*Türkiye Parazitoloji Dergisi, 30 (3): 239-245, **2006***
© Türkiye Parazitoloji Derneği

Acta Parasitologica Turcica
© Turkish Society for Parasitology

Androctonus crassicauda (Olivier 1807) Scorpionism in the Sanliurfa Provinces of Turkey

Ozcan OZKAN[1], Sühendan ADIGÜZEL[1], Selçuk YAKIŞTIRAN[1], Yıldırım CESARETLİ[1], Mehmet ORMAN[2], K. Zafer KARAER[3]

[1]Refik Saydam Hygiene Center, Poison Research Center; [2]Ankara University Faculty of Veterinary Medicine Department of Statistic, [3]Ankara University Faculty of Veterinary Medicine Department of Entomology and Protozology, Ankara

SUMMARY: In this study, the epidemiology and clinical findings of scorpion stings in the Şanlıurfa province of Turkey was evaluated between May and September 2003. Data obtained from questionnaires was evaluated and the identification of scorpions collected from the region was carried out in the laboratory. It was determined that of the species of scorpions only *Androctonus crassicauda* was collected. This species plays the major role in 50.8% of scorpionism cases. This study also showed that intoxications caused by A. crassicauda in southeast Anatolia region were seen in the summer during the hot months especially in August. Females and people above 15 years of age were the most affected and they had been stung on the extremities. In clinical evaluations, it was found that 17.7% of the cases showed systemic effects and no deaths were reported. Also parasympathetic effects were more common in comparison to sympathetic effects.

Key Words: Scorpion; *Androctonus crassicauda*; Turkey; scorpionism; epidemiology; clinical symptoms

Şanlıurfa'da *Androctonus crassicauda* (Olivier 1807) Scorpionizmi

ÖZET: Bu çalışma ile Türkiye'de ilk defa Şanlıurfa yöresinde akrep sokmalarının epidemisi ve klinik bulguları, halk sağlığı bakımından değerlendirilmiştir. Bölgede akrep sokmalarında etkili türü belirlemek amacıyla toplanan akreplerin tamamının *Androctonus crassicauda* olduğu; yapılan anket formundaki bilgilere göre skorpionizm olgularının %50,8'de bu türün rol oynadığı; en fazla akrep sokma olgusunun ise Ağustos ayında olduğu tespit edilmiştir. Klinik değerlendirmede; vakaların %17,7'sinde sistemik etkilerin görülmesine karşın ölüm bildirilmemiştir. Vakalarda parasematik etkilerin daha fazla görüldüğü tespit edilmiştir. Sonuç olarak yapılan çalışma ile Şanlıurfa yöresinde akrep sokmalarının halk sağlığını tehdit etmesi bakımından önemli olduğu anlaşılmıştır.

Anahtar Sözcükler: Akrep; *Androctonus crassicauda*; Türkiye; Skorpionizm; Epidemiyoloji; Klinik semptom

INTRODUCTION

Scorpions do not harbor agents of disease. However, they are medically important arthropods since they cause envenomations by stinging humans, most of the time to protect themselves (33, 34).

Scorpion venom contains shorts neurotoxin polypeptides consisting of low molecular weight simple proteins with lethal and paralytic effects (22, 30, 32, 35, 49, 51). Several studies on scorpion sting cases emphasized that various clinical pictures are seen ranging local symptoms to serious autonomic and central nervous system symptoms, death due to cardio and respiratory failure especially in children (1, 7, 8, 12, 16, 18, 21, 22, 26, 28, 32, 35, 43).

Geliş tarihi/Submission date: 12 Kasım/12 November 2006
Düzeltme tarihi/Revision date: 11 Mayıs/11 May 2006
Kabul tarihi/Accepted date: 01 Ağustos/01 August 2006
Yazışma /Correspoding Author: Özcan Özkan
Tel: (+90) (312) 433 70 01 Fax: (+90) (312) 433 70 00
E-mail: ozcanozkan_62@hotmail.com

Among 1500 species described, venoms of 50 species are dangeours for humans and most of these species belong to genera *Buthus, Parabuthus, Mesobuthus, Tityus, Leiurus, Androctonus, Centruroides* family of Buthidae (9, 13, 17, 18, 33, 35, 45, 49). Among these species, *Tityus serrulatus, T. bahiensis* are common and lethal scorpion species in South America, especially in Brazil; *Centruroides suffusus, C. limpidus, C. sculpturatus* in Mexico; *Leiurus quinquestriatus, Androctonus crassicauda, A. mauretanicus, A. australis, A. amoreuxi, Buthus occitanus* in the Middle East and North African countries; *Parabuthus granulatus, P. transvaalicus* in South African countries; *Mesobuthus tamulus and Palamneus swammerdami* in India (9 -11, 20, 30, 33, 34, 41, 42, 45, 50).

Scorpions and human envenomation cases are common in Turkey due to its geographical locations, climate and socio-economical structure. Scorpion envenomation is important

health problem in all regions and especially in South-eastern Anatolia (33-35). Important scorpions threatening public health in Turkey are *A. crassicauda, L. quinquestriatus, Mesobuthus gibbosus* and *M. eupeus* of *Buthidae* family (33-37)

Several studies have reported that the scorpion species *A. crassicauda* are common in South-eastern Anatolia region, especially Şanlıurfa and Mardin provinces, *M. gibbous* in Aegean and Middle Anatolia regions, *M. eupeus* in Eastern and South-eastern Anatolia regions and *L. quinquestriatus* in Adıyaman province (2, 14, 19, 33, 35-37, 44, 45).

This study aims to evaluate the epidemiology and clinical findings of *A. crassicauda* scorpionism common in Şanlıurfa, a province in the southeast of Turkey.

MATERIAL AND METHODS

This prospective study was based on the 598 subjects from Şanlıurfa city and its districts which applied to the provincial healthcare facilities in Şanlıurfa with scorpion stings from 1st of May 2003 to the first week of September 2003.

A questionnaire was distributed to physicians in provincial healthcare facilities to collect patient data (name, age, sex, scorpion identification date of sting, location of sting in the body and clinical manifestations). Scorpion [color of scorpion] identification was made according to the color of scorpion defined by the patient.

This study was carried out on the 299 patients with complaint of Black Scorpion, *A. crassicauda,* sting. Data obtained from questionnaires of these patients were analyzed with SPSS software using analysis of Pearson's chi-square method. Values obtained were considered to be significantly different if $P< 0.05$ (All data were analyzed Department of Statistic, Ankara University Faculty of Veterinary Medicine).

Within the scope of the study, scorpions were collected from the area at different times, transferred to the laboratory in 70% alcohol, and their species identified with common identification techniques (14, 31, 37) using a stereomicroscope, to identify scorpion species of the province and specifically those defined as black and yellow by the patients in their questionnaires.

RESULTS

Laboratory identification of the 32 scorpions collected from the area, which were reported as black scorpions by the patients, showed that they belong to *A. crassicauda* (Figure 1).

Analysis of questionnaire data revealed that 299 of the 598 scorpion stings resulted from black scorpion *A. crassicauda* (50.8%), the species identification being confirmed by the laboratory. 152 of the cases (25.8%) were reported as yellow scorpion stings; within the scope of the study, laboratory identification of these species was not carried out, however literature data (14, 19, 35, 33) shows that *M. eupeus* known as yellow scorpion is common in Şanlıurfa region. In 138 of the cases (23.4%), color distinction of scorpions involved could not be made by the patients (Figure 2).

Figure 1. *A. crassicauda* in Turkey by Ozkan (2003)

The distribution of the scorpion sting cases according to month of sting, sex and body location is given in tables and figures. The figure 3 shows that out of the 299 skorpionism cases 279 took place in the summer period (93.4%) the monthly distribution being as June (32.8%), July (22.1%), August (38.5%). 18 of the cases were encountered in May (6%) and 2 in September (0.7%).

It is also seen from the table that women were more liable to scorpion sting than men, the cases being reported as 61.9% for women and 38.1% for men (Table 1).

Table 1. The distribution of the scorpion sting cases according to sex of patients

	Number of patients (n: 299)	
Sex	**n**	**%**
Female	185	48,5
Male	123	41,1

With respect to age groups, it is shown the 15 – 30 age group has faced more scorpion sting (34.1%) than the other groups the distribution being 24.1% for the 0-14 age group, 23.7% for the 30-44 age group and 18.1% for 45 and over age group (Figure 4).

The body locations of stings given in the table are 48.5% for upper extremities and 41.1% for lower extremities (Table 2).

Table 2. The distribution of the scorpion sting cases according to body location of sting

Location of Body	Number of patients	%
Upper extremite	145	48,5
Lower extremite	123	41,1
Body	25	8,4
Head and Neck	6	2,0
Total	299	100.00

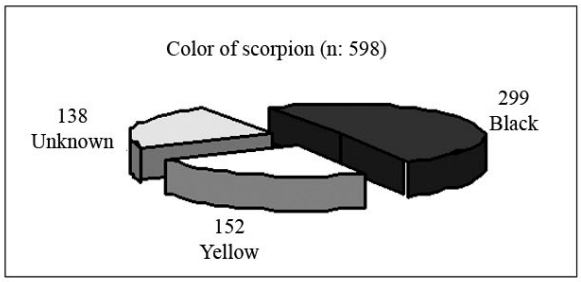

Figure 2. The distribution of the scorpion sting cases according to color of scorpion

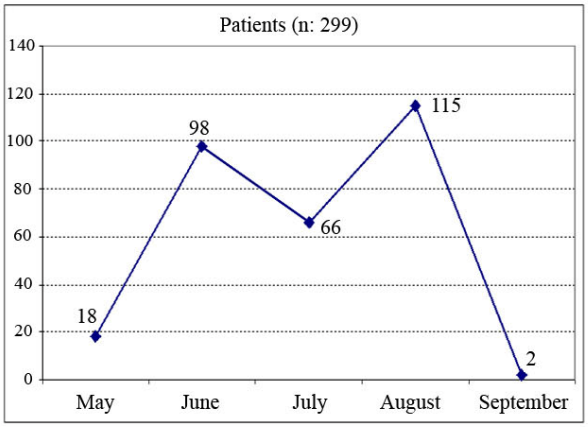

Figure 3. The distribution of the scorpion sting cases according to months of stings

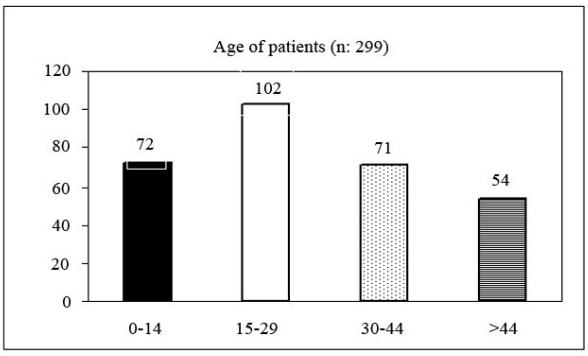

Figure 4. The distribution of the scorpion sting cases according to age of patients

Analysis of the data in records of the healthcare organization of Şanlıurfa province has alarm that in the 299-scorpionism cases caused by *A. crassicauda* the local and systemic symptoms have appeared. The local symptoms were seen as pain, hyperemia, swelling, burning, numbness, itching in the ratio of 97.3%, 86.0%, 66.6%, 8.0%, 0.7% and 0.7%, respectively (Table 3).

The incidence of blushing in July and August (P= 0.006) and burning (P= 0.000) in August being higher than the other months (May, June and September) was found statistically significant. On the other hand, the difluences in the local symptoms with respect to age groups and sex were not significant statistically.

Table 3. The distribution of the scorpion sting cases according to local and systemic symptoms

Clinical Symptoms	Number of patients (n: 299)	%
Local Symptoms		
Pain	291	97.3
Hyperemia	257	86.0
Swelling	199	66.6
Burning	24	8.0
Numbness	2	0.7
Itching	2	0.7
Systemic Symptoms		
Dry Mouth	34	11.4
Thirst	34	11.4
Sweating	25	8.4
Nausea	23	7.7
Dispnea	7	2.3
Vomiting	6	2.0
Lacrimation	4	1.3
Restlessness	4	1.3
Syanose	1	0.3
Local spasm	1	0.3
İncrease of secretion	1	0.3
Hypertension (n:145)	6	4.1
Hypotension (n: 124)	11	8.9
Tachycardia (n: 160)	4	2.5

The records of the healthcare organizations have also shown that the systemic symptoms in the 299 *A. crassicauda* scorpionism cases were in general drying of the mouth (11.4%), thirst (11.4%); hypotension (8.9%), sweating (8.4%) and nausea (7.7%). Occasionally hypertension (4.1%), tachycardia (2.5%), difficulty in breathing (2.3%), vomiting (2.0%), lacrimation (1.3%, restlessness (1.3%) increase of secretion (< 0.5 %) were added (Table 3). Nausea (P= 0.025) and sweating (P= 0.032) in the 30 - 44 age group was seen more often than the other age groups and this was found statistically significant. Differences between the monthly and sex related systemic symptoms were found non- significant statistically.

DISCUSSION

Scorpions are arthropods with length of which changes from 13 to 220 mm, so they are easily recognizable because of their morphologic structures (33, 34). Scorpions live mostly under ruins and stones in day times because they have no tolerance to high temperatures in hot seasons, by this way they protect themselves from high temperatures. Scorpions become active at night and sting for their own protection against human (15, 33, 46).

Soker and Haspolat (44) reported that 64 children cases with scorpion sting admitted to Pediatric Emergency Department in Dicle University Hospital in the southeastern part of Turkey

during 1995-1999 were examined retrospectively and Altınkaynak et al., (2) 24 children with scorpion stings were investigated retrospectively in Marmaris State Hospital between 1994 and 1999. There are no epidemiological and clinical researches on general scorpionism and about the importance of *A. crassicauda* stings in Turkey up to now. In our study, 598 scorpion sting cases seen in Şanlıurfa were investigated between May and September 2003 where patients had medical care and were followed in healthcare facilities.

This study shows that 50.8% of all cases were affected by *A. crassicauda*. This percentage is 70% in Saudi Arabia (15) and 41% in Iran (40).

Envenomation by arachnids causes significant medical illness worldwide. Scorpion sting is the most important arachnid envenomation causing adult morbidity and pediatric mortality (2, 24, 44). Scorpion envenomation remains a real health problem in developing countries especially in tropical, subtropical and also urban regions (7, 8, 16, 29, 32). Radmanesh (40) published that there were many scorpion stings in urban region in hot seasons and especially child deaths were seen due to scorpion toxicities in Iran. In a similar way, most scorpionism cases were seen in summer times in Brazil, Saudi Arabia, Egypt, and Morocco, when compared to the other months (4, 13, 18, 21, 23, 38). In this research also the most scorpion stings were seen as 93.4% in the summer months when the temperature was 40 – 45 °C; the monthly ranges being 32.8%, 22.1%, 38.5% in June, July and August respectively.

Typical effects of this venom were severe pain around the sting area, anesthesia and severe neurological effects. Children below 5 years of age and 20-25% of infants showed widespread hyperemia and most of the children below 11 years of age showed hypertension. Irritability with central nervous system effects were seen in most of the children and infants (13). In this study, the patients were grouped as 0-14, 15-29, 30-44 and over 44 ages. This is because we did not see signaficant differences between in the 0 - 5 age intervals. The literature data state that in Morocco 15 - 29 age group was influenced the most and ages 44 and over the least by scorpion stings (21). In this study also similar results have been found for the same age groups.

In Saudi Arabia, scorpion stings have been mostly seen in patients of the age of 15 and over (4, 23). Our study has similar results. The reason for this is considered to be due to the fact that the young population in this region work in agricultural fields and collect scorpions for economic reasons.

Epidemiological studies have shown that the ratio of patient affected by their extremities (hand, arm, leg, thigh, foot) is 86% in Saudi Arabia (4), 83% in Argentina (15) and 85% in Egypt (18). In this study, 89.6% of the patients had scorpion stings in their extremities such as hand, arm, leg, thigh and foot. Scorpion sting was reported to be seen mostly in the upper limbs in Morocco (21, 46) and Brazil (38) similar results were found in our study. The reason for the high ratio of scorpion sting in extremities is considered to be due to the socio-economic structure depending on agriculture in rural areas of Şanlıurfa province, wearing sandals in warm season, walking by bare foot (especially children), putting on shoes without pre-shaking, hand searching for scorpions in their homes, lifting up stones in a non controlled manner, waiving hands during sleep or resting to move away scorpions. The stings in the head, neck and other locations of the body are mostly seen at sleep or resting because of putting on clothes without checking and also not controlled bed mattresses.

In Egypt (18), Saudi Arabia (4), Argentina (13) and Brazil (38), epidemiological studies showed that most scorpion stings were seen in males but in our study this was different. The analysis of data showed that both in the total cases and in the monthly data, scorpion stings were seen mostly in females. It is thought that females have a high percentage when compared with males in population. Bergman (11) reported that scorpion stings were seen mostly in females in Zimbabwe. However, in a research made in two different regions of Morocco, scorpion stings in southwest regions were higher in males and in El-Kala, El-Jadida, Agdir and Tan-Tan regions it was high in females (21, 46). This helps to realize that male-female distribution shows differences according to region as seen in our study.

In addition to Turkey, *A. crassicauda* shows high distribution in Azerbaijan, Iran, Iraq, Syria, Jordan and Saudi Arabia (25, 34, 37). Toxicity of venom changes according to regions and species of scorpion (5). According to lethality tests, several LD_{50} values related to the same species were found. Although Ismail et al., (25) published that subcutaneous LD_{50} of *A. crassicauda* venom was 0.64 mg/kg, venom obtained from Latoxan laboratory had an LD_{50} value of 0.87 mg/kg. Altınkurt (3) reported that *A. crassicauda* species from Şanlıurfa region had intraperitoneal LD_{50} value of 11.5 mg/kg. Ozkan et al. (36) reported that *A. crassicauda* species from Şanlıurfa region had subcutan LD_{50} value of 2.68 mg/kg. Because of that in toxicities due to scorpion stings, local or systemic clinical effects could appear related to species of scorpion, feeding state, structure and amount of venom, number of stings, sensitivity of patient, age, weight and climate of the region (3, 13, 15, 36, 40). Soker and Haspolat (44) emphasized that 12.5% were dead in 64 children scorpion sting cases and also Altınkaynak et al., (2) stated that 8.3% were dead in 24 children scorpion sting cases in the west and southeastern part of Anatolia.

In our study, no dead was recorded since 299 cases had cured efficiently with first medical aid, sympomatic treatment and antivenom (prepared by Refik Saydam Hygiene Center) which was more effective than a homologous antivenom in neutralizing venom of the Algerian species *A. australis,* and was equal

to homologous antivenins in neutralizing of venoms of the Southern-European-North-African *B.occinatus*, and the South-American species *T. serrulatus* and *T. bahiensis*, in Anatolia *L. quinquestriatus* (47, 48, 50).

On the other hand, antihistaminic, steroid, anelgesic were given to all patients in timely manner in healthcare facility since people of region knows what they will do and immediately look for the treatment of scorpion sting.

Several studies were reported that scorpion venom in human was a powerful nervous system stimulant and these clinical effects were called "Autonomic or Sympathetic storm" and sometimes parasympathetic effects may become superior and also related to dose of venom, sympathetic activation in low doses and parasympathetic activation in high doses would appear and the clinical effects were characterized with mostly pain due to venom at low concentrations because venom could not stimulate acetylcholine receptors above threshold (15, 22, 39, 40).

In in vivo investigations scorpion venom causes acetylcholine secretion in presynaptic region so cholinergic effects appear and related to that effect by the way of stimulation of adrenergic receptors catecholamine is secreted continuously in adrenal glands and stimulation of post ganglionic receptors causes hypertension, sympathetic, parasympathetic effects, skeletal muscle and smooth muscle contractions and bronchoconstrictive effects appear (3, 6, 15, 45). Radmanesh (40) described that venom of *A. crassicauda* was neurotoxic because of the stimulation of acetylcholine receptors all over the body.

In this study, involving 299 A. crassicauda toxicity cases, patients showed local and systemic clinical effects. Parasympathetic (thirst, dry mouth, respiratory difficulty, nausea, vomiting, lacrimation, increase in bronchial secretion, hypotension) together with local effects characterized with severe pain, hyperemia and edema were seen dominant in toxicity cases.

Results of this study showed that intoxications caused by *A. crassicauda* in Southeast Anatolia region were seen in summer and in hot months, especially in August. Females and males above 15 years of age were mostly affected and stung from extremities. In clinical evaluations, 17.7 % of cases showed systemic effects and no death, and also parasympathetic effects were superior to sympathetic effects.

In many cases, the patients were stung by scorpions due to their lack of knowledge and carelessness such as in putting their hands into scorpion homes, walking bare foot, lifting up stones carelessly, putting on their clothes and shoes without shaking them to check for scorpions.

REFERENCES

1. **Abroug F, Nouira S, El Atrous S, Besbes L, Boukef R, Boussarsar M, Marghli S, Eurin J, Barthelemy C, El Ayeb M, Dellagi K, Carayon A.** 2003. A canine study of immunotherapy in scorpion envenomation. *Intensive Care Med.* 29(12):2266-2276.
2. **Altınkaynak S, Ertekin V, Alp H.** 2002. Scorpion envenomation in children. *Türk Pediatri Arşivi,* 37: 48-54.
3. **Altınkurt O, Altan M.** 1980. Pharmocological effects of the scorpion (*Androctonus crassicauda*) venom from Urfa environment on laboratory animals and the antagonistic effects of streptomycin to most of these effects. *J Fac Pharm*, 10: 41-61.
4. **Al-Sadoon MK, Jarrar BM.** 2003. Epidemiological study of scorpion stings in Saudi Arabia between 1993 and 1997. *J Venom Anim Toxins,* 9 (1):54-64.
5. **Amaral CFS, Rezende NA.** 2000. Treatment of scorpion envenoming should include both a potent specific antivenom and support of vital functions. *Toxicon,* 38: 1005 -1007.
6. **Ay I, Tuncer M, Onur R.** 1996. Effects of *Androctonus crassicauda* scorpion venom on endothelium dependent and independent vascular responses of rabbit aorta. *Gen. Pharmac,* 27(3): 519-523.
7. **Bahloul M, Ben Hamida C, Chtourou K, Ksibi H, Dammak H, Kallel H, Chaari A, Chelly H, Guermazi F, Rekik N, Bouaziz M.** 2004. Evidence of myocardial ischaemia in severe scorpion envenomation, Myocardial perfusion scintigraphy study. *Intensive Care Med.* 30: 461-467.
8. **Bahloul M, Bouaziz M, Dammak H, Ben Hamida C, Ksibi H, Rekik N, Chelly H, Teboul JL, Kallel H.** 2002. Value of plasma protein and hemoglobin concentration in the diagnosis of pulmonary edema in scorpion sting patients. *Intensive Care Med,* 28: 1600-1605.
9. **Balozet L,** 1971. *Scorpionism in the old world.* Bücherl W, Buckley EE (eds*.), Venomous animals and their venoms*. Volume 3. Venomous intervertebrates. Academic, New York, 349-371.
10. **Belghith M, Boussarsar M, Haguiga H, Besbes L, Elatrous S, Touzi N, Boujdaria R, Bchir A, N Semir, Bouchoucha S, Abroug F.** 1999. Efficacy of serotherapy in scorpion sting: A matched-pair study. *Clinical Toxicology,* 37(1): 51-57.
11. **Bergman NJ,** 1997. Clinical description of *Parabuthus transvaalicus* scorpionism in Zimbabwe. *Toxicon,* 35 (5) : 759-771.
12. **Blum A. Jawabreh S, Gumanovsky M, Soboh S,** 2000. Scorpion envenomation and myocardial damage. *Isr Med Assoc J,* 2: 318-319.
13. **De Roodt, AR, Garcia SI, Salomon OD, Segre L, Dolap SA, Funes RF, De Titto EH,** 2003. Epidemiological and clinical aspects of scorpionism by *Tityus trivittatus* in Argentina. *Toxicon,* 41(8), 971-977.
14. **Demirsoy A, Durmuş Y, Akbulut A.** 2001. Türkiye scorpiones (akrep) faunasının sistematik ve biyolojik yönden incelenmesi. Proje No : 1998 K 1001 40. Çevre Bakanlığı Çevre Koruma Genel Müdürlüğü Hayvanları Koruma Dairesi Başkanlığı. Ankara.
15. **Dittrich K, Power AP, Smith NA,** 1995. Scorpion sting syndrome- a ten year experience. *The Annals of Saudi Medicine,* 15(2):148-155.

16. **Dittrich K, Ahmed R, Ahmed QAA.** 2002. Cardiac arrest following scorpion envenomation, Case reports. *Annals of Saudi Medicine,* 22 (1-2): 87-90.

17. **Eftari P,** 1978. *Epidemiology Symptomatology and Treatment of Buthinae Stings*. In: Bettini S, ed. *Handbook of experimental pharmacology-arthropod venoms*; Berlin: Spinger Verlag, Chapter 13: 312-317.

18. **Farghly WM, Ali FA,** 1999. A clinical and neurophysiological study of scorpion envenomation in Assiut, Upper Egypt. *Acta Paediatr,* 88 (3): 290-294.

19. **Fet, V. & M. E. Braunwalder.** 2000. The scorpions (Arachnida, Scorpiones) of the Aegean area: current problems in taxonomy and biogeography. *Belgian Journal of Zoology,* 130 (Suppl. 1): 17–22.

20. **Gajre G, Dammas AS.** 1999 Scorpion envenomation in children: should all sting be given antivenom? *Annals ofg Saudi Medicine,* 19 (5): 444-446.

21. **Ghalim N, El-Hafny B, Sebti F, Heikel J, Lazar N, Moustanir R, Benslimane A.** 2000. Scorpion envenomation and sero terherapy in Morocco. *Am J Trop Med Hyg,* 62(2): 277-283.

22. **Gwee MC, Nirthanan S, Khoo HE, Gopalakrishnakone P, Kini RM, Cheah LS.** 2002. Autonomic effects of some scorpion venoms and toxins. *Clin Exp Pharmacol Physiol,* 29(9):795-801.

23. **Hisham Mahaba MA,** 1997. Scorpion sting syndrome: epidemiology, clinical presentation and management of 2240 cases. *East Mediterr Health J*, 3 (1): 82-99.

24. **Isbister GK, Graudins A, White J, Warrel D,** 2003. Antivenom treatment in Arachnidism. *J Toxicol Clin Toxicol,* 41 (3): 291-300.

25. **Ismail M, Abd-Elsalam MA, Al-Ahaidib MS,** 1994. *Androctonus crassicauda* (Olivier), a dangerous and unduly neglected scorpion-I. Pharmacological and clinical studies. *Toxicon,* 32 (12): 1599-1618.

26. **Ismail M.** 1994. The scorpion envenoming syndrome. *Toxicon,* 33 (7): 825-858.

27. **Ismail M.** 2003. Treatment of the scorpion envenoming syndrome: 12-years experience with seroterapy. *Int J Antimicrobial Agents,* 21 (2): 170-174.

28. **Karnard DR,** 1998. Heamodynamic patterns in patients with scorpion envomation. *Heart,* 79 (5): 485-489.

29. **Lourenço WR, Cuellar O,** 1995. Scorpions, scorpionism, Life history strategies and parthenogenesis *J Venom Anim Toxins*, 1(2): 61-62.

30. **Mahadevan S,** 2000. Scorpion sting. *Indian Pediaatrics,* 37(5): 504-514.

31. **Kovarik F.** 1999. Review of European scorpions, with a key to species. *Sekret.* 6(2):38-44.

32. **Osnaya-Romero N, Medina-Hernandez TJ, Flores- Hernandez SS, Leon-Rojas G,** 2001. Clinical symptoms observed in children envenomated by scorpion stings, at the children's hospital from the State of Morelos, Mexico. *Toxicon*, 39 (6): 781-785.

33. **Ozkan O, Karaer Z.** 2003. The scorpions in Turkey, *Turkısh Bulletin of Hygiene and Experimental Biology*, 60 (2): 55 – 62.

34. **Ozkan O, Filazi A.** 2004. The determination of acute lethal dose-50 (LD_{50}) levels of venom in mice, obtained by different methods from scorpions, *Androctonus crassicauda* (Oliver 1807). *T Parazitol Derg,* 28 (1) : 50-53.

35. **Ozkan O, I Kat I.** 2005. *Mesobuthus eupeus* scorpionism in Sanliurfa region of Turkey. *J Venom Anim Toxins,* 11 (4): 479-491.

36. **Ozkan O, Adiguzel S, Yakitiran S, Filazi A.** 2006. Study of the relationship between *Androctonus crassicauda* (Olivier, 1807; Scorpiones, Buthidae) venom toxicity and telson size, weight and storing condition. *J Venom Anim Toxins,* 12 (2): 297-309.

37. **Ozkan O, Kar S, Adıguzel S, Yakıstıran S, Karaer Z.** Analysis of *Androctonus crassicauda* (Olivier, 1807) (Scorpiones: Buthidae) Parametric Values In Turkey. *J Venom Anim Toxins,* (In press).

38. **Pardal PP, Castro LC, Jennings E, Pardal JS, Monteiro MR**. 2003 Epidemiological and clinical aspects of scorpion envenomation in the region of Santaren, Para, Brasil. *Rev Soc Bras Med Trop*, 36(3):349-53.

39. **Radha Krishna Murthy K, Abbas Zare M.** 2002. Scorpion antivenom reverses metabolic, electrocardiographic, and hormonal disturbances caused by Indian red scorpion *Mesoburhus tamulus concanesis*, Pocock envenomation. *J Venom Anim Toxins,* 8(1): 30-48.

40. **Radmanesh M,** 1990. *Androctonus crassicauda* sting and its clinical study in Iran. *J Trop Med Hyg,* 93 (5): 323-326.

41. **Sadeghian H,** 2003. Transient ophtolmoplegia following envenomation by the scorpion. *Neurology.* 2 (2):346-347.

42. **Silva RML, Amorim AM, Brazil TK.** 2000. Envenomation by *Tityus stigmurus* (Scorpiones; Buthidae) in Bahia, Brazil. *Rev Soc Bras Med Trop,* 33 (3): 239-245.

43. **Sofer S, Shahak E, Gueron M.** 1994. Scorpion envenomation and antivenom therapy. *J Pediat,* 124 (6): 973-978.

44. **Soker, M., Haspolat K.** 2000. Güneydoğu ve Anadolu bölgesinde çocuklarda akrep sokması: 64 vakanın değerlendirilmesi. *Çocuk Sağlığı ve Hastalıkları Dergisi*. 43: 43-50.

45. **Theakston RDG, Warrell DA, Griffiths E.** 2003. Report of a WHO workshop on the standardization and control of antivenom. *Toxicon,* 20: 1-17.

46. **Touloun O, Slimani T, Boumezzough A.** 2001. Epidemiological survey of scorpion envenomation in southwestern Morocco. *J Venom Anim Toxins*, 7(2): 199-218.

47. **Tulga T.** 1960. Cross-reactions between anti-scorpion (*Buthus quinquestriatus*) and anti-scorpion (*Prionurus crassicauda*) sera. *Turkish Bulletin of Hygiene and Experimental Biology*. 20(2): 191 – 203.

48. **Tulga T.** 1964. Scorpions found in Turkey and paraspecific action of an antivenin produced with the venom of the species *Androctonus crassicauda*. *Turkish Bulletin of Hygiene and Experimental Biology*. 24(2): 146– 155.

49. **Vatanpour H,** 2003. Effects of black scorpion *Androctonus crassicauda* venom on striated muscle preparation in vitro. *Iranian Journal of Pharmaceutical Research.* 2: 17-22.

50. **Whittemore FW, Keegan HL, Borowitz JL,** 1961. Studies of scorpion antivenins. 1. Paraspecificity. *Bull. WHO,* 25: 185–188.

51. **Zlotkin E, Miranda F, Rochat H,** 1978. Chemistry and pharmacology of Buthinae scorpion venoms (Chapter 13). In: Bettini S, ed. *Handbook of experimental pharmacology-arthropod venoms*, Berlin: Spinger Verlag. 317-319.