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THE DIET OF ADULT *TUPINAMBIS TEGUIXIN* (SAURIA: TEIIDAE) IN THE EASTERN CHACO OF ARGENTINA

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Analysis of the number, weight and volume of food items in the digestive tracts of 70 teiid lizards, *Tupinambis teguixin*, were obtained during spring-summer from areas neighbouring El Bagual Ecological Reserve in northeastern Argentina. The food items revealed the species to be a widely-ranging opportunistic omnivorous forager. *Tupinambis* consumed a large proportion of fruits, invertebrate and vertebrates. The species forages in both terrestrial and aquatic habitats, but no evidence was obtained for arboreal feeding habits. A sample of 27 to 49 digestive tracts is sufficient to reveal 80-90% of the prey types in the diet.

INTRODUCTION

Tupinambis teguixin, the black tegu lizard, is a member of the abundant fauna of South America characterized by large adult size, relatively small hatchling size, sexual dimorphism as adults, large clutch size and reproduction limited to a brief breeding season (Yanosky & Mercolli, 1992*a*). However, no detailed study of this lizard's diet has been published. Some ancillary information has been published about prey items in *Tupinambis*, based on data obtained in the wild or in captivity (see review in Mercolli & Yanosky, in press). Only a thesis by Herrera (1980) offered data on feeding habits during a drought period in Venezuela, and we earlier reported some prey items described within an ethological framework (Mercolli & Yanosky, 1989).

Little is known about the ecology of Argentinian lizards (Vega *et al.*, 1988). Knowledge about this teiid lizard is needed because of its importance in economic, social and cultural aspects of South Amercian human societies (Fitzgerald *et al.*, 1991; Yanosky & Mercolli, 1992*a*) and for this reason special conservation emphasis is now being directed towards *Tupinambis* species. Recently, the diet for *T. rufescens* has been reported (Williams *et al.*, 1990).

The study had the following aims: (1) to determine the food items taken by this terrestrial teiid lizard in the humid Chaco forest community, (2) to broaden our knowledge about the food web, and (3) to offer minimum, reliable sample sizes to determine food habits. This lizard is an intensive forager in the sense of Anderson & Vitt (1990), and relies on chemical cues for feeding (Cooper, 1990; Yanosky *et al.*, 1993).

MATERIALS AND METHODS

STUDY AREA

The study area is in the eastern-humid Chaco district of the Chaco province (Cabrera & Willink, 1973). All specimens were collected from adjacent areas to El Bagual Ecological Reserve (26° 59' 53" S, 58° 56' 39" W) in northeastern Argentina. The area is characterized by flooded savannas and forests, subject to cyclic fires and flooding (Neiff, 1986). The soils , originating from volcanic ash of northwestern Argentina, are planosoles, gley-humid and alluvial with poor drainage, and influenced by Bermejo River lowlands (Helman, 1987). The El Bagual Ecological Reserve annual mean temperature is 22°C with a maximum average of 27°C and minimum of 17°C. Extreme recorded temperatures ranged from - 2 to 45°C and there is a marked rainy season (November-April) with an annual rainfall of 1200 to 1900 mm.

FIELD TECHNIQUES

Between November 1990 and March 1992, seventy adult tegu lizards ranging from 290 to 480 mm snout-vent length were bought from local professional hunters in the department of Laishi (province of Formosa). These specimens were harvested under the regulations for a species listed in Appendix II of CITES and no individuals were killed specifically for the purpose of this study. Lizards were killed in the field by hunters, and the skins removed for trading . Specimens were not obtained during winter months (Yanosky & Mercolli, 1992*b*). Hideless carcasses were stored in 10% formalin within six hours of harvest. Each specimen was later eviscerated, labelled and returned to 10% formalin.

LABORATORY TECHNIQUES

Total digestive tract contents were analysed for each specimen because important prey were found from the rectum to the oesophagus. The contents of the preserved alimentary tract were emptied into bowls for collection of data and identification. Non-food items (parasites, inorganic material) were separated and recorded.

Where possible, food items were indentifided to species, but the lowest useful taxonomic level was order/

FOOD TAXA	Frequency		Number		Weight		Volume	
	n	%	*n*	%	*n*	%	*n*	%
PLANTAE								
Tomatillo	1	1.40	47	1.25	29.0	0.65	25.0	0.64
Coquito	5	7.14	84	2.25	297.0	6.65	279.5	7.12
Granadilla	2	2.80	27	0.73	11.5	0.25	9.5	0.24
Congorosa	2	2.80	151	4.04	71.5	1.60	71.0	1.81
Ñangapirí	2	2.80	28	0.75	7.0	0.15	6.5	0.17
Aguay	2	2.80	6	0.16	4.5	0.10	3.4	0.09
Mora	15	21.42	1263	33.80	353.5	7.91	30.8	7.85
Pindó	23	32.85	244	6.53	1198.0	26.82	994.2	25.40
Higuerón	9	12.85	359	9.60	85.5	1.91	77.1	1.90
Tala	8	11.42	140	3.75	27.5	0.61	24.5	0.60
Guabiyú	11	15.71	106	2.84	43.5	0.97	37.0	0.90
Palma	17	24.28	222	5.94	516.0	11.55	448.6	11.43
Cocú	1	1.40	2	0.05	0.5	0.01	0.3	Trace
Others	9	12.85	116	3.10	49.5	1.10	50.1	1.27
Seeds	9	12.85	75	2.00	10.0	0.22	7.4	0.18
Vegetal matter	62	88.57	-	-	281.6	6.30	271.1	6.90
INVERTEBRATES								
Crustacea	11	15.71	21	0.56	45.5	1.01	39.40	0.99
Gastropoda	48	68.57	379	10.14	289.3	6.47	272.20	6.94
Araneae ad.	13	18.57	26	0.70	26.5	0.59	26.30	0.68
Araneae ootheca	11	15.71	13	0.35	10.0	0.22	8.90	0.23
Miriapoda	6	8.57	17	0.45	4.5	0.10	3.20	0.08
Lepidoptera ad.	2	2.80	2	0.05	1.0	0.02	0.60	0.01
Lepidoptera pupae	2	2.80	2	0.05	2.0	0.04	1.80	0.04
Lepidoptera larvae	18	25.71	56	1.50	90.1	2.01	73.05	1.87
Coleoptera								
- Carabidae	5	7.14	11	0.29	5.0	0.11	3.80	0.09
- Chrysomelidae	1	1.40	1	0.02	0.5	0.01	0.20	Trace
- Coccinelidae	1	1.40	1	0.02	0.5	0.01	0.30	Trace
- Scarabeidae	1	1.40	1	0.02	0.5	0.01	0.30	Trace
- Others	28	40.00	54	1.44	29.5	0.66	25.20	0.64
- Larvae	1	1.40	1	0.02	9.5	0.21	10.50	0.27
Hemiptera	1	1.40	2	0.05	2.5	0.05	1.50	0.03
Homoptera	3	4.28	3	0.08	3.5	0.07	2.60	0.06
Orthoptera								
- Proscopidae	2	2.80	2	0.05	1.5	0.03	2.20	0.05
- Others	14	20.00	27	0.72	30.5	0.68	34.50	0.88
Hymenoptera								
- Vespidae	2	2.80	4	0.11	1.0	0.02	0.70	0.01
- Formicidae	3	4.28	4	0.11	1.5	0.03	1.30	0.03
Blattaria	7	10.00	11	0.29	10.5	0.23	9.40	0.24
Odonata	1	1.40	1	0.02	0.5	0.01	0.30	Trace
Unidentified insects	9	12.85	154	4.12	8.5	0.19	6.40	0.16
VERTEBRATES								
Pisces	4	5.71	10	0.27	85.5	1.91	74.10	1.87
Amphibia-Anura	19	27.14	49	1.31	475.0	10.63	409.6	10.44
Reptilia								
- Serpentes	4	5.71	4	0.11	60.5	1.35	56.50	1.44
- Sauria	1	1.40	1	0.02	20.5	0.45	20.00	0.52
Aves adults	2	2.80	5	0.13	50.0	1.12	46.00	1.17
Aves eggs	1	1.40	1	0.02	68.0	1.52	56.00	1.42
Mammalia								
Rodentia	4	5.71	4	0.11	145.5	3.26	123.80	3.20
Unidentified vertebrate	1	1.40	1	0.02	1.0	0.02	0.50	0.01
TOTALS	-	-	3738	100.00%	4466.5	100.00%	3924.8	100.00%

TABLE 1. Composition of food records for 70 black tegu lizards examined. Volume is measured in cm^3 and weight in g. Scientific names appear in Appendix 1. Trace = less than 0.01. Ad. = adults.

	Frequency		Number		Weight		Volume	
	n	%	*n*	%	*n*	%	*n*	%
Plantae	7	100.0	2870	76.8	2986.1	66.8	2613.2	66.6
Invertebrates	68	97.1	793	21.2	574.4	12.9	525.1	13.4
Vertebrates	31	44.3	75	2.0	906.0	20.3	786.5	20.0
Totals	-	-	3738	100.0	4466.5	100.0	3924.8	100.0

TABLE 2. Composition of food records for 70 black tegu lizards summarized in the three greatest taxonomic groups.

family. The developmental stage of invertebrates was also recorded (e.g. larvae, adults).

Each digestive tract was processed in the manner reported by Korschgen (1980). After weighing and measuring the volume of the tracts, the contents were washed in tap-water over a 0.5 mm sieve that removed small particles. Items were separated by size, and the smallest were identified under a binocular dissecting microscope. For each food type, volume, mass and frequency (Pianka, 1971) were calculated.

Absolute frequencies represented the total number of lizards that contained a particular item and relative frequencies were based on the total number of the lizards in the sample.

Food items were sorted into the following categories; (1) trophic levels (producer, primary/secondary consumer, omnivore, detritivore) and (2) life-forms (aerial, arboreal, terrestrial). Data files were prepared for individual gut contents. These files were then randomly selected in order to determine a minimal sample representative of cumulative prey items (Margalef, 1980).

RESULTS

All digestive tracts of the 70 tegu lizards examined contained food. The incidence of "non-food" items was low except for parasites. One female contained a stone-like piece of compact red soil and this contributed 14.3% by weight (2 g) and 11% by volume (1.5 cm^3) to food contents of that individual. Internal parasites were found in 69 animals (98.6%) and though most were located in the intestines, they were present throughout the alimentary canal. Parasitic load was 2.35±1.84 g and 2.11±1.83 cm^3 per individual (Three percent was the percentage to total weight and volume).

Most prey items were undigested, which allowed individual identification and inclusion in the analysis. A few insects and vertebrates (flesh) were unidentified, which contributed to 0.16% and 0.01% of the total volume, respectively.

Table 1 lists thirteen invertebrate orders that can be identified into 19 lower taxonomic groups; 6 taxonomic groups for vertebrates, 13 fruit species, in addition to ootheca, seeds, plant material and other fruit.

Total diet mass consisted of 69% plant matter and 33% animal matter (Table 2). Almost identical percentages were found for the total diet volume, 66.5% plant matter, and 33.5% animal matter. Plant material (stems, leaves, and vegetation remains) was the most frequent item recorded (89.57%), followed by snails (68.57%), Coleoptera (52.85%), pindó fruits (32.85%) and anura (27.14%). Weight values revealed that, pindó fruit were most important with 26.8%, followed by palm fruits (11.5%), anura (10.63%), and mora (7.9%). Volumetrically, the spectrum is in the same decreasing order, but for total biomass consumed, vertebrates were more important than invertebrates.

Table 3 shows numerical, weight and volumetric values for trophic levels of the most assignable food items. *Tupinambis teguixin* feeds predominantly on producers. Primary consumers follow in numerical improtance, but when weight/volume is considered, secondary consumers are more important than primary consumers. Predation on omnivorous species is not important in this lizard's diet.

Large proportions of the diet of *Tupinamibis teguixin* are flying/arboreal invertebrates, but this does not suggest that the lizard feeds in arboreal situations. This species is predominantly terrestrial though some

	Number		Weight		Volume	
	n	%	*n*	%	*n*	%
Primary producer	2870	79.6	2986.1	68.7	2613.2	66.5
Animal detritivore	39	1.1	101.0	2.3	188.0	4.7
Primary consumer	454	15.1	580.9	13.4	520.2	13.2
Secondary consumer	121	3.4	646.6	14.9	568.9	14.5
Omnivore	29	0.8	32.0	0.7	36.7	0.9

TABLE 3. Trophic levels of assignable prey items.

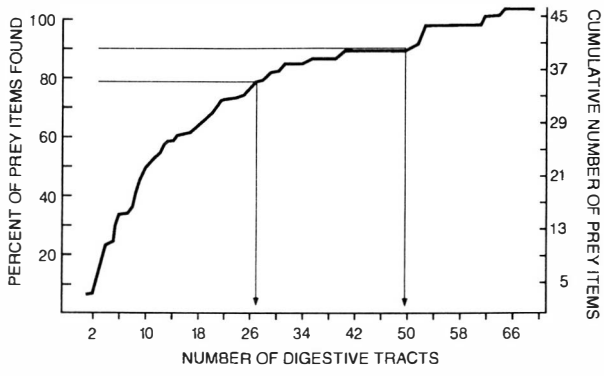

FIG. I. Cumulative number and percentage of prey items found for *Tupinambis* diets. Arrows indicate the minimum sample sizes needed to estimate 80% and 90% of the diet.

arboreal habits have been reported by Yanosky (1991). In addition, all fruits found in stomachs of these lizards belong to trees with fruits that fall to the ground when ripe. Birds eaten by this lizard were tinamous chicks, probably eaten while in the nest. Tinamous are terrestrial and poor fliers. The lizards appear to be entering shallow waters to prey upon fish, crabs and snails. Snail shells with operculae were found intact in the gut.

Fig. 1 shows the percentages assignable to the total cumulative prey items. A sample of 27 specimens estimates 80% of items in the diet, while a sample of 49 specimens estimates 90%.

DISCUSSION

Tupinambis teguixin does not consume local crops as commonly believed and should not be considered a potential pest. Our data do not indicate that the species is a scavenger as suggested by Donadío & Gallardo (1984).

Measures of potential prey availability were not made because previous literature suggested the *T. teguixin* occupies an intricate position in the food web (Donadío & Gallardo, 1984). Based upon total food consumption by this lizard, it is clearly omnivorous. *Tupinambis* could be considered a "keystone" species because of its size and trophic level, for complete removal of it could have a cascading effect on the food web (Vitt, *in litt*). At our site *Tupinambis teguixin* is 71% herbivorous and 29% carnivorous. Lepidopteran larvae found within digestive tracts were all characterized by irritant hairs. We presume that this teiid is immune to any toxins released by the hairs of these larvae.

The foraging mode, related to prey eaten by lizards (rodents, lepidopteran larvae, spiders, beetles and anurans) suggests a broad foraging strategy as a means of obtaining food, a common feature of teiid lizards (Anderson & Vitt, 1990; Pianka, 1970). Foraging mode in these lizards is a primitive trait and the diet is a consequence of their foraging mode, body size, and prey availability where they are studied. All fruits recorded in this study (which fall when ripe) together with flying insects that rest at ground level suggests that this species feeds on the ground, not in trees. In addition, presence of complete snail shells with operculae suggest that these items are ingested without chewing, as reported by Gudynas (1981).

In summary our analysis indicates that *Tupinamibis teguixin* is a food generalist and omnivore, that feeds on medium and large-sized arthropods, vertebrates and vegetative parts (stems, leaves, but principally fruits). Principal food items (Petrides, 1975) were fruits, snails, coleopterans, lepidopterans, anura and rodents. Several other food items of very low frequency were also present, suggesting they are occasionally ingested by this opportunistic teiid lizard.

Finally, a sample of 50 specimens is required to obtain a spectrum representing 91% of the diet. Our data supports the national effort to cover major gaps in the biology of *Tupinambis* lizards as stated by Dirección Nacional de Fauna Silvestre (1991).

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REFERENCES

Anderson, R. A. & Vitt, L. I. (1990). Sexual selection versus alternative causes of sexual dimorphism in teiid lizards. *Oecologia* **84**, 145-157.

Cabrera, A. L. & Willink, A. (1973). Biogeografía de América Latina. *Serie biologia OEA* No. **13**, Washington, D.C.

Cooper, W. E. (1990). Prey odor detection by teiid and lacertid lizards and the relationship of prey odor detection to foraging mode in lizard families. *Copeia* **1990**, 237-242.

Direccíon Nacional de Fauna Silvestre. (1991). *Restructuración del proyecto Tupinambis*. Buenos Aires.

Donadío, O. E. & Gallardo, J. M. (1984). Biología y conservación de las especies del género *Tupinambis* (Squamata, Sauria, Teiidae) en la República Argentina. *Rev. Mus. Arg. Cs. Nat. "B. Rivadavia", Zoo.* **13**. 117-127.

Fitzgerald, L. A., Chani, J.M. & Donadio, O. E. (1991). *Tupinambis* lizards in Argentina: implementing management of a traditionally exploited resource. In *Neotropical wildlife use and conservation*, 303-316. Robinson, J. G. & Redford, K. H. J. (eds.). London: University of Chicago Press.

Gudynas, E. (1981). Some notes on the behavior, ecology and conservation of the macroteiid lizard, *Tupinambis teguixin. Bull. Chic. herp. Soc.*, **16**, 29-39.

Helman, A. M. (1987). Suelos de la región subtropical argentina. Provincia de Formosa. *Rev. Soc. Rur. Formosa* 1987, **47**.

Herrera, E. A. (1980). *Estudio de la dieta del mato (Tupinambis tequixin) en los llanos del estado Apuré, durante una temporada de sequia.* "Licenciatura" thesis, Universidad Simón Bolivar, Venezuela, 78 pp.

Korschgen, L. J. (1980). Procedures for food-habits analyses. In *Wildlife management techniques manual*, 113-128. Schemnitz, S. D. (ed.). Washington: the Wildlife Society.

Margalef, R. (1980). *Ecología. Barcelona*: Ed. Omega.

Mercolli, C. & Yanosky, A. A. (1989). Répertoire des comportements du Téju (*Tupinambis teguixin*). Sauria: Teiidae. *Rev. Fr. Aquariol. Herpetol.* **16**, 123-130.

Mercolli, C. & Yanosky, A. A. (In press). A species that deserves international consideration: the black tegu lizard. Its ecology and behaviour. *Rev. Fr. Aquariol. Herpetol.*

Neiff, J. J. (1986). Sinopsis ecológica y estado actual del Chaco Oriental. *Ambiente Subtropical.* **1**, 5-35.

Petrides, G. A. (1975). Principal foods versus preferred foods and their relations to stocking rate and range condition. *Biol. Conserv.* **7**, 161-169.

Pianka, E. R. (1970). Comparative autoecology of the lizard *Cnemidophorus tigris* in different parts of its geographic range. *Ecology.* **51**, 703-723.

Vega, L. E, Chani, J. M. & Trivi de Mandri, M. (1988). Observations on the feeding habits of *Ameiva ameiva*. *Herp. Review.* **19**, 53-54.

Williams, J. D., Donadio, O. & Re, I. (1990). Aportes al conocimiento de la dieta de *Tupinambis rufescens* (Gunther, 1871)(Sauria: Teiidae) en el noroeste argentino. *VII Reunión Comunic. Herp., Asoc. Herp. Arg.*, Corrientes.

Yanosky, A. A. (1991). Arboreality in the teiid lizard *Tupinambis teguixin* (Reptilia, Lacertilia, Teiidae). *Spheniscus* **9**, 11-13.

Yanosky, A. A. & Mercolli, C. (1992*a*). Tegu lizard (*Tupinambis teguixin*) management in captivity at El Bagual Ecological Reserve, Argentina. *Arch. Zootec* **41**, 41-51.

Yanosky, A. A. & Mercolli, C. (1992*b*). Uso del hábitat y niveles estacinales de *Tupinambis teguixin* (Sauria: Teiidae), en la Reserva Ecológica El Bagual (Formosa). *Amph. & Rept.* (cons.)

Yanosky, A. A., Iriart, D. E. & Mercolli, C. (1993). Predatory behaviour in *Tupinambis teguixin* (Sauria: Teiidae). 1. Tongue-flicking responses to chemical food stimuli. *J. Chem. Ecol.* **19**, 291-299.

APPENDIX 1

SCIENTIFIC NAMES FOR FRUIT-PLANTS MENTIONED IN THE TEXT.

Aguay (*Chrysophyllum gonocarpum*: Sapotaceae)
Cocú (*Allophyllus edulis*: Sapindaceae)
Coquito (*Trithrinax campestris*: Palmeras)
Congorosa (*Maytenus ilicifolia*: Celastraceae)
Granadilla (*Schinus longifolia*: Anacardiaceae)
Guabiyú (*Eugenis pungens*: Mirtaceae)
Higueron (*Ficus monckii*: Moraceae)
Mora (*Chlorophora tinctoria*: Moraceae)
Ñangapirí (*Eugenia uniflora*: Mirtaceae)
Palma (*Copernicia alba*: Palmeras)
Pindó (*Syagrus romanzoffianum*: Palmeras)
Tala (*Celtis spinosa*: Ulmaceae)
Tomatillo (*Solanum* sp.: Solanaceae)

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