

Ecology and Species Composition of Scorpions (Arachnida, Scorpiones) in Masjed-Soleyman County, Southwestern Iran

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Abstract

Aims: The current study aimed to study the scorpion ecology and fauna of Masjed-Soleyman County, southwestern Iran to manage scorpion sting-related problems during 2016–2017. **Materials and Methods:** Scorpions were collected from different localities of Masjed-Soleyman using rock-rolling, digging the ground, Ultra Violet flashlight, pouring water in holes, and ordinary flashlight methods. The collected scorpions were placed to 70% alcohol. Morphological studies were completed under a stereomicroscope. The scorpion species were identified using diagnostic valid key for the Iranian scorpions. **Results:** Out of the 318 collected scorpions, 10 species from three families, *buthidae* (71.1%), *scorpionidae* (2.2%), and *hemiscorpiidae* (26.7%) were identified. The most abundant species were *Androctonus crassicauda* (32.4%), *Hemiscorpius lepturus* (26.7%), and *Mesobuthus phillipsii* (21.4%). The females were the dominant sex, i.e., 1.7:1 (F/M) sex ratio. The highest number of scorpions were caught in August (27.7%). The highest abundant of scorpions were collected in summer (65.7%). Furthermore, the majority of specimens were hunted through of ultraviolet flashlight (44.4%). The most abundant scorpions were caught in animal husbandry (23.6%). **Conclusion:** Because treatment of the patients who received stings should be managed according to the kind of their venom and the scorpion species, it is important for planning treatment and prevention according to the species composition of scorpions of each region.

Keywords: Ecology, fauna, Iran, scorpion

INTRODUCTION

Scorpions are nocturnal arthropods that have venomous stings that are mostly used to catch insects and defend themselves and are very dangerous. They hide in their nests during the day and come out at night for preying.^[1,2] The number of scorpion stings is about 1.2–1.5 million with approximately 3000–5000 deaths per year.^[3,4] Envenoming can lead to the death of victims, especially in children. The severity of scorpion envenomation depends on items such as the age of the victim, the degree of scorpion's stimulation, scorpion size, sting site, health status, and scorpion species.^[5]

This creature is one of the oldest terrestrial arthropods, dating back 330 million years. Their evolutionary history goes back to the Silurian period.^[6] Their food is insects, spiders, mites,

and some vertebrates, and they eat each other due to their cannibalism nature. About 2540 species in 21 families of scorpions have been reported worldwide. At least 68 species of scorpions belonging to four families have been reported from Iran.^[7] It should be noted that several species have been added to that Iranian scorpion fauna, including *Anomalobuthus talebii*, *Odontobuthus tigrari*, *Hemiscorpius kashkayi*, *Orthochirus gantenbeini*, *Hemiscorpius shahii*, *Hottentotta sistanensis*, and *Hottentotta navidpourii*.^[8] In addition, three Iranian new species: *Odontobuthus baluchicus*, *Odontobuthus chabaharensis* from Sistan-Baluchistan Province and *Odontobuthus kermanus*

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from Kerman Province have been described, increasing the total number of *Odontobuthus* species to nine in Iran.^[9] Some scorpion species names have been changed, such as *Simonoides farzanpayi* to *Orthochirus farzanpayi*, *Odontobuthus odonturus* to *Odontobuthus bidentatus*, and *Apistobuthus pterygocergus* to *Apistobuthus susanae*. In addition, *Mesobuthus eupeus phillipsii* has been uplifted to species level as *Mesobuthus phillipsii*.^[8] *M. eupeus* in Iran has four subspecies: *M. eupeus eupeus*, *M. eupeus kermanensis*, *M. eupeus philippovitschi* and *M. eupeus thersites*. Previously, *Olivierus caucasicus* belonged to *Olivierus* genus, but now researchers believe this species belongs to *Mesobuthus* genus. Species of *Orthochirus farzanpayi* belongs to genus of *Orthochirus*, that was formerly named as *Orthochirus scrobiculosus* form A, B, C and D. Recently in Iran, based on studies accomplished, the numbers of species of this genus have been enhanced. Therefore, the species names have been varied as follows: *Orthochirus stockwelli*, *O. zagrosensis*, *O. farzanpayi*, *O. iranensis*, *O. gantenbeini*, *O. carinatus*, *O. varius*, and *O. gruberi*.^[10] Six new scorpion species from Iran, *Orthochirus hormozganensis* from Hormozgan Province, *O. kermanensis* from Kerman Province, *O. kucerai* from Kerman Province, *O. mashipouri* from Bushehr Province, *O. semnanensis* from Semnan Province, and *O. vignolii* from Yazd Province were described, compared with other Iranian *Orthochirus* species.^[11] Finally, the number of scorpion species in Iran increases to 78 species, including nine new species listed above.

Scorpion envenomation is one of the most serious public health problems in different parts of the world. The problem of scorpion stings has always been common in Iran due to the favorable climate for scorpions to live. In Iran, two important families, Buthidae and Hemiscorpiidae, are involved in scorpion stings. Approximately 83.5% of the documented cases of scorpionism in Iran have been caused by *Buthidae* family.^[8] In Iran, almost the importance of scorpion stings is related to four species of scorpions, including *M. eupeus*, *M. phillipsii*, *Androctonus crassicauda*, and *Hemiscorpius lepturus*.^[1,2,4,5,8] Meanwhile, the other medically significant scorpion species reported from Iran are *Compsobuthus matthiesseni*, *Hottentotta zagrosensis*, *Hottentotta jaiakari*, *Hottentotta saulcyi*, *Orthochirus* spp., *A. susanae*, *Olivierus (Mesobuthus) caucasicus*, *O. bidentatus*, *Odontobuthus doriae*, and *Hemiscorpius acanthocercus* among which *H. lepturus*, *H. achantocercus*, *A. crassicauda* and *Orthochirus* spp., are considered as the most deadly scorpions of Iran.^[8]

The stings of two species of scorpion, *H. lepturus* and *A. crassicauda*, are often deadly. *H. lepturus* is the most dangerous species of scorpion in Khuzestan Province. This species has a high abundance in the south and southwest of the country. *M. eupeus* and *A. crassicauda* are distributed in most parts of Iran.^[6,8,12] Understanding the composition of scorpion species, in addition to their systematic importance, can lead to the knowledge of habitats as well as other

biological characteristics and study their role in the rate of scorpion stings and how to prevent them. For scorpion sting treatment, a polyvalent antivenom has been manufactured by Razi Vaccine and Serum Research Institute against six medically significant scorpions: *A. crassicauda*, *M. eupeus*, *H. zagrosensis*, *H. saulcyi*, *H. lepturus*, and *O. doriae*.^[8,13-15]

Due to unsanitary conditions in the villages, lack of improvement of rural houses, occupation of agriculture, animal husbandry and horticulture, and the expansion of construction in urban areas, the level of human community contact with wildlife has increased. Accordingly, the interaction of these contacts has raised the likelihood of human-scorpion collision, and it will increase the number of stings. It is obvious that knowledge of different bio-ecological aspects of existing species and recognition of dangerous species in each region will be the basic principles of scorpion control and treatment management. South and southwest of Iran has about 95% of the country's known scorpion species.^[4,5,16,17]

On average, the incidence of scorpion sting in Iran is approximately 42,000–54,000 cases. Khuzestan Province is highlighted for its scorpions and scorpionism amongst the provinces of Iran. Khuzestan with 19 species of scorpions is one of the most important regions in terms of scorpionism problem in the southwestern Iran.^[17-19] Most of the scorpion stings and most of its deaths occur in Khuzestan Province. Due to the favorable weather conditions, we see a large number of reports of scorpion stings and deaths in Masjed-Soleyman County every year. Reported incidence of scorpion sting in this county was 11,685 cases between 2015 and 2017.^[4,5,18] The aim of this study was to determine the fauna, frequency, geographical distribution, and sex ratio of scorpions in Masjed-Soleyman County during 2016–2017, in order to apply some health-medical methods to prevent scorpion stings.

MATERIALS AND METHODS

Masjed-Soleiman is located in the north of Khuzestan province, which has a hot and dry climate. This county, like most counties in Khuzestan, has a hot and humid climate and has hot summers and Mediterranean winters. The county is located between 31°56'11"N latitude and 49°18'14"E longitude with the elevation of 240 meters above sea level. At Masjed-Soleyman, the summers are long, sweltering, arid, and clear and the winters are cool, dry, and mostly clear. The average annual rainfall is 400 mm, and the average temperature is less than 0°C in winter and more than 50°C in summer.^[4]

The study was approved by the Committee of Ethics in Research, Ahvaz, Jundishapur University of Medical Sciences and registered as IR.AJUMS.REC.1396.530. The ethical principles of this research were investigated and discussed in the research committee of the above mentioned department and after making needed modifications, it was approved. Inclusion criteria were areas with a high percentage of scorpion stings. Exclusion criteria were impassable areas.

This study is a descriptive research that was done by random capturing method of scorpions in plain and mountainous areas Masjed-Soleyman County in different seasons (with emphasis on spring and summer) during the year 2016–2017. Scorpion hunting programs were mainly carried out in areas where more scorpion stings were reported. Twenty-one sampling regions were selected based on scorpionism reports, geographical status, local data, weather, and flora. In different geographical areas, one to three times in each season, scorpions were caught from cracks in walls, holes in the ground, rodent burrows, under the thorns and debris of plants, under the rock, and construction debris. To catch this arthropod in the plains and mountains, at day and night time the method of rock-rolling, Ultra Violet flashlight, pouring water in holes, and ordinary flashlight were used. They were collected by the tail by long-handled tongs.

Specimens then transferred to the laboratory in 70% ethanol-containing plastic bottles. Some main information like place and date were recorded. Identification of scorpions was done by morphological features based on the national standard diagnostic keys,^[7,20] furthermore, their sexes were studied. Data related to scorpions were inputted into IBM SPSS software/Singapore, version 22.0, presented in descriptive tables.

RESULTS

In this field-laboratory investigation, a total of 318 specimens (ten species in nine genera) from three families, Buthidae (71.1%), Scorpionidae (2.2%), and Hemiscorpiidae (26.7%) were identified. *A. crassicauda* (50.9%), *H. lepturus* (26.7%) and *M. phillipsii* (28.5%) were the most abundant in the studied regions. The other seven species were identified as: *C. matthiesseni*, *O. (Mesobuthus) caucasicus*, *O. bidentatus*, *Scorpio maurus*, *Razianus zarudnyi*, *Orthochirus scrobiculosus*, and *Compsobuthus jayakari*. The largest number of the captured scorpions were from the plain areas (86.5%) [Table 1]. Totally, 117 males and 201 females were identified, showing M/F sex ratio of about 1:1.7 [Tables 1 and 2]. They had their most period of activity in August ($n = 88$, 27.7%) and September

($n = 64$, 20.1%), respectively [Table 3]. The most scorpions were hunted in summer ($n = 209$, 65.7%), spring ($n = 76$, 23.9%), winter ($n = 4$, 1.3%) and autumn ($n = 29$, 9.1%), respectively. Abundance distribution of the collected scorpions by the type of environment showed that the most abundant scorpions were caught in animal husbandry 23.6% ($n = 75$), and abandoned places 19.2% ($n = 61$), respectively [Table 4]. According to the collecting method, most of the specimens caught through ultraviolet (UV) light ($n = 141$, 44.4%), pouring water into the pits ($n = 72$, 22.6%), rock rolling ($n = 64$, 20.1%), and ordinary flashlight ($n = 41$, 12.9%), respectively.

DISCUSSION

During this study, from April to the end of March, a total of 318 scorpion specimens from different regions Masjed-Soleyman County was caught. A total of 10 species of scorpions from the families of *Buthidae* (71.1%), *Scorpionidae* (2.2%), and *Hemiscorpiidae* (26.7%) were identified, which indicates the diverse and rich fauna of scorpions due to the good habitat and suitable climatic conditions of the study area. In this study, the most abundant species were *A. crassicauda* (32.4%), *H. lepturus* (the most deadly scorpion of Iran) (26.7%), and *M. phillipsii* (21.4%) in all the twenty-one regions studied. The lowest abundance stood for *O. scrobiculosus* (1.3%) and *C. jayakari* (0.6%), respectively. A research in Zarrin-dasht County (Fars Province, southern Iran) displayed a wide diversity of scorpion species, with three families and 12 species and subspecies. *O. odonturus* with (42.1%) and *S. maurus townsendi* (40.1%) were the most abundant in the studied regions. *A. crassicauda* (0.4%), *S. zarudnyi* (0.4%), and *H. lepturus* (0.4) were rare species.^[17] In another study in Ahvaz City (Khuzestan Province, southwestern Iran), the collected specimens included seven species in two families: *Buthidae* (76.8%) and *Hemiscorpiidae* (23.2%). Out of 237 specimens taken, the highest frequency was related to *M. eupeus* (65%) and *H. lepturus* (23.2%) the lowest frequency was related to *B. macrocentrus* (0.4%).^[17] In total, 85 scorpions belonging to two families (*Scorpionidae* and

Table 1: The scorpions captured according to species, abundance, relative frequency, gender and geographical area in Masjed-Soleyman County

| Family | Species | Number of captured, n (%) | Sex | | Geographical area | |
|-------------------------------------|----------------------------------|-----------------------------|---------------|-----------------|-------------------|-------------------|
| | | | Male, n (%) | Female, n (%) | Plain, n (%) | Mountain, n (%) |
| <i>Buthidae</i> C.L. Koch, 1837 | <i>Androctonus crassicauda</i> | 103 (32.4) | 31 (30.1) | 72 (69.9) | 85 (82.5) | 18 (17.5) |
| | <i>Mesobuthus phillipsii</i> | 68 (21.4) | 30 (44.1) | 38 (55.9) | 58 (85.3) | 10 (14.7) |
| | <i>Compsobuthus matthiesseni</i> | 22 (6.9) | 5 (22.7) | 17 (77.3) | 18 (81.8) | 4 (18.2) |
| | <i>Olivierus caucasicus</i> | 13 (4.1) | 4 (30.8) | 9 (69.2) | 11 (84.6) | 2 (15.4) |
| | <i>Odontobuthus bidentatus</i> | 9 (2.8) | 4 (44.4) | 5 (55.6) | 7 (77.8) | 2 (22.2) |
| | <i>Razianus zarudnyi</i> | 5 (1.6) | 2 (40) | 3 (60) | 5 (100) | 0 |
| | <i>Orthochirus scrobiculosus</i> | 4 (1.3) | 1 (25) | 3 (75) | 4 (100) | 0 |
| | <i>Compsobuthus jayakari</i> | 2 (0.6) | 0 | 2 (100) | 2 (100) | 0 |
| <i>Scorpionidae</i> Latreille, 1802 | <i>Scorpio maurus</i> | 7 (2.2) | 3 (42.9) | 4 (57.1) | 6 (85.7) | 1 (14.3) |
| <i>Hemiscorpiidae</i> Pococ, 1893 | <i>Hemiscorpius lepturus</i> | 85 (26.7) | 37 (43.5) | 48 (56.5) | 79 (92.9) | 6 (7.1) |
| Total | | 318 (100) | 117 (36.8) | 201 (63.2) | 275 (86.5) | 43 (13.5) |

Table 2: The sex ratio of hunted scorpions in Masjed-Soleyman County

| Species | Sex ratio of male to female |
|----------------------------------|-----------------------------|
| <i>Androctonus crassicauda</i> | 1:2.3 |
| <i>Hemiscorpius lepturus</i> | 1:1.2 |
| <i>Mesobuthus phillipsii</i> | 1:1.2 |
| <i>Compsobuthus matthiesseni</i> | 1:3.4 |
| <i>Olivierius caucasicus</i> | 1:2.2 |
| <i>Odontobuthus bidentatus</i> | 1:1.2 |
| <i>Scorpio maurus</i> | 1:1.3 |
| <i>Razianus zarudnyi</i> | 1:1.5 |
| <i>Orthochirus scrobiculosus</i> | 1:3 |
| <i>Compsobuthus jayakari</i> | 1:0 |
| Total | 1:1.7 |

Table 3: Distribution of scorpion frequency by month in Masjed-Soleyman County

| Month | n (%) |
|-----------|-----------|
| April | 14 (4.4) |
| May | 23 (7.2) |
| June | 39 (12.3) |
| July | 57 (17.9) |
| August | 88 (27.7) |
| September | 64 (20.1) |
| October | 16 (5.1) |
| November | 6 (1.9) |
| December | 7 (2.2) |
| January | 2 (0.6) |
| February | 1 (0.3) |
| March | 1 (0.3) |
| Total | 318 (100) |

Table 4: Distribution of scorpion frequency captured by environment in Masjed-Soleyman County

| Type of environment | n (%) |
|------------------------|-----------|
| Animal husbandry | 75 (23.6) |
| Abandoned site | 61 (19.2) |
| Construction debris | 44 (13.8) |
| Cracks in the building | 38 (11.9) |
| Plant debris | 33 (10.4) |
| Home warehouse | 26 (8.2) |
| Garden-Orchard | 18 (5.7) |
| Courtyard | 12 (3.8) |
| Inside the house | 11 (3.4) |

Buthidae) were captured in the present study. Of the collected samples, *S. maurus* 47 (55%) was the most abundant, followed by *H. sauleyi* 28 (33%), and *A. crassicauda* 10 (12%). In a research on scorpion fauna in Zakho Province of Northern Iraq, 85 scorpions belonging to two families (Scorpionidae and Buthidae) were captured. Out of the collected specimens, *S. maurus* (55%) was the most abundant, followed by *H. sauleyi* (33%), and *A. crassicauda* (12%).^[21]

In this study, the prevalence of *H. lepturus* was 26.7% and *A. crassicauda* has hunted with prevalence 32.4%. *A. crassicauda* and *H. lepturus* are the most venomous scorpions, especially in Khuzestan Province. Envenomation by *H. lepturus* was responsible for ninety percent of deaths in the southern provinces of Iran.^[18] *H. lepturus* is occurred in south-west and south of Iran abundantly and its stings cause major injuries frequently in children.^[22] It is widespread in Iranian provinces of Hormozgan, Kermanshah, Khuzestan, Kurdistan, Bushehr, Semnan, Lorestan, Ilam, and Fars.^[18] This Species has been hunted from Khuzestan, Kerman, Kohgilouyeh Va Boyer Ahmad, Hormozgan, and Ilam Provinces with relative frequency 24.9%, 0.9%, 21.6%, and 5.56%, respectively.^[18,23-25] Meanwhile, *H. lepturus* finds in Pakistan, Yemen, and Iraq.^[18,26] *A. crassicauda* has wide distribution in whole areas of Iran. It was captured in the Iranian provinces of Khuzestan, Kerman, and Ilam with abundance 28.7%, 28.5%, and 25.44%, respectively.^[18,22,23] *A. crassicauda* is distributed from Egypt, Jordan, Syria, Palestine, Armenia, Turkey, Azerbaijan, and Iraq to the Arabian Peninsula.^[18,22]

In this study, the sex ratio was 1:1.7 in favor of females. Meantime, Two-hundred one females and 117 males' specimens were identified. This showed that females of captured scorpions were more prevalent than males. Because pregnant females require more hunting for their immature scorpions, thus their foraging activity is higher and hunted more than males. This result was the same as other studies.^[27-29] In Sharifinia *et al.*'s study in Ilam Province, 138 males and 253 females were identified showing M/F sex ratio of about 1:2.^[27] In Kassiri *et al.*'s study, 194 (77.0%) females and 58 (23.0%) males was captured. The sex ratio was calculated 1:3.34.^[18]

From the results recorded in scorpion captured forms, the monthly activity of these species was determined, and as can be seen, their peak activity was in August. According to the results of operations in different regions, it shows that the activity of scorpions starts from the beginning of April and their maximum activity was in August and September, and gradually from the end of October, their seasonal activity decreased. Correlation between the environmental circumstances and scorpion frequency and was one of the main results of this research. Low temperatures in the cold months of the research region caused low activity of these arthropods, but this activity grows little by little with increase in temperature, so that in August (27.7.9%) and September (20.1%) the peak of activity can be seen (due to the suitable temperature and humidity).

In this study, most of the specimens caught through UV light (44.4%) during the night. In Dehghami *et al.*'s study in Khuzestan Province, the most abundant of scorpions was collected using rock-rolling technique (53.7%). The rock-rolling and blacklight techniques are respectively recommended for collecting scorpions during the day and at

night.^[16] In the study of Zergan *et al.*, most scorpions were hunted by UV method.^[30]

In this study, most scorpions were caught from animal husbandry (23.6%) and abandoned places (19.2%). Since most of the specimens were taken in the village and considering that most of the villagers also keep livestock at home, so most of the specimens were from the human environment and livestock together. Most scorpions caught from animal waste and livestock storage environment, which are very suitable places for scorpion habitat.

The limitations of this study were: The relative small number of specimens collected and the impossibility of sampling from all areas of the county. The strengths of the research included sampling in all seasons and by four methods. The highlight of this study was the rich fauna of scorpions in the area.

CONCLUSION

A. crassicauda and *H. lepturus* are the most abundant species in Masjed-Soleyman County and considered the most venomous scorpion species in this region. Therefore, residents of the area, especially children, should take careful care to prevent scorpion stings. Despite the small size of the study area, diverse scorpion fauna was observed in comparison with other studies in different counties of Iran. Such geographical distribution may be due to global warming, climate change, habitats, and even the pattern of distribution of each species.

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Conflicts of interest

There are no conflicts of interest.

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