



Spatial Distribution of Medically Important Scorpions in Iran: A Review Article

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Abstract

Context: There are three families and 66 species of scorpions in Iran, some of these species are medically relevant, and their sting cause public health problems. Thus, producing of the new geographical distribution of scorpions and the new species is very important. The goal of this study was to produce the distribution maps of Iranian scorpions that are medically important according to the latest information.

Evidence Acquisition: This present study included a review of all the articles related to Iranian scorpions published in ISI, PubMed, Scopus, ScienceDirect, and Google Scholar databases during 2008 - 2019, using the relevant MeSH keywords. The data were entered in an Excel file, and spatial distribution maps were prepared.

Results: From the review of the related published documents, we found that there are 66 scorpion species in Iran, some scorpion names have been changed and new scorpion species have been added to Iranian scorpion fauna and the spatial distribution of some species has become wider.

Conclusions: Considering the new distribution maps and data on Iranian scorpions, for scorpion envenomation treatment and control programs, these variations should be regarded.

Keywords: Scorpion, Envenomation, Buthidae, Distribution, Hemiscorpiidae, Iran

1. Context

Iranian scorpion fauna belongs to the three families of Buthidae, Hemiscorpiidae, and Scorpionidae that comprise 66 species (1, 2). Scorpion envenomation is one of the most important public health problems in Iran, especially in southern parts (3, 4). Annually about 40000 - 50000 cases of scorpion envenomation occur in Iran with 16 - 18 deaths, most cases of envenomation and death occur in southern parts of Iran. The most medically important scorpion species reported from Iran are *Hemiscorpius lepturus*, *Hemiscorpius acanthocercus*, *Hottentotta saulcyi*, *Hottentotta zagrosensis*, *Hottentotta jaiakari*, *Mesobuthus eupeus*, *Mesobuthus phillipsii*, *Mesobuthus caucasicus*, *Orthochirus* sp., *Androctonus crassicauda*, *Apistobuthus susanae*, *Odontobuthus doriae*, *Odontobuthus bidentatus*, and *Compsobuthus matthiesseni*, among which *H. lepturus*, *H. achantocercus*, *A. crassicauda*, and *Orthochirus* sp., are considered as the most deadly scorpions of Iran. *M. eupeus* and *A. crassicauda* are distributed in most parts of Iran (4-9).

For scorpion envenomation treatment, a polyvalent antivenom has been prepared by Razi Vaccine and Serum Research Institute (RVSRI) against six medically important scorpions: *M. eupeus*, *A. crassicauda*, *O. doriae*, *H. saulcyi*, *H. zagrosensis*, and *H. lepturus* (5, 8, 10), but in some cases it has failed to treat the patient. To solve this problem, RVSRI plans to produce a monovalent antivenom. For doing this, the updated distribution maps of medically relevant scorpions is needed.

Because of the lack of a valid scorpion identification key in Iran, researchers mostly use the Farzanpey key, which is very old and has been prepared for only 27 species of scorpions (11), while now there are 66 species of scorpion in Iran. Some researchers have erroneously reported some scorpions in some areas of Iran and provided misinformation to other researchers. For example, some studies have reported *Odontobuthus odonturus* from Iran, while recently it has been documented that this species does not exist in Iran.

Some scorpion species names have been changed,

such as *Apistobuthus petricergus* to *Apistobuthus susanae*, *Simonoides Farzanpayi* to *Orthochirus farzanpayi*, and *Odontobuthus odonturus* to *Odontobuthus bidentatus*, and *Mesobuthus eupeus phillipsii* has been raised to species level as *Mesobuthus phillipsii* (12). More recently some species have been added to Iranian scorpion fauna that are not included in the Farzanpayi key: *Hemiscorpius kashkayi* (13), *Anomalobuthus talebii* (14), *Odontobuthus tigrari* (15), *Hottentotta navidpouri*, *Hottentotta sistansensis* (16), *Orthochirus gantenbeini* (17), and *Hemiscorpius shahi* (18). Based on new data, the exact distribution of Iranian scorpions has changed, and regarding new studies on scorpions in Iran, the distribution area for each scorpion has become more extended than before, so there is a big gap in the valid information about Iranian scorpion fauna including the medically important ones. This is the first attempt to produce new data on the spatial distribution maps of medically important scorpions in Iran. The results can be used to produce regional or monovalent antivenoms. They can also be used by public health staff for scorpion control. Thus, the aim of this study was to determine the distribution maps of medically important Iranian scorpions according to the latest information.

2. Evidence Acquisition

This is a narrative review study of all the articles related to Iranian scorpions published in ISI, PubMed, Scopus, ScienceDirect, and Google Scholar databases during 2008 - 2019, using the relevant MeSH keywords. The data on the localities, scientific names, morphological characteristics, medically important information, habitats, and geographical coordinates of scorpions were extracted from articles, and entered into an Excel file. Then, the spatial distribution maps for medically important scorpion species were prepared using ARC GIS 4 software.

3. Results

According to the latest studies, there are three families of scorpions, including Buthidae, Hemiscorpiidae, and Scorpionidae in Iran, and to date, 19 scorpion genera and 66 species have been reported from Iran.

3.1. Buthidae Family

This family is considered as the most frequent family with 92 genera and 1053 species in the world (19). In Iran, this family comprising 17 genera and 58 species. The members of this family are distributed in all regions of Iran, the members of the *Mesobuthus*, *Androctonus*, *Hottentotta*, *Compsobuthus*, *Apistobuthus*, *Odontobuthus* and *Orthochirus*

genera are the most medically important, among which the *Mesobuthus* and *Androctonus* genera are more prevalent in most area in Iran. *Androctonus* is regarded as the most deadly one. Nearly 83.5% of the documented cases of scorpion envenomation in Iran have been caused by this family (5).

3.1.1. *Mesobuthus eupeus*

This species in Iran has five identified subspecies including: *Mesobuthus eupeus eupeus* (distributed from north, west, central and east of Iran), *Mesobuthus eupeus philippovitschi* (from northwest & north), *Mesobuthus eupeus thersites*, *Mesobuthus eupeus afghanus* (from the north-east), and *Mesobuthus eupeus kirmanensis* (from the south-east) (12).

This species is known as Iranian yellow scorpion; its body color is yellow to orange with three to five dark longitudinal spots on the mesosoma. Although this species is not deadly, it makes the stung person refer to a hospital or medical care center to decrease the pain of the sting. It lives in different habitats, including under stones and barks, in the abandoned holes of rodents, in the spider and beetle nests, under the brick and cement pieces, and inside the roof of abandoned houses. This species tends to live near human houses, therefore, it is a big treat for humans. This species is distributed from Turkey to China, and in Iran it is found in East Azerbaijan, West Azerbaijan, Ardabil, Zanjan, Tehran, Mazandaran, Golestan, Markazi, Khorasan-e-Razavi, North Khorasan, South Khorasan, Kurdistan, Hamadan, Qom, Ilam, Kermanshah, Kerman, Isfahan, Markazi, Sistan and Baluchistan, Yazd, Kohgiluyeh and Boyer-Ahmad, Semnan, Fars, Khuzestan, and Hormozgan (Figures 1 and 2) (1, 4, 5, 7-9, 20-29).

3.1.2. *Mesobuthus phillipsii*

This species was formerly considered as a subspecies of *Mesobuthus eupeus* as: *Mesobuthus eupeus phillipsii*, but recently Mirshamsi has raised it to a single species as *M. phillipsii*.

This species is very similar to *M.e. eupeus* morphologically. The only clear morphological difference between this species and *M.e. eupeus* is that the metasoma of *M. phillipsii* is more hirsute than that of *M.e. eupeus*. This species has various habitats, including under stones, inside the sand hills, inside the gaps and seams of the soil, and in the abandoned burrows of lizards and rodents. It has a limited distribution area in Iran, including Khuzestan, Chahar Machal and Bakhtiari, Fars, Kohgiluyeh and Boyer Ahmad, Bushehr, and Hormozgan provinces. (Figures 1 and 2) (11, 12, 27, 30).



Figure 1. The medically important scorpions in Iran; First row: *Hotentotta saulcyi*, *Hotentotta zagrosensis*, *Hemscorpius lepturus* (male and female). Second row: *Apistobuthus susanae*, *Odontobuthus doriae*, *Androctonus crassicauda*. Third row: *Orthochirus iranensis*, *Mesobuthus eupeus*, *Compsobuthus matthiesseni*, *Me* (all photos are from Navidpour articles)

3.1.3. *Mesobuthus caucasicus*

This species was formerly called *Olivierus caucasicus*. The color of this species is yellow, except for the lateral and median eyes, the body length of this species varies between 6 - 6.5 cm. Symptoms of envenomation by this species

are similar to those of *M. eupeus*, and death from it has not been reported. This species inhabits in West Azerbaijan, East Azerbaijan, Ardabil, North Khorasan, Sistan and Baluchistan, Esfahan, Tehran, Markazi, Semnan, and Yazd provinces. (Figures 1 and 2) (6, 11, 29).

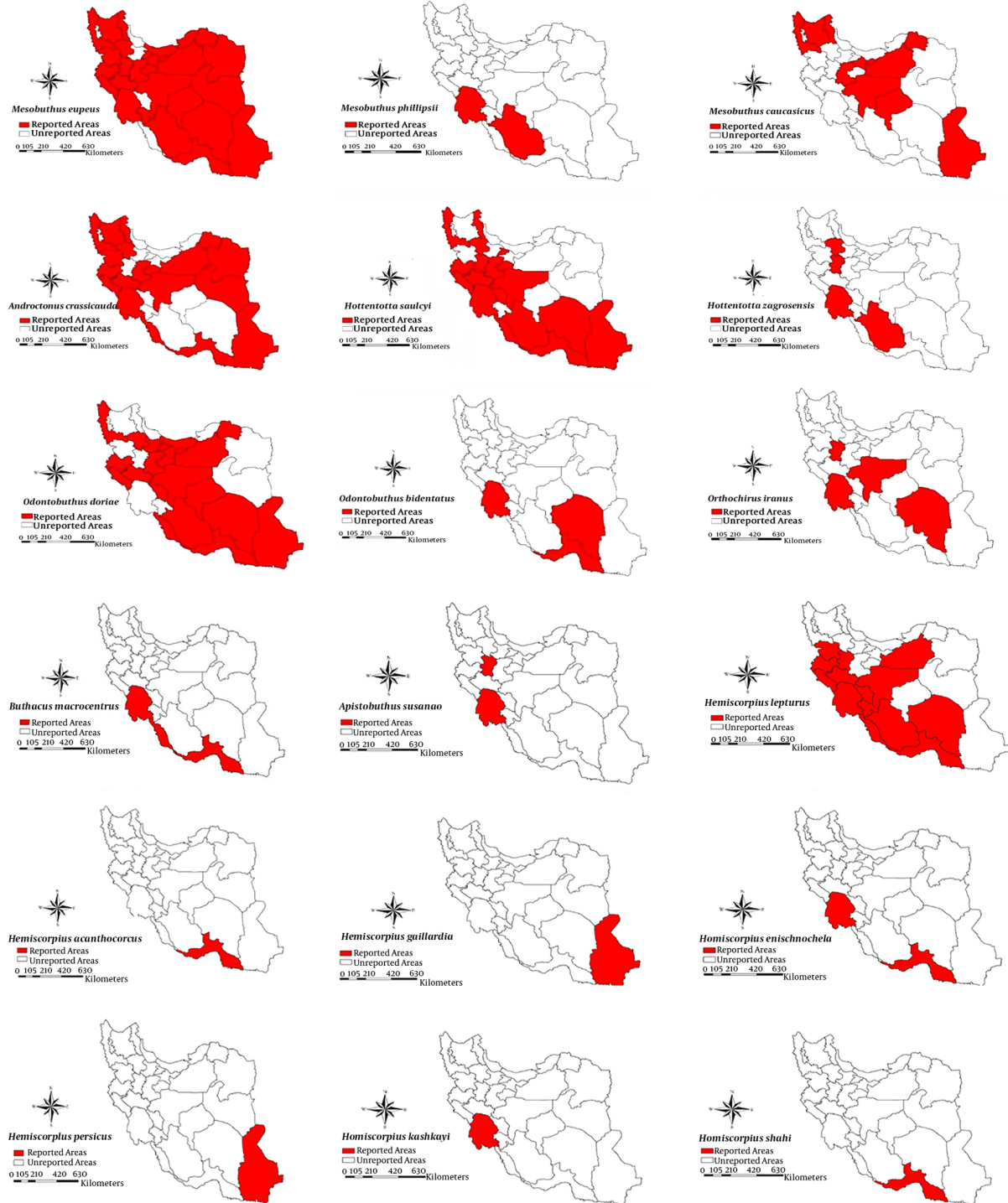


Figure 2. Spatial distribution maps of medically important scorpion species of Iran

3.1.4. *Androctonus crassicauda*

The total body length of this scorpion is about 11 - 12 cm, and its color varies from brown to black, it is most

commonly found under the rocks, in sand dunes, and the crevices of the earth. It is a dangerous and deadly scor-

pion, and after the *Hemiscorpius lepturus*, it is regarded as the second deadly scorpion of Iran. This scorpion sting is very painful and causes cardiovascular problems and sometimes can be fatal (6).

It is distributed in Ardabil, East Azerbaijan, West Azerbaijan, Zanjan, Kurdistan, Kermanshah, Ilam, Lorestan, Khuzestan, Bushehr, North Khorasan, Razavi Khorasan, South Khorasan, Semnan, Qom, Markazi, Hormozgan, and Sistan and Baluchistan provinces (Figures 1 and 2) (31).

3.2. The Species of the Genus *Odontobuthus*

Until now, five species of this genus including: *O. doriae* (more prevalence) *Odontobuthus bidentatus*, *Odontobuthus brevidigitus*, *Odontobuthus tigrari* (northeastern Iran), and *Odontobuthus tavighiae* (Hormozgan Province) have been identified in Iran, among which *O. doriae* has wide distribution area in Iran and is regarded as a most medically important one (15).

3.2.1. *Odontobuthus doriae*

This species is a digger species, its body color varies from lemon to straw and pale green to bluish-green. It has 5 - 6 granules under the terminal denticle of the chela movable finger, all the denticle rows of chela have external and internal granules, the ventral carines of the second and third segments are projecting, also these projecting carines can be seen on anterior margin of third and fourth metasomal segments. The anal arch has two lobes, and the trichobotrial formula in this species is type A. Centro lateral and posteriors-medial carines are connected to each other (11, 15).

This species is not considered as deadly scorpion, but it is very dangerous. It does not live near residential areas. This scorpion is dangerous and deadly to people like soldiers and workers who live in desert areas and camps (32-37).

Odonthubutus doriae is one of the dangerous scorpions in the country, whose sting is life-threatening to humans. The main clinical symptoms of *O. doriae* envenomation are shortness of breath, rapid breathing, and abnormally rapid heartbeat.

This species is distributed in the provinces of Esfahan, Fars, Hamadan, Kerman, Kermanshah, Mazandaran, Markazi, Teheran, Alborz, West Azerbaijan, Zanjan, Qazvin, Qom, Semnan, North Khorasan, Ilam, Bushehr, Hormozgan, Yazd, Chahar Mahal and Bakhtiyari, Sistan and Baluchistan (Figures 1 and 2) (32).

3.2.2. *Odontobuthus bidentatus*

This species is more similar to *O. doriae* morphologically, and there is no information about envenomation by

this species because generally people know this species as *O. doriae*. These two digger scorpions are very similar to each other, except for the fact that *O. doriae* has two lateral lobes on the anal arch and *O. bidentatus* has three lateral lobes on anal arch. This species has limited distribution in Iran and can be found only in Khuzestan, Hormozgan, and Kerman provinces. More researchers consider this species as *Odontobuthus odonturus*, but this is wrong and *O. odonturus* does not exist in Iran (Figures 1 and 2) (11).

3.3. The Species of the Genus *Hottentotta*

Until now, the following species have been reported from this genus in Iran:

Hottentotta zagrosensis, *Hottentotta schach*, *Hottentotta saulcyi*, *Hottentotta lorestanus*, *Hottentotta khoozestanus*, *Hottentotta jaiakari*, *Hottentotta navidpouri*, *Hottentotta sistansensis*, among which *H. saulcyi* and *H. zagrosensis* are considered as the most medically important ones (16).

3.3.1. *Hottentotta saulcyi*

This scorpion is not a deadly species, and formerly it was considered as *Buthotus saulcyi*. Unfortunately, now some researchers call this species *B. saulcyi*, which is wrong. The body color of this species varies from yellow to brown, but the carapace, fifth metasomal segment, and telson are black, and the telson of this scorpion is hirsute, there are four granules under the main denticle of chela movable finger. It has about 15 rows of cutting denticles with external and internal accessory granules, with trichobotrial formula A (11).

Buthotus saulcyi inhabits in several provinces of Iran such as West Azerbaijan, Ardabil, Alborz, Markazi, Zanjan, Qom, Kermanshah, Lorestan, Fars, Esfahan, Hamadan, Hormozgan, Ilam, Kerman, Bushehr and Khuzestan, Chahar Machal and Bakhtiyari, and Sistan and Baluchistan (Figures 1 and 2). The clinical manifestations of envenomation by this scorpion are clear and the affected area becomes very painful (6, 28).

3.3.2. *Hottentotta zagrosensis*

This species is not deadly scorpion, and it was formerly called *Buthotus schach* or *Hottentotta schach* and some researchers still called it the same. It has a large, black, hirsute body. Its pedipalp chela movable finger has four terminal granules, with 14 - 16 cutting rows of denticles, external and internal accessory granules, and trichobotrial formula A. The clinical manifestations of this scorpion sting is not clear and require more research. This species has been found in Zanjan, Khuzestan, Fars, Lorestan and Chahar Mahal and Bakhtiyari provinces (22, 25, 30, 38).

3.4. The Species of the Genus *Orthochirus*

Formerly all species of this genus were called *Orthochirus scrobiculosus* by Farzanpey. This researcher has mentioned that in Iran there are four types of this species including *O. scrobiculosus* forms 1, 2, 3 and 4, but now the following species have been reported: *O. iranensis*, *Orthochirus farzanpayi*, *Orthochirus stockwelli*, *Orthochirus varius*, *Orthochirus gruberi*, *Orthochirus zagrosensis*, *Orthochirus iranensis*, *O. gantenbeini* and *Orthochirus carinatus*, among them *O. iranensis* is more prevalence and medically important (17).

3.4.1. *Orthochirus iranensis*

The body size of this scorpion is small (3 - 4 cm), the color of dorsal mesosoma and carapace varies from black to blackish, and the legs, pedipalp and ventral surface vary from yellow to yellowish and black to blackish and olive to brown. There are 9 rows of denticle on chela movable finger with external and internal accessory granules. This species is distributed in Khuzestan, Esfahan, Kerman, and Lorestan provinces (Figures 1 and 2). It is the quietest scorpion in Iran and can be held by hand with no risk of a sting, but there is a report of human death by a scorpion of the genus *Orthochirus* from Khuzestan (6, 11).

3.5. The Species of the Genus *Compsobuthus*

Regarding old and new references these species of this genus have been identified in Iran:

Compsobuthus persicus, *Compsobuthus plutenkoi*, *Compsobuthus kaftani*, *Compsobuthus garyi*, *Compsobuthus petrioli*, *Compsobuthus sobotniki*, *Compsobuthus jaksai*, *Compsobuthus plutenkoi*, *Compsobuthus rugosulus*, *Compsobuthus kafkai* and *C. matthiesseni* are distributed in more area and is one of the medically important scorpions in Iran (39).

3.5.1. *Compsobuthus matthiesseni*

This is a slender small scorpion (less than 4.5 mm length), the color of this scorpion is pale yellow and in the posterior of the fourth metasomal segment and anterior part of the fifth metasomal segment are black. Lateroventral carines of the fifth metasomal segment are uniform, the anal arch has three lobes, there are four granules under the terminal denticle of chela movable finger. It has external and internal cutting rows on the chela movable finger, and the trichobotrial type is A. One of the most important clinical manifestations of this scorpion is hematuria in stung person (11).

It has been reported from Kermanshah, Bushehr, Fars, Hamadan, Khuzestan, Kerman, Kurdistan, Kohgiluyeh and Boyer-Ahmad, Markazi, Qom, Ilam, West Azerbaijan, Esfahan, Lorestan, and Sistan and Baluchistan provinces. (Figures 1 and 2) (6, 28).

3.5.2. *Apistobuthus susanae*

The formerly name of this scorpion was *Apistobuthus petricergus*, it has a large body size (10 - 11 cm), two accessory terminal granules on chela movable finger, and 12 - 15 cutting rows of denticle on chela movable finger. The specific morphological characteristic of this scorpion is that the first segment of the metasoma is wider than the other segments and it has a discoid shape. This species inhabits in Khuzestan and Lorestan (Figures 1 and 2), and the clinical manifestations of the sting by this species are slightly similar to those of *A. crassicauda* (1, 6, 11, 22).

3.5.3. *Buthacus macrocentrus*

This non-digger scorpion, which belongs to the family Buthidae, is not a deadly scorpion. The adult *B. macrocentrus* grows up to about 7 cm, and its color ranges from pale yellow to darker yellow. There are four accessory granules under the main denticle of the chela movable finger, and there are 10 cutting rows on chela movable finger with external and internal accessory granules. This species can be found in Khuzestan, Hormozgan and Bushehr provinces. (Figures 1 and 2) (11).

3.6. Family Hemiscorpiidae

Iranian deadly scorpions belong to this family, scorpions of this family have wide chela and pentagonal sternum, the trichobotrial formula is type C, the members of this family were formerly located at family Scorpionidae but now are considered as a single family: Hemiscorpiidae, the genus *Hemiscorpius* is the only genus of this family in Iran and includes the species of *H. lepturus* (wide distribution), *Hemiscorpius persicus* (Sistan and Baluchistan), *H. achantocercus* and *Hemiscorpius gaillardia* (Sistan and Baluchistan), *Hemiscorpius enischnochela* (from Hormozgan and Khuzestan), *Hemiscorpius kashkayi* (Khuzestan), and *Hemiscorpius shahi* (Hormozgan), among which *H. lepturus* and *H. acanthocercus* are the most deadly ones (13, 18, 40).

3.6.1. *Hemiscorpius lepturus*

The total body length is 5 and 7.5 cm for females and males respectively. There is sexual dimorphism in this species such that the tail of males is longer than that of females. The color of this scorpion varies from pale yellow to darker yellow, the sting of this scorpion is mostly cytotoxic and causes gangrene in stung person, and most of the deaths caused by this scorpion have occurred in Khuzestan and Hormozgan provinces. This species has been reported from Khuzestan, Semnan, Fars, Kurdistan, Hormozgan, Bushehr, Ilam, Lorestan, Kermanshah, Isfahan, Hamadan, Kohgiluyeh and Boyer-Ahmad, Kerman, and Chahar Mahal and Bakhtiari provinces (Figures 1 and 2) (6, 11).

3.6.2. *Hemiscorpius acanthocercus*

This scorpion is very similar to *H. lepturus*, but in males, carines of metasoma at the dorsal extremities are spiniform. This scorpion inhabits in Hormozagan province, and Shahi for the first time reported that this species caused death in this province (Figures 1 and 2) (40, 41).

4. Discussion

In this study, we provided updated spatial distribution maps with new scorpion species names, new distribution variations of medically important scorpions in Iran, and some new data about Iranian scorpions. This is the first attempt to produce distribution maps for *M. phillipsii* and *O. bidentatus*, and for other medically important species like *M. eupeus*, *A. crassicauda*, *M. caucasicus*, *H. saulcyi*, *H. zagrosensis*, *O. doriae*, *A. susanae*, *O. iranensis*, *H. lepturus*, and *B. macrocentrus*. We produced distribution maps based on new data recorded for these scorpions in recent studies, so for each species locality, some provinces were added and the range of distribution of some species was increased.

Our results showed the existence of two medically important scorpion families in Iran including Buthidae and Hemiscorpiidae. The world's deadliest and most dangerous scorpion species belong to family Buthidae, but in contrast, the members of Hemiscorpiidae are the deadliest ones in Iran. In Iran, for scorpion envenomation treatment, a polyvalent antivenom prepared by Razi Vaccine and Serum Research is used against six medically important scorpion species (i.e., *H. lepturus*, *A. crassicauda*, *M. eupeus*, *O. doriae*, *H. saulcyi*, and *H. zagrosensis*) (8).

Among these scorpions, *H. lepturus* and *A. crassicauda* are the deadliest ones, the former one has limited distribution area and it has been reported only in southern parts of Iran and most fatalities from scorpion envenomation occurred in this area. Therefore, more scorpion control programs should be held in this area, and this region is considered as a high-risk area with respect to scorpion envenomation (5-7).

The second deadliest scorpion species in Iran is *A. crassicauda* that has been found in most provinces of Iran. In provinces which are free of *Hemiscorpius*, this species sometimes causes death, especially in children under 12 years old. This species inhabits under the rocks, so people inhabiting or traveling to this area should not permit their children to roll the rocks to avoid contact with this scorpions (8).

The species *M. eupeus* is considered as the more prevalent species in Iran, as it has been captured in almost in all provinces of Iran. Fortunately, so far there have been no reports of death from this scorpion, but it is considered as a

medically important species and has caused public health problems. The provinces of Khuzestan, Hormozgan, and Kerman are considered as high-risk areas because all the six mentioned dangerous scorpion species have been reported from these regions (24).

Recently, more scorpion species have been identified for the first time in Iran including: *M. phillipsii*, *Hemiscorpius shahi*, *Hemiscorpius ghashghaii*, *Hottentotta navidpourii*, *Hottentotta sistensis*, and *Odontobuthus tigrari*. Also, there are four species from the genus *Odontobuthus* reported from Iran including: *O. doriae*, *O. bidentatus*, *O. tavighiae*, and *O. tigrari*, and there are four subspecies of *M. eupeus* from Iran including *M.e. eupeus*, *M.e. thersites*, *M.e. kermanensis*, and *M.e. philipovitschi* (12, 15, 18). Regarding this new species of scorpion fauna in Iran, any one of these newly reported scorpion species has a special ecology and a likely venom composition. Thus, for scorpion control programs these newly recorded scorpion species should be regarded, because there is no scorpion identification key in Iran for all species. As mentioned above, 66 scorpion species have been reported from Iran, but for the identification of species, only the Farzanpayi key is used. This identification key is very old and only includes 27 species (11), and some species' names have been changed. Unfortunately, some researchers currently use this key because the first step of arthropod control programs including scorpions are species identification and producing spatial distribution maps; thus, our results can be used in this field.

5. Conclusion

There are 66 scorpion species in Iran, the deadliest of which include *H. lepturus*, *H. acanthocercus*, and *A. crassicauda*. These scorpions mostly inhabit in southern parts of the country, but *A. crassicauda* is distributed from north to south and from west to east of Iran. *M. eupeus* is a medically important scorpion that inhabits in most parts of Iran and is considered as the most prevalent scorpion species in Iran. A polyvalent antivenom is used against six medically important scorpion species including *M. eupeus*, *A. crassicauda*, *O. doriae*, *H. saulcyi*, *H. zagrosensis*, and *H. lepturus*, because now there are more than 12 medically important scorpion species, but they have not been considered in antivenom production. The prepared antivenom may sometimes fail to cure patients, because different scorpion species have different venom compositions. Thus, we suggest producing regional antivenoms, because recently there have been reports of new medically important scorpion species in different parts of Iran, but people and some researchers are not familiar with them.

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Footnotes

Authors' Contribution: MMB and AS conceptualized the study. AS and MMB were the project designers and wrote the manuscript. AS and MMB performed spatial analysis. All the authors read, modified, and approved the final version of the manuscript.

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