

New evidence for a disrupted distribution pattern of the 'Tityus confluens' complex, with the description of a new species from the State of Pará, Brazil (Scorpiones, Buthidae)

by

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Abstract

The existence of a possible scorpion complex known as the 'Tityus confluens' complex is discussed once again in the present paper. The species *Tityus confluens* BORELLI, 1899 is native to Bolivia, Paraguay and Argentina. It has also been found in the States of Mato Grosso and Mato Grosso do Sul in Brazil. Recent studies have confirmed the existence of several additional species associated with this 'Tityus confluens' complex. Most of these are distributed in savannah (cerrado) areas of central Brazil, but one, *Tityus sylviae* LOURENÇO, 2005, was recently described from the upper Rio Negro region, in Brazilian Amazonia. This species was the first indication of a disrupted pattern of distribution within the complex. In the present paper, another new species, *Tityus marajoensis* n.sp., is described from the State of Pará, Brazil. It provides further evidence of a disrupted pattern of distribution. Some biogeographic comments are also added.

Keywords: Scorpion, 'Tityus confluens' complex, new species, Marajó Island, State of Pará, Brazil.

Resumo

É discutida mais uma vez no presente artigo, a provável existência de um complexo definido como 'Tityus confluens'. A espécie *Tityus confluens* BORELLI, 1899 é nativa da Bolívia, Paraguai e Argentina, tendo sido igualmente confirmada nos Estados de Mato Grosso e Mato Grosso do Sul no Brasil. Estudos recentes confirmaram a existência de diversas espécies adicionais igualmente associadas ao complexo 'Tityus confluens'. A maioria dessas espécies apresenta uma distribuição geográfica em áreas de vegetação aberta do tipo cerrado na região central do Brasil. Uma porém, *Tityus sylviae* LOURENÇO, 2005, descrita recentemente do alto Rio Negro aparece como uma exceção a essa regra. Esta espécie é o primeiro elemento indicador de um modelo de distribuição disjunta dentro do complexo. No presente artigo uma nova espécie, *Tityus marajoensis* n.sp., é descrita do Estado do Pará no Brasil. Ela confirma o modelo de distribuição disjunta do complexo. Alguns comentários biogeográficos são igualmente incluídos.

Introduction

As pointed out in previous publications (MAURY 1974; LOURENÇO 1980; LOURENÇO & SILVA 2006), *Tityus confluens* was originally described by BORELLI (1899) under the name *Tityus trivittatus confluens*, on the basis of a single female holotype collected at Caiza in the Bolivian Chaco, Bolivia, as well as one female and one juvenile paratype collected at Misione di San Francisco, alto Pilcomayo, Bolivia. After its description, this subspecies failed to attract the attention of many authors. Indeed, only MAURY (1974) proposed a full redescription. He raised the subspecies to species rank, as *Tityus confluens*. The study by MAURY (1974) was the first to be based on re-analysis of the type material, and his opinion was later confirmed by LOURENÇO (1980). In his monograph on South American scorpions, MELLO-LEITÃO (1945) had published a redescription of this subspecies, based on specimens collected in Iguaçu, in the State of Paraná, Brazil. This redescription incorrectly indicated that the type locality was Chaco, Argentina. Moreover, the characters redescribed by MELLO-LEITÃO (1945) do not agree with those of Borelli's types. As suggested by MAURY (1974) and confirmed by LOURENÇO (1980), the specimens used by MELLO-LEITÃO in his study almost certainly correspond with some other species, possibly *Tityus trivittatus* KRAEPELIN 1898.

The controversy regarding the presence of *Tityus confluens* in Brazil has been the subject of several publications. It has recently been revised and, to some extent clarified (see LOURENÇO & SILVA 2006). In more recent years too, the presence of *T. confluens* has been confirmed in several localities of the States of Mato Grosso and Mato Grosso do Sul (SILVA, unpubl. data). Furthermore, as do some other species of *Tityus* (see LOURENÇO & CLOUDLSEY-THOMPSON 1996; LOURENÇO et al. 1996) this species appears to show the ecological capacity necessary for it readily to become adapted to modified urban environments. For this reason, *T. confluens* is now to be found in several cities and towns of these two States, especially Cuiabá, Cáceres, and Campo Grande. The presence of *T. confluens* in numerous localities in the States of Mato Grosso and Mato Grosso do Sul is unquestionable (LOURENÇO et al. 2004). Its range of distribution has also been extrapolated by BERTANI et al. (2005) to include several others States of Brazil. This claim has, however, been shown undoubtedly to be fallacious. It has doubtless been engendered by lack of knowledge of the existence of a considerable number of species closely associated with *T. confluens* (see LOURENÇO & SILVA 2006). In recent years, several additional species have been added what is evidently a 'T. confluens' complex. Several of these have been described in the last few years (LOURENÇO 2003; LOURENÇO & SILVA 2006), while others have only recently been associated with the complex (LOURENÇO et al. 1997). The most unexpected discovery has been that of *Tityus sylviae* LOURENÇO (LOURENÇO 2005), a species described on the basis of specimens collected in the upper Rio Negro of occidental Brazilian Amazonia. This species can also be associated with *Tityus confluens*, but shows a totally disrupted pattern of distribution with regard to the other species of the complex. Another new species, also associated with the 'T. confluens' complex, is described below from campos areas in the Island of Marajó in the State of Pará, confirming thereby the disrupted pattern of distribution of the 'T. confluens' complex of species.

Methods

Illustrations and measurements were produced using a Wild M5 stereo microscope with a drawing tube and an ocular micrometer. Measurements follow STAHNKE (1970) and are given in mm. Trichobothrial notations follow VACHON (1974) and the morphological terminology mostly follows VACHON (1952) and HJELLE (1990).

Species associated with the 'Tityus confluens' complex

As already pointed out (LOURENÇO et al. 1997; LOURENÇO & Silva 2006), the first attempt at a revision of the genus *Tityus* was proposed by MELLO-LEITÃO (1931) when he mentioned a new species, *Tityus blaseri* MELLO-LEITÃO, of which he provided only a short description and a single rather poor photo. According to MELLO-LEITÃO, the type specimen on which the description was based consisted of a small (35 mm) female collected at Veadeiros, in the State of Goiás on the Central Plateau of Brazil. MELLO-LEITÃO (1931) included *Tityus blaseri* in the group of small scorpions defined as 'A-Group *Tityus clathratus* (KOCH)'. In his later monograph on South American scorpions (MELLO-LEITÃO 1945), *Tityus blaseri* was redescribed and again placed in the 'Tityus clathratus' group. Only in recent years have LOURENÇO et al. (1997) proposed a redescription of *Tityus blaseri*. This was based on fresh material collected in the region of Niquelândia in the State of Goiás, from a locality geographically very close to Veadeiros, the type locality. Moreover, the type material of *Tityus blaseri* was located in the Museu Nacional in Rio de Janeiro. Close examination of the type material, together with the specimens collected in Niquelândia, confirmed the identification of *Tityus blaseri*. The study also showed that *Tityus blaseri* does not belong to the 'Tityus clathratus' group, but is associated with *Tityus confluens* and its related species. Another species, also associated with *T. confluens*, is *Tityus uniformis*, described by MELLO-LEITÃO (1931), again from the State of Goiás. The status of this species remains unclear, however, since the types have been lost and the type locality was not clearly defined. It may perhaps be a junior synonym of *Tityus blaseri*, but further collecting will be necessary before a final decision can be made. More recently yet two other new species, *Tityus adrianoi* LOURENÇO (2003) and *Tityus paulistorum* LOURENÇO & SILVA (2006) were described respectively from the regions of the Serra do Cipo in the State of Minas Gerais and from the cerrados of the State of São Paulo. These two species should also be included in the 'Tityus confluens' complex.

The most unexpected event concerning species associated with the 'T. confluens' complex has been the discovery and description of *Tityus sylviae* by LOURENÇO (2005) in the upper Rio Negro region. This is a typical case of a disrupted biogeographic distribution within the species of the 'T. confluens' complex. This biogeographic pattern is now confirmed by the description of another species, this time from the Marajó Island in oriental Amazon region in Brazil.

Description of a new species from the State of Pará

Taxonomic treatment

Tityus marajoensis n.sp. (Figs. 1-9, Table 1)

Brazil, State of Pará, Ilha de Marajo, X/1973 (collected by local Indians; J.-B. LACROIX leg.) 1 female holotype, 1 female paratype. Deposited in the Muséum national d'Histoire naturelle, Paris.

Etymology: the specific name makes reference to the locality in which the new species was collected.

Diagnosis. Scorpions of medium size, the female having a total length of 49 mm. Coloration yellowish, with carapace and tergites reddish-brown to brown, much darker than appendages. Granulation

moderately marked throughout the body. Fixed and movable fingers with 15/17 rows of granules. All carinae moderately to strongly marked. Pectinal tooth count 19-20 in the female holotype and 19-19 in the female paratype; basal middle lamella not dilated; basal piece to the genital operculum strongly developed (Fig. 6). *T. marajoensis* n.sp. belongs to the subgenus *Tityus* (sensu LOURENÇO 2006) and to the 'Tityus confluens' complex of species.

Relationships

In its general morphology and pattern of coloration the new species shows affinities with *Tityus confluens* BORELLI from Argentina, Paraguay and Brazil and with *Tityus blaseri* MELLO-LEITÃO from Chapada dos Veadeiros in the State of Goiás. The distribution of the three species is, however, quite distinct. *T. blaseri* for example, inhabits a campo rupestre formation at altitudes ranging from 1000 to 2000 m, whereas the new species originated from a coastal campo formation, with an altitude averaging 0 to 100 m (EITEN 1978; MURÇA PIRES & PRANCE 1985). The following characters may be distinctive: (i) the chelicerae of the new species lack the variegated blackish spots which are present in both *T. confluens* and *T. blaseri* (Fig. 7), (ii) the tergites are divided by a yellow longitudinal strip, absent from the other two species, (iii) the basal piece to the genital operculum is remarkably developed in the new species, but reduced in the other two species (Fig. 6).

Description based on female holotype and female paratype

Coloration. Basically yellowish to slightly reddish-yellow. Carapace and tergites I to VI reddish-brown to brownish with a longitudinal yellowish strip over the tergites I to VI; tergite VII yellowish to reddish-yellow; eyes strongly marked with black pigment. Metasoma: segments I to V yellowish to reddish-yellow. Vesicle with the same colour as segment V; extremity of aculeus darker than vesicle. Venter yellowish-brown; genital operculum and pectines pale yellow. Chelicerae yellowish without any variegated dark pigmentation; fingers reddish; teeth reddish-brown. Pedipalps: yellowish; granulations on cutting edge of fingers reddish. Legs yellowish without any spots.

Morphology. Carapace moderately to strongly granular; anterior margin with a weakly marked median concavity. Anterior median superciliary and posterior median carinae moderate; all other carinae weak. All furrows moderately deep. Median ocular tubercle slightly anterior to the centre of the carapace. Three pairs of lateral eyes. Sternum triangular. Mesosoma: tergites moderately granular. Median carina strong in all tergites. Tergite VII pentacarinata. Venter: genital operculum larger than high; basal piece strongly developed. Pectines: pectinal tooth count 19-20 in female holotype, 19-19 in female paratype; basal middle lamellae of the pectines not dilated. Sternites with thin granulation and elongate stigmata; VI with vestigial carinae; VII with four carinae, moderate. Metasoma: segments I-II with ten carinae; lateral inframedian carinae on segment I complete, crenulate; on II represented by granules covering only the distal one fourth; segments III-IV with eight complete carinae; segment V with five carinae. Intercarinal spaces moderately granular. Telson, with some weakly marked granulations on ventral and lateral surfaces; aculeus long and strongly curved; subaculear tooth strong and spinoid with two dorsal teeth. Cheliceral dentition characteristic of the family Buthidae; ventral teeth on movable finger moderately marked; ventral aspect of both fingers and manus with long dense setae (VACHON 1963). Pedipalp: femur pentacarinata; patella with seven carinae; chela with nine carinae; all carinae moderate to strong; all faces weakly granular. Fixed and movable fingers with 15/17 oblique rows of

granules. Trichobothriotaxy; orthobothriotaxy A- α (alpha) (VACHON 1974, 1975). Legs: tarsus with numerous short setae ventrally. Pedal spurs moderate.

Biogeographical comments

The pattern of geographic distribution presented by *Tityus marajoensis* n.sp. and its associated species, *Tityus confluens*, *Tityus blaseri* and *Tityus sylviae*, suggests that these are allopatric species. *T. confluens* and *T. blaseri* inhabit similar landscape formations, respectively of the type Chaco / Pantanal-cerrado and campo rupestre which, however, belong to different categories according to EITEN (1978, 1982). Furthermore, their areas of distribution are separated by almost 1000 km of cerrado gradients which acts as a barrier. In contrast, *T. sylviae* inhabits forest formations in the upper Rio Negro possibly associated with Amazonian caatinga and campinarana. The present geographical pattern of disrupted distribution of the different species belonging to the 'T. confluens' complex suggests that in past times a contact zone probably existed between these today distinct populations. The present pattern of distribution is almost certainly the result of climatic vicissitudes in tropical South America during the late Cenozoic and Pleistocene (AB'SABER 1977a, b; PRANCE 1982; LOURENÇO 1986a, 1987, 1996).

Buthids show the widest distribution among the different scorpion families present in South America. They are present in almost all regions of the continent with the exception of the centre and South of Chile and Southern Argentina. Within the family Buthidae, the genus *Tityus* is the only one present in almost every geographical region and type of vegetation of South America. The genus *Ananteris* THORELL 1891, found mainly in South America but also in Africa, also presents quite a wide range, but most of the species are only present in small endemic patches between which there are many gaps. The genus *Rhopalurus* THORELL 1876 is typical of open vegetation formations in South America. Its core areas of distribution are the cerrados and caatinga formations of the central and North-eastern regions of Brazil. One species is known from a single enclave in a savanna formation inside oriental Amazonia, two others from the savannas of Roraima.

Several interesting examples of both genera and species presenting a discontinuous distribution can be observed among the scorpions exclusively adapted to savanna or rainforest. These examples have an important relationship with species endemic to present habitat islands of savanna in Amazonian enclaves and with forest islands inside xerophytic formations such as the Brazilian caatingas. These isolated endemic populations provide good evidence in support of the hypothesis of past connections between the savannas of central Brazil and the savanna enclaves in Amazonia and Gran-Sabana (Guayana region). When forest cover was reduced during past dry periods, open vegetation formations probably coalesced (AB'SABER 1977a, b; PRANCE 1982).

Scorpions provide strong evidence in support of this suggestion. Examples are provided by the genera *Rhopalurus* of the family Buthidae and *Opisthacanthus* of the family Liochelidae. *Rhopalurus*, a genus specifically adapted to open vegetation (savannas) in South America, is widely distributed from north-eastern and central Brazil to Guyana, Venezuela and Colombia, with some species present in the Greater-Antilles (LOURENÇO 1982). This genus probably exhibited a continuous distribution during Pleistocene dry periods and the present disrupted distribution is a possible consequence of the reestablishment of rainforest over the region. Evidence for this hypothetical

paleodistribution is provided by the species *R. amazonicus* LOURENÇO, 1986, endemic to savanna enclaves in Alter do Chão, State of Pará, Brazil (LOURENÇO 1986b). An analysis of the species of *Rhopalurus* demonstrated that *R. amazonicus* is phylogenetically closely related to *R. acromelas* LUTZ & MELLO, 1922 from central Brazil, distributed in a region close to the area of transition between cerrados and Amazonia. A similar example is provided by two allopatric species of *Opisthacanthus* PETERS, 1861. *O. cayaporum* VELLARD, 1932 is distributed among enclaved cerrado formations in the South of Brazilian Amazonia, while its sibling species, *O. heurtaultae* LOURENÇO, 1980 is known only from the coastal savannas of French Guiana. It is quite possible that these two species experienced contacts in the past, when the forested formations knew extensive regressions during dry episodes of the Pleistocene. With the expansion of wet forest these two populations were again isolated (LOURENÇO 1986a, 1987, 1996). This biogeographical model seems to fit well with the pattern of distribution observed today among the species associated with the 'T. confluens' complex.

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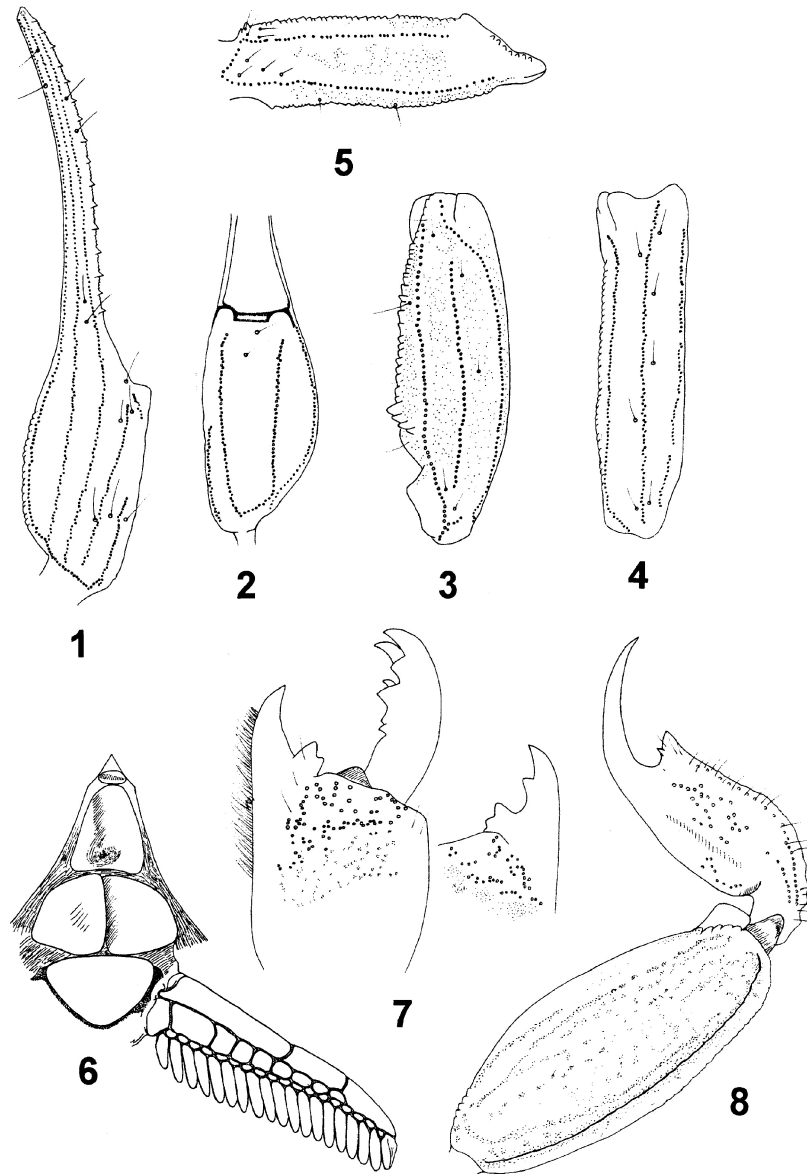
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Table 1: Morphometric values (in mm) of the female holotype of *Tityus marajoensis* n.sp., male and female of *Tityus blaseri* from Niquelândia, State of Goiás and, male and female of *Tityus confluens* from Mato Grosso do Sul, Brazil.

	<i>Tityus marajoensis</i> n.sp. ♀	<i>Tityus blaseri</i> ♂ ♀		<i>Tityus confluens</i> ♂ ♀	
Total length	49.1	55.6	44.3	49.3	47.4
Carapace:					
- length	6.1	6.8	6.2	6.0	6.0
- anterior width	4.2	4.6	4.1	4.0	4.1
- posterior width	6.5	7.4	6.4	6.0	6.1
Metasomal segment I:					
- length	3.8	4.7	3.8	4.0	3.8
- width	3.2	3.7	3.4	3.2	2.8
Metasomal segment V:					
- length	6.8	8.9	6.8	7.3	6.6
- width	2.9	4.2	2.8	3.5	2.4
- depth	2.9	4.2	2.7	3.3	2.4
Vesicle:					
- width	2.1	2.7	2.1	2.2	2.0
- depth	2.0	2.8	2.1	2.1	2.2
Pedipalp:					
- Femur length	6.3	7.1	5.9	6.6	6.4
- Femur width	1.9	2.1	1.8	1.6	1.7
- Patella length	6.8	7.7	6.3	7.0	6.9
- Patella width	2.2	2.7	2.3	2.2	2.2
- Chela length	11.6	13.9	11.2	11.7	11.2
- Chela width	2.2	3.9	2.2	3.1	1.9
- Chela depth	2.1	3.7	2.1	2.8	1.8
Movable finger:					
- length	7.6	8.8	7.6	7.6	7.7



Figs. 1-8:

Tityus marajoensis n.sp. female holotype. 1-5: Trichobothrial pattern. 1-2: Chela, dorso-external and ventral aspects. 3-4: Patella, dorsal and external aspects. 5: Femur, dorsal aspect. 6: Ventral aspect showing sternum, genital operculum, basal piece and pecten. 7: Right chelicera and fixed finger of left chelicerae, dorsal aspect. 8: Metasomal segment V and telson, lateral aspect.

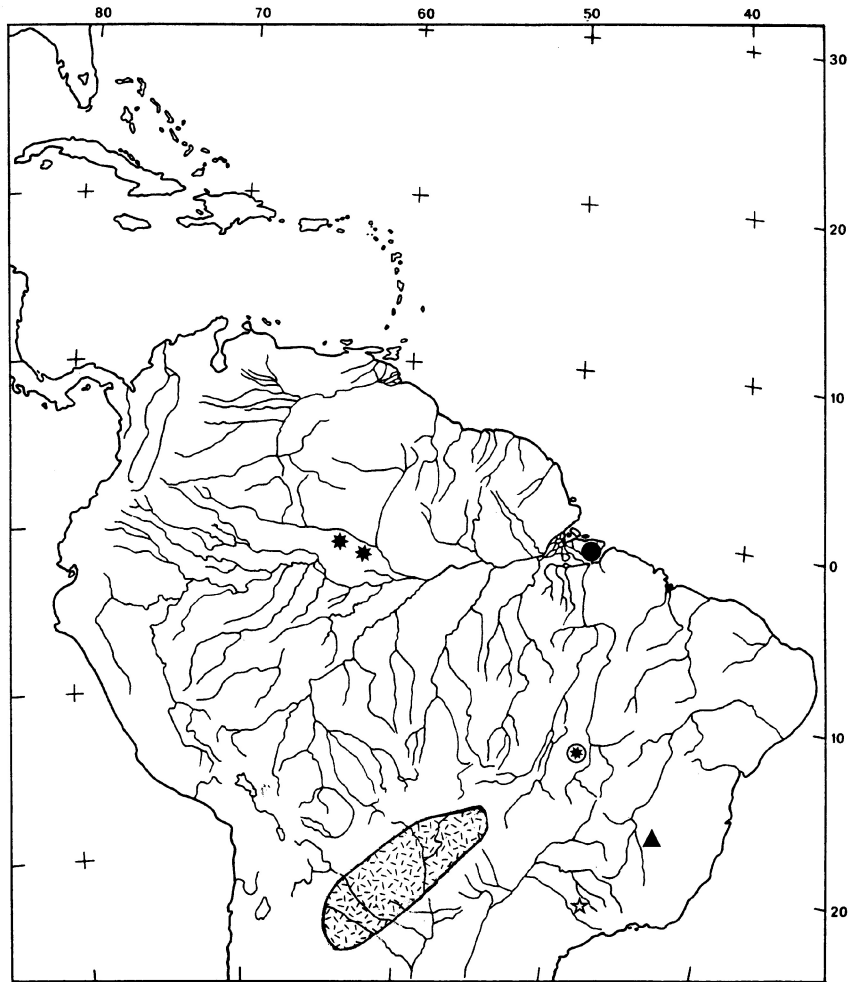


Fig. 9:
 Map of Central South America and Brazil showing the areas of distribution of the species associated to the 'Tityus confluens' group. *Tityus confluens* (shaded area). *Tityus sylvia* (black star). *Tityus blaseri* (open circle with black star). *Tityus adrianoi* (black triangle). *Tityus paulistorum* (white star). *Tityus marajoensis* n.sp. (black circle).