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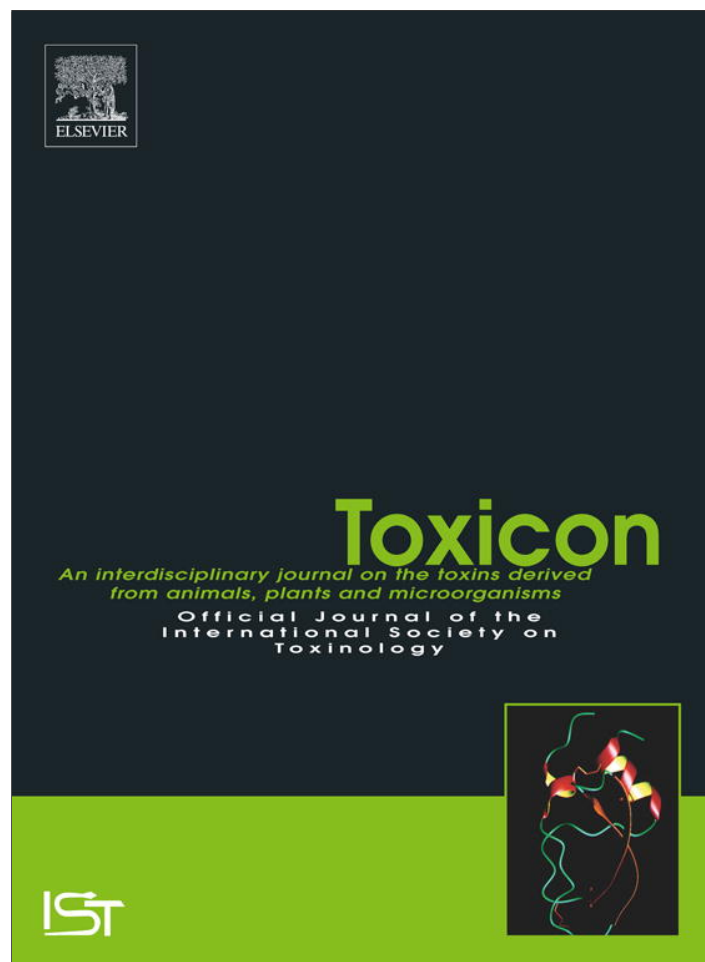


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Clinico-epidemiology of stings and envenoming of *Hottentotta tamulus* (Scorpiones: Buthidae), the Indian red scorpion from Jaffna Peninsula in northern Sri Lanka



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ABSTRACT

In recent years, stings of a lethal scorpion species were recorded from Jaffna Peninsula in the northern dry zone of Sri Lanka. This species was identified as *Hottentotta tamulus* (Scorpiones: Buthidae) which is the Indian red scorpion commonly found in Maharashtra, India. The Teaching Hospital, Jaffna recorded 84 *H. tamulus* stings over a year in 2012 and of them, 23 cases provided offending scorpions (proven cases). Three localities in Jaffna were recorded as hotspots of scorpion stings namely Palali, Achchuvali and Karainagar. Of the proven cases, 13 (57%) and 10 (43%) were males and females respectively and had a mean age of 30 years (SD ± 20 years). Among them, 5 (22%) were children below 12 years. In 13 (57%) patients stings occurred inside their houses including two children (40%). Six (26%) stings occurred at night when the victims were in sleep. Median time taken to arrive at the hospital from the time of stinging was 58 min (range 8–550 min). Signs of over activation of autonomic nervous system predominated the clinical picture—tachycardia in 14 (61%), high blood pressure in 11 (48%), excessive sweating in 9 (39%), excessive salivation in 5 (22%), hypotension in 4 (17%) and piloerection in 3 (13%). Children showed higher predilection to develop tachycardia – 4 (80%) and excessive salivation – 3 (60%). Priapism was not observed and 17 (74%) patients have developed intense pain at the site of sting. The commonest ECG change was tachycardia (73%) and occasional T wave inversion. Prazosin as a treatment was given to 22 (96%) patients. All patients made recovery and 13 (57%) patients left the hospital within two days. In future, there is a potential risk of spreading this species to elsewhere in the country and may disturb the ecological balance.

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1. Introduction

Although, Sri Lanka is considered as one of the biologically most diverse countries in Asia (Davis and Haywood, 1994), its scorpion fauna remains as a poorly studied group. In the past scorpion stings were considered trivial, but currently it has attracted attention as scorpion stings in the northern part of Sri Lanka (especially in Jaffna District) were causing severe envenoming. Northern territory of Sri

Lanka remained inaccessible to medical researchers until 2009 due to the war which ravaged the region over three decades. Thus, the problem of scorpion stings remained hibernating until the clinicians in the Teaching Hospital Jaffna (THJ) brought it to the notice of researchers for identification of the offending species of scorpion. The people and the medical professionals in the area named this offending scorpion as 'White Scorpion' (Fig. 1) as they thought it has a lighter color compared to commonly found 'Black Scorpions' (mainly the *Heterometrus* species, also commonly called a giant forest scorpion) (Fig. 2) in the country. There were neither published literatures nor personal experience of 'White Scorpion' stings in Jaffna peninsula during pre-war and war period.

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Fig. 1. *Hottentotta tumulus* (Fabricius, 1798), male in its natural habitat.



Fig. 2. *Heterometrus gravimanus* (Pocock, 1894), ("Black scorpion").

Therefore, concerted team effort was taken to identify the offending species in 2012. Ranawana et al. (2013) in the first report of this scorpion described its distribution in Jaffna district (Fig. 3) and identified it as *Hottentotta tumulus* (Family: Buthidae) or commonly known as Indian red scorpion.

The Indian red scorpion was popularly named as *Mesobuthus tamulus* and has been subjected to taxonomic revision and renamed as *H. tamulus* (Kovařík, 2007). There is a possibility of introduction of this species inadvertently to Jaffna from India by movement of goods during the long civil war or possibly during IPKF (Indian Peace Keeping Force) occupation of Jaffna between 1987 and 1990.

At present the scorpion stings are a frequent cause of admission to THJ. Unaccounted epidemiology found children and house wives as the common victims and many stinging were occurring inside houses where scorpions are found even among clothes and mats. Incidence of severe envenoming with features of autonomic over activation was common. Even though, fatalities were not uncommon in past, there were no deaths from 2009 with the use of alpha-adrenergic blocker, prazosin as a treatment. This background prompted us to document epidemiological and clinical data of patients coherently to understand a clear picture. This study describes the epidemiology, clinical manifestations and outcome of *H. tamulus* stings in northern Sri Lanka.

2. Materials and methods

2.1. Settings

We conducted a prospective observational hospital-based study of scorpion stings in the Teaching Hospital Jaffna in the Northern Province of Sri Lanka over a period of one year from January 2012 to February 2013. All patients with a history of scorpion stings were included in the data collection. The Jaffna district (9° 40'N 80° 00'E) is the northern most land of Sri Lanka, 396 km away from the capital city, Colombo. Jaffna peninsula is made of lime stones, land mass is flat at sea level and belongs to the dry zone of the island with the mean annual rainfall of 1200 mm and its average temperature ranges from 19 to 36 °C. The land area of the Jaffna district

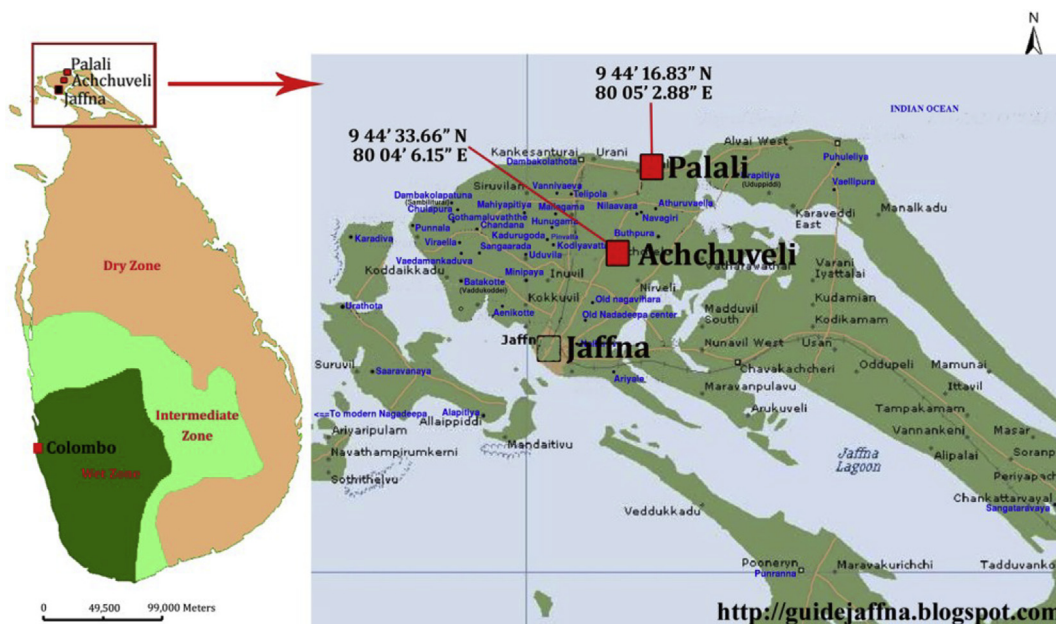


Fig. 3. Collection sites of *Hottentotta tumulus* from the Jaffna Peninsula. (Source: Ranawana et al., 2013).

is 1114 square km and comprises the major part of the peninsula and small islands (islets) on the western side of it (Fig. 3). Central part of the district is rich with very fertile red soil whilst coastal areas and the neighboring islands have sparse vegetation in the sandy soil.

2.2. Identification of scorpions

The offending scorpions (living or dead) brought along with patients were provisionally identified and were transported to the Department of Zoology, Faculty of Science, University of Peradeniya for definitive identification using a standard taxonomic keys (Ranawana et al., 2013). Their length was measured, sex was identified, labeled and cataloged. Both live and dead specimens were photographed, and a photo catalog of specimens is maintained for comparative work. Total length of the specimens ranged from 50 to 90 mm and all had uniformly yellow to reddish body color.

2.3. Clinical assessment and treatments

Clinical assessment included a detailed history on admission comprising time of sting, geographical place, site of sting in the body, time taken to arrive at hospital, treatment given at the local hospital and symptoms of envenoming. Patients were examined for physical signs both local and systemic envenoming. Further assessment included measurement of urine output, vital parameters, blood counts, serum electrolytes, serum creatinine and regular ECGs. Patients were managed according to a protocol adopted by the clinicians in the hospital, based on published treatment literature from India (Bawaskar and Bawaskar, 1992, 2012).

2.4. Statistical analysis and preparation of figures

The data were computerized and analyzed using the statistical software, SPSS version 10 (SPSS, 1997, Chicago, USA) and described using proportions and percentages. The digital maps of Sri Lanka and the Northern Province were prepared with the assistance of the Department of Zoology, University of Peradeniya according to standard scales. The vital statistics of Jaffna district were obtained from the District Secretariat and Meteorological Department, Thirunelvely.

3. Results

There were 90 cases of hospital admissions with a history of scorpion stings over 12 months. Of them, in 84 cases, offending scorpion was *H. tamulus* and others were mainly stung by black scorpions. In 23 cases of *H. tamulus* stings, the offending scorpions were available for identification (proven cases) and in the rest (*n*, 61) the victims or witnesses have seen the offending scorpions but were not able to catch them. Comparison of clinical features between these two groups showed no significant difference (Table 1).

3.1. Epidemiology

Three localities in Jaffna were recorded as hotspots of scorpion stings namely Palali, Achchuvali and Karainagar in the main land where most of the stings have occurred. There were no cases reported from the neighboring islands in the peninsula (Fig. 3). These scorpions were found inside the compounds and also close to human dwelling among leaf litter, logs, and piles of firewood. Of the proven cases, 13 (57%) and 10 (43%) were males and females respectively and had a mean age of 30 years (SD ± 20years). Among them, 5 (22%) were children below 12 years. All stings were non-

Table 1

Comparison of clinical features between patients presented with the offending scorpion specimens (confirmed cases, *n*, 23) and without specimens (*n*, 61) groups.

Clinical feature	Patients presented with specimen <i>n</i> (%)	Patients presented without specimen <i>n</i> (%)	<i>P</i> value ^a
Tachycardia	14 (61)	45 (74)	0.249
Bradycardia	2 (9)	0	–
Hypertension	11 (48)	27 (44)	0.77
Hyperthermia ^b	1 (4)	1 (2)	–
Pulmonary edema	0	1 (2)	–
Diaphoresis	9 (39)	19 (31)	0.489
Piloerection	3 (13)	13 (21)	0.39
Hypotension ^c	4 (17)	6 (10)	0.34
Salivation	5 (22)	17 (28)	0.569
Lacrimation	0	4 (7)	–
Incontinence	0	2 (3)	–
Local reaction			
Pain	23 (100)	61 (100)	–
Erythema	16 (70)	45 (74)	0.7
Induration	12 (52)	34	0.77
Wheal	3 (13)	0	–

^a Chi square and Fisher's exact test.

^b Body temperature – 41 °C or above.

^c Systolic blood pressure below 90 mmHg.

provocative and in 13 (57%) patients stings occurred inside their houses. Of the five children, two (40%) were stung inside the compounds. Stings have occurred throughout the day with two peaks, 6.00 am to 12.00 noon 10 (43%) and 6.00 pm to mid night 8 (35%). Interestingly, 6 (26%) of the inside house stings occurred at night. Some of the victims were sleeping at that time. The offending scorpions were very often found in bed linen, cloths, mats and furniture at the time of stinging. The site of stinging included fingers and arms in 10 (43%) cases, lower limb in 12 (52%) cases and the back of the chest in one case (Table 2).

Median time taken to arrive at the hospital from the time of stinging was 58 min (range 8–550 min). Of the total, 13 (57%) and 18 (78%) patients have arrived the hospital within 1 h and 3 h respectively. The time taken to arrive at hospital was not dependent on either age of the patient or time of stinging (Table 3). All the patients on admission had evidence of envenoming either local or systemic manifestations.

3.2. Clinical manifestations

Signs of over activation of autonomic nervous system predominated the clinical picture-tachycardia in 14 (61%), high blood pressure in 11 (48%), excessive sweating in nine (39%), excessive salivation in five (22%), hypotension in four (17%) and piloerection in 3 (13%). Children showed higher predilection to tachycardia – 4 (80%), excessive salivation – 3 (60%) and hypotension – 2 (40%). Priapism was not observed in any patient despite careful examination. Upon sting, 17 (74%) patients have developed intense pain at the site of sting followed by numbness and 16 (70%) patients had local erythema (Table 4).

Table 2

Site of sting versus place of sting.

Site of sting	Place of sting		Total
	Inside home	Outside home	
Hands including fingers	5	5	10
Legs-below knee	7	5	12
Back of the chest	1	0	1
Total	13	10	23

Table 3
Sting to hospital admission time versus age categories and time of sting.

Description	Sting to admission time				Total
	Within 1 h	1–2 h	2–3 h	>3 h	
<i>Age categories (years)</i>					
≤12	4	0	1	0	5
12–60	9	1	2	5	17
>60	0	0	1	0	1
<i>Time of sting</i>					
Mid night–6.00 am	0	0	0	2	2
6.00 am–12.00 noon	4	1	3	2	10
12 noon–6.00 pm	3	0	0	0	3
6.00 pm–mid night	6	0	1	1	8

Clinical picture of primary sympathetic over activity was evident in 10 (43%) patients, primary parasympathetic over activity in 2 (9%) and overlapped autonomic activity in 6 (26%) patients (Table 5). About 5 patients had co-morbidities such as hypertension (2, 9%), ischemic heart disease (1, 4%) and bronchial asthma (2, 9%). One patient gave a history of atopy and allergy. There were no specific abnormalities in basic blood counts and biochemical tests (Table 6). The commonest ECG change was tachycardia (35%) and had occasional T wave inversion.

3.3. Severity and management

Different levels of clinical severity of the cases were as follows – local reaction only in 5 (22%) mild systemic envenoming in 14 (61%) patients and severe systemic effects in 4 (17%) patients. Prazosin was given to 22 (96%) patients. Those who developed severe envenoming needed inotropic support and managed in the intensive care unit. Local pain was treated with local application of lignocaine gel in 15 (65%) cases. All patients made recovery and 13 (57%) patients left the hospital within 2 days.

4. Discussion

We studied 84 cases of *H. tamulus* stings within a year from northern Sri Lanka and described the clinico-epidemiology of 23 proven cases where offending scorpions were available for

Table 4
Comparison of clinical manifestations between the two age groups: Age ≤12; n = 5, Age >12; n = 18.

Clinical manifestation	Patients with age ≤12 years (n, %)	Patients with age >12 years (n, %)	Total (n, %)
Tachycardia	04 (80)	10 (56)	14 (61)
Bradycardia	0	2 (11)	2 (9)
Arrhythmia	0	0	0
Hypertension	1 (20)	10 (56)	11 (48)
Hyperthermia	0	1 (6)	1 (4)
Pulmonary edema	0	0	0
Diaphoresis	1 (20)	8 (44)	9 (39)
Piloerection	1 (20)	2 (11)	3 (13)
Hypotension	2 (40)	2 (11)	4 (17)
Salivation	3 (60)	2 (11)	5 (22)
Lacrimation	0	0	0
Incontinence	0	0	0
Pharyngeal spasms	0	0	0
<i>Local reaction</i>			
Mild pain	1 (20)	3 (17)	4 (17)
Moderate pain	1 (20)	1 (6)	2 (9)
Severe pain	3 (60)	14 (78)	17 (74)
Erythema	3 (60)	13 (72)	16 (70)
Induration	3 (60)	9 (50)	12 (52)
Wheal	1 (20)	2 (11)	3 (13)

Table 5
Pattern of the activation autonomic nervous system.

Component	Number of patients (n, %)
Primary sympathetic over activity ^a	10 (43)
Primary parasympathetic over activity ^b	2 (9)
Activation of both components simultaneously	6 (26)

^a Evidence for sympathetic over activity: tachycardia, hypertension, piloerection, urinary/faecal incontinence.

^b Evidence for parasympathetic over activity: bradycardia, hypotension, salivation, lacrimation.

identification. Currently, it is an emerging health issue confined only to the mainland of Jaffna, but a potential risk exists for spreading to other regions of the country. Most of the stings happened inside human dwellings irrespective of age or genders of the victims. Highest incidence of stings inside compounds happened at night and offending scorpions were found in bed linen, cloths, mats, underside of furniture and in dark recesses. Severe local pain is a common finding and the clinical picture tallies with the over activation of autonomic nervous system. The common manifestations were tachycardia, excessive sweating and hypertension whilst children had high incidence of tachycardia and excessive salivation. In some cases these manifestations were life threatening. Currently, more work on scorpion fauna are carried out in Jaffna peninsula of Sri Lanka (Veronika et al., 2013) Similar to India, *H. tamulus* is a killer scorpion in Sri Lanka as it has caused many unaccountable numbers of deaths before 2009 (personal experience of Dr. S. Sivensuthen). Unpublished retrospective audit of pediatric admissions to THJ from 2000 to 2009 has found 34 deaths due to “white scorpion stings” (communication of Dr. NP Dinamithra). In India, some reports claim that the mortality rate due to Indian red scorpion stings before wide use of prazosin and calcium channel blockers was about 30% and with the current treatments it has come down to 2–3% (Bawaskar and Bawaskar, 1992, 2007, 2012).

Scorpion stings are common in many regions of the world such as Africa, Latin America, China, India and Middle East, causing about 1.5 million envenoming and 2600 deaths. There are more than 1500 species of scorpions in the globe and of them, more than 30 belong to the family Buthidae (Chippaux, 2012; Natu et al., 2006). India alone has 99 species and family Buthidae is leading, to which, Indian red scorpion belongs (Radhakrishnamurthy, 2000). With this latest development, Sri Lanka qualifies to enter the list of countries where scorpion envenoming is common. We found distinctive epidemiological features from emerging scorpion stings in Sri Lanka such as geographical distribution of cases, stinging pattern, their habitat and behavior. The children are at special risk as many stings happening at night inside houses. Scorpion is a prolific breeder and we observed one clutch containing more than 50 offspring and the mother *H. tamulus* exhibiting cannibalism (experience of Dr. NP Dinamithra). Epidemiological facts of stings of many species of scorpions have similarities and dissimilarities (Chippaux, 2012; Bawaskar and Bawaskar, 1992, 2007, 2012; Ulug et al., 2012). It is important to use this knowledge to develop preventive strategies against scorpion stings and to develop protocol of

Table 6
Basic investigation findings.

Parameter	Number of patients	Mean (SD)
Hemoglobin	7	12.8% (2.2)
Leukocyte count	7	8.7 × 10 ⁹ /L (3.6)
Platelet count	7	252 × 10 ⁹ /L (51.8)
Serum Na+	10	142.6 mmol/L (4.9)
Serum K+	10	4.3 mmol/L (0.6)

health education. We found that the people are aware of importance of coming to hospitals soon and they have reached hospital within few hours. Similar trend has been observed in other parts of the globe contributing for reduction of overall mortality (Chippaux, 2012).

Classical picture of over activation of autonomic nervous system explains the clinical picture of our patients in par with the knowledge of scorpion envenoming in the globe (Chippaux, 2012; Bawaskar and Bawaskar, 1992, 2007, 2012). However, none of the patients had priapism which is a common finding of Indian red scorpion envenoming in India (Bawaskar and Bawaskar, 1992, 2007, 2012). So comparative studies between Sri Lanka and India would be important and may find some more differences to arouse curiosity for further research. Either multiple organ dysfunction or metabolic derangements were not found in our patients, whilst these manifestations were described in the literature in other species of scorpion stings (Chippaux, 2012; Gonçalves et al., 2012; Cavari et al., 2013). Indian literature documents myocarditis, myocardial ischemia and pulmonary edema in Indian red scorpion stings and they have identified a high molecular weight pulmonary edema producing toxin (PoTx) from the scorpion venom (Dutta and Deshpande, 2011). In our series, only one patient developed pulmonary edema. We observed high incidence of hypotension and excessive salivation in children advancing to life threatening envenoming. It is a common observation that children have higher fatality rate than adults in scorpion envenoming (Chippaux, 2012; Uluğ et al., 2012).

There are diverse studies on venom of scorpions done over decades have unraveled many questions of envenoming. Data are available on venom composition, toxicity, action and properties from different regions of the globe. It is understood that venom toxins acting on ion channels particularly sodium channel results in strong depolarization of cell membrane (Bosman and Tytgat, 2007; Meves et al., 1986). This results in release of neurotransmitters which stimulate adrenergic and cholinergic pathways leading autonomic storm (Chippaux, 2012). Action of catecholamines and kinins said to cause cardiac ischemia with obvious ECG changes (Chippaux, 2012) that would explain some ECG changes observed in the present study. We hope this study would be an eye opener for Sri Lankan scientists to take up venom studies of *H. tamulus* in future. Currently, toxinologists in many laboratories are exploring to use scorpion venom for therapeutic drug development and to understand physiology of ion channels (Chippaux, 2012).

Even though, alpha blocker, prazosin is used heavily today, there is no guarantee that it would be the ideal treatment. Immunotherapy is the novel concept that in many countries anti-scorpion antivenoms are found to be superior (Chippaux, 2012). The same facility is available in India against Indian red scorpion venom. In fact, there are control studies comparing efficacy of anti-scorpion antivenom versus conventional treatment methods in India (Bawaskar and Bawaskar, 2007; Natu et al., 2006). These studies have demonstrated the superiority of antivenom over prazosin. In the context of Sri Lanka, antivenom is an option for future.

5. Conclusions

In conclusion, we described the epidemiology and clinical manifestations of *H. tamulus* stings in northern Sri Lanka. This description may help clinicians in managing their patients and would generate interest in research in this field. Furthermore, concerted collaborative research between Sri Lanka and India would help to understand more about the envenoming of *H. tamulus* and to develop new treatment methods.

Ethical statement

Ethical clearance was obtained from the Ethical Clearance Committee, Faculty of Medicine, University of Jaffna.

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None.

Authors' contribution

SAMK and SS conceived the idea and supervise the study; NPD, BT, VK did data collection; KBR did identification scorpions; KW did analysis of data; SAMK drafted the paper. All authors contributed to the final version of the manuscript and approved it.

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Conflict of interest

None.

Transparency document

Transparency document related to this article can be found online at <http://dx.doi.org/10.1016/j.toxicon.2014.11.225>.

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