

## Investigations of Bio-Ecology on *Androctonus crassicauda*: Buthidae Occuring in Sanliurfa

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### ABSTRACT

*Androctonus crassicauda* scorpion species lives in nature both as a prey and a predator. So it has venom that can be effective for hunting and protection. It can cause venoming and death by stinging people and animals. It is of great importance to know the ecological characteristics and density of this scorpion species, especially in regions where venoming cases are high. In the present study, Şanlıurfa province, where the scorpion species *Androctonus crassicauda* is prevalent, was chosen as the research area. 289 samples were collected after field studies in all districts of Şanlıurfa province. Owing to desolated and stony structure, *Androctonus crassicauda* was observed to be more intensive in Harran district. It was generally found from April to October. The most abundant period of the species is June, July, and August. Considering the seasonal expectation, test results of correlation for a series with non-normal distribution were listed in two options, Kendall'stau\_b correlation coefficient and Spearman'srho correlation coefficient. There was a positive correlation of 0,168 (16%) at 1% significance between month and population for the former (Kendall'stau\_b) coefficient. A positive correlation of 0,231 (23%) at 1% significance level between month and population for the latter (Spearman'srho) coefficient. In the view of regional expectation, results of correlation test for a non-normal distribution were presented in two options. A negative correlation of 0,099 (9%) was found at 5% significance level between region and population for the former coefficient. There was a negative correlation of 0,128 (12%) at 5% significance level between region and population for the second coefficient. The study revealed a variation between seasons and districts.

### Biology

### Research Article

### Article History

Geliş Tarihi : 15.09.2021

Kabul Tarihi : 14.11.2021

### Keywords

Scorpion  
*Androctonus crassicauda*  
Bioecology  
Population dynamics  
Şanlıurfa

## Şanlıurfa İlinde Yaylış Gösteren *Androctonus crassicauda*:Buthidae Türünün Biyo-Ekolojisi Üzerine Araştırmalar

### ÖZET

*Androctonus crassicauda* akrep türü doğada hem av hem de yırtıcı olarak yaşar. Bu yüzden avlanma ve korunma için etkili olabilecek zehirlere sahiptir. İnsanları ve hayvanları sokarak zehirlenmeye ve ölüme neden olabilmektedir. Özellikle zehirlenme vakalarının yoğun olduğu bölgelerde bu akrep türünün ekolojik özelliklerinin ve yoğunluğunun bilinmesi büyük önem taşımaktadır. Bu çalışmada, araştırma alanı olarak *Androctonus crassicauda* akrep türünün yaygın olduğu Şanlıurfa ili seçilmiştir. Şanlıurfa ilinin tüm ilçelerinde yapılan saha çalışmaları sonucunda 289 örnek toplanmıştır. Harran ilçesinde ıssız ve taşlı yapısı nedeniyle *Androctonus crassicauda*'nın daha yoğun olduğu görülmüştür. Genellikle Nisan'dan Ekim'e kadar bulunmuştur. En yoğun olduğu dönem Haziran, Temmuz ve Ağustos aylarıdır. Mevsimsel beklenti gözetilerek ve normal dağılmayan bir seri için yapılan koraasyon testi sonuçları Kendall'stau\_b korelasyon katsayısı ve Spearman'srho korelasyon katsayısı şeklinde iki opsiyon şeklinde listelenmiştir. İlk (Kendall'stau\_b) katsayı için ay ile popülasyon

### Biyoloji

### Araştırma Makalesi

### Makale Tarihiçesi

Received : 15.09.2021

Accepted : 14.11.2021

### Anahtar Kelimeler

Akrep  
*Androctonus crassicauda*  
Biyoeoloji  
Popülasyon dinamik  
Şanlıurfa

arasında %1 anlamlılık seviyesine göre 0,168 (%16) pozitif bir korelasyon söz konusudur. İkinci (Spearman'srho) katsayı için ay ile popülasyon arasında %1 anlamlılık seviyesine göre 0,231 (%23) pozitif bir korelasyon olduğu görünmektedir. Bölgesel beklenti gözlemlenerek ve normal dağılmayan bir seri için yapılan korelasyon testi sonuçları iki opsiyon şeklinde listelenmiştir. Önceki katsayı için bölge ve popülasyon arasında %5 anlamlılık düzeyinde 0,099 (%9) negatif korelasyon bulunmuştur. İkinci katsayı için bölge ve popülasyon arasında %5 anlamlılık düzeyinde 0,128 (%12) negatif korelasyon bulunmaktadır. Bu çalışma mevsimler ve ilçeler arasındaki değişiklikleri ortaya çıkarmaktadır.

**To Cite :** Aslan N, Toprak Ş 2022. Investigations of Bio-Ecology on *Androctonus crassicauda*: Buthidae Occuring in Sanliurfa. KSU J. Agric Nat 25 (6): 1354-1363. <https://doi.org/10.18016/ksutarimdog.vi.995964>  
**Atf Şekli:** Aslan N, Toprak Ş 2022. Şanlıurfa İlinde Yayılış Gösteren *Androctonus crassicauda*:Buthidae Türünün Biyo-Ekolojisi Üzerine Araştırmalar. KSÜ Tarım ve Doğa Derg 25 (6): 1354-1363. <https://doi.org/10.18016/ksutarimdog.vi.995964>

## INTRODUCTION

Scorpion habitats are hot and dry regions, and generally prefer to stay away from residential areas (Mansouri et al., 2021). It is a nocturnal animal that hibernates in winter and is active in warm seasons (Demir, 2020). Scorpions are at the top of the food chain because they feed as predators in nature. Therefore, they are of great importance in keeping insect populations in balance and in ensuring ecological balance (Ayhan, 2015). Scorpions are distributed in subtropical, tropical, and temperate climate zones on all grand continents and large islands on earth, except Antarctic and New Zealand (Nenilin and Fet, 1992; Yağmur, 2011). Scorpions body size and variety increased towards Equator (Yaman, 1996; Özcel and Daldal, 1997; Demirsoy et al., 2001; Özkan, 2009). Because scorpions living under stones, in cracks of trees and under tree barks mostly choose moist and warm environments, they are rather found beside plants such as sugar cane, palm tree, banana tree (Yaman, 1996; Özkan and Yaman, 2004; Özkan and Karaer, 2007; Özkan, 2009). Ground scorpions thriving in cracks, hollows, and soil prefer very dry areas and move deep inside the ground to seek for a humid environment. The species *Alacran tartarus* was observed to go 812 m deep down in the soil (Özkan and Yaman, 2004; Özkan, 2009).

All of the scorpion species are venomous however only a small number has venom that is fatal to humans. But scorpion stings cause significant social and economic impacts on people around the world (Shah et al., 2018). A majority is as venomous as honeybee. There is no any danger unless the person who stung is allergic to that venom. This feature indicates that the poison is effective, not that the scorpion is deadly. For example, *Aegaeobuthus gibbosus* has an potent venom but is not usually deadly. Although *Compsobuthus matthiesseni* species, which is also found in Şanlıurfa province, has a very thin chela, its poison is quite ineffective (Herms, 1956; Yağmur,

2005). Scorpions with a dense distribution in all regions of Turkey are very abundant in the Southeast and consequently envenomation cases are frequent in this region (Altınkurt and Altan, 1980; Çalışkan, 2008). According to the latest sources, it has been shown that there are 41 scorpion species in Turkey in four families (Buthidae, Iuridae, Scorpionidae, Euscorpiidae) and 15 genera (Filazi and Özkan, 2021). One of these species, *Androctonus crassicauda* which belongs to the family of Buthidae, is a dangerously venomous species and widely distributed in the Middle East, including *A. crassicauda* has been recorded from Armenia, Azerbaijan, Bahrain, Egypt (Sinai), Iran, Iraq, Israel, Jordan, Kuwait, Oman, Saudi Arabia, Syria, Turkey, United Arab Emirates and Yemen (Fet & Lowe, 2000; Hendrixson, 2006). *Androctonus crassicauda* was first detected in Tuzluca (İğdır) (Birula, 1904; Vachon, 1951; Tulga, 1960; 1964) in our country.

Later, its distribution was determined in most provinces of eastern and southeastern Anatolia regions (Vachon, 1947; Vachon, 1951; Tolunay, 1959; Crucitti, 1999; Crucitti and Cicuzza, 2001; Karataş, 2001; Crucitti, 2003; Yağmur, 2005). It is understood that *A. crassicauda* is mostly found in the provinces of Elazığ, Diyarbakır, Sanliurfa, Mardin, Gaziantep, Adana, Hatay, in the South East Anatolia and East Anatolia regions of Turkey (Vachon, 1947a; 1951; Tolunay, 1959; Tulga, 1960; 1964; Merdivenci, 1981; Crucitti, 1999; Demirsoy et al., 2001; Crucitti, 2003; Crucitti and Cicuzza, 2001; Crucitti and Vignoli, 2002; Ozkan et al. Filazi, 2004; Karataş and Colak, 2005; Karataş and Kurtüllü, 2006; Yağmur et al., 2008).

In Şanlıurfa, this species has been determined to be both common and effective in scorpion stings (Özkan et al., 2006). According to Yağmur et al. (2008), other records of *A. crassicauda* known from Şanlıurfa are the village of Horoz, the town of Kısas, the area around Harran, the area around Birecik, the village

of Çiçekalan and the village of Körkürün. The number of studies on this scorpion have recently increased in Turkey and especially in Southeastern Anatolian Region (Crucitti, 1999; Crucitti and Cicuzza, 2000; 2001; Crucitti and Vignoli, 2002; Crucitti (2003); Karataş & Karataş (2003); Karataş & Gharkheloo (2006); Karataş (2007); Koç and Yağmur (2007), Yağmur ve ark. 2007; 2008a; 2008b; 2009; Kovařík ve ark., 2010; 2011; 2013; Lowe ve ark., 2014; Kovařík ve ark., 2018; 2019; Varol ve ark. 2006; Yağmur ve ark. 2008a; 2008b; Yağmur, 2010).

Research on bioecological characteristics and especially seasonal population dynamics is quite limited. The present study assessed population dynamics of *Androctonus crassicauda* in Şanlıurfa province where scorpion sting is frequent, the species is commonly found and revealed seasonal variations with distribution of population size by districts. The purpose of the selection of Şanlıurfa for this species; considering the ecological conditions, it is seen that the most suitable habitat and place to breed is Şanlıurfa.

*A. crassicauda* is an opportunistic species that uses the innumerable cracks and crevices in the walls of the rammed earth rural houses, made up of from a mixture of mud, straw and small Stones. It moves

quickly both on the floor and on the walls, internal and external, of buildings or ruderal environments (Crucitti & Cicuzza, 1999; Crucitti, 2003). The activity of *A. crassicauda* is carried out with an ambient air temperature and of the substrate not lower than 30 °C (Crucitti & Cicuzza, 2001, Crucitti, 2003).

Although *Androctonus crassicauda* is found under stones and in the steppe, it is commonly collected in villages, ruins, adobe houses and steppe lands around the houses (Crucitti, 2000, 2001; Crucitti and Vignoli, 2002; Crucitti, 2003; Yağmur, 2005; Özkan, 2009).

## MATERIAL and METHOD

Şanlıurfa province is located between 36° 40' - 38° 02' north latitudes and 37° 50' - 40° 12' east longitudes. It is surrounded by Mardin in the east, Syria in the south, Gaziantep in the west, Adiyaman in the northwest, and Diyarbakır in the north. Şanlıurfa with 19.451 km<sup>2</sup> of surface area is the seventh largest city in Turkey (Figure 1). Summers are very dry and hot, winters are rainy and relatively mild. Şanlıurfa is located in a region closer to the Equator and far from the sea effect due to its mathematical location. It has suitable conditions for scorpions to live.

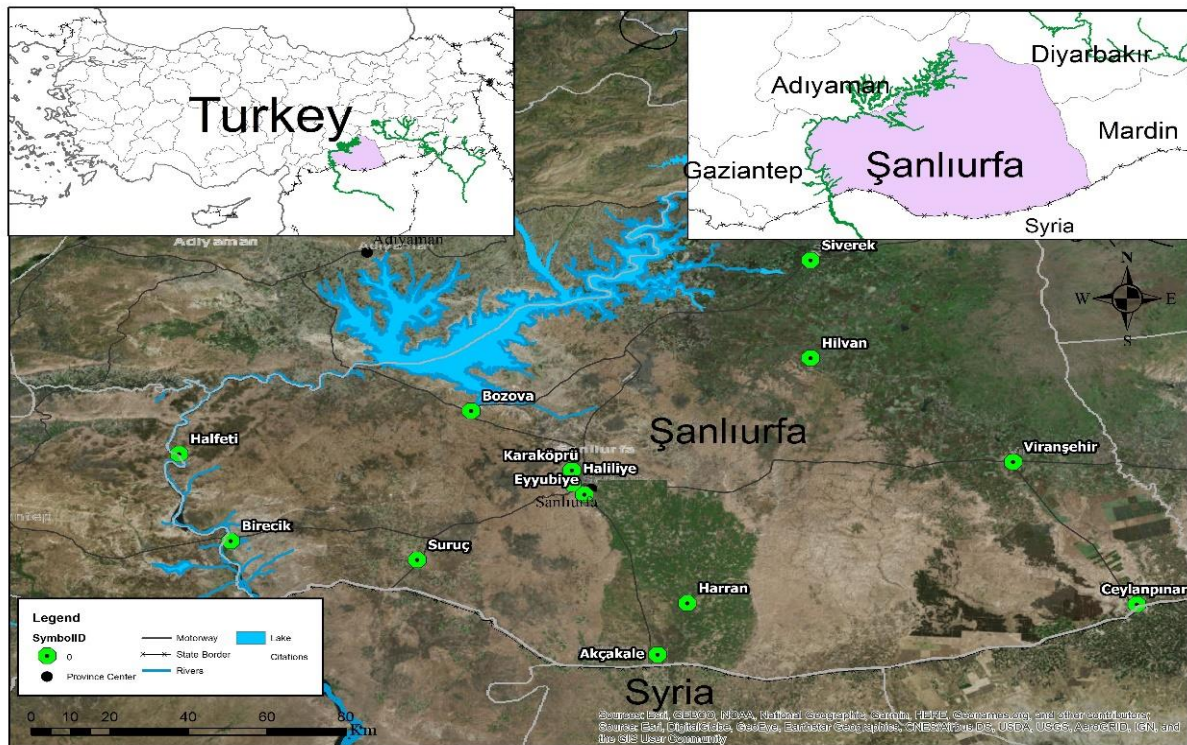


Figure 1. Black Scorpion sampling areas map in the study area of Şanlıurfa Province.  
Şekil 1. Şanlıurfa ili çalışma alanında Kara Akrep örnekleme alanları haritası.

Field studies were carried out regularly and in monthly periods to cover the whole of Şanlıurfa. The localities where the samples were collected are marked in Figure 1. Scorpions were collected by field

survey during day and night. Field survey carried out at 21:00-24:00 during night using ultraviolet torch, on the days with convenient temperature. Samples were collected with the help of forceps from under stones



and rocks, bottom of plants and ground (Figure 2). On the day survey, samples were collected from under stones, under and inside decayed logs by using forceps. Samples were kept in jars with plastic lid then transferred to laboratory.

Live samples were placed in to 18x22x11 cm glass

tanks with some soil, under 50-60% humidity,  $26 \pm 2$  °C of ambient conditions in Ecological Sciences Laboratory (Figure 2). Animals such as grasshopper, insect, fly were left in the tank to feed them. Samples that were collected dead were kept in glass jar with 96% ethanol.



Figure 2. Images of *A. crassicauda* sampled in the field and living samples in the laboratory.

Şekil 2. Kalınkuyruklu Akrep'in tarlada ve laboratuvarında yaşayan örneklerin görüntüleri.

The studied localities and coordinates are given in Table 1.

*Androctonus crassicauda* specimens we collected are between 80 and 100 millimeters in length. Its color is black and dark brown, although rarely, dark yellow or cream-colored specimens are encountered. The tip of the telson is black or reddish. The walking legs and ventral of the mesosomal are lighter in color. Its tail is curved and its claws are stocky. There are lateral eyes and there are three. In chela, the manus part is shorter than the fingers. There are 14 oblique granules in the fixed finger and 15 in the moving finger (Figure 3) (Vachon, 1951; 1952a; Demirsoy ve ark., 2001; Yağmur, 2005; Kürtüllü, 2006; Ozkan ve ark., 2006c; Rein, 2008; Özkan, 2009). Species identification key was used to identify species (Levy

and Amitai, 1980; Farzanpay, 1990; Yağmur, 2011). Figure 4 shows the general image of the black scorpion and its body parts. Prosoma is the front part of the body and the part where the eyes are. The mesosoma region is the front of the abdomen. The clamped fourth and fifth segments of the pedipalps are called Chela. Identified samples were classified according to location and months, and their averages and standard deviations were calculated. A series of correlation tests were listed as Kendall's tau b correlation coefficient and Spearman's rho correlation coefficient in order to determine the change in population density of *Androctonus crassicauda* species by months. All statistical analyzes were made in the SPSS statistical program.

Table 1. The studied localities and coordinates  
*Çizelge 1. Çalışılan lokaliteler ve koordinatlar*

Localities	Coordinates		Altitude (m)
	K	D	
Harran	3651'52.73	3901'52.57	372
Akçakale	3643'02.17	3857'07.22	482
Ceylanpınar	3651'41.93	4003'33.22	366
Viranşehir	3713'34.93	3946'33.24	553
Siverek	3744'31.20	3918'47.91	743
Hilvan	3729'12.62	390224.38	672
Bozova	3721'22.90	3832'12.12	592
Birecik	3701'27.07	3759'13.86	429
Suruç	3658'32.42	3824'48.98	499
Halfeti	3714'45.83	3752'08.44	430
Eyyübiye	3708'32.24	3847'44.50	507
Karaköprü	3712'15.68	3846'01.67	587
Haliliye	3710'15.68	3846'01.67	587



Figure 3. Preparation of samples for identification.  
*Şekil 3. Tanımlama için numunelerin hazırlanması.*



Figure 4. General appearance and body parts of *A. crassicauda*  
*Şekil 4. Kalınkuyruklu Akrep'in genel görünümü ve vücut bölümleri.*

## RESULTS and DISCUSSION

In this study, since Harran and Eyyübiye districts contain suitable habitats for the natural distribution of scorpions, especially in these districts, it is quite a lot in areas such as ruined houses, cemeteries, barns, and the highest collection in these areas is in harmony with the literature (Crucitti, 2003).

It has been observed that *Androctonus crassicauda* prefers arid and hot habitats (Crucitti, 2003) and spreads in the south of the Eastern Taurus Mountains (Yağmur, 2011).

A total number of 289 scorpion samples were collected via day and night survey from the survey area, Şanlıurfa province, in between June 2016 and May 2017. Within the research area, the highest number of individuals, 54 were collected from Harran district and secondly from Eyyübiye district with 30

individuals. The lowest number of samples were collected from Karaköprü with 10 and Haliliye with 12 individuals respectively (Table 1). Desolated and stony structure of Harran district led *Androctonus crassicauda* to be observed more intensively. Species was seen less frequently in Karaköprü and Haliliye districts because of recent urbanization and settlement. Research revealed that population size was smaller in Siverek and Viranşehir districts because of higher altitude and harsh climate conditions compared to other districts.

As seen in Table 2, when the seasonal variation of the collected samples is examined, it has been determined that winter months are the least frequent, spring and autumn months are rarely, and summer months are the most intense.

Table 2. Distribution table of *A. crassicauda* population in Sanliurfa by sampling areas and months.

*Çizelge 2. Şanlıurfa'daki Kalıncuysuklu akrep popülasyonunun örnekleme alanları ve aylara göre dağılım tablosu.*

Years Localities / Months	2016							2017					Localities	
	Jun	Jul	Agu	Sep	Oct	Nov	Dec	Jan	Feb	Mar	Apr	May	Total	Average
Harran	9	12	10	7	4	0	0	0	0	1	4	7	54	4.50
Akçakale	6	8	10	5	3	0	0	0	0	0	1	2	35	2.92
Ceylanpınar	5	6	7	3	1	0	0	0	0	0	0	1	23	1.92
Viranşehir	3	3	4	2	1	0	0	0	0	0	0	1	14	1.17
Siverek	4	5	5	2	1	0	0	0	0	0	0	2	19	1.58
Hilvan	3	4	5	2	1	0	0	0	0	0	0	1	16	1.33
Bozova	4	5	5	3	2	0	0	0	0	0	0	1	20	1.67
Birecik	3	4	4	1	1	0	0	0	0	0	1	1	15	1.25
Suruç	3	3	5	2	1	0	0	0	0	0	0	1	15	1.25
Halfeti	4	5	3	3	1	0	0	0	0	0	0	1	17	1.42
Eyyübiye	9	10	8	6	3	0	0	0	0	0	0	3	39	3.25
Karaköprü	2	3	3	1	1	0	0	0	0	0	0	0	10	0.83
Haliliye	3	2	3	2	1	0	0	0	0	0	0	1	12	1.00
Total	58	70	72	39	21	0	0	0	0	1	6	22	289	1.85
Monthly avrg.	4.46	5.38	5.54	3.00	1.62	0.0	0.0	0.0	0.0	0.08	0.46	1.69		
S.deviation	2.26	2.96	2.47	1.87	1.04	0.00	0.00	0.00	0.00	0.28	1.13	1.75		

Even though seasonal distribution of the scorpion species *A. crassicauda* showed small differences by localities, it was found to display seasonal variation throughout Şanlıurfa province.

Table 3 shows ANOVA analysis between months, which is 2,806 for inter-groups F value; 0,002 for P value. Scorpion population in Şanlıurfa was seen to rise from April to May when they start to emerge, was at maximum level in July and August, declined beginning form October and disappeared in November (Table 2). Sampling survey carried out between November and March did not found any scorpions.

Table 3. Analysis of ANOVA among different months.

*Çizelge 3. ANOVA'nın farklı aylar arasında analizi.*

ANOVA (Months)						
Source variation	SS	df	MS	F	P-value	F crit
Between groups	2563.119	11	233,011	2.806	0.002	1.850
Within groups	12952.286	156	83.027			
Total	15515.405	167				

One scorpion was sampled in March only in Harran district.

In general, male individuals are more actively wandering and foraging as they seek females for mating. It is also eaten by females. For this reason, as the number of men is less, it has been observed that there is a decrease from May to October. However, since July, the number of offspring or under-adults has increased due to births.

Table 4 indicates ANOVA analysis between localities, which is 2.229 for inter-groups F value; 0.013 for P value.



Table 4. Analysis of ANOVA between different localities  
*Çizelge 4. Farklı lokaliteler arasında ANOVA analizi.*

ANOVA (Localities)						
Source variation	SS	df	MS	F	P-value	F crit
Between groups	163.526	12	13.627	2.229	0.013	1.820
Within groups	874.083	143	6.112			
Total	1037.609	155				

Distribution of scorpions by districts varied depending on temperature, altitude, humidity, and habitat conditions. One of our targets is to show the correlation by giving the increase in the spring, the activation temperature and humidity measurements, which reach the highest level in July and August.

Populational status of scorpions were also parallel in the similar localities (Harran, Akçakale, and Eyyübiye) with the most appropriate habitat, temperature, and altitude for scorpions. In Siverek and Viranşehir districts where altitude is high and average temperature is lower, scorpion population was smaller. According to Koç and Yağmur (2007), it has been determined that the number of males is higher than females, the activity of females starts earlier in the year than males, and the activity of both sexes is at the highest level in August.

Average population density was found to be 1,85 individuals after population study conducted in 13 districts during a year within entire survey area. Evaluation of mean population by months revealed that while monthly average of June, July, August, and September was higher than overall average, other months remained below overall average. When mean population was assessed by districts, average value of Harran, Akçakale and Eyyübiye districts was greater than overall average (1,85), other districts had mean population lower than overall average. Ceylanpınar district displayed average population which is very close to overall average.

Significant differences were determined between districts of survey area in terms of population density (Table 1). These differences were found to be statistically significant. Considering the seasonal variation, statistically significant differences by months were revealed for scorpion population.

Scorpions live in dry and temperate regions, the number of species increases towards equator (Özkan and Karaer, 2007; Ramel, 2010; Kovarik, 2009; Rein, 2010).

During their past in the nature, scorpions has acquired various levels of adaptation under diverse ecological conditions (Navidpour et al., 2015). Scorpions are arthropods with medicinal importance that can survive in warm and dry environments, are classified within Arachnida class (Farzanpay, 1990). Therefore, ecological and climatic conditions are important parameters for distribution of scorpions. Şanlıurfa, the survey area with 19.451 km<sup>2</sup> of wide

surface area, is the 7th largest city of Turkey, has different districts that poses various biogeographical and ecological conditions. Thus, scorpion populations of the districts vary too. It was found that Harran, Akçakale, and Eyyübiye districts of Şanlıurfa were locations convenient for scorpions in terms of their ecological and climatic conditions and the largest scorpion population was found in these districts. Scorpion populations were smaller in the districts Siverek, Viranşehir, Halfeti, Karaköprü and Hilvan where climate is more harsh and ecological conditions are not suitable for scorpions. This was compatible with the literature data about distribution areas of scorpions (Özkan and Karaer, 2007; Ramel, 2010; Kovarik, 2009; Rein, 2010; Navidpour et al., 2015). *Androctonus crassicauda* (black scorpion) population was considerably variant by districts of Şanlıurfa. This difference was statistically significant (df:12, P=0,013).

It was found that *A. crassicauda* population displayed seasonal variation within the survey area (df 11, p= 0,002), population started to increase in May, reached to maximum size in July and August, declined beginning from October. These results were parallel to the findings of other studies conducted in Turkey (Özkan et al., 2006), Saudi Arabia (Jarrar et al., 2008) and Iran (Nazar and Hassan, 2016).

Overall average of the all individuals of *A. crassicauda* sampled from the survey area during a year and all of the districts was 1,8 individuals. Monthly average of June (4,5 individuals) July (5,4 individuals), August (5,5 individuals), and September (3,0 individuals) was far above the overall average, it was below overall average for the remaining months. By the districts of the survey area, average number of scorpions found in Harran (4,5), Eyyübiye (3,3), Akçakale (2,92), and Ceylanpınar (1,92) was higher than the overall average, on the other hand remaining districts were below overall average.

All scorpions have venomous sting and tens of thousands of people die because of scorpion sting every year. This mortality ratio is caused by approximately 25 species of scorpions, including the speies *A. crassicauda* (Keegan, 1980; Polis, 1990). Hazardous results of scorpion sting consist of severe and fatal hemolysis, acute renal failure, deep necrotic wound, severe rheumatoid arthritis, temporary and permanent psychosis, and death (Mohseni et al., 2013). Scorpion sting remains to be a crucial public

health problem within Şanlıurfa, the survey area, particularly during summer. Clinical findings and epidemic of scorpion sting was evaluated in terms of public health by (Özkan et al., 2006b) in Şanlıurfa province of Turkey for the first time. The relevant study revealed that all of the scorpions collected for identification of the species playing active role in scorpion sting within the region was *A. crassicauda* and scorpion sting cases occurred in August most (Özkan et al., 2006; Özkan, 2009). This result was compatible with our findings. As the result of this study, distribution of venomous *A. crassicauda* (black scorpion) was determined in the districts of Şanlıurfa and populational status was presented by months. Results of this study pose significant data for prevention of and avoiding from scorpion sting in Şanlıurfa province.

In Turkey, scorpion sting which is frequent particularly during summer is an important public health problem. Since people sleep outside, on the roof, and garden during summer in Şanlıurfa, they are always exposed to the risk of scorpion sting. It is necessary to take continuous precautions especially in months and habitats with abundance of scorpions. These precautions should be taken as physical, mechanical and chemical spraying.

As a result, people are vulnerable to scorpion stings, as there is intensive agriculture and livestock farming is practiced even in urban centers in many districts. As a result, people are vulnerable to scorpion stings, as there is intensive agriculture and livestock farming is practiced even in urban centers in many districts. Therefore, we think that *Androctonus crassicauda*, which is represented by a dense population in Şanlıurfa, should be protected in its distribution areas.

## ACKNOWLEDGEMENTS

The present study was derived from master thesis of Nevin Aslan. We would like to thank to Harran University Research Fund for funding this study (Project No: 17034).

## Statement of Conflict of Interest

Authors declare that there is no conflict of interest.

## Author's Contributions

The authors declare that they have contributed equally to the article.

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