# SHORT NOTES

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## NATURAL HISTORY OF *TROPIDURUS SPINULOSUS* (SQUAMATA: TROPIDURIDAE) FROM THE DRY CHACO OF SALTA, ARGENTINA

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The genus *Tropidurus* is very complex and diverse, at least 44 recognized species are distributed in tropical and central South America (Rodrigues, 1987; Frost, 1992; Cei, 1993). *Tropidurus spinulosus* is a medium-sized lizard, inhabiting all of north-central Argentina and central Brazil. In Cordoba, Argentina, this lizard is observed on granitic boulders (Martori & Aún, 1994), whereas in the dry chaco and cerrado habitats it is observed on tree trunks (Vitt, 1991; Colli, *et al.*, 1992; Lavilla *et al.*, 1995). *Tropidurus spinulosus* is very cryptic on tree bark.

Different aspects of the ecology of this species have previously been studied, including diet (Vitt, 1991; Colli *et al.*, 1992; Martori & Aún, 1994), and it has been found to be mainly insectivorous. Only Colli *et al.* (1992) found plant material in *T. spinulosus* stomachs but the relative composition of fruits, flowers and somatic parts was not described. Flowers were part of the diet in three populations of *Tropidurus* species studied by Vitt (1991, 1993); Van Sluys (1993) found flowers, leaves and seeds in *T. itambere*. Vitt *et al.* (1996) commented on the presence of fruits in *T. hispidus* diet from Roraima (Brazil). Reproduction was studied by Vitt (1991) and Martori & Aún (1994); only the latter work described the length of the reproductive cycle and the number of clutches per year, although both articles provided data on clutch characteristics. Thermal biology was described by Martori & Aún (1994).

Vitt & Zani (1996) commented on the need to collect basic natural history data on neotropical lizards, as most life-history traits could be obtained from such data (e.g. Tinkle et *al.*, 1970; Dunham & Miles, 1985; Fitch, 1982). The aim of this study is to provide further data on the diet, reproduction, and thermal biology of *T. spinulosus* from the dry chaco of Argentina. The information obtained herein will then be compared to data of the same species from other localities, and to other *Tropidurus* species.

The study site is located on a private ranch called "Los Colorados" (24°35'S, 63°11'W), Salta, Argentina. The climate is characterized by a marked rainy season between October and April, during which more than 85% of the annual precipitation (530 mm) falls. Temperature also varies seasonally, but in a less-pronounced cycle than rainfall, which is typical for temperate-subtropical climates (Bucher, 1980). The type of habitat corresponds to what Cabrera & Willink (1980) called the chacoan occidental district.

Lizards were studied during the spring-summer months between October 1995 and January 1997. *Tropidurus spinulosus* is active mainly during the warmer months, that is, from September through to March.

Sampling was performed in two plots of approximately 1 ha each, which lay within a total 10 000 hectares of the "Los Colorados" ranch. Lizards were collected by shooting with an air rifle, as the heights at which they were observed made other collection methods, such as noosing or ptifall trapping, difficult. After killing, specimens were fixed in 10% formaldehyde and then transferred to 75% ethanol. The sampling areas were therefore very small in relation to the total areas available to the lizards, and the trees from which samples were taken were observed to be recolonized by lizards within a few weeks. The sampling was therefore considered to have a neglible effect on lizard populations, particularly when related to the extensive loss of dry chaco habitat due to agricultural development. The material was deposited in the collection of the Instituto de Herpetologia, Fundación Miguel Lillo (FML), Tucumán, Argentina.

Stomach contents and parasites were dissected out and analysed in the laboratory. The length and width of each prey item was measured with vernier calipers to the nearest 1 mm. Prey volume was estimated using the formula for a spheroid or a cylinder depending on the type of prey. Niche breadth was calculated using the reciprocal Simpson's measure following Vitt (1991, 1993).The first lizards to reach maturity were taken as the smallest male and female with evidence of reproductive activity; individuals smaller than these were considered to be juveniles. Reproductive stages were determined on the basis of enlarged (yolked) follicles and oviductal eggs in females, and enlarged testes and convoluted epididymides in the males. The number of enlarged follicles and oviductal eggs was used to estimate clutch size. Temperature data were obtained using a thermocouple within 30 seconds of shooting the individual, and air temperature was taken 1-3 cm above the ground; substrate temperature was taken 1 cm into the soil.

One hundred and thirty-eight lizards were captured at the study site, 130 of which (94%) were captured on tree trunks. Diet data of *T. spinulosus* were obtained from 92 individuals (mean SVL = 98.11 mm; SD = 19.24; range = 37.49-131.76). Mature males were larger (mean = 107.22 mm; SD = 16.33; range = 75.7-139.8; $n = 50$) than mature females (mean = 94.09 mm; SD = 7.98; range = 80.34-110.15; $n=35$), exhibited larger dorsal spines and were more brightly coloured than females.

TABLE 1. Diet composition of *T. spinulosus*. No. lizards indicates the number of lizards containing each prey category; No. items is the number of items corresponding to each category; Volume is the total volume ($mm^3$) found for each category. % represents percentages of the total sample.

| Prey type | No. lizards | % lizards | No. items | % items | Volume | % Volume |
|---|---|---|---|---|---|---|
| Orthoptera | 14 | 15.22 | 15 | 0.54 | 5413.93 | 2.79 |
| Aeridídae | 12 | 13.04 | 13 | 0.46 | | |
| Gryllidae | 2 | 2.17 | 2 | 0.07 | | |
| Hemiptera | 12 | 13.04 | 17 | 0.61 | 11965.32 | 6.16 |
| Pentatomidae | 8 | 8.70 | 9 | 0.32 | | |
| Lygaeidae | 4 | 4.35 | 8 | 0.29 | | |
| Coleoptera | 67 | 72.83 | 154 | 5.51 | 43678.63 | 22.49 |
| Scarabidae-Carabidae | 43 | 46.74 | 77 | 2.75 | | |
| Scarabidae | 11 | 11.96 | 17 | 0.61 | | |
| Coccinelidae | 7 | 7.61 | 37 | 1.32 | | |
| Staphylinidae | 6 | 6.52 | 7 | 0.25 | | |
| Curculionidae | 4 | 4.35 | 7 | 0.25 | | |
| Cerambycidae | 3 | 3.26 | 3 | 0.11 | | |
| Tenebrionidae | 3 | 3.26 | 4 | 0.14 | | |
| Lampyridae | 1 | 1.09 | 2 | 0.07 | | |
| Formicidae | 75 | 81.52 | 1594 | 56.99 | 39080.64 | 20.12 |
| Other Hymenoptera | 43 | 46.74 | 167 | 5.97 | 22688.61 | 12.40 |
| Apidae | 35 | 38.04 | 154 | 5.51 | 19853.67 | 10.94 |
| *Apis* | 21 | 22.83 | 56 | 2.00 | | |
| *Melipona* | 20 | 21.74 | 98 | 3.50 | | |
| Vespidae-Sphecidae | 10 | 10.87 | 13 | 0.46 | 2834.94 | 1.46 |
| Lepidoptera | 3 | 3.26 | 24 | 0.86 | 24651.90 | 12.69 |
| Diptera | 8 | 8.70 | 14 | 0.50 | 1139.12 | 0.59 |
| Araneae | 10 | 10.87 | 12 | 0.43 | 10951.56 | 5.64 |
| Larvae | 61 | 66.30 | 155 | 5.54 | 16516.81 | 8.50 |
| Coleoptera | 39 | 42.39 | 117 | 4.18 | | |
| Lepidoptera | 18 | 19.57 | 23 | 0.82 | | |
| Unidentified larvae | 12 | 13.04 | 15 | 0.54 | | |
| Blattaria | 12 | 13.04 | 18 | 0.64 | 8143.53 | 4.19 |
| Homoptera | 8 | 8.70 | 571 | 20.41 | 5423.67 | 2.79 |
| Cicadelidae | 1 | 1.09 | 560 | 20.02 | | |
| Cicadidae | 7 | 7.61 | 11 | 0.39 | | |
| Pseudoescorpionida | 7 | 7.61 | 8 | 0.29 | 154.93 | 0.08 |
| Isoptera | 6 | 6.52 | 8 | 0.29 | 282.05 | 0.15 |
| Myriapoda (Julida) | 4 | 4.35 | 4 | 0.14 | 757.77 | 0.39 |
| Unidentified insects | 10 | 10.87 | 10 | 0.36 | 3387.12 | 1.74 |
| Fruits | 22 | 23.91 | 26 | 0.93 | | |
| *Ceigis* | 13 | 14.13 | 17 | 0.61 | | |
| *Ziziphus* | 5 | 5.43 | 5 | 0.18 | | |
| Other fruits | 4 | 4.35 | 4 | 0.14 | | |
| TOTAL | 92 | | 2797 | | 194239.59 | |

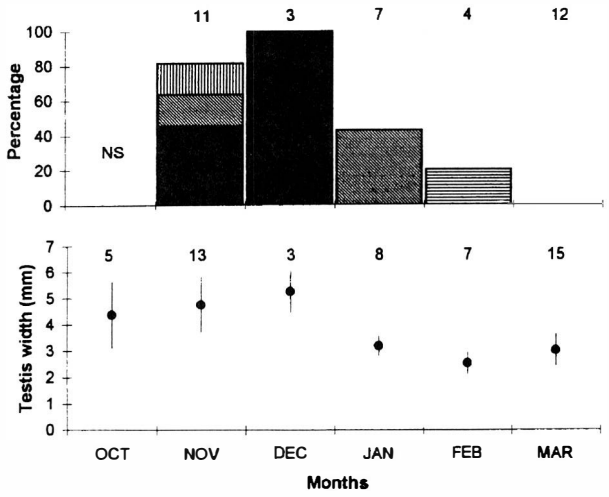


FIG. 1. Reproductive events of *Tropidurus spinulosus*. Top: filled bars represent enlarged follicles, hatched bars represent oviductal eggs, vertical lines represent simultaneous oviductal eggs and enlarged follicles; horizontal lines represent corpora lutea. Below: dots and lines represent mean testis width ±1SD, respectively. In both cases data are grouped by month and upper numbers represent sample size, NS= no sample.

*Tropidurus spinulosus* in the dry chaco of Argentina feeds mainly on ants, beetles, coleopteran and lepidopteran larvae, and bees (Table 1). Fruits are also present in the diet; 22 out of 92 individuals contained entire mature fruits of *Ceitis tala* and *Ziziphus mistol*, that are common in the study area and that fall on the ground when mature. Adult lepidopterans were abundant in volume, but not in number or occurrence. Lizards were observed feeding while they were vertically perched on tree trunks.

From 2766 identified prey, 72.74 % were active insects, whereas 764 prey (560 Cicadelidae corresponded to a single stomach) were motionless or very slow-moving arthropods (Blattaria, Homoptera, Pseudoscorpionida, Isoptera and Myriapoda) and larvae. Only one specimen was found with exclusively non-mobile prey. Within each stomach, more than one species of ant, and at least two castes (workers and soldiers), were observed. Mean number of prey categories per stomach was 4.29 (SD = 2.01; range = 1-12), with only five individuals containing a single prey category. Number of prey did not vary significantly with SVL. Average prey length was 9.86 mm (SD=5.65; range = 1.95-34.07 mm; $n = 358$). No significant relationship ($P>0.05$) was found between mean prey length or maximum prey length and lizard SVL, but total volume increased with SVL ($r = 0.382$, $n = 87$, $P<0.05$).

Mean maximum prey volume was 419.57 $mm^3$ (SD = 4 16.56; $n = 82$). Diet niche breadth was 2.61 by prey number and 7.7 by prey volume.

One stomach contained one fore-limb from a conspecific. Two stomachs contained bird egg shell, and five stomachs were totally empty.

Females were reproductive from November to January (Fig. 1). Mean clutch size was 5.0 (range = 3-7; $n = 17$) and positively correlated with female SVL ($r = 0.48$; $P<0.05$; $n = 17$). More than one clutch per year could be laid according to the simultaneous presence of enlarged follicles and oviductal eggs in some females. Males were reproductively active from October to December, and in January testis width decreased considerably (Fig. 1).

Body temperatures ranged from 29.2°C to 37.8°C (mean = 34.22°C; SD = 1.83; $n = 37$), and was higher than air and substrate temperature (Air: mean = 29.33°C, range = 24.3-34.5; SD = 2.9; $n = 31$. Substrate: mean = 29.36°C; range = 22.1-35.5; SD = 3.54, $n = 31$). Body temperature was positively correlated with both air and substrate temperature ($r = 0.447$, $P<0.014$, $n = 31$; $r = 0.42$, $P<0.02$, $n = 31$, respectively).

*Tropidurus spinulosus* from dry chaco feeds on a variety of arthropods, but primarily on ants, beetles, larvae and bees. Mobile prey (active insects) are more abundant in the diet, as expected for a sit-and-wait forager. Interestingly, about 25% of the individuals contained fruits in their stomachs. Flowers and plant matter were recorded for the diet of other *Tropidurus* species (Vitt, 1991; Van Sluys, 1993). Colli *et al.* (1992) found almost 10% of the diet was plant matter in *T. spinulosus* from Mato Grosso (Brazil), but fruits were only mentioned by Vitt *et al.* (1996) in *T. hispidus* from Roraima (Brazil). Another distinguishable aspect in this population was the role of bees in the diet. Bees are abundant and use tree holes in the study area, and some *T. spinulosus* were observed feeding around tree holes, presumably on bees or wasps. Data from other localities (Vitt, 1991; Colli *et al.*, 1992; Martori & Aún, 1994) are consistent with the results obtained here with respect to the dominance of prey categories; ants, beetles, larvae, and non-ant hymenopterans are the main sources of food for *T. spinulosus;* the differences are given by the importance of fruits and bees.

In the dry Chaco, *T. spinulosus* eat larger prey and have a wider niche breadth than Brazilian populations (Vitt, 1991; Colli *et al.*, 1992). *Tropidurus spinulosus* in the Chaco is 10 mm larger in mean SVL than in Brazilian localities. The size of ants could explain the differences observed in the diet better than the SVL. The number of different prey categories is also higher than in the other localities studied, reaching 16 prey categories. Mean ant length and volume in the diet of *T spinulosus* (6.04 mm and 38.34 $mm^3$) is larger than the values obtained for total prey in the studies by Vitt (1991) and Colli *et al.* (1992).

Reproductive characteristics in *T. spinulosus* are similar to other *Tropidurus* species (Vitt & Goldberg, 1983; Vitt, 1991, 1993; Van Sluys, 1993; Cruz, in press).

In the dry chaco *T. spinulosus* reproduce seasonally, with a relatively low clutch mass, and more than one clutch per cycle (Cruz *et al.*, in press). In Cordoba only one clutch is laid (Martori & Aún, 1994). This difference could be related to the degree of arboreality of the Chaco population; smaller clutches (low RCM) are easier to carry by an arboreal individual, and by laying

a second clutch, the differences in individual clutch characteristics could be less pronounced in relation to that of Cordoba population. Furthermore, the higher temperatures and the greater duration of favourable climatic conditions in Salta (where lizards could be observed for a longer period than in Cordoba), could also favour a second clutch.

*Tropidurus spinulosus* body temperatures were closer to those of *T. torquatus, T. itambere, T. oreadicus* and *T. etheridgei* (Bergallo & Rocha, 1993; Vitt, 1993; Van Sluys, 1992; Cruz *et al.,* unpublished data), than to the population from Cordoba belonging to the same species (Martori & Aún, 1994). This may reflect air and substrate temperatures, and it may also be due to the fact that *Tropidurus* species are thermoconformers, possibly as a result of selection of particular thermic sites along their activity range (Huey & Slatkin, 1976; Espinoza & Tracy, in press).

*Tropidurus spinulosus* show plasticity in their habits, and they can be arboreal or riparian depending on where they are found. In Argentina this species has a distinct reproductive cycle. More than one clutch may be laid in Salta, while in Cordoba a single clutch is laid per cycle. Myrmecophagy seems to be characteristic of *T. spinulosus,* but in the dry chaco bees and fruit are also conspicuous in the diet.

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