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Observations on the life history of *Chaerilus philippinus* Lourenço & Ythier, 2008 (Scorpiones, Chaerilidae) from the Philippines

Wilson R. Lourenço^{a,*}, Eric Ythier^b, John L. Cloudsley-Thompson^c

^a Muséum national d'Histoire naturelle, Département de systématique et évolution, USM 0602, section arthropodes (arachnologie), CP 053, 57, rue Cuvier, 75005 Paris, France

^b SynTech Research, 613, route du bois de Loyse, 71570 La Chapelle de Guinchay, France

^c 10, Battishill Street, Islington, London N1 1TE, United Kingdom

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Abstract

Biological observations on *Chaerilus philippinus* were based on specimens from the region of Appari, North of Luzon in the Philippines. The total duration of embryonic development was estimated as being between 110 to 136 days, while the moults between successive juvenile instars and adulthood took place at ages that averaged 7, 39, 73, 190 and 327 days. These developmental periods are shorter and different from those previously observed among species of non-buthid scorpions. They prove to be rather similar to those observed in buthid scorpions, however. Morphometric growth values of the different instars are similar or smaller than those of other species of scorpions that have been studied. Aspects of maternal care and social behaviour are also commented.

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Résumé

Observations sur le cycle biologique de *Chaerilus philippinus* Lourenço & Ythier, 2008 (Scorpiones, Chaerilidae) des Philippines. Des observations biologiques ont été réalisées chez *Chaerilus philippinus*, pour des spécimens collectés dans la région d'Appari dans le nord de Luzon aux Philippines. La durée totale du développement embryonnaire peut être estimée entre 110 à 136 jours, tandis que les mues nécessaires à l'acquisition des différents stades juvéniles ainsi que le stade adulte ont eu lieu à 7, 39, 73, 190 et 327 jours. Les durées en jours, observées pour le développement de *C. philippinus* sont globalement différentes et plus courtes que celles observées préalablement pour des espèces de scorpions non-Buthidae, mais très similaires à celles observées pour les espèces de scorpions Buthidae. Les taux de croissance observés pour les différents stades sont soit similaires, soit plus faibles que ceux observés pour d'autres espèces de scorpions. Des commentaires sont également apportés sur les comportements maternel et social. **Pour citer cet article :** W.R. Lourenço et al., C. R. Biologies 331 (2008).

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* Corresponding author.

E-mail addresses: arachne@mnhn.fr (W.R. Lourenço), eythier@syntechresearch.com (E. Ythier).

1. Introduction

Scorpions are unusual among terrestrial arthropods in several traits of their life-history: ritualized and complex courtship with fertilization by means of a spermatophore; viviparous embryonic development; maternal care and, in some species, a degree of social behaviour; post-embryonic development and life span generally very lengthy. Because of these unusual traits in their life-history, many aspects of the reproductive biology of scorpions were poorly understood by early authors [1,2].

Since the mid-1950s, several accounts of various aspects of the reproductive biology and, in some cases, of the entire post-embryonic development of scorpions, have been published (see [2] for references). For example, several researchers discovered, apparently independently, that sperm transfer is accomplished by means of a spermatophore. The first of these were Angermann [3] and Alexander [4]. The mid-1970s saw a renewal of interest in the reproductive biology of scorpions and particularly in their post-embryonic development. Research on this subject multiplied during the 1980s and continued throughout the 1990–2000s. Interestingly, most of the authors of this work were primarily taxonomists who, in addition to obtaining biological information, were investigating the ontogenetic variability of the characters used in taxonomy [1,2]. Only Polis and Farley [5,6] have made any attempt to explain reproductive traits in the context of evolutionary ecology.

With regard to known biological data, a great disparity clearly exists between the groups of scorpions studied. For the 16 to 20 recognized family-groups of scorpions [7], less than 50% of these have been the subject of precise biological studies. The small family Chaerilidae Pocock, 1893, with the single genus *Chaerilus* Simon, 1877, and about 20 species distributed exclusively in Asia is one of these groups. Precise observations on the entire life cycles of chaerilid scorpions remain unavailable.

Precise data are now for the first time available for *Chaerilus philippinus* Lourenço & Ythier, with respect to its embryonic and postembryonic development as well as for certain aspects of maternal behaviour of the species, and these are summarised below.

2. Material and methods

The scorpions were reared by standard methods in plastic terraria of different sizes (Fig. 1). These contained a layer of soil, 2–3 cm in depth, as well as a few pieces of bark and a small Petri dish containing wa-



Fig. 1. *Chaerilus philippinus*. Males and females in a common terrarium.

ter. Food, consisting of crickets and cockroaches, was provided once every 7 to 10 days. Temperatures ranged from 24 to 27 °C and the humidity was maintained at 60–70%. After each moult, the exuvia were removed from the terrarium. Morphometric growth values were measured from individuals that died in captivity and from exuvia. Three parameters were recorded: carapace length, the length of the metasomal segment V, and of the movable finger [2,8]. The growth factor (Dyar's constant) between succeeding instars was determined for each individual from each of these three structures (by dividing the dimension at one instar 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 has been deposited in the Muséum national d'Histoire naturelle, Paris.

3. Characteristics of *Chaerilus philippinus*

These scorpions are rather small compared with other species in the genus. The adults range from 15 to 19 mm in total length and have general coloration, yellowish to slightly reddish-yellow with brownish spots over the body and appendages. For more precise details, refer to the original description [9]. Population densities of most known *Chaerilus* spp. appear to be low, and *C. philippinus* seems to be rather uncommon in the rainforests of Luzon. The diel behaviour of *C. philippinus*, both in the field and in the laboratory, is characteristic of a species dwelling in forests [10]. The scorpions move slowly and only leave their retreats at night. Their predatory technique is of the sit-and-wait type. They wait motionless with the pedipalp fingers opened. Cannibal-

ism seems to be unknown in areas of primary forest, and was not observed under laboratory conditions.

4. Developmental period

Two male and three female specimens of *Chaerilus philippinus* were collected in the region of Appari, North of Luzon and were brought into the laboratory, in France on the 1 November 2006. From 5 to 10 November 2006 cases of mating were observed among them. One female also reproduced, suggesting that she had already been inseminated in the field.

Subsequently, five cases of mating were observed among these three females. The duration of embryonic development ranged from 110 to 136 days and the number of offspring at birth ranged between 8 and 25, with an average value of 15 (Fig. 2). These values are similar to those of other small or moderate sized species of scorpions [2]. After being carried on their mother's back for 7–8 days, the first moult of the young scorpions took place (Fig. 3). Juveniles began to leave their mother's back at the age of 10–12 days. Subsequent moults took place at different ages. The average number of days occupied by each were as follows: The second moult took place between 38 and 40 days (mean 39), the third between 71 and 74 days (mean 73), the fourth between 184 and 196 (mean 190) and the fifth between 323 and 332 days (mean 327).

The times spent in postembryonic development and the duration of the instars necessary to reach adulthood in *Chaerilus philippinus* are shorter and considerably different from those observed in other species of non-buthid scorpions [11]. In fact, these values tend to be similar to those observed in buthid scorpions [2]. These results could bring further support to the hypothesis according to which chaerilid scorpions are more closely related to buthid than to non-buthid scorpions [7], especially because reproductive parameters seem to be rather associated to phylogenetic than ecological factors [2,14].

Of the seven scorpions that reached adulthood, five died shortly afterwards, whereas the two others are still alive at the time of writing (April, 2008). Consequently, the duration of the life span in *Chaerilus philippinus* can only be assumed with certainty as being similar to that observed in many other small species of scorpions, buthids in particular [2].

The theoretical morphometric growth factor for arthropods, as defined by Dyar [12] and Przibransky and Megusar [13] is 1.26. Growth parameters based on morphometric values, measured both on dead individuals and on exuvia, are shown in Table 1 and Fig. 4. The re-



Fig. 2. *Chaerilus philippinus*. Females with offspring. Two females, in common terrarium, with pre-juveniles (instar I), during simultaneous birth process.



Fig. 3. *Chaerilus philippinus*. Female with offspring. Juveniles (Instars II) just after the first moult.

sults obtained for morphometric growth values of the different instars in *C. philippinus* are very similar to the standard theoretical values, but smaller than those obtained for most other species of scorpions [2,8,11,14].

5. Aspects of maternal care, and social behaviour

Maternal behaviour and care has been known in scorpions for a considerable time [8,15]. In fact, newborn scorpions of all species stay with their mothers until just after the first moult (Fig. 3). This period usually lasts from one week to almost one month and represents a subsocial stage along the family route [16]. Some species retain their young for longer periods.

More cooperation exists between mother and offspring in some non-buthid scorpions. In these cases

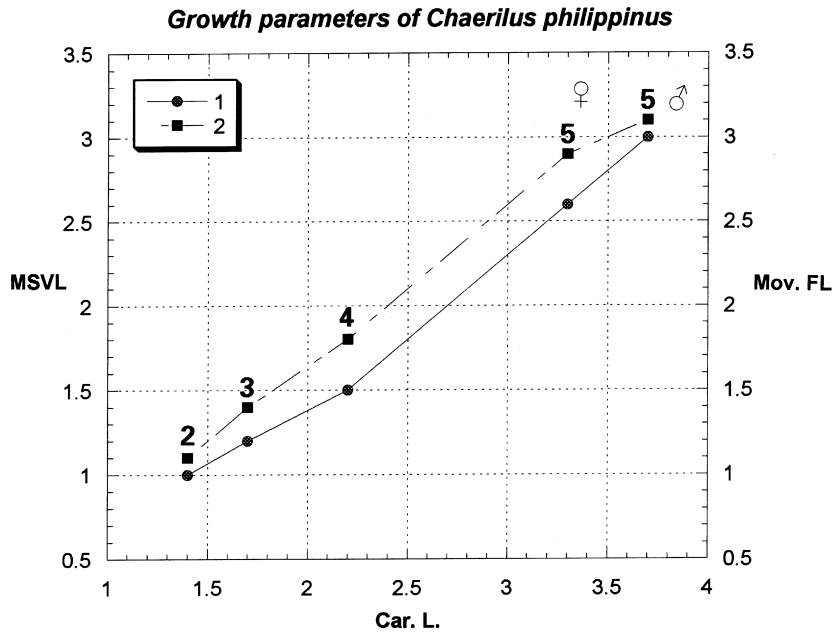


Fig. 4. The distribution of morphometric values (in mm), in juvenile and adult instars of *Chaerilus philippinus*. Car. L. = Carapace length. M.S.V.L. = Metasomal segment V length. Mov. F.L. = Movable finger length. 1 = Car. L. vs. M.S.V.L.; 2 = Car. L. vs. Mov. F.L. Values for instars 2 to 4 are similar for males and females, but distinct at instar 5 (adults).

Table 1
Average morphometric values (in mm) for juvenile and adult instars of both males and females of *Chaerilus philippinus*

	Car. L.	M.S.V.L.	Mov. F.L.	G.V.	N ^o
Instar I	–	–	–		
Instar II	1.4	1.0	1.1		
Instar III	1.7	1.2	1.4	1.21/1.20/1.27	12
Instar IV	2.2	1.5	1.8	1.30/1.25/1.29	12
Instar V	2.8	2.1	2.4	1.27/1.40/1.33	10
Instar VI (adult-♀)	3.3	2.6	2.9	1.18/1.24/1.21	04
Instar VI (adult-♂)	3.7	3.0	3.1	1.32/1.43/1.29	03
AGV				1.26/1.30/1.28	

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^o Number of specimens measured. Growth values between instars I and II can be considered as atypical due to very strong morphological differences between juveniles of these instars. For this reason these values are not considered in the final calculation. N^o = number of individuals measured, including exuvia.

mother and offspring may forage together; capture and drag prey into their burrows and may also feed communally. In some cases adults share the prey that they capture with their young. Such active cooperation between mother and offspring characterizes the intermediate subsocial stage of sociality along the family route. There is no evidence, however, that scorpions show more advanced stages of sociality.

For non-buthid scorpions, in particular those showing embryonic development with diverticula [2], some examples of species living in the field in mixed groups of related and possible unrelated individuals are known [16]. In such cases the degree of cooperative behaviour corresponds either to the intermediate sub-social stage (family route) or to the quasisocial stage (parasocial route).

All individuals of *Chaerilus philippinus* observed in this study were raised together in a common terrarium. These unrelated and subsequently related specimens showed certain particular traits in their behaviour which could be assimilated both to the intermediate sub-social stage (family route) and to the quasisocial stage (parasocial route).

To start with, no case of cannibalism was ever observed among the specimens raised. A more peculiar behaviour was observed when distinct females had their offspring in the same period. These females with broods stayed together in the terrarium where other females and males were also present. On several occasions it was possible to observe that first instar pre-juveniles would move from their mother's back to the back of another female with or without a brood, and even to the backs of males. These exchanges could last for some minutes or even some hours. Just before the process of the first moult, however, first instar pre-juveniles returned to the backs of their own mothers. We do not have a precise

explanation to this behaviour, but it is almost certainly connected with social behaviour.

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