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Original article

Factors affecting the distribution of scorpions (Arachnida: Scorpions) in Iran

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Abstract

Background: The distribution of scorpions is influenced by various factors, which determine their presence and abundance in different regions. Elucidating these factors is essential for comprehending scorpion ecology and predicting their potential influence on ecosystems.

Objective: This review aimed to provide an overview of the distribution of scorpions within Iran, as well as the factors that affect their distribution by highlighting their ecological preferences and adaptations to different regions.

Methods: Forty-nine documents were collected from well-known indexing services and databases, including Elsevier, Google Scholar, PubMed, ScienceDirect, Scopus, Springer, and Web of Science. After carefully studying the documents, they were classified into specific subtopics and discussed.

Results: Iran exhibits a wide range of climatic conditions, which contribute to the distribution patterns of scorpion species, and boasts considerable scorpion species diversity. Based on the results of this study, the following factors were identified as being involved in the distribution of scorpions in Iran, which have been discussed in detail: biological and environmental factors, climate, human impact, the availability of food, suitable shelters and hiding places, and the geological features of the different regions.

Conclusion: The distribution of scorpions is undeniably influenced by human activities, which have led to substantial alterations in their habitats.

Keywords: Biological and environmental factors, climate, distribution, food availability, human activity, scorpions.

Among arthropods that threaten human health, such as cockroaches, [1-5] fleas, flies, human lice, mites, sandflies, scorpions, [6-9] ticks, [10-14] and mosquitoes, [15-17] only ticks, sandflies, and scorpions are capable of causing death in humans because of the transmission of Crimean-Congo hemorrhagic fever, [18-20] transmission of visceral leishmaniasis, and venomous stings, respectively. [21-24] Scorpions (Arachnida: Scorpions) are fascinating creatures known for their unique appearance and venomous stings, which make them feared and admired by humans. [25] They are a small group of approximately 2,713 acknowledged species divided into 21 families of nocturnal terrestrial arthropods that have successfully adapted to a wide range of habitats worldwide, except Antarctica. [26, 27] Iran, as a vast and diverse country located in the Middle East, harbors a considerable diversity of scorpion species. [28] With its diverse landscapes ranging from deserts and mountains to forests and coastal areas, Iran provides an ideal habitat for these arachnids. [29]

By examining the geographical distribution patterns of scorpion species across Iran, we can gain insights into their ecological requirements and understand how environmental factors shape their presence within the various regions. Understanding the distribution of scorpions in Iran is essential for assessing the potential risks posed by venomous species to human populations. [29] The distribution of scorpions is influenced by various factors that

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determine their presence and abundance in different regions. Furthermore, elucidating these factors is crucial for comprehending scorpion ecology and predicting their potential effect on ecosystems. This review aimed to provide an overview of the distribution of scorpions within Iran and the factors that affect their distribution by highlighting their ecological preferences and adaptations to different regions, as well as predicting their possible influence on ecosystems.

Materials and methods

Iran is a country in Western Asia. Moreover, it is bordered to the northwest by Armenia and Azerbaijan, to the north by the Caspian Sea, to the northeast by Turkmenistan, to the east by Afghanistan and Pakistan, to the south by the Persian Gulf and the Gulf of Oman, and to the west by Turkey and Iraq. Iran exhibits a wide range of climatic conditions, which contribute to the distribution patterns of scorpion species, and features a remarkable scorpion species diversity. To provide an overview of the distribution of scorpions within Iran and the factors that affect their distribution, ecological preferences, and adaptations to different regions, 49 documents were obtained from well-known indexing services and databases, including Elsevier, Google Scholar, PubMed, ScienceDirect, Scopus, Springer, and Web of Science. After carefully studying the documents, the scientific findings were classified into the following topics and discussed: geographical distribution of scorpions in Iran; diversity of scorpion species in Iran; factors affecting the distribution of scorpions in Iran; climate, the availability of food, suitable shelters and hiding places, and the geological features of different regions affecting the distribution of scorpions in Iran; environmental factors affecting the distribution of scorpions in Iran; biological factors affecting the distribution of scorpions in Iran; and human impact on the distribution of scorpions in Iran.

Results and discussion

Geographical distribution of scorpions in Iran

As Iran is located in the Middle East, it boasts a diverse landscape that provides an ideal habitat for scorpions. With its vast deserts, mountains, and coastal regions, the country exhibits an extensive range of climatic conditions that contribute to the distribution patterns of scorpion species. [27, 30, 31] Scorpions generally inhabit warm and arid environments, with high temperatures and low humidity being favorable conditions for their survival. Consequently, they are commonly found worldwide in deserts, savannas, and dry grasslands. However, some species have adapted to more temperate climates and even live in caves or forests. Another factor that influences scorpion distribution is habitat availability. Scorpions prefer specific microhabitats, such as burrows or crevices, where they can hide during the day and hunt at night. [32]

The southwestern part of Iran, particularly the Khuzestan and Hormozgan provinces, is home to numerous scorpion species because of its arid climate and rocky terrain. [27, 30, 31] In contrast, the central and eastern regions, such as the Kerman and Sistan-Baluchestan provinces, are characterized by desert ecosystems with high temperatures and low precipitation levels, which support distinct scorpion populations. In addition, mountainous areas, such as the Alborz and Zagros ranges, offer unique habitats for specific scorpion species that have adapted to higher altitudes **(Figure 1).** [29, 30]

Diversity of scorpion species in Iran

Iran boasts a remarkable diversity of scorpion species, which makes it an important hotspot for scorpion research and conservation. With an estimated more than 80 known species, the country has one of the most diverse scorpion communities in the world. The extensive range of habitats found throughout Iran, including deserts, mountains, and forests, enables the thriving populations of these arachnids. Scorpions in Iran exhibit a wide array of adaptations and ecological roles. [25, 29, 33, 34] According to the updated checklist of the scorpion species of Iran, they comprise 68 species that belong to 19 genera and 4 families. [26] Some species have developed impressive burrowing abilities to survive in the arid desert environment, while others dwell among rocks or vegetation. The distribution patterns of these scorpions vary across different regions within the country because of factors such as habitat suitability and environmental conditions. Understanding the diversity and distribution of these scorpion species is critical for establishing effective conservation strategies. [31, 35, 36]

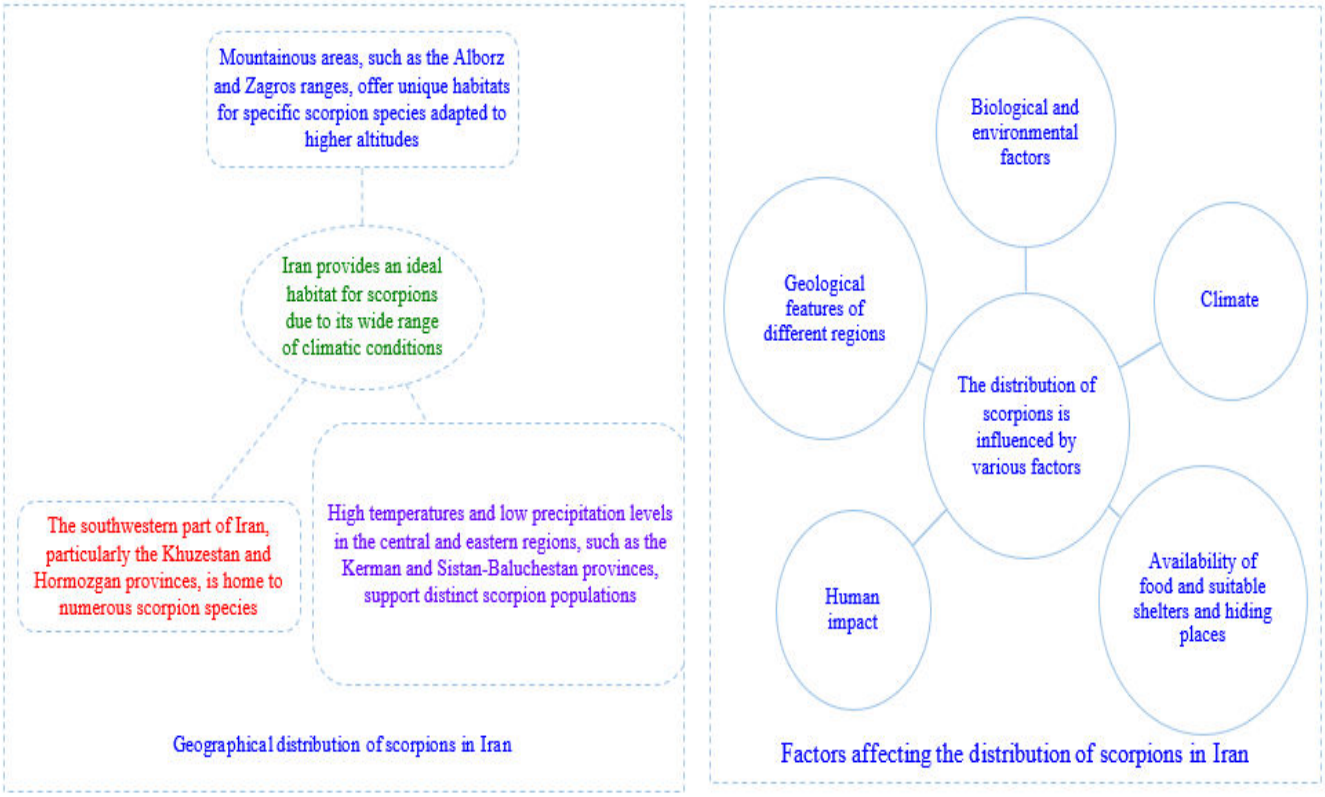

Figure 1. Factors affecting the distribution of scorpions in Iran

Factors affecting the distribution of scorpions in Iran

Based on the results of this study, the following factors were identified as being involved in the distribution of scorpions in Iran, which have been discussed: biological and environmental factors, climate, human impact, the availability of food, suitable shelters and hiding places, and the geological features of different regions **(Figure 1).**

Climate, the availability of food, suitable shelters and hiding places, and the geological features of different regions that affect the distribution of scorpions in Iran

The distribution of scorpions in Iran is influenced by various factors, thereby contributing to their diverse presence across the country. As scorpions are highly adapted to arid and semi-arid regions, the climate is a crucial factor that affects scorpion distribution. Hot and dry conditions are prevalent in large parts of Iran, which creates favorable habitats for the scorpion populations. Another important factor is the availability of suitable shelters and hiding places. [29, 34, 36, 37]

Scorpions prefer rocky terrains, deserts, and areas with plentiful crevices and burrows to seek shelter during the day and hunt at night. Consequently, the geological features of different regions play a crucial role in determining their distribution patterns. Furthermore, food availability plays a pivotal role in their distribution, as scorpions primarily feed on insects, spiders, and other small arthropods. Therefore, areas with abundant prey species will likely have a higher scorpion population. [38]

Environmental factors affecting the distribution of scorpions in Iran

Various environmental factors greatly influence the distribution of scorpions. One crucial factor is temperature, as scorpions are ectothermic arthropods that rely on external heat sources to regulate their body temperature. They generally inhabit warm regions, with optimal temperatures of 25–35°C. However, extreme heat can be detrimental to their survival, and humidity levels also play a considerable role in scorpion distribution. [29] The relative abundance of scorpions is variable across months and exhibits

annual activity, with a potential dynamic being observed in some months during the hot period. However, they have a reduced presence during cold periods. [39, 40] In a time distribution study, scorpion abundance gradually peaked from April to September. [23, 24] In parallel with the abundance of scorpions, the number of reported scorpion stings throughout the year was lowest in January, gradually increased from April to July, reached its highest level in July to September, and then gradually decreased to its lowest levels in December. [21, 38, 39, 41, 42] Moreover, there was a substantial positive and negative correlation between the abundance of scorpions and the temperature and humidity, respectively. [43] In addition, a relationship was observed between climatic factors (temperature, evaporation rate, sunlight duration, humidity, and rainfall), particularly an increase in temperature and a decrease in rainfall and humidity, and an increase in the number of scorpion stings. [44] The increase in rainfall and humidity coincided with the decrease in the number of stinging scorpions, whereas the increase in temperature, evaporation, and sunlight duration were associated with the increase in the number of stinging scorpions. However, no notable relationship was identified between wind speed/direction and the reported incidences of stings. [41]

These arachnids prefer areas with moderate humidity (40–70%), as excessive moisture can lead to fungal growth, which may affect their ability to survive. In addition, the availability of suitable shelter and hiding spots impacts scorpion distribution. They seek refuge in crevices, burrows, rocks, and vegetation during the day to avoid desiccation and predators. Moreover, factors such as soil type, vegetation cover, prey availability, and competition with other species also influence scorpion distribution patterns. [45] The *Mesobuthus eupeus*, *Hemiscorpius lepturus (H. lepturus)*, and *Compsobuthus matthiesseni* species prefer loamy, silty, and sandy loam soils, whereas the *Androctonus crassicauda (A. crassicauda)* species prefer silty loamy, loam, and sandy loam soils **(Table 1).** [24]

Biological factors affecting the distribution of scorpions in Iran

Biological factors play a critical role in shaping the distribution patterns of scorpion species across various habitats. One factor is the availability of suitable prey. Scorpions are carnivorous arachnids that mainly feed on insects, spiders, and other small invertebrates. Therefore, areas that are abundant in these prey species are more likely to support greater scorpion populations. Another biological factor influencing scorpion distribution is competition with other predators. [29, 46] Scorpions often compete with other predatory arthropods, such as spiders and centipedes, for resources and territories. Interspecific interactions may limit the range of scorpion populations by creating barriers to their colonization or causing localized extinctions. Furthermore, reproductive strategies also have an effect on scorpion distribution. Some species exhibit specialized behaviors during courtship and mating that may restrict their ability to disperse over long distances.

H. lepturus never makes a nest, and therefore, the local distribution of this species is particularly vast. This leads to the expansion of the epidemiology of scorpion stings from *H. lepturus* as they use any shelter to hide from their natural enemies, which causes an increase in the rate of fatalities; therefore, there is a need for more biological and ecological studies to find further methods of epidemiological control. [47] The main factors for habitat suitability for *Odontobuthus doriae* were soil type, average temperature of the wettest neighborhood, and slope. Furthermore, the factors for habitat suitability for *Scorpio maurus* were soil type, precipitation of the coldest neighborhood, and slope. Moreover, factors that had the greatest influence on the distribution of *Oxyepoecus bidentatus* were the annual temperature range, average temperature of the driest quarter, and land use. [48]

Table 1. Soil type preference of scorpion species

Scorpion species	Soil type preference	References
Androctonus crassicauda	Silty loamy, loam, and sandy loam soils	[24]
Compsobuthus matthiesseni	Loamy, silty, and sandy loam soils	[24]
Hemiscorpius lepturus	Loamy, silty, and sandy loam soils	[24]
Mesobuthus eupeus	Loamy, silty, and sandy loam soils	[24]

Human impact on the distribution of scorpions in Iran

The distribution of scorpion species is undeniably influenced by human activities, which have resulted in considerable alterations to their habitats. Urbanization and deforestation are notable factors that disrupt the natural distribution patterns of scorpions. As cities expand and encroach upon previously undisturbed areas, scorpion populations experience habitat loss and fragmentation. The destruction of forests eliminates suitable habitats and disrupts the ecological balance by reducing prey availability, thereby affecting the survival and reproduction rates of scorpions. Furthermore, human-induced climate change has a profound impact on scorpion distribution patterns. Increasing temperatures and altered precipitation patterns can directly influence their abundance and geographical range. Scorpions are ectothermic arachnids and highly sensitive to variations in temperature. Therefore, changes in climatic conditions may limit their survival or drive their expansion into new areas. [35, 36] In rural areas, *A. crassicauda* hides underground and in walls of mud, cemeteries, bark, dried tree trunks, foundation stones of buildings, stone walls at the edge of fields, and under stones. In urban areas, they hide underground and in the walls of mud; however, in uninhabited desert areas, they hide under the sand and animal nests, and in mountainous areas, they hide under rocks. [49]

Conclusion

Iran has a wide range of climatic conditions that contribute to the distribution patterns of scorpion species, and it exhibits a remarkable diversity of scorpion species. Based on the results of this study, the distribution of scorpions in Iran is influenced by biological and environmental factors, climate, human impact, the availability of food, suitable shelters and hiding places, and the geological features of different regions. Furthermore, the distribution of scorpions is undeniably affected by human activities, which have led to substantial alterations in their habitats.

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Conflicts of interest statement

All authors have completed and submitted the International Committee of Medical Journal Editors Uniform Disclosure Form for Potential Conflicts of Interest. None of the authors had any conflict of interest to disclose.

Data sharing statement

All data generated or analyzed in the present study are included in this published article and the citations herein. Further details, opinions, and interpretations are available from the corresponding author upon reasonable request.

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