Review Article

A Review on Scorpionism in Iran

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Abstract

Background: Scorpions are one of the most important venomous animals in Iran. Their sting has more prevalence in the south and southwest areas. The aim of this study was to introduce their sting agent species in the country.

Methods: Data were extracted by a mini review on scorpion stinging articles in Iran until early 2018 and then the sting agent species in each area were studied. Geographical and provincial distribution of each species also was provided.

Results: Twelve scorpion species are causative agents of sting. According to their deadly rate and clinical symptoms, some of them are considered the most dangerous venomous animals in Iran. Some death cases have been reported because of the sting of 3 species of Hemiscorpius lepturus, H. acanthocercus and Androctonus crassicauda. Remaining species have not deadly sting but because of their frequency, they encounter the individuals and cause the stinging.

Conclusion: The highest number of sting agents is in Khuzestan, however Gilan and Mazandaran have the lowest frequency. Because of the high prevalence of sting agent species in that province, the necessity of providing control and prevention programs is very important.

Keywords: Province, Sting agent, Scorpion, Iran

Introduction

Scorpion stinging has been reported in most of the warm areas of the world. These animals belong to the Arthropoda. Scorpion’s geographic distribution is all over the world and the latitude between equator North 50 degree and south 52 degree (1) but even in this geographic area, they have different distribution. These animals have been seen in many habitats and are able to live in very tough conditions. They use the least energy (2). They sting in order to defend and feed. They are opportunist in terms of selecting their habitat and using any natural and artificial or human-made spaces and gaps for hiding and habitat (3, 4). Some of them are nest makers and diggers. They make nests in the soil with smoother soil pattern and proper physical structure (5-7). Some species of these animals have adapted their activity inside or around the human residential areas and for this reason their probable encounter with humans has increased. Therefore, in these cases, sting threat is more in comparison with active species which are out of and farther from the human residential places (8-11).

In Iran, the species which sting humans are more opportunist in terms of habitat selection. They use ready spaces and gaps provided in the buildings because of using traditional building materials. This arthropod starts its activities at night and uses its venomous sting to defend or hunt insects to feed. The habitat of most of them is desert and non-residential places (12-14). Since these animals are hunters, like tarantulas, this kind of habitats attract the animals which are these hunters’ food. On the other hand, the scorpion hunters are attracted and make a complete food web with different food chains. Therefore, this kind of plac-
es, in addition to providing proper shelter and habitat, make their food available (15-17).

Scorpions are dangerous for humans because of having toxic and deadly sting and for this reason they are medically important so that according to the available statistics, they have the highest human casualties by venomous arthropod in the world (8, 18). Till now, 64 scorpion species have been reported in Iran (2) but no report is available if they all sting or not. The population frequency of scorpion species in Iran is more than other stinging and biting animals like venomous and non-venomous snakes; therefore, their consequence is more stings (19, 20). In Iran, scorpion sting is about 10 times more than snake biting. The highest human fatalities are caused by venomous arthropods in the world (21-23). Scorpion sting which threatens many people to death annually is one of the most important health issues in tropical and subtropical areas like Iran. The highest statistics of stings and fatalities belong to Khuzestan and Hormozgan (24-30).

Since many species live in Iran but sting of all of them has not been reported, the purpose of this study is introducing the sting agent species and determining their province distribution during the past 50 years in Iran.

Materials and Methods

In this review article, keywords like scorpion, sting agents, dangerous species, provincial distribution, Iran, identification, studies, family and species were used in the sites related to valid medical and health journals, searching in databases like Web of Science, Ovid, PubMed, Systematic Review, SID, Iran Medex, Scirus, Google Scholar and Medline to have access to the articles during 1977 until early 2018. The including criteria for entry in this study articles were as follows, the first all Iranian articles about animal bites were searched. In the next step, they study focused on venomous animal bites and stings. Then the sting agents among of the scorpions were noticed, and then all articles of the scorpion sting agents in the past decades till now have been noticed. Overall, 150 sources were found, but only 75 of these considering the purpose of the study; i.e., report of the sting agent and concentration of study on Iran, 73 sources were surveyed. In addition to the survey of these studies, their application in Iran was done. Then the gained results were provided in tables, graph and figure.

Results

Up to now, three scorpion families have been reported in Iran. The sting agent scorpions in Iran include two families of Buthidae and Hemiscorpiidae. They have 12 species from the 8 genus which 10 species belong to Buthidae family and 2 species belong to Hemiscorpiidae family. More than 83.5% of the identified sting agent species in Iran belong to Buthidae family and 16.5% belong to Hemiscorpiidae family (29, 2, 31, 32, 33). Identification of sting agent species among the scorpions of Iran has been done by different researchers especially in the field of medical sciences. Still, there are changes in the number of families, genus and species of sting agents in Iran so that in the initial reports of researchers, sting agent scorpions in Iran were introduced to be 3 to 4 species while they are 12 species now (2, 31). According to the last studies about scorpion sting agent species, there are 2 families in Iran: Buthidae and Hemiscorpiidae.

The species of *Mesobuthus eupeus* are in Ardabil, Kerman, Isfahan, Markazi, Mazandaran, Sistan and Baluchistan, Yazd, Kohgiluyeh and Boyer-Ahmad, Semnan, Fars, Khuzestan, Hormozgan, Golestan, Tehran, Kordistan, Kerman-shah, Ilam, west Azarbaijan, Khorasan Razavi and Khorasan Jonoobi. Then, *Compsobuthus matthiesseni* in Bushehr, Chaharmahal and Bakhtiari, Fars, Hamadan, Kerman, Kohgiluyeh and Boyer-Ahmad, Kordistan, Lorestan, Markazi, Qom, Khuzestan, Hormozgan, Khorasan, Kermanshah, Ilam, west Azarbaijan and Isfahan, *Hottentotta saulcyi* in Lorestan, Hamadan, Chaharmahal and Bakhtiari, Khuzestan, west

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Azarbajian, Kermanshah, Hormozgan, Ilam, Sistan and Balochistan, Kordestan, Kohgiluyeh and Boyer-Ahmad, Fars, Isfahan, Kerman and Ardabil, Odontobuthus dorai in Hormozgan, Kerman, Yazd, Isfahan, Markazi, Ghazvin, Tehran, Alborz, Semnan, west Azerbaijan, Kerman-shah, Bushehr, Hamedan, Hormozgan, Hemiscorpius lepturus in Khuzestan, Semnan, Fars, Kordestan, Hormozgan, Bushehr, Ilam, Lorestan, Kermanshah, Isfahan, Hamedan, Kohgiluyeh and Boyer-Ahmad and Kerman, Orthochirus scrobidicusus in Khuzestan, Hormozgan, Tehran, Sistan and Balochestan, Qom, Isfahan, med-dian (Razavi) Khorasan, Khorasan Jonobi, Gilan, Semnan, Kermanshah, Ilam, Androctonus crassicauda in Bushehr, Semnan, Khuzestan, Ilam, west Azarbajian, Kordestan, Khorasan Razavi, south Khorasan, Kermanshah, Kerman and Sistan and Balochistan, Mesobuthus or Olivierus caucasicus in west Azarbajian, Sistan and Balochestan, Isfahan, south Khorasan, Tehran, Markazi and Semnan, Hottentotta jayakari in Qom, Hormozgan and Fars, Hottentotta schach in Fars and Khuzestan, Hemiscorpius acantho-cercus in Hormozgan and Apistobuthus ptery-gocercus in Khuzestan have been reported, respectively (31-53) (Table 1, Fig. 1).

All the provinces of Iran have at least one or some species of scorpions of Scorpionida order which cause the sting. In Iran, the number of sting agents of order Scorpionida in Fars Province is 12 species. Overall, 64 species of scorpions have been reported in Iran so far (2, 29). Mesobuthus eupeus has a wide geography distribution in Iran and at least has been reported in 20 provinces. Most of the sting agent species are found in the South of Iran specially Khuzestan. During the last years, about 80% of all the reported sting cases in Iran have been from this area. The sting of H. jayakari has been first reported from Iran (8, 18).

According to the reports, scorpions’ venoms which their LD50 is measured less than 1.5mg/kg, in mice are considered to be in the dangerous and or deadly group. Among the species in Iran, LD50 of 5 species of this arthropod has been measured among which M. eupeus is in the dead border and has been measured as 1.45mg but LD50 of others is less (Table 2). LD50 of H. lepturus is much more than Buthidae family species but because of the delay mechanism of the venom of this arthropod, it is considered as one of the most deadly species in Iran (8, 18, 33, 54, 55). The highest geographical distribution of sting agent scorpions is related to M. eupeus and C. matthesensii reported in 20 and 18 provinces, respectively. In this study, the minimum geographical distribution belongs to H. acanthocercus reported from Hormozgan and A. pterygocercus reported from Khuzestan (8, 18, 21). Apistobuthus pterygocercus is described as A. susanae based on new samples in Khuzestan Province. However, in the reports, the name is A. pterygocercus as a sting- ing agent in Khuzestan (8, 18, 56) (Fig. 2).

**Discussion**

The number of scorpion species has been rapidly increasing in the last 3 decades in the world (57-61). The number of described species in the world has reached 2231 classified in 208 genus and 20 families. The family Buthidae with a higher frequency than others are scattered all over the world. This family includes the most dangerous species. From this family, deadly species live in Iran. In addition, the family Hemiscorpiidae from Hemiscorpius genus includes dangerous and deadly species in the Middle East especially Iran and Iraq and are classified as the most deadly scorpions of the world (62-71). At present, one of the control methods of health is the use of pesticides, that it may cause resistance to several of urban pests such as scorpions, flies and etc., therefore, the improvement of the environment and the removal of shelters could reduce the risk of scorpion stings (72-75).
Table 1. Scorpion sting agent in Iran based on family, genus and species

| Family      | Genus                     | Species                                      | Number of provinces | Author                     |
|-------------|---------------------------|----------------------------------------------|---------------------|----------------------------|
| Buthidae    | Mesobuthus                | Mesobuthus eupeus (C. L. Koch, 1839)         | 20                  | 2, 30, 29, 28, 24, 23      |
| Buthidae    | Compsotharus              | Compsotharus matthieseni (Birula, 1905)      | 18                  | 8, 13, 14, 2, 16           |
| Buthidae    | Hottentotta               | Hottentotta saulcyi (Simon, 1880)           | 15                  | 8, 18, 23–28               |
| Buthidae    | Odontobuthus              | Odontobuthus dorae (Thorell, 1876)           | 14                  | 8, 23, 25, 31, 32, 33      |
| Hemicorpiidae| Hemiscorpius             | Hemiscorpius lepturus (Peters, 1862)         | 13                  | 34–51                      |
| Buthidae    | Orthochirus               | Orthochirus scrobiculosis (Birula, 1900)     | 12                  | 8, 18                      |
| Buthidae    | Androctonus               | Androctonus crassicauda (Olivier, 1807)      | 12                  | 8, 18, 28, 27, 30, 52      |
| Buthidae    | Mesobuthus or Olivierus   | Mesobuthus or Olivierus caucasicus (Nordmann, 1840) | 7                   | 8, 18                      |
| Buthidae    | Hottentotta               | Hottentotta jayakari (Pocock, 1895)         | 3                   | 28                         |
| Buthidae    | Hottentotta               | Hottentotta schach (Birula, 1905)           | 2                   | 8, 18                      |
| Hemicorpiidae| Hemiscorpius             | Hemiscorpius acanthocercus (Monod et Lourenço, 2005) | 1                   | 53                         |
| Buthidae    | Apistobuthus              | Apistobuthus pterygocercus (Finnegan, 1932)  | 1                   | 8, 18                      |

Table 2. LD_{50} of sting agent scorpions in Iran based on the injection method

| Species                  | LD_{50}*       | Method**       | Family   |
|--------------------------|----------------|----------------|----------|
| Androctonus crassicauda  | 0.08–0.50      | Sc/iv          | Buthidae |
| Odontobuthus dorae       | 0.19           | iv             | Buthidae |
| Hottentotta saulcyi      | 1.01           | iv             | Buthidae |
| Mesobuthus eupeus        | 1.45           | iv             | Buthidae |
| Hottentotta schach       | 3.36–4.2       | iv             | Buthidae |
| Hemiscorpius lepturus    | 5.81           | iv             | Hemicorpiidae |

*The dose is expressed in mg of venom per kg of mouse

**Method: iv= intravenous injection, ip= intraperitoneal injection, sc= subcutaneous injection

Fig. 1. Provincial abundance of scorpion sting agents in Iran
Conclusion

At present, the most dangerous species of scorpions are in the South and Southwest of Iran. However, completing the data about the sting agent scorpions’ species in Iran needs more efforts of young researchers. Meanwhile, the completion of data in the field of Iran’s sting agent scorpion species and different aspects of it needs cooperation between the physicians of the venomous animal’s sting therapy units and the entomologist in this field. More accurate studies will be done with the cooperation of specialists of different fields about the sting agent species and the clinical effects of each species. This work necessitates a complete research in the country with a similar method and in the provinces and cities. Still, the highest species diversity is seen in the South and Southwest provinces but the diversity of scorpions in the Northeast and Northwest of Iran is less than the Southwest. In high-risk cities and villages, we recommend to the authorities of emergency department of hospitals and treatment centers, to emphasis on having scorpion sting agent by victim companions, because it helps to accurately identify sting agent.

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The authors declare that there is no conflict of interests.

References

1. Chippaux JP, Goyffon M (2008) Epidemiology of scorpionism: a global appraisal. Acta Trop. 107(2): 71–79.
2. Motevalli Haghi F, Dehghani R (2017) A Review of Scorpions Reported in Iran. J Mazandaran Univ Med Sci. 27(151): 213–226.
3. Dehghani R, Hoseindoost G, Seyyedi Bidgoli N, Zamani M, Ghadami F (2017) Study of Pests of Residential Complex and Student Dormitories of Kashan University of Medical Sciences. J Ent Res. 41(3): 311–316.
4. Ahmadimazale M, Sabuhi H, Sabahi Bidgoli
M, Dehghani R, Hoseindoost G, Mesgari L (2017) Study of Scorpion Species Abundance in cities Aran and Bidgol and Kashan, Isfahan, Iran. J Ent Res. 41(3): 337–342.
5. Dehghani R, Kamiabi F, Mohammadzadeh N (2017) Burrowing Habits of two Arthropods; Odonthobutus doriae and Hemilepistus shirazi in desert soils of Isfahan, Iran. J Ent Res. 41(2): 113–118.
6. Dehghani R, Kamiabi F (2017) Frequency of Odonthobutus doriae Thorell 1876 nests in desert soils, Esfahan, Iran. J Ent Res. 41(1): 13–18.
7. Yousef-Mogaddam M, Dehghani R, Enayati AA, Fazeli-Dinan M, Vazirianzadeh B, Yazdani-Cherati J, Motevalli Haghi F (2017) Scorpion Fauna (Arachnida: Scorpiones) in Darmian County, Iran (2015–2016). J Mazandaran Univ Med Sci. 26(144): 108–118 (Persian)
8. Dehghani R, Fathi B (2012) Scorpion sting in Iran: A review. Toxicon. 60(5): 919–933.
9. Dehghani R, Kassiri H (2017) Geographical Distribution of Scorpion Odonthobutus doriae in Esfahan Province, Central Iran. J Arthropod Borne Dis. 11(3): 433–440.
10. Nejati J, Mozafari E, Saghafigour A, Kiyani M (2014) Scorpion fauna and epidemiological aspects of scorpionism in south-eastern Iran. Asian Pac J Trop Biomed. 4(Suppl 1): S217–S221.
11. Nejati J, Saghafigour A, Mozaffari E, Keyhani A, Jesri N (2017) Scorpions and scorpionism in Iran’s central desert. Acta Trop. 166: 293–298.
12. Yousef-Mogaddam M, Dehghani R, Enayati AA, Fazeli-Dinan M, Motevalli Haghi F (2016) Epidemiology of Scorpionism in Darmian, Iran, 2015. J Mazandaran Univ Med Sci. 26(141): 131–136. (Persian)
13. Dehghani R, Arani MG (2015) Scorpion sting prevention and treatment in ancient Iran. J Tradit Complement Med. 5(2): 75–80.
14. Nazari M, Hajizadeh MA (2016) Faunistic Study on Scorpions and the Epidemiology of Scorpionism in Bam, Southeast of Iran. Glob J Health Sci. 9(2): 177–182.
15. Dehghani R, Valizade R, Mahmoudi S (2016) A review of the scorpion predators and the introduction of Scartes subterraneus, as a new predatory of them in Iran. J Ent Res. 40(3): 291–296.
16. Dehghani R, Khamenehchian T, Miranzadeh MB (2007) Surveying on the Biologic behaviors of Hemiscorpius lepturus (Peters, 1861) scorpion in laboratory (Khuzestan, Iran) (Scorpions: Hemiscorpiidae). Pak J Biol Sci. 10(18): 3097–3102.
17. Dehghani R (2017) Solpugidophobia in Iran: Real or Illusion. J Biol Today's World. 6(3): 46–48.
18. Dehghani R, Djadid ND, Shahbazzadeh D, Bigdelli S (2009) Introducing Compsobuthus matthiesseni (Birula, 1905) scorpion as one of the major stinging scorpions in Khuzestan, Iran. Toxicon. 54(3): 272–275.
19. Dehghani R, Sharif A, Madani M, Kashani HH, Sharif MR (2016) Factors Influencing Animal Bites in Iran: A Descriptive Study. Osong Public Health Res Perspect. 7(4): 273–277.
20. Dehghani R, Dadpour B, Keyler D, Panjehshahi M, Jazayeri M, Mehrpour O, Tamijani AH (2016) A survey on Non-Venomous Snakes in Kashan (Central Iran). J Biol Today's World. 5(4): 65–75.
21. Dehghani R, Mehrpour O, Shahi MP, Jazayeri M, Karrari P, Keyler D, Zamani N (2014) Epidemiology of venomous and semi-venomous snakebites (Ophidia: Viperidae, Colubridae) in the Kashan City of the Isfahan Province in Central Iran. J Res Med Sci. 19(1): 33–40.
22. Dehghani R, Fathi B, Shahi MP, Jazayeri M (2014) Ten years of snakebites in Iran. Toxicon. 90: 291–298.
23. Dehghani R, Sharif A, Assadi MA, Hadad-Kashani H, Sharif MR (2016) Fungal flora in the mouth of venomous and non-venomous snakes. Comp Clin Pathol. 25:
1207–1211.
24. Jalali A, Rahim F (2014) Epidemiological review of scorpion envenomation in Iran. Iran J Pharm Res. 13(3): 743–756.
25. Shahi M, Mousavi SH, Navidpour SH, Rafinejad J (2015) A Review Study on Distribution and Medical Importance of *Hemiscorpius* Peters, 1861 in Iran. J Mazandaran Univ Med Sci. 24(120): 107–124 (Persian).
26. Dehghani R, Rafinejad J, Fathi B, Panjeh-Shahi M, Jazayeri M, Hashemi A (2017) A Retrospective Study on Scorpionism in Iran (2002–2011). J Arthropod Borne Dis. 11(2): 184–193.
27. Dehghani R, Vazirianzadeh B, Rahimi Nasrabadi M, Moravej SA (2010) Study of scorpionism in Kishan in central of Iran. Pak J Med Sci. 26(10): 955–958.
28. Shahbazzadeh D, Amirkhani A, Djadid ND, Bigdeli S, Akbari A, Ahari H, Amini H, Dehghani R (2009) Epidemiological and clinical survey of scorpionism in Khuzestan Province, Iran (2003). Toxicon. 53(4): 454–459.
29. Sanaei-Zadeh H, Marashi SM, Dehghani R (2017) Epidemiological and clinical characteristics of scorpionism in Shiraz (2012–2016), development of a clinical severity grading for Iranian scorpion envenomation. Med J Islam Repub Iran. 31: 27.
30. Nazari M, Najafi A (2016) An Epidemiological Study on Scorpion Envenomation in Kazerun, Iran, 2009–2014. J Mazandaran Univ Med Sci. 26(140): 206–211 (Persian)
31. Mirshamsi O, Sari AR, Hosseinie S (2011) History of study and checklist of the scorpion fauna (Arachnida: Scorpiones) of Iran. Progress in Biological Sciences. 1(2): 16–28.
32. Dehghani R, Saberi HR, Sabahi Bidgoli M, Charkhloo E, Chimehi E, Mohammadzadeh N (2018) Survey of museum beetle (*Dermestes* sp.) damage to the scorpion collection in the Health Faculty of Kashan University of Medical Sciences. J Ent Res. 42(2): 295–300.
33. Vatanpour H, Ahmadi F, Mirakabadi AZ, Jalali A (2012) Two Biological Active Fractions Isolated from *Buthotus schach* (BS) Scorpion Venom Examined on Striated Muscle Preparation, In-vitro. Iran J Pharm Res. 11(3): 905–911.
34. Dehghani R, Moabed S, Kamyabi F, Haghdoost A, Mashayekhi M, Soltani H (2008) Scorpions fauna of Kerman Province-Iran. Journal of Kerman University of Medical Sciences. 15(2): 172–181.
35. Zare-Mirakabadi A (2013) *Hemiscorpius lepturus* envenomation: manifestations and management with specific antivenom. Arch Razi Inst. 68(2): 91–99.
36. Radmanesh M (1990) Clinical study of *Hemiscorpius lepturus* in Iran. J Trop Med Hyg. 93(5): 327–332.
37. Moosavy SH, Shahi M, Rafinejad J, Zare S, Madani A, Navidpour S (2016) Epidemiological aspect of scorpion sting in Bandar Abbas, Iran, during 2009–2011. Electron Physician. 8(4): 2286–2290.
38. Pipelzadeh MH, Jalali A, Taraz M, Pourabbas R, Zaremirakabadi A (2007) An epidemiological and a clinical study on scorpionism by the Iranian scorpion *Hemiscorpius lepturus*. Toxicon. 50(7): 984–992.
39. Radmanesh M (1998) Cutaneous manifestations of the *Hemiscorpius lepturus* sting: a clinical study. Int J Dermatol. 37: 500–507.
40. Malhotra KK, Chadha JS, Mirdehghan M, Tandon D (1978) Acute renal failure following scorpion sting. Am J Trop Med Hyg. 27(3): 623–626.
41. Mostafazadeh B, Gorbani A, Mogaddaspour M, Khoddami Vishteh HR (2017) The effect of plasmapheresis on treating disseminated intravascular coagulation (DIC) caused by a *Hemiscorpius lepturus*
42. Dehghani R, Khamenehian T, Vazirianzadeh B, Moravvej S (2012) Toxic effects of scorpion, Hemiscorpius lepturus (Hemiscorpiidae) venom on mice. J Anim Plant Sci. 22(3): 593–596.
43. Ghafourian M, Ganjilikhahakemi N, Hemmati AA, Dehghani R, Kooti W (2016) The Effect of Hemiscorpius lepturus (Scorpionida: Hemiscorpiidae) Venom on Leukocytes and the Leukocyte Subgroups in Peripheral Blood of Rat. J Arthropod Borne Dis. 10(2): 159–167.
44. Shayesteh AA, Zamiri N, Peymani P, Zargani FJ, Lankarani KB (2011) A novel management method for disseminated intravascular coagulation like syndrome after a sting of Hemiscorpius lepturus: a case series. Trop Biomed. 28: 518–523.
45. Rahmani AH, Jalali A (2012) Symptom patterns in adult patients stung by scorpions with emphasis on coagulopathy and hemoglobinuria. J Venom Anim Toxins Incl Trop Dis. 18(4): 427–431.
46. Valavi E, Ansari MA (2008) Hemolytic uremic syndrome following Hemiscorpius lepturus (scorpion) sting. Indian J. Nephrol. 18(4): 166–168.
47. Mirakabbadi A, Zolfagharian H, Hedayat A, Jalali A (2007) Clinical and biochemical manifestation produced by scorpion (Hemiscorpius lepturus) venom in experimental animals. J Venom Anim Toxins Incl Trop Dis. 13(4): 758–765.
48. Seyedian R, Jalali A, Babaei MH, Pipelzadeh MH, Rezaee S (2012) A biodistribution study of Hemiscorpius lepturus scorpion venom and available polyclonal antivenom in rats. J Venom Anim Toxins Incl Trop Dis. 18(4): 375–383.
49. Jalali A, Pipelzadeh MH, Seyedian R, Rahmani AH, Omidian N (2011) In vivo pharmacological study on the effectiveness of available polyclonal antivenom against Hemiscorpius lepturus venom. J Venom Anim Toxins Incl Trop Dis. 17(2): 142–149.
50. Kassiri H, Teimouri A, Shemshad M, Sharifiinia N, Shemshad K (2012) Epidemiological survey and clinical presentation on scorpionism in south-west of Iran. Middle-East J Sci Res. 12(3): 325–330.
51. Zare Ma, Jalali A, Jahromi Ea, Vatanpour H, AKBary A (2006) Biochemical changes and manifestation of envenomation produced by Odonthobuthus doriae venom in rabbits. J Venom Anim Toxins Incl Trop Dis. 12: 67–77.
52. Jalali A, Vatanpour H, Hosseininasab Z, Rowan EG, Harvey AL (2007) The effect of the venom of the yellow Iranian scorpion Odonthobuthus doriae on skeletal muscle preparations in vitro. Toxicology. 50(8): 1019–1026.
53. Radmanesh M (1990) Androctonus crassicauda sting and its clinical study in Iran. J Trop Med Hyg. 93: 323–326.
54. Shahi M, Rafinejad J, Az-Khosravi L, Moosavy SH (2015) First report of death due to Hemiscorpius acanthocercus envenomation in Iran: Case report. Electron Physician. 7(5): 1234–1238.
55. Oukkache N, Jaoudi RE, Ghalim N, Chgoury F, Bouhaouala B, Mdaghri NE, Sabatier JM (2014) Evaluation of the lethal potency of scorpion and snake venoms and comparison between intraperitoneal and intravenous injection routes. Toxins. 6 (6): 1873–1881.
56. Navidpour S, Lowe G (2009) Revised diagnosis and redescription of Apistobuthus susanae (Scorpiones, Buthidae). J Arachnol. 37(1): 45–59.
57. Mohammadi-Bavani M, Rafinejad J, Hanafi-Bojd AA, Oshaghi MA, Navidpour S, Dabiri F, Badakhshan M, Ghorbani G, Bagheri M (2017) Spatial distribution of medically important scorpions in north west of Iran. J Arthropod Borne Dis. 11 (3): 373–382.

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58. Soleglad ME, Fet V, Kovařík F (2005) The systematic position of the scorpion genera *Heteroscorpion* Birula, 1903 and *Urodacus* Peters, 1861 (Scorpiones: Scorpionoidea). Euscorpius. 20: 1–38.

59. Prendini L (2000) Phylogeny and classification of the superfamily *Scorpinoidea lateillei* 1802 (Chelicerata, Scorpiones): An exemplar approach. Cladistics. 16: 1–78.

60. Prendini L, Wheeler WC (2005) Scorpion higher phylogeny and classification, taxonomic ancestry, and standards for peer review in online publishing. Cladistics. 21(5): 446–494.

61. Soleglad ME, Fet V (2003) High-level systematics and phylogeny of the extent Scorpions (Scorpiones: Orthosterni). Euscorpius. 11: 1–175.

62. Prendini L (2011) Order Scorpiones C.L. Koch, 1850. In Animal Biodiversity: An Outline of Higher-Level Classification and Survey of Taxonomic Richness; Zhang ZQ, Ed., Zootaxa: Auckland, New Zealand. 3148: 115–177.

63. Santibáñez-López CE, Francke OF, Ureta C, Possani LD (2015) Scorpions from Mexico: From species diversity to venom complexity. Toxins (Basel). 8(1): 2.

64. Rein-Ove J, Scorpion Files (2014) Trondheim. Norwegian University of Science and Technology. Available at: http://www.ntnu.no/ub/scorpion-files (accessed on 21 March 2017).

65. Soleglad ME, Fet V (2008) Contributions to scorpion systematics. III. Subfamilies Smeringurinae and Syntropinae (Scorpiones: Vaejovidae). Euscorpius. 71: 1–115.

66. Lowe G (2016) Two new *Hemiscorpius* Peters, 1861 (Scorpiones: Hemiscorpiidae) from Northern Oman. Euscorpius. 2010 (91): 1–24.

67. Monod L, Lourenço WR (2005) Hemiscorpiidae (Scorpiones) from Iran, with descriptions of two new species and notes on biogeography and phylogenetic relationships. Rev Suisse Zool. 112(4): 869–941.

68. Dehghani R, Kamiabi F, Mohammadi M (2018) Scorpionism by *Hemiscorpius* spp. in Iran: a review. J Venom Anim Toxins Incl Trop Dis. 24(1): 8.

69. Dehghani R, Khoobdel M, Sobati H (2018) Scorpion Control in Military Units: A Review Study. J Mil Med. 20(1): 3–13.

70. Dehghani R, Kamiabi F, Kassiri H, Hashemi A, Mohammadzadeh N, Gharagazloo F (2018) A Study on Litter Size in Several Important Medical Scorpions Species (Arachnida: Scorpionida), Iran. J Entomol. 15: 155–160.

71. Dehghani R, Kassiri H (2018) A Checklist of Scorpions in Iran (By 2017). Asian J Pharm. 12(3): 880–887.

72. Mostafaii G, Dehghani R, Najafi M, Moosavi G, Rajaei M, Moghadam VK, Takhtfiroozeh S (2017) Frequency of urban pests and pesticides consumption in the residential houses of the east of Tehran City, Iran. J Entomol Res. 41: 125–132.

73. Dehghani R, Limooe M, Zarghi I (2012) The review of pesticide hazards with emphasis on insecticide resistance in arthropods of health risk importance. Sci J Kurdistan Univ Med Sci. 17: 82–98 (Persian).

74. Kazemi-Moghaddam V, Dehghani R, Hadei M, Dehgan S, Sedaghat MM, Latifi M, Alavi-Moghaddam S (2018) Rodent-borne and rodent-related diseases in Iran. Comp Clin Pathol. pp. 1–13.

75. Dehghani R, Sedaghat MM, Bidgoli MS (2012) Wound myiasis due to *Musca domestica* (Diptera: Muscidae) in Persian horned viper, *Pseudocerastes persicus* (Squamata: Viperidae). J Arthropod Borne Dis. 6: 86–89.