



## Embryonic and post-embryonic developments of the Malagasy scorpion *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015 (Scorpiones: Hormuridae)

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**Abstract.** Biological observations were made since 2005 by both authors on live specimens of *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015. These were collected in the north of Madagascar, from an imprecise location, but probably from grassland formations of the extreme north, the same from where the type material of *P. septentrionalis* was collected. The total duration of embryonic development was of 17 months. The observed post-embryonic developmental periods are significantly longer than those of most medium-sized species of scorpions but are similar to the ones previously observed in species of the closely related genus *Opisthacanthus*. Morphometric growth values of the different instars are also similar to those in other studied species of the family Hormuridae. No significant allometric growing of appendages has been observed in males.

**Riassunto.** Sviluppo embrionale e post-embriionale dello scorpione malgascio *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015 (Scorpiones: Hormuridae). A partire dal 2005 entrambi gli autori hanno effettuato osservazioni sulla biologia di *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015, avvalendosi di esemplari viventi. Questi sono stati raccolti nel Madagascar settentrionale, in una località imprecisata, ma probabilmente appartenente alle praterie dell'estremo nord, le stesse da cui proviene il materiale tipico di *P. septentrionalis*. La durata totale dello sviluppo embrionale è stata di 17 mesi. I periodi di sviluppo post-embriionale osservati sono stati nettamente più lunghi di quelli di molte specie di scorpioni di media grandezza, ma simili a quelli precedentemente osservati in specie del genere affine *Opisthacanthus*. I valori morfometrici di crescita nei vari stadi sono risultati simili a quelli riscontrati in altri studi effettuati sulla famiglia Hormuridae. Non sono state osservate crescite allometriche nelle appendici dei maschi.

**Résumé.** Développement embryonnaire et post-embryonnaire du scorpion malgache *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015 (Scorpiones: Hormuridae). Des observations biologiques ont été menées depuis 2005, par les deux auteurs, sur des spécimens vivants de *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015. Les spécimens ont été collectés dans le nord de Madagascar, dans une station imprécise, mais très probablement correspondant aux formations herbacées de l'extrême nord, les mêmes où le matériel type de *P. septentrionalis* a été collecté. La durée totale du développement embryonnaire a été égale à 17 mois. Les différentes périodes du développement post-embryonnaire sont nettement plus longues que celles observées pour la majorité des espèces de scorpion de taille moyenne mais similaires à celles observées pour des espèces du genre *Opisthacanthus*. Les valeurs morphométriques de croissance de différents stades sont également similaires à celles d'autres espèces de la famille des Hormuridae. Aucune croissance allométrique des appendices n'a été observée chez les mâles.

**Key words.** Scorpion, *Palaeocheiloctonus septentrionalis*, Madagascar, life history, embryonic development, post-embryonic development.

### Introduction

In 2005 several living specimens of *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015, collected in northern Madagascar, were obtained by the junior author. For a while these specimens

remained misidentified as *Opisthacanthus* sp., situation later corrected by the senior author. Until that date, only one species of *Palaeocheiloctonus* Lourenço, 1996 was known from Madagascar (LOURENÇO, 1996), however this species, *Palaeocheiloctonus pauliani* Lourenço, 1996 was only known from the south-western of the island.

During the same period, a similar material of *Palaeocheiloctonus* was obtained in Madagascar from the Diana Region in the area of ‘Montagne des Français’, dominated by western dry forest/wooded, grassland-bushland and anthropic grasslands. This material led to the description of a new species, *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015 (LOURENÇO & WILMÉ, 2015).

Since the mid-1970s, numerous observations have been made on the biology of several species of scorpions (LOURENÇO, 2002). Nevertheless, observations on the entire life cycles of most scorpion species and, in particular, on species belonging to the family Hormuridae are extremely scarce. Several species of the related genus *Opisthacanthus* Peters, 1861, from Africa and South America, have been the subject of intensive studies on their life cycles and reproductive biology (LOURENÇO, 1985, 1991). However, the life cycle of any *Palaeocheiloctonus* species has never been studied until now.

Since the live specimens of *Palaeocheiloctonus* could be identified after the description of the northern species, and in account of a number of observations obtained on their life cycle, we therefore decided to summarize here the available data on the biological cycle and growing factors of this species.

### Material and methods

The scorpions were reared by standard methods in plastic terrariums of different sizes. These contained layers of soil, 2-3 cm in depth, as well as a few pieces of bark and a small Petri dish containing water. Food, consisting of *Tenebrio molitor* L. larvae and of crickets, was provided once every 7 to 10 days. Temperatures ranged from 25 to 27°C and the humidity was maintained at 70-80%. After each moult, the exuviae were removed from the terrarium. Morphometric growth values of these exuviae, and of individuals that died in captivity, were measured. Three parameters were recorded: carapace length, the length of metasomal segment V, and of the movable finger (LOURENÇO, 1979, 2002). The growth factor (Dyar’s constant) between succeeding instars was determined for every individual from each of these three structures (by dividing the dimension at one instar stage by the dimension of the previous instar). 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 is now deposited in the Muséum national d’Histoire naturelle, Paris.

### Characteristics of *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015

*Palaeocheiloctonus septentrionalis* (Figs 1-2) is very similar in size to the only other known species of the genus, *P. pauliani* (Lourenço & Wilmé, 2015). Both species of this genus are, however, smaller when compared with several species of the genus *Opisthacanthus* present in Madagascar. Medium size scorpions: male and female with respectively 56.4 and 62.9 mm in total length. Coloration from pale yellow to reddish-yellow; male with absence of any dark to blackish zones on pedipalp carinae and chelal fingers. Pectines with 6-6 and 6-7 teeth in male and female. Hemispermatophore with the distal lamina more enlarged than in *Palaeocheiloctonus pauliani*. Male genital operculum large and slightly oval in shape. Female genital operculum slightly heart-like shaped plate without any incision in the base. Trichobothrial pattern of type C, orthobothriotaxy (VACHON, 1974). Legs: tarsi with 3 lateral rows of spines, surrounded by some long setae.

The population density of *Palaeocheiloctonus pauliani* is probably high given that the species has been reported as common in the region of Toliara (LOURENÇO, 1996). In contrast very little is known about the population of *Palaeocheiloctonus septentrionalis* but the species seems to be rare (LOURENÇO & WILMÉ, 2015).

Nothing is known about the diel behaviour of *P. septentrionalis* (or *P. pauliani*) in the field. Under laboratory conditions, the scorpions move slowly and only leave their retreats at night. Their predatory technique is of the ‘sit-and-wait’ type (CLOUDSLEY-THOMPSON, 1981). They remain motionless with the pedipalp fingers opened. Cannibalism has not been observed during the present

study, not even when several individuals were maintained together, and is most probably uncommon, as for most species of the genus *Opisthacanthus* (LOURENÇO, 2002).



Fig. 1. *Palaeocheloctonus septentrionalis* Lourenço & Wilmé, 2015. Adult male.



Fig. 2. *Palaeocheloctonus septentrionalis* Lourenço & Wilmé, 2015. Adult female.

### Laboratory observations - Developmental periods

Among the 6-7 specimens collected in the field, one male and one female reached adulthood. Courtship and mating behaviour was observed for this pair of scorpions. The female gave birth to a brood composed of 18 neonates. The total duration of embryonic development was 17 months and can be assumed to be either similar or shorter than that of some species of *Opisthacanthus* (LOURENÇO, 2002; LOURENÇO *et al.*, 2010). After being carried on their mother's back for 11-12 days, the first moults of the young scorpions were observed. Juveniles began to disperse from their mother's back at the age of 20 days. Subsequent moults took place at different ages (Figs 3-5). The average number of days occupied by each of these were as follows: Second moult (93 days), Third (171 days), Fourth (285 days), Fifth (384 days), Sixth (453 days). Two surviving males become adult from the fifth moult, whereas two surviving females become adult with the sixth moult. These observations are similar to those observed for *Opisthacanthus asper* (Peters, 1861) from Mozambique (LOURENÇO, 1991). The duration of different instars observed in laboratory conditions can vary greatly, even among elements of the same brood.

### Growth factors

The theoretical morphometric growth factor for arthropods, as defined by DYAR (1890) and PRZIBRAM & MEGUSAR (1912), is 1.26. Growth parameters of *P. septentrionalis*, based on morphometric values (measured on both dead individuals and on exuviae), are shown in Figs 6-7 (Tabs I and II). Three parameters were considered: the length of the carapace, of the movable finger, and of metasomal segment five. The results obtained from morphometric growth values in the different instars of *P. septentrionalis* are comparable with those observed for several studied species of the closely related genus *Opisthacanthus* (LOURENÇO 1985, 1991, 2002).



Fig. 3. *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015. Female of instar IV a few days before the molting process.



Fig. 4. *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015. Same female of instar V, just after the molt. Note the very pale pigmentation, almost white.



Fig. 5. *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015. Same female of instar V, several days after the molting process, when natural yellow colours became more visible.

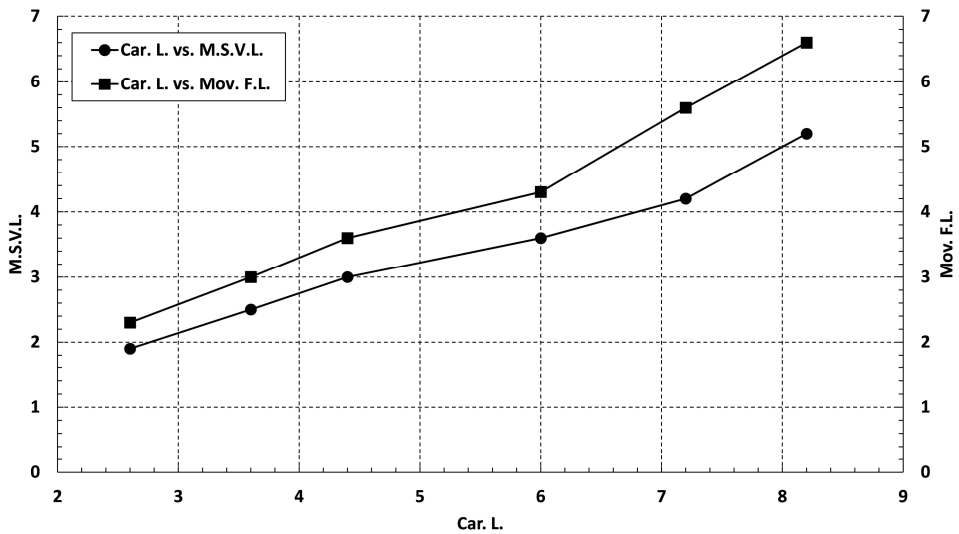


Fig. 6. The distribution of morphometric values (in mm), in juvenile and male adult instars of *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015. Car. L. = Carapace length. M.S.V.L. = Metasomal segment V length. Mov. F.L. = Movable finger length.

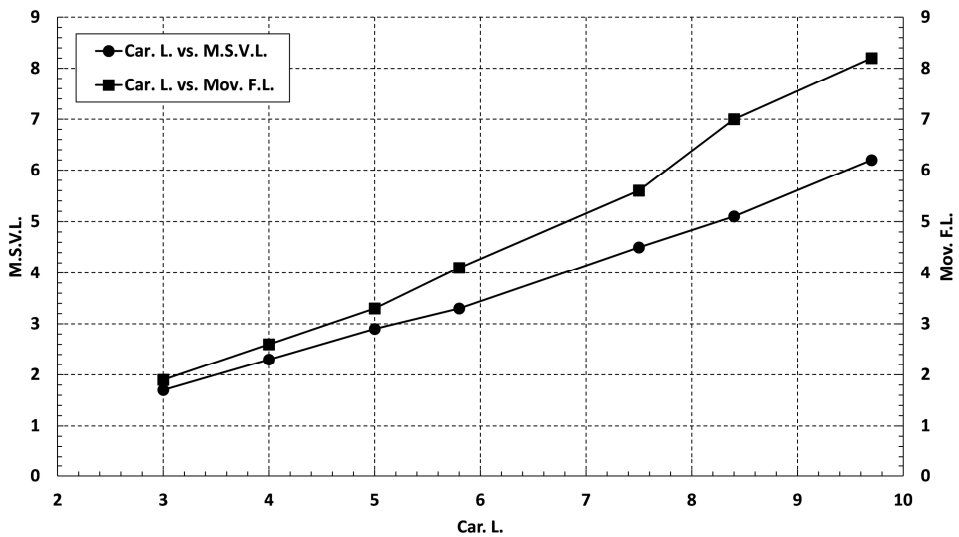


Fig. 7. The distribution of morphometric values (in mm), in juvenile and female adult instars of *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015. Car. L. = Carapace length. M.S.V.L. = Metasomal segment V length. Mov. F.L. = Movable finger length.

	Car. L	M.S.V.L.	Mov. F.L.	G.V.	Nb
Instar I	2.6	1.9	2.3	-	8
Instar II	3.6	2.5	3.0	1.38/1.32/1.30	7
Instar III	4.4	3.0	3.6	1.22/1.20/1.20	4
Instar IV	6.0	3.6	4.3	1.36/1.20/1.19	3
Instar V	7.2	4.2	5.6	1.20/1.17/1.30	2
Instar VI (L-adult)	8.2	5.2	6.6	1.14/1.24/1.18	2
<b>AGV</b>				<b>1.26/1.23/1.23</b>	

Tab. I. Average morphometric values (in mm) for juvenile and adult instars of males of *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015. Car. L. = carapace length. M.S.V.L. = metasomal segment V length. Mov. F.L. = movable finger length. G.V. = growth values. AGV = average growth values. Nb = number of individuals measured, including exuviae. L = Laboratory adult.

	Car. L	M.S.V.L.	Mov. F.L.	G.V.	Nb
Instar I	3.0	1.7	1.9	-	8
Instar II	4.0	2.3	2.6	1.33/1.35/1.37	6
Instar III	5.0	2.9	3.3	1.25/1.26/1.27	4
Instar IV	5.8	3.3	4.1	1.16/1.14/1.24	4
Instar V	7.5	4.5	5.6	1.29/1.36/1.36	3
Instar VI	8.4	5.1	7.0	1.12/1.14/1.25	2
Instar VII (L-adult)	9.7	6.2	8.2	1.15/1.21/1.17	2
<b>AGV</b>				<b>1.22/1.24/1.27</b>	

Tab. II. Average morphometric values (in mm) for juvenile and adult instars of females of *Palaeocheiloctonus septentrionalis* Lourenço & Wilmé, 2015. Car. L. = carapace length. M.S.V.L. = metasomal segment V length. Mov. F.L. = movable finger length. G.V. = growth values. AGV = average growth values. Nb = number of individuals measured, including exuviae. L = Laboratory adult.

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