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The life cycle of the Malagasy scorpion *Opisthacanthus madagascariensis* Kraepelin, 1894 (Liochelidae)

WILSON R. LOURENÇO, ELISE-ANNE LEGUIN
& JOHN L. CLOUDSLEY-THOMPSON

(with 10 figures)

Abstract

Biological observations were made during the 1980s by the senior author on living specimens of *Opisthacanthus madagascariensis* Kraepelin, 1894. These were collected by French biologists on a field trip in 1980-1981 to the Parc National de Namoroka, Mahajanga Province, Madagascar. The total duration of embryonic development averaged 18 months. The moults necessary to reach the various juvenile instars and adulthood took place at average ages of 13, 101, 204, 327 and 442 days. These developmental periods are significantly longer than those of most medium-sized species of scorpions but are similar to the ones previously observed in other species of the genus *Opisthacanthus*. Morphometric growth values of the different instars are also similar to those in other known species of *Opisthacanthus*. A significant allometric growing of pedipalps is observed for some males collected in the field, suggesting the existence of at least one extra instar.

K e y w o r d s: Scorpiones, *Opisthacanthus madagascariensis,* life history, allometric growth, Mahajanga Province, Madagascar.

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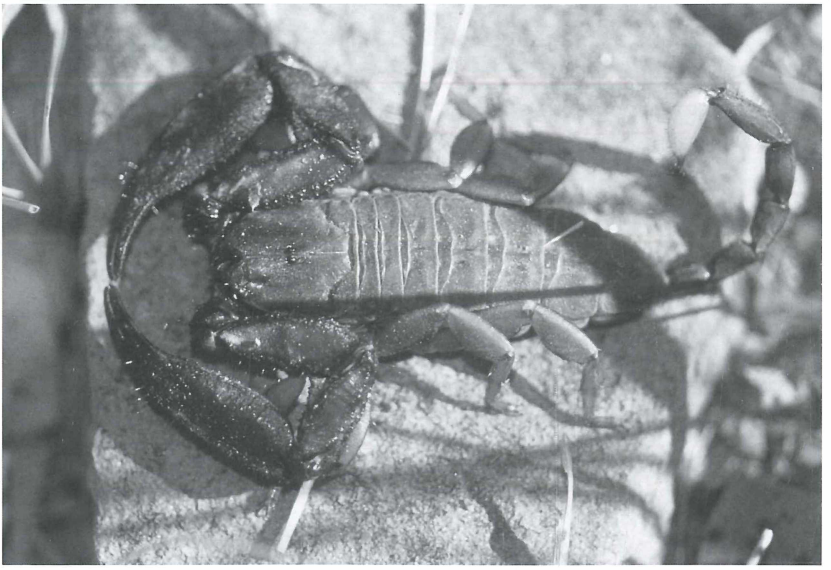

Fig. 1. *O. madagascariensis* Kraepelin, adult ♂ in the field, Beza Mafaly (Photo H. Schütz).

Fig. 2. *O. madagascariensis* Kraepelin, adult ♀ in the field, P. N. Tsingy de Bemaraha (Photo: W. R. Lourenço).

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Introduction

During a field trip to Madagascar during the southern hemisphere summer of 1980-1981, French biologists, with the help of local people, collected several living specimens of *Opisthacanthus madagascariensis* Kraepelin, 1984 in the Parc National de Namoroka, located in the Province of Mahajanga.

Some of the specimens collected have been, maintained alive under laboratory conditions for several years. During much of this period, the senior author was preparing his Doctorial Degree in Science ('Doctorat d'Etat'), focused on the phylogeny and biology of the species of the genus *Opisthacanthus* (Lourenço 1985). The specimens of *O. madagascariensis*, together with other species of *Opisthacanthus* not only from Africa but also from South America, have been the subject of intensive studies on their life cycles and reproductive biology (Lourenço *l.c.*, 1991). The specific results concerning the biological cycle of *O. madagascariensis*, were not, however, added to or published in the final version of Lourenço's thesis (Lourenço 1985).

Since the middle 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 Liochelidae, are extremely scarce. The composition and patterns of distribution of the Malagasy species of *Opisthacanthus*, however, have been much better defined more recently (Lourenço & Goodman 2006, 2008). The study of numerous specimens collected in diverse regions of the Island have enabled certain aspects of the parameters of growth of *O. madagascariensis* to be better understood (Lourenço & Goodman 2006). 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 terraria 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 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 exuvia were removed from the terrarium. Morphometric growth values of these exuvia, 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. Photos 3-8: by W. R. Lourenço & E.-A. Leguin. The available voucher material from the laboratory-reared specimens is deposited now in the Zoologisches Museum Hamburg (ZMH Acc. No. A27/10).

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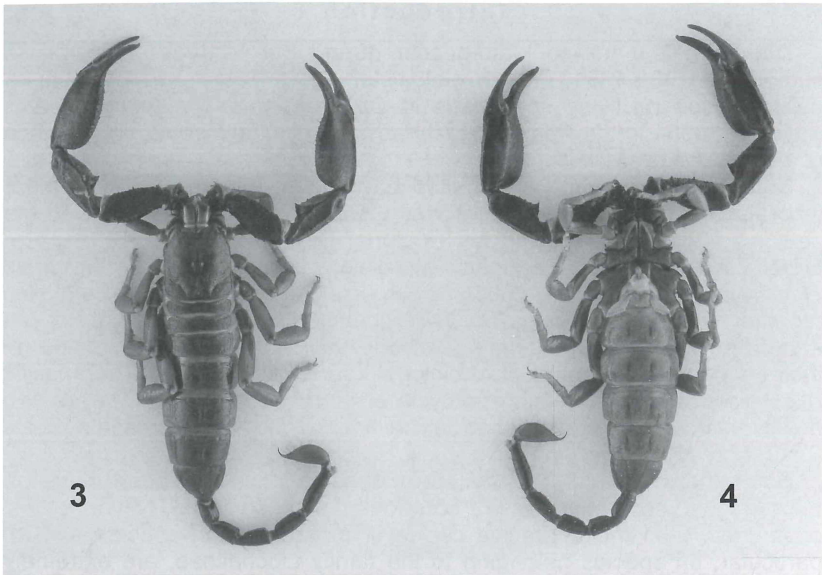
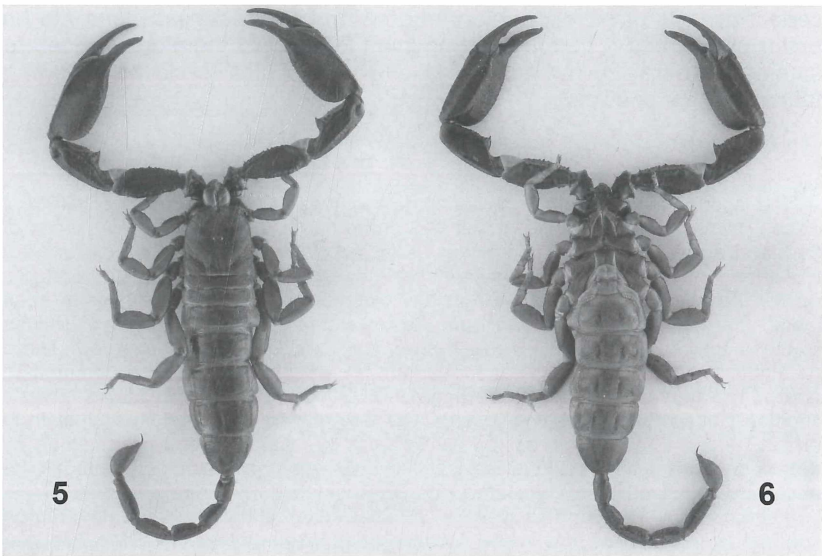


Figs 3-4. *O. madagascariensis* Kraepelin, adult ♂ of instar VI. Dorsal and ventral aspects.



Figs 5-6. *O. madagascariensis* Kraepelin, adult ♂ of instar VII. Dorsal and ventral aspects.

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Characteristics of *Opisthacanthus madagascariensis*

O. madagascariensis is large when compared with other species of the genus *Opisthacanthus* present in Madagascar. Males and females measure up to 65-75 mm in total length. Coloration: basically reddish-brown to dark brown with some blackish zones on the pedipalp carinae and metasomal segments. Metasomal segments darker than prosoma and mesosoma; vesicle reddish-yellow; aculeus dark reddish on the tip. Chelicerae reddish-brown; base of fingers blackish; the whole surface with dark variegated spots; fingers dark with reddish teeth. Pedipalps blackish-brown. Venter and sternites reddish-yellow to reddish-brown; pectines and genital operculum paler than sternites; legs yellowish to reddish-yellow with very diffused spots. Morphology: body and appendages weakly granulated and almost smooth but with punctuations. Sternum wider than long. Genital operculum formed by two semi-oval plates in males, and a single heart-shaped plate in females, with a small incision in the base of the latter. Pectinal tooth count 7 to 8 in males and 6 to 8 in females; mode 8 in males, 7 in females. Trichobothriotaxy type *C*; orthobothriotaxic (Vachon 1974). Legs: tarsi with 3 lateral rows of spines, surrounded by some long setae. Hemispermatophore with the distal lamina long and complex.

Population densities appear to be high in several known Malagasy *Opisthacanthus* spp. *O. madagascariensis* seems to be fairly common in the region of the Ankarana Massif and also in the Parc National Tsingy de Bemaraha (Fage 1929, Lourenço & Goodman 2006). We cannot, however, estimate the relative position of *O. madagascariensis* within the guild, because very little is known about the other scorpion species present in its region of distribution (Lourenço & Goodman 2006). Not much is known about the diel behaviour of *O. madagascariensis* in the field (Cloudsley-Thompson 1981). Under laboratory conditions, the scorpions move slowly and only leave their retreats at night. Their predatory technique is of the 'sit-and-wait' type. They remain motionless with the pedipalp fingers opened. Cannibalism appears to be uncommon in the natural habitat, and was never observed among specimens of *O. madagascariensis* in the laboratory even when several individuals of different sizes were maintained together in numbers varying from 4 to 6.

Laboratory observations - Developmental periods

Courtship and mating behaviour was observed in two pairs of these scorpions. In 1983-1984 the females gave birth to broods composed of 26 and 30 neonates. The total duration of embryonic development averaged 18 months and can be assumed to be either similar or shorter than that of other species of *Opisthacanthus* (Lourenço 2002). After being carried on their mother's back for 12-14 days, the first moults of the young scorpions were observed. Juveniles began to disperse from their mother's back at the age of 18-22 days. Subsequent moults took place at different ages. The average number of days occupied by each of these were as follows: second moult (101 days), third (204 days), fourth (327 days), fifth

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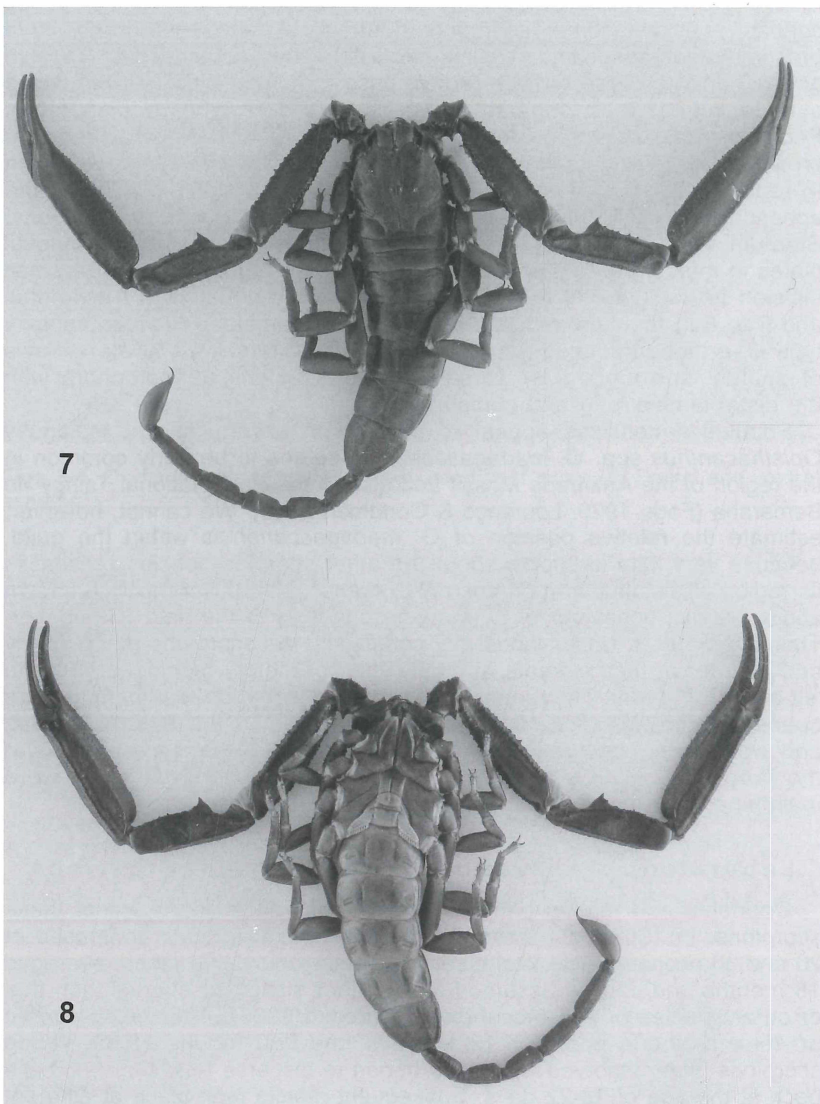
(442 days). Males may become adult from the fifth moult. Females become adult with the sixth moult. The duration of different instars observed in laboratory conditions can vary greatly, even among members of the same brood.



Figs 7-8. *O. madagascariensis* Kraepelin, adult ♂, possibly of instar VIII. Dorsal and ventral aspects (Specimen collected in the field from P.N. de Namoroka).

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Growth factors

The theoretical morphometric growth factor for arthropods, as defined by Dyar (1890) and Przibram & Megusar (1912), is 1.26. Growth parameters of *O. madagascariensis*, based on morphometric values (measured on both dead individuals and on exuvia), are shown in Figures 9-10. 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 *O. madagascariensis* are comparable with those observed among other studied species of *Opisthacanthus* (Lourenço 1985, 1991, 2002).

Under laboratory conditions, some individuals exhibited variability in the period of their development. A few of them passed through an extra instar before they become adult. In such cases, the adults were slightly larger. Even larger adults, however, were collected in the field. In the case of females these may imply an extra instar. Even more remarkable was the collection of several males in the regions of P. N. de Namoroka, P. N. Tsingy de Bemaraha and Tsingy Beanka. These showed significant allometric growth of the pedipalps, suggesting the existence of two more instars than among the specimens raised in laboratory conditions (Figs 7-8).

The existence of both small and large adults and, in particular, of small and large males has previously been observed in the savannicolous species *Tityus fasciolatus* Pessôa, 1935 (see Lourenço 1979, 1995).

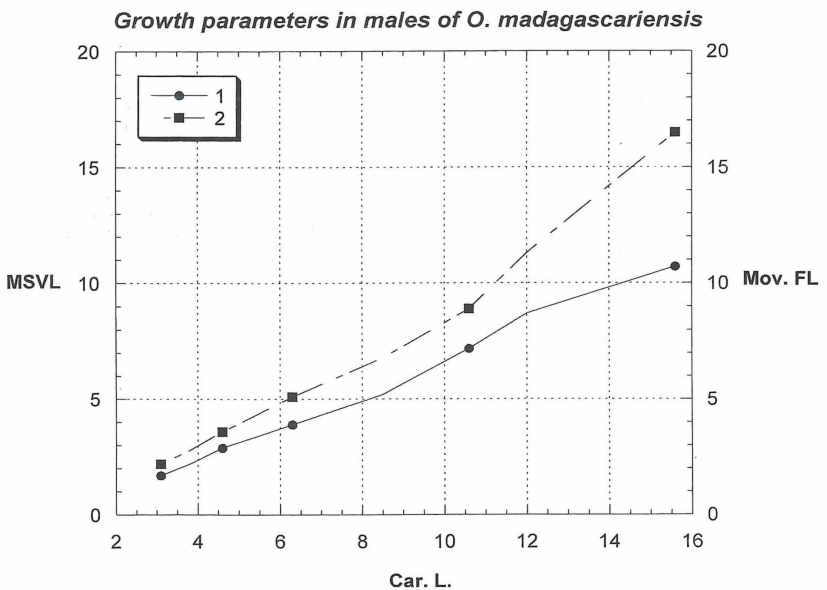

Fig. 9. The distribution of morphometric values (in mm), in juvenile and male adult instars of *O. madagascariensis* Kraepelin. Car. L. = carapace length; M.S.V.L. = metasomal segment V length; Mov. F.L. = movable finger length. **1** = Car. L. vs. M.S.V.L.; **2** = Car. L. vs. Mov. F.L.

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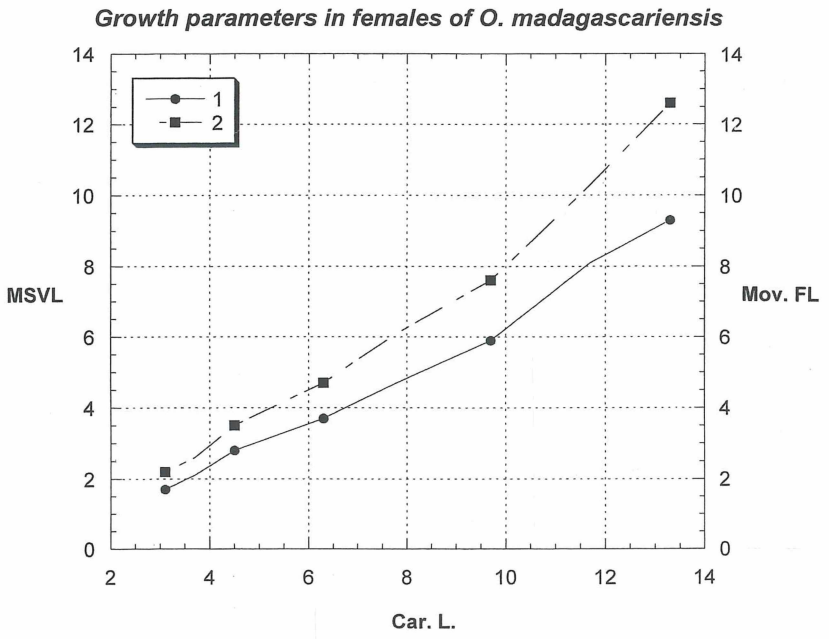

Fig. 10. The distribution of morphometric values (in mm), in juvenile and female adult instars of *O. madagascariensis* Kraepelin. Car. L. = carapace length; M.S.V.L. = metasomal segment V length; Mov. F.L. = movable finger length. **1** = Car. L. vs. M.S.V.L.; **2** = Car. L. vs. Mov. F.L.

Table 1. Average morphometric values (in mm) for juvenile and adult instars of males of *Opisthacanthus madagascariensis* Kraepelin.

	Car. L.	M.S.V.L.	Mov.F.L.	G.V.	n
Instar I	3.1	1.7	2.2	-	20
Instar II	3.8	2.2	2.8	1.22/1.29/1.27	17
Instar III	4.6	2.9	3.6	1.21/1.32/1.28	14
Instar IV	6.3	3.9	5.1	1.37/1.34/1.42	10
Instar V	8.5	5.2	6.8	1.35/1.33/1.33	09
Instar VI (L-adult)	10.6	7.2	8.9	1.25/1.38/1.31	08
Instar VII (L&F-adults)	12.0	8.7	11.3	1.14/1.21/1.27	07
Instar VIII (F-adult)	15.6	10.7	16.5	1.30/1.23/1.46	17
			AGV	1.26/1.30/1.33	

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. n = number of individuals measured, including exuvia. L = laboratory adult. F = field adult.

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Table 2. Average morphometric values (in mm) for juvenile and adult instars of females of *Opisthacanthus madagascariensis* Kraepelin.

	Car. L.	M.S.V.L.	Mov. F.L.	G.V.	n
Instar I	3.1	1.7	2.2	-	18
Instar II	3.7	2.1	2.6	1.19/1.23/1.18	16
Instar III	4.5	2.8	3.5	1.22/1.33/1.35	14
Instar IV	6.3	3.7	4.7	1.40/1.32/1.34	12
Instar V	7.8	4.7	6.1	1.24/1.27/1.30	10
Instar VI	9.7	5.9	7.6	1.24/1.25/1.25	07
Instar VII (L-adult)	11.7	8.1	10.3	1.21/1.37/1.35	06
Instar VIII (F-adult)	13.3	9.3	12.6	1.14/1.15/1.22	01
			AGV	1.23/1.27/1.28	

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. n = number of individuals measured, including exuvia. L = laboratory adult. F = field adult.

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Authors' address:

Dr. W. R. Lourenço, Muséum national d'Histoire naturelle, Département de Systématique et Evolution, Section Arthropodes (Arachnologie), CP 053, 57 rue Cuvier 75005 Paris, France (e-mail: arachne@mnhn.fr);

E.-A. Leguin, MSc, Muséum national d'Histoire naturelle, Direction des Collections, CP 053, 57 rue Cuvier 75005 Paris, France (e-mail: leguin@mnhn.fr);

Prof. J. L. Cloudsley-Thompson, 10 Battishill Street, Islington, London N1 1TE, United Kingdom.

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