



## Research article

## 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 Hemiscorpiidae 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/scorpion-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; Karataş et al., 2012; Kovařík et al. 2017, 2018, 2019a; Mirshamsi et al., 2011a; Rafizadeh et al., 2013; Firoozfar et al., 2019). These venomous

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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* (Kovařík, 1997), *Odontobuthus doriae* (Thorell, 1876), *Odontobuthus bidentatus* (Vachon, 1950), *Compsobuthus matthieseni* (Birula, 1905), *Orthochirus iranensis* (Kovařík, 2004), *Buthacus macrocentrus*, *Apistobuthus susanae* (Lourenço, 1998), *Hemiscorpius lepturus* (Peters, 1861), and *Hemiscorpius acanthocercus* (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 anti-venom 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.

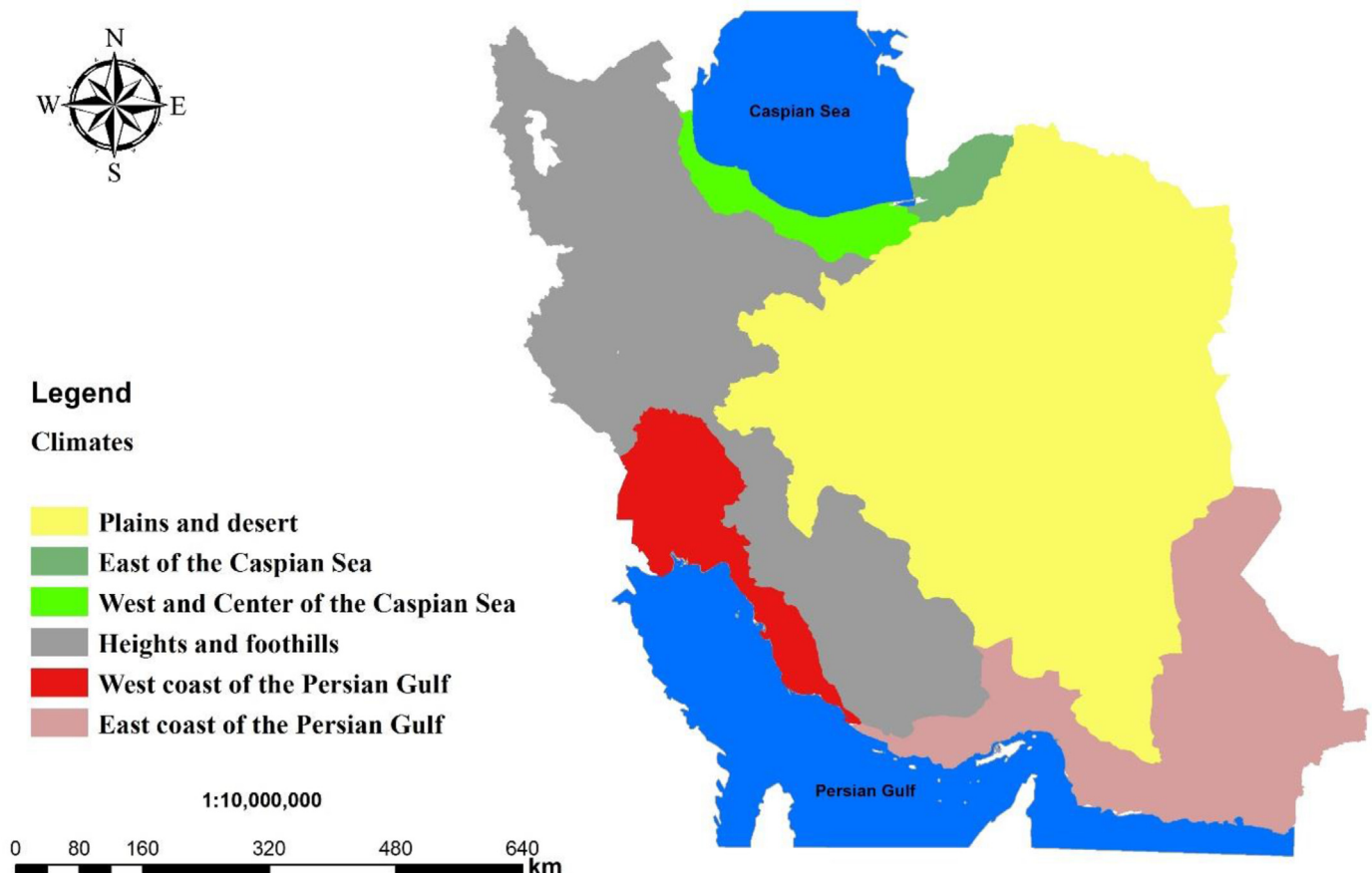


Figure 1. Iran and its seven physiographic areas.

- 3 - West and Center of the Caspian Sea: This region includes Mazandaran and Gilan Provinces. These areas are similar to the regions east of the Caspian Sea.
- 4&5- Heights and foothills: This area includes Kurdistan, West Azerbaijan, East Azerbaijan, Ardabil, Tehran, Alborz, Markazi, Zanjan, Qazvin, Kohgiluyeh & Boyer Ahmad, Chahar Mahal & Bakhtiari, Hamadan, Kermanshah, Ilam, Lorestan and Fars provinces. It includes the high-elevation Alborz and Zagros Ranges located in the northwest and west of the country. This region has a high spring rainfall (Raziei, 2018).
- 6 - West coast of the Persian Gulf: This area includes Bushehr and Khuzestan provinces. It is located in the southwest of Iran. In this region, most of the annual precipitation falls in the winter and spring seasons, with a very dry summer and moderate fall (Raziei et al., 2012).
- 7 - East coast of the Persian Gulf: This area includes Hormozgan and some parts of Sistan & Baluchestan provinces. This area is an arid piece of land with a long summer in the southeast of Iran (Domroes et al., 1998). The relevant 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.MUQ.REC.1399.223).

### 3. Results

According to the most 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 Diplocentridae (Karsch, 1880; Francke, 1980), but most Iranian researchers have not mentioned such a species in their reports (Firoozfar et al., 2019; Dehghani and Kassiri, 2018; Motevalli Haghi and Dehghani, 2017). Therefore, to prove the existence of this species in Iran, it is necessary to catch some new specimens and describe an example of this species, hence, more research is needed.

A: Buthidae (C. L. Koch, 1837) family includes 17 genera and 62 species as follow:

- A. 1-Genus *Mesobuthus* (Vachon, 1950): 1-*Mesobuthus eupeus* (C. L. Koch, 1839), 2-*Mesobuthus persicus* (Fet et al., 2001), 3-*Mesobuthus thersites* (C. L. Koch, 1839), 4-*Mesobuthus afghanus* (Pocock, 1889), 5-*Mesobuthus macmahoni* (Pocock, 1900), 6-*Mesobuthus caucasicus* (Nordmann, 1840), 7-*Mesobuthus vesiculatus* (Pocock, 1899), 8-*Mesobuthus iranensis* (Birula, 1917), 9-*Mesobuthus phillipsii* (Pocock, 1889), and 10-*Mesobuthus macmahoni* (Pocock, 1900). 11-*Mesobuthus parthorum* (Pocock, 1889), 12-*Mesobuthus brutus* (Fet et al., 2018).
- A. 2-Genus *Androctonus*: 13-*Androctonus crassicauda* (Olivier, 1807), 14-*Androctonus baluchicus* (Pocock, 1900), and 15-*Androctonus robustus* (Yağmur et al., 2016).

**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	Hemiscorpiidae	1	7	8.75%
3	Scorpionidae	1	2	2.5%
Total		19	80	100%

- A. 3-Genus *Odontobuthus* (Vachon, 1950): 16-*Odontobuthus doriae* (Thorell, 1876), 17-*Odontobuthus bidentatus* (Lourenço and Pézier, 2002), 18-*Odontobuthus baluchicus* (Vachon, 1950), 19-*Odontobuthus chabaharensis*, 20-*Odontobuthus turgari* (Mirshamsi et al., 2013), 21-*Odontobuthus tavighiae* (Navidpour et al., 2013), and 22-*Odontobuthus kermanus*.
- A. 4-Genus *Orthochirus* (Karsch, 1892): 23-*Orthochirus scrobiculosus* (Grube, 1873), 24-*Orthochirus fuscipes* (Pocock, 1900), 25-*Orthochirus zagrosensis* (Kovářík, 2004), 26-*Orthochirus fazanpayi* (Navidpour et al., 2011), 27-*Orthochirus carinatus* (Navidpour et al., 2019), 28-*Orthochirus iranensis* (Kovářík, 2004), 29-*Orthochirus navidpourii* (Kovářík et al., 2019a), 30-*Orthochirus stockwelli* (Lourenço and Vachon, 1995), 31-*Orthochirus gantenbeini* (Kovářík et al., 2019a), 32-*Orthochirus varius* (Kovářík, 2004), 33-*Orthochirus hormozganensis* (Kovářík and Navidpour, 2020), 34-*Orthochirus kermanensis* (Kovářík and Navidpour, 2020), 35-*Orthochirus kucerai* (Kovářík and Navidpour, 2020), 36-*Orthochirus mashipouri* (Kovářík and Navidpour, 2020), 37-*Orthochirus semnanensis* (Kovářík and Navidpour, 2020), 38-*Orthochirus vignolii* (Kovářík and Navidpour, 2020), and 39-*Orthochirus mesopotamicus* (Birula, 1918).
- A. 5-Genus *Compsobuthus* Vachon, 1949. 40-*Compsobuthus matthiesseni* (Birula, 1905), 41-*Compsobuthus kaftani* (Kovářík, 2003), 42-*Compsobuthus petriolii* (Vignoli, 2005), 43-*Compsobuthus garyi* (Lourenço and Vachon, 2001), 44-*Compsobuthus jakesi* (Kovářík, 2003), 45-*Compsobuthus persicus* (Navidpour, 2008), 46-*Compsobuthus plutenkoi* (Kovářík, 2003), 47-*Compsobuthus acutecarinatus* (Simon, 1882), 48-*Compsobuthus rugosulus* (Pocock, 1900), and 49-*Compsobuthus sobotniki* (Kovářík, 2003).
- A. 6-Genus *Hottentotta* (Birula, 1908): 50-*Hottentotta saulcyi* (Simon, 1880) (Simon, 1880), 51-*Hottentotta jayakari* (Pocock, 1895), 52-*Hottentotta sistansensis* (Kovářík et al., 2018), 53-*Hottentotta zagrosensis* (Kovářík, 1997), 54-*Hottentotta lorestanus* (Navidpour et al., 2010), 55-*Hottentotta schach* (Birula, 1905), 56-*Hottentotta khoozestanensis* (Navidpour et al., 2008b), 57-*Hottentotta navidpourii* (Kovářík et al., 2018), and 58-*Hottentotta juliae* (Kovářík et al., 2019b).
- A. 7-Genus *Sassanidotus* (Farzanpay, 1987): 59-*Sassanidotus gracilis* (Birula, 1900),
- A. 8-Genus *Liobuthus* (Birula, 1898): 60-*Liobuthus kessleri* (Birula, 1898),
- A. 9-Genus *Kraepelinia* (Birula, 1903): 61-*Kraepelinia palpator* (Birula, 1903),
- A. 10-Genus *Anomalobuthus* (Kraepelin, 1900): 62-*Anomalobuthus talebii* (Teruel et al., 2014),
- A. 11-Genus *Sassanidotus* (Farzanpay, 1987): 63-*Sassanidotus gracilis* (Birula, 1900), 64-*Sassanidotus zarudnyi* (Birula, 1900),
- A. 12-Genus *Razianus* (Farzanpay, 1987): 65-*Razianus zarudnyi* (Farzanpay, 1987),
- A. 13-Genus *Buthacus* (Birula, 1908): 66-*Buthacus macrocentrus* and 67-*Buthacus leptochelys*.
- A. 14-Genus *Polisius* (Fet et al., 2001): 68-*Polisius persicus* (Fet et al., 2001),
- A. 15-Genus *Iranobuthus* (Kovářík, 1997): 69-*Iranobuthus krali* (Kovářík, 1997),
- A. 16-Genus *Vachoniolus* (Levy et al., 1973): 70-*Vachoniolus iranensis* (Navidpour et al., 2008b).
- A. 17-Genus *Apistobuthus* (Finnegan, 1932): 71-*Apistobuthus susanae* (Lourenço, 1998).

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

- B. 1: Genus *Scorpio* (Linnaeus, 1758): 72-*Scorpio maurus kruglovi* and 73-*Scorpio maurus townsendi* (Pocock, 1900), (Barahoei et al., 2021).

C: Hemiscorpiidae (Pocock, 1893) family includes one genus and seven species including.

C. 1: Genus *Hemiscorpius* (Peters, 1861): 74-*Hemiscorpius lepturus* (Peters, 1861), 75-*Hemiscorpius acanthocercus* (Monod and Lourenço, 2005), 76-*Hemiscorpius kashkayi* (Karataş and Gharkheloo, 2013), 77-*Hemiscorpius enischnochela* (Monod and Lourenco, 2005), 78-*Hemiscorpius shahi*, 79-*Hemiscorpius gaillardia* (Vachon, 1974) and 80-*Hemiscorpius persicus* (Birula, 1903).

**1-Scorpions of plains and desert areas (Table 2):**

In this physiographic area, there are three families (Buthidae, Scorpionidae and Hemiscorpiidae), 15 genera, and 37 scorpion species including: 1-*Mesobuthus eupeus*, 2-*Mesobuthus thersites*, 3-*Mesobuthus afghanus*, 4-*Mesobuthus persicus*, 5-*Mesobuthus macmahoni*, 6-*Mesobuthus caucasicus*, 7-*Mesobuthus vesiculatus*, 8-*Mesobuthus parthorum* 9-*Androctonus crassicauda*, 10-*Odontobuthus doriae*, 11-*Odontobuthus bidentatus*, 12-*Orthochirus semnanensis*, 13-*Orthochirus kucerae* 14-*Odontobuthus tirkari*, 15-*Orthochirus scrobiculosus*, 16-*Orthochirus fuscipes*, 17-*Orthochirus zagrosensis*, 18-*Orthochirus fazanpayi*, 20-*Orthochirus kermanensis*, 21-*Compsobuthus kaftani*, 22-*Compsobuthus matthiesseni*, 23-*Compsobuthus kaftani*, 24-*Compsobuthus petriolii*, 25-*Orthochirus vignolii* 26-*Hottentotta*

*saulyci*, 27-*Hottentotta jayakari*, 28-*Hottentotta sistansensis*, 29-*Sassanidotus gracilis*, 30-*Liobuthus kessleri*, 31-*Kraepelinia palpator*, 32-*Anomalobuthus talebii*, 33-*Sassanidothus zarudnyi*, 34-*Iranobuthus krali*, 35-*Scorpio maurus townsendi* and 36-*Scorpio maurus kruglovi* from Scorpionidae family and, 36-*Hemiscorpius acanthocercus* and 37-*Hemiscorpius lepturus* from Hemiscorpiidae family (Barahoei et al., 2021; Kovarik 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 doriae*, 5-*Odontobuthus bidentatus*, 6-*Orthochirus scrobiculosus*, 7-*Compsobuthus matthiesseni*, 8-*Compsobuthus petriolii*, 9-*Iranobuthus krali*, and 10-*Hottentotta saulyci* (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-*Compsobuthus matthiesseni*, 6-*Compsobuthus kaftani*, 7-*Hottentotta saulyci*, 8-*Odontobuthus doriae*, 9-*Odontobuthus kermanus*, 10-

**Table 2. Scorpion composition in different physiographic areas in Iran.**

Physiographic areas	Scorpions families, species and subspecies			Number of scorpion species
	Buthidae	Hemiscorpiidae	Scorpionidae	
Plains and deserts	<i>Mesobuthus eupeus</i> , <i>Mesobuthus thersites</i> , <i>Mesobuthus afghanus</i> , <i>Mesobuthus persicus</i> , <i>Mesobuthus macmahoni</i> , <i>Mesobuthus caucasicus</i> , <i>Mesobuthus vesiculatus</i> , <i>Mesobuthus parthorum</i> , <i>Androctonus crassicauda</i> , <i>Odontobuthus doriae</i> , <i>Odontobuthus bidentatus</i> , <i>Orthochirus semnanensis</i> , 13- <i>Orthochirus kucerae</i> , <i>Odontobuthus tirkari</i> , <i>Orthochirus scrobiculosus</i> , <i>Orthochirus fuscipes</i> , <i>Orthochirus zagrosensis</i> , <i>Orthochirus fazanpayi</i> , <i>Orthochirus kermanensis</i> , <i>Compsobuthus kaftani</i> , <i>Compsobuthus matthiesseni</i> , <i>Compsobuthus kaftani</i> , <i>Compsobuthus petriolii</i> , <i>Orthochirus vignolii</i> , <i>Hottentotta saulyci</i> , <i>Hottentotta jayakari</i> , <i>Hottentotta sistansensis</i> , <i>Sassanidotus gracilis</i> , <i>Liobuthus kessleri</i> , <i>Kraepelinia palpator</i> , <i>Anomalobuthus talebii</i> , <i>Sassanidothus zarudnyi</i> , <i>Iranobuthus krali</i> ,		<i>Scorpio maurus townsendi</i> <i>Scorpio maurus kruglovi</i>	37
East of the Caspian Sea	<i>Mesobuthus eupeus</i> , <i>Mesobuthus caucasicus</i> , <i>Orthochirus farzanpayi</i> , <i>Orthochirus scrobiculosus</i>	-	-	4
West and center of the Caspian Sea	<i>Mesobuthus eupeus</i> , <i>Hottentotta saulyci</i>		<i>Scorpio maurus townsendi</i>	3
Heights and foothills	<i>Mesobuthus eupeus</i> , <i>Mesobuthus brutus</i> , <i>Mesobuthus iranus</i> , <i>Mesobuthus persicus</i> , <i>Mesobuthus caucasicus</i> , <i>Mesobuthus phillipsii</i> , <i>Androctonus crassicauda</i> , <i>Hottentotta saulyci</i> , <i>Hottentotta zagrosensis</i> , <i>Hottentotta lorestanus</i> , <i>Hottentotta schach</i> , <i>Hottentotta juliae</i> , <i>Compsobuthus matthiesseni</i> , <i>Compsobuthus persicus</i> , <i>Compsobuthus petriolii</i> , <i>Compsobuthus kaftani</i> , <i>Compsobuthus jakesi</i> , <i>Compsobuthus rugosulus</i> <i>Orthochirus carinatus</i> , <i>Orthochirus iranus</i> , <i>Orthochirus zagrosensis</i> , <i>Orthochirus navidpouri</i> , <i>Orthochirus scrobiculosus</i> , <i>Orthochirus mesopotamicus</i> , <i>Odontobuthus doriae</i> , <i>Odontobuthus bidentatus</i> , <i>Odontobuthus tavighiae</i> , <i>Apistobuthus susanae</i> , <i>Razianus zarudnyi</i> , <i>Buthacus macrocentrus</i> , <i>Polisius persicus</i> , <i>Iranobuthus krali</i> , <i>Vachoniolus iranus</i>	<i>Hemiscorpius lepturus</i> <i>Hemiscorpius gaillardia</i>	<i>Scorpio maurus townsendi</i>	35
West coast of the Persian Gulf	<i>Mesobuthus eupeus</i> , <i>Mesobuthus phillipsii</i> , <i>Androctonus crassicauda</i> , <i>Compsobuthus garyi</i> , <i>Compsobuthus jakesi</i> , <i>Compsobuthus matthiesseni</i> , <i>Compsobuthus persicus</i> , <i>Hottentotta saulyci</i> , <i>Hottentotta schach</i> , <i>Hottentotta zagrosensis</i> , <i>Hottentotta juliae</i> , <i>Hottentotta khoozestanus</i> , <i>Odontobuthus bidentatus</i> , <i>Orthochirus farzanpayi</i> , <i>Orthochirus iranus</i> , <i>Orthochirus stockwelli</i> , <i>Orthochirus gantenbeini</i> , 18- <i>Orthochirus navidpouri</i> , <i>Orthochirus mesopotamicus</i> , <i>Orthochirus scrobiculosus</i> , <i>Razianus zarudnyi</i> , <i>Vachoniolus iranus</i> , <i>Sassanidothus zarudnyi</i> , <i>Apistobuthus susanae</i> , <i>Buthacus macrocentrus</i>	<i>Hemiscorpius lepturus</i> , <i>Hemiscorpius acanthocercus</i> , <i>Hemiscorpius enischnochela</i> , <i>Hemiscorpius gaillardia</i> , <i>Hemiscorpius persicus</i> <i>Hemiscorpius shahi</i>	<i>Scorpio maurus townsendi</i>	31
East coast of Persian Gulf	<i>Mesobuthus eupeus</i> , <i>Mesobuthus phillipsii</i> , <i>Mesobuthus persicus</i> , <i>Mesobuthus caucasicus</i> , <i>Androctonus crassicauda</i> , <i>Androctonus baluchicus</i> , <i>Androctonus robustus</i> , <i>Compsobuthus matthiesseni</i> , <i>Compsobuthus persicus</i> , <i>Compsobuthus plutenkoi</i> , <i>Compsobuthus jakesi</i> , <i>Hottentotta saulyci</i> , <i>Hottentotta navidpouri</i> , <i>Hottentotta sistansensis</i> , <i>Odontobuthus bidentatus</i> , <i>doriae</i> , <i>Odontobuthus tavighiae</i> , <i>Orthochirus farzanpayi</i> , - <i>Orthochirus stockwelli</i> , <i>Orthochirus varius</i> , <i>scrobiculosus</i> , <i>Buthacus macrocentrus</i> , <i>Buthacus leptochelys</i> , <i>Iranobuthus krali</i> , <i>Kraepelinia palpator</i> , <i>Polisius persicus</i> <i>Razianus zarudnyi</i> , <i>Sassanidotus gracilis</i>	<i>Hemiscorpius lepturus</i> , <i>Hemiscorpius acanthocercus</i> , <i>Hemiscorpius enischnochela</i> , <i>Hemiscorpius gaillardia</i> , <i>Hemiscorpius persicus</i> and <i>Hemiscorpius shahi</i>	<i>Scorpio maurus townsendi</i>	35



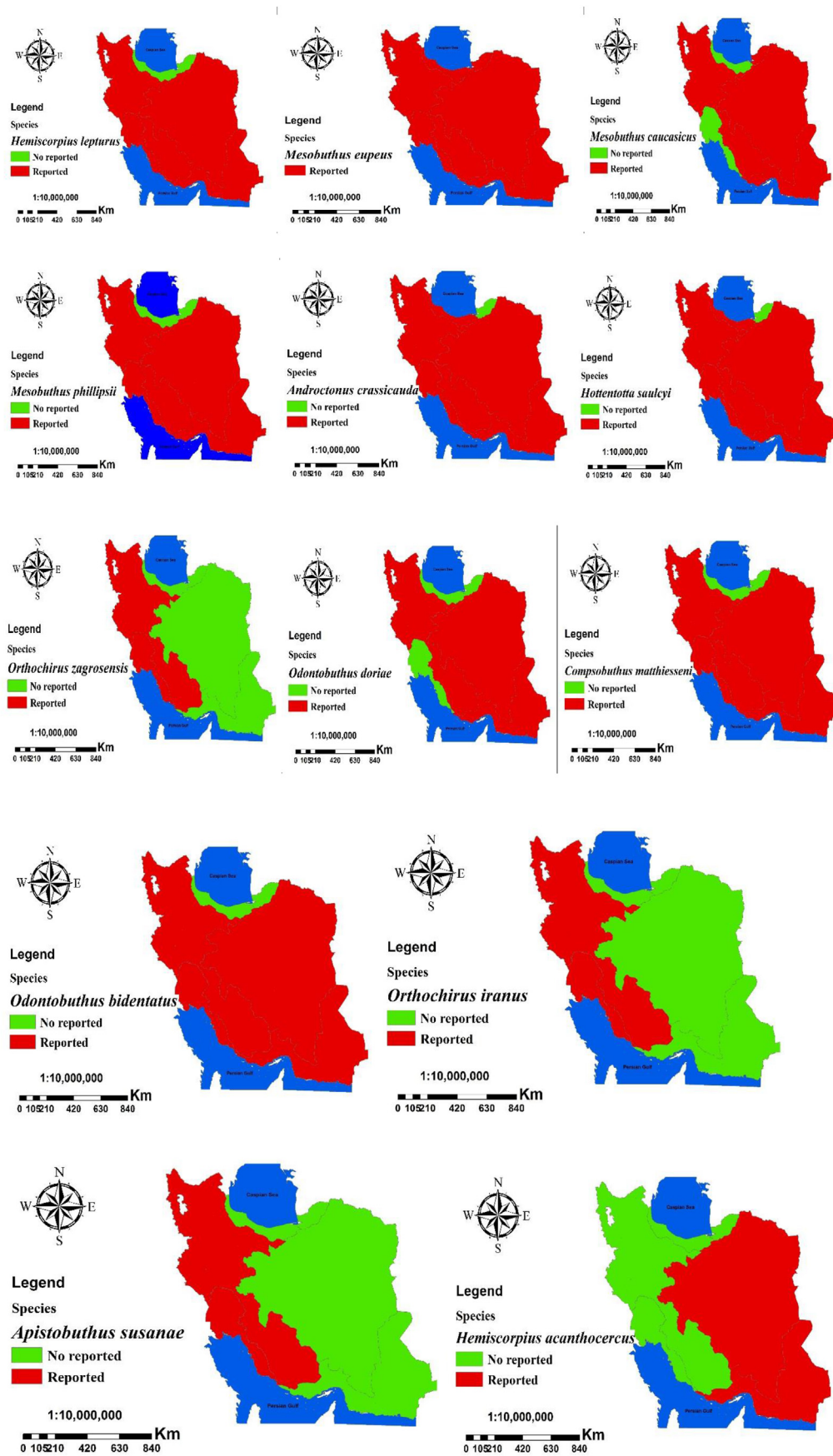


Figure 2. Spatial distribution of medically important scorpion species of Iran based on seven physiographic areas.

*Orthochirus scrobiculosus*, 11-*Orthochirus farzanpayi*, 12-*Orthochirus gruberi*, 13-*Orthochirus zagrosensis*, 14-*Orthochirus kucerai*, 14-*Orthochirus kermanensis*, 15-*Kraepelinia palpator*, 16-*Polisius persicus*, 17-*Sassanidotus gracilis*, and 18-*Kraepelinia palpator* From family Buthidae, 19-*Scorpio maurus townsendi* from Scorpionidae family and 20-*Hemiscorpius lepturus*, 21-*Hemiscorpius enischnochela* and 22-*Hemiscorpius acanthocercus* from Hemiscorpiidae family (Barahoei et al., 2021; Karataş et al., 2012; Navidpour et al., 2011; Dehghani et al., 2008; Nazari and Hajizadeh, 2016).

Semnan Province: In this province, there are eight scorpion species: 1-*Mesobuthus eupeus*, 2-*Mesobuthus caucasicus*, 3-*Androctonus crassicauda*, 4-*Odontobuthus doriae*, 5-*Orthochirus scrobiculosus*, 6-*Orthochirus semnansensis*, from Buthidae family, 7-*Scorpio maurus kruglovi*, 8-*Scorpio maurus townsendi* from Scorpionidae family, and 8-*Hemiscorpius lepturus* from Hemiscorpiidae family (Motevalli Haghi and Dehghani, 2017; Karataş et al., 2012; Azghadi et al., 2014).

North Khorasan province: In this province, there are seven scorpion species: 1-*Mesobuthus eupeus*, 2-*Mesobuthus caucasicus*, 3-*Odontobuthus doriae*, 4-*Androctonus crassicauda*, 5-*Hottentotta saulcyi*, and 6-*Orthochirus farzanpayi*, all belongs to Buthidae family, 7-*Scorpio maurus kruglovi* from Scorpionidae family (Firoozfar et al., 2019; Karataş et al., 2012; Karataş and Gharkheloo, 2006).

Razavi Khorasan province: There are ten scorpion species in this province including: 1-*Mesobuthus eupeus*, 2-*Mesobuthus afghanus*, 3-*Mesobuthus thersites*, 4-*Mesobuthus caucasicus*, 5-*Mesobuthus parthorum*, 6-*Odontobuthus doriae*, 7-*Odontobuthus tirgari*, 8-*Orthochirus scrobiculosus* and 9-*Liobuthus kessleri*, all belonging to Buthidae family, and 10-*Scorpio maurus kruglovi* (Azghadi et al., 2014; Vatani and Khoobdel, 2009; Kovářik, 2019; Mirshamsi et al., 2011b; Cokendolpher et al., 2019; Fet et al., 2018).

South Khorasan province: In this province, there are ten species including: 1-*Mesobuthus eupeus*, 2-*Mesobuthus caucasicus*, 3-*Mesobuthus parthorum*, 4-*Androctonus crassicauda*, 5-*Odontobuthus doriae*, 6-*Odontobuthus tirgari*, 7-*Orthochirus scrobiculosus*, 8-*Compsobuthus matthiessenim*, 9-*Anomalobuthus talebii*, 10-*Kraepelinia palpator*, all belonging to Buthidae family (Motevalli Haghi and Dehghani, 2017; Motevalli Haghi et al., 2020; Yousef Mogaddam et al., 2017; Teruel et al., 2014).

Isfahan province: There are 17 scorpion species in this province: 1-*Mesobuthus eupeus*, 2-*Mesobuthus caucasicus*, 3-*Mesobuthus phillipsii*, 4-*Mesobuthus vesiculatus*, 5-*Androctonus crassicauda*, 6-*Odontobuthus doriae*, 7-*Sassanidotus zarudnyi*, 8-*Compsobuthus matthiesseni*, 9-*Compsobuthus kaftani*, 10-*Orthochirus scrobiculosus*, 11-*Orthochirus scrobiculosus*, 12-*Orthochirus zagrosensis*, 13-*Iranobuthus krali*, 14-*Polisius persicus*, 15-*Sassanidotus zarudnyi*, 16-*Kraepelinia palpator* belonging to from Buthidae family and 17-*Scorpio maurus townsendi* from Scorpionidae family (Ahmadmarzale et al., 2017; Vignoli et al., 2003; Kovářik, 2002, 2004; Kovářik et al., 2011; Lowe, 2010).

Yazd province: There are eight of scorpion in this region of Iran: 1-*Mesobuthus eupeus*, 2-*Mesobuthus vesiculatus*, 3-*Mesobuthus caucasicus*, 4-*Androctonus crassicauda*, 5-*Orthochirus zagrosensis*, 6-*Compsobuthus kaftani*, 7-*Odontobuthus doriae*, and 8-*Orthochirus vignolii* all belonging to the family Buthidae (Vignoli and Crucitti, 2005).

## 2-Scorpions of east of the Caspian Sea area (Table 2):

This physiographic area of Iran includes only one province and there are only three scorpions, all belonging to Buthidae family:

Golestan province: There are three scorpion species in this province including: 1-*Mesobuthus eupeus*, 2-*Mesobuthus caucasicus* and 3-*Orthochirus farzanpayi*, 4-*Orthochirus scrobiculosus* all belonging to the family Buthidae (Sofizadeh et al., 2021; Kovářik and Fet, 2006) (Figure 2).

## 3-West and center of the Caspian Sea area (Table 2):

Mazandaran province: There are three species of scorpion in this province: 1-*Mesobuthus eupeus*, 2-*Hottentotta saulcyi* from Buthidae family and 3-*Scorpio maurus* from Scorpionidae family (Karataş and Gharkheloo, 2006; Haghi et al., 2004).

Gilan province: There are four scorpion species in this province: *Mesobuthus eupeus*, *Androctonus crassicauda*, from Buthidae family and

*Scorpio maurus townsendi* from Scorpionidae family (Karataş et al., 2012; Farzanpay, 1987) (Figure 2).

## 4&5- Heights and foothills area (Table 2):

In this physiographic area of Iran there are three families (Buthidae, Scorpionidae and Hemiscorpiidae), 14 genera, and 35 scorpion species:

1-*Mesobuthus eupeus*, 2-*Mesobuthus brutus*, 3-*Mesobuthus iranrus*, 4-*Mesobuthus persicus*, 5-*Mesobuthus caucasicus*, 6-*Mesobuthus phillipsii*, 7-*Androctonus crassicauda*, 8-*Hottentotta saulcyi*, 9-*Hottentotta zagrosensis*, 10-*Hottentotta lorestanus*, 11-*Hottentotta schach*, 12-*Hottentotta juliae*, 13-*Compsobuthus matthiesseni*, 14-*Compsobuthus persicus*, 15-*Compsobuthus petriolii*, 16-*Compsobuthus kaftani*, 17-*Compsobuthus jakesi*, 18-*Compsobuthus rugosulus* 19-*Orthochirus carinatus*, 20-*Orthochirus iranrus*, 21-*Orthochirus zagrosensis*, 22-*Orthochirus navidpourii*, 23-*Orthochirus scrobiculosus*, 24-*Orthochirus mesopotamicus*, 25-*Odontobuthus doriae*, 26-*Odontobuthus bidentatus*, 27-*Odontobuthus tavighiae*, 28-*Apistobuthus susanae*, 29-*Razianus zarudnyi*, 30-*Buthacus macrocentrus*, 31-*Polisius persicus*, 32-*Iranobuthus krali*, *Vachoniolus iranrus* 33-*Scorpio maurus townsendi*, from Scorpionidae family, 34-*Hemiscorpius lepturus* and 35-*Hemiscorpius gaillardi* 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 Kassiri, 2018; Motevalli Haghi and Dehghani, 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 caucasicus*, 3-*Androctonus crassicauda*, 4-*Hottentotta saulcyi*, 5-*Compsobuthus petriolii*, 6-*Hottentotta zagrosensis* and 7-*Scorpio maurus* (Gharakhloo et al., 2018; Bavani et al., 2017; Kovářik, 2007).

East Azerbaijan province: There are three scorpion species in this province, all belonging to Buthidae family: 1-*Mesobuthus eupeus*, 2-*Mesobuthus caucasicus* 3-*Mesobuthus vesiculatus*, and 4-*Androctonus crassicauda*, 5-*Compsobuthus petriolii*, *Odontobuthus doriae* (Karataş et al., 2012; Lowe, 2010; Bavani et al., 2017).

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

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

Zanjan province: In this region, there are seven scorpion species including: 1-*Mesobuthus eupeus*, 2-*Mesobuthus brutus*, 3-*Androctonus crassicauda*, 4-*Hottentotta saulcyi*, 5-*Hottentotta zagrosensis*, 6-*Odontobuthus doriae* form Buthidae family and 7-*Scorpio maurus townsendi* 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* and 6-*Odontobuthus doriae*, from Buthidae family and 7-*Scorpio maurus townsendi* from Scorpionidae family (Fet et al., 2018; Navidpour, 2020).

Kohgiluyeh & Boyer Ahmad and Chahar Mahal & Bakhtiari Provinces: There are 18 scorpion species in this province: 1-*Mesobuthus eupeus*, 2-*Mesobuthus phillipsii*, 3-*Mesobuthus caucasicus*, 4-*Androctonus crassicauda*, 5-*Compsobuthus matthiesseni*, 6-*Hottentotta saulcyi*, 7-*Hottentotta zagrosensis*, 8-*Hottentotta schach*, 9-*Odontobuthus doriae*, 10-*Odontobuthus bidentatus*, 11-*Orthochirus iranrus*, 12-*Orthochirus zagrosensis*, 13-*Orthochirus farzanpayi*, 14-*Orthochirus scrobiculosus*, 15-*Orthochirus zagrosensis*, 16-*Razianus zarudnyi* from Buthidae family, 17-*Scorpio maurus townsendi* from Scorpionidae and 18-*Hemiscorpius lepturus* from

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 iranensis*, 3-*Mesobuthus persicus* 4-*Androctonus crassicauda*, 5-*Hottentotta saulcyi*, and 6-*Odontobuthus doriae*, 7-*Compsobuthus matthiesseni*, 8-*Razianus zarudnyi*, from Buthidae family and 9-*Scorpio maurus kruglovi* from Scorpionidae family (Karataş et al., 2012; Kovařík, 2007; Navidpour, 2019; Nazari et al., 2015).

Kermanshah province: In this province, there are eight scorpion species: 1-*Mesobuthus eupeus*, 2-*Mesobuthus caucasicus*, 3-*Androctonus crassicauda*, 4-*Compsobuthus matthiesseni*, 5-*Odontobuthus doriae*, 6-*Hottentotta saulcyi* from Buthidae family, 7-*Scorpio maurus townsendi* from Scorpionidae family and 8-*Hemiscorpius lepturus* from Hemiscorpiidae family (Dehghani and Kassiri, 2018; Motevalli Haghi and Dehghani, 2017; Kovařík, 2007).

Ilam province: There are 18 scorpion species in this region: 1-*Mesobuthus eupeus*, 2-*Mesobuthus phillipsii*, 3-*Androctonus crassicauda*, 4-*Hottentotta saulcyi*, 5-*Odontobuthus doriae*, 6-*Odontobuthus bidentatus*, 7-*Compsobuthus matthiesseni*, 8-*Compsobuthus jakesi*, 9-*Orthochirus iranensis*, 10-*Orthochirus mesopotamicus*, 11-*Orthochirus scrobiculosus*, 12-*Apistobuthus susanae*, 13-*Buthacus macrocentrus*, 14-*Razianus zarudnyi*, 15-*Polisius persicus*, and 16-*Vachoniolus iranensis* from Buthidae family, 17-*Scorpio maurus townsendi* from Scorpionidae family, and 18-*Hemiscorpius lepturus* from Hemiscorpiidae family (Mozaffari et al., 2013; Sharifinia et al., 2017; Gowhari et al., 2012; Navidpour et al., 2008a).

Lorestan province: There are 17 species of scorpions in this province: 1-*Mesobuthus eupeus*, 2-*Mesobuthus phillipsii* 3-*Androctonus crassicauda*, 4-*Hottentotta saulcyi*, 5-*Hottentotta lorestanus*, 6-*Hottentotta zagrosensis*, 7-*Odontobuthus doriae*, 8-*Compsobuthus matthiesseni*, 9-*Compsobuthus rugosulus*, 10-*Orthochirus iranensis*, 11-*Orthochirus navidpouri*, 12-*Orthochirus scrobiculosus* and 13-*Razianus zarudnyi*, 14-*Buthacus macrocentrus*, 15-*Apistobuthus susanae* from Buthidae family, 16-*Scorpio maurus townsendi* from Scorpionidae family and 17-*Hemiscorpius lepturus*, from Hemiscorpiidae family (Kovařík et al., 2019a; Navidpour et al., 2010; Kovařík and Navidpour, 2020; Mokhayeri et al., 2014; Nazari and Hassan, 2016; Kovařík, 2003).

Fars province: There are 26 scorpion species in this province: 1-*Mesobuthus eupeus*, 2-*Mesobuthus persicus*, 3-*Mesobuthus caucasicus*, 4-*Mesobuthus phillipsii*, 5-*Androctonus crassicauda*, 6-*Compsobuthus persicus*, 7-*Compsobuthus matthiesseni*, 8-*Compsobuthus petrioli*, 9-*Compsobuthus rugosulus*, 10-*Compsobuthus persicus*, 11-*Hottentotta saulcyi*, 12-*Hottentotta schach*, 13-*Hottentotta zagrosensis*, 14-*Hottentotta juliae*, 15-*Iranobuthus krali*, 16-*Odontobuthus bidentatus*, 17-*Odontobuthus doriae*, 18-*Odontobuthus tavighiae*, 19-*Orthochirus farzanpayi*, 20-*Orthochirus zagrosensis*, 21-*Orthochirus scrobiculosus*, 22-*Razianus zarudnyi*, 23-*Sassanidothus zarudnyi*, from Buthidae family, 24-*Scorpio maurus townsendi* from Scorpionidae family and 25-*Hemiscorpius lepturus*, 26-*Hemiscorpius gaillardi*, from Hemiscorpiidae family (Karataş et al., 2012; Navidpour et al., 2012; Kovařík 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, Scorpionidae and Hemiscorpiidae), 13 genera, and 31 scorpion species: 1-*Mesobuthus eupeus*, 2-*Mesobuthus phillipsii*, 3-*Androctonus crassicauda*, 4-*Compsobuthus garyi*, 5-*Compsobuthus jakesi*, 6-*Compsobuthus matthiesseni*, 7-*Compsobuthus persicus*, 8-*Hottentotta saulcyi*, 9-*Hottentotta schach*, 10-*Hottentotta zagrosensis*, 11-*Hottentotta juliae*, 12-*Hottentotta khoozestanensis*, 13-*Odontobuthus bidentatus*, 14-*Orthochirus farzanpayi*, 15-*Orthochirus iranensis*, 16-*Orthochirus stockwelli*, 17-*Orthochirus gantenbeini*, 18-*Orthochirus navidpouri*, 19-*Orthochirus mesopotamicus*, 20-*Orthochirus scrobiculosus* 21-*Razianus zarudnyi*, 22-*Vachoniolus iranensis*, 23-*Sassanidothus zarudnyi*, 24-*Apistobuthus susanae*, 25-*Buthacus macrocentrus*, 26- from Buthidae family, 27-*Scorpio maurus townsendi* from Scorpionidae and 28-*Hemiscorpius lepturus*, 29-*Hemiscorpius enischnochela*, and 30-*Hemiscorpius kashkayi* from Hemiscorpiidae family (Figure 2).

Bushehr province: In this province, there are 16 scorpion species: 1-*Mesobuthus eupeus*, 2-*Mesobuthus phillipsii*, 3-*Androctonus crassicauda*, 4-

*Buthacus macrocentrus*, 5-*Compsobuthus jakesi*, 6-*Compsobuthus matthiesseni*, 7-*Compsobuthus persicus*, 8-*Hottentotta saulcyi*, 9-*Odontobuthus bidentatus*, 10-*Orthochirus farzanpayi*, 11-*Orthochirus iranensis*, 12-*Orthochirus stockwelli*, 13-*Orthochirus mashipouri*, 14-*Razianus zarudnyi* from Buthidae family, 15-*Scorpio maurus townsendi* from Scorpionidae family and 16-*Hemiscorpius lepturus* from Hemiscorpiidae family (Kovařík and Navidpour, 2020; Navidpour et al., 2008b; Kovařík, 1997; Navidpour, 2008).

Khuzestan province: In this province, there are 29 scorpion species: 1-*Mesobuthus eupeus*, 2-*Mesobuthus phillipsii*, 3-*Androctonus crassicauda*, 4-*Apistobuthus susanae*, 5-*Buthacus macrocentrus*, 6-*Compsobuthus garyi*, 7-*Compsobuthus jakesi*, 8-*Compsobuthus matthiesseni*, 9-*Hottentotta saulcyi*, 10-*Hottentotta schach*, 11-*Hottentotta zagrosensis*, 12-*Hottentotta khoozestanensis*, 13-*Hottentotta juliae*, 14-*Odontobuthus bidentatus*, 15-*Orthochirus farzanpayi*, 16-*Orthochirus iranensis*, 17-*Orthochirus stockwelli*, 18-*Orthochirus gantenbeini*, 19-*Orthochirus scrobiculosus*, 20-*Orthochirus navidpouri*, 21-*Orthochirus mesopotamicus*, 22-*Vachoniolus iranensis*, 23-*Razianus zarudnyi*, 24-*Buthacus macrocentrus*, 25-*Sassanidothus zarudnyi* from Buthidae family, 26-*Scorpio maurus townsendi* from Scorpionidae and 27-*Hemiscorpius lepturus*, 28-*Hemiscorpius enischnochela*, and 29-*Hemiscorpius kashkayi* from Hemiscorpiidae family (Karataş et al., 2013; Kovařík et al., 2017, 2019a; Navidpour et al., 2008c; Akbari, 2007; Dehghani et al., 2018a).

#### 7-East coast of Persian Gulf (Table 2):

In this physiographic area, there are three families (Buthidae, Scorpionidae and Hemiscorpiidae), 14 genera, and 35 scorpion species: 1-*Mesobuthus eupeus*, 2-*Mesobuthus phillipsii*, 3-*Mesobuthus persicus*, 4-*Mesobuthus caucasicus*, 5-*Androctonus crassicauda*, 6-*Androctonus baluchicus*, 7-*Androctonus robustus*, 8-*Compsobuthus matthiesseni*, 9-*Compsobuthus persicus*, 10-*Compsobuthus plutenkoi*, 11-*Compsobuthus jakesi*, 12-*Hottentotta saulcyi*, 13-*Hottentotta navidpouri*, 14-*Hottentotta sistansensis*, 15-*Odontobuthus bidentatus*, 16-*Odontobuthus doriae*, 17-*Odontobuthus tavighiae*, 18-*Orthochirus farzanpayi*, 19-*Orthochirus stockwelli*, 20-*Orthochirus varius*, 21-*Orthochirus scrobiculosus*, 22-*Buthacus macrocentrus*, 23-*Buthacus leptochelys*, 24-*Iranobuthus krali*, 25-*Kraepelinia palpator*, 26-*Polisius persicus* 27-*Razianus zarudnyi*, 28-*Sassanidothus gracilis* from Buthidae family, 29-*Scorpio maurus townsendi* from Scorpionidae and 30-*Hemiscorpius lepturus*, 31-*Hemiscorpius acanthocercus*, 32-*Hemiscorpius enischnochela*, 33-*Hemiscorpius gaillardi*, 34-*Hemiscorpius persicus* and 35-*Hemiscorpius shahi* from Hemiscorpiidae family (Figure 2).

Hormozgan province: Scorpion species in this province are including 29 species: 1-*Mesobuthus eupeus*, 2-*Mesobuthus phillipsii*, 3-*Mesobuthus persicus*, 4-*Androctonus crassicauda*, 5-*Compsobuthus matthiesseni*, 6-*Compsobuthus persicus*, 7-*Compsobuthus plutenkoi*, 8-*Compsobuthus acutecarinatus*, 9-*Compsobuthus jakesi*, 10-*Hottentotta saulcyi*, 11-*Hottentotta navidpouri*, 12-*Odontobuthus bidentatus*, 13-*Odontobuthus doriae*, 14-*Odontobuthus tavighiae*, 15-*Orthochirus farzanpayi*, 16-*Orthochirus stockwelli*, 17-*Orthochirus varius*, 18-*Orthochirus hormozganensis*, 19-*Orthochirus scrobiculosus*, 20-*Buthacus macrocentrus*, 21-*Buthacus leptochelys*, 22-*Iranobuthus krali*, 23-*Razianus zarudnyi*, 24-*Sassanidothus gracilis* from Buthidae family, 25-*Scorpio maurus townsendi* from Scorpionidae and 26-*Hemiscorpius lepturus*, 27-*Hemiscorpius acanthocercus*, 28-*Hemiscorpius enischnochela* and 29-*Hemiscorpius shahi* from Hemiscorpiidae family (Kovařík et al., 2018, 2019a; Navidpour et al., 2013; Fekri et al., 2012).

Sistan & Baluchestan province: There are 19 species of scorpions in this province including: 1-*Mesobuthus eupeus*, *Mesobuthus caucasicus*, 2-*Androctonus baluchicus*, 3-*Androctonus robustus*, 4-*Odontobuthus bidentatus*, 5-*Odontobuthus baluchicus*, 6-*Odontobuthus chabaharensis*, 7-*Odontobuthus tigrari*, 8-*Odontobuthus tavighiae*, *Hottentotta saulcyi*, 9-*Hottentotta jayakari*, 10-*Hottentotta sistansensis*, 11-*Compsobuthus matthiesseni*, 12-*Orthochirus scrobiculosus*, 13-*Orthochirus fuscipes*, 14-*Sassanidothus gracilis*, *Kraepelinia palpator*, *Polisius persicus*, *Razianus zarudnyi*, *Sassanidothus gracilis*, *Sassanidothus zarudnyi*, 15-*Hemiscorpius acanthocercus*, 16-*Scorpio maurus townsendi*, 17-*Hemiscorpius gaillardi*, 18-*Hemiscorpius persicus*, and 19-*Hemiscorpius lepturus* from Hemiscorpiidae family (Barahoei et al.,



2021; Kovařík et al., 2018; Dehghani and Kassiri, 2018; Nejati et al., 2014; Moradi et al., 2020; Yağmur et al., 2016).

#### 4. Discussion

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 Hemiscorpiidae 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 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 Persian Gulf there, are three families, 14 genera, and 35 scorpion species.

The Buthidae family has the most prevalent species with and Hemiscorpiidae 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 philippovitschi* is synonymized with *Mesobuthus eupeus eupeus*, and some subspecies elevated to species level: *Mesobuthus eupeus phillipsi* to *Mesobuthus phillipsi*, *Mesobuthus eupeus afghanus* to *Mesobuthus afghanus*, *Mesobuthus eupeus iranensis* to *Mesobuthus iranensis*, *Mesobuthus eupeus thersites* to *Mesobuthus thersites*, and *Mesobuthus eupeus persicus* to *Mesobuthus persicus* (Kovařík, 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. hormozganensis* (Hormozgan province), *O. kermanensis* (Kerman province), *O. kucerai* (Kerman province), *O. mashipouri* (Bushehr province), *O. semnanensis* (Semnan province), and *O. vignolii* (Yazd province), *O. baluchicus* (Sistan-Baluchestan province), *O. chabaharensis* (Sistan and Baluchestan province), and *O. kermanus* (Kerman province) (Kovařík et al., 2018; Kovařík and Navidpour, 2020).

Buthidae and Hemiscorpiidae members are medically important, but the members of the Scorpionidae family are not medically as important because they are digger scorpions and the contact between such species and people is less common (Bavani et al., 2017). The number of scorpion species belonging to the Buthidae family is more than those of the Hemiscorpiidae family (Dehghani et al., 2018b). Among Buthidae family members, the *Mesobuthus eupeus* has a wide distribution area and is found in almost all seven physiographic areas in Iran (Motevalli Haghi and Dehghani, 2017; Kovařík, 1997; Shahi et al., 2009; Amiri et al., 2018; Ramezani Avval Riabi et al., 2010). This non-digger Iranian yellow scorpion species is an errant species that has different habitats including under rocks and tree barks in the arachnids and insect's nests, in the abandoned rodent nests, under pieces of wood and cement and tiles, and inside the roof of wooden houses. This species of scorpion has a lot of climatological conditions adaptability and can live in different physiographic areas including tropical and cold regions (Mirshamsi, 2013; Mirshamsi et al., 2010; Mohammadi Bavani et al., 2021; Mirshamsi, 2013). Although this scorpion species is not deadly, it makes the victim refer to a hospital or medical care center to decrease the pain of the sting (Bavani et al., 2017; Ghorbani et al., 2018; Dehghani et al., 2018c). The second most prevalent scorpion species in Iran is *A. crassicauda* that is also called the fat-tailed scorpion. This species belongs to the Buthidae family and is distributed to most physiographic areas in Iran except for eastern, central and western areas around the Caspian Sea which are free of this species. The stung person by this scorpion feels severe pain and possibly experiences seizures and, cardiovascular problems which can sometimes result death (Dehghani and Fathi, 2012; Mohseni et al., 2013). This scorpion is regarded as the second deadly scorpion in Iran (Firoozfar et al., 2019).

The first deadly scorpion species in Iran belongs to the genus *Hemiscorpius* from the Hemiscorpiidae family; the members of this family are distributed to the physiographic areas of plains and deserts, heights and

foothills, and the west and east coast of the Persian Gulf, but they do not inhabit in eastern, central and western areas of the Caspian Sea. The area near the Caspian Sea has poor scorpion fauna and density, so less scorpion envenomation with no record of death occurs in this part of the country (Dehghani and Fathi, 2012; Dehghani et al., 2017, 2018b).

Heights and foothills include several provinces. In this climatological area of Iran, there are three families (Buthidae, Scorpionidae and Hemiscorpiidae), 14 genera, and 35 scorpion species, among which *M. eupeus*, *M. phillipsii*, *M. caucasicus*, *A. crassicauda*, *O. doriae*, *H. saulcyi*, *H. zagrosensis*, *O. Iranus*, *C. matthiesseni*, 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. crassicauda*, 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; Mohammadi Bavani et al., 2021; Mahshidfar et al., 2017; Radmanesh, 1990; Moradiasl 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. crassicauda*, 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: 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 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 Ghanaee Arani, 2015; Dehghani and Fathi, 2012; Dehghani et al., 2018a; Dehghani et al., 2018b).

#### Declarations

##### Author contribution statement

Mulood Mohammadi Bavani, Abedin Saghafipour: 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 Saedi: 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.



## Additional information

No additional information is available for this paper.

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