



Journal of **Entomology**

ISSN 1812-5670



Academic
Journals Inc.

www.academicjournals.com

Morphometry Indices of the Black Fat-tailed Scorpion *Androctonus crassicauda* (Scorpiones Buthidae), from Fars Province, Southern Iran

¹Mohammad Ebrahimi, ²Kourosh Azizi, ²Mohammad D. Moemenbellah-Fard,
²Mohammad R. Fakoorziba and ¹Aboozar Soltani

¹Department of Medical Entomology and Vector Control, School of Health, Shiraz University of Medical Sciences, P.O. Box 71645-111, Shiraz, Iran

²Department of Medical Entomology and Vector Control, Research Centre for Health Sciences, School of Health, Shiraz University of Medical Sciences, P.O. Box 71645-111, Shiraz, Iran

Corresponding Author: Kourosh Azizi, Department of Medical Entomology and Vector Control, Research Centre for Health Sciences, School of Health, Shiraz University of Medical Sciences, P.O. Box 71645-111, Shiraz, Iran

ABSTRACT

Scorpions are one of the most important venomous arthropod groups in Iran. Their identification is mainly based on morphometry indices. The black scorpion *Androctonus crassicauda*, is the second most frequent species of scorpion in Fars province of South Iran. It is very dangerous since its venom affects the victims' nervous system. A total of 30 (15:15) individual adult male and female scorpions of *A. crassicauda* were actively captured using hand-catch method from 20 different parts of Fars province over a 20 month sampling period. Their most important morphometry indices including whole body length, pedipalp length, length and width of carapace, leg segments, abdomen and tail segments, as well as size of poison gland and pectines' number and length were scored using a Collis-Vernier caliper scale. The relevant data were analyzed using SPSS version 16 software. Morphometry indices between adult male and female scorpions showed a statistically significant difference. The size of different female body parts was larger than those of male, except that the pectin size and the number of pectin teeth in male were bigger than those of female. This study on the most important morphometry indices of *A. crassicauda* scorpions indicated that the mean scores of these indices were generally greater in females than males. The findings presented in this study could partly be manipulated to construct a national diagnostic taxonomic key of scorpions in Iran.

Key words: Scorpion, *Androctonus*, morphometry, taxonomy, Buthidae, Iran

INTRODUCTION

Scorpions are potentially fatal venomous arthropods. They behave as predators which catch their prey by injection of venom to render them immobile and ready to eat. They belong to the class of Arachnida which includes the phylogenetically related spiders, ticks and mites. There are approximately 1500 known species of scorpions only about two dozen or less of which are capable of causing serious toxicity or death in man, besides another 30 or so that are innocuous (Mullen and Stockwell, 2002; Ozkan and Yaman, 2004a). They are a highly diverse group of arachnids which currently comprises 155 genera distributed in 16 families with a controversial phylogenetic affinity (Davila *et al.*, 2005).

Scorpions have a distinct morphology which makes them readily identifiable (Ozkan and Karaer, 2003, 2004). Some of the most clinically dangerous species are from the *Buthus*, *Tityus*, *Leiurus*, *Mesobuthus*, *Parabuthus*, *Androctonus* and *Centruroides* genera of the Buthidae family (Gajre and Dammas, 1999; Al-Sadoon and Jarrar, 2003). Scorpions have extensive geographical distribution and their species diversity occur mostly in subtropical regions between 23° and 38° latitudes (Polis, 1990).

Given the geographical coordinates of Iran between 25° and 40° north, its scorpion distribution and species diversity is rather remarkable (Farzanpay, 1988; Kovarik, 1997). The country of Iran is thus significant for the presence of arthropods, particularly scorpions, in the light of its variable climatic and topographical characteristics (Dehghani, 2003). It is among those countries wherefrom several dangerous species of scorpions have been reported (Sharafkandi, 1991). The scorpions of Iran include 23 genera in three families of Buthidae, Scorpionidae and Hemiscorpiidae with well over 50 named species, 18 species of which occur in the southern Iranian province of Fars; though these numbers continue to fluctuate with new developments in this field (Dehghani and Fathi, 2012; Mohseni *et al.*, 2013).

Among the 64 Old World genera, the genus *Androctonus* Ehrenberg 1828 has a wide geographical distribution throughout the rocky deserts and semi-desert areas on both sides of the equator where they take refuge under rocks or in the burrows of other animals (Chippaux and Goyffon, 2008). Large specimens of *Androctonus* are mainly dangerous. There are 8 species or 17 subspecies within this genus (Fet and Lowe, 2000). New species of *Androctonus* are recently described from Afghanistan, Mauritania, Pakistan, India, Egypt and Tunisia (Lourenco and Qi, 2006, 2007; Kovarik and Ahmed, 2013; Teruel *et al.*, 2013; Teruel and Kovarik, 2014). About 22 countries in the North Africa, Middle East and Southwest Asia are known to possess this scorpion. The systematic of this genus at the species level remains poorly defined and major review of the group is indispensable (Desouky and Alshammari, 2011). The female of this scorpion is viviparous and may live up to three years (Bonnet, 1997). *Androctonus* is more active nocturnally during the summer months. It uses an ambush (or sit-and-wait) strategy in its hunting behavior which involves "not chase its prey butwaits for it to cross its path" (Bonnet, 1997).

The highly venomous black fat-tailed scorpion species known as *Androctonus crassicauda* Olivier, 1807 (Arachnida: Buthidae) is a medically important arachnid and among the most venomous species in the world (Ismail *et al.*, 1994; Ozkan and Yaman, 2004b). It is sexually dimorphic and is found in Saudi Arabia, Syria, Yemen, Jordan, Iraq, Azerbaijan, Turkey and Iran (Vatanpour, 2003). Few studies have been conducted on the distribution of scorpions, particularly *A. crassicauda*, in Iran. A study in Shiraz, Fars province, south Iran, captured 159 scorpions, 15 (9%) of which were *A. crassicauda*; the second dominant species in this region in 1998 (Azizi *et al.*, 1998). Another study in the adjacent province of Kohgiluyeh-Boyer Ahmad caught 791 scorpions, 78 (10%) of which were *A. crassicauda*; the fifth most frequent species in this region (Azizi *et al.*, 2001).

The importance of studying of arthropods' morphometry in medical entomology is highlighted in a recent review (Dujardin, 2008). Many of the important issues outlined in this review are not covered in the present study which is a preliminary step to that end. The current report investigates the morphometrics of *A. crassicauda* from Fars province, south Iran.

MATERIALS AND METHODS

Study area: There were 20 county towns in Fars province (54°25'E, 26°22'N), south Iran, from which different species of scorpions were caught. They included Abadeh, Darab, Estahban, Farashband, Firoozabad, Gerash, Ghirkarzin, Kazeroon, Larestan, Mamasani, Marvdasht, Mohr,

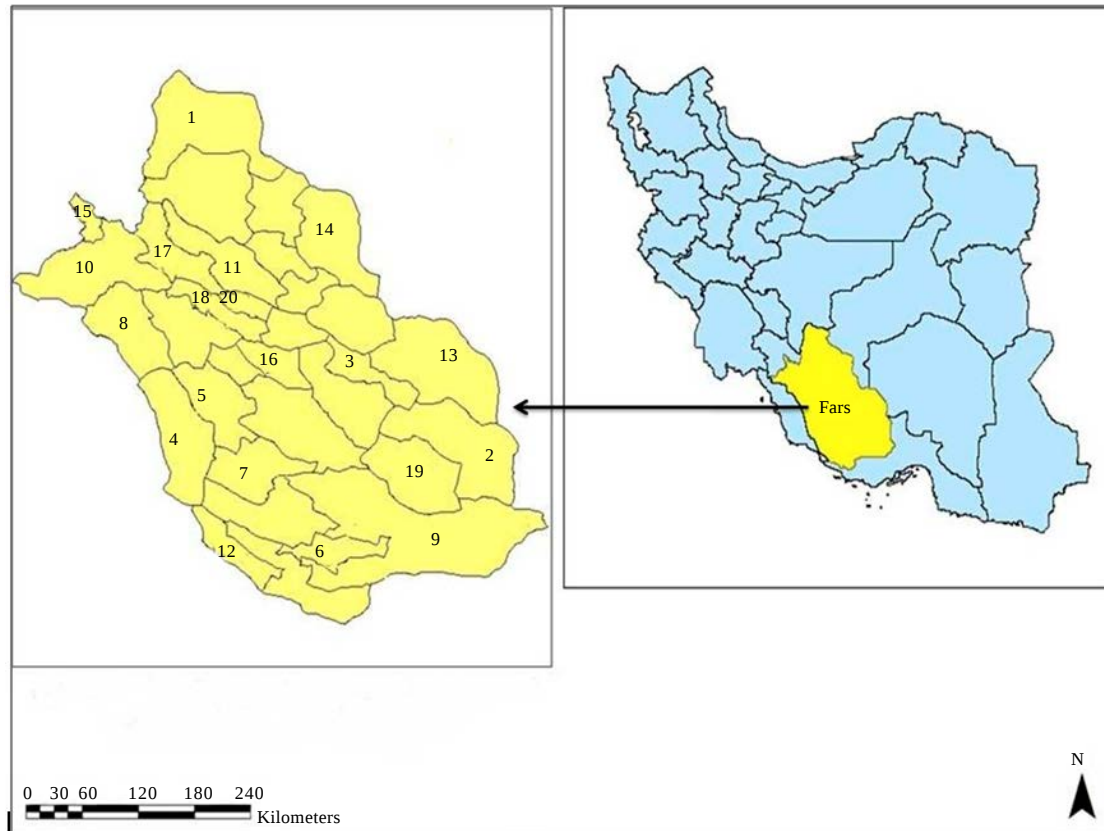


Fig. 1: Map of Iran showing the locations of sampling areas: (1-Abadeh, 2-Darab, 3-Istahban, 4-Farashband, 5-Firouzabad, 6-Gerash, 7-Qir-o-Karzin, 8-Kazeroun, 9-Larestan, 10-Nourabad-Mamasani, 11-Marvdasht, 12-Mohr, 13-Neyriz, 14-Nether, 15-Rostam, 16-Sarvestan, 17-Sepidan, 18-Shiraz, 19-Zarindasht, 20-Zarqan)

Neiriz, Nether, Rostam, Sarvestan, Sepidan, Shiraz, Zarindasht and Zarqan (Fig. 1). These county towns were randomly scattered all over the Fars province which has an area of 122,400 km². They ranged in topography from subtropical hot deserts in southeast to mild mountainous regions in northwest of province. Samples were collected using hand catch method with UV torch (night catch) on different occasions for 20 months from June 2012 to January 2014. Specimens were mostly found under large stones during the day, preserved in ethanol and deposited in the central lab, Medical Entomology Department, School of Health, Shiraz University of Medical Sciences (SUMS), Shiraz, Iran.

Morphological identification: Morphological identification was conducted according to the taxonomic keys with a zoom stereo dissecting microscope. Some 38 different characters related to their morphs were carefully examined to their nearest 0.1 mm scale. The main reference consulted for systematic and identification key was on scorpions of Iran (Farzanpay, 1988). The exclusion criteria included immature and damaged specimens. The inclusion criteria involved all adult male and female scorpions. These were fixed in 80% ethanol. The most important morphometry indices

including whole body length, pedipalp length, length and width of carapace, leg segments, abdomen and tail segments, as well as the size of poison gland and pectines' number and length were scored using a Collis-Vernier caliper scale.

Statistical analysis: The relevant data were analyzed using SPSS version 16 software. A p value of <0.05 was considered to be statistically significant.

RESULTS

A total of 882 specimens of scorpions were captured and examined carefully, most (609, 69%) of which were females (Table 1). The county towns of Farashband and Firoozabad were the most (No = 333) and the least (No = 1) scorpion-infested areas, respectively. They were all identified to species level. Overall, 13 different species from 11 genera in 3 families of scorpions (Buthidae, Scorpionidae and Hemiscorpiidae) were named based on their taxonomic characteristics. The first (430, 48.8%) and the second (112, 12.7%) most frequently captured scorpions belonged to the *Mesobuthus eupeus* and *Androctonus crassicauda* species, respectively.

Some of them were identified to be *A. crassicauda*. Of these, 30 adult male and female specimens were actively caught using hand-catch method from different habitats in Fars province, Iran. All these specimens had dark brown body color (Fig. 2). There were no trichobothria (sensory setae) on the undersides of patellae of their pedipalps. The latter were red-brown to black in color. Chelae supported the slender long fixed finger (tibia) and the movable finger (tarsus) on the outer side. The latter had one terminal and three sub-terminal granules. The dentate margin of pedipalp chelae movable finger had thus four distal granules (Fig. 3).



Fig. 2(a-d): *Androctonus crassicauda* scorpion showing the dorsal and ventral surfaces, (a) Dorsal surface female, (b) Dorsal surface male, (c) Ventral surface female and (d) Ventral surface male

Table 1: Fauna and distribution of scorpions taken from twenty different county towns of Fars province, south Iran, 2013

	<i>H. lepturus</i>			<i>M. eupeus</i>			<i>O. doriae</i>			<i>A. crassicauda</i>			<i>H. zagrosensis</i>			<i>C. matthiesseni</i>			<i>O. scrobiculosus</i>		
Location	♂	♀	T	♂	♀	T	♂	♀	T	♂	♀	T	♂	♀	T	♂	♀	T	♂	♀	T
Abadeh	0	0	0	4	6	10	0	0	0	2	1	3	0	0	0	0	0	0	0	0	0
Darab	2	0	2	0	2	2	1	0	1	5	1	6	0	1	1	0	0	0	0	0	0
Estahbun	0	0	0	1	2	3	1	1	2	1	1	2	0	0	0	1	0	1	0	0	0
Farashband	0	3	3	66	258	324	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Firoozabad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
Gerash	0	0	0	0	0	0	0	1	1	2	1	3	0	0	0	0	0	0	0	0	0
Ghirkarzin	0	0	0	6	5	11	0	5	5	0	0	0	0	0	0	0	0	0	0	0	0
Kazerun	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0
Larestan	15	10	25	3	5	8	0	5	5	23	19	42	0	0	0	8	7	15	0	0	0
Mamasani	0	1	1	9	8	17	0	0	0	13	12	25	4	0	4	0	0	0	0	0	0
Marvdasht	2	0	2	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0
Mohr	0	0	0	5	9	14	0	0	0	3	4	7	0	0	0	0	0	0	0	0	0
Neiriz	0	0	0	3	1	4	0	0	0	2	0	2	0	0	0	1	0	1	0	0	0
Nether	0	0	0	3	2	5	0	0	0	1	3	4	4	0	4	0	0	0	0	4	4
Rostam	0	1	1	0	0	0	0	0	0	5	3	8	3	0	3	3	1	4	0	0	0
Sarvestan	0	0	0	0	3	3	0	0	0	1	1	2	0	0	0	0	0	0	0	0	0
Sepidan	0	0	0	9	10	19	0	0	0	0	0	0	2	3	5	1	0	1	0	0	0
Shiraz	0	0	0	2	2	4	0	0	0	2	1	3	0	0	0	0	0	0	0	0	0
Zarindasht	0	0	0	0	0	0	1	11	12	3	4	7	0	0	0	2	0	2	0	0	0
Zarqan	0	11	11	0	6	6	0	0	0	0	0	0	0	0	0	9	9	18	0	1	1
Total	19	26	45	111	319	430	3	23	26	62	50	112	14	4	18	25	17	42	0	5	5
Percentage		5.1			48.75			2.95		12.7		2.04			4.76		0.57				
Abadeh	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	13
Darab	0	1	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	8	6	14
Estahbun	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	5	5	10
Farashband	0	0	0	0	0	0	0	1	1	0	1	1	0	1	1	1	2	3	67	266	333
Firoozabad	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	1	1
Gerash	0	0	0	0	6	6	0	0	0	0	0	0	0	1	1	0	0	0	2	9	11
Ghirkarzin	0	0	0	0	0	0	0	0	0	0	0	0	1	4	5	0	0	0	7	14	21
Kazerun	0	0	0	0	0	0	0	0	0	1	0	1	0	0	0	0	0	0	2	0	2
Larestan	0	0	0	0	38	38	0	1	1	2	0	2	12	11	23	0	0	0	58	101	159
Mamasani	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	27	21	48
Marvdasht	2	3	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	8
Mohr	0	0	0	0	4	4	0	0	0	0	0	0	0	1	1	0	0	0	8	18	26
Neiriz	1	0	1	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	7	2	9
Nether	0	3	3	0	1	1	2	2	4	0	0	0	0	0	0	0	0	0	10	15	25
Rostam	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	5	16
Sarvestan	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	5
Sepidan	2	1	3	0	0	0	2	1	3	2	0	2	0	0	0	0	0	0	18	15	33
Shiraz	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	2	4
Zarindasht	0	0	0	2	27	29	1	0	1	0	0	0	6	38	44	1	0	1	16	80	96
Zarqan	3	9	12	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	12	36	48
Total	9	17	26	2	76	78	5	5	10	5	2	7	19	59	78	3	2	5	273	609	882
Percentage		3			9			1.1		1			8.8		1				100		

The carapace of prosome was covered with distinct granules and well-raised linear keels or carinae which were dark in color. The tergal plates were trapezoidal in shape and darker than the



Fig. 3: Three main granules and one terminal granule on movable finger of chelae

triangular sternal plates of the mesosome. The metasomal segments were ring-shaped in red-brown color with black keels. These became gradually longer with well-developed keels and spiniform granules on the posterior end of each segment.

The data on morphometry of *A. crassicauda* are tabulated according to gender in Table 2. Female scorpions presented on average larger bodies than their male counterparts. It indicated that males and females of *A. crassicauda* differ significantly from one another in terms of their carapace width, pectin length and number of pectinal teeth ($p < 0.05$). The values for the latter two characters were generally smaller in females than males. All the other characters were, however, larger (or approximately similar) in measurements among females than males.

DISCUSSION

The results of the present study approved the importance of venomous arthropods such as the black fat-tailed scorpion *Androctonus crassicauda*, in Fars province of southern Iran. This species could often be found in the vicinity of human habitations. Some 13 different species of scorpions were caught over a 20 month study period in this province. The frequency and species richness of these arthropods in this region reflected the tuning of optimal bio-ecological conditions necessary for their refuge, reproduction and survival. The numerical preponderance of females (69%) over males (31%) could be due to the likely cannibalism of one sex over another or the potential female parthenogenesis.

The range of quantitative parameters is large for some intra-specific morphological features but small for some others. Small spectrum variation of certain characters is considered to have minimal scalar overlapping with their homologues from other intra-specific scorpions. These limited variations could thus be manipulated to construct a valid taxonomic key for the rapid identification and diagnosis of suspected species. The selection of 38 morphological characters used in this study was thus based on these criteria as well as the evidence provided by previous reports (Farzanpay, 1988; Ozkan *et al.*, 2006).

Table 2: Results of morphometric measurements on samples of male and female scorpion *Androctonus crassicauda* species in Fars province, 2013

Parameters	N	X (mm) ♂	±SD	N	X (mm) ♀	±SD
Total length	15	84.01	5.69	15	96.64	5.00
Cephalothorax						
Carapace length	15	8.14	0.48	15	9.41	0.48
Carapace width*	15	7.58	0.58	15	8.87	0.48
Pedipalp						
Total length	15	13.58	0.53	15	15.38	0.37
Trochanter length	15	4.21	0.38	15	4.32	0.17
Trochanter width	15	1.86	0.18	15	2.16	0.20
Femur length	15	8.32	0.36	15	8.67	0.50
Femur width	15	1.39	0.09	15	1.72	0.12
Patella length	15	6.59	0.33	15	7.12	0.27
Patella width	15	1.83	0.07	15	2.15	0.05
Tibia width	15	1.00	0.14	15	1.10	0.08
Manus length	15	3.66	0.22	15	3.78	0.16
Manus width	15	0.81	0.08	15	0.92	0.07
Manus height	15	0.29	0.04	15	0.43	0.03
Manus tibia length	15	7.35	0.39	15	7.84	0.19
Preabdomen						
Mesosoma length	15	18.37	2.20	15	23.40	3.80
Mesosoma width	15	10.22	0.86	15	12.20	1.06
Pecten length	15	9.08	0.47	15	8.31	0.36**
Number of pectinal teeth	15	31.13	1.12	15	25.66	1.67**
Post abdomen						
Metasoma total length	15	42.52	2.14	15	45.40	1.91
Metasoma segment 1						
Length	15	5.58	0.26	15	6.12	0.19
Width	15	6.24	0.48	15	6.81	0.36
Height	15	5.01	0.57	15	5.53	0.18
Metasoma segment 2						
Length	15	6.42	0.38	15	6.78	0.33
Width	15	6.69	0.50	15	7.20	0.34
Height	15	5.45	0.58	15	6.13	0.33
Metasoma segment 3						
Length	15	6.57	0.36	15	7.06	0.44
Width	15	7.14	0.52	15	7.38	0.48
Height	15	6.14	0.74	15	6.78	0.57
Metasoma segment 4						
Length	15	7.70	0.50	15	8.22	0.39
Width	15	7.24	0.62	15	7.42	0.46
Height	15	6.01	0.57	15	6.66	0.25
Metasoma segment 5						
Length	15	8.66	0.34	15	9.10	0.33
Width	15	6.74	0.46	15	6.62	0.47
Height	15	4.26	0.35	15	5.08	0.19
Telson						
Length	15	8.10	0.41	15	8.62	0.32
Width	15	3.21	0.16	15	3.87	0.28
Height	15	3.05	0.21	15	3.59	0.40

N: No. of scorpion, X: Mean, SD: Standard deviation, *: Caudal carapace width, **: p<0.05

In the current study, sexual dimorphism among black fat-tailed scorpion, *A. crassicauda*, was confirmed. In a similar study on parametric values of 11 male and 11 female *A. crassicauda* specimens from Turkey, differences between sexes were statistically significant for pectinal organ length, pectinal tooth count and carapace width (Ozkan *et al.*, 2006). This finding was in line the present results. In another report on morphometry values of *Iranobuthus krali* from Fars province, southern Iran, the sizes of carapace, mesosoma, metasomal segments, femur, patella and tibia were measured (Navidpour and Mashipour, 2009). In a study on parametric values of two different *Hemiscorpius* species from southwest Iran, differences between the two species of *H. lepturus* and *H. persicus* were statistically significant for mesosoma, carapace and telson I but the pectinal tooth count in both species were similar (Mashipour *et al.*, 2010).

It is concluded that the black scorpions of Fars province, south Iran, represent a homogenous group of arachnids in terms of their morphologically-stated parametric values.

ACKNOWLEDGMENTS

The authors appreciate the improvements to this article that were meticulously proposed by the anonymous peer reviewers. The present paper was extracted from the results of an approved M.Sc student thesis (No. 92-6700 Dated 22 Sep 2013) conducted by the first author, Mr. M. Ebrahimi. Thanks are due to the Vice-Chancellor for Research and Technology at SUMS, for permitting the use of facilities at the university.

REFERENCES

- Al-Sadoon, M.K. and B.M. Jarrar, 2003. Epidemiological study of scorpion stings in Saudi Arabia between 1993 and 1997. *J. Venom. Anim. Toxins Including Trop. Dis.*, 9: 54-64.
- Azizi, K., S. Tirgary and M.A. Seyedi-Rashti, 1998. Faunistic study of scorpions in Shiraz and investigation in their fecundity. *J. Armaghan Danesh*, 3: 23-32.
- Azizi, K., G. Shahraki and M. Omrani, 2001. Determination of the fauna and sex ratio of scorpions from villages and suburban of Kohkiloie and Boierahmad province in 2000. *J. Armaghan Danesh*, 6: 6-13.
- Bonnet, M.S., 1997. Toxicology of *Androctonus* scorpion. *Br. Homoeopathic J.*, 86: 142-151.
- Chippaux, J.P. and M. Goyffon, 2008. Epidemiology of scorpionism: A global appraisal. *Acta Trop.*, 107: 71-79.
- Davila, S., D. Pinero, P. Bustos, M.A. Cevallos and G. Davila, 2005. The mitochondrial genome sequence of the scorpion *Centruroides limpidus* (Karsch 1879) (Chelicerata; Arachnida). *Gene*, 360: 92-102.
- Dehghani, R., 2003. Thermotherapy in the treatment of *Hemiscorpius lepturus*. Ph.D. Thesis, Tehran University of Medical Sciences, Iran.
- Dehghani, R. and B. Fathi, 2012. Scorpion sting in Iran: A review. *Toxicon*, 60: 919-933.
- Desouky, M.M.A. and A.M. Alshammari, 2011. Scorpions of the Ha'il region, northern Saudi Arabia and molecular phylogenetics of two common species *Androctonus crassicauda* and *Scorpio maurus kruglovi*. *Arachnology*, 15: 193-200.
- Dujardin, J.P., 2008. Morphometrics applied to medical entomology. *Infect. Genet. Evol.*, 8: 875-890.
- Farzanpay, R., 1988. A catalogue of the scorpions occurring in Iran, up to January 1986. *Revue Arachnol.*, 8: 33-44.
- Fet, V. and G. Lowe, 2000. Family Buthidae CL Kock, 1837. In: *Catalog of the Scorpions of the World (1758-1998)*, Fet, V., W.D. Sissom, M.E. Braunwalder and G. Lowe (Eds.). New York Entomological Society, New York, USA., pp: 54-286.

- Gajre, G. and A.S. Dammas, 1999. Scorpion envenomation in children: Should all stings be given antivenom? *Ann. Saudi Med.*, 19: 444-446.
- Ismail, M., M.A. Abd-Elsalam and M.S. Al-Ahaidib, 1994. *Androctonus crassicauda* (Olivier), a dangerous and unduly neglected scorpion-I. Pharmacological and clinical studies. *Toxicon*, 32: 1599-1618.
- Kovarik, F., 1997. Results of the Czech biological expedition to Iran. Part 2. Arachnida: Scorpiones, with descriptions of *Iranobuthus kralli* gen. 1. et sp. n. and *Hottentotta zagrosensis* sp. n. (Buthidae). *Acta Societatis Zoologicae Bohemicae*, 61: 39-52.
- Kovarik, F. and Z. Ahmed, 2013. A review of *Androctonus finitimus* (Pocock, 1897), with description of two new species from Pakistan and India (Scorpiones buthidae). *Euscorpius*, 168: 1-10.
- Lourenco, W.R. and J.X. Qi, 2006. A new species of *Androctonus* Ehrenberg, 1828 from Afghanistan (Scorpiones buthidae). *Zool. Middle East*, 38: 93-97.
- Lourenco, W.R. and J.X. Qi, 2007. A new species of *Androctonus* Ehrenberg, 1828 from Mauritania (Scorpiones buthidae). *Bol. Soc. Entomol. Aragonesa*, 40: 215-219.
- Masihipour B., S.H. Navidpour and S. Albooshoke, 2010. Parametric values of *Hemiscorpius* species (Peters, 1861) (Scorpions: Hemiscorpiidae) from Southwestern Iran. *J. Exp. Zool. India*, 13: 487-490.
- Mohseni, A., B. Vazirianzadeh, M. Hossienzadeh, M. Salehcheh, A. Moradi and S.A. Moravvej, 2013. The roles of some scorpions, *Hemiscorpius lepturus* and *An-droctonus crassicauda*, in a scorpionism focus in Ramhormoz, Southwestern Iran. *J. Insect Sci.*, Vol. 13. 10.1673/031.013.8901
- Mullen, G. and S.A. Stockwell, 2002. *Scorpions* (Scorpiones). In: Medical and Veterinary Entomology, Mullen, G.R. and L.A. Durden (Eds.). Academic Press, Amsterdam, Netherland, ISBN-13: 9780080536071, pp: 411-423.
- Navidpour, S. and B. Masihipour, 2009. Study of morphometrical values of *Iranobuthus kralli* (Scorpiones: Buthidae) from Fars province, Southern Iran. *Arch. Razi Inst.*, 64: 97-100.
- Ozkan, O. and Z. Karaer, 2003. The scorpions in Turkey. *Turk. Bull. Hyg. Exp. Biol.*, 60: 55-62.
- Ozkan, O. and N. Yaman, 2004a. Scorpion venom. *Turk. Bull. Assoc. Vet. Med.*, 2: 19-22.
- Ozkan, O. and N. Yaman, 2004b. Scorpion. *Turk. Bull. Assoc. Vet. Med.*, 11: 15-18.
- Ozkan, O. and Z. Karaer, 2004. Body structures of scorpions. *Acta Parasitologica Turcica*, 28: 54-58.
- Ozkan, O., S. Adiguzel and S. Kar, 2006. Parametric values of *Androctonus crassicauda* (Oliver, 1807) (Scorpiones: Buthidae) from Turkey. *J. Venomous Anim. Toxins Include. Trop. Dis.*, 12: 549-559.
- Polis, G.A., 1990. Ecology. In: The Biology of Scorpions, Polis, G.A. (Ed.). Stanford University Press, Stanford, California, ISBN-13: 9780804712491, pp: 247-293.
- Sharafkandi, A., 1991. Persian Translation of Canon in Medicine (Avicenna). Soroush Press, Tehran, Iran.
- Teruel, R., F. Kovarik and C. Turiel, 2013. A new species of *Androctonus* Ehrenberg, 1828 from northwestern Egypt (Scorpiones: Buthidae). *Euscorpius*, 177: 1-12.
- Teruel, R. and F. Kovarik, 2014. Redescription of *Androctonus bicolor* Ehrenberg, 1828 and description of *Androctonus turieli* sp. N. From Tunisia (Scorpiones Buthidae). *Euscorpius*, 186: 1-15.
- Vatanpour, H., 2003. Effects of black scorpion *Androctonus crasicuda* venom on striated muscle preparation *in vitro*. *Iran. J. Pharm. Res.*, 2: 17-22.