Toxicon 52 (2008) 606–610

Contents lists available at ScienceDirect

Toxicon

journal homepage: www.elsevier.com/locate/toxicon

Epidemiologic and clinical survey of victims of centipede stings admitted to Hospital Vital Brazil (São Paulo, Brazil)

C.R. Medeiros [a,e], T.T. Susaki [a], I. Knysak [b], J.L.C. Cardoso [a], C.M.S. Málaque [a], H.W. Fan [a], M.L. Santoro [c], F.O.S. França [a], K.C. Barbaro [d,*]

[a] Hospital Vital Brazil, Butantan Institute, Av. Vital Brasil 1500, 05503-900, São Paulo, SP, Brazil
[b] Laboratory of Arthropods, Butantan Institute, Av. Vital Brasil 1500, 05503-900, São Paulo, SP, Brazil
[c] Laboratory of Pathophysiology, Butantan Institute, Av. Vital Brasil 1500, 05503-900, São Paulo, SP, Brazil
[d] Laboratory of Immunopathology, Butantan Institute, Av. Vital Brasil 1500, 05503-900, São Paulo, SP, Brazil
[e] Department of Internal Medicine, Division of Allergy and Clinical Immunology, University of São Paulo School of Medicine Hospital das Clínicas, Brazil

ARTICLE INFO

Article history:
Received 16 January 2008
Received in revised form 27 June 2008
Accepted 16 July 2008
Available online 29 July 2008

Keywords:
Centipede
Envenomation
Scolopendra
Cryptops
Otostigmus

ABSTRACT

We retrospectively analyzed 98 proven cases of centipede stings admitted to Hospital Vital Brazil, Butantan Institute, São Paulo, Brazil, between 1990 and 2007. Most stings occurred at the metropolitan area of São Paulo city ($n = 94$, 95.9%), in the domiciles of patients ($n = 67$, 68.4%), and during the warm-rainy season ($n = 60$, 61.2%). The mean age of the victims was 32.0 ± 18.8-years-old. *Cryptops* and *Otostigmus* genera were responsible for most cases. Around 86% of the patients sought medical care within 6 h after the sting. Both lower (56.1 %) and upper limbs (41.8 %) were most frequently bitten, especially the feet and hands (89.8%). The most frequent local clinical manifestations were pain (94.9%), erythema (44.9%) and edema (21.4%), and the latter was mainly observed in patients bitten by *Otostigmus* spp. Supportive treatment was used in only 28.6% of the patients, namely administration of local anesthesia (9.2%) and systemic analgesia (13.3%). No sequels or complications were observed in patients, and the prognostic was benign.

1. Introduction

Centipedes (Chilopoda) – one of the four major lineages of myriapods – are an important group of predatory arthropods in many terrestrial habitats. They comprise approximately 3300 species belonging to the five orders. Centipedes are known from all continents except Antarctica, with the greatest diversity occurring in the tropics and warm temperate regions (Edgecombe and Giribet, 2007). Adult body length ranges from 4 to 300 mm, with most species measuring 10–100 mm long (Edgecombe and Giribet, 2007), and their bodies are covered by chitin segments, which one containing a pair of walking legs. In the first segment there is a pair of forcipules where the venom glands are located (Bücherl, 1971; Jangi, 1984). The last pair of legs is not used for locomotion, but it is a sensorial organ used to capture preys (usually earthworms, worms, beetles and other arthropods), which are captured alive, immobilized and inoculated with venom (Bücherl, 1946; Jangi, 1984; Knysak et al., 1998). Centipedes are terrestrial, have nocturnal habits and are rapid. Their body is adapted to penetrate in narrow spaces, like humid dumps, underground galleries, leaves and barks. These animals are also well adapted to live in urban areas because of the abundance of preys and spaces to hidden, namely around or inside houses (Barnes et al., 1995; Knysak et al., 1998).

Although venomous centipedes of South and Central America have been studied in Brazil since 1940, mainly with the Bücherl's works (Bücherl, 1971), there is little literature on the effect of their venoms on man (Knysak et al., 1998; Barroso et al., 2001). The clinical picture is

* Corresponding author. Tel.: +55 11 37267222x2278/2134; fax: +55 11 37261505.
E-mail addresses: kbarbaro@usp.br, kbarbaro@butantan.gov.br (K.C. Barbaro).

0041-0101/$ – see front matter © 2008 Elsevier Ltd. All rights reserved.
doi:10.1016/j.toxicon.2008.07.009

characterized by pain and sometimes erythema and edema (Knysak et al., 1998). Generally, envenomations caused by centipedes are mild and associated with spontaneous healing without complications. Treatment to stings is supportive and, when necessary, includes analgesic drugs to control the pain (Cardoso and Haddad, 2003). In Brazil, the genera frequently associated with human stings are *Cryptops*, *Otostigmus* and *Scolopendra* (Knysak et al., 1998). Literature shows reports of other symptoms, such as migraine, indisposition, vertigos, irradiated pain, marked edema, local necrosis, enlarged lymph nodes, lymphangitis, fever, tremors, chills, sudoresis, ecchymosis, dyspnea, emesis, anxiety, local hyperthermia, palpitation, local hyperesthesia, sleepiness and anorexia (Jangi, 1984; Knysak et al., 1998; Bush et al., 2001).

The pathophysiology mechanisms of envenomation have not been elucidated yet, and such studies are rare in the literature (Malta et al., 2008), likely because it is difficult to obtain enough quantity of venom to perform tests. However, studies have demonstrated that centipede venoms are a complex mixture containing proteases, hyaluronidases, carboxypeptidases, histamine, serotonin, lipids, lipoprotein, esterases, polysaccharides, phospholipases, alkaline phosphatases among others (Gomes et al., 1982; Mohamed et al., 1983; Jangi, 1984; Rates et al., 2007; Malta et al., 2008). Brazilian centipede (*Otostigmus pradoi*, *Cryptops iheringi* and *Scolopendra viridicornis*) venoms were also able to induce nociception, edema and miotoxicity in mice (Malta et al., 2008).

Due to the lack of reports about centipede envenomation in Brazil, this study aimed to survey the accidents admitted to Hospital Vital Brazil in São Paulo, Brazil, from 1990 to 2007. We surveyed epidemiological and clinical manifestations of victims and the treatment used by physicians, aiming to improve the medical treatment used in this envenomation.

2. Methods

2.1. Study design and population

A retrospective study was performed by reviewing the records of patients admitted to Hospital Vital Brazil (HVB), Butantan Institute (São Paulo, Brazil), between January 1990 and December 2007, with diagnosis of envenomation by centipedes. Only proven cases, in which the causative animal was brought and identified, were included. The taxonomical identification, of the species involved in envenomations was carried out at Laboratory of Arthropods, Butantan Institute.

The following variables were analyzed: sex and age of patients, the geographical region of the accident, month of the accident, circumstance and site of the sting, genus of the animal that caused the accident, clinical manifestations and treatments. The study was approved by the hospital ethics committee.

2.2. Statistical analysis

To ascertain whether the values were distributed normally, the Kolmogorov-Smirnov test was used. The chi-square test was applied for the analysis of the significance of data obtained. When at least one cell of the 2×2 contingency tables had an expected frequency of less than 5, Fisher's exact test was used to assess the association between health outcomes and the genera of centipedes. Values of $p < 0.05$ were considered statistically significant.

All statistical analyses were performed using the Statistical Package for Social Sciences (SPSS) for Windows (version 13.0, 2004; Statistical Products and Service Solutions Inc., Chicago, IL, USA).

3. Results

Ninety-eight records were analyzed. All cases occurred in the São Paulo city and suburbs (Fig. 1), with a predominance of accidents in urban areas ($n = 94$, 95.9%).

The centipedes that caused the accident were identified as belonging to *Cryptops* spp. ($n = 67$), *Otostigmus* spp. ($n = 26$), *Scolopendra* spp. ($n = 4$) and *Otocryptops* spp. ($n = 1$) (Table 1). This distribution of centipede stings showed that *Cryptops* spp. (68.4%) and *Otostigmus* spp. (26.5%) were the most frequent animals involved in accidents (Fig. 1), and the chi-square test showed statistical significance ($X^2 = 113.5$, $p < 0.001$) for both genera.

Table 2 shows the number of centipede stings occurring during the warm-rainy (October–March) and dry-cold (April–September) seasons, and a higher frequency of accidents was noticed during the warm-rainy season ($X^2 = 4.94$, $p = 0.026$). Such seasonality was observed for accidents caused by *Otostigmus* spp., but not by *Cryptops* spp. ($X^2 = 9.85$, $p = 0.002$).

The domiciles of patients ($n = 67$, 68.4%) were the place where most stings occurred. The remaining stings occurred in workplaces ($n = 7$, 7.1%), during leisure time ($n = 15$, 15.3 %) or other activities ($n = 9$, 9.2%).

The number and percentage of cases, by age and sex, are given in Table 3. The mean age of the patients was 32.0 ± 18.8 years old, and the median age was 31 years old (interquartile range 16.7–47.0). From the 98 subjects, 59 (60.2%) were female, and most patients were between 21 and 40 years old ($X^2 = 16.9$, $p = 0.001$). The time between the sting and the admittance to hospital was usually less than 6 h ($n = 84$, 85.7%).

The lower limbs ($n = 55$, 56.1%) were the site that stings occurred most frequently, followed by the upper limbs ($n = 41$, 41.8%). The feet ($n = 48$, 49.0%) and the hands ($n = 40$, 40.8%) were the anatomical regions most frequently bitten (Table 4). As shown in Table 5, local clinical manifestations included local pain ($n = 93$, 94.9%), edema ($n = 21$, 21.4%) and local erythema ($n = 44$, 44.9%). Although no statistically significant differences were found for occurrence of pain (Fisher's exact test, $p = 0.569$) and erythema ($X^2 = 2.29$, $p = 0.130$) in stings caused by *Otostigmus* spp. and *Cryptops* spp., edema was more frequently observed in victims bitten by *Otostigmus* spp. ($X^2 = 11.4$, $p = 0.001$).

Table 6 shows that solely 28 patients (28.6 %) received supportive therapy, namely local anesthesia ($n = 9$, 9.2 %) and systemic analgesia ($n = 13$, 13.3 %). No sequels or complications were observed during the follow-up of patients, and the prognostic was benign.

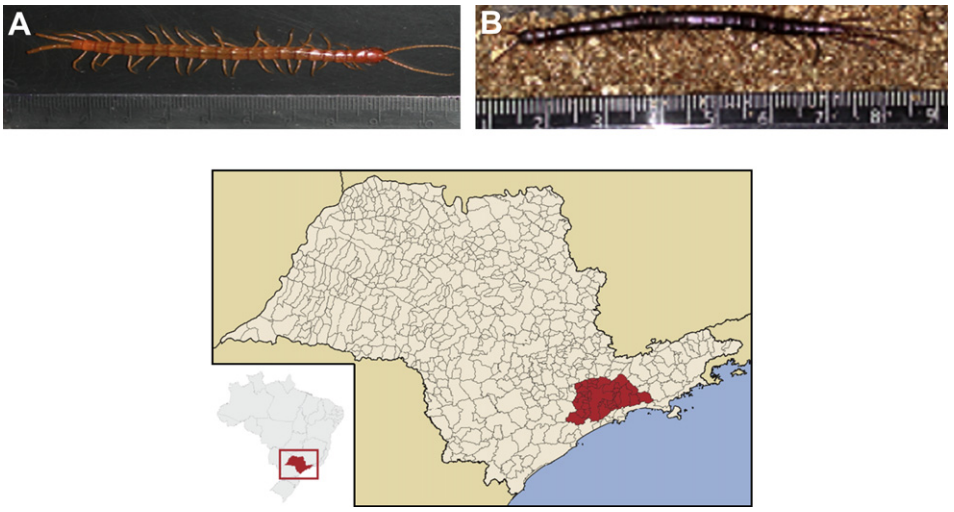

Fig. 1. Main species (*Cryptops* spp. and *Otostigmus* spp.) responsible for stings in metropolitan area (map) of São Paulo city, Brazil.

4. Discussion

The purpose of the present study was to address clinical and epidemiological information about accidents caused by centipedes, which were admitted at Hospital Vital Brazil between 1990 and 2007. We observed that most accidents occurred in the urban area of São Paulo city. This fact confirms the sinanthropism of centipedes (Knysak et al., 1998).

Our data showed that *Cryptops* spp. and *Ostotigmus* spp. were the cause for most cases of centipede envenomation, as reported by Knysak et al. (1998). In our study, most specimens brought by patients in this survey have been crushed or some essential parts necessary to taxonomical classification have been damaged. Besides, animals can also make autonomy when threatened. For these reasons, it was impossible to classify all specimens at the level of species. Nevertheless, it can be said that most animals that could be taxonomically classified were *O. pradoi* and *C. iheringi*.

There was an evident increase in number of accidents between December and January, likely related to the greater availability of food and to the reproductive cycle of centipedes, which occur during the warm-rainy season (Barnes et al., 1995; Knysak et al., 1998; Cardoso and Haddad, 2003). However, this seasonality is mostly related to accidents caused by *Otostigmus* spp., but not to *Cryptops* spp., likely due to differences in habits of this genus (Barnes et al., 1995).

Adults were the main victims of centipede stings, and most accidents occurred during performing domestic activities in their domiciles. According to Minelli (1978) and Jangi (1984), centipedes are predators that use their venom mostly to capture preys, but when their habitat or their hiding place is invaded, the hunt structures are used to defense. Such behavior of centipedes, associated with sinanthropism and domestic adaptation, contributes to the higher exposition of human beings to centipede accidents in residences (Knysak et al., 1998).

The upper and lower limbs were the areas most attacked, since they are the most favorable to accidental contact with animals in their preferential habitats, e.g. holes, gutters, shoes and dark places. Such findings were also evidenced in other clinical-epidemiological studies (Lin et al., 1995; Knysak et al., 1998; Cardoso and Haddad Jr., 2003; Mufarrej et al., 2004; Balit et al., 2004).

The most common clinical signs were pain, local erythema, and in some cases local edema. Those manifestations are a prevalent triad in accidents caused by centipedes (Bücherl, 1946; Mohri et al., 1991; Lin et al., 1995; Knysak et al., 1998; Mufarrej et al., 2004; Balit et al., 2004). Although no significant differences was noticed in the frequency of pain and erythema in stings inflicted by

Table 1
Species involved in centipede accidents admitted to Hospital Vital Brazil, Butantan Institute, São Paulo, Brazil (1990–2007)

Centipede	*n* (%)
Cryptops spp.	67 (68.4)
Otostigmus spp.	26 (26.5)
Scolopendra spp.	4 (4.1)
Otocryptops spp.	1 (1.0)
Total	98 (100)

Table 2
Distribution of centipede accidents according to season and species involved

Centipede genus	Season		Total *n* (%)
	Warm-rainy[a] *n* (%)	Dry-cold[b] *n* (%)	
Cryptops spp.	35 (35.7)	32 (32.7)	67 (68.4)
Otostigmus spp.	21 (21.4)	5 (5.1)	26 (26.5)
Scolopendra spp.	4 (4.1)	0 (0)	4 (4.1)
Otocryptops spp.	0 (0)	1 (1.0)	1 (0.7)
Total *n* (%)	60 (61.2)	38 (38.8)	98 (100)

Hospital Vital Brazil, Butantan Institute, São Paulo, Brazil (1990–2007).
[a] October–March.
[b] April–September.

Table 3
Distribution of centipede accidents according to age and sex of patients

Age (years)	Sex		Total *n* (%)
	Females *n* (%)	Males *n* (%)	
0–20	18 (18.4)	12 (12.2)	30 (30.6)
21–40	18 (18.4)	17 (17.3)	35 (35.7)
41–60	18 (18.4)	7 (7.1)	25 (25.5)
Over 60	5 (5.1)	3 (3.1)	8 (8.2)
Total	59 (60.2)	39 (39.8)	98 (100)

Hospital Vital Brazil, Butantan Institute, São Paulo, Brazil (1990–2007).

Table 4
Distribution of centipede accidents according to the site of the sting

Site of the sting	*n* (%)
Hands	40 (40.8)
Arms	1 (1.0)
Feet	48 (49.0)
Legs	7 (7.1)
Others	2 (2.0)
Total	98 (100)

Hospital Vital Brazil, Butantan Institute, São Paulo, Brazil (1990–2007).

Table 5
Main symptoms manifested by patients after centipede stings according to the genus of centipedes

Genus	Symptoms		
	Pain *n* (%)	Erythema *n* (%)	Edema *n* (%)
Cryptops $n = 67$	63 (94.0)	27 (40.3)	9 (13.4)
Otostigmus $n = 26$	25 (96.2)	15 (57.7)	12 (46.2)
Scolopendra $n = 4$	4 (100)	2 (50.0)	0 (0.0)
Otocryptops $n = 1$	1 (100)	0 (0.0)	0 (0.0)
Total $n = 98$	93 (94.9)	44 (44.9)	21 (21.4)

Table 6
Therapies used for patients bitten by centipedes

Therapy	*n* (%)
Anesthetic blockade	9 (9.2)
Systemic analgesia	13 (13.3)
Blockade and systemic analgesia	1 (1.0)
Cortisone	1 (1.0)
Antihistaminic	4 (4.1)
Total	28 (28.6)

Hospital Vital Brazil, Butantan Institute, São Paulo, Brazil (1990–2007).

Otostigmus spp. and *Cryptops* spp., edema was more frequently observed in victims bitten by *Otostigmus* spp. Malta et al. (2008) verified intense hyaluronidase and direct hemolytic activities in *O. pradoi* venom, but not in *C. iheringi* venom. These toxic properties could contribute to increase the local damage and consequently the edema that occurs in stings inflicted by these animals.

The genus *Scolopendra* has been associated with cases of severe envenomation in human beings (Ménez et al., 1990). Cardiovascular alterations, tachypnea, palpitation and hypotension were described by Ozsarac et al. (2004) and Yildiz et al. (2006). Hasan and Hassan (2005) reported a case of proteinuria in a 15-year-old girl bitten by *Scolopendra* spp. Rhabdomyolysis and acute renal failure have also been reported in patient bitten by *Scolopendra heros* (Logan and Ogden, 1985). Paralysis on the site of the sting and at distance was reported after *Scolopendra* spp. sting (Mumcuoglu and Leibovici, 1989). The death of a 62-year-old man by intracranial hemorrhage was reported by Harada et al. (1999). A cardiotoxin isolated from *Scolopendra subspinipes* venom (Toxin-S) caused vasoconstriction and increased the capillary permeability in guinea pigs, inducing hypertension (Gomes et al., 1982; Stankiewicz et al., 1999). Those events can be associated with the activity of this toxin in ion channels, increasing the release of neurotransmitters (Stankiewicz et al., 1999; Gutiérrez et al., 2003). In the nature, this interaction of centipede toxins (polypeptides) with cellular components is related to the ability of centipede venoms to paralyze preys by excitation or inhibition of neurotransmitters involved in breathing (Gomes et al., 1982; Gutiérrez et al., 2003). However, no occurrence of severe manifestations or sequels was noticed in the present study, not even on four cases of envenomation caused by *Scolopendra* spp.

Local pain was the main symptom noticed immediately after the accident, and patients usually seek for medical assistance during the first 4 h after the sting. Gomes et al. (1982) and Mcfee et al. (2002) reported that the intensity of pain depends on the size of the centipedes and on the site of the sting, inferring that the release of histamine is involved in nociception, and therefore suggested the use of histamine receptor antagonists. The results of the present study ratify pain as the most important and evident phenomenon of human injuries caused by centipedes. However, histamine receptor antagonists were used in only seven patients in this study, and the spontaneous resolution of the painful was the rule. Balit et al. (2004) prescribed the immersion of the bitten limb in warm water to treat painful pictures. In Hospital Vital Brazil, the relief of pain is achieved by using systemic analgesia and/or local anesthetic blockade when necessary. The results are in accordance with previous reports demonstrating that complications are not common in accidents by centipedes (Knysak et al., 1998; Cardoso and Haddad Jr., 2003; Mufarrej et al., 2004).

In conclusion, *Cryptops* spp. and *Ostotigmus* spp. centipedes caused most envenomations in the metropolitan area of São Paulo. Clinical manifestations included pain, erythema and sometimes edema at the site of the sting. The patients presented mild local disturbances that healed spontaneously. Most accidents occurred during the warm-rainy season, likely associated to changes in the biological behavior of these two genera.

Acknowledgements

This work was supported by FAPESP (03/04527-1). TT Susaki received a FUNDAP fellowship. We also thank CNPq for the grant of Katia C. Barbaro (306158/2004-3).

Conflict of interest

The authors declare that there are no conflicts of interest.

References

Balit, C.R., Harvey, B., Waldock, J.M., Isbister, G.K., 2004. Prospective study of centipedes bites in Australia. J. Toxinol. 42, 41–48.

Barnes, R.S.K., Calow, P., Olive, P.J.W., 1995. Os Invertebrados: uma nova síntese. São Paulo. Atheneu, 526 p.

Barroso, E., Hidaka, A.S.V., Santos, A.X., França, J.D.M., Sousa, A.M.B., Valente, J.R., Magalhães, A.F.A., Pardal, P.P.O., 2001. Acidentes por centopéias notificados pelo "Centro de Informações Toxicológicas de Belém", num período de dois anos. Rev. Soc. Bras. Med. Trop. 34, 527–530.

Bücherl, W., 1946. Ação do veneno dos escolopendromorfos no Brasil, sobre alguns animais de laboratórios. Mem. Inst. Butantan 19, 181–198.

Bücherl, W., et al., 1971. Venomous chilopods or centipedes. In: Bücherl, W. (Ed.), Venomous Animals and their Venoms. Academic Press, New York, pp. 169–196.

Bush, S.P., King, B.O., Norris, R.L., Stockwell, A.S., 2001. Centipede envenomation. Wild. Environm. Med. 12, 93–99.

Cardoso, J.L.C., Haddad Jr., V., et al., 2003. Acidentes por Coleópteros vesicantes e outros artrópodes. In: Cardoso (Ed.), Animais Peçonhentos no Brasil: biologia, clínica e terapêutica dos acidentes. Savier, São Paulo, pp. 258–264.

Edgecombe, G.D., Giribet, G., 2007. Evolutionary biology of centipedes (Myriapoda: Chilopoda). Annu. Rev. Entomol. 52, 151–170.

Gomes, A., Datta, A., Bandita, S., Kar, P.K., Lahiri, S.C., 1982. Occurrence of histamine and histamine release by centipede venom. Indian J. Med. Res. 76, 888–891.

Gutiérrez, M.C., Abarca, C., Possani, L.D., 2003. A toxic fraction from venom increase the basal release of neurotransmitters in the ventral ganglia of crustaceans. Comp. Physil. C. 135, 205–214.

Harada, K., Asa, K., Imachi, T., Yamaguchi, Y., 1999. Centipede inflicted postmortem injury. J. Forensic Sci. 44, 849–850.

Hasan, S., Hassan, K., 2005. Proteinuria associated with centipede bite. Ped. Nephrol. 20, 550–551.

Jangi, B.S., 1984. Centipede venoms and poisoning. In: Tu, A.T. (Ed.), Handbook of Natural Toxins: Insect Poisons, Allergens and Other Invertebrate Venoms. Marcel Dekker, New York, pp. 333–368.

Knysak, I., Martins, R., Bertim, C.R., 1998. Epidemiological aspects of centipede (Scolopendromorphae: Chilopoda) bites registered in Greater S. Paulo, SP, Brazil. Rev. Saúde Publica. 32, 514–518.

Lin, T., Yang, C., Yang, G., Ger, J., Tsai, W., Deng, J., 1995. Features of centipede bites in Taiwan. Trop. Geo. Med. 47, 300–302.

Logan, J.L., Ogden, A.D., 1985. Rhabdomyolysis and acute renal failure following the bite of the giant desert centiped *Scolopendra heros*. West. J. Med. 142, 549–550.

Malta, M.B., Lira, M.S., Soares, S.L., Rocha, G.C., Knysak, I., Martins, R., Guizze, S.P.G., Santoro, M.L., Barbaro, K.C., 2008. Toxic activities of Brazilian centipede venoms. Toxicon 52, 255–263.

Mcfee, R.B., Caraccio, T.R., Mofenson, H.C., McGuigan, M.A., 2002. Envenomation by the Vietnamese centipede in a Long Island pet store. Clin. Toxicol. 40, 573–574.

Minelli, A., 1978. Secretions of centipedes. In: Bettini, S. (Ed.), Handbuch der experimentellen Pharmakologie. Heffter-Heubner. New Series, vol. 48, pp. 73–85.

Ménez, A., Zimmerman, K., Zimmerman, S., Heatwole, H., 1990. Venom apparatus and toxicity of the centipede *Ethmostigmus rubripes* (Chilopoda, Scolopendridae). J. Morphol. 206, 303–312.

Mohamed, A.H., Abu-Sinna, G., El-Shabaka, H.A., El-Aal, A.A., 1983. Proteins, lipids, lipoproteins and some enzyme characterizations of the venom extract from the centipede *Scolopendra morsitans*. Toxicon 21, 371–377.

Mohri, S., Sugiyama, A., Saito, K., Nakajima, H., 1991. Centipede bites in Japan. Cutis 47, 189–190.

Mufarrej, L.D., Gonçalves, M.C., Vaz, A.C., Pardal, P.O., Silva, F.E.R., 2004. Perfil epidemiológico dos acidentes causados por centopéia (*Scolopendra* sp.) notificados no CIT-Belém. Rev. Soc. Brás. Méd. Trop. 37, 130.

Mumcuoglu, K.Y., Leibovici, V., 1989. Centipede (*Scolopendra*) bite: a case report. Isr. J. Med. Sci. 25, 47–49.

Ozsarac, M., Karcioglu, O., Ayrik, C., Somuncu, F., Gumrukcu, S., 2004. Acute coronary ischemia following centipede envenomation: case report and review of the literature. Wild. Environ. Med. 15, 109–112.

Rates, B., Bemquerer, M.P., Richardson, M., Borges, M.H., Morales, R.A.V., De Lima, M.E., Pimenta, A.M.C., 2007. Venomic analyses of *Scolopendra viridicornis nigra* e *Scolopendra angulata* (Centipede Scolopendromorpha): shedding light on venoms from a neglected group. Toxicon 49, 810–826.

Stankiewicz, M., Hamon, A., Benkhalifa, R., Kadziela, W., Hue, B., Lucas, S., Mebs, D., Pelhate, M., 1999. Effects of a centipede venom fraction on insect nervous system, a native *Xenopus* oocyte receptor and on expressed *Drosophila* muscarinic receptor. Toxicon 37, 1431–1445.

Yildiz, A., Biceroglu, S., Yakut, N., Bilir, C., Akdemir, R., Akilli, A., 2006. Acute myocardial infarction in a young man caused by centipede sting. Emerg. Med. J. 23, e30.