New data on medically important scorpion species of Iran based on seven physiographic areas

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HIGHLIGHTS

• In east and west coast of Persian Gulf area, in this two climatological region together (including only four provinces: Khuzestan, Bushehr, Hormozgan and Sistan-Baluchestan), there are three families of scorpions (Buthidae, Hemiscorpiidae and Scorpionidae), 18 genera and 45 species, the density of scorpions are very high, and the most scorpion species are inhabited in this region and the most scorpion envenomation and death due to scorpion sting occur in this corner of Iran.
• In this region there are seven species of genus Hemiscorpius belonging to Hemiscorpidae family, these species are among the most deadly scorpion in Iran, among which, Hemiscorpius lepturus is the most deadly scorpion, in Iran 67% of death due to scorpion envenomation caused by H. lepturus, this species cause significant local, systemic and cytotoxic symptoms which make it different among other species.

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ABSTRACT

There are 2612 and 80 scorpion species in the world and Iran, respectively. Iran is rich in climatic conditions and biodiversity. In this study, new data on scorpion fauna of different physiographic areas of Iran were obtained from various databases, including plains and deserts, eastern area of the Caspian Sea, western and central areas of the Caspian Sea, heights and foothills, the west coast of the Persian Gulf and the east coast of the Persian Gulf. Then, spatial distribution maps for scorpion species in different physiographic areas were prepared using ARC GIS software. There are three families (Buthidae, Hemiscorpiidae, and Scorpionidae), 19 genera, and 80 species and subspecies. In plains and deserts, there are three families, 15 genera, and 37 scorpion species; in the Caspian Sea area, there is only one family with four scorpions; in heights and foothills, there are three families, 14 genera, and 35 scorpion species; in the west coast of the Persian Gulf, there are three families, 13 genera, and 31 scorpion species; and finally, in the east coast of the Persian Gulf, there are three families, 14 genera, and 35 scorpion species. The Buthidae is the most prevalent family in Iran. Because of good climatological conditions on the east and west coast of the Persian Gulf, there are three families of scorpions, 18 genera, and 45 species. The majority of scorpion species inhabit this region, and the highest rate of scorpionism and death due to scorpion sting occurs in this part of Iran.

1. Introduction

Scorpions are one type of medically important arthropods. There are about 2612 scorpion species in the world (https://www.ntnu.no/ub/sco rpi-on-files/) (Rein, 2021). There are three families in Iran: Buthidae (17 genera and 71 species), Hemiscorpiidae (one genus and seven species), and Scorpionidae (one species and two subspecies) with 19 genera, 80 species and subspecies (Barahoei et al., 2021; Dehghani and Kassiri, 2018; Karataz et al., 2012; Kovarik et al. 2017, 2018, 2019a; Mirshamsi et al., 2011a; Rafizadeh et al., 2013; Firoozfar et al., 2019). These venomous...
animals sting 40,000 to 50,000 people in Iran annually, and scorpion envenomation is one of the most serious public health problems in the country (Dehghani and Ghanaee Arani, 2015). Located in the Middle East, Iran is a vast country between the Caspian Sea in the north and the Persian Gulf and the Oman Sea in the south. It has different types of soils and climates: mild and quite wet on the coast of the Caspian Sea, continental and arid in the plateau, cold in high mountains and deserts, and hot on the southern coast and in the southeast (Iran, from Wikipedia). Iran is rich in climatic conditions and biodiversity, hence, a suitable breeding place for a high diversity of animals, including several scorpion species. Environmental factors such as temperature, humidity, rainfall, and the number of sunny days can affect the abundance of scorpions and increase the number of scorpions as well as the number of scorpion species. Thus, in the southern regions of the country with favorable temperatures and environmental conditions, the abundance and species diversity of scorpion species are higher with a higher rate of stings in these areas.

In some areas such as Khuzestan, Hormozgan, Bushehr, Sistan & Baluchistan, and Fars provinces, there are many inhabiting scorpion species that can sting people and cause public health problems. Therefore, the highest scorpionism and fatalities belong to these provinces. All the Iranian medically important species inhabit this area: *Mesobuthus eupeus* (C. L. Koch, 1839), *Mesobuthus phillipsii* (Pocock, 1889), *Androctonus crassicauda* (Olivier, 1807), *Hottentotta saulcyi* (Simon, 1880), *Hottentotta zagrosensis* (Kovarik, 1997), *Odontobuthus doriae* (Thorell, 1876), *Odontobuthus bidentatus* (Vachon, 1950), *Compsobuthus matthieseni* (Birula, 1905), *Orthochirus iranus* (Kovarik, 2004), *Buthacus macrocentrus*, *Apistobuthus susanae* (Lourenço, 1998), *Hemiscorpius lepturus* (Peters, 1861), and *Hemiscorpius acaanthocercus* (Monod and Lourenço, 2005). Of these species, the deadliest scorpions belong to *Hemiscorpius* (Peters, 1861) and *Androctonus* (Lane and Crosskey, 2012; Dehghani and Fathi, 2012; Jalali and Rahim, 2014). Many studies have been done on scorpion fauna and scorpionism in the country, but there is no information on scorpion fauna in different physiographic areas of Iran; thus, there is a big gap of valid information about scorpions in different zoogeographical areas in Iran. Accordingly, to bridge the gap, we seek to produce new information on scorpion fauna including medically important ones from different physiographic areas in this study. This valuable data can be used for producing regional or monovalent antivenom on the one hand and be used by public health staff for scorpion control on the other. So, this study aims to determine new data on Iranian scorpions including medically important ones in different physiographic areas according to the most updated information.

### 2. Materials and methods

In this narrative review study, all published data on scorpion fauna of all seven physiographic areas of Iran (Katirae-Boroujerdy et al., 2020) (Figure 1) were reviewed, including:

1. Plains and desert areas (Qom, Kerman, Semnan, North Khorasan, Razavi Khorasan, South Khorasan, Isfahan, and Yazd provinces). This area is an arid region located in the central part of Iran. This region, covering major areas of the country, also includes some high-elevation areas with rainfalls more abundant than flat areas (Katirae-Boroujerdy et al., 2020).
2. East of the Caspian Sea: This region includes only Golestan Province. This area is located in the north of Iran and has the highest annual precipitation.

![Figure 1. Iran and its seven physiographic areas.](image-url)
3. Results

According to the recently published data on Iranian scorpions, there are three families, 19 genera, and 80 species and subspecies (Table 1). Some researchers claim that there is a species called Nebo hengamicus (Francke, 1980) in Iran belonging to the family Diplodectidae (Karsch, 1880; Francke, 1980), but most Iranian researchers have not mentioned such a species in their reports (Firoozfar et al., 2019; Firoozfar et al., 2020). The recent data was indexed in various databases including ISI, PubMed, Scopus, Science Direct, and Google Scholar databases, using the relevant MeSH keywords from 1966 to 2021. The data on the localities, scientific names, medically important information, habitats, and geographical coordinates of scorpions were extracted from articles and put into an Excel file; then, spatial distribution maps for scorpion species in different physiographic areas were prepared using ARC GIS 4 software. The study protocol was approved by the ethical admission committee, Qom University of Medical Sciences, Iran (Code of Ethics: IR.MU.Q.REC.1399.223).

Table 1. The number of Families, genera, and species of Iranian scorpions.

| Number | Family | Number of Genera | Number of species & subspecies | Percent |
|--------|--------|------------------|-------------------------------|---------|
| 1      | Buthidae | 17               | 71                            | 88.75%  |
| 2      | Hemiscoriidiae | 1               | 7                             | 8.75%   |
| 3      | Scorpionidae | 1                | 2                             | 2.5%    |
| Total  |         | 19               | 80                            | 100%    |

A. 3-Genus Odontobuthus (Vachon, 1950): 16-Odontobuthus dorai (Thorell, 1876), 17-Odontobuthus bidensita (Lourenço and Pézier, 2002), 18-Odontobuthus baluchicus (Vachon, 1950), 19-Odontobuthus chabaharensis, 20-Odontobuthus tirgiri (Mirshamsi et al., 2013), 21-Odontobuthus tavihtae (Navidpour et al., 2013), and 22-Odontobuthus kermanicus.

A. 4-Genus Orthochirus (Karsch, 1892): 23-Orthochirus scrobiculocus (Grube, 1873), 24-Orthochirus fusiceps (Pocock, 1900), 25-Orthochirus sagrosensis (Kovarik, 2004), 26-Orthochirus fazanpavii (Navidpour et al., 2011), 27-Orthochirus carinatus (Navidpour et al., 2010), 28-Orthochirus iranus (Kovarik, 2004), 29-Orthochirus navidpouri (Kovarik et al., 2019a), 30-Orthochirus stockelli (Lourenço and Vachon, 1995), 31-Orthochirus gantembeini (Kovarik et al., 2019a), 32-Orthochirus varius (Kovarik, 2004), 33-Orthochirus hormozganensis (Kovarik and Navidpour, 2020), 34-Orthochirus kermanensis (Kovarik and Navidpour, 2020), 35-Orthochirus kucerae (Kovarik and Navidpour, 2020), 36-Orthochirus mashhouri (Kovarik and Navidpour, 2020), 37-Orthochirus semnansensis (Kovarik and Navidpour, 2020), 38-Orthochirus vognelli (Kovarik and Navidpour, 2020), and 39-Orthochirus mesopotamicus (Birula, 1918).

A. 5-Genus Compsobuthus Vachon, 1949, 40-Compsobuthus matthiessenii (Birula, 2005), 41-Compsobuthus khafani (Kovarik, 2003), 42-Compsobuthus petriolii (Vignoli, 2005), 43-Compsobuthus garyi (Lourenço and Vachon, 2001), 44-Compsobuthus jakesi (Kovarik, 2003), 45-Compsobuthus persicus (Navidpour, 2008), 46-Compsobuthus plutenkoi (Kovarik, 2003), 47-Compsobuthus acutecarinatus (Simon, 1882), 48-Compsobuthus rufogarrit (Pocock, 1900), and 49-Compsobuthus sobotniki (Kovarik, 2003).

A. 6-Genus Hottentotta (Birula, 1908): 50-Hottentotta saucyi (Simon, 1880), 51-Hottentotta jayakari (Pocock, 1895), 52-Hottentotta sistanensis (Kovarik et al., 2018), 53-Hottentotta sagrosensis (Kovarik, 1997), 54-Hottentotta loersteinus (Navidpour et al., 2010), 55-Hottentotta schach (Birula, 1905), 56-Hottentotta khoosestanus (Navidpour et al., 2008b), 57-Hottentotta navidpouri (Kovarik et al., 2018), and 58-Hottentotta jui (Kovarik et al., 2019b).

A. 7-Genus Sassanidotus (Farzanpay, 1987): 59-Sassanidotus gracilis (Birula, 1900), 60-Sassanidotus persicus (Birula, 1900), 61-Sassanidotus semnansensis (Kovarik et al., 2019b).

A. 8-Genus Liobuthus (Birula, 1989): 62-Liobuthus kessleri (Birula, 1898), 63-Liobuthus sp. (Teruel et al., 2014), 64-Liobuthus sp. (Birula, 1900).

A. 9-Genus Kraepelina (Birula, 1903): 65-Kraepelina palpator (Birula, 1903), 66-Kraepelina sp. (Birula, 1903), 67-Kraepelina sp. (Birula, 1903).

A. 10-Genus Anomalobuthus (Kraepelin, 1900): 68-Anomalobuthus talebii (Teruel et al., 2014), 69-Anomalobuthus sp. (Birula, 1900), 70-Anomalobuthus sp. (Birula, 1900).

A. 11-Genus Sassanidotus (Farzanpay, 1987): 71-Sassanidotus gracilis (Birula, 1900), 72-Sassanidotus sp. (Birula, 1900), 73-Sassanidotus sp. (Birula, 1900).

A. 12-Genus Rastianus (Farzanpay, 1987): 74-Rastianus sp. (Birula, 1900), 75-Rastianus sp. (Birula, 1900), 76-Rastianus sp. (Birula, 1900), 77-Rastianus sp. (Birula, 1900).

A. 13-Genus Buthacus (Birula, 1908): 78-Buthacus macropus (Birula, 1908), 79-Buthacus sp. (Birula, 1908), 80-Buthacus sp. (Birula, 1908), 81-Buthacus sp. (Birula, 1908).

A. 14-Genus Polisius (Fet et al., 2001): 82-Polisius sp. (Fet et al., 2001), 83-Polisius sp. (Fet et al., 2001), 84-Polisius sp. (Fet et al., 2001), 85-Polisius sp. (Fet et al., 2001).

A. 15-Genus Iranobuthus (Kovarik, 1997): 86-Iranobuthus krali (Kovarik, 1997), 87-Iranobuthus sp. (Kovarik, 1997), 88-Iranobuthus sp. (Kovarik, 1997).

A. 16-Genus Vachoniulus (Levy et al., 1973): 89-Vachoniulus iranus (Navidpour et al., 2008b), 90-Vachoniulus sp. (Navidpour et al., 2008b).

A. 17-Genus Apistobuthus (Finnegan, 1932): 91-Apistobuthus susanae (Lourenço, 1998).

B. Scorpionidae family include one genus, one species and two subspecies.

B. 1: Genus Scorpion (Linnaeus, 1758): 72-Scorpion maurus krugovi and 73-Scorpion maurus townsendii (Pocock, 1900), (Barahoei et al., 2021).

C. Hemiscorpiidae (Pocock, 1893) family includes one genus and seven species including.
C. 1: Genus Hottentotta (Peters, 1861): 74-Hottentotta saulcyi, 27-Hottentotta sistanensis, 29-Sassanidotus gracilis, 30-Liobuthus kessleri, 31-Kraepeolina palpator, 32-Anomalobuthus tawlbei, 33-Sassanidota saulcyi, 34-Iranothorax krali, 35-Scorpio maurostheni and 36-Scorpio maurostheni kraglovii from Scorpioniidae family and 36-Hemiscorpius acanthocerus and 37-Hemiscorpius lepturus from Hemi- scorpiidae family (Barahoei et al., 2021; Kovařík et al., 2018; Nejati et al., 2014, 2017; Moradi et al., 2020) (Figure 2).

Qom province: In this province, there are ten species of scorpions, all belongs to Buthidae family: 1-Mesobuthus eupeus, 2-Mesobuthus caucasicus, 3-Androctonus crassicauda, 4-Odontobuthus dotiae, 5-Odontobuthus bidentatus, 6-Orthochirus scrobiculosus, 7-Compobuthus mathiesi, 8-Compobuthus petriolii, 9-Iranothorax krali and 10-Hottentotta saulcyi (Nejati et al., 2017; Karataş et al., 2012; Sissom and Fet, 1998; Habibi, 1971).

Kerman province: There are 22 scorpion species from two families of Buthidae and Hemiscorpiidae: From family Buthidae: 1-Mesobuthus eupeus, 2-Mesobuthus persicus, 3-Mesobuthus macmahoni, 4-Androctonus crassicauda, 5-Compobuthus kaftani, 6-Compobuthus matthiesseni, 7-Compobuthus kermanensis, 8-Compobuthus kaftani, 9-Compobuthus petriolii, 10-Orthochirus vignolii, 11-Orthochirus scrobiculosus, 12-Orthochirus kermanensis, 13-Orthochirus navidpouri, 14-Orthochirus mesopotamicus, 15-Orthochirus semnanensis, 16-Orthochirus jayakari, 17-Orthochirus iranensis, 18-Orthochirus stockwelli, 19-Orthochirus varius, 20-Orthochirus fuscipes, 21-Orthochirus fuscipes, 22-Orthochirus scrobiculosus, 23-Orthochirus varius, 24-Orthochirus stockwelli, 25-Orthochirus vignolii,26-Hottentotta saulcyi, 27-Hottentotta jayakari, 28-Hottentotta sistanensis, 29-Sassanidotus gracilis, 30-Liobuthus kessleri, 31-Kraepeolina palpator, 32-Anomalobuthus tawlbei, 33-Sassanidota saulcyi, 34-Iranothorax krali, 35-Scorpio maurostheni and 36-Scorpio maurostheni kraglovii from Scorpioniidae family and 36-Hemiscorpius acanthocerus and 37-Hemiscorpius lepturus from Hemi- scorpiidae family (Barahoei et al., 2021; Kovařík et al., 2018; Nejati et al., 2014, 2017; Moradi et al., 2020) (Figure 2).

1-Scorpions of plains and desert areas (Table 2): In this physiographic area, there are three families (Buthidae, Scorpioniidae and Hemiscorpiidae), 15 genera, and 37 scorpion species including:1-Mesobuthus eupeus, 2-Mesobuthus thersites, 3-Mesobuthus afganensis, 4-Mesobuthus persicus, 5-Mesobuthus macmahoni, 6-Mesobuthus caucasicus, 7-Mesobuthus vesiculatus, 8-Mesobuthus parthorum 9-Androctonus crassicauda, 10-Odontobuthus dotiae, 11-Odontobuthus bidentatus, 12-Orthochirus semnanensis, 13-Orthochirus kuceri 14-Orthochirus tawleri, 15-Orthochirus scrobiculosus, 16-Orthochirus fuscipes, 17-Orthochirus zagrosensis, 18-Orthochirus fasanpam, 20-Orthochirus kermanensis, 21-Compobuthus kaftani, 22-Compobuthus mathiesi, 23-Compobuthus kaftani, 24-Compobuthus petriolii, 25-Orthochirus vignolii, 26-Hottentotta saulcyi, 27-Hottentotta jayakari, 28-Hottentotta sistanensis, 29-Sassanidotus gracilis, 30-Liobuthus kessleri, 31-Kraepeolina palpator, 32-Anomalobuthus tawlbei, 33-Sassanidota saulcyi, 34-Iranothorax krali and 35-Scorpio maurostheni kraglovii from Scorpioniidae family and 36-Hemiscorpius acanthocerus and 37-Hemiscorpius lepturus from Hemi- scorpiidae family (Barahoei et al., 2021; Kovařík et al., 2018; Nejati et al., 2014, 2017; Moradi et al., 2020) (Figure 2).
Figure 2. Spatial distribution of medically important scorpion species of Iran based on seven physiographic areas.
several scorpion species in this geographic area of Iran. First, there are three families (Buthidae, Scorpionidae, and Hemiscorpiidae), 14 genera, and 35 scorpion species: 1- Mesobuthus eupeus, 2-Mesobuthus brutus, 3-Mesobuthus irananus, 4-Mesobuthus persicus, 5-Mesobuthus cucacicus, 6-Mesobuthus philippisi, 7-Androctonus crassicauda, 8-Hottentotta saulcyi, 9-Hottentotta zagrosensis, 10-Hottentotta lorestanensis, 11-Hottentotta schach, 12-Hottentotta juliae, 13-Compsobuthus matthiesseni, 14-Compsobuthus persicus, 15-Compsobuthus petrolii, 16-Compsobuthus kaftani, 17-Compsobuthus jakesi, 18-Compsobuthus rugosulus 19-Orthocirus carinatus, 20-Orthocirus irananus, 21-Orthocirus zagrosensis, 22-Orthocirus navidpouri, 23-Orthocirus scrobiculosus, 24-Orthocirus mesopomaticus, 25-Orthocirus doriae, 26-Orthocirus bidentatus, 27-Orthocirus tavighiae, 28-Orthocirus attenuata, 29-Razianus zarudnyi, 30-Stephanus macrocentrus, 31-Polistus persicus, 32-Iranobuthus krali, Vachonius irananus 33-Scorpio maurus townsendi, from Scorpionidae family, 34-Hemiscorpius lepturus and 35-Hemiscorpius gaiardi from Hemiscorpiidae family (Figure 2).

Kurdistan province: There are six scorpion species in this province: 1-Mesobuthus eupeus, 2-Androctonus crassicauda, 3-Compsobuthus matthiesseni, 4-Hottentotta saulcyi, from Buthidae Family and 5-Scorpio maurus townsendi from Scorpionidae family and 6-Hemiscorpius lepturus from Buthidae Family (Dehghani and Kaziri, 2018; Motevali Hagh and Deghani, 2017; Habibi, 1971; Farzanpay, 1987).

West Azerbaijan province: There are five scorpion species in this province belonging to two families; Buthidae and Scorpionidae: 1-Mesobuthus eupeus, 2-Mesobuthus cucacicus, 3-Androctonus cucacicus, 4-Hottentotta saulcyi, 5-Compsobuthus petrolii, 6-Hottentotta zagrosensis and 7-Scorpio maurus (Gharakhloo et al., 2018; Banavi et al., 2017; Kovarik, 2007).

East Azerbaijan province: There are three scorpion species in this province, all belonging to Buthidae family: 1-Mesobuthus eupeus, 2-Mesobuthus cucacicus 3-Mesobuthus vesiculatus, and 4-Androctonus crassicauda, 5-Compsobuthus petrolii, Odontobuthus doriae, 6-Androctonus irananus, 7-Ornhocirus bidentatus from Scorpionidae family (Gharakhloo et al., 2018; Banavi et al., 2017; Kovarik, 2007).

Ardebil province: There are three scorpion species in this province: 1-Mesobuthus eupeus, 2-Mesobuthus cucacicus from Buthidae family and 3-Scorpio maurus from Scorpionidae family (Bavani et al., 2017).

Tehrán, Alborz and Markazi provinces: There are nine scorpion species in these provinces including: 1-Mesobuthus eupeus, 2-Androctonus crassicauda, 3-Compsobuthus matthiesseni, 4-Hottentotta saulcyi, 5-Compsobuthus petrolii, 6-Orthocirus doriae, 7-Scorpio maurus townsendi from Scorpionidae family and 8-Orthocirus krali, from Buthidae family and 9-Scorpio maurus townsendi from Scorpionidae family (Karatay et al., 2012; Navidpour et al., 2019; Jafari et al., 2015).

Zanjan province: In this region, there are seven scorpion species belonging to one province including: 1-Mesobuthus eupeus, 2-Mesobuthus brutus, 3-Androctonus crassicauda, 4-Hottentotta saulcyi, 5-Hottentotta zagrosensis, 6-Ornhocirus doriae, and 7-Scorpio maurus from Scorpionidae family (Fet et al., 2018; Moradi et al., 2015).

Qazvin province: In this province, there are six scorpion species including: 1-Mesobuthus eupeus, 2-Mesobuthus brutus, 3-Androctonus crassicauda, 4-Hottentotta saulcyi, 5-Hottentotta zagrosensis, 6-Ornhocirus doriae, from Buthidae family and 7-Scorpio maurus from Scorpionidae family (Fet et al., 2018; Moradi et al., 2015).

Kohgiluyeh & Boyer Ahmad and Chahar Mahal & Bakhtiyari provinces: There are 18 scorpion species in this province including: 1-Mesobuthus eupeus, 2-Mesobuthus philippisi, 3-Mesobuthus cucacicus, 4-Androctonus crassicauda, 5-Compsobuthus matthiesseni, 6-Hottentotta saulcyi, 7-Hottentotta zagrosensis, 8-Hottentotta schach, 9-Ornhocirus doriae, 10-Ornhocirus bidentatus, 11-Ornhocirus irananus, 12-Ornhocirus zagrosensis, 13-Ornhocirus farzanpayi, 14-Ornhocirus scrobiculosus, 15-Ornhocirus zagrosensis, 16-Razianus zarudnyi from Buthidae family, 17-Scorpio maurus from Scorpionidae family, and 18-Ornhocirus lepturus from Hemiscorpiidae family (Figure 2).
Hemiscorpiidae family (Pirali-Kheirabadi et al., 2009; Akbari et al., 2001).

Hamadan province: In this province, there are nine scorpion species including: 1-Mesobuthus eupeus, 2-Mesobuthus iranus, 3-Mesobuthus persicus 4-Androctonus crassicauda, 5-Hottentota saulcyi, and 6-0ndobuthus doriae, 7-Compsobuthus matthesi, 8-Razianus zarudnyi, from Buthidae family and 9-Scorpio maurus kruglovi from Scorpionidae family (Karataş et al., 2012; Kovarik, 2007; Navidpour, 2019; Nazari et al., 2013).

Kermanshah province: In this province, there are eight scorpion species: 1-Mesobuthus eupeus, 2-Mesobuthus philli, 3-Androctonus crassicauda, 4-Hottentota saulcyi, 5-0ndobuthus doriae, 6-0ndobuthus bidentatus, 7-Compsobuthus matthesi, 8-Compsobuthus jakesi, 9-Orthochirus iranus, 10-Orthocithus mesopotamicus, 11-Orthochirus scrobiculatus, 12-Androcto-thus susanae, 13-Butacchus macrocentrus, 14-Razianus zarudnyi, 15-Polius persicus, and 16-Vachoniolus iranus from Buthidae family, 17-Scorpio maurus Townsendi from Scorpionidae family and 18-Hemiscorpius lep- turus from Hemiscorpiidae family (Mozaffari et al., 2013; Sharifinia et al., 2017; Gowhari et al., 2012; Navidpour et al., 2008).

Lorestan province: There are 17 species of scorpions in this province: 1-Mesobuthus eupeus, 2-Mesobuthus philli, 3-Androctonus crassicauda, 4-Hottentota saulcyi, 5-Hottentota loestan, 6-Hottentota zagrosensis, 7-0ndobuthus doriae, 8-Compsobuthus matthesi, 9-Compsobuthus rigo- sulus, 10-Orthochirus iranus, 11-Orthochirus navidpouri, 12-Orthochirus scrobiculatus and 13-Razianus zarudnyi, 14-Butacchus macrocentrus, 15-Aipitobuthus susanae from Buthidae family, 16-Scorpio maurus Townsendi from Scorpionidae family and 17-Hemiscorpius lepturus, from Hemi- scorpiidae family (Kovarik et al., 2019a; Navidpour et al., 2016; Kovarik and Navidpour, 2020; Mokhayeri et al., 2014; Nazari and Hassan, 2016; Kovarik, 2003).

Farz province: There are 26 scorpion species in this province: 1-Mesobuthus eupeus, 2-Mesobuthus persicus, 3-Mesobuthus caucasicus, 4-Mesobuthus philli, 5-Androctonus crassicauda, 6-Compsobuthus persicus, 7-Compsobuthus matthesi, 8-Compsobuthus petiolii, 9-Compsobuthus riosolus, 10-0ndobuthus persicus, 11-Hottentota saulcyi, 12-Hottentota schach, 13-Hottentota zagrosensis, 14-Hottentota jules, 15-Iranobuthus krali, 16 -0ndobuthus bidentatus, 17-0ndobuthus doriae, 18-0ndobuthus tavigiae, 19-Orthochirus farsanpaya, 20-Orthochirus zagrosensis, 21-Orthochirus scrobiculatus, 22-Razianus zarudnyi, 23-Sassanidostus zarudnyi, from Buthidae family, 24-Scorpio maurus Townsendi from Scorpionsidae family and 25-Hemiscorpius lepturus, 26-Hemiscorpius gaillard, from Hemiscorpiidae family (Karataş et al., 2012; Navidpour et al., 2012; Kovarik et al., 2019b, Kassiri et al., 2015; Nazari et al., 2018; Monod and Lourenco, 2005).

6-The west coast of the Persian Gulf (Table 2): In this physiographic area, there are three families (Buthidae, Scor- pionidae and Hemiscorpiidae), 13 genera, and 35 scorpion species: 1-Mesobuthus eupeus, 2-Mesobuthus philli, 3-Mesobuthus persicus, 4-Mesobuthus caucasicus, 5-Androctonus crassicauda, 6-Androctonus robustus, 7-Androctonus riosolus, 8-Compsobuthus matthesi, 9-Compsobuthus persicus, 10-Compsobuthus rosenkoi, 11-Compsobuthus jakesi, 12-Hottentota saulcyi, 13-Hottentota jules, 14-0ndobuthus bidentatus, 15-Androctonus crassicauda, 16-Androctonus baluchicus, 17-Scorpio maurus townsendi from Buthidae family, 18-Androctonus robustus, 19-Scorpio maurus townsendi from Scorpionsidae family and 20-Hemiscorpius le- turus from Hemiscorpiidae family (Kovarik et al., 2019a; Nazari et al., 2018).

7-East coast of Persian Gulf (Table 2): In this physiographic area, there are three families (Buthidae, Scor- pionidae and Hemiscorpiidae), 14 genera, and 35 scorpion species: 1-Mesobuthus eupeus, 2-Mesobuthus philli, 3-Mesobuthus persicus, 4-Mesobuthus caucasicus, 5-Androctonus crassicauda, 6-Androctonus robustus, 7-Androctonus riosolus, 8-Compsobuthus matthesi, 9-Compsobuthus persicus, 10-Compsobuthus rosenkoi, 11-Compsobuthus jakesi, 12-Hottentota saulcyi, 13-Hottentota jules, 14-0ndobuthus bidentatus, 15-Androctonus crassicauda, 16-Androctonus baluchicus, 17-Androctonus riosolus, 18-Compsobuthus matthesi, 19-Compsobuthus jakesi, 20-Orthochirus navidpouri, 21-Orthochirus mesopotamicus, 22-Vachoniolus iranus, 23-Razianus zarudnyi, 24-Buthus macrocentrus, 25-Sassanidostus zarudnyi from Buthi- dae family, 26-Scorpio maurus Townsendi from Scorpionsidae family and 27-Hemiscorpius lep- turus, 28-Hemiscorpius enischnochela, and 29-Hemiscorpius kaschkayi from Hemiscorpiidae family (Barahoei et al., 2001).
Based on the newest data on scorpions in Iran, there are three families, 19 genera, and 80 scorpion species and subspecies. Buthidae is the largest family comprising 17 genera and 71 species. The family Hemi-scorpiidae includes one genus and seven species, and the family Scorpionidae includes one genus, one species, and two subspecies. In the plains and deserts, there are three families, 15 genera, and 35 scorpion species; in the Caspian Sea area, there is only one family with four scorpions in heights and foothills, there are three families, 14 genera, and 35 scorpion species; in the west coast of the Persian Gulf, there are three families, 14 genera, and 31 scorpion species, and finally, in the east coast of Persian Gulf there, are three families, 14 genera, and 35 scorpion species.

The Buthidae family has the most prevalent species with and Hemi-scorpiidae and Scorpionidae located in the second and third places (Barahoei et al., 2021; Dehghani and Kassiri, 2018; Dehghani et al., 2017). Recently, changes have been made to scorpion taxonomy in Iran: Mesobuthus eupeus philippovitschii is synonymized with Mesobuthus eupeus eupeus, and some subspecies elevated to species level: Mesobuthus eupeus philippisi to Mesobuthus philippisi, Mesobuthus eupeus afghanus to Mesobuthus afghanus, Mesobuthus eupeus iranus to Mesobuthus iranus, Mesobuthus eupeus thoraxis to Mesobuthus thoraxis, and Mesobuthus eupeus persicus to Mesobuthus persicus (Kovarik, 2019; Mirshamsi et al., 2010, 2011a).

More recently, the following scorpion species have been added to the Iranian scorpion fauna: H. juliae (Fars province), O. hormooganensis (Hormozgan province), O. kermanensis (Kerman province), O. kuererai (Kerman province), O. masiphour (Bushehr province), O. semanensis (Semnan province), and O. vignonii (Yazd province), O. baluchicus (Sistan-Baluchestan province), O. chabaharensis (Sistan and Baluchestan province), and O. kermanus (Kerman province) (Kovarik et al., 2018; Kovarik and Navidpour, 2020).

Both the Buthidae and Hemi-scorpiidae members are medically important, but the members of the Scorpionidae family are not medically as important and Navidpour, 2020).

Based on the newest data on scorpions in Iran, there are three families (Buthidae, Scorpionidae and Hemiscorpiidae), 14 genera, and 35 scorpion species, among which M. eupeus, M. philippisi, M. caucasicus, A. crassicaudata, O. dorier, H. saulcyi, H. zagrosensis, O. iran, C. matthiessenii, and H. lepturus are the most medically important ones. The northern and northwestern parts of this region have a low species composition; the only deadly scorpion in this region is A. crassicaudata, but this corner of Iran is not a good place for living Hemiscorpius species, so the death due scorpion sting is very low hence (Bavani et al., 2017; Ghorbani et al., 2018; Nazari et al., 2015, 2016; Mohammad Bavi et al., 2021; Mahshidfar et al., 2017; Radmanesh, 1996; Moradi et al., 2019).

In the western, central, and southern parts of this region, there are more scorpion species, and the scorpion sting is high in comparison with northern and northwestern parts. Also, the mortality rate due to scorpion sting in these parts is more than the previous part because, in addition to the scorpion species A. crassicaudata, there is also the deadly: H. lepturus species in these areas causing more death (Nazari and Hassan, 2016; Sanaei-Zadeh et al., 2017).

Because of good climatological conditions (temperature, etc.) in the east and west coast of the Persian Gulf (including only four provinces: Khorезstan, Bushehr, Hormozgan, and Sistan-Baluchestan), there are three families of scorpions (Buthidae, Hemiscorpiidae and Scorpionidae), 18 genera, and 45 species; the density of scorpions is very high, and many scorpion species inhabit this region. Moreover, the highest rate of scorpion envenomation and death due to scorpion sting occurs in these regions as all medically important species including the deadly ones have been reported in these areas. In comparison with other regions of Iran, these regions are rich in scorpions, especially the genus Hemiscorpius; in this region, there are seven species of this genus belonging to the Hemiscorpiidae family. These species are among the most deadly scorpions in Iran, among which, Hemiscorpius lepturus is the most deadly scorpion. In Iran, 67% of deaths due to scorpion envenomation is caused by H. lepturus which can, cause significant local, systemic, and cytotoxic symptoms, making it different from other species (Dehghani and Ghanae Arani, 2015; Dehghani and Fathi, 2012; Dehghani et al., 2018a; Dehghani et al., 2018b).

Declarations

Author contribution statement

Mulood Mohammad Bavi, Abedin Saghaipour: Conceived and designed the study; Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data; Wrote the paper.

Nahid Jesri, Mahsa Sarvi: Analyzed and interpreted the data; Contributed reagents, materials, analysis tools or data.

Shahin Saeedi: Contributed reagents, materials, analysis tools or data.

Leila Shirani-Bidabadi: Contributed reagents, materials, analysis tools or data; Wrote the paper.

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Data availability statement

Data will be made available on request.

Declaration of interests statement

The authors declare no conflict of interest.
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