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Notes on the ecology, distribution and postembryonic development of *Tityus cambridgei* Pocock, 1897 (Scorpiones, Buthidae) from French Guyana and Oriental Amazonia

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Abstract

Tityus cambridgei Pocock, 1897 is distributed from the Oriental region of Brazilian Amazonia (Pará) to as far as the Guayanas, but is centred mainly in French Guyana. Preliminary biological observations were carried out in the middle of the 1970s and the early 1980s on specimens from the area of Belém (Brazil) and completed from 1997 to 1998 on specimens from Cacau (French Guyana). The duration of embryonic development, observed in Brazilian specimens, ranged from 3 to 4 months, while the molts necessary for the acquisition of the different juvenile instars and adulthood took place at ages that averaged: 4, 48, 93, 136 and 260 days for the specimens from Cacau, and 5, 56, 108, 157 and 349 days for the specimens from Belém. These developmental periods are not greatly different from those in other species of *Tityus*; however, they are shorter than those previously observed in the larger species of the genus. Morphometric growth values of the different instars are comparable with those of all other species of *Tityus*.

Introduction

Tityus cambridgei Pocock, 1897, was originally described from the State of Pará in the Oriental region of Brazilian Amazonia. This species has a wide distribution ranging from the centre of the State of Pará as far as Guayanas, but is centred throughout French Guyana (Lourenço 1983, 1986a, b, 1991) (Fig. 1). Since the middle of the 1970s, biological observations on *T. cambridgei* from Belém (Pará, Brazil) have been made by one of the present authors (WRL). These preliminary and unpublished studies did not, however, include observations on the entire life cycles of members of the same brood. Several new observations have been made since 1997 (by DH), based on material from the area of Cacau, French Guyana. More precise data are therefore now available regarding not only the habitat and micro-habitat of *T. cambridgei* but also with respect to its embryonic and postembryonic development. These are summarized below.

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Various species of the genus *Tityus* are responsible for a large number of incidents for human beings in South America and, in particular, in Brazil. Here, scorpion stings have shown an alarming increase in recent years and represent a real public health problem. More than 15,000 scorpion stings, resulting in hundreds of deaths, have been reported since 1988. Moreover, new lethal cases have been caused by species not previously suspected of being dangerous to humans. They have been reported from both Peruvian and Brazilian Amazonia (Lourenço & Cloudsley-Thompson 1996a; Lourenço *et al.* 1996). *T. cambridgei* appears to be one of the species responsible for many of the more serious incidents. Some cases have been reported from the area of Belém, and others from the peripherical districts of Cayenne, where at least one fatal case has been observed (Hommel *et al.* 1999).

Material and methods

Scorpions were reared according to standard methods using plastic terraria of different sizes. 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 water. Food, consisting of crickets and spiders, was provided once every week to 10 days. Temperature ranged from 24 to 27 °C and humidity was maintained at saturation level. After each molt the exuvia were removed from the terraria and stored in boxes - one for each individual scorpion. Morphometric growth values were measured on both dead specimens and on the exuvia. Three parameters were recorded: Carapace length; metasomal segment V length; and movable finger length (Lourenço 1979, 1991).

The available voucher material has been deposited in the Zoologisches Museum Hamburg.

Characteristics of *Tityus cambridgei*

Scorpions, which are rather large for the family Buthidae and ranging from 70 to 90 mm in total length. General coloration brown to blackish-brown. The pigmentation correlates well with the general pattern observed among scorpions living in dense forest and rainforest (Lourenço & Cloudsley-Thompson 1996b).

Population densities of several *Tityus* spp. appear to be high, and *T. cambridgei* is one of the most common, if not the most common species, both in French Guyana, and in parts of the State of Pará, Brazil. The diel behaviour of *T. cambridgei,* both in the field and in the laboratory, is characteristic of a species dwelling in dense forest (see Cloudsley-Thompson 1981). 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. Cannibalism seems to be uncommon in areas of primary forest, but may perhaps occur in disturbed areas where scorpion populations normally increase faster; it was not observed under laboratory conditions.

The habitat of *T. cambridgei* in the rainforest of Oriental Amazonia and French Guyana

T. cambridgei inhabits very dense rainforest, situated at elevations from sea level to 150 m. This forest is composed of considerable numbers of different families

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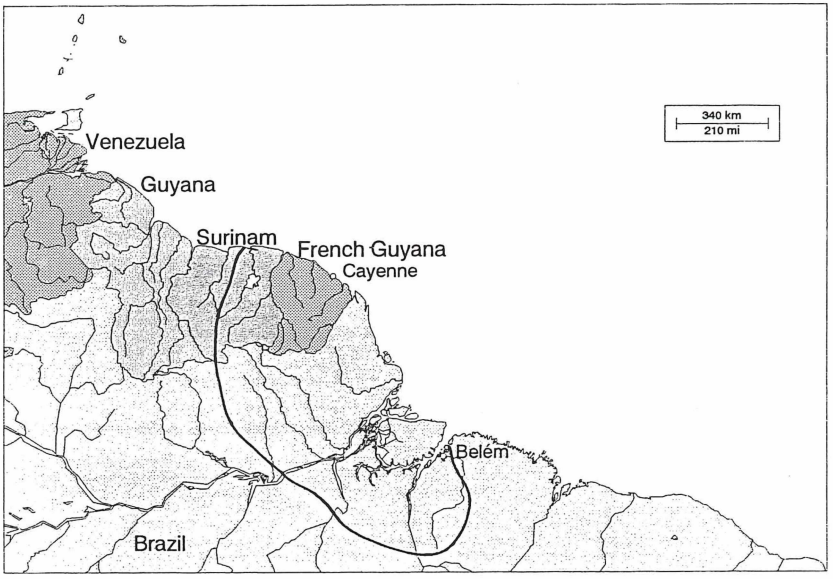

Fig. 1. Records of *Tityus cambridgei* Pocock.

of plants, which vary according to the gradient (Murça Pires & Prance 1985). *T. cambridgei* is found in "Terra Firme" forest, as well as in the "Várzeas and Igapós" (inundated forests) at different seasons of the year.

The vegetation is so dense in some areas that daylight scarcely reaches soil level. The scorpions were found under logs and bark, as well as in soil litter. Other scorpion species may be sympatric with *T. cambridgei*. In one particular biotope, represented by the roots of a palm tree, *Astrocaryum paramaca* Martius, six species were found together with *T. cambridgei*: *Ananteris coineaui* Lourenço, 1982 and *Tityus silvestris* Pocock, 1897 (Buthidae), *Broteochactas fravalae* (Lourenço, 1983), *Broteochactas schaumi* (Karsch, 1880), *Brotheas gervaisi* Pocock, 1883 and *Brotheas granulatus* Simon, 1877 (Chactidae) (Lourenço 1983). *T. cambridgei* was also collected from the canopy at heights of 30 to 40 m in the area of Petit Saut, French Guyana (Lourenço 1997).

Several specimens have been gathered, in recent years, in the peripherical districts of Cayenne and also not far from Belém. In both cases, this seems to suggest a degree of adaptation of *T. cambridgei* to disturbed areas. Similar adaptation can be observed in the species which are responsible of most of the incidents involving humans, namely *Tityus stigmurus* (Thorell, 1876), *T. serrulatus* Lutz & Mello, 1922 and *T. bahiensis* (Perty, 1834), in a large number of the cities and towns in Brazil.

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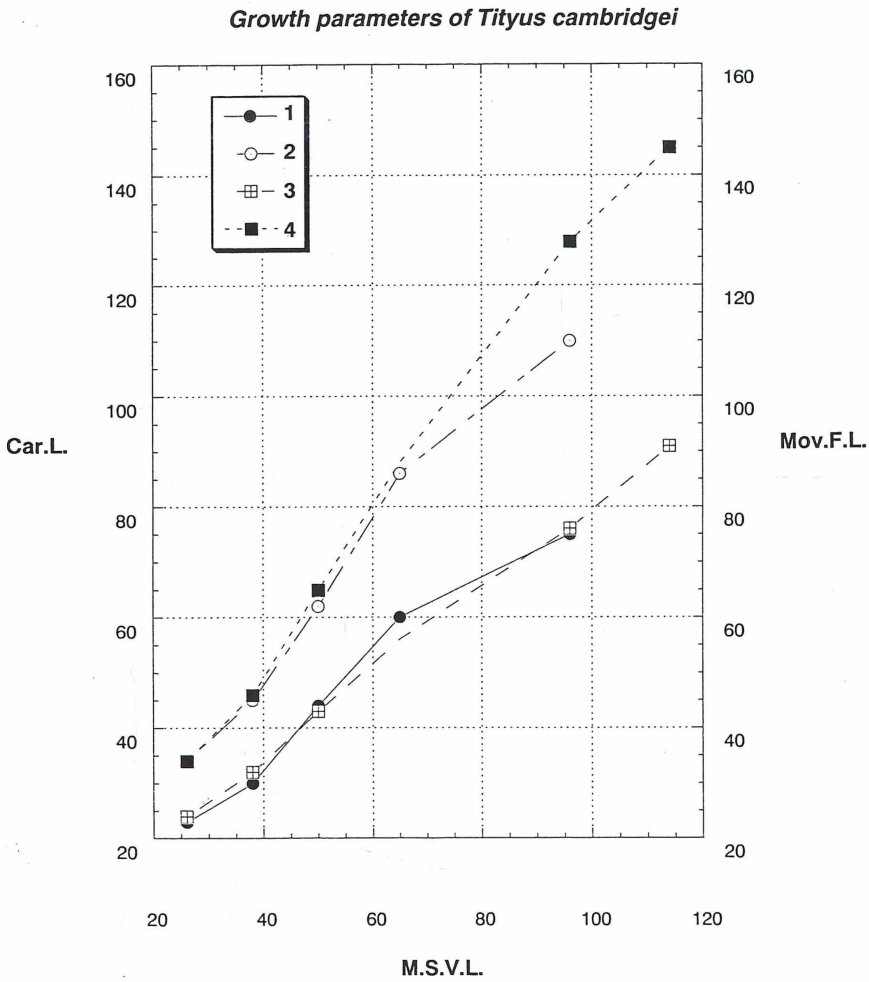

Fig. 2. The distribution of morphometric values (in mm, x 0.1), for juvenile and adult instars of *Tityus cambridgei* Pocock. (Car. L. = carapace length; M.S.V.L. = metasomal segment V length; Mov. F.L. = movable finger length; ***1*** = Car.L. versus M.S.V.L. (female); ***3*** = as above, male; ***2*** = Mov. F.L. vs. M.S.V.L., female; ***4*** = as above, male. (Extra plots in curves ***3*** and ***4*** correspond to males which passed through an extra instar before they reached adulthood).

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Positive selection of these opportunistic species of *Tityus* is endangered by human activities. In a profoundly modified environment, as in the cities of Brazil, and also around Cayenne, the three main factors transforming a region into an important center of scorpionism manifest themselves: (i) expansion of the human population; (ii) rapid expansion of the noxious, opportunistic species of scorpions, which soon occupy all the ecological niches abandoned by the regression or disappearence of non-adaptable species. In many cases, the opportunistic species changes its behaviour and begins to live inside human dwellings; (iii) overlapping of a large human population with a dense population of noxious scorpions greatly increases the probability of incidents of scorpionism. This situation is typical of certain regions in Brazil. We do not know if these three conditions also coincide in the area of Cayenne. Perhaps too, the plasticity of *T. cambridgei* may be less marked than that of the noxious Brazilian species. Consequently, two different situations are possible: (i) like many other species, *T. cambridgei* may be less adaptable and therefore will be partially or totally selected against by the destruction of their habitat before the human population becomes large and vulnerable; (ii) alternatively, if their plasticity proves to be high, they may infest urban areas, both in Brazil and French Guyana, thereby creating the same kind of problem as that which is presently observed in Brazil with the other *Tityus* spp. (Lourenço & Cloudsley-Thompson 1996a).

Developmental period

Combination of the results obtained in the 1970s and the early 1980s (by WRL) and since 1997 (by DH), show that females of *T. cambridgei* usually gave birth to 15 to 25 offspring. The duration of embryonic development in the Brazilian specimens ranged from 3 to 4 months. The young scorpions molted for the first time after an average of 4 or 5 days on their mother's back. The subsequent molts took place at different ages in specimens of the two populations. On average, the number of days observed in the Cacau specimens were: 2° molt at 48 days; 3° molt at 93 days; 4° molt at 136 days; 5° molt at 260 days, whereas those observed in the specimens from Belém were 56, 108, 157 and 349 days.

These developmental periods are not greatly different from those observed in most other species of *Tityus*, but they are shorter than those previously observed in other large species of the genus (see Lourenço & Cloudsley-Thompson 1999).

Variability in the developmental period was observed in different individuals. Some of these passed through an extra instar before they reached adulthood. In such cases the adults were larger (Fig. 2). This phenomen of the existence of both small and large adults, and in particular of small and large males, has previously been observed for *Tityus fasciolatus* Pessôa, 1935, a savannicolous species (Lourenço 1979, 1995).

The adult life span of *T. cambridgei* is long and probably extends for 40-48 months or even more. This is similar to what has been observed in other buthid species (Lourenço 1992).

Morphometric growth values of the different instars are comparable with those found in other species of *Tityus*. Growth parameters based on morphometric values,

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measured both on dead individuals and on exuvia, are shown in Fig. 2. Three parameters were considered: the length of the carapace, of the movable finger, and of metasomal segment five. The results are similar to those previously obtained with the other *Tityus* species (Lourenço 1979, 1992; Lourenço & Eickestedt 1988; Lourenço & Cloudsley-Thompson 1998, 1999).

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