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PARTHENOGENESIS IN *HOTTENTOTTA CABOVERDENSIS* LOURENÇO & YTHIER, 2006 (SCORPIONES, BUTHIDAE) FROM THE CAPE VERDE ISLANDS*

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Abstract: Parthenogenesis is rare in chelicerates with the exception of mites. In scorpions this form of asexual reproduction has been observed in some species of the families Buthidae and Liochelidae. In the present paper, parthenogenesis is reported in a species of scorpion inhabiting the Cape Verde islands and recently described as *Hottentotta caboverdensis*. The postembryonic development of *H. caboverdensis* is also described. The Cape Verde population of *H. caboverdensis* seems to be an obligate thelytokous (all-female broods) parthenospecies.
Key words: Scorpiones, Buthidae, *Hottentotta caboverdensis*, parthenogenesis, thelytoky, life history, Cape Verde islands.

Partenogénesis en los *Hottentotta caboverdensis* Lourenço & Ythier, 2006 (Scorpiones, Buthidae) de las islas de Cabo Verde
Resumen: La partenogénesis es rara en los quelicerados, con excepción de los ácaros. En los escorpiones esta forma de reproducción asexual se ha observado en algunas especies de las familias Buthidae y Liochelidae. En el presente trabajo se señala la existencia de partenogénesis en una especie de escorpión que habita en las islas de Cabo Verde y que se ha descrito recientemente como *Hottentotta caboverdensis*. Se describe igualmente el desarrollo postembrionario de *H. caboverdensis*. La población de Cabo Verde de *H. caboverdensis* parece ser una partenoespecie, de telitoquia obligada (con sólo hembras).
Palabras clave: Scorpiones, Buthidae, *Hottentotta caboverdensis*, partenogénesis, telitoquia, biología, islas de Cabo Verde.

Introduction

With the exception of mites, parthenogenetic reproduction is rare among chelicerates (Taberly, 1987; Palmer & Norton, 1991; Norton & Palmer, 1991; Nagelkerke & Sabelis, 1991). It has, however, also been demonstrated in a few species of harvestmen (Tsurusaki, 1986), spiders (Lake, 1986; Deeleman-Reinhold, 1986; Camacho, 1994) and scorpions (Lourenço & Cuellar, 1994; Lourenço *et al.*, 2000). Of almost 1500 species of scorpions distributed throughout the world, only 10 are known to be parthenogenetic (Lourenço & Cuellar, 1994, 1999; Lourenço *et al.*, 2000). The first of these was reported by Matthiesen (1962) in the Brazilian species *Tityus serrulatus* Lutz & Mello (Buthidae). The other nine known parthenogenetic species are the buthids *Tityus uruguayensis* Borelli from Uruguay and Brazil, *Tityus columbianus* (Thorell) from Colombia, *Tityus trivittatus* Kraepelin from Argentina, *Tityus stigmurus* (Thorell) from Brazil, *Tityus metuendus* Pocock from Peru and Brazil, *Ananteris coineaui* Lourenço from French Guyana, *Centruroides gracilis* (Latreille) from Cuba, *Hottentotta hottentotta* (Fabricius) from West Africa and *Liocheles australasiae* (Fabricius) (Liochelidae) from the South Pacific (Lourenço & Cuellar, 1994, 1999; Lourenço *et al.*, 2000; Teruel, 2004; Yamazaki & Makioka, 2005; Toscano-Gadea, 2005). In the present paper, parthenogenesis is reported in a species of scorpion inhabiting the Cape Verde Islands and recently described as *Hottentotta caboverdensis* by Lourenço and Ythier (2006).

Material and methods

Scorpions were reared by standard methods in plastic terraria of different sizes. These contained a layer of soil, 2-3 cm in depth, as well as a few pieces of bark, flattened stones and a Petri dish containing water. Food, consisting of crickets (*Acheta domestica*, *Grillus assimilis* or *Grillus bimaculatus*) and/or cockroaches (*Shelfordella tartara*), was provided once every 7 to 10 days. Temperatures ranged from 27 to 30°C and the terrarium was dampened once a week. After each moult, the exuvium was removed from the terrarium (Lourenço, 1979).

Morphometric growth was calculated based on all the specimens (including individuals that had died in captivity) and in the exuvia. Three parameters were recorded: carapace length, length of metasomal segment V and length of the movable finger (Lourenço, 1979, 2002). The growth factor (Dyar's constant; Dyar, 1890; Przibram & Megusar, 1912) between successive instars was determined for each individual based on each of these three structures by dividing the dimension at one instar stage by the dimension of the previous stage. The average growth factor per moult for each structure was then calculated from the pooled data. The available voucher material from the laboratory-reared specimens has been used as part of a taxonomic study and is now deposited in the Muséum national d'Histoire naturelle, Paris.

Fig. 1. *Hottentotta caboverdensis*, adult female A with offspring of brood 3.

Hottentotta caboverdensis Lourenço & Ythier, 2006

Hottentotta caboverdenis (fig. 1) is moderately sized for the family Buthidae, ranging from 58 to 63 mm in total length. The general coloration is reddish-brown to dark brown with carinae and granulations blackish. The population densities of *H. caboverdensis* remain unknown. The diel behaviour of *H. caboverdensis,* both in the field and in the laboratory, is characteristic of other species of scorpion dwelling in arid environments. The scorpions move rapidly and show marked aggressiveness: they only leave their retreats at night (Cloudsley-Thompson, 1981). Their predatory technique is of the sit-and-wait type. They wait motionless with the pedipalp chelae fingers opened. Cannibalism has not been observed among adults under laboratory conditions, however it could take place among first juvenile instar individuals, if enough food is not provided. Adults are very resistant to humidity variations, but this is not the case in juveniles which soon die when levels of humidity drops.

Results

Three adult females, one sub-adult female and one juvenile were collected in the field on the 2 February, 2002 from beneath some very deeply buried rocks in São Tiago Island, Cape Verde. The collection was made in a district of the city of Praia known as 'Tira Chapéu', where several houses were under construction. That is why the heavy stones were removed. The general conditions are rather dry, but soil under the rocks was consistently damp, even in the absence of rain. The vegetation at the site of collection consisted mainly of *Robinia pseudoacacia* L. trees.

The specimens collected were brought to the laboratory where two of the three adult females gave birth to broods of young. One adult female was killed by parasitic Acarina, and the juvenile specimen died after some days in the laboratory. The sub-adult female moulted within a few days, on 12 February 2002, becoming adult. It gave birth 4.6 months later, on 1 July 2002 to an **F-1** brood defined as **n°1** and composed of 27 neonates. This female was designated female **A**. Subsequently, female **A** gave birth to two more **F-1** broods: **n°2** consisting of 52 neonates on 20 January 2003, and **n°3** composed of 30 neonates, on 19 June 2003. Further observations were made on two females from brood **n°3** of female **A** born in the laboratory. These females are designated **B** and **C** (Fig. 2).

Female **B** was born on 19 June 2003 and post-embryonic development concluded on 10 October 2004, 16 months after birth. This female gave birth to two **F-2** broods, the first on 4 March 2005 composed of 34 neonates and the second on 11 June 2005 composed of 39 neonates.

Female **C** was born on 19 June 2003. Post-embryonic development was also completed in 16 months, on 1 October 2004. This female gave birth to two **F-2** broods, the first on 20 March 2005 composed of 23 neonates, and the second on 29 June 2005. Neonates in this brood could not be counted precisely because both the female and the juveniles died before their first moult. Their number was, however, similar to that in the first brood. Because all the broods were exclusively composed of females, the Cape Verde population of *Hottentotta caboverdensis* seems to be an obligate thelytokous (all-female broods) parthenospecies.

The postembryonic development

Post-embryonic development was observed more precisely in **F-2** broods **n°2** of female **B** and **n°1** of female **C**. In the other broods, most of the juveniles died as a consequence of parasitism by Acarina.

Hottentotta caboverdensis usually gave birth to 23 – 52 offspring, with an average of 34 neonates **(over 9 observed parturitions).** The duration of post-embryonic development of the Cape Verde parthenogenetic specimens ranged from 470 to 480 days (16 months) (For comparative data on the duration of post-embryonic developments see Lourenço, 2002). The young scorpions moulted for the first time after an average of 3-4 days on their mother's back. The subsequent moults took place at different ages in those specimens that survived. On average, the number of days of development were: 2° moult at 57 days **(N = 44)**; 3° moult at 111 days **(N = 28)**; 4° moult at 215 days **(N = 16)**, 5° moult at 331 days **(N = 14)** and 6° moult at 475 days **(N = 12)**, after which sexual maturity was attained. Developmental periods are similar to those observed for other buthid species. The adult life span of *H. caboverdensis* extends to 48-50 months and is also similar to that observed in other buthid species (for a complete list of references see Lourenço, 2002).

The theoretical morphometric growth factor for the development of arthropods, as defined by Dyar (1890) and Przibram & Megusar (1912) is 1.26. The growth parameters based on the three morphometric values for both individuals of *H. caboverdensis* bred in the laboratory and those collected in the field are shown in Table I and figure 3. These results obtained fall within the same range as those of other Buthidae (Lourenço, 2002).

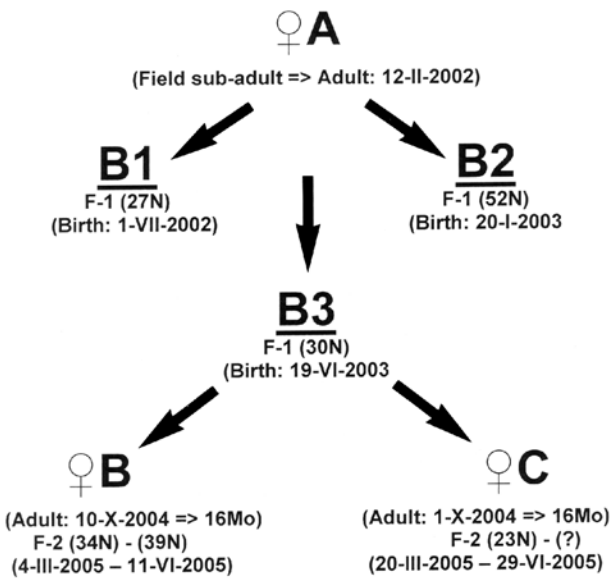

Fig. 2. Schematic plan of reproduction of female **A**, with the births of $\mathbf{F_1}$ broods, $\mathbf{B_1}$, $\mathbf{B_2}$ and $\mathbf{B_3}$. For the second generation, females **B** and **C**, from brood $\mathbf{B_3}$ give birth to $\mathbf{F_2}$ broods (N = the number of neonates).

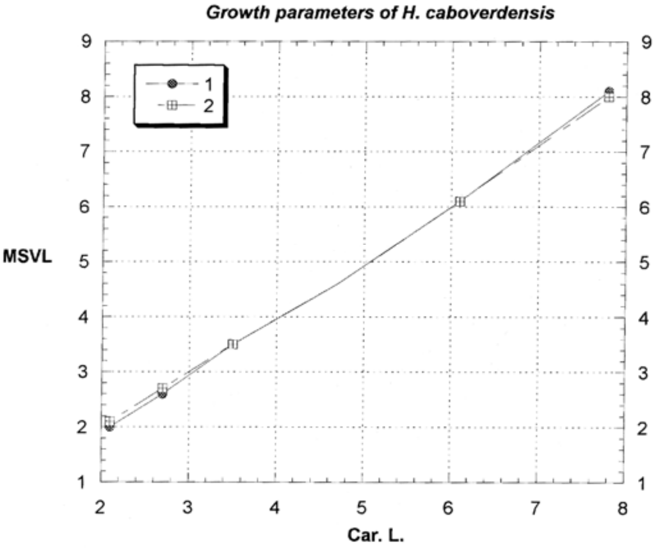

Fig. 3. The distribution of morphometric values (in mm), for juvenile and adult instars of *Hottentotta caboverdensis* (females). **Car. L.** = Carapace length. **M.S.V.L.** = Metasomal segment V length. **Mov. F. L.** = Movable finger length. 1 = **Car. L.** vs. **M.S.V.L.** 2 = **Mov. F. L.** vs. **M.S.V.L.**

Table I. Average morphometric values (in mm) for juvenile and adult instars of females of *Hottentotta caboverdensis* Lourenço & Ythier. Car. L. = carapace length. M.S.V.L. = metasomal segment V length. Mov. F.L. = movable finger of the pedipalp chela length. G.V. =growth values. AGV = average growth values. Growth values between instars I and II can be considered as atypical due to very strong morphological differences between juveniles of these instars. For the number (N) of examined specimens refer to the section on the postembryonic development.

Instar	Car. L.	M.S.V.L.	Mov. F.L.	G.V.
II	2.1	2.0	2.1	1.40/1.42/1.32
III	2.7	2.6	2.7	1.30/1.30/1.29
IV	3.5	3.5	3.5	1.22/1.35/1.30
V	4.7	4.6	4.6	1.34/1.31/1.31
VI	6.1	6.1	6.1	1.30/1.33/1.32
VII (adult)	7.8	8.1	8.0	1.28/1.33/1.31
			AGV	1.29/1.34/1.31

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