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ORIGINAL RESEARCH PAPER

Bioecology and scorpion envenomation in Ramshir district, Khuzestan Province, southwestern Iran

Saber Gholizadeh[1,2] · Emran Lalehzari[1,2] · Mulood Mohammadi Bavani[1,2] · Arezoo Hosseini[3] · Hamid Reza Khalkhali[4] · Javad Rafinejad[5]

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Abstract Scorpion envenomation is a leading public health hazard in southwestern Iran. This study was carried out to analyze the bioecology and medical importance of scorpions in Ramshir district in Khuzestan Province of Iran from 2006 to 2011. Epidemiological data of victims in Ramshir was obtained from a standard data sheet and analyzed by SPSS 16 software. Scorpions were collected using standard rock-rolling and UV light methods, as well as the rubber band technique in 2013. Morphological identification was performed using Iranian scorpion's identification key. During a 6-year period (2006–2012), 1502 envenomed cases—with high prevalence of stinging from June to October in each year—were obtained. More than half of the accidents were in the age group 15–34 years, and the most frequently stung body parts were legs and hands, respectively. There were 283 scorpion specimens collected, which belonged to three families: Buthidae, Scorpionidae, and Hemiscorpiidae. There were five species: *Mesobuthus phillipsii* (Pocock), *Androctonus crassicauda* (Olivier), *Hemiscorpius lepturus* (Peters), *Orthochirus iranus* (Kovarík), and *Scorpio maurus* (Linnaeus). All species were classified as epigean (92.2 %) and fossorial (7.8 %) guilds. In conclusion, the high prevalence of scorpion envenomation and distribution of dangerous scorpion species in Ramshir suggest the necessity for educational and preventive programs to decrease scorpionism incidence in terms of scorpion control, patient treatment, and prevention measures.

Keywords Scorpions · Scorpionism · Ramshir · Khuzestan · Iran

✉ Javad Rafinejad
jrafinejad@yahoo.com

Saber Gholizadeh
sabergholizadeh@yahoo.com

Emran Lalehzari
emranlalezari@gmail.com

Mulood Mohammadi Bavani
mulud.muhammady@yahoo.com

Arezoo Hosseini
hosseiniare@yahoo.com

Hamid Reza Khalkhali
hamid_rekh@yahoo.com

[1] Social Determinants of Health Research Center, Urmia University of Medical Sciences, P.O. Box: 5756116111, Urmia, Iran

[2] Medical Entomology Department, School of Public Health, Urmia University of Medical Sciences, Urmia, Iran

[3] Taleghani Hospital, Urmia University of Medical Sciences, Urmia, Iran

[4] Inpatient's Safety Research Center, Urmia University of Medical Sciences, Urmia, Iran

[5] Medical Entomology Department, School of Public Health, Tehran University of Medical Sciences, Tehran, Iran

Introduction

Scorpion-sting envenomation is a leading public health problem in Khuzestan Province, Iran, particularly among children (Dehghani and Velaei 2010; Mirdehghan and Motlagh 2001; Shahbazzadeh et al. 2009). Ramshir (30°53′ 28″N and 49°24′ 21″E) is a district in Khuzestan Province located at the head of the Persian Gulf and has the highest incidence of scorpionism from June to September (Taj et al. 2012).

Recorded study of scorpion fauna began in the nineteenth century with Peters (1861) and has continued since, with many changes in classification (Dehghani et al. 2008;

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Lourenço 2001). In 1807, Olivier identified and recorded Iranian scorpions for the first time. Following his study, various investigations were designed to identify scorpion species in different parts of the country (Farzanpey 1994; Habibi 1971; Zarei et al. 2009). In 2004, Dehghani and coworkers classified scorpions into 29 species and three families (Dehghani and Valaie 2005). Classification of Iranian scorpion fauna has increased to 52 species (31 endemic to Iran) belonging to 19 genera and four families (Karataş and Gharkheloo 2013; Kovařík and Ojanguren Affilastro 2013; Mirshamsi et al. 2011, 2013; Navidpour et al. 2013; Tahir et al. 2014; Teruel et al. 2014). Of these 52 species, at least seven are medically important and responsible for human envenoming in Iran (Jalali and Rahim 2014).

Scorpions are frequently characterized based on their habitat and requisite morphological modifications. Polis (1990) identified four ecomorphotypes, including fossorial, psammophilous, errant, and lithophilous, whereas Prendini (2001) introduced fossorial and epigean guilds with further subdivisions into distinct ecomorphotypes (Polis 1990; Prendini 2001). On the other hand, Wehr and Sheath (2003) defined ecomorphotype as "type of morphological modification caused by or related to certain ecological conditions" (Wehr and Sheath 2003).

Iran has various zoogeographic regions and is a temperate, tropical, and unique location at the cross point of the Palearctic, Oriental, and Afrotropical regions bordering Iran, Afghanistan, and Pakistan. Therefore, it can be postulated that there should be the possibility of differentiation within populations of arthropod species in this unique region. Despite various taxonomic, faunistic, and epidemiological studies on Iranian scorpions, there is still lack of sufficient information in this field. Thus, this study was designed to evaluate species composition, relative abundance, and ecology of scorpion fauna in Ramshir district in Khuzestan Province, Iran, as well as to assess the epidemiology of scorpion envenomation (scorpionism) in this district based on clinical reports.

Materials and methods

Study area

The study was carried out in Ramshir district in the central part of the Khuzestan Province, southwestern Iran, where almost 6.6 % of the Iranian population lives (Fig. 1). Comprehensive identification of scorpion envenomation in Ramshir was obtained from a standard data sheet that recorded age, sex, location where the accident occurred, scorpion color, sting site, and date of injury.

To study ecomorphotype of scorpions in Ramshir, the district was divided into five regions in rural and urban areas. Scorpions were collected from March to October 2013 using the standard methods: rock-rolling (Williams 1968) and UV lights (Russell 1969). However, local habitants use another method for hunting burrower scorpions, namely, the rubber band technique (Fig. 2), which we also used. In brief, a piece of rubber band (80 cm) is inserted into the scorpion burrow and when grasped by the scorpion's chelicerae, the animal is pulled out its habitat. All scorpion specimens were preserved in 75 % ethanol and then transported in batches to the School of Public Health, Urmia University of Medical Sciences, Urmia, Iran.

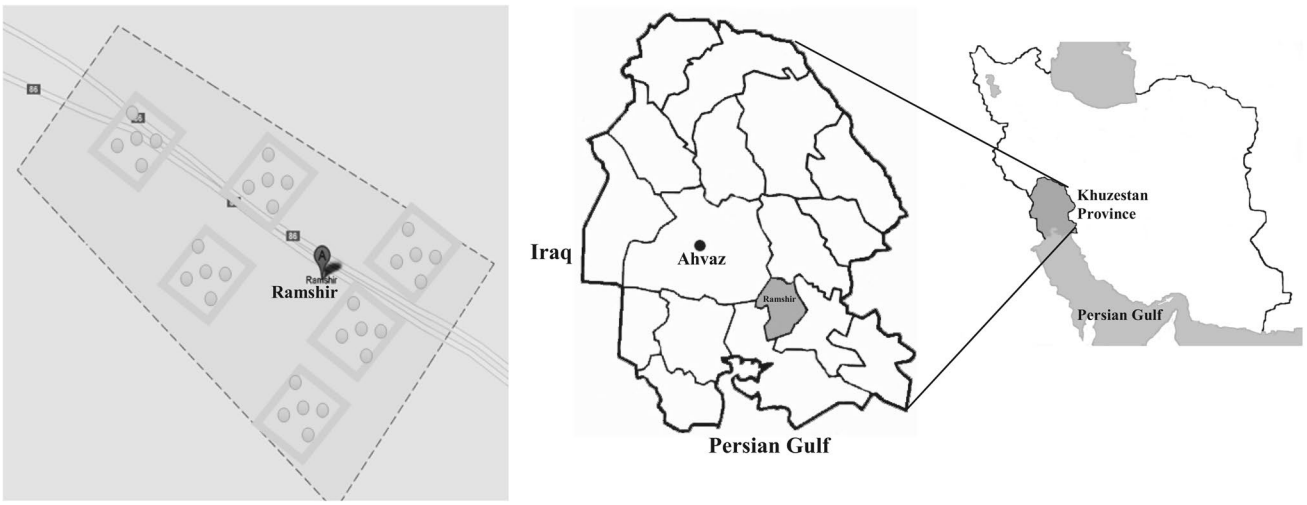

Fig. 1 Khuzestan province and geographical region of Ramshir district

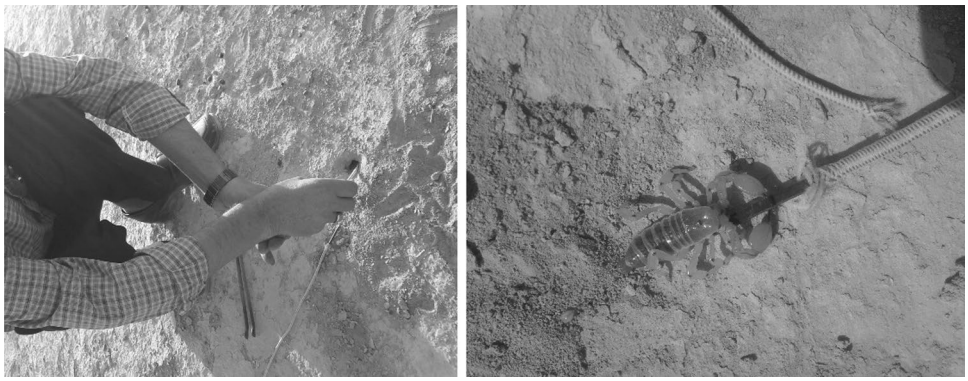

Fig. 2 Rubber band method of extracting *Scorpio maurus* from burrows

Morphological identification

Primary morphological identification and classification were carried out using a stereomicroscope and the Iranian scorpion identification key (Dehghani and Velaei 2005; Farzanpay 1988). Complete identification and classification of unidentified specimens were performed using morphological keys of Polis (1990) and Vachon (1974). Suspicious specimens were double-checked in both the School of Public Health, Tehran University of Medical Sciences (Iran), and Razi Vaccine and Serum Research Institute (Iran).

Statistical analysis

The SPSS 16 software package was used to tabulate data. Primary data, simple measures of frequency, and Pearson's chi-square method were employed to describe and analyze data.

Results

In total, 1502 envenomed cases were analyzed over a period of 6 years (2006–2012) (Table 1). A 34.8 % decrease was observed in the number of recorded cases during the study period: from 310 in 2006 to 108 in 2012. The annual average incidence rate of scorpionism is 30 per 1000 inhabitants, and males (50.4 %) are more frequently stung than females. Accidents occurs more often in summer (46.27 %), followed by spring (36.55 %), autumn (14.38 %), and winter (2.8 %). Chi-square analysis showed there are significant differences in scorpion stings in different seasons ($p < 0.001$). More than half of the accidents (55.3 %) were in the age group of 15–34 years old. The most frequently stung body part was legs (45.3 %), followed by hands (43.4 %) and other parts of the body (11.3 %). Scorpion color was described as yellow and black in 52.3 % and 36.8 % of cases, respectively. All cases recovered after the injection of 5 ml polyvalent antivenom prepared by Razi Vaccine and Serum Research Institute.

Collectively, five species and 283 individual scorpions belonging to three families (Buthidae, 88.3 %; Scorpionidae, 7.8 %; Hemiscorpiidae, 3.9 %) were captured using daytime rock-rolling, nighttime UV light sampling, and the rubber band technique. Identified species were *Mesobuthus phillipsii* (Pocock) (78.44 %), *Androctonus crassicauda* (Olivier) (2.8 %), *Hemiscorpius lepturus* (Peters) (3.9 %), *Orthochirus iranus* (Kovarík) (6.7 %), and *Scorpio maurus* (Linnaeus) (7.8 %). *M. phillipsii* was the most abundant species in rural (46.4 %) and urban (85.5 %) areas. In addition, four species—except *S. maurus*—were gathered using daytime rock-rolling and nighttime UV light sampling. However, all *S. maurus* specimens ($n = 22$) were collected from the inside of burrows using the rubber band technique.

The five species recorded in the Ramshir were categorized into two different guilds: fossorial or burrowing (7.8 %), and epigean (which do not construct burrows) (92.2 %). Each guild was further subdivided into Psammophilic, Lapidocolous, Pelophilous, and Lithophilus ecomorphotypes based on features presented by Prendini (2001).

Discussion

Having enough information about the local composition of scorpion fauna is the first step in identifying species causing envenomation. Over the past decade, envenomation by scorpion stings has been reported as a public health risk factor, especially in the oil-rich province of Iran, Khuzestan (Jalali and Rahim 2014; Mirdehghan and Motlagh 2001). In Iran, 52 scorpion species have been identified that belong to 19 genera (Jalali et al. 2010; Jalali and Rahim 2014; Karataş and Gharkheloo 2013; Mirshamsi et al. 2011). Among them, seven medically important species responsible for human envenomation are *H. lepturus*, *Odontobuthus doriae* (Thorell), *Hottentotta saulcyi* (Simon), *H. schach* (Birula), *A. crassicauda*, *M. eupeus* (C.L. Koch), and *Apistobuthus susanae* (Lourenço) (Jalali et al. 2010; Jalali and Rahim 2014; Lourenço 1998; Navidpour and Lowe 2009). There are at least 18 scorpion species in Khuzestan belonging

Table 1 Envenomed cases by scorpions in Ramshir district, Khuzestan Province, southwestern Iran, from 2006 to 2012

Year	Months												Total
	Mar–Apr	Apr–May	May–Jun	Jun–Jul	Jul–Aug	Aug–Sep	Sep–Oct	Oct–Nov	Nov–Dec	Dec–Jan	Jan–Feb	Feb–Mar	
2006–2007	19	20	77	58	48	31	34	17	4	0	0	2	310
2007–2008	16	30	58	56	45	35	26	20	6	0	3	8	303
2008–2009	16	27	85	61	53	62	26	11	8	4	2	9	364
2009–2010	14	24	69	60	56	23	5	10	2	2	0	12	277
2010–2011	18	9	27	26	20	16	10	13	1	0	0	0	140
2011–2012	4	14	22	10	24	11	12	6	5	0	0	0	108
Total	87	124	338	271	246	178	113	77	26	6	5	31	1502

to three families: Buthidae, Scorpionidae (one species), and Hemiscorpiidae (one species) (Farzanpay 1987; Karataş and Gharkheloo 2013). In our study, we report for the first time five Iranian scorpion fauna in Ramshir district, including *A. crassicauda*, *H. lepturus*, *M. phillipsii*, *S. maurus*, and *O. iranus*. Interestingly, 85 % of species collected from Ramshir were *M. phillipsii*, *H. lepturus*, and *A. crassicauda*. The last two species have been estimated to be the cause of all scorpionism deaths in Khuzestan Province each year (Jalali and Rahim 2014).

In Iran, *A. crassicauda* and *H. schach* are known as black scorpions and *M. eupeus*, *H. saulcyi*, *O. doriae*, and *H. lepturus* as yellow (Akbari 2007; Mirdehghan and Motlagh 2001). Although the 1502 clinical cases in our study were stung by unknown species, victims indicate being bitten by yellow (52.3 %) or black (36.8 %) scorpions. Because *M. phillipsii*, *H. lepturus*, and *A. crassicauda* compose a high proportion of Ramshir scorpions (85 %), it is rational to infer that at least 89.1 % of the 1502 cases were envenomed by one of these three black and yellow scorpion species. However, this deduction needs to be tested in future by training local people to bring the scorpion specimen when referred to the health center.

Mesobuthus phillipsii was reported as the most of frequent scorpion species captured by daytime rock-rolling in Ramshir, whereas envenomation might occur at home or while walking about at night. The reason for this discrepancy may be that UV sampling is the most efficient method for detection of scorpion surface activity; thus, collecting samples by daytime rock-rolling and the rubber band method of extracting *S. maurus* from the burrow may not be highly relevant to normal human–scorpion interactions. In addition, due to some environmental and cultural constraints, more night sampling using UV light detection is not possible.

Garatash and Gharkheloo (2014) raised Iranian members of the genus *Hemiscorpius* to six species. They identified *H. kashkayi* (Peters) as a new endemic species collected from Andimeshk, Omidiyeh, and Masjed Soleyman districts in Khuzestan Province (Karataş and Gharkheloo 2013). *H. kashkayi* has a short metasoma; interestingly, *Hemiscorpius* specimens collected by us from Ramshir had long and slender metasoma and telson. Therefore, all collected *Hemiscorpius* specimens were properly identified as *H. lepturus.*

Scorpions are generally nocturnal arthropods, meaning that they spend the day under rocks and in crevices. Although 26.6 % of envenomation in Khuzestan Province occurred in Ramhormoz, the reports from the district closest to Ramshir (Shahbazzadeh et al. 2009), Mohseni et al. (2013) concluded that most victims in that district were stung by *H. lepturus* and very few by *A. crassicauda* (Mohseni et al. 2013). There was also a high percentage

of cases stung by *H. lepturus* species, which is in contrast with the low percentage of *H. lepturus* specimens collected in Ramshir. Therefore, it is probable that human envenomation further depends on the ecology and distribution of each species and their intersection with humans. On the basis of several ecological morphotypes and widespread geographical distribution scorpion species (Jalali and Rahim 2014; Mirshamsi et al. 2011; Prendini 2001), Ramshir scorpions were classified—for the first time—into two fossorial and epigean guilds. The only obligate burrower (fossorial scorpions) species was *S. maurus*, whereas the remaining four species were classified as epigean.

The routine methods of collecting burrower scorpions are digging and water injection to the burrow (Dehghani and Bigdelli 2007; Vignoli et al. 2003; Williams 1968). Another special collecting method—the rubber band method—is used extract *S. maurus* from its burrow. All *S. maurus* (7.8 %) specimens in this study were gathered using the rubber band technique; water injection was unsuccessful. Therefore, it can be suggested that the rubber band technique could be an alternative method for collecting burrower scorpions; however, more field studies need to evaluate its reliability and validity.

Altogether, our investigation allows us to report for the first time epidemiological data on scorpion envenomation and prevalence of scorpion species in Ramshir district, Khuzestan Province, southwestern Iran. This information is potentially important for obtaining a better understanding of scorpionism in this district, which accounts for a significant public health problem. Thus, these data are of general interest to the medical community, contributing information about scorpion species being contributors to public health issues; the information may also be useful for improving public education and helping reduce the rate of envenomation.

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