

Geographic distribution and parturition of *Mabuya arajara* Rebouças-Spieker, 1981 (Squamata, Sauria, Scincidae) from Ceará, northeastern Brazil

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ABSTRACT - *Mabuya arajara* Rebouças-Spieker, 1981 has been considered an endemic species from the southern of state of Ceará, restricted to the Deciduous Dry Forests in the slopes of Plateau of Araripe (Chapada do Araripe). Here, we present an updated distributional map for the species and demonstrate that its range is not restricted as formerly believed. In addition, we had an opportunity to observe a gravid female and we describe aspects regarding parturition and number of offspring for the species.

THE skinks of genus *Mabuya* Fitzinger, 1826 comprise 33 species (Uetz et al., 2009), 13 of which are distributed within Brazilian territory (Bérnils, 2009). In northeastern Brazil, five species *Mabuya agmosticha* Rodrigues, 2000, *Mabuya arajara* Rebouças-Spieker, 1981, *Mabuya heathi* Schmidt & Inger, 1951, *Mabuya macrorhyncha* Hoge, 1947, and *Mabuya nigropunctata* (Spix, 1825) are recorded in the Caatinga and/or Atlantic Rain Forest Biomes (Rodrigues, 2000). The taxonomy of the genus is poorly known, sometimes ambiguous, and there is a need for a major taxonomic revision (Avila-Pires, 1995; Rodrigues, 2000).

The South and Central American species of *Mabuya* have an interesting reproductive biology. They are lecithotrophic viviparous lizards that present certain similarities to therian mammals in terms of placental structure and function (Blackburn & Vitt, 1992). Studies of the reproductive biology of a few Brazilian species of *Mabuya* have been conducted in the last four decades, and information is available for *Mabuya agilis* (Rocha & Vrcibradic, 1999; Rocha et al., 2002), *Mabuya*

caissara (Vanzolini & Rebouças-Spieker, 1976), *Mabuya dorsivittata* (Vrcibradic, 2001), *Mabuya frenata* (Vrcibradic & Rocha, 1998), *Mabuya heathi* (Vitt & Blackburn, 1983; Blackburn & Vitt, 1992, 2002), *Mabuya macrorhyncha* (Rocha et al., 2002), and *Mabuya nigropunctata* (Vitt & Blackburn, 1991; Blackburn & Vitt, 1992). *Mabuya arajara* is placed in a large species group with a normal snout, paired frontoparientals, and no vertebral stripes on the body (Rodrigues, 2000). It is considered closely related to *M. nigropunctata* (sensu Avila-Pires, 1995), with the main difference between them being colour pattern. In *Mabuya arajara*, the dark lateral stripe begins in the loreal region and starts to fade away in the middle of the body. The white dorsolateral stripe, which begins in the superciliaries, dwindles behind the arm. In *M. nigropunctata*, both stripes are well defined and marked all over the body, reaching the tail (Rebouças-Spieker, 1981).

Mabuya arajara is the least known species of the group; it was described based on specimens collected from a single locality, the district of Arajara, municipality of Barbalha, southern of state

of Ceará. No ecological data or new distributional records are known for the species and it is considered endemic to the locality. Therefore, in order to cover gaps in information we present an updated distribution map for *Mabuya arajara*, and describe the parturition process and offspring size for the first time.

METHODS AND MATERIALS

During October 2005 and May 2009, we carried out field trips in several localities in the state of Ceará in order to find new records of occurrence for *M. arajara*. Specimens were obtained through time constrained searches (Campbell & Christman, 1982) and opportunistic encounters. Effort was concentrated on mountainous areas (120-950 m ASL) as there is no indication that this species occurs in open areas from lowlands. To create a distribution map for *M. arajara* we compiled our data with that available in literature. The map was constructed using the DIVA -GIS software (www.diva-gis.org) (Hijmans et al., 2002). In order to find possible relationships between the occurrences of the species and altitude, we incorporated an altitudinal layer of 2.5 miles (ca. 5 km) of spatial resolution in the final map. For each specimen we recorded data on type of substrate, typography, geographical coordinates and altitude. Geographical coordinates and altitude were obtained with a portable GPS Garmin Etrex Legend®.

Parturition events were observed from a pregnant female found during a field trip. The specimen was kept in a terrarium covered with a layer of sediment and leaf litter to simulate natural conditions. The air temperature was not controlled. The female was fed with crickets and mealworms, and monitored daily until the newborns' birth. Body measurements of the pregnant female and her neonates were taken with the aid of a digital caliper (scale graduation = 0.01 mm), and body weight was obtained with a digital balance (scale graduation = 0.01 g).

Collecting permits were authorized by Instituto Brasileiro do Meio Ambiente e dos Recursos Naturais Renováveis (IBAMA) (Processes 16381-1 and 17400-2). Voucher specimens were deposited in Universidade Federal de Brasília Herpetological

collection (CHUNB 57367, 57370), Brasília, Distrito Federal, Brazil; Universidade de Campinas Natural History Museum (ZUEC 3407), Campinas, São Paulo, Brazil.

RESULTS AND DISCUSSION

Geographic Distribution

Several expeditions were conducted in the main mountainous areas of Ceará state. The new records of occurrence for *M. arajara* were exclusively located in the northwestern and southern parts of Ceará state (Fig. 1). Descriptions for each area and for *M. arajara* records are given below. Four specimens of *M. arajara* were recorded in the Ubajara's National Park located at the municipality of Ubajara (03°49'50"S; 40°53'16"W; 390 m ASL): an adult gravid female (SVL = 91.89 mm; tail length = 123.72 mm) on 25 October 2008, kept in a terrarium to observe parturition aspects described in this study, and three adult specimens between November and December 2008. Two main habitat types were observed in this area. The first one is the Sub-evergreen Tropical Nebular Rainforest, a relictual wet forest with a canopy more than 20 m high, extending about 150 km in length, between 400 and 950 m wide, covering the eastern and northern regions of Plateau of Ibiapaba (Planalto da Ibiapaba). The second is the Deciduous Dry Forest, a forest located at low altitudes (120-450 m), exhibiting trees up to 20 m high with straight trunks and an understory composed of small trees and short-lived bushes. All individuals were found foraging in the leaf litter in the areas of the Deciduous Dry Forest.

Two other specimens of *Mabuya arajara* were collected on 2 December 2005 in an expedition to Ubatuba hills (Serra da Ubatuba), municipality of Granja, state of Ceará (03°18'04"S; 41°08'37"W; 645 m ASL). The vegetation of the area is characterized by Deciduous Dry Forest on the slopes, with gallery forest and savannah vegetation (cerrado) in the rocky outcrops of the plateau. Individuals were found basking on the leaf litter of the Deciduous Dry Forest.

Two new distributional records were obtained in the slopes of Plateau of Araripe (Chapada do Araripe). Individuals of *Mabuya arajara* were observed in the leaf litter at the border of the Sub-

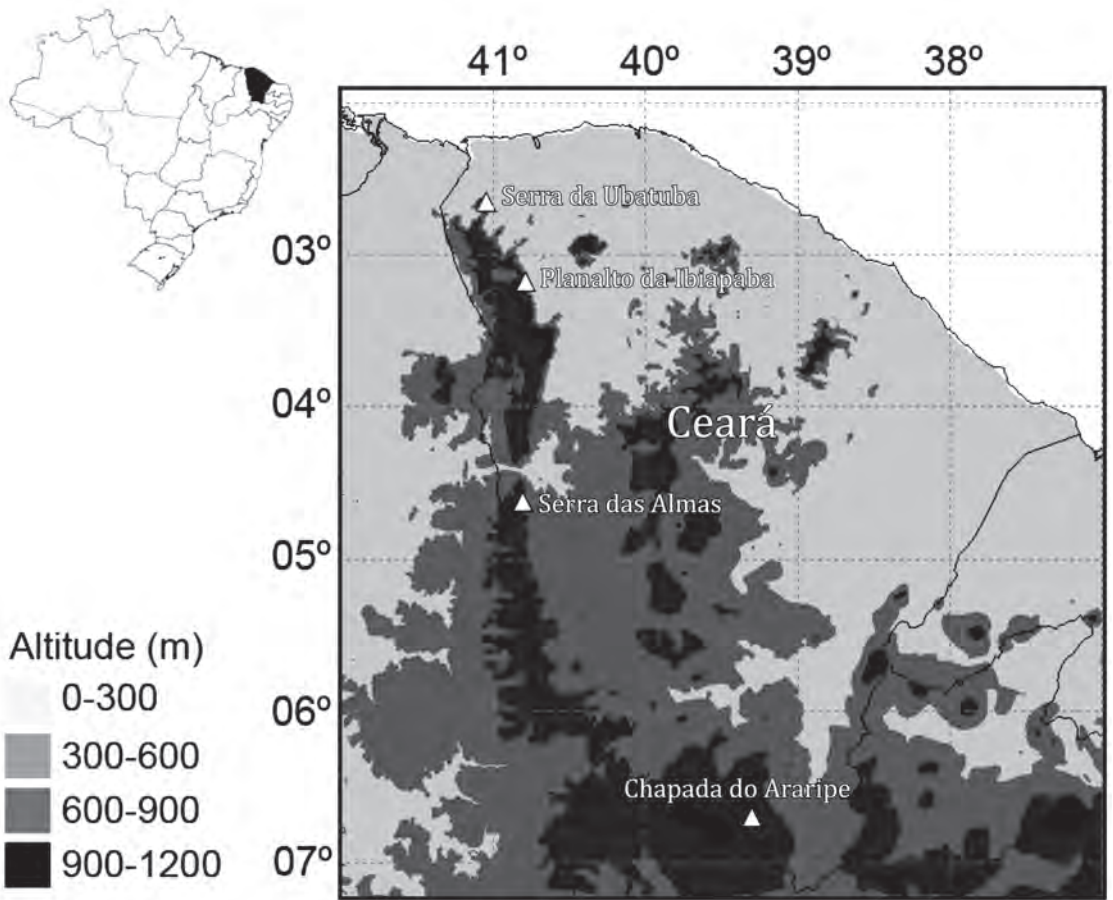


Figure 1. Current knowledge of *Mabuya arajara* range (altitudinal and geographical).

evergreen Tropical Nebular Rainforest near a stream in the locality of Granjeiro, municipality of Crato (07°16'50"S; 39°26'19"W; 708 m ASL), and in the municipality of Missão Velha in the locality of Arajara Park (07°36'17"S; 39°24'43"W; 751 m ASL). The specimens were found in the border of the relictual forest, in leaf litter and under fallen logs.

Mabuya arajara has been considered to be endemic to a very restricted distribution in the Plateau of Araripe mountain, municipality of Barbalha (Rebouças-Spieker, 1981; Borges-Nojosa & Caramaschi, 2003; Ribeiro et al., 2008). Borges-Nojosa & Cascon (2005) mentioned the presence of a similar species (*Mabuya* sp. [aff. *arajara*]) outside its known range, in the municipality of Crateús, in a Deciduous Dry Forest of the Almas

hills complex (complexo Serra das Almas) (05°16'04"S; 40°54'13"W; 681 m ASL). However, based on the photograph of the individual from Almas hills (see Borges-Nojosa & Cascon [2005], p. 242), which clearly shows the typical coloration pattern of *M. arajara*, and, based on our records of lower latitudes, we can confirm the presence of the species in the area.

Therefore, considering the species presence confirmed for Almas hills and the new records for Ibiapaba Plateau complex (municipalities of Ubajara and Granja) we demonstrate *Mabuya arajara* is not endemic to Araripe Plateau. In addition, we believe the species has a high probability of occurring in the neighbouring states of Piauí and Pernambuco considering the current knowledge of its range (altitudinal and geographical) (Fig. 1).

The *Mabuya* appear to have different habitat preferences. *Mabuya arajara* prefers the Deciduous Dry Forests among ca. 350 to 700 m ASL, although it can also be found eventually in the border of the Sub-evergreen Tropical Nebular Rainforest. *Mabuya heathi* should be considered the most habitat flexible species but it is more frequently found in the steppe savannah (low altitude Caatinga). *Mabuya nigropunctata* is mainly associated with the Sub-evergreen Tropical Nebular Rainforest.

The Deciduous Dry Forests in the state of Ceará are exclusively located in areas with irregular topography, characterised by elevated humidity, low temperatures and high degree of rainfall when compared to “Caatinga *sensu strictu*” areas. These abiotic conditions seem to occur along all of *M. arajara*'s distribution: the Araripe Plateau, Almas hills, and Ibiapaba Plateau complexes. In fact, these complexes are relatively interconnected, and the Poti River is the major altitudinal/fluvial barrier found in the area. Even so, there is no evidence that Poti River should be considered a barrier for any reptile species inhabiting the mountain complexes. On the other hand, there is no indication (Borges-Nojosa & Caramaschi, 2003; present study) that *M. arajara* inhabits other mountainous areas of the state of Ceará with similar altitude and physiognomy such as Maranguape hills (03°53'36”S; 38°43'26”W), Baturité hills (04°16'55”S; 38°56'46”W), Pacatuba hills (03°58'02”S; 38°38'06”W), and Uruburetama hills (03°36'25”S; 39°34'58”W). The wide track of steppe savannah (low altitude Caatinga) formation (> 100 km of extension) amidst these mountain chains (Araripe Plateau, Almas hills, and Ibiapaba Plateau) seems to be a possible reason for the species not to occur on these mountains.

According to the Vanishing Refuge Theory (Vanzolini & Williams, 1981), during the dry periods of climate cycle events in the Holocene, species from forested areas pre-adapted to live in open formations could have endured a speciation process in forest refuges. In order to corroborate this theory the authors focused mainly on *M. arajara* as the species seems to have originated *M. nigropunctata*, a species specialised to live in forested areas.

Mabuya nigropunctata occurs throughout Brazilian Amazonia, in the gallery forests of cerrado

areas (Blackburn & Vitt, 1992) and in the Atlantic rain forest of northeastern Brazil, in the states of Pernambuco, Alagoas, and Ceará (Vanzolini, 1981; Borges-Nojosa & Caramaschi, 2003). This species is well adapted to living outside forested areas, occupying open spots at the edge of the forest (Vitt & Blackburn, 1991; Vanzolini, 1992; Avila-Pires, 1995). Therefore, its ecology is very similar to *M. arajara* which may have experienced an ecological reversal from the forest adapted life of its origin to life in open environments (Vanzolini, 1992) such as the Dry Deciduous Forests in the plateaus of Ibiapaba and Araripe.

Reproductive Aspects

The gravid female of *M. arajara* (91.89 mm SVL; 123.72 mm tail length) that was kept in the terrarium gave birth to four neonates on 19 November 2008 (see Table 1. for body measurements).

	Newborn Weight (g)	SVL (mm)	TL (mm)
1	0.80	33.58	39.45
2	0.79	32.85	39.54
3	0.71	32.43	40.18
4	0.82	32.02	40.36

Table 1. Weight, snout-vent length and tail length in mm, of the four neonate *Mabuya arajara* collected in the Ubajara National Park, municipality of Ubajara, state of Ceará.

During observations of the birth of one of these at 17:21 the female did not eat the embryonic membranes to help the newborn to be freed (Fig. 2). A brood size of four newborns documented by *M. arajara* seems to be very common among the South American viviparous species of *Mabuya* which can vary from 1-9 (Vanzolini & Rebouças-Spieker, 1976; Vitt & Blackburn, 1983; Vitt & Blackburn, 1991; Blackburn & Vitt, 1992; Vrcibradic & Rocha, 1998; Rocha & Vrcibradic, 1999; Vrcibradic, 2001; Rocha et al., 2002; Blackburn & Vitt, 2002). *Mabuya nigropunctata*, a closely related species to *M. arajara*, was documented to have a brood size of 2-9 embryos, with a gestation period of 10 to 12 months. The number of embryos was positively correlated with female size (Vitt & Blackburn, 1991). *Mabuya heathi*, a sympatric species to *M.*



Figure 2. The gravid female *Mabuya arajara* with neonates.

arajara, also has a brood size of 2-9 and gestation period of 8 to 12 months with parturition occurring at the end of the dry season (Vitt & Blackburn, 1983). This parturition regime seems the same for *M. arajara* in the municipality of Ubajara. One interesting aspect of the neonates was the presence of a well defined dark stripe from the snout to the tail, just like the adults of *M. nigropunctata*. It is possible that the colour pattern shifts during ontogeny and starts to fade away in adulthood. This reinforces the possible process of speciation that *M. nigropunctata* may have undergone to originate *M. arajara* - as proposed by Vanzolini & Williams (1981).

Vanzolini & Rebouças-Spieker (1976) described maternal care by a female in *M. macrorhyncha*, an aspect that was not observed for *M. arajara*. There are two possibilities to explain the difference. First, it is possible that stress induced by confined conditions in the terrarium caused the female to leave her offspring without maternal care after parturition. Second, maternal care may not constitute a characteristic in the Scincomorpha as proposed by Vanzolini & Rebouças-Spieker (1976). There is still little information about *M. arajara* ecology and future studies are necessary to further understand the reproductive biology of the species.

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REFERENCES

- Ávila-pires, T.C. (1995). Lizards of Brazilian Amazonia (Reptilia: Squamata). *Zool. Verh., Leiden* **299**, 1-706.
- Bérnils, R.S. (2009). Brazilian reptiles. Sociedade Brasileira de Herpetologia. <www.sbherpetologia.org.br>. [Accessed: April 2009].
- Blackburn, D.G. & Vitt, L.J. (2002). Specialization of the chorioallantoic placenta in the Brazilian Scincid lizard *Mabuya heathi* a new placental morphotype for reptiles. *J. Morphol.* **254**, 121-131.
- Blackburn, D.G. & Vitt, L.J. (1992). Reproduction in viviparous South American lizards of the genus *Mabuya*. In: *Reproductive Biology of South American Vertebrates*. Pp. 150-164. Hamlett, W.C. (Ed.). New York: Springer-Verlag.
- Borges-Nojosa, D.M. & Caramaschi, U. (2003). Composição e análise comparativa da diversidade e das afinidades biogeográficas dos lagartos e anfisbenídeos (Squamata) dos brejos nordestinos. In: *Ecologia e Conservação da Caatinga*. Pp. 489-540. Leal, I. Silva, J.M.C. & Tabarelli, M.. (Eds.). Recife UFPE.
- Borges-Nojosa, D.M. & Cascon, P. (2005). Herpetofauna da área Reserva da Serra das Almas, Ceará. In: *Análise das Variações da Biodiversidade do Bioma Caatinga*. Pp. 245-260. Araújo, F.S. Rodal, M.N.J. & Barbosa, M.R.V. (Eds.). Brasília: Ministério do Meio Ambiente.
- Campbell, H.W. & Christman, S.P. (1982). Field techniques for herpetofaunal community analysis. In: *Herpetological Communities: a Symposium of the Society for the Study of Amphibians and Reptiles and Herpetologists' League*. Pp. 193-200. Scott Jr, N.J. (Ed.). Washington: US Fish and Wildlife Service.
- Hijmans, R.J. Guarino, L. & Rojas, E. (2002). DIVA-GIS. A geographic information system for the analysis of biodiversity data. Manual. Lima: International Potato Center, 73 pp.
- Rebouças-Spieker, R. (1981). Sobre uma nova espécie de *Mabuya* do Nordeste do Brasil (Sauria, Scincidae). *Pap. Avulsos Zool. São Paulo* **34** (9), 1-123.
- Ribeiro, S.C. Ferreira, F.S. Brito, S.V. Santana, G.G. Vieira, W.L.S. Alves, R.R.N. & Almeida, W.O. (2008). The squamata fauna of the Chapada do Araripe, northeastern Brazil. *Cadernos de Cultura e Ciência* **3**, 1-14.
- Rocha, C.F.D. & Vrcibradic, D. (1999). Reproductive traits of two sympatric viviparous skinks (*Mabuya macrorhyncha* and *Mabuya agilis*) in a Brazilian restinga habitat. *Herpetol. J.* **9**, 43-53.
- Rocha, C.F.D. Vrcibradic, D. Teixeira, R.L. & Cuzzuol, M.G.T. (2002). Interpopulational

- variation in litter size of the skink *Mabuya agilis* in southeastern Brazil. *Copeia* **2002** (3), 857-864.
- Rodrigues, M.T. (2000). A new species of *Mabuya* (Squamata: Scincidae) from the semiarid Caatingas of northeastern Brazil. *Pap. Avulsos Zool. São Paulo* **41** (21), 313-328.
- Uetz, P. et al. (2009). The Reptile Database. <www.reptile-database.org>. [Accessed: July 2009].
- Vanzolini, P.E. & Rebouças-Spieker, R. (1976). Distribution and differentiation of animals along the coast and in continental islands of the state of São Paulo, Brazil. 3. Reproductive differences between *Mabuya caissara* and *Mabuya macrorhyncha* (Sauria, Scincidae). *Pap. Avulsos Zool. São Paulo* **29** (15), 95-109.
- Vanzolini, P.E. (1981). A quasi-historical approach to the natural history of differentiation of reptiles in the tropical geographic isolated. *Pap. Avulsos Zool. São Paulo* **34** (19), 189-204.
- Vanzolini, P.E. & Williams, E.E. (1981). The vanishing refuge: a mechanism for ecological geographic speciation. *Pap. Avulsos Zool. São Paulo* **34** (23), 251-255.
- Vanzolini, P.E. (1992). Paleoclimas e especiação em animais da América do Sul tropical. *Estudos Avançados* **6** (15), 41-65.
- Vitt, L.J. & Blackburn, D.G. (1983). Reproduction in the lizard *Mabuya heathi* (Scincidae): a commentary on viviparity in new world *Mabuya*. *Can. J. Zool.* **61**, 2798-2806.
- Vitt, L.J. & Blackburn, D.G. (1991). Ecology and life history of the viviparous lizard *Mabuya bistrriata* (Scincidae) in the Brazilian Amazon. *Copeia* **1991**, 918-927.
- Vrcibradic, D. (2001). Ecologia de cinco espécies de *Mabuya* (Lacertilia; Scincidae) no Sudeste do Brasil: padrões reprodutivos, térmicos, tróficos e comunidades de nematódeos parasitas associados. Tese de doutorado. Universidade Estadual de Campinas. 210 pp.
- Vrcibradic, D. & Rocha, C.F.D. (1998). Reproductive cycle and life-history traits of the viviparous skink *Mabuya frenata* in southeastern Brazil. *Copeia* **1998** (3), 612-619.
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