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Observations on newborn *Opisthacanthus maculatus* Lourenço & Goodman, 2006 (Scorpiones, Liochelidae) from Madagascar

Lucian K. Ross

Abstract:

Observational data on the early development and post-birth behavior of a single litter of the Malagasy endemic scorpion, *Opisthacanthus maculatus* Lourenço & Goodman, 2006 (Liochelidae) is reported for the first time. A single female gave birth to a litter of 11 offspring during a 10 hour period of parturition. The young molted to the second-instar within a 14 day period. After an additional 10–12 day period, the young dispersed from the maternal female. This is the first report of post-birth behavior for a Malagasy endemic *Opisthacanthus* species.

Key words: Scorpiones, Liochelidae, *Opisthacanthus*, *Monodopisthacanthus*, birth process, katoikogenic, post-birth behavior, offspring, Madagascar.

Observaciones sobre un escorpión recién nacido, endémico de Madagascar, *Opisthacanthus maculatus* Lourenço & Goodman, 2006 (Scorpiones, Liochelidae)

Resumen:

Se presentan por primera vez observaciones sobre el desarrollo temprano y el comportamiento post-natal de una camada del escorpión endémico de Madagascar *Opisthacanthus maculatus* Lourenço & Goodman, 2006 (Liochelidae). Una hembra dio a luz a una camada de 11 crías durante un de parto de 10 horas. Las crías mudaron al segundo estadio en un plazo de 14 días. Después de un período de 10-12 días adicionales, los jóvenes se dispersaron de la hembra materna. Este es el primer informe del comportamiento post natal de una especie de escorpión endémica de Madagascar.

Palabras clave: Scorpiones, Liochelidae, *Opisthacanthus*, *Monodopisthacanthus*, comportamiento post-natal, progenie, Madagascar

NOTA BREVE:

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Introduction

The island of Madagascar is the third largest in the world and supports an extraordinarily high number of endemic plant and animal species (Lowry et al. 2001). The flora and fauna of Madagascar are threatened with extinction through continuing habitat destruction (Green & Sussman 1990). At present, little is known about the life-histories of the Malagasy scorpion fauna and a paucity of data exists regarding the reproductive biology and development of the majority of the Malagasy scorpion fauna (Lourenço & Goodman 2006). To date, life-history studies have been limited to Malagasy members of the families Buthidae C. L. Koch, 1837 (Lourenço & Cloudsley-Thompson, 1998; Lourenço & Goodman 2006) and Heteroscorpionidae Kraepelin, 1905 (Lourenço & Cloudsley-Thompson 2003), with only a small number of biogeographic and taxonomic studies published on endemic members of the genus *Opisthacanthus* Peters, 1861 (Liochelidae). Currently, seven *Opisthacanthus* species have been described from Madagascar and placed into the endemic subgenus *Monodopisthacanthus* (Lourenço & Goodman, 2006, 2008). The following observations are the first reported for a member of the genus *Opisthacanthus* from Madagascar. *Opisthacanthus* (*Monodopisthacanthus*) *maculatus* Lourenço & Goodman, 2006 (Scorpiones, Liochelidae), is a small (34.3–36 mm) reddish-brown to dark brown species limited in geographic distribution to the transition zone of spiny-bush and dry deciduous forest in the Mikea Forest region, between Toliara and Morombe, southwestern Madagascar (Lourenço & Goodman 2006).

Methods

In June 2008, several adult females of *O.* (*M.*) *maculatus* (34.3–35.6 mm: n = 5) were collected from an unknown locality near Toliara, and acquired by the author from a private invertebrate dealer. Specimens were maintained in serially numbered, individual glass enclosures (9.5 L: 30 x 12.5 x 20 cm), with a dry 40–50 mm layer of mixed sand (60%) and topsoil (40%) substrate. In each enclosure, a semi-tubular piece of cork bark (Fagaceae: *Quercus suber* L.) was placed horizontally on the substrate surface to provide refuge to scorpions during periods of inactivity. All specimens were maintained at temperatures of 26–29°C, under a 12L;12D hour photoperiod. Ambient humidity (%RH) was not controlled, but it ranged from 38–50%. Prey consisted of immature (15–20 mm) common house crickets (Gryllidae: *Acheta domesticus* L.), with each specimen receiving a single cricket every 10–15 days. A small petri dish of distilled water was placed in each enclosure to provide drinking water to specimens. Specimens were often observed imbibing water from petri dishes. All measurements were taken with digital calipers (Starrett model 799).

Results

On 06 April 2009, at approximately 0730 hours, I discovered one of the females (34.3 mm) in the process of giving birth to a single offspring. By 1720 hours, the female had given birth to 10 additional offspring. Offspring were born metasoma first and did not possess birth membranes. The entire litter consisted of 11 dark-colored offspring that ranged in size from 9.5–10.5 mm total length. The integument and elastic membranes were light-brown in coloration with the chelicerae, carapace, tergites, chelate pedipalps, and walking legs darker brown in coloration. While the position of the female within her cork bark retreat obscured viewing most of the birth and post-birth behaviors, some details were observed. Emergent offspring were delivered into a birth basket formed by the anterior pairs of walking legs (Legs I and II) and remained in the birth basket for an indeterminable length of time (position of the female partially obstructed the view and identification of individual offspring) before ascending up the walking legs forming the birth basket and taking up positions on the dorsum of the maternal female.

While the larval orientation pattern of the offspring in other *Opisthacanthus* species in the subgenera *Opisthacanthus* Peters, 1861 (Neotropical) and *Nepabellus* Francke, 1974 (Afrotropical) have been reported as randomly organized (Lourenço, 1985), the offspring of *O.* (*M.*) *maculatus* formed a single layer, with the prosoma oriented towards the prosoma of the female. The pattern, however, is unlike the highly ordered longitudinal orientation pattern of many species within the family Vaejovidae Thorell, 1876 (Williams 1969; Ross 2009), in which, the offspring are arranged in single, transverse rows upon the females and the anterior edge of the prosoma of the offspring are in direct contact with the dorsal integument of the females until the first molt to the second-instar. In contrast, the modified dorsal orientation pattern of offspring was first reported in two species of *Microtityus* Kjellesvig-Waering, 1966 by Lourenço et al. (1999) and is typical of many bark scorpions in the genera *Babycurus* Karsch, 1886, *Centruroides* Marx, 1890, *Isometrus* Ehrenberg, 1828, *Lychas* C. L. Koch, 1845, and *Tityus* C. L. Koch, 1836 (Ross, pers. obs.) within the cosmotropical family Buthidae and involves the offspring arranged in single or staggered multiple layers; oriented anteriorly toward the prosoma of maternal females, and the prosoma of offspring may or may not be in direct contact with the integument of maternal females. This pattern of larval orientation may have evolved in bark scorpions in order to facilitate a more secure and stable arrangement of the first-instar offspring upon the dorsa of females that may resume surface activities such as foraging and mating immediately following the birth of offspring (Williams 1969; Ross, pers. obs.).

By 1900 hours, all of the offspring had ascended to the dorsum of the female. During the entire birth and immediate post-birth period the female did not attempt to cannibalize any of the young. While cannibalistic tendencies have not been reported in *Opisthacanthus* spp., cannibalism of three first-instar young by *Opisthacanthus asper* (Peters, 1861), immediately following parturition, was previously observed by the author. During the parturition, post-parturition and dorsal transportation stages, the maternal female made no attempts to feed upon her offspring and refused to feed even when prey (*Acheta domesticus* L.) was offered. On 05 May 2009, after all of the young had dispersed and been removed from the enclosure of the female, she resumed feeding on 08 May 2009, 33 days post-birth.

On 15 April 2009, after a period of 10 days, five of the young successfully molted to the second instar on the dorsum of the maternal female. Two others molted on 16 April and another three on 17 April. Finally, the last remaining young molted to the second-instar on 19 April, with the 11 offspring successfully completing the molt to second-instar in 10–14 days. During the first 24 hours post-molt, the young gradually darkened becoming dark brown in overall coloration. Second-instar specimens exhibited increasingly greater levels of mobility and after and additional 10–12 day period, the nutritionally independent young dispersed from the dorsum of the maternal female. Free-living second instar specimens were transferred to serially numbered, individual 50 dram vials, with a slightly moistened 25–30 mm layer of topsoil and a single small sub-vertically arranged piece of cork bark. Specimens were maintained under environmental conditions similar to adults. Specimens were provided immature common house crickets (*A. domesticus*) once per week.

Second-instars used the anterior walking legs to excavate shallow depressions at the base of sub-vertical structures. During crepuscular and nocturnal periods, all specimens became active and foraged and moved over sub-vertical structures and on the substrate proximal to the base of structures. A hungry specimen would move to the base of the structure within the container and assume a positive geotropic position on the structure with the tips of the chelal fingers resting upon the substrate or

Fig. 1 *Opisthacanthus maculatus* Lourenço & Goodman, 2006 with Instar 1 offspring

within 1–2 mm of the substrate surface. Moving prey that moved near or made contact with the chelae of the immobile scorpion were immediately captured with the chelae and stung once before being consumed at the site of capture.

Discussion

All extant scorpions are viviparous (Francke 1982; Polis & Sissom 1990). Scorpion reproduction is classified as either apoikogenic or katoikogenic based upon the anatomy of the female reproductive system and the internal development of the embryos (Laurie 1896). Apoikogenic scorpions have a simple ovariuterus without diverticula; embryonic development occurs in the lumen of the ovariuterus, and nutrition is provided to the embryos by yolk and supplemented by a diffuse placenta. Katoikogenic scorpions possess an ovariuterus with numerous diverticulae; offspring develop in the diverticula, and embryonic nutrition is provided by specialized cells leading into the oral cavity of each embryo (Francke 1982). Females of the genus *Opisthacanthus* (Liochelidae) produce katoikogenic offspring (Polis & Sissom 1990).

While the limited birth and post-birth behaviors observed were not unlike those previously reported for other katoikogenic *Opisthacanthus* spp. (Lourenço 1985, 1991, 2002), parturition time in the observed female lasted approximately 10 hours, which is comparable to parturition times reported for apoikogenic scorpions (e.g. Buthidae C. L. Koch, 1837) but much shorter than those previously reported for other katoikogenic scorpions (Francke 1982; Polis & Sissom 1990). Parturition times tend to last longer in katoikogenic species (24–240 hours) compared to apoikogenic species (1–37 hours) (Williams 1969, 1971; Francke 1982; Polis & Sissom 1990). However, data on parturition times in katoikogenic scorpions is limited to only a few taxa; primarily in the families Diplocentridae Karsch, 1880 and Scorpionidae Latreille, 1802 (Polis & Sissom 1990).

Litter size in *O.* (*M.*) *maculatus* was only slightly smaller than those previously reported for other *Opisthacanthus* species from the Afrotropic and Neotropic regions (Lourenço 1985, 1991, 2002; Polis & Sissom 1990). Litter sizes of 12–22 offspring have been reported for females of the Afrotropical species *Opisthacanthus* (*Nepabellus*) *asper* (Peters, 1861) and *Opisthacanthus* (*Nepabellus*) *capensis* (Thorell, 1876) (Lourenço 1985, 2002). Litter size in the South American species *Opisthacanthus* (*Opisthacanthus*) *cayaporum* Vellard, 1932 and *Opisthacanthus* (*Opisthacanthus*) *elatus* (Gervais, 1844) has been reported to be in the range of 15–25 offspring (Lourenço 1985, 2002). Additionally, Lourenço (1985) listed litter size (LS) in single broods of *Opisthacanthus* (*Nepabellus*) *africanus* Simon, 1876 (LS = 16) and *Opisthacanthus* (*Monodopisthacanthus*) *madagascariensis* Kraepelin, 1894 (LS = 26). More recently, Outeda-Jorge et al. (2009) reported on a single specimen of *O.* (*O.*) *cayaporum* that gave birth to an unusually small, single litter of three offspring. In *O.* (*M.*) *maculatus*, the slight reduction in litter size may be the result of the female allocating greater resources into producing smaller litters of larger offspring or reproductive constraints placed on females due to their smaller body size (females 34–35 mm total length) thus, limiting the total number of offspring produced by each female (Bradley 1984; Sinervo & Licht 1991). Comparatively, females of other *Opisthacanthus* species for which reproductive data has been reported are larger in size (45–91 mm), and the increase in body size may allow females of these larger species to produce larger and greater numbers of offspring (Stearns

1992). Larger females are often predicted to produce more and larger offspring due to increased body space to store developing embryos and being better at obtaining and allocating greater resources for reproduction (Brown et al. 2003; Brown 2004). As litter size has been demonstrated to increase with female body size in many species, it has been suggested that larger females have a fitness advantage (Fox & Czesak 2000). Unfortunately, the small sample size of *O.* (*M.*) *maculatus* reported herein is too small to make comprehensive comparisons between the various *Opisthacanthus* species.

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