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Research Article

A New Study of the Species Composition of Scorpions in Golestan Province, Northeast of Iran

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AS and MMB designed the study and prepared the manuscript. EAK did the GIS analysis. SS contributed to writing the manuscript.

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Abstract | The scorpion sting and the resulting mortality are considered among the most critical health problems in Iran. This research was aimed to study on the scorpion's species in Golestan Province, Northeast Iran. Scorpions were captured during day and night using rock rolling and ultra violet methods from May to September, 2019. Then, the specimens were put into a 75% alcohol-containing plastic bottle. Finally, the specimens were identified using a valid identification key. Distribution maps were prepared using ArcGIS (Ver 10.4.). A total of 111 scorpion samples were captured. All the samples belonged to *the Buthidae* family, including *Mesobuthus eupeus* (97.3%), *Orthochirus farzanpayi* (0.9%), and *Mesobuthus caucasicus* (1.8%). *M. eupeus* had the highest distribution and abundance in the region and was recognized as the leading cause of scorpion sting in the region. *O. farzanpayi* and *M. caucasicus* are new to the scorpion's species of this province. *M. eupeus* is the most prevalent species in Golestan Province and is one of the dangerous the scorpion in the region.

Novelty Statement | For the first time, we determined the distribution of scorpion species in Golestan province, also *O. farzanpayi* and *M. caucasicus* are recorded for the first time in this region of Iran. This information can be very useful for the production of regional antivenom for scorpion sting treatment.

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Introduction

Scorpions belong to one of the medically important orders of arachnids. More than 2000 scorpion species have been identified so far (Dehghani *et al.*, 2017). Currently, there are families of *Buthidae* (55 species, 86% of total species), Hemiscorpiidae (six species, 9.5% of total species), and *Scorpionidae* (three species, 4.5% of total species) in Iran. Scorpions are venomous animals that sing 40,000 to 50,000 people in Iran, annually (Motevalli and Dehghani, 2017; Dehghani *et al.*, 2017, 2018). In ancient Iran, religious and historical texts also reported scorpion sting cases, indicating the history and importance of this issue in the country. The scorpion sting problem has always been present in Iran (Dehghani *et al.*, 2006).

Many studies have been recently conducted on the fauna, spatial distribution, morphological properties, ecological conditions, genetic diversity, and medical importance of scorpions in Iran. According to these studies, among wich, *Hemiscorpius lepturus* and *Hemiscorpius acanthocercus* from the Hemiscorpiidae family and *Androctonus crassicauda*

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from Buthidae are the most dangerous and deadly one. Recently several researchers have been described more other species in Iran.

Mesobuthus eupeus phillipsii subspecies was promoted to *Mesobuthus phillipsii* species. *H. lepturus* causes mortality in the southern regions. However, *A. crassicauda* is distributed in many provinces of Iran. Also, *M. eupeus* has the highest distribution in Iran (Farzanpay, 1978; Dehghani *et al.*, 2006; Masihipour and Navidpour, 2009; Mirshamsi et al., 2010; Mirshamsi et al., 2011; Sedaghat et al., 2012; Mirshamsi et al., 2013; Karataş and Gharkheloo, 2013; Teruel, 2014; Nejati et al., 2014; Navidpour, 2012, 2015; Moradi et al., 2015; Aydın *et al.*, 2016; Gholizadeh et al., 2016; Mohammadi *et al.*, 2017; Mongiardino et al., 2017; Vazirianzadeh et al., 2017; Fet et al., 2018; Firoozfar *et al.*, 2019; Kovařík *et al.*, 2017, 2018, 2019; Navidpour *et al.*, 2010, 2013, 2019).

In Iran, a polyvalent antivenom is produced against some dangerous species, for scorpion sting treatment (Dehghani *et al.*, 2018). However, the number of scorpions in Iran has increased in recent years (Mirshamsi et al., 2013; Kovařík *et al.*, 2017, 2018). The Razi Institute intends to produce monovalent or regional antivenom, and thus, it is essential to study scorpion composition. Because the most scorpionism occur in the country's southern parts, most studies on scorpions have been conducted in this region. However, in other parts of Iran, including Golestan Province, scorpion related studies have been neglected. Thus, in this research we study the scorpion composition in this province.

Materials and Methods

Study area

With an area of 20437.74 Km^2, Golestan Province covers about 1.3 percent of Iran's total area in the northeast corner.

Study area and collection procedure

Scorpions were collected from different locations in Golestan Province (Northeast of Iran) using Rock Turing and ultra violet methods May to September, 2019. GPS recorded geographical coordinates (longitude, latitude, and altitude) of scorpion collection sites. The samples were put into a plastic bottle containing 75% ethanol alcohol. The specimens were identified under the stereomicroscope using a valid Iranian scorpion identification key. Distribution maps were prepared using ArcGIS (Ver 10.4.).

Results and Discussion

Totally 111 scorpion specimens were captured from ten locations and four counties (Kalaleh, Maraveh Tapeh, Gonbad Kavous, and Gorgan) in Golestan Province. Sixty female and 51 male samples were identified. The sex ratio was 1:0.85. All the collected scorpions belonged to *the* Buthidae family, were non-digging, and included *M. eupeus*, *M. caucasicus*, and *O. farzanpayi*.

Mesobuthus eupeus (Koch, 1839)

This non-digging species had the highest frequency (108 samples) (97.3%), comprising (50%) 59 females and (50%) 59 males and sex ratio for this species was 1:1. This species had a wide distribution in the province so that it was collected from all the four studied counties (Kalaleh, Maraveh Tapeh, Gonbad-e Kavus, and Gorgan), as well as from all the studied areas, including mountainous and forest-rich, mountainous and semi-arid, and plain and semi-arid areas with high and low altitudes (Table 1 and Figures 1, 2).

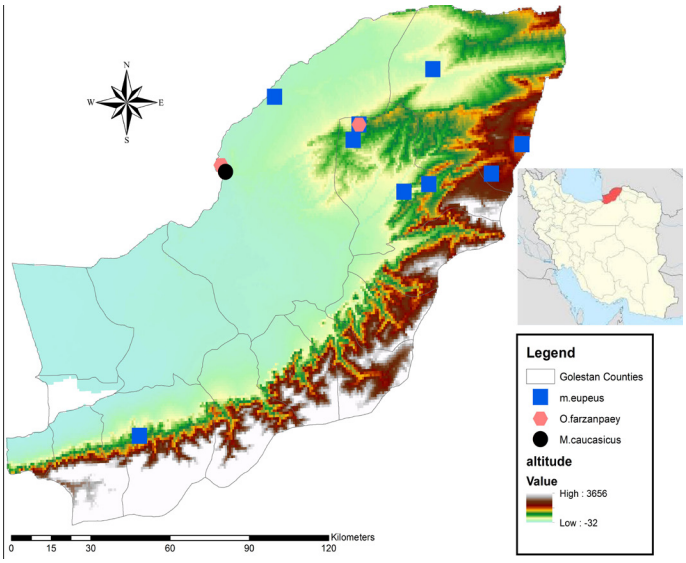

Figure 1: Dispersal map of the captured scorpion specimens in Golestan Province (based on altitude), 2019.

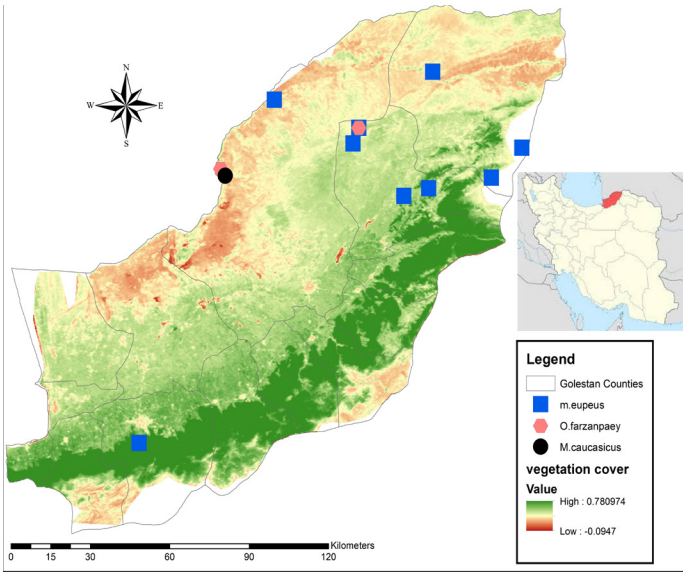

Figure 2: Dispersal map of the captured scorpion specimens in Golestan Province (based on vegetation cover), 2019.

Table 1: Species composition in different localities of Golestan Province in 2019.

Counties	Collection sites	Altitude	The geographical and climatic situation	Species	No. of the collected sample		
					Female	Male	Total
Kalaleh	Azizabad	356	Mountainous and forest	*Mesobuthus eupeus*	0	1	1
	Pishkamar	236	Mountainous and semi-arid	*Mesobuthus eupeus*	5	5	10
	Ooqchi	331	Mountainous and semi-arid	*Mesobuthus eupeus*	2	2	4
	Khalednabi	550	Mountainous and semi-arid	*Mesobuthus eupeus*	36	21	57
				Orthochirus farzanpay	1	0	1
Maraveh Tapeh	Coeilar	1031	Mountainous and forest	*Mesobuthus eupeus*	1	5	6
	Eslam abad	811	Mountainous and semi-arid	*Mesobuthus eupeus*	1	2	3
	Chaeili	141	Plateau and semi-arid	*Mesobuthus eupeus*	4	6	10
Gonbad-e Kavus	Damaq	58	Plateau and semi-arid	*Mesobuthus eupeus*	5	2	7
	Dashli Boron	18	Plateau and semi-arid	*Mesobuthus caucasicus*	0	1	1
				Orthochirus farzanpay	0	1	1
Gorgan	Hezarpich	427	Mountainous and forest	*Mesobuthus eupeus*	5	5	10
Total					60	51	111

This species had a large habitat and was mostly caught beneath cliffs in mountainous areas, beneath rocks in plains, beneath footsteps in old buildings, beneath piles of brick and cement blocks left in the backyard of rural homes, and inside abundant arthropods and rodent holes. It is about 5 to 6 cm long. This species can be captured in the most parts of Iran. Because of its desire to live close to human settlements, the yellow scorpion can live in various habitats, including beneath rocks, in the garbage, in construction debris, and in trees. This species' venom is neurotoxic and causes feelings of thirst, dizziness, and uneasiness due to fear in humans (Farzanpay, 1987; Mirshamsi *et al*., 2011; Dehghani et al., 2016).

Mesobuthus caucasicus (Nordmann, 1840)

Only one male (0.9%) sample of this species was collected in Gonbad-e Kavus County (a lowland area with a semi-arid climate) (Table 1 and Figures 1, 2).

This species has a length of about 6 to 6.5 cm (Farzanpay, 1987; Dehghani *et al*., 2016).

Orthochirus farzanpayi (Vachon et Farzanpay, 1987)

Only two samples (one male and one female) (1.8% of all the samples) of this species were collected from Khalaleh and Gonbad-e Kavus Counties. This species was captured from mountainous and semi-arid regions as well as from lowland and semi-arid areas (Table 1 and Figures 1, 2).

This species is 2.5 to 4 cm long and is one of Iran's smallest species. The color of its abdomen ranges from brown to light brown. In 2006, a death due to the sting of this species (*Orthochirus* spp) was reported from Khuzestan Province (Farzanpay, 1987; Dehghani *et al*., 2016).

Our results showed that there were three scorpion species, including *M. eupeus*, *M. caucasicus*, and *O. farzanpayi,* in Golestan Province belonging to *the Buthidae* family but no species of *Hemiscorpiidae* and *Scorpionidae* families. *M. eupeus* species was also collected from Golestan Province in previous studies (Motevalli and Dehghani, 2017). However, *M. caucasicus* and *O. farzanpayi* species are new to scorpions composition in Golestan province. *M. caucasicus* is inhabited in the Sistan and Baluchestan, Isfahan, Markazi, North Khorasan, Tehran, Semnan, Yazd, and West and East Azarbaijan provinces. *O. farzanpayi* species has also been reported in Hormozgan, Khuzestan, Bushehr, Kerman, North Khorasan, and South Khorasan provinces (Motevalli and Dehghani, 2017). Therefore, it can be concluded that according to previous studies, *O. farzanpayi* species has been reported mainly in southern provinces and only in North Khorasan Province in the country. Some species such as *A. crassicauda*, *Orthochirus scrobiculosus*, *Scorpio maurus townsendi*, and *H. lepturus* have been reported in Semnan Province bordering Golestan Province to the north. However, in our study, we could not capture these scorpions (Motevalli and Dehghani, 2017).

In a study conducted in Ardebil Province as well as in East and West Azerbaijan Provinces, similar to our results, 97.1% of collected scorpions belonged to the Buthidae family and no Hemiscorpiidae species was captured. Moreover, *M. eupeus* species has the highest distribution in this study, about 80.16% of the total samples belonged to this species, which agrees with our results (Mohammadi *et al*., 2017). In another study conducted in North Khorasan Province, similar to our results, all the collected species belonged to the Buthidae family and *M. eupeus* species had the highest frequency (59.44%) with the most spatial distribution area in the province (Firoozfar *et al*., 2019).

A review study in Iran showed that the Buthidae

family caused more than 83.5% of scorpion sting and *M. eupeus* species had the highest distribution in Iran (Dehghani *et al.*, 2016). Other studies also showed that *M. eupeus* species was widely distributed in most provinces of Iran and was observed in different climatic conditions ranging from warm lowlands regions (Khuzestan, Gorgan, Bandar Abbas, and Varamin Plains) to snow-covered highlands, which agrees with our results (Sedaghat et al., 2012; Dehghani *et al.*, 2016, 2017).

No mortality due to this scorpion sting has been so far reported in Iran, although there have been some mortality reports from this scorpion sting in Tunisia and Algeria (Dehghani *et al.*, 2016). All the three species collected in our study are medically important, and *M. eupeus* is a significant medical scorpion in Iran, which produces antivenom against its venom for the treatment of scorpion in Iran. *M. eupeus* species introduced as the most significant medical species in Golestan Province had the highest distribution and abundance in this study. This species has multiple habitats and is highly compatible with geographical and climatic conditions. As a result, we were able to capture this species from different climates, including high altitude areas (1031 m above sea level), lowland areas (58 m), and medium-altitude areas, as well as high, medium and low vegetation areas. The size, color, and appearance of *Mesobuthus eupeus* species vary in different areas; however, their size reaches a maximum of about 6 cm. there are several subspecies of this species in Iran.

Among wich *Mesobuthus eupeus eupeus* subspecies has been collected from different regions of Iran. Also, in our study, all the collected *M. eupeus* specimens were identified as *M. eupeus*. In this subspecies, there are three lateral anal lobes on the fifth metasomal segment, venom gland width is less than the fifth metasomal segment width, and dark spots in the dorsal surface of carapace and mesosoma are arranged in 3–5 distinct bands (Farzanpay, 1987; Mirshamsi *et al.*, 2011).

O. farzanpayi and *M. caucasicus* species were the second and third most abundant and highly distributed species, respectively, and are new to scorpions of Golestan Province. *O. farzanpayi* species previously named *Orthochirus scrobiculosus* form A, B, C, and D belongs to the Orthochirus genus (Farzanpay, 1987). Unfortunately, some researchers now use the same name. However, according to recently conducted studies, the number of species belonging to this genus has increased in Iran (Farzanpay, 1987; Kovařík *et al.*, 2019). In this study, we captured only two samples of *O. farzanpayi*. This species sting causes relatively severe pain at the bite site after itching symptoms that lasts about 10 to 15 hours (Dehghani *et al.*, 2016).

M. caucasicus species can be captured in villages and on roofs of old rural houses (Mohammadi *et al.*, 2017). This species, previously called *Olivierus caucasicus*, belongs to the *Olivierus* genus. However, researchers currently believe this species belongs to the *Mesobuthus* genus (Farzanpay, 1987; Fet *et al.*, 2018). In this study, we could capture only one specimen of this species.

Conclusions and Recommendations

According to other studies conducted in other parts of Iran, the *Mesobuthus eupes* distributed to the most parts of Iran. In agreement with these studies, our results confirmed that this species had the high density in this corner of Iran. Therefore, health authorities should pay more attention to biological properties and environmental conditions related to the yellow scorpion species in Golestan Province and plan to control its population. The study results are also useful for the production of regional or monovalent anti*venom* for the Razi Institute.

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Conflicts of interest

The authors have declared no conflict of interest.

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