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Species diversity and abundance of scorpions in Ahvaz city, Southwest Iran

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Abstract. *Mansouri NJS, Akbarzadeh K, Jahanifard E, Vazirianzadeh B, Rafinejad J. 2021. Species diversity and abundance of scorpions in Ahvaz city, Southwest Iran. Biodiversitas 22: 763-768.* Arthropods are one of the most important and diverse phyla of the animal kingdom. This phylum includes several classes of insects and arachnids, which are of medical and veterinary importance. Scorpions are at the top of the group of venomous arthropods in terms of having venomous bites and causing death. Scorpions live mainly in tropical and subtropical regions of the world and therefore have higher diversity and richness in these regions. This study aimed to investigate the biodiversity and abundance of scorpions in Ahvaz city, Khuzestan province, Iran. It has the highest species diversity and species richness in Iranian scorpions. Scorpions were collected from five regions in Ahvaz using various methods. In total 237 scorpions were collected and identified. They belonged to two families, seven genera and seven species: *Mesobuthus eupeus* (65%), *Hemiscorpius lepturus* (23.2%), *Androctonus crassicauda* (3.8%), *Compsobuthus rugosulus* (3.4%), *Orthochirus zagrosensis* (2.5%), *Apistobuthus susanae* (1.7%), *Buthacus macrocentrus* (0.4%). Except for *H. lepturus* (Hemiscorpiidae), other species belonged to the Buthidae family. That all of them were non-burrowing. *M. eupeus* was the dominant species diversity analysis indicated higher species richness and species diversity for summer (Margalef = 1.07; Shannon = 1.55). Logistic regression analysis showed that the variables of geographical location, humidity, and temperature had a significant relationship with the abundance of scorpion species, while height had no statistically significant.

Keywords: Biodiversity, Iran, Khuzestan, Scorpion sting

INTRODUCTION

Scorpions were among the first animals, which left marine environments and occupy terrestrial environments. Approximately more than 2,000 species of this group are currently known. Fifty of them can be dangerous to humans (Schwerdt et al. 2016). Scorpions belong to the class Arachnida. They are closely related to spiders, mites, and ticks the pests of greatest economic and public health concern. Scorpion habitats range from the intertidal zone to snow-covered mountains but they are commonly thought of as desert dwellers (Shahi et al. 2016). Scorpions can be found worldwide, except in Antarctica. The presence of some species in urban areas is well-known. Most of the time, scorpions prefer to stay away from urban environments. But today with the increase in population and uncontrolled urbanization, the possibility of contact between humans and these animals has increased and become a prevalent pest, especially in the outskirts of cities.

Iran has a high plant and animal diversity due to a diverse climate. Scorpion stings are a public health problem in south and southwest Iran (Molaee et al. 2014) because of high scorpion envenomation incidence (Kassiri et al. 2014b; Kassiri et al. 2014a; Rahmani and Jalali 2012). According to the latest studies, Iranian scorpions include three families Hemiscorpiidae (9.5%), Scorpionidae (4.5%), Buthidae (86%) and they include 44 species in 23 genera (Kassiri et al. 2014b). *Androctonus crassicauda* and *Odontobuthus doriae* are distributed in all parts of the country (Rafinejad et al. 2020), while other reported species are mainly distributed in the southern and southwestern regions and with about 95% of species of scorpions are the most densely populated areas in the country (Dehghani and Fathi 2012; Navidpour 2008; Navidpour et al. 2008). Nearly about 50,000 stung cases are reported yearly in Iran, which puts Iran in the second grade after Mexico (Kassiri et al. 2012). Most of the scorpion stings are reported from the southern and southwestern areas of the country (Jalali and Rahim 2014).

Ahvaz city is located in the plains of Khuzestan in a dry climate. Unlike most organisms, most scorpion species prefer arid areas. Species richness and diversity of scorpions are higher in these areas (Lourenço 1994). Climate factors and habitat type are the most important determinants of the distribution of these venomous arthropods (Rafinejad et al. 2020).

Diversity is a concept that refers to the range of changes or differences between the creatures of society and usually implies a measure of both species number and ‘equitability’ (or ‘Evenness’). Three types of indices can be distinguished: (i) Species richness indices, (ii) Evenness indices (Evenness expresses how evenly the individuals in a community are distributed among the different species), (iii) Taxonomic indices (these indices take into account the

taxonomic relationships between different organisms in a community) (Khan 2006). Biodiversity is the variation among living organisms from different sources including terrestrial, marine, and desert ecosystems, and the ecological complexes of which they are apart (Hamilton 2005). There are the following three different types of biodiversity: Genetic diversity (intraspecific), Species diversity (interspecies), Ecological diversity (between ecosystems) (Chernov et al. 2015). The main objective of the present study was to determine the species diversity, habitat, and abundance of scorpions in Ahvaz city.

MATERIALS AND METHODS

Study area

Ahvaz is a city in the southwest of Iran and the capital of Khuzestan province (Figure 1) in 31° 19′ 13″ N and 48° 40′ 9″ E. Ahvaz is located in Khuzestan plain with a height of 18 m a.s.l. It has a subtropical hot and humid climate with hot summers and short, mild winters. The northern and central parts of Ahvaz city are flat and relatively fertile plains, while the eastern and western margins are dunes that run parallel to the heights of the southern Zagros, from northwest to southeast. There is a dry and barren plain of marl in the southern and southeastern part of the city (a type of calcium carbonate soil that contains 65% clay and 35% carbonate). This city is placed in the hottest areas of Iran due to the acute shortage of vegetation. Summer temperatures are regularly at least 45°C sometimes exceeding 50°C with many sandstorms and dust storms common during the summer period. However, in winters, the minimum temperature can fall to around 5°C (41 °F). The average annual rainfall is around 230 mm.

Study procedure and collection technique and identification

A study was conducted in Ahvaz city from April of 2018 to March of 2019 in five stations. For this purpose, sampling was done by various methods (Figure 2) from different areas of Ahvaz city (north, south, east, west, and center). The northern and central areas of the plain were smooth and relatively fertile, south and southeast margins were plain dry, and Eastern and Western margins were sand and dunes. In an area of 100 × 100 m (10 000 m^2), during four seasons (once per season). In each area, at the beginning of the work, a hygrometer and thermometer were placed in a suitable place, and at the end of the search and catching scorpions, while recording the temperature and humidity of the study area, the geographical location was determined using a GPS device and recorded in the relevant tables.

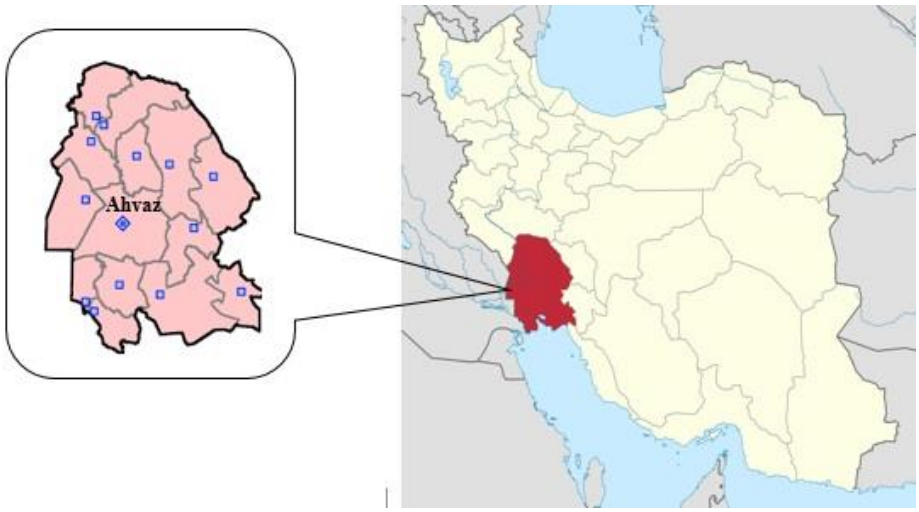

Figure 1. The geographical location of Ahvaz City, Khuzestan Province, southwest Iran

A **B** **C**

Figure 2. The used methods of scorpion sampling. A. UV light, B. Pitfall trap, C. wet bags

Biodiversity and statistical analysis

To calculate the species richness we used Menhinick's index DMn=S/√N where S is the total number of species, N is the sample size or a total number of individuals in the sample) and Margalef index (S-1)/lnN), which is: lnN natural logarithm N 6 or log e N) and to calculate biodiversity from the Shannon-Weiner index (H = -∑ Pi(lnPi)) where Pi is the share of individuals in species i to the total sample that The form Pi=ni/N) which is most frequently used to characterize the diversity of communities. The evenness of the taxon abundances mainly determines the Shannon index. The evenness measure from the Shannon index is sometimes calculated separately using the observed evenness ratio to its maximum value. Simpson index (D = ΣPi2 where S is the total number of sample species and Pi is the share of individuals in species i) the value of D decreases when the evenness of the taxa increases; therefore, the Simpson index is frequently used in form 1– D (called the probability of interspecies encounter) or in the form 1/D (called the inverse Simpson index or the Williams polydominance index) which is frequently determined as the probability of belonging to different taxa for two organisms randomly selected from an indefinitely large community. Evenness index (***E*=*H*'/*lns***=H/H max) at the alpha level (diversity of organisms in a Habitat or a selected sample) was measured and calculated. The data were analyzed using Microsoft Excel 2010 software.

RESULTS AND DISCUSSION

In this study, a total of 237 scorpion specimens from Ahvaz city were collected and identified from five regions for 12 months. Most samples were collected from the central area (48.5%) and the lowest was in the western region (6.3%). The highest average temperature was related to summer (44.6°C) and the lowest was related to winter (17.5°C). the average temperature of the city was 29°C in one year. And the highest average humidity was related to winter (76.5%) and the lowest was related to spring at 21.8% and the average humidity of the city was 47.7% in one year (Table 1).

The collected samples included two families: Buthidae (76.8%) and Hemiscorpiidae (23.2%). Seven species in seven genera were non-burrowing. Out of 237 samples taken, the highest frequency was related to *M. eupeus* (65%) of Buthidae family and the lowest frequency was related to *B. macrocentrus* (0.4%). The results also showed that two species, *M. eupeus* and *H. lepturus*, accounted for 88.2% of the samples collected from the five regions (Table 2).

Diversity analysis indicated higher species richness and species diversity for Summer (Margalef = 1.07; Shannon = 1.5). But Menhinick index was higher in autumn (*E*=0.82). The average diversity indices for seasons ranged from 0.32 to 1.5 for the Shannon index and from 0.5 to 0.74 for the Simpson index. The evenness index of scorpions was also higher in summer (*E*=0.86) (Table 3).

Biodiversity data for the Scorpion community in different seasons in Ahvaz indicates higher species diversity in the Scorpion community in summer compared to other seasons. Although in summer the dispersion uniformity index shows a small amount since this index (dispersion uniformity) is small but with little change almost throughout the year. By using the higher Shannon index and Margaleph index in summer, the overall biodiversity in summer can be taken into account. The scorpion community of Ahvaz seems to have relatively higher stability in summer than in other seasons. Important species diversity index (Shannon: 0.77*) of scorpion community in Ahvaz during winter has reached its lowest level in different seasons. However, the Simpson Index chart has an increasing trend in winter has shown itself. So the scorpion community of Ahvaz seems to be relatively less stable in winter. This situation indicates the appropriate conditions of society for the activity of the most dominant species or species. But since the species richness index has been low this season. The emergence or activity of a species as the dominant species in this season cannot be considered as significant (Figure 3).

To investigate the effect of temperature, humidity, and geographical location on the abundance of scorpion species in Ahvaz in 2018-2019, the multilevel logistic regression analysis method was used (Tables 4).

Table 2. Scorpions collected from Ahvaz city, southwest Iran, 2018-2019

Family	Species	Frequency (%)
Buthidae	*Mesobuthus eupeus* (C.L.Cock1839)	154 (65)
	Androctonus crassicauda (Oliver 1807)	9 (3.8)
	Compsobothus rugosulus (Pocock 2005)	8 (3.4)
	Orthochirus zagrosensis (Kova¯Ìk, 2004)	6 (2.5)
	Buthacus macrocentrus (Ehrenberg, 1828)	1 (0.4)
	Apistobuthus susanae (Lourenco 1998)	4 (1.7)
Hemiscorpiidae	*Hemiscorpius lepturus* (Peters, 1861)	55 (23.2)
Total	7	237 (100)

Table 1. Seasonal average temperature and humidity (April 2018-March 2019) Ahvaz, southwest Iran

Seasons	Spring	Summer	Autumn	Winter	Annual average
Average temperature (degrees)	34.2	44.6	19.4	17.5	29
Average humidity (%)	21.8	37.6	55	76.5	47.7

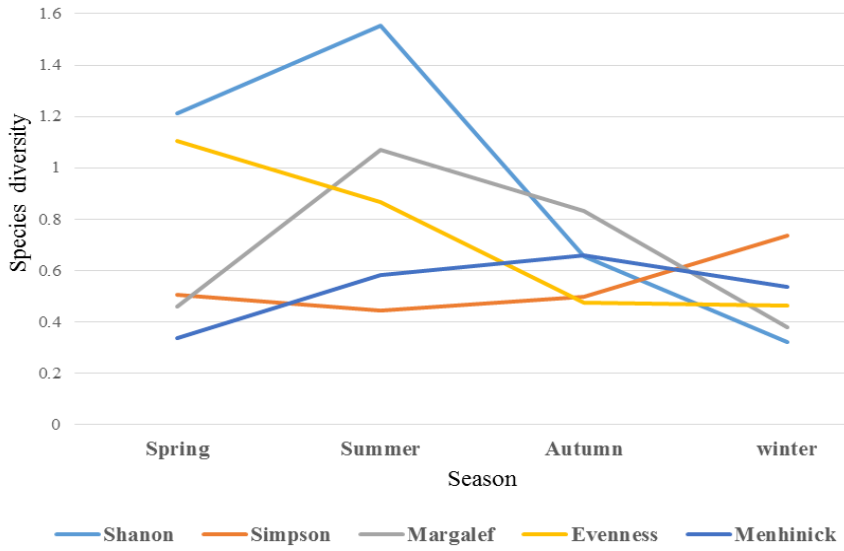

Figure 3. Seasonal Diversity parameters of collected scorpion in Ahvaz city, southwest Iran, 2018-2019

Table 3. Diversity parameters for Scorpions at different seasons, collected from April of 2018 to march of 2019

Diversity indices	Spring	Summer	Autumn	Winter
Shannon	1.21	1.5	0.65	0.32
Simpson	0.5	0.45	0.5	0.74
Margalef	0.46	1.07	0.83	0.38
Evenness	1.1	0.86	0.47	0.46
Menhinick	1.23	0.58	0.82	0.53

Table 4. Effect of Temperature, Humidity, and Geographical Location on Scorpion in Ahvaz city, southwest Iran, 2018-2019

	Species	B	SE	Wald	df	Sig.	Exp(B)
M.eupeus	Intercept	6.386	3.072	4.322	1	.038	
	Temperature	-.071	.068	1.095	1	.295	.931
	Humidity	-.035	.027	1.705	1	.192	.965
	[sex=0]	-.951	.717	1.757	1	.185	.387
	[sex=1] [a]	-	-	-	-	-	-
	[geo_direction=0]	1.376	1.127	1.489	1	.222	3.958
	[geo_direction=1]	1.221	1.039	1.381	1	.240	3.392
	[geo_direction=2]	-4.994	1.200	17.318	1	.000	.007
	[geo_direction=3]	1.227	1.359	.815	1	.367	3.409
	[geo_direction=4] [b]	-	-	-	-	-	-
H.lepturus	Intercept	12.971	4.093	10.042	1	.002	
	Temperature	-.206	.092	5.024	1	.025	.813
	Humidity	-.118	.036	10.517	1	.001	.889
	[sex=0]	-1.424	.772	3.404	1	.065	.241
	[sex=1] [a]	-	-	-	-	-	-
	[geo_direction=0]	.301	1.251	.058	1	.810	1.351
	[geo_direction=1]	-.237	1.382	.029	1	.864	.789
	[geo_direction=2]	-23.076	.000	.	1	.	9.515E-11
	[geo_direction=3]	-15.297	1674.312	.000	1	.993	2.273E-7
	[geo_direction=4] [b]						

Note: a) Sex=1 was considered as reference category; b) Geo_direction=4 was considered as the reference category; B= this is the coefficient for the constant, SE= this is the standard error around the coefficient for the constant, Wald= This is the Wald chi-square test that tests the null hypothesis that the constant equals 0, df= degrees of freedom, sig= significance, Exp(B)= This is the exponentiation of the B coefficient, which is an odds ratio

Logistic regression analysis showed that geographical location, humidity, and temperature had a positive significant relationship with species caught but altitude had no significant relationship with the species of scorpion caught. In *M.eupeus*, the chance of catching this species in the eastern region was significantly less than other species relative to the center region. Effect of variables such as humidity, temperature, and geographical area in *H. lepturus* catch was significantly different compared to other species. For example, by increasing one unit of temperature, the chance of catching *H. lepturus* species compared to other species decreases by 12%.

In 1807, Olivier identified and recorded Iranian scorpions for the first time(Dehghani and Fathi 2012). Later, many types of research were designed in different parts of the country to identify scorpion species (Dehghani and Valaie 2004). Most scorpion species are in the southern part of Iran due to their geographical location and climate, include Khuzestan province, where the climate is relatively dry and suitable for scorpions. Scorpion-sting envenomation is one of the public health problems and injuries in the Khuzestan province and this area has a high rate of a scorpion sting (Gholizadeh et al. 2016).

The temperature has an important role in scorpion stings (Molaee et al. 2014). The results of this study showed that the activity of scorpions increases with increasing temperature. Diversity analysis indicated higher species richness and species diversity for summer (Margalef = 1.07; Shannon = 1.55). Some other studies reported that 49.7-93.4% of scorpion sting cases occurred in summer (Taj et al. 2012; Shahi et al. 2016; Vazirianzadeh et al. 2006; Haghi et al. 2018). These results are consistent with our study.

According to a study in Ramshir, Khuzestan province collectively, five species and 283 individual scorpions belonging to three families (Buthidae, 88.3 %; Scorpionidae, 7.8 %; Hemiscorpiidae, 3.9 %) were captured (Gholizadeh et al. 2016). The reason for this difference might be due to ecological and weather-related factors.

Mesobuthus eupeus is a polymorphic and native scorpion in the Iranian Buthidae family. In this study, 78% of the scorpions collected belonged to the Buthidae family, and *M. eupeus* was the most abundant species (65%). The distribution range of this species is quite extensive in Iran. It is thought to be the most widely dispersed *Mesobuthus* species, perhaps even of the family Buthidae. They do not dig burrows and prefer using natural spaces and burrows under stones and other objects. This species mostly lives in arid or semi-arid habitats with little or no vegetation like the Ahvaz city (Mirshamsi et al. 2011).

In the study on scorpions in the Khuzestan province, Vazirianzadeh et al. (2008) identified 14 species related to *M eupeus*, *H. lepturus*, and *A.crassicauda*, which was consistent with the results of the present study.

In the present study, this scorpion was the second most common scorpion (23.2%). Because the present study was conducted in urban areas and this species is very dangerous in terms of toxicity, necessary measures should be taken to control it. It also occurs in Pakistan, Yemen, and Iraq. Previous studies have shown that *H. lepturus* has a wide distribution in Semnan, Hormozgan, Khuzestan, Bushehr, Fars, Kurdistan, Ilam, Lorestan, Kohgilouyeh Va Boyer Ahmad, and Kermanshah provinces (Dehghani et al. 2018; Pirali-Kheirabadi et al. 2009; Mozaffari et al. 2013).

The third most common species was *Androctonus crassicauda* (3.8%). This species is not a digger and was found in and around rural areas. These species were nocturnal, inside buildings and houses in the villages.

Other species collected in this study are *Compsobuthus rugosulus*, *Orthochirus zagrosensis*, *Buthacus macrocentrus*, and *Apistobuthus susanae*. Because caught near human places, each of these species can cause dangers and Injuries, if encountered by humans.

The results of this study can be very valuable for the health system because the sampling areas have been on the outskirts of the city and close to human places. And they can cause a lot of problems, especially for children. Therefore, necessary measures should be taken to prevent accidents and injuries caused by scorpions.

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REFERENCES

Dehghani R, Fathi B. 2012. Scorpion sting in Iran: A review. Toxicon 60: 919-933.

Dehghani R, Kamiabi F, Mohammadi M. 2018. Scorpionism by *Hemiscorpius* spp. in Iran: A review. J Venom Anim Toxins Incl Trop Dis 24: 1-10.

Dehghani R, Valaie N. 2004. The review of classification of scorpions and their diagnostic key of Iran scorpions. Feyz Journal 8: 62-84.

Gholizadeh S, Lalehzari E, Bavani MM, Hosseini A, Khalkhali HR, Rafinejad J. 2016. Bioecology and scorpion envenomation in Ramshir district, Khuzestan Province, Southwestern Iran. Appl Entomol Zool 51: 37-42.

Hamilton AJ. 2005. Species diversity or biodiversity?. J Environ Manage 75: 89-92.

Jalali A, Rahim F. 2014. Epidemiological review of scorpion envenomation in Iran. Iran J Pharm Res 13: 743-756.

Kassiri H, Feizhaddad MH, Abdehpanah M. 2014a. Morbidity, surveillance and epidemiology of scorpion sting, cutaneous leishmaniasis and pediculosis capitis in Bandar-mahshahr County, Southwestern Iran. J Acute Dis 3: 194-200.

Kassiri H, Kassiri A, Sharififard M, Shojaee S, Lotfi M, Kasiri E. 2014b. Scorpion envenomation study in Behbahan County, Southwest Iran. J Coast Life Med 2: 416-420.

Kassiri H, Mahijan NM, Hasanvand Z, Shemshad M, Shemshad K. 2012. Epidemiological survey on scorpion sting envenomation in Southwest, Iran. Zahedan J Res Med Sci 14: 80-83.

Khan SA. 2006. Methodology for assessing biodiversity. Centre of Advanced Study in Marine Biology.

Lourenco W. 1994. Diversity and endemism in tropical versus temperate scorpion communities. Compte rendu des séances de la société de biogéographie 70: 155-160.

Mirshamsi O, Sari A, Elahi E, Hosseinie S. 2011. Mesobuthus eupeus (Scorpiones: Buthidae) from Iran: A polytypic species complex. Zootaxa 2929: 1-21.

Molaee SM, Ahmadi KA, Vazirianzadeh B, Moravvej SA. 2014. A climatological study of scorpion sting incidence from 2007 to 2011 in the Dezful area of Southwestern Iran, using a time series model. J Insect Sci 14: 1-6.

Haghi FM, Mogaddam MY, Enayati AA, Dehghani R, Fazeli-Dinan M. 2018. Biodiversity Species and Ecological Distribution of Scorpions in the City of Darmian, Southern Khorasan, Iran. Iran J Public Health 6(4): 10-21

Mozaffari E, Sedaghat MM, Dehkordi AS, Akbarzadeh K. 2013. Bidiversity and species composition of scorpions (Arachnida, Scorpiones) in Ilam County, Iran. J Appl Sci Res 9: 5412-5418.

Navidpour S. 2008. Description study of Compsobuthus (Vachon, 1949) species in South and Southwestern Iran (Scorpiones: Buthidae). Arch Razi Inst 63(1): 29-37.

Navidpour S, Kovařík F, Soleglad ME, Fet V. 2008. Scorpions of Iran (Arachnida, Scorpiones). Part I. Khoozestan Province. Euscorpius 2008: 1-41.

Pirali-Kheirabadi K, Navidpour S, Fet V, Kovařík F, Soleglad ME. 2009. Scorpions of Iran (Arachnida, Scorpiones). Part V. Chahar Mahal & Bakhtiyari Province. Euscorpius 2009:1-23.

Rafinejad J, Shahi M, Navidpour S, Jahanifard E, Hanafi-Bojd AA. 2020. Effect of climate change on spatial distribution of scorpions of significant public health importance in Iran. Asian Pacific J Trop Dis 13: 503-514.

Rahmani A, Jalali A. 2012. Symptom patterns in adult patients stung by scorpions with emphasis on coagulopathy and hemoglubinuria. J Venom Anim Toxins Incl Trop Dis 18: 427-431.

Schwerdt L, Copperi S, Pompozzi G, Ferretti N. 2016. Diversity and seasonal composition of the scorpion fauna from a mountainous system on pampean grasslands in Central Argentina. Stud Neotrop Fauna Environ 51: 169-175.

Shahi M, Moosavy SH, Hanafi-Bojd AA, Navidpour S, Zare S, Madani A, Rafinejad J. 2016. Spatial distribution of scorpion sting in a high-risk area of Southern Iran. J Med Entomol 53: 1198-1204.

Taj S, Vazirian M, Vazirianzadeh B, Bigdeli S, Salehzadeh Z. 2012. Effects of climatological variables on scorpion sting incidence in Ramshir area Southwest of Iran. J Exp Zoology India 15: 575-577.

Vazirianzadeh B, Samie M, Entomology IM. 2006. Epidemiological study of scorpionism in the Khozestan. Iranian 2nd Congress of Medical Entomology 2006: 24-26.

Chernov TI, Tkhakakhova AK, Kutovaya OV. 2015. Assessment of diversity indices for the characterization of the soil prokaryotic community by metagenomic analysis. Eurasian Soil Sci 48(4): 410-415.