Implication of *Tityus apiacas* (Lourenco, 2002) in scorpion envenomations in the Southern Amazon border, Brazil

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Abstract

Herein, four cases of scorpion stings caused by *Tityus apiacas* recorded from the municipality of Apuí, in the southern region of the Brazilian Amazon, are described. Patients showed systemic clinical manifestations, described as unusual, involuntary, and generalized tingling and numbness, reported by patients as an *electric shock sensation*, lasting up to 24 hours after the sting. All patients described local pain and sensation, along with other clinical symptoms including local edema and erythema. Systemic manifestations were not life threatening. Antivenom therapy was administered to all patients, who were discharged without complaints.

**Keywords:** Scorpion sting. *Tityus apiacas*. Envenomation.

INTRODUCTION

Scorpion stings are a major health problem, notably in the African continent, the Middle East, Southern India, and Latin America, especially in Mexico, Brazil, the Guianas, and in Venezuela. Approximately 2 billion people live in at-risk areas for scorpion envenomation, occurring with a frequency of over 1 million annually worldwide[1]. In Brazil, a total of 727,113 cases of scorpion stings were recorded by the official surveillance system from 2000 to 2015, with an increasing trend, from 12,552 cases in 2000 (7.4 cases/100,000 inhabitants) to 74,598 in 2015 (43.2 cases/100,000 inhabitants)[2]. Incidence was higher in the northeastern region of the country, with a rate of 76.9 cases/100,000 inhabitants in 2015. In the same year, there were 21 and 9.9 cases per 100,000 in the Brazilian Amazon and the State of Amazonas, respectively[2].

Scorpion stings incidents show an extensive distribution in the Brazilian Amazon and represent a potential health problem for rural communities[3]. In this region, risk of developing severity was significantly higher in children and, interestingly, in stings occurring in the Apuí region of the Southern Amazon[3]. Unfortunately, there is scarce information on the regional scorpion fauna, as well as the differences in their toxicity. Sufficient taxonomical and distribution information is available for thirteen *Tityus* spp. reported for the State of Amazonas[4], and the species responsible for human envenomation were identified as *Tityus metuendus*, *Tityus mathieseni*, *Tityus bastosi*, and *Tityus silvestris*[5,6]. *Tityus obscurus* has been shown to cause severe stings in the Western region of the State of Pará[7]. *Tityus apiacas* is a scorpion species recorded in the Southern Amazon[4], but it has not been associated with envenomation in humans. Thus, the identification of venomous scorpion species is essential to guide future clinical studies and antivenom testing in affected regions, as well as studies of the biological activities of the venoms of Amazon noxious species.

This study aimed to describe four cases of scorpion stings recorded from the municipality of Apuí, in the Southern region of the State of Amazonas, Western Brazilian Amazon.

CASE REPORT

At the end of 2015, after observing a high clinical severity among scorpion stings occurring in the Southern Amazon, in the Apuí region[4], the local health secretariat requested for the Fundação de Medicina Tropical Dr. Heitor Vieira Dourado (FMT-HVD), the tertiary reference center for tropical diseases in the State of Amazonas, to identify four scorpion specimens that caused injuries in that municipality. Apuí is located in the Southern Region of the State of Amazonas, Western Brazilian Amazon (Figure 1), and comprises an area of 54,239.9km², approximately 408km from Manaus, the state capital.
The estimated population of the municipality was 20,258 inhabitants in 2014, with 41.2% living in rural areas. The original vegetation cover is mainly a dense evergreen rain forest. The climate is classified as the equatorial super-humid type, with rainfalls over 2,000mm per annum and average annual temperatures between 26°C and 28°C. The main economic activity is related to agriculture (coffee, banana, cassava, beans, soybeans, fruits, vegetables, and sugar cane), cattle breeding, fish farming, and forestry.

Scorpions were collected by the victims and are described in detail in the following section. They presented reddish-brown colorations, especially the older specimens, with some yellowish zones on the sternites. Metasomal segments I to V were blackish-brown, with 10-8-8-6(8)-5 darker carinae; there was absence of ventral carinae on the metasomal segment IV of male scorpions; telson paler than segment V. There were dentate margins of pedipalp-chela fingers with 16 oblique rows of granules. A strong spinoid subaculear tooth was present, with two dorsal granules. There were pectines with 18 to 20 teeth and the basal middle lamellae dilated in female scorpions. Male pedipalps were longer and more slender than the female pedipalps. Based on these morphological characteristics, and also on previous data regarding spatial distribution of scorpion fauna in the Brazilian Amazon4, the specimens collected by the victims were identified as two young female, one of an adult male, and one of an adult female of Tityus apiacas (Figure 2).

Identification was made by one of the authors (Fé NF), in the Department of Entomology of the FMT-HVD, and confirmed by two specialists of the Instituto Butantan (Drs. Denise Maria Candido and Andria de Paula Santos da Silva). Specimens were fixed in ethanol 70% to be part of the arthropods collection of the FMT-HVD.

Medical records from the Apuí Municipality Hospital were reviewed, with the clinical aspects of the proven T. apiacas cases shown in Table 1. In common, all accidents occurred in rural settings, and most patients were in labor activities. The time elapsed between the scorpion sting and hospital admission was relatively short (less than 3 hours). All patients referred local pain and sensation of electric shock, which started almost immediately after the sting. Other clinical symptoms at admission to the emergency hospital included local edema and erythema. Systemic manifestations were relatively mild and not life threatening; thus, all patients were considered moderately envenomed, according to the Brazilian Ministry of Health guidelines. All remained hemodynamically stable. Antivenom therapy was given to all patients in doses corresponding to moderate envenomation, after pre-medication with IV hydrocortisone and IM promethazine. None presented early reactions to antivenom immunoglobulins. Hematologic and biochemical laboratory tests were not carried out and all patients were discharged without complaints.
FIGURE 2 - Scorpion specimens of Tityus apiacas collected by the patients identified as sting agents in the study area.

TABLE 1
Demographic and clinical aspects of patients bitten by Tityus apiacas in Southern Amazon.

| Case | Age (years) | Gender | Time from sting to hospital admission | Site of sting | Symptomatology of envenomation | Antivenom therapy | Supportive treatment | Outcome | Identification of the agent |
|------|-------------|--------|--------------------------------------|---------------|--------------------------------|------------------|--------------------|---------|---------------------------|
| A    | 55          | Male   | 3h                                   | Right hand   | Immediate local pain, *electric shock sensation*, local erythema, sweating, tremors | 2 vials*        | IV dipyrene         | Discharge 48h after sting | Tityus apiacas, 42mm young female (Figure 2A) |
| B    | 10          | Female | 40 min                               | Right foot   | Immediate local pain, *electric shock sensation*, local erythema, vomiting, diarrhea, palor, tremors, myosis | 2 vials**       | IV analgesics        | Discharge 72h after sting | Tityus apiacas, 55mm young female (Figure 2B) |
| C    | 48          | Female | 3h                                   | Finger of right hand | Immediate local pain, *electric shock sensation*, local edema and erythema, tremors | 2 vials*        | Not referred         | Discharge 48h after sting | Tityus apiacas, 85mm adult male (Figure 2C) |
| D    | 13          | Female | 1.5h                                 | Right foot   | Immediate local pain, *electric shock sensation*, local edema, sweating, tremors, agitation | 2 vials*        | Not referred         | Discharge 48h after sting | Tityus apiacas, 80mm adult female (Figure 2D) |

* Tityus antivenom. **Loxosceles and Phoneutria spiders and the Tityus scorpion antivenom.

Ethical considerations
This study was approved by the Ethics Review Board of the Fundação de Medicina Tropical Dr. Heitor Vieira Dourado (approval number 872.520/2014).

DISCUSSION
In the present study, we report four cases of human envenomation caused by T. apiacas in the Amazon region. The most frequent species involved in human stings are referred as being T. obscurus, Tityus silvestris, and T. metuendus, probably owing to their large geographical distribution in the Amazon basin; whereas Tityus apiacas Lourenço, 2002, has a Southern distribution in Amazonia, South of the Rio Solimões/Amazonas in the States of Amazonas, Mato Grosso and Pará, Brazil. These species belong to the group Tityus asthenes, and it is closely related to T. obscurus and Tityus dinizii, thus potentially leading to a misidentification between T. apiacas and...
T. obscurus. Both species are usually dark-colored, and large, from 75 to 100mm in total length when adult⁶.

Clinical manifestations in our scorpion-envenomed patients are similar to those described for some moderate T. obscurus envenomations and diverse from those reported in other Brazilian regions, specifically Tityus serrulatus scorpion stings⁸, which have a distinct spectrum of symptomatology when compared with the other scorpions in the Amazon. Patients stung by T. apiacas showed systemic clinical manifestations, described as unusual, involuntary, and generalized tingling and numbness, affecting mainly the trunk and both legs that prevented walking or holding objects. Reported by patients as an electric shock sensation, this set of symptoms lasted up to 24 hours after the sting. However, other neurological manifestations described in T. obscurus envenomation, such as myoclonia, dysmetria, dysarthria, and ataxia⁷ were not recorded, although specific neurological examination were not performed and therefore these neurological issues could be present to some extent. This may be owing to differences in venom composition. Oddly, there are no studies on the composition and mechanism of action of T. apiacas venom.

The rapid onset of the clinical manifestations as herein reported corroborates experimental studies of the pharmacokinetics of scorpion venom injection, demonstrating rapid venom absorption¹⁰. These findings indicate the importance in the recognition of risk groups and early intervention.

To better understand the effects of T. apiacas and other Amazonian scorpion venoms, studies should be carried out to evaluate the Tityus antivenom for clinical use in the Amazon. In the process of this antivenom production, horses are immunized by antigens from T. serrulatus venom, thus purifying specific antibodies from the hyperimmune plasma¹¹. For the treatment of systemic scorpion envenomation, two types of antivenoms are available in Brazil and are equally distributed throughout the country: Tityus antivenom and Loxosceles, Phoneutria, and Tityus antivenom. Both products have the same in vivo potency specification and use the same production process involving T. serrulatus venom as an antigen to immunize horses. Therefore, it is fundamental to assess the potential differences in toxin antigenic cross-reactivity between Amazonian species and the prevalent of antivenom produced in Brazil, as well as to establish the ideal therapeutic approach for these scorpion stings. Nevertheless, it is always important to consider symptomatic treatment to treat painful symptoms, and to prevent systemic complications. As used in the four cases, oral or parenteral analgesics are important since pain is frequent and sometimes intense. Local anesthesia should not be used, since local injection of anesthetics could exacerbate muscle spasms, responsible for the electric shock sensation. Our data are not conclusive regarding the efficacy of antivenom in reversing systemic envenomation. Differences in the venom composition and the spectrum of envenomation may also hamper comparisons with the outcome of patients stung by T. apiacas and T. serrulatus. Nevertheless, it is noticeable that all patients described a consistent tingling and numbness that subsided only after 24 hours of medical observation, as in T. obscurus envenomation. However, antivenom reverse scorpion envenomation lasted up to two hours after specific therapy in T. serrulatus scorpion stings¹². In vivo experiments and randomized clinical trials should assess if the commonly available antivenom in Brazil can effectively resolve the clinical neurotoxic manifestations associated with envenomation by scorpions of the Amazon.

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Conflict of interest
The authors declare that have no conflicts of interest.

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