

DISCOVERY OF A SEXUAL POPULATION OF *TITYUS SERRULATUS*, ONE OF THE MORPHS WITHIN THE COMPLEX *TITYUS STIGMURUS* (SCORPIONES, BUTHIDAE)

Wilson R. Lourenço: Laboratoire de Zoologie (Arthropodes), Muséum National d'Histoire Naturelle, 61 rue de Buffon 75005 Paris, France

John L. Cloudsley-Thompson: 10 Battshill Street, Islington, London N1 1TE, United Kingdom

ABSTRACT. *Tityus serrulatus* Lutz & Mello 1922 (in fact, the form confluenciata within the *Tityus stigmurus* complex) is an extremely toxic scorpion of considerable medical importance in Brazil. Its rapid spread is partially due to parthenogenesis. Speculation regarding the occurrence of sexual individuals has been resolved by the discovery of a population, described here, having a male-female sex ratio of 1/2.5. Four color morphs of the *T. stigmurus* complex are described, and it is concluded that *T. serrulatus* and *Tityus lamottei* Lourenço 1981 are junior synonyms of *T. stigmurus* (Thorell 1877).

Scorpionism is well known in Brazil and has been documented there since the end of the 19th century. Two species are currently associated with most incidents of medical importance, *Tityus serrulatus* Lutz & Mello 1922 and *Tityus bahiensis* (Perty 1934). The first comprehensive study of the phenomenon of scorpionism was that of Maurano (1915); this work, however, dealt primarily with *Tityus bahiensis* (Perty), the second most toxic species in South America. This species was originally described from Brazil. In recent years, the geographic range of the Brazilian scorpion *T. serrulatus* has increased considerably (Lourenço & Cloudsley-Thompson 1996). In Brazil, this species poses an exceptional health problem due to its rapid expansion in urban areas, its sudden proliferation and its great toxicity.

Since the description of *Tityus serrulatus*, most attention has been focused on its medical importance. However, it was observed that males are absent from all known populations, and Matthiesen (1962) first demonstrated that this species reproduces by parthenogenesis. This phenomenon although rare, has been demonstrated in other species of scorpions, also (Lourenço & Cuellar 1994). *Tityus serrulatus* was considered to be an obligate parthenogenetic species because bisexual populations had not been detected. Moreover, the apparent absence of related bisexual individ-

uals within its known geographic distribution suggested that the generating species either had been eliminated after giving rise to parthenogenesis, or that *T. serrulatus* evolved elsewhere and has since occupied an extensive region from which its bisexual progenitors were absent (Lourenço & Cuellar 1994; Lourenço & Cloudsley-Thompson 1996; Lourenço et al. 1996).

METHODS

The specimens of the sexual population of *Tityus serrulatus* were collected during daytime and were found under logs and bark. The area where this population was located presents a transitional vegetation type ranging from dry forests and cerrados to caatingas. In contrast, parthenogenetic populations are only known from modified sites and are often found inside cities and towns, where they live inside houses, but are also frequent in cemeteries and even in the sewer system. For details see (Lourenço & Cuellar 1995; Lourenço & Cloudsley-Thompson 1996; Lourenço et al. 1996).

Identification of sex was based both on external features and on dissection of adult males and females. The voucher material concerning the sexual population of *Tityus serrulatus* is partially deposited in the Natural History Museum in Paris, but also in the Ezequiel Dias Foundation in Belo Horizonte, Brazil.

RESULTS AND DISCUSSION

Lourenço (1981) suggested that *T. serrulatus* was closely related to *Tityus stigmurus* (Thorell 1877), a bisexual species with a range of distribution further north of *T. serrulatus*. Several other authors had discussed the status of these two species and their possible relationship. In the opinion of some (Pessôa 1935; Mello-Leitão 1939; Eickstedt 1983), both species should be considered distinct. Others asserted that, before about 1920, *Tityus stigmurus* had been a common species in the central and southern regions of Brazil (States of Minas Gerais, São Paulo and Goiás), and that the two species are varieties of a single species (Mello-Campos 1924; Vellard 1932). A few years ago, Lourenço (unpubl.) checked the notes of Vellard and some of his collected material. This confirmed that *Tityus stigmurus* was undoubtedly a common species in the State of Minas Gerais and south of Goiás, until at least the 19th Century (Lourenço & Cloudsley-Thompson 1996).

Lourenço & Cloudsley-Thompson (1996) and Lourenço et al. (1996) suggested that the sexual and the parthenogenetic populations of a complex *T. stigmurus/T. serrulatus* might correspond respectively to the northern range of *T. stigmurus* and the southern range of *T. serrulatus* in Brazil. However, recent unpublished field observations by Lourenço show that both the morphs *T. serrulatus* (= *confluenciata*) and *T. stigmurus* (= *unifasciata*) reproduce by parthenogenesis. Moreover, the sexual individuals of *T. stigmurus* occur in an undisturbed region of Exu in the State of Pernambuco, whereas the parthenogenetic populations are found among human communities along the coastal regions of its northern range.

Two other sexual morphs (*confluenciata/maculata* and *trifasciata*) occur in undisturbed regions. The first corresponds to the species described by Lourenço (1981) as *Tityus lamottei*. It occurs in a transitional zone between two major natural ecosystems, Cerrados and Caatingas in the western part of the State of Bahia, whereas *trifasciata* occurs in the State of Ceará at the extreme northern end of its range. Although these species are at present sexual, we speculate that future human disturbance could possibly lead to their replacement by parthenogenetic counterparts (see Louren-

ço & Cuellar 1995; Lourenço & Cloudsley-Thompson 1996) (Fig. 1).

Recent field observations on the polymorphic patterns of pigmentation (Lourenço in press) suggested that the above distinction between *T. stigmurus* (= sexual) and *T. serrulatus* (= parthenogenetic) forms, is not sufficiently comprehensive. The following classification of color morphs is therefore proposed: (a) Morph *unifasciata*: with a single median longitudinal dark stripe over the body as observed in the species named *T. stigmurus* (Thorell 1877). (b) Morph *confluenciata*: with confluent dark spots over the tergites as observed in the species named *T. serrulatus* Lutz & Mello 1922. (c) Morph *confluenciata/maculata*: with the same pattern as in b, but with dark spots over the pedipalps and legs, as observed in the species named *T. lamottei* Lourenço 1981. (d) Morph *trifasciata*: with three longitudinal dark stripes over the body as observed on an undescribed population from the State of Ceará. Other patterns probably exist but have not yet been documented.

Where the sexual populations of the *confluenciata* (= *T. serrulatus*) form are distributed remains unsolved. Recently a sexual population was located by one of the authors (WRL) in the north of the State of Minas Gerais, Brazil, in the region of Irapé close to the Jequitinhonha river (Fig. 1).

A sample of 39 specimens containing 12 males, 27 females and immature individuals of different instars was collected, giving a sex-ratio of 1 to 2.25 in favor of females. This is close to the sex-ratios observed in other species of *Tityus* (Lourenço, 1980). Detailed examination of all these specimens revealed few differences from the morphology of the parthenogenetic population. The pattern of coloration is very similar in both males and females, and in both sexual and parthenogenetic populations. The general morphology of the females is also similar in both the sexual and the parthenogenetic populations, with the exception of body size which seems to be slightly larger and bulkier in the sexual females. The general morphology of the males is quite different, however, from that of the females. The pedipalps are longer and more slender (Figs. 2, 3). The pectines are larger although the total number of teeth is almost the same in both sexes: males, 22–27; females, 22–26.

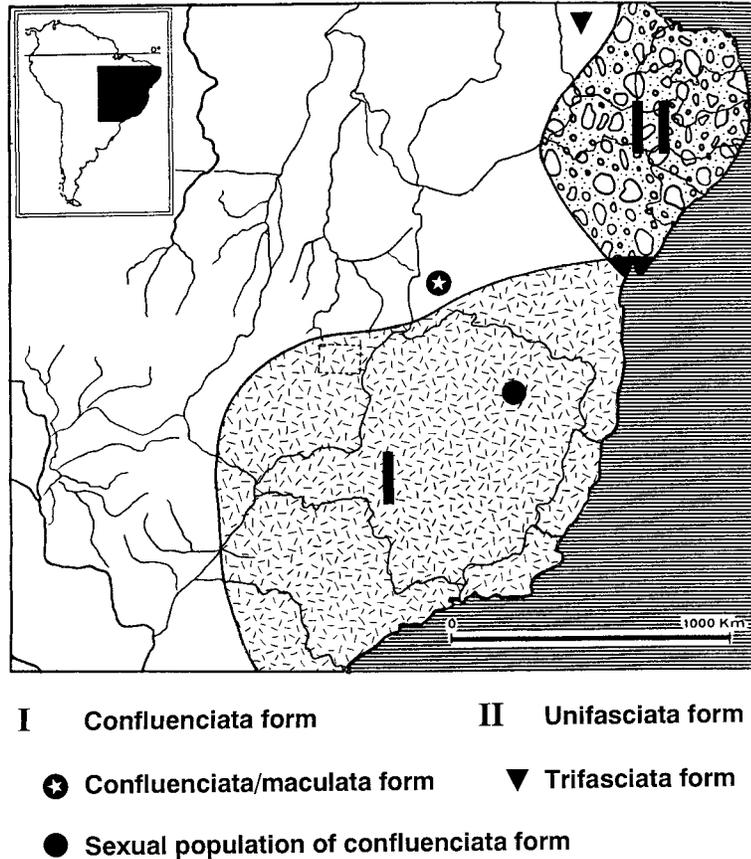


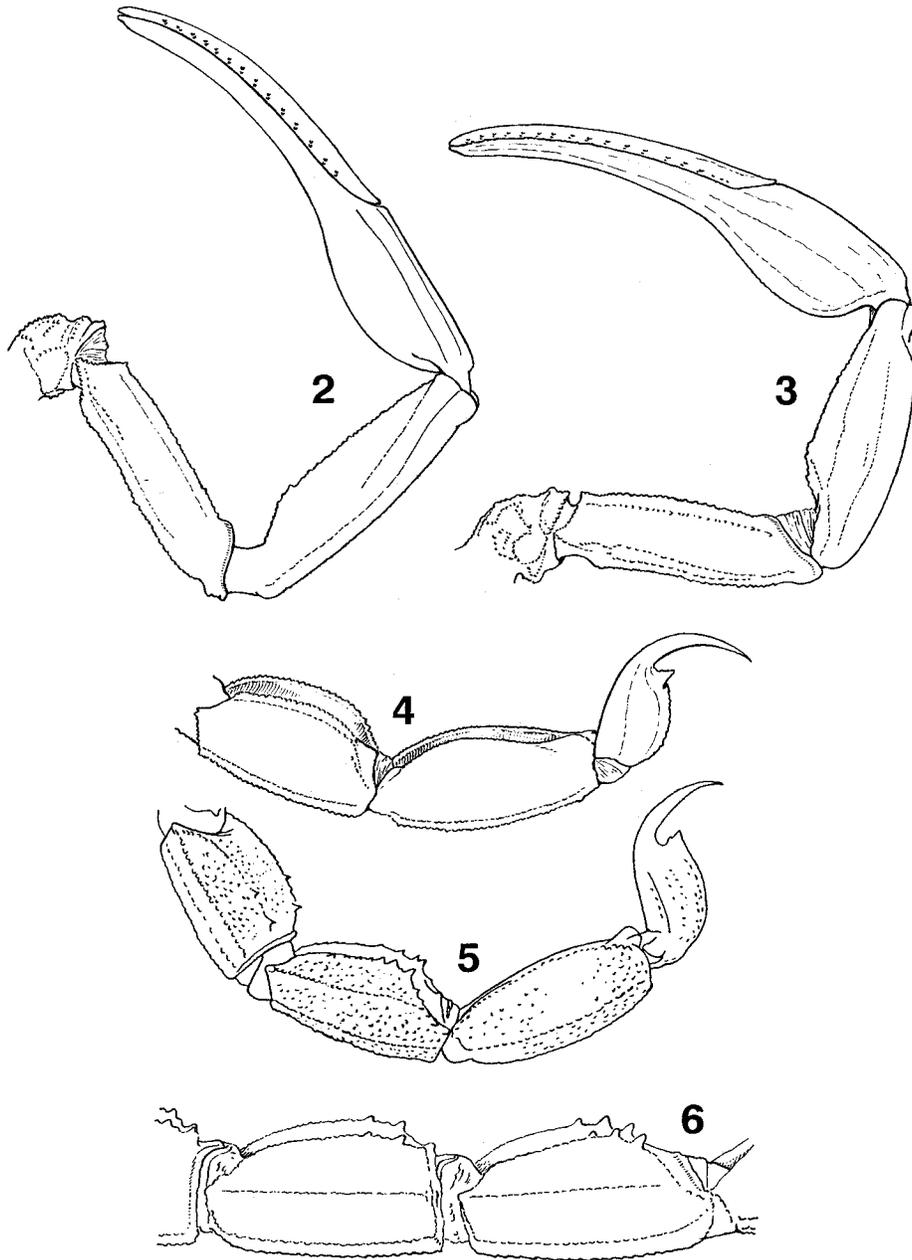
Figure 1.—Present geographical distribution of *Tityus stigmurus* (morph *unifasciata*) and *Tityus serrulatus* (morph *confluenciata*). The black represents the contact zone between the two populations. In detail, the localities where *Tityus lamottei* (morph *confluenciata/maculata*), morph *trifasciata* and the sexual population of *T. serrulatus* have been collected.

The first two differences characterize males of many species (Polis & Sissom 1990).

One major morphological difference was, however, observed between the sexual and parthenogenetic populations. The typical trait which characterizes the parthenogenetic population, as suggested by the Latin name "*serrulatus*", is the presence of granules modified as spines on the posterior region of the dorsal keels of metasomal segments III and IV. The number of spines varies from 2–10. In the sexual population, these spines were present in the immature instars, but disappeared after the last molt and were absent in adults (Figs. 4–6). This difference cannot yet be explained but is almost certainly associated with genetic differences between the two populations corre-

lated with their modes of reproduction. Further studies on the biology of the sexual population are required.

Diagnosis of the sexual *confluenciata* form.—Scorpions of medium size ranging from 55–70 mm in total length. General coloration yellowish. Metasoma: segments I to V yellowish with blackish lateral and ventral spots: 10-10-8-8-5 keels present. The dorsal keels of segments III and IV with the posterior granules modified as spines varying in number from 8–10, only present in immature instars; absent from adults. Dentate margins of pedipalp-chela fingers composed of 13–17 oblique rows of granules. Telson with a long curved aculeus; subaculear tooth strong and spinoid. Pectines with 22–27 teeth; slightly



Figures 2–6.—Morphological characters of sexual and parthenogenetic populations of the *confluenciata* form. 2, 3. Pedipalps in dorsal view of male and female sexual individuals showing dimorphism; 4. Metasomal segments IV, V and telson in lateral view of an adult sexual female showing the absence of typical spines; 5. Metasomal segments III to V and telson, in lateral view, of an adult parthenogenetic female population showing the typical spines; 6. Same with metasomal segments III and IV in detail.

greater than that observed in the parthenogenetic population (19–24) (see Lourenço & Eickstedt 1981).

For nomenclatural correctness, only the name *Tityus stigmurus* (Thorell 1877) should be retained, while *Tityus serrulatus* Lutz & Mello 1922 and *Tityus lamottei* Lourenço 1981 must be considered as junior synonyms of *Tityus stigmurus*. The designations *unifasciata*, *confluenciata*, *confluenciata/maculata* and *trifasciata* provide a practical way of identifying the different forms.

Phylogenetic work at the molecular level would be of great value for a better definition of the genetic relationships among the different forms of the *Tityus stigmurus* complex. A beginning has already been made and this molecular work is in progress with research teams in Mexico and Brazil.

ACKNOWLEDGMENTS

We are most grateful to Mr. Jacques Rebière, Laboratoire de Zoologie Arthropodes, for preparing several illustrations.

LITERATURE CITED

- Eickstedt, V.R.D. 1983. Escorpionismo por *Tityus stigmurus* no nordeste do Brasil (Scorpiones; Buthidae). Mem. Inst. Butantan, 47/48:133–137.
- Lourenço, W.R. 1980. Contribution à la connaissance systématique des scorpions appartenant au « complexe » *Tityus trivittatus* Kraepelin, 1898 (Buthidae). Bull. Mus. Natn. Hist. Nat., Paris, 4e sér., 2 (A3):793–843.
- Lourenço, W.R. 1981. Sur la systématique des scorpions appartenant au complexe *Tityus stigmurus* (Thorell, 1877) (Buthidae). Rev. Brasileira Biol., 41(2):351–362.
- Lourenço, W.R. (in press). A guide to the scorpions of Brazil. Mém. Soc. Biogéogr., Paris.
- Lourenço, W.R. & J.L. Cloudsley-Thompson. 1996. Effects of human activities on the environment and the distribution of dangerous species of scorpions. Pp. 49–60, *In* Envenomings and their treatments. (C. Bon & M. Goyffon, eds.). Edit. Fondation M. Mérieux, Lyon.
- Lourenço, W.R., J.L. Cloudsley-Thompson, O. Cuellar, V.R.D. von Eickstedt, B. Barraviera & M.B. Knox. 1996. The evolution of scorpionism in Brazil in recent years. J. Venom. Anim. Toxins, 2(2):121–134.
- Lourenço, W.R. & O. Cuellar. 1994. Notes on the geography of parthenogenetic scorpions. Biogeographica, 70(1):19–23.
- Lourenço, W.R. & O. Cuellar. 1995. Scorpions, scorpionism, life history strategies and parthenogenesis. J. Venom. Anim. Toxins, 1(2):51–62.
- Lourenço, W.R. & V.R.D. von Eickstedt. 1981. A propósito da indicação de um neótipo para *Tityus serrulatus* Lutz e Mello, 1922 (Scorpiones; Buthidae). Mem. Inst. Butantan, 44/45:181–190.
- Matthiesen, F.A. 1962. Parthenogenesis in scorpions. Evolution, 16(2):255–256.
- Maurano, H.R. 1915. O escorpionismo. These Facul. Medic., Rio de Janeiro.
- Mello-Campos, O. 1924. Os escorpiões brasileiros. Mem. Inst. Osw. Cruz, 17(2):237–363.
- Mello-Leitão, C. 1939. Revisão do gênero *Tityus*. Physis, 17:57–76.
- Pessôa, S.B. 1935. Nota sobre alguns escorpiões do gênero *Tityus* e *Bothriurus*. Ann. Paulista Méd. Cir., 29(5):429–436.
- Polis, G.A. & W. D. Sissom. 1990. Life History. Pp. 161–223, *In* The Biology of scorpions. (G.A. Polis, ed.), Stanford Univ. Press, Stanford.
- Vellard, J. 1932. Scorpions. *In* Mission scientifique au Goyaz et au Rio Araguaya. Mém. Soc. Zool. France, 29(6):539–556.

Manuscript received 3 April 1998, revised 6 September 1998.