

A Morphometric Study of *Mesobuthus eupeus* (Scorpionida: Buthidae) in Fars Province, Southern Iran

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Abstract

Background: Scorpions are a group of poisonous invertebrates that are widely distributed in the Middle East countries including Iran. They cause serious injuries and death to humans and domestic animals in Fars province. These arthropods are settled in subtropical regions of the province.

Methods: In this study, a total of 35 out of 430 *Mesobuthus eupeus*, including 15 males and 20 females, were selected, and then their major morphometric characteristics including the whole body length, pedipalp length, length and width of carapace, leg segments, abdomen, and tail segments, as well as the size of the poison gland, pectinal organ length, and pectinal tooth count were measured using a Collis-Vernier caliper scale.

Results: The measurements of different body parts were bigger in females than in males, except that pectinal tooth count in males (26.93mm±.88) was greater than that in females (22.20±1.00). The number of simple eyes on each side did not differ between males and females. Other features showed to be higher for females than males.

Conclusion: The results of the main morphometric features showed that the mean scores of the characters, except for the pectinal tooth count, in female *M. eupeus* species were bigger than those in male ones. The findings of this study are suggested to be used to provide a valid identification key for scorpions in Iran.

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Introduction

Scorpions are classified within arachnids. The fossils of scorpions originated in the sea and emerged on land during the Silurian era about 425-450 million years ago. Scorpions have a wide geographical distribution ranging from tropical regions to mild regions including deserts, treeless plains, tropical forests, mountains of over 550 m altitude, and tidal areas.¹

Scorpions are the most frequent kind of arachnids.² In Iran, scorpions and scorpion stings are considered a health and medical issue which, besides fear, worries, and medical costs caused by it, has threatened many people's lives over the years.^{3,4} In Mexico, annually,

1000 people die from scorpion stings, 70 percent of whom are children under 5 years old.⁵⁻⁷ Also, in Brazil, 7000 cases of scorpion stings are reported annually, and despite providing anti-venom serum treatment, there is still 1% possibility of death.⁵ In Iran, 42 scorpion species from 23 genera have been identified so far which belong to 3 families of Buthidae, Scorpionidae, and Liochelidae, of which seven species possess lethal venom and the most poisonous species is *Hemiscorpius lepturus*.⁸⁻¹⁰

Mesobuthus eupeus has a wide geographical distribution in Iran.¹¹ During 1998, a total of 159 scorpions were collected from Shiraz in Fars province, of which 135 species (84/9 %) were *M.*

eupeus which were the most common species in the region.¹² In another study in Kohgiluyeh va Booyer-Ahmad province (in 2000), totally 341 species (43%) of 791 captured scorpions were *M. eupeus*, which were reported to be the most frequent species in the region.¹³ In another study in Fars province, 15 male and 15 female scorpions of the species *Androctonus crassicauda* were selected and their main morphometric characteristics were measured, showing that the measurements in female specimens were bigger than those in male specimens in general, except that pectinal organ length (9.08 ± 0.47 vs. 8.31 ± 0.36) and pectinal tooth count (31.13 ± 1.12 vs. 25.66 ± 1.67) were greater in males. Also, the number of simple eyes on each side of the head differed slightly, being 3.40 ± 0.50 for males and 3.33 ± 0.61 for females.¹⁴ Furthermore, morphometric values of *Obuthus krali* (Scorpionida: Buthidae), (the characters of carapace, mesosoma, metasomal segment, femur, patella, tibia) were measured in Fars province in southern Iran during 2009.¹⁵

Methods

Study Area

Fars province, with an area of about 122000 km², is located in the southwest of Iran, and includes 23 counties. This province is one of the warmest regions of Iran with three distinct climatic areas (moderate cold winter and mild summer in the mountainous regions of north and northwest parts, rainy mild winters and hot dry summers in the central parts, and cold winters with hot summers in the south and southeast parts of the province). The average daily high temperature is 25 °C. In the current study, 430

M. eupeus (Scorpionida: Buthidae) were captured in different counties of Fars province including Mohr, Abadeh, Larestan, Darab, Farashband, Zarghan, Neiriz, Ghir and Karzin, Mamasani, Sarvestan, Sepidan, Estehban, and Shiraz (Figure 1). Then, 35 scorpions, including 15 males and 20 females, were selected for morphometric study.

Diagnosis

The main morphometric indices of scorpions which could be used to identify and provide an identification key were extracted by exploring the relevant literature and then tabulated. Therefore, characteristics including the whole body length, pedipalp length, length and width of carapace, leg segments, abdomen, and tail segments, as well as the size of the poison gland, pectinal organ length, and pectinal tooth count were measured using a Collis-Vernier caliper scale.

Results

In the current study, the captured scorpion species were yellow to dark yellow in color (Figure 2). The tarsomere of the first and second legs had a pair of barbs on the ventral surface; the carinae of the fifth tail segment was enlarged, and often edged/serrated with or without granules on the ventral surface; the median, lateral and dorso-median carinae are interconnected. The ventral surface tail segments lacked long denticle rows, and the terminal tail segment had regular denticles (Figure 3).

Other characteristics including pectinal organ length (4.86 ± 0.59 mm in ♂: 5.06 ± 0.24 mm in ♀), pedipalp length (♀: 8.42 ± 0.38 mm; ♂: 7.33 ± 0.50 mm), body length (2.20mm; ♂: 52.61 ± 3.29 mm±♀: 61.05),

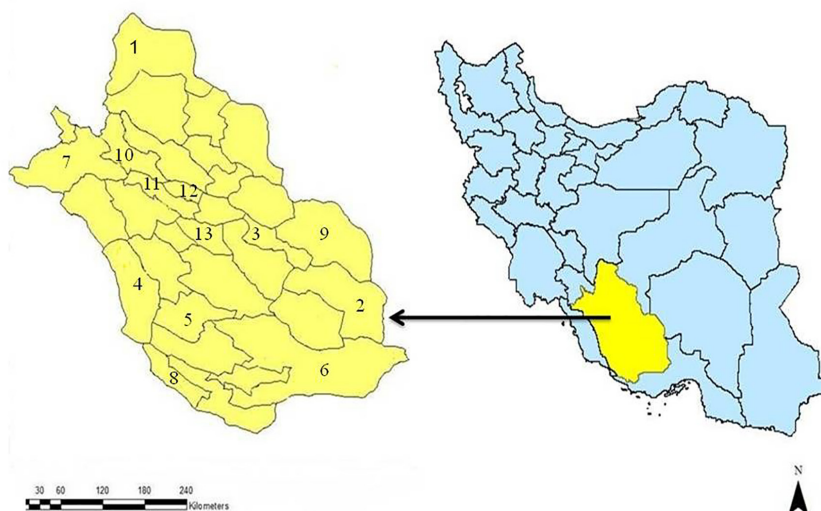


Figure 1: Map of Iran showing the location of the sampling areas of *Mesobuthus eupeus*: (1-Abadeh, 2-Darab, 3-Istahban, 4- Farrashband, 5- Ghir and karzin, 6-Larestan, 7-Noorabad Mamassani, 8-Mohr, 9-Neyriz,10-Sepidan, 11-Shiraz, 12-Zarqan 13-Sarvestan).



Figure 2: Scorpions *Mesobuthus eupeus* of the dorsal surface and the abdomen: (a): dorsal surface male, (b): ventral surface male, (c): dorsal surface female, and (d): ventral surface female)

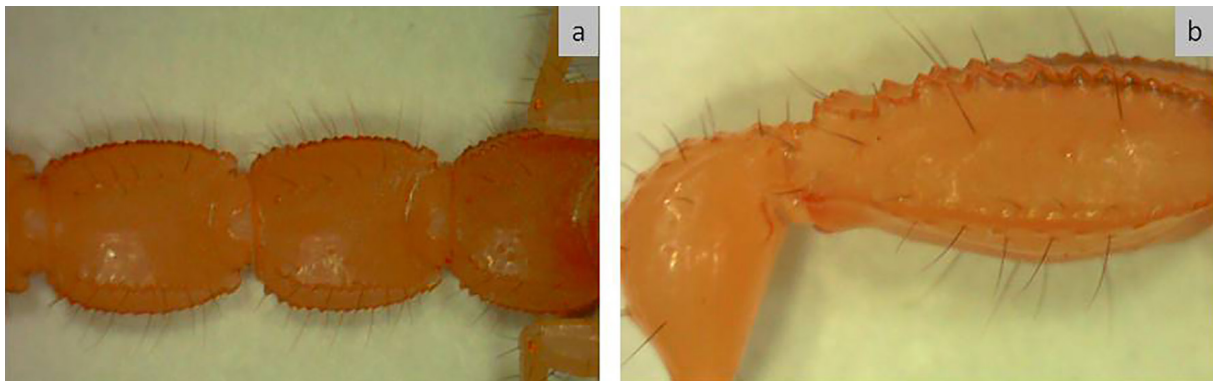


Figure 3: Scorpions *Mesobuthus eupeus* tale segments: (a): the ventral surface tail segments lack long denticle rows, and (b): the terminal tail segment has regular denticles (b).

abdomen length ($13.00 \pm 1.28\text{mm}$; ♂: $16.34 \pm 1.94\text{mm}$), abdomen width (♀: $7.18 \pm 0.71\text{mm}$; ♂: $5.54 \pm 0.87\text{mm}$) and metasoma length (♀: $24.29 \pm 2.24\text{mm}$; ♂: $27.35 \pm 1.13\text{mm}$) were measured. Fauna, distribution, and morphometric features of *M. eupeus* are displayed in Tables 1 and 2.

Discussion

Mesobuthus eupeus has the widest geographical distribution in Iran, particularly in Fars province. This finding is similar to previous results reported in this province.^{11, 12} In the current study, 430 specimens (48.75%) of this species were captured in different counties of Fars province, including Mohr, Abadeh, Larestan, Darab, Farashband, Zarghan, Neiriz, Ghir and Karzin, Mamasani, Sarvestan, Sepidan, Estehban and Shiraz, and were found to be the most frequent species. Measurements such as the whole body length,

abdomen width, pectinal organ length, pectinal tooth number, and carapace length are the parameters which are commonly used to identify the species and distinguish between sexes.¹⁶ In this study, as many as 36 characters were examined, the main of which were whole body length, pedipalp length, length and width of carapace, leg segments, abdomen, and tail segments, as well as the size of the poison gland, pectinal organ length, and pectinal tooth count. Characteristics with limited intraspecific variation and different from those of other closely related species can be used as useful taxonomic indices to provide valid identification keys. In *M. eupeus*, the whole body length, pedipalp length, pectinal organ length, pectinal tooth count, as well as abdomen length and width, having been manipulated slightly, were selected as the main taxonomic indices.¹¹ In this study, using selected indices and following valid identification keys, we made an attempt to present a valid, illustrated identification key to the scorpions of

Table 1: The results of measurements of morphometric characteristics according to sex in N: Number of scorpion; X: Mean; SD: Standard deviation; *: Caudal carapace width, **: p<0.05

Parameter	N	XX(mm) ♂	±SD	N	XX(mm) ♀	±SD
Total length	15	52.61	3.29	20	61.05	2.20
Cephalothorax						
Carapace length	15	4.39	0.28	20	5.14	0.19
Carapace width	15	4.03	0.25	20	4.79	0.31
Pedipalp						
Total length	15	7.33	0.50	20	8.42	0.38
Trochanter length	15	1.98	0.12	20	2.18	0.12
Trochanter width	15	1.14	0.03	20	1.21	0.07
Femur length	15	4.58	0.52	20	4.65	0.15
Femur width	15	0.92	0.04	20	1.11	0.07
Patella Length	15	3.60	0.24	20	4.14	0.09
Patella Width	15	1.14	0.03	20	1.33	0.03
Tibia length	15	1.88	0.17	20	2.06	0.07
Tibia width	15	0.57	0.02	20	0.65	0.04
Manus length	15	1.62	0.15	20	1.98	0.10
Manus width	15	0.49	0.04	20	0.47	0.02
Manus height	15	0.20	0.02	20	0.21	0.02
Manus tibia length	15	3.51	0.32	20	4.04	0.14
Preabdomen						
Mesosoma Length	15	13.00	1.28	20	16.34	1.94
Mesosoma Width	15	5.54	0.87	20	7.18	0.71
Pecten length	15	4.86	0.59	20	5.06	0.24
Number of pectinal teeth	15	26.93	0.88	20	22.20	1.00
Post abdomen						
Metasomal total length	15	24.29	2.24	20	27.35	1.13
Metasomal segment 1						
Length	15	3.12	0.14	20	3.22	0.10
Width	15	3.14	0.34	20	3.51	0.09
Height	15	2.34	0.04	20	3.77	0.09
Metasomal segment 2						
Length	15	3.68	0.33	20	3.94	0.06
Width	15	3.17	0.40	20	3.44	0.07
Height	15	2.34	0.04	20	3.14	0.08
Metasomal segment 3						
Length	15	3.73	0.33	20	4.09	0.09
Width	15	3.10	0.31	20	3.42	0.07
Height	15	2.57	0.19	20	2.58	0.14
Metasomal segment 4						
Length	15	4.38	0.28	20	4.62	0.08
Width	15	2.95	0.22	20	3.17	0.08
Height	15	2.71	0.11	20	2.49	0.08
Metasomal segment 5						
Length	15	4.94	0.44	20	5.51	0.08
Width	15	2.58	0.28	20	2.75	0.09
Height	15	2.42	0.10	20	2.27	0.08
Telson						
Length	15	4.10	0.04	20	5.20	0.08
Width	15	1.95	0.09	20	2.47	0.04
Height	15	1.69	0.16	20	1.80	0.07
Number of Ocellus	15	3.00	0.00	20	3.00	0.00

Fars province.^{3, 16} Karatas and Karatas used pectinal tooth count to identify the species and distinguish between sexes.¹⁷

In the current study, the mean score of pectinal tooth count was observed to be 26 for males and 22 for females, which did not differ significantly.

Mesobuthus eupeus were found in different regions of Iran.¹⁸⁻²² The present study showed that *M. eupeus* species were found in different places including crevices, sandy areas, inside houses, beneath rags, beneath tree layers, over the surface of and underneath stones, and in dried excrements within animals' dens.

Table 2: Fauna and distribution of scorpions in Fars province, during 2013

Species	<i>H. lepturus</i>	<i>M. eupeus</i>	<i>O. doriae</i>	<i>A. crassicauda</i>	<i>H. zagrosensis</i>	<i>C. mat-thiesseni</i>	<i>O. scro-bicinctus</i>	<i>H. jayakari</i>	<i>S. maurus</i>	<i>H. saulcyi</i>	<i>S. farzanyai</i>	<i>O. caucasicus</i>		<i>R. zarudnyi</i>		Total																										
	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀																										
Location	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	♂	♀	T																									
Abadeh	0	0	4	6	10	0	0	0	0	0	0	0	0	0	0	0	0	0	6	7	13																					
Darab	2	0	2	0	2	1	0	1	5	6	0	1	1	0	0	0	1	1	0	0	0	8	6	14																		
Etabhun	0	0	0	1	2	0	0	0	1	2	0	0	0	0	0	0	1	1	0	0	0	0	0	5	10																	
Farashband	0	3	66	258	324	0	0	0	0	0	0	0	0	0	1	1	1	1	1	1	2	3	67	266	333																	
Firoozabad	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	0	0	1	1																
Gerash	0	0	0	0	0	1	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	2	9	11								
Ghirkarzin	0	0	6	5	11	0	5	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	4	5	0	0	0	0	7	14	21										
Kazerun	0	0	0	0	0	1	0	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	0	0	0	0	0	0	0	2	0	2								
Larestan	15	10	25	3	5	8	0	5	23	19	42	0	0	0	0	0	0	0	0	0	1	2	0	2	12	11	23	0	0	0	0	58	101	159								
Mamasani	0	1	9	8	17	0	0	0	13	12	25	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	0	1	27	21	48							
Marvdasht	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	5	3	8						
Mohr	0	0	5	9	14	0	0	0	3	4	7	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	0	8	18	26							
Neiriz	0	0	0	3	1	4	0	0	2	0	2	0	0	0	0	0	0	0	0	0	0	0	0	0	1	1	0	0	0	0	0	7	2	9								
Nether	0	0	0	3	2	5	0	0	1	3	4	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	10	15	25								
Rostam	0	1	0	0	0	0	5	3	8	3	8	3	0	3	1	4	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	11	5	16								
Sarvestan	0	0	0	3	3	0	0	1	1	2	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	1	4	5								
Sepidan	0	0	9	10	19	0	0	0	0	0	0	2	3	5	1	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	18	15	33								
Shiraz	0	0	2	2	4	0	0	0	2	1	3	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	2	4	0								
Zarindasht	0	0	0	0	0	1	11	12	3	4	7	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0					
Zarqan	0	11	11	6	6	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	0	6	38	44	1	0	1	16	80	96										
Total	19	26	45	111	319	430	3	23	26	62	50	112	14	4	18	25	17	42	0	5	5	9	17	26	2	76	78	5	10	5	2	7	19	59	78	3	2	5	273	609	882	
%	5.1	48.75	2.95	12.7	2.04	4.76	0.57	2.95	8.84	1.13	0.79	8.84	0.57	100	0.57	100	0.57	100	0.57	100	0.57	100	0.57	100	0.57	100	0.57	100	0.57	100	0.57	100	0.57	100	0.57	100	0.57	100	0.57	100	0.57	100

Conclusion

This is the first study in Iran to study the morphometric characters of *M. eupeus* species and their respective numerical values. Therefore, the characteristics of the whole body length, pedipalp length, length and width of carapace, leg segments, abdomen, and tail segments, as well as the size of the poison gland, pectinal organ length, and pectinal tooth count are introduced as important identification factors to distinguish and characterize this species from others.

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Conflict of Interest: None declared.

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