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Ecology of the Skink, *Mabuya arajara* Rebouças-Spieker, 1981, in the Araripe Plateau, Northeastern Brazil

Samuel C. Ribeiro,[1,5,6] Diego A. Teles,[2] Daniel O. Mesquita,[1] Waltécio O. Almeida,[2,3] Luciano A. dos Anjos,[4] and Miriam C. Guarnieri[4]

[1]*Programa de Pós-Graduação em Ciências Biológicas, Departamento de Sistemática e Ecologia, Universidade Federal da Paraíba – UFPB, João Pessoa, Paraíba, Brazil*
[2]*Programa de Pós-Graduação em Bioprospecção Molecular, Universidade Regional do Cariri – URCA, Crato, Ceará, Brazil*
[3]*Departamento de Química Biológica, Universidade Regional do Cariri – URCA, Crato, Ceará, Brazil*
[4]*UNESP – Univ. Estadual Paulista, Campus de Ilha Solteira, Faculdade de Engenharia de Ilha Solteira, Departamento de Biologia e Zootecnia, Ilha Solteira, São Paulo, Brazil*
[5]*Programa de Pós-Graduação em Biologia Animal, Laboratório de Animais Peçonhentos e Toxinas, Universidade Federal do Pernambuco – UFPE, Departamento de Zoologia, Recife, Pernambuco, Brazil*

Abstract.—We studied diet, reproduction, and sexual dimorphism in *Mabuya arajara* (Arajara Skink; Scincidae) in a rainforest on the slopes of the Araripe Plateau, northeastern Brazil. Diet was composed mainly of arthropods, mostly termites, when considering both number (93.5%, *n* = 58) and volume (58.5%, *n* = 58). *Mabuya arajara* can be classified as a forager that uses intermediate foraging techniques, as do most of its congeners. Brood size of *M. arajara* ranged from two to nine neonates (4.8 ± 1.7), and larger females tended to produce larger broods. The period of parturition occurs between October and December. Adult females of *M. arajara* were larger and heavier than adult males. There was no significant difference between the body size of males and females, but there was a significant difference in body shape between sexes. The positive relationship between brood size and female size can be considered an important correlate of the sexual selection of bigger females in *Mabuya* and other South American lizards in general.

Several aspects of the ecology of lizards of the genus *Mabuya* have proven phylogenetically conservative (e.g., Vrcibradic and Rocha, 1998a,b, 2011). Species of *Mabuya* present similarities in many aspects of their life history, such as reproductive activity, which is characterized by similar offspring size, similar significant influence of female dimensions on clutch size, and similar long gestation periods with high energy expenditure (e.g., Vitt and Blackburn, 1983, 1991; Vrcibradic and Rocha, 1998b; Rocha and Vrcibradic, 1999). In relation to diet, these are generalist animals that consume small amounts of plant material and have a diet composition indicative of a type of foraging intermediate between typical active and typical sit-and-wait foraging (e.g., Vitt and Blackburn, 1991; Vrcibradic and Rocha, 1995). These animals also present similar average body temperatures, usually with environmental temperatures exerting a significant influence (e.g., Vrcibradic and Rocha, 1995, 1998a).

For nearly 3 decades, *Mabuya arajara* was regarded as endemic to the southern part of the state of Ceará on the Araripe Plateau in northeastern Brazil (Rebouças-Spieker, 1981). Since then, Roberto and Loebmann (2010) have recorded this species in other mesic enclaves ('brejos-de-altitude') of the northern part of Ceará: Ubajara National Park and the Ibiapada, Ubatuba, and Almas mountain ranges. Roberto et al. (2012) furthermore recorded the occurrence of *M. arajara* in the State of Piauí. *Mabuya arajara* is morphologically similar to *Mabuya nigropuntacta* (Black-spotted Skink), which is widely distributed in the forest regions of northern, northeastern, and central Brazil (Ávila-Pires, 1995). Both species, *M. arajara* and *M. nigropuntacta*, are grouped within the *arajara/nigropuntacta* complex characterized by large body size, paired frontoparietals, and no vertebral stripes (Rodrigues, 2000).

Various aspects of the life history of *M. nigropuntacta* have been studied (Vitt and Blackburn, 1991; Ávila-Pires, 1995; Vitt et al., 1997) and so with other congeners (Vitt, 1991, 1995; Vrcibradic and Rocha, 1996, 1998a,b; Ramírez-Pinilla et al., 2002). However, published information about *M. arajara* has appeared only recently, such as the observation of the parturition of a female in captivity (Roberto and Loebmann, 2010), thanatosis defensive behavior (Ribeiro et al., 2010), pulmonary infection by pentastomids (Ribeiro et al., 2012a), and geographic distribution (Ribeiro et al., 2012b; Roberto et al., 2012).

The understanding of the ecology of populations of closely related species is recognized as an invaluable contribution to the conservation of *M. arajara*, particularly because of the increase in information on the different degrees of conservatism of life history patterns in lizards (Bogert 1949; Cooper, 1994). In this sense, we studied the ecology of *M. arajara* and provided a comparison with congeners, seeking to answer the following questions: 1) What is the reproductive period and mean brood size? 2) Are there differences in energy expenditure regarding reproduction between the sexes? 3) What is the effect of female size on brood size? 4) Is there sexual dimorphism in size and body shape? 5) What is the influence of lizard body size on diet composition?

Material and Methods

Study Area.—This study was conducted between September 2009 and July 2010. Collecting excursions occurred bimonthly on the slopes of the Araripe Plateau, each one lasting 10 consecutive days, at sites located in Crato (07°15′19″S, 39°28′13″W, site one; and 07°16′50″S, 39°26′18″W, site two) and Barbalha Municipalities (07°21′49″S, 39°17′51″W, site one; and 07°58′19″S, 39°24′38″W, site two), state of Ceará, northeastern Brazil. The study areas are located within the boundaries of the Environmental Protection Area of Araripe-APA Araripe. This forest enclave, along with all forest enclaves in the Caatinga Biome which are related to slopes of hills, is known as 'brejos-de-

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[6]Corresponding Author. E-mail: ribeiroherpeto@gmail.com

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altitude.' The rainforest occurs on the upper third of the north–northeast slopes (600 to 800 m of altitude) of the Araripe Plateau.

The region has a predominantly warm, semi-arid, tropical-type climate with temperatures ranging between 24–26°C. The rainy season extends from January to May and the mean annual rainfall is 1,100 mm^3 (IPECE, 2010).

Collecting and Laboratory Procedures.—One hundred and thirty-one lizards were captured manually or by air gun (4-mm caliber). The specific numbers of animals used in each section of the manuscript are described below. Animals that were taken alive were euthanized by injection of lydocain, packed in boxes with ice, and taken to the laboratory where mass was determined using a digital scale (precision 0.001 mg). The following measurements were taken (digital caliper, to the nearest 0.01 mm): snout–vent length (SVL); tail length (TL, measured from cloaca to the tip tail, considering only individuals with an intact tail); head length (Hl, measured from the snout to the anterior tympanum border), head height and width (Hh and Wh, respectively), and labial commissure (LC, measured from the snout to the mouth). The specimens were preserved in 70% alcohol and housed in the collection of the Universidade Regional do Cariri (URCA-H 2041–2067, 2082–2090, 2727–2819).

To give a phylogenetic view of the ecological traits of Brazilian *Mabuya*, we built a cladogram, adapting a recently proposed phylogenetic hypothesis (Pyron et al., 2013) and including *M. arajara* as the sister species of *M. nigropuntacta* based on morphological similarity (Rodrigues, 2000). We considered that all species belong to the genus *Mabuya*, and did not adopt the classification of multiple genera suggested by Hedges and Conn (2012), for the reasons proposed by Pyron et al. (2013). Only Brazilian species of *Mabuya* were included.

Diet.—Items found in the stomachs of the lizards after dissection were identified to the lowest taxonomic level possible (usually Order). The prey volume (V) was estimated by the ellipsoid formula (Dunham, 1983) using the measures of prey width (w) and length (l):

$$v=\frac{4}{3}\pi\left(\frac{w}{2}\right)^2\left(\frac{l}{2}\right)$$

The numeric and volumetric percentage of each prey category was calculated, and these values were used to determine the niche width using the inverse of Simpson's diversity index (B) (Simpson, 1949):

$$B=\frac{1}{\sum_{i=1}^{n}p_i^2}$$

where i is the category of the resource, p is the proportion of the resource category i, and n is the total number of categories. The standardized niche width was calculated by dividing B by the number of categories of resources. This procedure produces values that range from 0 to 1. The standardized value of niche could thus be compared with the values of other studies (see Pianka, 1986).

The diet overlap ($\varnothing_{jk}$) between sexes was calculated using the following equation (Pianka, 1973):

$$\varnothing_{jk}=\frac{\sum_{i=1}^{n}p_{ij}p_{ik}}{\sqrt{\sum_{i=1}^{n}p_{ij}^2\sum_{i=1}^{n}p_{ik}^2}}$$

where the symbols are as described earlier, but with j and k representing the compared sexes. The overlap $\varnothing_{jk}$ ranges from 0 (no overlap) to 1 (complete overlap). To investigate the presence of nonrandom pattern in the niche overlap for diet, we used the Niche Overlap Module of EcoSim (Gotelli and Entsminger, 2003). The matrix was reshuffled to produce random patterns that would be expected in the absence of underlying structure. We used the options 'Pianka's niche overlap index' and 'randomization algorithm 3.'

The differences between sexes with regard to the average number of food items per stomach were analyzed using the Mann–Whitney test, and the mean volume of the five largest items (or of all items if fewer than five were consumed) consumed was compared between sexes with a t-test. The relationships between lizard body measurements and the number and average volume of the food items were analyzed using Pearson's correlation. Only lizards containing identifiable food items were included in the analysis.

To investigate if there was a relationship between prey size and lizard head dimensions, a canonical correlation analysis was performed using the following variables: maximum length and maximum width of prey vs. labial commissure, head width, head height, and head length.

Sexual Dimorphism.—To separate the variation in body size and body shape of lizards, body size was defined as the scores of an isometric vector with $p^{-0.5}$ values, where p is the number of variables (Jolicoeur, 1963). The scores were obtained as an eigenvector, called body size, by multiplying the matrix $n \times p$ of $\log_{10}$-transformed data (for standardization of data), where n is the number of observations, by isometric vector $p \times l$ (Rohlf and Bookstein, 1987).

Differences between the sexes were checked using the t-test for body size (isometric vector described above) and a multivariate analysis of variance (MANOVA) for $\log_{10}$-transformed variables. A discriminant analysis was used to verify which variables better explained the differences between sexes. For these analyses, we used only adult individuals (defined by the smallest male with enlarged testicles and convoluted epididymides and the smallest female containing ova or embryos in their oviducts, Stage 3).

Reproduction.—The vitellogenic follicles in the ovaries, and eggs and embryos in the oviducts of each female, were counted and measured along their longer and shorter axes. The reproductive stage of each female was assessed using an adaptation of the method proposed by Rocha and Vrcibradic (1999), with six stages of embryo development including (at Stage 3) eggs without evident structures, with a uniform liquid mass aspect measuring up to 11 mm in diameter. Females were considered reproductive when they contained ova or embryos in their oviducts (Stages 3 to 6). Brood size was estimated using data from all females containing eggs or embryos in their oviducts. To assess whether lizard body size affected the size of the brood, a linear regression analysis was performed on number of eggs/embryos × SVL. The final number of newborns could be reduced because of egg reabsorption in smaller females, which sometimes cannot accommodate all the ova under development (Vitt and Blackburn, 1983, 1991). To minimize the effect of the possible reabsorption of embryos on final brood size, as well as to enable comparisons with other studies (Vrcibradic and Rocha, 1998b), a simple linear regression was performed using only pregnant females in Stages 5–6 (Rocha and Vrcibradic, 1999). Using the frequency of each reproductive stage of females throughout the year, the approximate duration of each stage of

TABLE 1. Number (*N*), volume (*V*) (mm^3), and frequency of occurrence (F) of prey in the diet of juveniles and adult males and females of *M. arajara* on the Araripe Plateau, Ceará, northeastern Brazil.

	Adult males ($N = 32$)			Adult females ($N = 22$)			Juveniles ($N = 4$)			Total ($N = 58$)	
Item	*N* (%)	*V* (%)	F	*N* (%)	*V* (%)	F	N (%)	*V* (%)	F	*N* (%)	*V* (%)
Insecta											
Isoptera	876 (95.7)	92.5 (63.7)	26	500 (90.9)	63.5 (52.6)	12	2 (22)	3 (50)	2	1378 (93.5)	159 (58.5)
Hemiptera	3 (0.3)	4.5 (3.1)	3	3 (0.5)	2 (1.6)	2	-	-	-	6 (0.4)	6.5 (2.3)
Orthoptera	4 (0.4)	9 (6.2)	4	2 (0.3)	11 (9.1)	2	-	-	-	6 (0.4)	20 (7.3)
Coleoptera	4 (0.4)	6 (4.1)	2	1 (0.1)	3.5 (2.9)	1	-	-	-	5 (0.3)	9.5 (3.4)
Siphonaptera	-	-	-	2 (0.3)	3 (2.4)	1	-	-	-	2 (0.1)	3 (1.1)
Lepidoptera	2 (0.2)	3.5 (2.4)	2	-	-	-	-	-	-	2 (0.1)	3.5 (1.2)
Hymenoptera (non-ant)	-	-	-	1 (0.1)	1 (0.8)	1	-	-	-	1 (0.06)	1 (0.3)
Odonata	1 (0.1)	1 (0.6)	1	-	-	-	-	-	-	1 (0.06)	1 (0.3)
Formicidae	-	-	-	1 (0.1)	1 (0.8)	1	1 (11)	1 (16.6)	1	2 (0.1)	2 (0.7)
Dermaptera	-	-	-	1 (0.1)	1 (0.8)	1	-	-	-	1 (0.06)	1 (0.3)
Blattaria (nymph)	-	-	-	-	-	-	1 (11)	1 (16.6)	1	1 (0.06)	1 (0.3)
Insect larvae	-	-	-	10 (1.8)	1.5 (1.2)	1	-	-	-	10 (0.6)	1.5 (0.5)
Arachnida											
Aranae	18 (1.9)	17 (11.7)	9	26 (4.7)	27 (22.4)	9	3 (33.3)	1 (16.6)	1	47 (3.3)	45 (16.5)
Opiliones	3 (0.3)	7 (4.8)	1	-	-	-	-	-	-	3 (0.2)	7 (2.5)
Pseudoscorpiones	1 (0.1)	1 (0.6)	1	-	-	-	-	-	-	1 (0.06)	1 (0.3)
Scorpiones	-	-	-	1 (0.1)	3.5 (2.9)	1	-	-	-	1 (0.06)	3.5 (1.2)
Acari	-	-	-	-	-	-	2 (22)	0,05	1	2 (0.1)	0.05 (0.2)
Mollusca											
Gastropoda	2 (0.2)	1.5 (1.0)	1	-	-	-	-	-	-	2 (0.1)	1.5 (0.5)
Others											
Plant material	-	-	-	1 (0.1)	1 (0.8)	1	-	-	-	1 (0.06)	1 (0.3)
Lizard shed skin	1 (0.1)	2 (1.3)	1	1 (0.1)	1.5 (1.2)	1	-	-	-	2 (0.1)	3.5 (1.2)
Total numbers	915	145		550	120.5		9	6.05		1474	271.5
Niche breadth	1.0	2.3		1.2	2.9		4.2	3.2		1.1	2.6

the reproductive cycle was estimated (Ramírez-Pinilla et al., 2002).

For each male, the width and length of the testicles were measured and their volume was estimated using the ellipsoid volume formula (see above). To verify if there was a relationship between the volume of the testicles and the body size (SVL) of males, we used Spearman coefficients.

All the gonad and embryo measurements were taken with a digital caliper (0.01-mm accuracy). The inguinal fat bodies in animals of both sexes were weighed with an analytical balance (precision 0.001 mg). Differences in the volume of the testicles, as well as differences in the total mass of fat bodies in both sexes throughout the year and among developmental stages of embryos, were assessed using the Kruskal–Wallis test.

Monthly variations in testis volume (largest value of each male), in the volume of embryos (calculated by the ellipsoid formula, see above), and in the total fat body mass of both males and females were evaluated separately (mean ± 1 SD) using residuals from a regression of these variables on SVL (all $\log_{10}$-transformed). To assess the existence of a variation in the use of fat bodies over the months, fat mass residues of adults were correlated with the residues of the mean volume of the testicles and the average volume of embryos using a simple regression analysis.

Descriptive statistical analyses used throughout the paper include means ± 1 SD. Statistical analyses were performed in Statistica 7.0 and EcoSim 7.0 softwares.

RESULTS

Diet.—One hundred and one lizards were dissected for examination of food items, of which 8.9% ($n = 9$) had empty stomachs and 33.6% ($n = 34$) had nonidentifiable items in their stomachs. Lizards with stomachs damaged during capture were not included in the analysis ($n = 30$). We identified 20 prey categories, the most important being Isoptera both in terms of volume (58.5%) and number (93.5%) (Table 1). The mean number of prey items per stomach was 24.6 ± 37.5 (range 1–183) and the mean number of prey categories per stomach was 1.5 ± 0.7 (range 1–4). The food niche breadth was 1.14 (standardized = 0.05) and 2.63 (standardized = 0.13) based on numerical and volumetric proportions of prey, respectively. Males and females showed no significant differences in number (Mann–Whitney Z $[U] = 0.87$, $P = 0.38$) or mean volume of prey items ingested ($t = 0.49$, $P = 0.62$).

The first canonical correlation was 0.57, statistically significant ($P = 0.02$), indicating that there must be an association between head size and prey dimensions (Table 2). Nevertheless, the correlations between head measures and prey dimensions were low. The first and second canonical variables of head length represented a contrast among other measurements. The first canonical variable of prey size gave a greater emphasis on the greater prey width.

The relationship between prey length and prey number in each stomach was negative and significant (Spearman $r = -0.35$, $P = 0.01$). Males and females exhibited high overlap in their diet ($Ø_{jk} = 0.99$). *Mabuya arajara* consumed a small amount of plant material and lizard shed skin (Table 1).

Sexual Dimorphism.—There was no significant difference in the body size between males and females ($t = 0.77$, $P = 0.43$). However, there was a significant difference in body shape between sexes (MANOVA Wilk's lambda = 0.792; $P < 0.001$). A stepwise discriminant analysis selected two variables as the most important in the separation of the sexes (SVL and LC) and classified 75% of individuals correctly, with females (mean SVL = 91.3 ± 9.9 mm, range 71.9–114 mm) being longer than males (mean SVL 83.6 ± 6.9 mm, range 70.2–103.8 mm). In addition, adult females of *M. arajara* are heavier ($t = 0.427$, $P < 0.001$; mean

TABLE 2. Canonical correlation analysis between dimensions of the prey and head dimensions of *M. arajara* on the Araripe Plateau, Ceará, northeastern Brazil.

	First canonical variable	Second canonical variable	
Canonical coefficients of the measures of the head			
Head width	0.8539	0.0726	
Head height	0.2508	0.4446	
Head length	−0.0401	−0.3170	
Labial commissure	0.1605	0.3217	
Canonical coefficients of the measures of the preys			
Maximum width of prey	0.9981	0.0622	
Maximum length of prey	0.3800	−0.9250	
Canonical variables	Correlation canonical	*F*	*P*
I	0.579	2.35	0.0253
II	0.154	0.33	0.8061

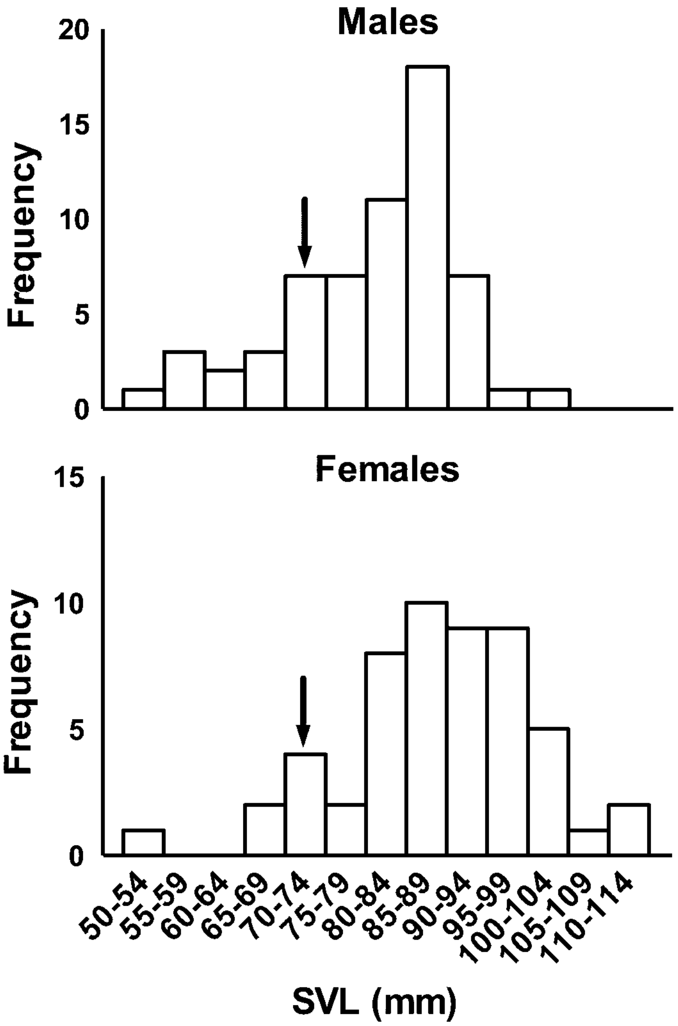


FIG. 1. Distribution of male and female body sizes (mm) of *M. arajara* studied on the slopes of the Araripe Plateau, Ceará, northeastern Brazil. Arrows indicate the smallest reproductive individual.

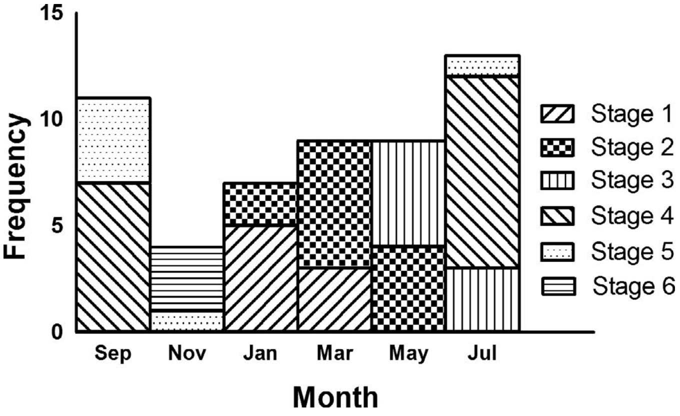


FIG. 2. Frequency of reproductive stages of sexually mature females of *M. arajara* studied on the slopes of the Araripe Plateau, Ceará, northeastern Brazil.

body mass 18.8 ± 5.7 g, range 7.9–37.8 g; $n = 52$) than adult males (mean body mass 14.3 ± 3.5 g, range 5.9–20.3 g; $n = 54$).

Reproduction.—The smallest reproductive female measured 72 mm (SVL) (contained ova or embryos in their oviducts, Stage 4, even smaller than females in stage 3), with the smallest female at parturition (smallest SVL for females containing well-formed embryos) measuring 87.7 mm. The smallest male with enlarged testicles and convoluted epididymides was 70 mm of SVL (Fig. 1). *Mabuya arajara* presented a mean brood size of 4.9 ± 1.6 (range 2–9; $n = 45$). Considering only females in Stages 5–6 (preparturient), mean brood size was 6.0 ± 1.8 (range 3–9; $n = 9$). The average time of gestation is estimated at 10–12 mo (defined by the duration of each stage of the cycle, see Ramírez-Pinilla et al., 2002), with females in Stages 1 and 2 (postparturient) between November and May. The parturition period occurred in November when the first neonate was recorded in the field (35 mm SVL) and pregnant females showed fully developed embryos (Stage 6) (Fig. 2). The average length (comp. of the embryo sac with the embryo curled inside) of these embryos was 22.1 ± 2.1 mm (range 19.6–24.6 mm, $n = 7$). The number of embryos was positively and significantly correlated with female SVL ($r^2 = 0.50$, $P < 0.001$, $n = 45$, Fig. 3), even when considering only females in the final reproductive stages ($r^2 = 0.58$, $P = <$

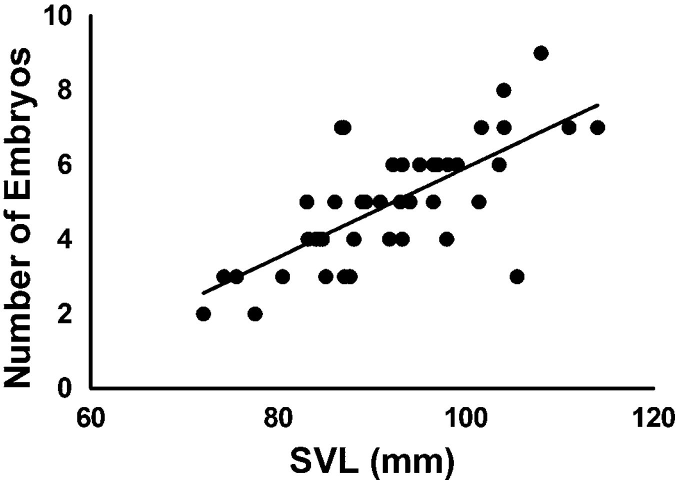


FIG. 3. Relationship between the number of embryos and body size (SVL, mm) of sexually mature females of *M. arajara* studied on the slopes of the Araripe Plateau, Ceará, northeastern Brazil ($r^2 = 0.50$, $P < 0.001$, $n = 45$).

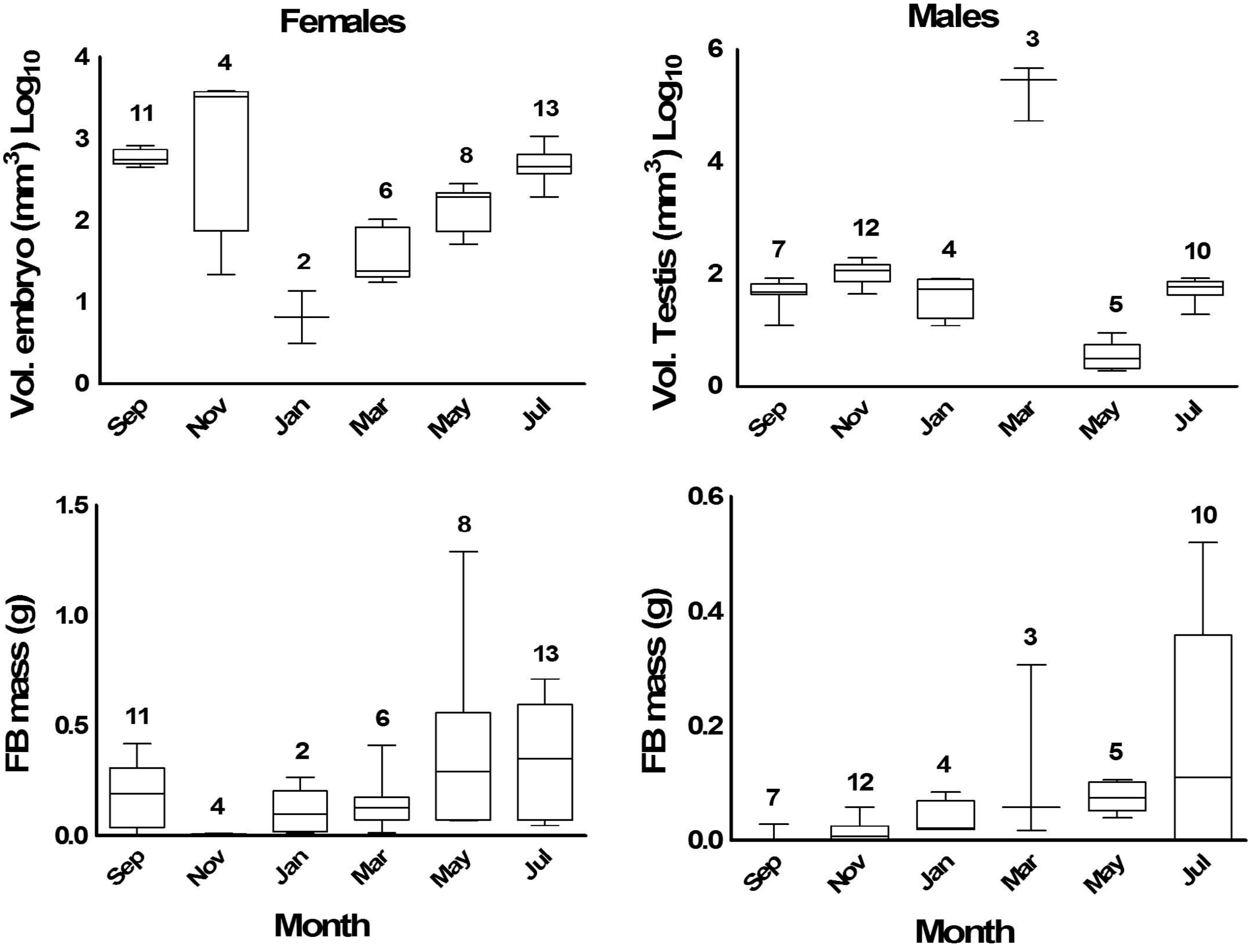


FIG. 4. Monthly distribution of the average values of the embryos (above left; expressed by average values of the two largest eggs or embryos in each female) and volume (mm^3) of testicles (above right; expressed by the values of the largest testicle of each lizard) (all $\log_{10}$-transformed), and mass of fat bodies (FB; g) in both sexes (below) of the lizard *M. arajara* on the slopes of the Araripe Plateau, Ceará, northeastern Brazil.

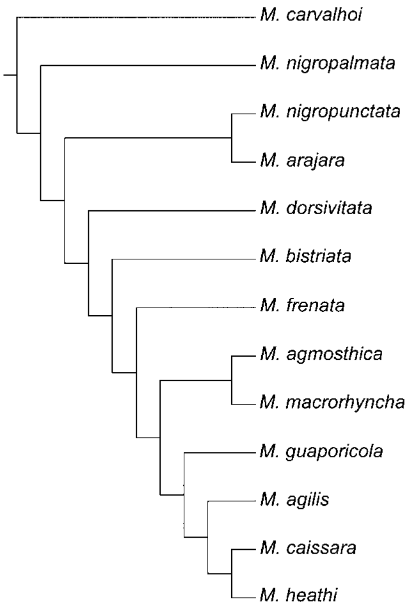
0.01, $n = 9$). There was no significant relationship between female SVL and the volume (Spearman $r = 0.21$, $P = 0.20$) and length of embryos ($r = 0.24$, $P = 0.12$). In males, there was a significant relationship between the volume of testicles and SVL (Spearman $r = 0.50$, $P < 0.001$). There was no significant correlation between fat-body accumulation and reproductive stage in females ($r = -0.164$, $P = 0.63$, $n = 30$) or with volume of testes in males ($r = 0.18$, $P = 0.25$, $n = 41$) (Fig. 4). A review of the ecology of *Mabuya* spp. shows that several features appear to be phylogenetically conservative such as the presence of sexual dimorphism, brood size, and preference for certain types of prey (termites, spiders, and Orthoptera) (Fig. 5).

DISCUSSION

Diet.—The diet of *M. arajara* is characteristic of an opportunistic predator, indicated by the use of a broad spectrum of food items (20 categories, Table 1), which is in accordance with previous findings for Scincidae (Huey and Pianka, 1977) including *Mabuya* (e.g., Vitt and Blackburn, 1991; Vrcibradic and Rocha, 1995; Vitt et al., 1997; Teixeira et al., 2003; Vrcibradic et al., 2004). The diet of *M. arajara* consisted of arthropods, with an ample predominance of termites. The other items in the diet were consumed at a low frequency, with the exception of spiders, the second-most consumed item and recognized as an important diet item of *Mabuya* spp. (e.g., Vitt and Blackburn, 1991; Vitt, 1995; Vrcibradic and Rocha, 1996; 1998a) (Fig. 5).

The insignificance of plant material in the diet of *M. arajara* appears to be a common feature in these lizards (Rocha et al., 2004), with the exception of the Noronha Skink *Trachylepis atlantica*, which consumes a considerable amount of plant material (Rocha et al., 2009), explained by their insular distribution and the reduced availability of invertebrates (Cooper and Vitt, 2002). The high frequency of available termites (Surname, pers. obs.) indicates an opportunistic food strategy (Vrcibradic and Rocha, 1995; Vrcibradic and Rocha, 1998a).

Foraging animals of the 'sit-and-wait' type tend to ingest large amounts of high-mobility prey (such as spiders) while, in general, active foraging animals consume more sedentary or gregarious prey (for example, termites and insect larvae, e.g., Huey and Pianka, 1981; Magnusson et al., 1985). However, the association between the type of prey and the foraging mode does not always conform to the expected and should be seen more as a tendency than a strict standard. In addition, the foraging mode is not only a reflection of prey availability but a



	Sexual dimorphism	Brood size	Diet	Max SVL	REF
M. carvalhoi	?	?	?	63	5
M. nigropalmata	?	?	?	60	1
M. nigropunctata	P	2-9	Te,He,Ar,Or,Co,Bl	113	7,16,20
M. arajara	P	2-9	Te,Ar	114	Present study
M. dorsivitata	?	3-4	Ar,Co,Di,Ho	84	18, 21
M. bistriata	?	4-8	?	83	9
M. frenata	P	1-9	Te,Ar,Ho	91	6,11
M. agmosthica	P	1-4	?	72	8,13
M. macrorhyncha	P	1-6	He,Fo,Ar,Te,Bl,Or	85	3,12,19, 21
M. guaporicola	P	4-5	Co,Or,He,Te	98	2,14,16
M. agilis	P	1-9	Ar,Or,Bl	96	12,15,16,17
M. caissara	?	2-9	?	90	3
M. heathi	P	2-9	Or,Te,Ar	88	4,10

FIG. 5. Phylogeny of *Mabuya* lizards (modified from Pyron et al., 2013) showing the mapping of ecological characteristics. Abbreviations: Te = termite, He = Hemiptera, Ar = Aranae, Or = Orthoptera, Co = Coleoptera, Bl = Blattaria, Di = Diptera, Ho = Homoptera, Fo = Formicidae. Reference: Andersson (1918) = 1; Dunn (1936) = 2; Vanzolini and Rebouças-Spieker (1976) = 3; Vitt and Blackburn (1983) = 4; Rebouças-Spieker and Vanzolini (1990) = 5; Vitt (1991) = 6; Vitt and Blackburn (1991) = 7; Stevaux (1993) = 8; Ávila-Pires (1995) = 9; Vitt (1995) = 10; Vrcibradic and Rocha (1998a,b) = 11; Rocha and Vrcibradic (1999) = 12; Rodrigues (2000) = 13; Mesquita et al., 2000 = 14; Teixeira et al. (2003) = 15; Pinto and Ávila-Pires (2004) = 16; Rocha et al. (2004) = 17; Vrcibradic et al. (2004) = 18; Vrcibradic and Rocha (2005) = 19; Mesquita et al. (2006) = 20; Vrcibradic and Rocha (2011) = 21.

combination of ecological and historical factors (Perry, 1999). For example, *Mabuya frenata* (Cope's Skink) studied in rocky outcrops in southeastern Brazil showed a diet basically composed of termites and, although relatively sedentary, it adopted an active foraging strategy (Vrcibradic and Rocha, 1998a). While not assessed, *M. arajara* seems to have low rates of movement, typical of 'sit-and-wait' animals, even though it also has characteristics of active foraging animals because of a strong tendency to consume gregarious prey and its possession of a chemosensory system to locate prey (Cooper, 1994). Thus, *M. arajara* can be classified as a forager that uses intermediate foraging techniques, as do most of its Brazilian congeners (Vitt, 1991; Vrcibradic and Rocha, 1996).

Mabuya arajara and its congeners have a generalist diet, consuming mainly arthropods of various kinds but with termites, spiders, and Orthoptera being of high importance (Vitt and Blackburn, 1991; Vitt, 1995; Vrcibradic and Rocha, 1995; Vitt et al., 1997; Vrcibradic et al., 2004) (Table 1). The opportunistic feeding habits of these lizards may reflect prey availability in the environment. However, it would be reasonable to assume that there is preference for some prey, such as termites and spiders, as evidenced by the diet similarity of several *Mabuya* species (Fig. 5).

Some authors have indicated that relationships between head and prey size may be related to resource partitioning (e.g., Vitt and Ávila-Pires, 1998). Our analyses of relationships between measures of lizards and the number of prey showed a positive correlation, suggesting the possibility of a symmetrical interaction, contrary to that stated for *M. nigropuntacta* in the Amazon region (see Vitt et al., 1997).

Finally, the low frequency of empty stomachs (8.9%) in the studied population could indicate a positive energy balance (see Huey et al., 2001).

Sexual Dimorphism.—The major differences between male and female *M. arajara* are related to body shape. Females have larger and more-robust bodies, whereas males show greater relative dimensions of the head, as is true for several congeners (see Blackburn and Vitt, 1992; Stevaux, 1993) (Fig. 5). These differences might be a result of sexual selection. The brood size produced by many lizard species is related directly to the body size of females (Stevaux, 1993). Females of *M. arajara* attain larger body sizes than do males, reaching the highest value ever recorded for this genus in Brazil (SVL of 114 mm). The directly proportional relationship between brood size and female size is an important factor for the selection of bigger females (Trivers, 1976) recorded in *Mabuya* lizards (Vitt and Blackburn, 1983; Stevaux 1993; Vrcibradic and Rocha 1998b; Rocha and Vrcibradic 1999; Ramírez-Pinilla et al., 2002). In contrast, selective pressures driven by agonistic interactions should favor males that have proportionately larger heads and mouths than do females (Stevaux, 1993).

Reproduction.—Studies on the reproduction of *Mabuya* lizards reveal that some reproductive traits are very conservative (Vrcibradic and Rocha, 2011), even though there are some variations within species along their geographic range (Vanzolini and Rebouças-Spieker 1976; Rocha et al., 2002). After initial phylogenetic proposals based on molecular data (e.g., Whiting et al., 2006), Vrcibradic and Rocha (2011) evaluated the similarities of reproductive traits among species, proposing some species groups based on reproductive similarities. Because of variation in the maximum size of females among species, we adapted the groups proposed by Vrcibradic and Rocha (2011), considering only one large-bodied group of species with size (SVL) greater than 110 mm in which are included *M. arajara* and *M. nigropuntacta*. In addition, we propose a small-bodied group of species with size (SVL) smaller than 70 mm, such as *Mabuya* *carvalhoi* (Carvalho's Skink) and *Mabuya nigropalmata* (Black Skink), considering the other species with intermediate size to be the intermediate-bodied group. Considering brood size, the taxa can be divided into a 'small-brooded' group (comprising *Mabuya agmosticha* [Rodrigue's Skink], *Mabuya macrorhyncha* [Hoge's Skink], and lowland *Mabuya agilis* [Haddi's Skink]) and a 'large-brooded' group containing the remaining taxa (Vrcibradic and Rocha, 2011), including *M. arajara* (Fig. 5).

The breeding period of *M. arajara* was found to be similar to that of other congeners (e.g., Vitt and Blackburn, 1983, 1991; Vrcibradic and Rocha, 2005), occurring at the end of the dry season. However, unlike most congeners, reproduction seems to cease immediately at the beginning of the rainy season. The reproductive adjustment according to the seasonality (independent of climatic variations in different regions), in which the period of parturition coincides with the beginning of the rainy season or a little earlier, is a reproductive feature of the Neotropical species of *Mabuya* (Vitt and Blackburn, 1983; Vitt, 1991; Stevaux, 1993). This reproductive adjustment likely favors the young individuals, which experience periods of higher moisture, when the supply of food (i.e., arthropods) tends to be greater, as reported in the Araripe Plateau rainforest (Azevedo et al., 2011). *Mabuya arajara* apparently reproduces in its first year of life, as suggested by the small body size of the smallest reproductive female, proportionally similar to those reported for congeners (Vrcibradic and Rocha, 2011) except for *M. macrorhyncha* (Rocha and Vrcibradic, 1999) and *M. agmosticha* (Stevaux, 1993), which attain reproductive maturity later.

Although *M. arajara* did not present a significant negative relationship between the mass of fat bodies and the volume of embryos or testis, among females this was a clearly observed trend (Fig. 4). Minimum amounts of accumulated fat bodies were found in the last stage of embryo development, with an increase of these values in the subsequent months until mid-May, declining again in July, synchronously with the greater development of embryos (Stage 5). After that time those values decreased, virtually disappearing in the next stage, indicating an additional use of fat bodies during the development of embryos, a pattern already registered in females of other *Mabuya* lizards (Stevaux, 1993; Vrcibradic and Rocha, 1998b; Rocha and Vrcibradic, 1999). In males, the increased use of fat bodies has not been clearly evidenced. This difference in the use of abdominal fat bodies with testicular development accumulated during reproduction can indicate a larger reproductive cost in females compared to males, as suggested by Rocha and Vrcibradic (1999).

Finally, in general *M. arajara* presents typical reproductive characteristics of Neotropical *Mabuya* (see Vrcibradic and Rocha, 2011); small ova in the early stage of development, embryos developed with relatively large sizes, prolonged pregnancy, reproductive cycle apparently dependent on local seasonality, early sexual maturity, apparent use of energy reserves during gestation, brood size positively related to the dimensions of the females, and sexual dimorphism in shape (SVL).

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