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ORIGINAL ARTICLES

Bidiversity and species composition of Scorpions (Arachnida, Scorpiones) in Ilam County, Iran

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ABSTRACT

Objective: Scorpion sting is one of the most important medical problems in Iran with many victims annually in the country. This study has been conducted with the aim of finding exact species composition and biodiversity of health threatening scorpion species of Ilam county. **Methods:** Collections were made randomly during the daytime and by black light at night.The local morphological identification keys were used to identify the scorpions. **Results:** A total number of 228 scorpion specimens were collected belonging to three families include: Buthidae, Scorpionidae and Hemiscorpiidae. During this study seven scorpion species were found:*Hottentotta (Buthotus) saulcyi* (28.95%), *Androctonus crassicauda* (25.44%), *Scorpio maurus* (18.42%),*Mesobuthus eupeus* (10.09%), *Hemiscorpius lepturus* (8.33%), *Compsobuthus matthiesseni* (5.70%) and *Odontobuthus doriae* (3.70%). The Simpson's and Shanon-Wiener's indices for the scorpion community in Ilam County were 0.2 and 1.73 respectively. This study has shown that *H. saulcyi* is more predominant than other species. **Conclusion:** Biodiversity analysis proved that the scorpion community in Ilam isn't stable. Therefore the increasing of population of any species is expected. This condition may be increase the risk of scorpion biting to human. These results may aware health policy makers to conduct a suitable control program for the area.

Key word: Biodiversity, Buthidae, Scorpionidae, Hemiscorpiidae, Ilam, Iran

Introduction

Scorpions are found in many parts of the world particularly in south of about 49° N, except New Zealand and Antarctica. They are common in desert although, they occur in many other habitats including grasslands and savannahs, deciduous forests, mountain pine forests, intertidal zones, rain forest and caves (Polis, 2002). There are more than 1500 scorpion species worldwide, while 50 species are dangerous to humans (Allen, 1992). Scorpions are important venomous arthropods which kill many people annually across the globe. Scorpion sting is one of the most important medical problems in Iran withabout 40000-50000 victims annually in the country (Dehghani, 2003).

The scorpions of Iran consist of three families: Buthidae, Scorpionidae and Hemiscorpiidae (Kovarik, 1997; Dehghani and Valaie, 2004). Seven species implicated in envenoming of humans and considered medically important (Farzanpay, 1988). Studies of identification and bilogy of scorpions in Iran have been carried out in some parts of the country. Habibi published a checklist including 2 families, 11 genus and 24 species (Habibi, 1971). Following her, Farzanpay had a very through studies on Iranian scorpions and recognized 2 families, 17 genus and 23 species of scorpions in the country (Farzanpay, 1988). Kavorik described a new genus of scorpions, Iranobuthus, in Iran (Kovarik, 1997). Tirgari and Zargan studied scorpions in urban areas of the country and conducted some laboratory research in this field (Tirgari and Zargan, 2002). Although numbers of researches on scorpio fauna have been carried out in some provinces, yet the faunistic information on these arachnids is incomplete. Eight species of scorpion reported from Kerman to clarify the scorpion fauna of this province (Dehghani *et al*., 2008). Shahi *et al*. found ten scorpion species in Hormozgan (Shahi *et al*., 2008) and Navidpour *et al*. raised the scorpiofauna of Khoozestan to nineteen species (Navidpour$_a$ *et al*., 2008). At the meantime Navidpour *et al*. reported eleven, fourteen and fifteen scorpion species from KohgilouyehVa Boyer Ahmad, Ilam and Bushehr provinces respectively (Navidpour$_{b,c}$ *et al*., 2008).

The fundamental relationship between biodiversity and human health is generally unappreciated by policymakers and the public, and as a result, the preservation of habitats and species is given a low priority (Grifo and Rosenthal, 1997). The biodiversity which is a manner of distribution and individual number of some dangerous species can threaten the human health. The present study designed to determine the biodiversity and

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species composition of scorpions in Ilam county. This kind of studies will provide a clue for control of fatal scorpions and can reduce their stings.

Materials and Methods

The city of Ilam is located in the west of Iran. It lies at an altitude of 1319 meters above sea level at a latitude of 33° 38′ N and a longitude 46° 26′ E. Ilam Province from east and south has 425 km borders with Iraq.It has cold and semi-humid climate in north with average rainfall of 578 mm and has warm climate in south with average rainfall of 200 mm. Although Ilam is surrounded by mountains (Zagros Mountains), its climate is also affected by deserts from the west and the south. This province has a highly variable annual weather profile. Humid weather with heavy snow in the winter and dusty, hot and dry weather in the summer are normal for this region.

The study was conducted in urban and rural areas of Ilam, Ilam Province, 2009-2012. Scorpions observed and collected in different habitats during the six times field trips (3-17 August and 14-17 November 2009, 3-8 August and 8-13 September 2010, 18 October until 12 November 2011 and 27 March until 3 April 2012). The studied areas were selected by clustered random sampling consist of six localities in the study area : Pelkelab, ca. 921 m (33º 44’ N, 46º 10’ E); Shahrake Shahid Rajaee , ca. 1061 m (33º 45’ N, 46º 09’ E); Ban Amrud, ca. 1195 m(33º 46’ N, 46º 11’ E) ; Hajbakhtiar, ca. 1093 m (33º 46’ N, 46º 09’ E) ; Ban Sarve, ca. 1177 m (33º 48’ N, 46º 08’ E) and Parde, ca. 1226 m (33º 49’ N, 46º 07’ E).

The sampling was carried out under stones, in crevices, on trees, within burrows, inside old shoes and disposable things during day, and with an ultraviolet lamp on suitable nights, then the specimens were collected by forceps. After collection, all specimens were preserved in 70 % alcohol; date and time of sampling and place of collection were recorded on each container. The identification keys of Farzanpay (1988) and Dehghani and Valaie (2004) were used to identify.

Simpson’s and Shanon-Wiener’s indices (Magurran, 1988) have been calculated to estimate the biological diversity indices for scorpion’s community in the study two indices has been calculated. Simpson Index shows the diversity of dominant species but the Shanon-Wiener’s Index showing the biodiversity of all species.

Results:

Seven different described species were identified all belonging to the three families, Buthidae, Scorpionidae and Hemiscorpiidae. During this study a total 228 specimens were identified including one hundred twenty eight females and one hundred males. Seven species were identified as *Hottentotta (Buthotus) saulcyi* (28.95%),*Androctonus crassicauda* (25.44%), *Scorpio maurus* (18.42%),*Mesobuthus eupeus* (10.09%), *Hemiscorpius lepturus* (8.33%), *Compsobuthus matthiesseni*(5.70%) and *Odontobuthus doriae*(3.70%).(Fig.1 and Table1).

Hottentotta saulcyi (Simon, 1880):

*Hottentotta (Buthotus) saulcyi*was the most common scorpion from all collection sites (28.95%), collected from under stones, in cranny and upon tree branches. This species belongs to Buthidae family and considers as the most common scorpion in the country. A total sixty six specimens were collected in our study area including twenty nine males and thirty seven females (Table 1). The body's colorwas yellow, except black anterior part of carapace, telson and fifth metasomal segment. Nearly the entire bodies were hirsute, pedipalps, dorsal surface of mesosoma, legs, lateral and ventral surfaces of metasomal segments, vesicle covered with hair. All metasomal segments were smooth, without any granules between carinae (Fig. 1).

Androctonus crassicauda (Olivier, 1807):

Androctonus crassicauda was the second most common scorpions in the study area (25.44%). This taxon is not a digger species; we found it in and around rural area. This species were found at night, inside buildings and houses in the villages (Table 1).The specimens were collected from under stones and piece of cork bark at daytime. A total fifty eight specimens were collected in our study area including thirty one males and twenty seven females. The body’s color was a brownish/black (Fig. 1).

Scorpio maurus Linnaeus, 1758:

The specimens were collected within burrows during the daytime (Fig.1). A total forty two specimens were collected in Ilam (18.42%) including fifteen males and twenty seven females (Table 1). This species is a digger

species which can dig burrows with 20 - 70 cm deep. Most had a yellow to red brown color, the tip of the claws were usually dark red-brown.

Mesobuthus eupeus (Koch, 1839):

Mesobuthus eupeus was the fourth species which we found in this study. Three specimens were collected from a cave near BanSarve. A total twenty three specimens (10.09%) were collected including nine male and fourteen females (Table 1).It is not a digger species. The whole body was yellow to yellowish-brown and with the coloration relatively uniform on the carapace, mesosomal tergites and metasomal segments. Mesosomal tergites often had irregular longitudinal blackish-brown stripes. Pedipalp chelae relatively inflated and wider than patella, fingers had strong basal lobe and notch combination (Fig.1).

Hemiscorpius lepturus Peters, 1861:

Nineteen specimens (8.33%) of this species were found in the areaincluding ten female and nine males (Table 1). Two specimens collected from inside theold shoes and disposable things while three other specimens were found with digging the ground in Ban Amrud and Ban Sarve. This species is a digger scorpion belongs to the family Scorpionidae. It is consider as the most dangerous scorpion in the region. The collectedspecimens were yellow/yellow-brown and had a dark stripe on the mesosoma (Fig. 1).

Odontobuthus doriae (Birula, 1905):

Thisspecies werecollectedfrom understones and deepburrows.This species belongs to Buthidae family and consider as the least scorpion species in the country(3.07).Only7 specimens collected in Ban Sarv village that including 3 males and 4 females (Table 1).The features of the collectedspecimens were toothy form tail end.Color of these species is varying from light yellow to dull yellow.

Compsobuthus matthiesseni (Thorell, 1876):

This species were found in rocks and inside theold closets. This species includes (5.70%) of scorpions. This species' shape is narrow and long. Color varies from light yellow with spots to dull yellow. In specimens that collected in Ban Sarv village, there were specimens that had special feature; there were dark spots in 1 or 2 last clauses. All samples were collected in Ban sarv village that including 4 males and 9 females (Table 1).

The Simpon's index in this study was 0.2 for the scorpion community in Ilam County. This study has shown that *Hottentotta saulcyi* is more predominant than other species (Table 2).

Discussion:

A number of articles have been published on the scorpions (Arachnida, Scorpions) of Iran. Although there are large numbers of scorpion species in Iran, only a few of them are considered as clinical or health problem (Jalali *et al* 2010). However, scorpion stings remain a major public health problem in some southern parts of Iran especially in tropic areas. The number of reported cases of scorpion envenomation in Ilam Province is in the third place in Iran after Khoozestan and Kohgilouyeh Va Boyer Ahmad provinces (Azhang and Moghisi, 2006). The present survey revealed a wide diversity of scorpion population in the Ilam region, with three families and a minimum of seven species.

*Hottentotta saulcyi*has been recorded from many provinces of Iran including Khoozestan, Kohgilouyeh Va Boyer Ahmad, Ilam (Navidpour$_{a,c}$ *et al*., 2008) West Azerbaijan, Kermanshah, Hormozgan, Sistan Va Baluchestan, Fars, Isfahan, Kerman, Lorestan and Ardebil (Taherian, 2003; Chomeili *et al*., 2008). It has distributed over the Middle East from Syria and Turkey to Iraq, Iran and Afghanistan (Kovarik, 1997; Fet and Lowe, 2000). While the prevalenceof *H. saulcyi* was 28.95% in Ilam. It has reported from Khoozestan with prevalence 3.35%, from Kerman with prevalence 0.35% (Dehghani *et al*., 2008; Dehghani *et al*., 2009) and from Hormozgan with prevalence 3.4 % (Shahi *et al*., 2008). The prevalence of *H. saulcyi*'s stings were recorded 13% in Khoozestan (Radmanesh and Shaffiee, 1989). In the present study *H. saulcyi* was the most numerous scorpion in both rural and urban area (Table1).*Androctonus crassicauda* has wide distribution in all parts of Iran from the northern to the southern provinces including West Azerbaijan, Khorasan, Kermanshah, Kurdistan, Ilam, Semnan, Kerman, Bushehr, Qeshm Island and Khoozestan (Navidpour$_{a,c}$ *et al*., 2008; Zarei *et al*., 2009). The species distributed from Egypt, Palestine, Jordan, Syria, Turkey, Armenia, Azerbaijan and Iraq to the Arabian Peninsula (Fet and Lowe, 2000). *Androctonus crassicauda* was the most common scorpion in Khoozestan with prevalence 28.7% and in Kerman with prevalence 28.5% (Dehghani *et al*., 2008; Dehghani *et al*., 2009) while in our study area this species with the same prevalence (25.44%) considered as the second

common scorpions. It was also the second common scorpion in Qeshm Island with prevalence 34.31 % (Zarei *et al*., 2009). Shahi *et al*. found it with prevalence 11% in Hormozgan (Shahi *et al*., 2008). We found it only in rural area in this study (Table1). This species responsible for 41% scorpion stings in the endemic area Khoozestan (Radmanesh and Shaffiee, 1989). *Androctonus crassicauda* is known as a dangerous scorpion in Saudi Arabia and has been incriminated in most recorded scorpion stings (Annobil, 1993; Jarrar and Al-Rowaıly, 2008).

The other species in this area was *Scorpio maurus* which is known as a polymorphic species. Molecular evidence suggested that this species includes some cryptic species (Froufe *et al*., 2008). This species normally lives in warm habitats, but it has found in cold winter weather. *Scorpio maurus* has been reported in Iran from Khoozestan, Kurdistan, Hormozgan, Qeshm Island, Golestan, Tehran, Ilam, West Azerbaijan, Kermanshah and Khorasan provinces (Navidpour$_{a,c}$ *et al*., 2008; Zarei *et al*., 2009) and around the world from Algeria, Egypt, Libya, Mauritania, Morocco, Senegal, Tunisia to Lebanon, Palestine, Jordan, Turkey, Iraq, Kuwait, Qatar, Saudi Arabia, Syria, and Yemen (Rein, 2010). The prevalence of this species in Hormozgan has been recorded 3.8% (Shahi *et al*., 2008) while its prevalence was 18.42% in both rural and urban area of Ilam.

The twenty three species found in this study,*Mesobuthus eupeus*, is a common scorpion in Iran. It has been recorded from Khoozestan, Kurdistan, Hormozgan, Qeshm Island, Golestan, Tehran, Ilam, West Azerbaijan, Kermanshah and Khorasan provinces (Navidpour$_{a,c}$ *et al*., 2008; Dehghani *et al*., 2009; Zarei *et al*., 2009). In addition to Iran, *M. eupeus* has distribution in Iraq, Turkmenistan, Afghanistan, and Pakistan (Vachon and Kinzelbach, 1987; Karatas, 2003). This species reported as the dominant scorpion in mutinous area in Sari (Haghi *et al*., 2004) and also in Kerman province (Dehghani *et al*., 2008). While, its prevalences were 21.43% in Taibat in Northeast Iran (Vatani and Koobdel, 2009), 21.7% in Khoozestan (Dehghani *et al*., 2008) and 24% in Hormozgan (Shahi *et al*., 2008), we found it in fourth place with prevalence 10.09% from only one locality in rural area. *Mesobuthus eupeus* considered as an important scorpion with 25.8% of the scorpionism cases in Turkey (Ozkan and Kat, 2005). In Iran it is responsible for 45% of all cases of scorpionism (Radmanesh and Shaffiee, 1989).

Hemiscorpius lepturus is considered as the most dangerous scorpion in Iran, it is generally found in the southern areas of the country (Farzanpay, 1988; Pipelzadeh *et al*., 2007) it also occurs in Iraq, Pakistan and Yemen (Rein, 2010). Previous studies have shown that *H. lepturus* has wide distribution in Khoozestan, Semnan, Fars, Kurdistan, Hormozgan, Bushehr, Ilam, Lorestan, Kermanshah and KohgilouyehVa Boyer Ahmad provinces (Navidpour$_{a,d}$ *et al*., 2008; Dehghani *et al*., 2009). Epidemiological studies revealed that envenomation by *H. lepturus*, is responsible for 90% of reported deaths in the southern areas of Iran (Jalali *et al*., 2010; Pipelzadeh *et al*., 2007).This species has been reported from Khoozestan with prevalence 24.9%, from Kerman with prevalence 0.9% (Dehghani *et al*., 2008; Dehghani *et al*., 2009) and from Hormozgan with prevalence 21.6% (Shahi *et al*., 2008). In this study the prevalence *H. lepturus* was 5.56% only in rural area, it means that there is a potential of real threat for resident of the country. Radmanesh reported that 13% of all scorpion sting cases were due to this species in Iran (Radmanesh, 1990).

The coexistence of the three families in this region includes Buthidae, Scorpionidae and Hemiscorpiidae explain that Ilam is an endemic area for scorpions. Navidpour *et al*. have done a very good survey in this province and found more species in their study (Navidpour$_{c}$ *et al*., 2008).This study was focused on the rural and urban areas of Ilam city in north of the province. The sevenmentioned species were found exactly around the rural and urban areas of Ilam city in north of the province. In contrast, Navidpour *et al*. found all species mostly from southern part of the province close to the border of Khoozestan. Although, Navidpour *et al*. recorded *A. crassicauda* and *H. saulcyi* from the southern parts of the province; they did not find them in/around Ilam city areas. Similarly, they reported *H. lepturus* and *S. maurus* from central and southern parts of the province and could not find them from northern parts and Ilam city areas. The present survey recognized three scorpion species, *H. lepturus*, *A. crassicauda* and *M. eupeus*, with a very important role in scorpion stings in Iran. Although, people in rural areas are familiar with scorpions, it is important to improve their knowledge and attenuate to avoid their stings.

Although the scorpion control is very difficult, knowledge of scorpion biology, ways to avoid their stings and treatments of victims are essential for successful control programs. It is important to improve the knowledge of people, heath workers and physicians as a key factor to prevent of scorpion stings in the area. Unfortunately there are no regional scorpion control programs in the Middle East, it is need to achieve, develop and improve safe strategies for the people who live in the endemic areas. Further research should be focused on identification of scorpions and dissemination of information in endemic area like Ilam.

The range of Simpson's Index is between 0 – 1 (Magurran, 1988). This index for scorpion community in Ilam was 0.2 that is showed a high dominant diversity. Despite of high diversity which has showed by Simpson Index of Diversity (D), the overall diversity of scorpion's community with Shannon-Wiener was low in the region (1.73). The range of Shannon-Wiener Index is usually between 1.5 – 3.5 (Magurran, 1988). It is cleared that *Hottentotta saulcyi* is more predominant species in study area due to its higher Simpson index in comparisons with other species.

J. Appl. Sci. Res., 9(9): 5412-5418, 2013

Fig. 1: Original photos of seven species of scorpions were identified in Ilam: 1-*Hottentotta saulcyi*, 2-*Androctonus crassicauda*, 3-*Scorpio maurus*, 4-*Mesobuthus eupeus*, 5-*Hemiscorpius lepturus* 6-*Compsobuthusm atthiesseni* 7-*Odontobuthus doriae*

Table 1: Collection data the collected scorpions in Ilam, Iran.

Species	Number of specimens			(%)	Average body length of adult (cm)	Location	No	Altitude	Co-ordinates
	M	F	n.						
Hottentotta saulcyi	29	37	66	28.95	12.5	Pelkelab	3	921	33º 44’ N, 46º 10’E
						Shahrake Rajaee	8	1061	33º 45’ N, 46º 09’E
						Ban Amrud	7	1195	33º 46’ N, 46º 11’E
						Hajbakhtiar	18	1093	33º 46’ N, 46º 09’E
						Ban Sarve	20	1177	33º 48’ N, 46º 08’E
						Parde	10	1226	33º 49’ N, 46º 07’E
Androctonus crassicauda	31	27	58	25.44	11	Pelkelab	12	921	33º 44’ N, 46º 10’E
						Ban Amrud	14	1195	33º 46’ N, 46º 11’E
						Ban Sarve	25	1177	33º 48’ N, 46º 08’E
						Parde	7	1226	33º 49’ N, 46º 07’E
Scorpio maurus	15	27	42	18.42	5.5	Shahrake Rajaee	12	1061	33º 45’ N, 46º 09’E
						Ban Amrud	22	1195	33º 46’ N, 46º 11’E
						Ban Sarve	8	1177	33º 48’ N, 46º 08’E
Mesobuthus eupeus	9	14	23	10.09	6	Ban Sarve	23	1177	33º 48’ N, 46º 08’E
Hemiscorpius lepturus	9	10	19	8.33	7	Ban Amrud	8	1195	33º 46’ N, 46º 11’E
						Ban Sarve	11	1177	33º 48’ N, 46º 08’E
Odontobuthus doriae	3	4	7	3.07	9	Ban Sarve	7	1177	33º 48’ N, 46º 08’E
Compsobuthus matthiesseni	4	9	13	5.70	4	Parde	13	1226	33º 49’ N, 46º 07’E
Total	100	128	228	100	-	-	228	-	-

Table 2: Calculating of Simpson's dominant diversity index and Shanon-Wiener diversity index, Ilam, Iran.

			Simpson Index	Shanon-Wiener Index		
Species	ni	pi	pi^2	lnPi	Pi(lnPi)	_pi(lnPi)
Hottentotta saulcyi	66	0.289474	0.083795	-1.239691	-0.358858	0.358857888
Androctonus crassicauda	58	0.254386	0.0647122	-1.368903	-0.34823	0.348229614
Scorpio maurus	42	0.184211	0.0339335	-1.691676	-0.311625	0.311624528
Mesobuthus eupeus	23	0.100877	0.0101762	-2.293851	-0.231397	0.231397292
Hemiscorpius lepturus	19	0.083333	0.0069444	-2.484907	-0.207076	0.207075554
Odontobuthus doriae	7	0.030702	0.0009426	-3.483435	-0.106948	0.106947581
Compsobuthus matthiesseni	13	0.057018	0.003251	-2.864396	-0.163321	0.16332084
Total	228	1	0.203755	15.4268594	1.7274533	1.727453297

Conclusion:

The high level of dominant diversity and low level of overall biodiversity in scorpion community in Ilam county showed that this community has not equal distribution and has variation in individual numbers. This conditions show a not stable community therefore the increasing of population of any species. This condition may be increase the risk of scorpion biting to human.

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