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Notes on the biology of *Lacerta andreanszkyi* (Reptilia: Lacertidae)

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Reported only from three general areas at elevations between 2500-3700 m within the High Atlas Mountains of Marrakech Prefecture, Morocco, *Lacerta andreanszkyi* appears little studied (Saint Girons, 1953; Pasteur and Bons, 1960; Bons, 1967; Klemmer, 1969). Since Werner's (1929) description of this apparently restricted apecies, nothing has been published regarding its biology. The following limited data concerning population density, biomass, sex ratio, feeding ecology, reproduction, frequency of injury, and thermal environment and response of this elusive species are presented below to partially fill this void.

Materials and Methods

Field data and specimens were collected along the western margin of the rapidly-flowing stream in the SE corner of the meadow at Oukaïmedene (2650 m), Marrakech Prefecture, Morocco, between 31 May and 3 June 1982. Cloacal temperatures of active lizards were assessed with a calibrated Schultheis rapid-recording thermometer, black-body ambient temperatures (shaded from the sun, one cm above the site at which the lizard was found) with a calibrated Weksler bi-metal thermometer. Pesola spring field balances were used to determine the live weight of individual lizards and a steel ruler was used to measure snout-vent length (SVL; to the nearest mm) in the field. Sampled individuals were immediately preserved in 10% formalin, transported to the Museum of Vertebrate Zoology, University of California, Berkeley (MVZ 178204-178278), and transferred to 70% ethyl alcohol for permanent storage.

The sex of each individual was determined by examination of the gonads in the laboratory. At this time, individuals with intact and regenerated tails, and specimens with damaged toes, were also enumerated. Stomachs were excised and invertebrate prey items were identified to order; the total length of each intact item was determined using an ocular micrometer on a stereoscopic dissecting microscope. The number of prey items per individual stomach and the number of empty stomachs were recorded and arranged by sex. Mean prey size (MPS) of invertebrate prey, defined as the grand mean obtained from multiplying the

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length of each individual prey item by the number of items of that length, summing these values over all prey lengths represented, and dividing by the total number of measurable items in the stomach, was determined for each individual.

Lengths and widths of shelled oviducal eggs were determined with dial calipers accurate to 0.1 mm, weights were assessed on a Mettler P1200 electronic balance after excess fluid was blotted. Yolked ovarian follicles were measured *in situ* with an ocular micrometer on a stereoscopic dissecting microscope.

Correlations between SVL and MPS per individual, and between lizard mass and oviducal egg mass, were evaluated with Spearman's rank correlation coefficient. Similarity in taxonomic composition of the diet between males and females was evaluated with Pianka's (1973) symmetric overlap measure, and trophic diversity per individual (*sensu* Hurtubia, 1973) was determined with Brillouin's diversity index (Pielou, 1969; Busack, 1980). The hypothesis that males and females may be present at differing frequencies in this population was evaluated with the Chi-square test after Yates' correction. Spearman's rank correlation values, r_s, were transformed according to Fisher's z transformation procedures. All probabilities presented are those for committing a Type I error in a two-tailed test.

Population density, biomass, and sex ratio

Thirty females, 45 males, and six unsexed individuals inhabited the 164 m^2 site during the four days of the study; the sexes appeared evenly distributed (Chi-square = 3.02, $P > 0.05$). Results from a removal census allow the direct-count estimate of 0.5 individuals/m^2 for this particular 0.02 ha area, and extrapolation to a potential density of 2950 individuals/ha. If realized, this population density would rank as the highest yet recorded for a lacertid lizard (Turner, 1977).

Males in this population range in SVL from 24 to 51 mm, and in mass from 0.3 to 2.5 g (N = 45); females range from 29 to 54 mm and from 0.5 to 3.0 g (N = 28). The combined mass of 73 individuals was 119.6 g ($\sim$ 6.0 kg/ha) and males contributed biomass at the average rate of 0.4 g/m^2, females at 0.3 g/m^2. Females at 41.9 mm SVL (an "average" SVL for adults of either sex) average 1.5 g, 93% of the mass of a male of similar size (Fig. 1).

Feeding ecology

Individuals of both sexes consume a variety of invertebrate prey items (Table 1). Increasing average prey size ($z = 1.78$, N = 37, $P << 0.001$ for males; $z = 0.45$, N = 22, $P = 0.05$ for females) and increasing diet diversity ($z = 0.87$, N = 40, $P << 0.001$ for males; $z = 1.3$, N = 24, $P << 0.001$ for females) are significantly correlated with increasing SVL (= age) in both sexes, but only in males did the maximum size of prey items appear to increase along with SVL ($z = 1.70$, N = 37, $P << 0.001$).

Reproductive ecology

From two to three shelled oviducal eggs ($\bar{x}$ = 2.1 eggs/individual) were found in each of eight females measuring between 44 and 53 mm SVL and between one and two vitellogenic follicles (4.2-6.4 mm in diameter) were distinct in individuals with SVLs

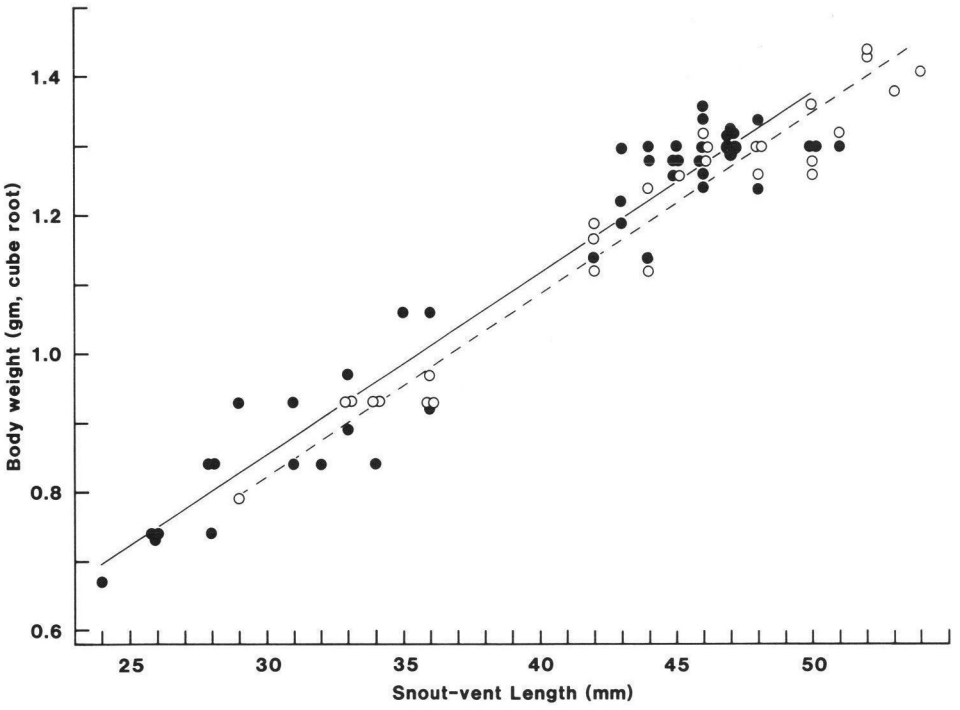

Fig. 1. Weight-length relationship in *Lacerta andreanszkyi* at Oukaïmedene, Morocco. The linear regression formula (± SE) that best fits the relationship between SVL and cube root of weight in males (closed circles, solid line) is y = 0.07 (± 0.04) × + 0.03 (± 0.001; r = 0.97); for females y = 0.07 (± 0.005) × + 0.03 (± 0.001; r = 0.97).

between 42 and 54 mm. If the number of vitellogenic follicles are as indicative of the number of eggs that would have been laid during this reproductive season as are oviducal eggs, then females measuring at least 42 mm SVL are reproductive and clutch size in this population varies from one to three ($\bar{x}$ = 1.9, N = 17).

Evidence for the production of two clutches during a single breeding season may be inferred from individuals demonstrating asymmetrical vitellogenic growth of follicles between ovaries (Jones, 1978). One female (50 mm SVL) with a greatly distended left oviduct also contained a single vitellogenic follicle in the right ovary. If oviducal distention indicates recent egg deposition, then the additional presence of a vitellogenic follicle suggests that second clutches may occasionally be produced. No vitellogenic follicles were found in any of the specimens containing shelled eggs, however.

Oviducal eggs ranged in size from 11.0 × 5.2 mm to 13.0 × 5.7 mm in females carrying only two eggs; in one female carrying three eggs, the eggs measured between 8.7 × 5.1 and 10.5 × 5.2 mm. The mean size of 17 shelled oviducal eggs was 11.7 × 5.2 mm and represented 25% of the mean SVL of the females carrying them; the total mass of the eggs carried by any single female represented between 15 and 23% of the

Table 1. Taxonomic composition of the diet of *L. andreanszkyi*.

Prey categories	Males		Females	
	Number	(%)	Number	(%)
Oligochaeta	1	(<1)	2	(1)
Crustacea				
Isopoda	-	-	2	(1)
Arachnida				
Acarina	-	-	1	(<1)
Araneae	9	(4)	7	(3)
Insecta				
Coleoptera	62	(30)	31	(14)
Collembola	18	(9)	7	(3)
Diptera	5	(2)	4	(2)
Hemiptera	-	-	6	(3)
Hymenoptera	34	(17)	94	(42)
Lepidoptera	7	(3)	8	(4)
Neuroptera	2	(1)	3	(1)
Odonata	1	(<1)	-	-
Orthoptera	45	(22)	34	(15)
Plecoptera	3	(1)	2	(1)
Unidentified				
(larvae)	16	(8)	25	(11)
(nymphs)	1	(<1)	-	-
Seeds	13	(6)	6	(3)
Empty Stomachs	5	(11)	6	(20)
Total*	204		226	
Mean items/stomach*	5.1		9.4	
Diversity/Evenness*	1.83/0.75		1.77/0.71	
Diet similarity*		0.76		

* seeds not included

mass of that female. Larger females demonstrated a tendency to produce oviducal eggs of greater mass than smaller females ($z = 2.0$, $N = 8$, $P < 0.05$).

Thermal ecology

Black-body ambient temperatures and cloacal temperatures associated with active lizards are presented in Figure 2. Active lizards were observed between 1000 and 1700 h while ambient temperatures varied between 17.3 and 28.9°C and cloacal temperatures ranged between 25.0 and 36.0°C. The mean activity temperature of 55 active lizards was 31.4°C and the mean difference between ambient and cloacal temperatures was 9.2°C (range 3.3-15.8). Two lizards (cloacal temperatures = 21.5 & 22°C) were observed to emerge from shelter at 0730 h while ambient temperature was only 13.1°C.

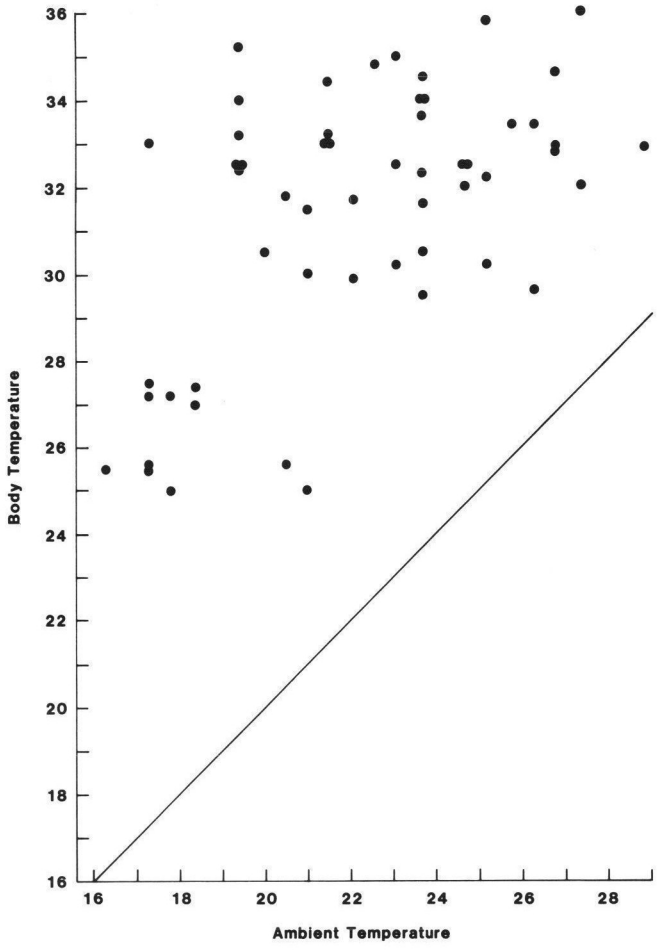

Fig. 2. Relationship between ambient temperature and cloacal temperature in 55 adult *Lacerta andreanszkyi*; diagonal line indicates the region where ambient and cloacal temperatures are equivalent.

Frequency of injury

The frequency of injury (regenerated tails, missing toes, etc.) in lizards of a given population may suggest either that those lizards have successfully escaped predation or that they have been involved in agonistic encounters. Damaged or missing toes were recorded in 13 of 30 females and in 20 of 45 males, regenerated tails were recorded in 14 of 25 females and 30 of 39 males. Toe damage was most extensive in older (= larger) individuals of either sex while regenerated tails were evenly distributed among all sizes of both sexes.

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