiny lizard *Sceloporus poinsetti* in Southwestern New Mexico. Ame. Midl. Nat. 97: 482-484. USA.

Ballinger, R. E., *and* R. A. Ballinger. 1979. Food resource utilization during periods of low and high food availability in *Sceloporus jarrovi* (Sauria: Iguanidae). Southwest. Nat. 24: 347-363. USA.

Brower, J. E., *and* J. H. Zar. 1979. Field and laboratory methods for general ecology. Wm. C. Brown. Co. USA. 194 p.

[15] Smith, D. D. *and* W. W. Milstead. 1971. Stomach analysis of the crevice spiny lizard (*Sceloporus poinsetti*). 50 : 837-844.

[16] Stebbins, R. C. 1954. Amphibians and Reptiles of Western North America.

[17] Ballinger. R. E., *and* R. A. Ballinger. 1979. Food resource utilization during periods of low and high food availability in *Sceloporus jarrovi* (Sauria: Iguanidae). 24: 347-363.

Burquez, A., O. Flores-Villela, *and* A. Hernandez. 1986. Herbivory in a small iguanid lizard, *Sceloporus torquatus torquatus*. J. Herpetol. 20: 262-264. USA.

Frost, D. R., *and* R. Etheridge. 1989. A phylogenetic analysis and taxonomy of iguanid lizards (Reptilia: Squamata). Univ. Kansas Mus. Nat. Hist. Misc. Publ. 81:1-65. USA.

García, E. 1973. Modificaciones al sistema de clasificación climática de Köppen. Instituto de Geografía, UNAM, Mexico.

Iverson, J. B. 1982. Adaptations to herbivory in iguanine lizards. *In:* Bughardt, G.M., *and* S. Rand (eds.). Iguanas of the world, their behavior, ecology, and conservation. pp. 60-76. Noyes Publ. Park Ridge, N.J. USA.

Mautz, W. J., *and* W. Lopez-Forment. 1978. Observations on the activity and diet of the cavernicolous lizard *Lepidophyma smithii* (Sauria: Xantusidae). Herpetologica 34: 311-313. USA.

McBee, R. H., *and* V. H. McBee. 1982. The hindgut fermentation in the green iguana, *Iguana iguana*. *In:* Bughardt, G.M., *and* S. Rand (eds.). Iguanas of the world, their behavior, ecology, and conservation. pp. 77-83. Noyes Publ. Park Ridge, N.J. USA.

Méndez, F. R. *y* M. Villagrán. 1983. Contribución al conocimiento de la ecología y ciclo reproductor de la lagartija vivípara *Sceloporus mucronatus mucronatus*. Tesis de Licenciatura (Biólogo). Escuela Nacional de Estudios Profesionales Iztacala, Mexico.

Méndez, F. R., L. J. Guillette, M. Villagrán *and* G. Casas-Andreu. 1988. Reproductive and fat body cycles of the viviparous lizards, *Sceloporus mucronatus* (Sauria: Iguanidae). J. Herpetol. 22: 1-12. USA.

Pough, F. H. 1973. Lizard energetics and diet. Ecology 54: 837-854. USA.

Smith, D. D., *and* W. W. Milstead. 1971. Stomach analysis of the crevice spiny lizard (*Sceloporus poinsetti*). Ecology 50: 837-844. USA.

Smith, H. M. 1936. The lizards of the *torquatus* group of the genus *Sceloporus* Weigman 1828. Univ. Kansas Sci. Bull. 24: 539-693. USA.

Stebbins, R. C. 1954. Amphibians and Reptiles of Western North America. McGraw-Hill. New York. USA.

Acknowledgments

A permit (412.2.1.2.0.06869 Dirección General de Conservación Ecológica de los Recursos Naturales) to collect specimens for research was kindly granted by Dr. Graciela de la Garza García. John Rowe and Geoff Smith provide useful comments on an early draft of this manuscript. This research was supported by Instituto Nacional de Investigaciones Forestales y Agropecuarias (INIFAP), and Consejo Nacional de Ciencia y Tecnología de México (CONACyT).