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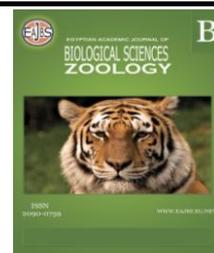


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## Survey and Morphological Studies on Scorpions Inhabiting New Valley Governorate, Egypt

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### ABSTRACT

The main objective of the present study is to make a survey on scorpion species inhabiting New Valley governorate, Egypt as well as to make some morphometric measurements on the recorded species and to design a key for the recorded species. To achieve the aims of the study, random samples were collected during the period from April to July, 2017 and from July to September, 2019. The study revealed the presence of four scorpion species belonging to family Buthidae namely: *Leiurus quinquestriatus*, *Androctonus amoreuxi*, *Orthochirus innesi* and *Buthacus leptochelys*. The study provides a key for the identification of the species and some morphometric measurements. The morphometric measurements included: Carapace length, Mesosoma length, Metasoma length, Telson length, Aculeus length, Vesicle length, Pedipalp femur length, Pedipalp patella length, Pedipalp chela length and total body length. The study revealed significant differences between the recorded four species. It also revealed significant differences between males and females of each species.

### INTRODUCTION

Scorpions are the old arachnids on the earth. Scorpions are the most successful terrestrial arthropods inhabiting deserts worldwide (Polis and Yamashita, 1991). Desert scorpion species show ecomorphological specialization, specific habitats and morphological adaptations to the substrates such as sand (Prendini, 2001). Santibáñez- López *et al* (2015) said that about 2300 species of scorpions are distributed worldwide. Scorpions are widely distributed in Africa, Europe, and Asia, especially in Arabian countries like Lebanon Jordan, Iraq, Syria and etc (Vachon, 1966).

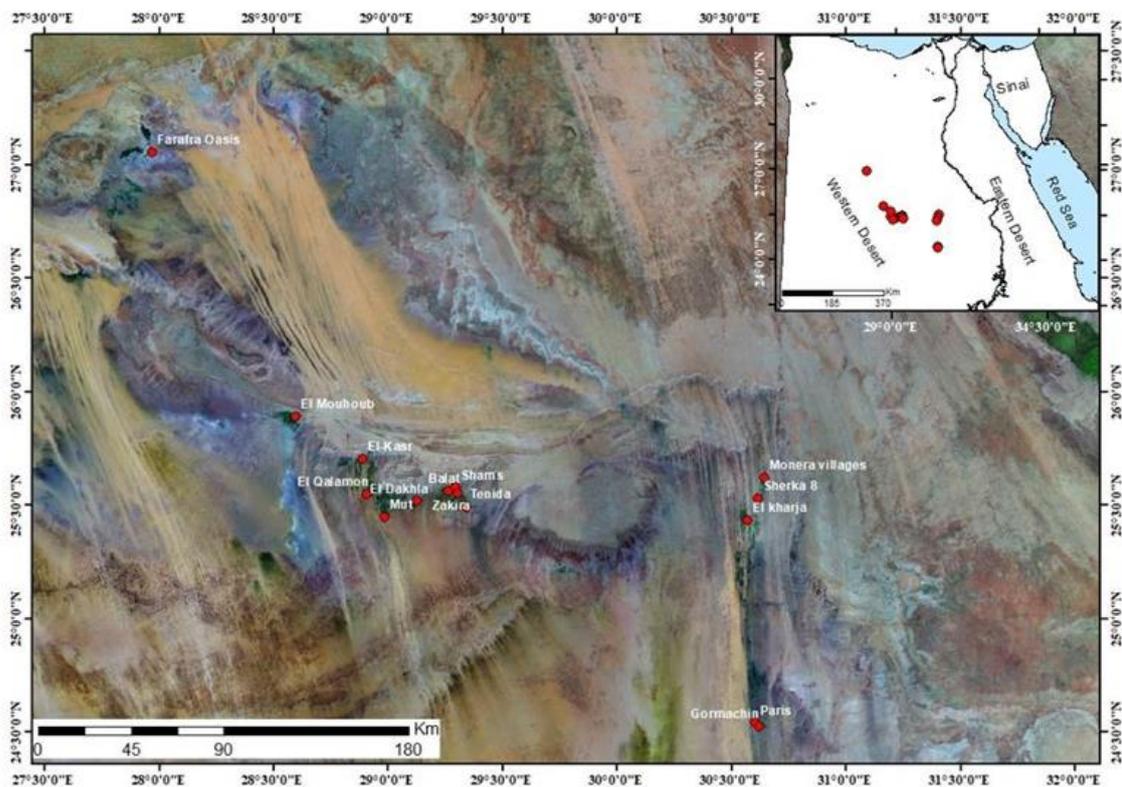
The classification of Class Arachnida is based on morphological characters, however, some researchers use techniques like DNA sequencing, to identify species, subspecies and varieties (Sissom, 1990). El- Hennawy (1992) indicated that about 31 species and subspecies of scorpions, 11 genera and 4 families are found in Egypt which includes the following families: - Buthidae, Scorpionidae, Diplocentridae and Euscorpidae (Chactidae). New Valley Governorate or El Wadi El Gedid Governorate is one of the governorates of Egypt. It is in the southwestern part of the country, in Egypt's Western Desert (part of the Sahara Desert), between the Nile, northern Sudan, and southeastern Libya. The governorate consists of

roughly half of Egypt's area, this spacious governorate is the country's largest and most sparsely populated, and one of the biggest subnational divisions on the African continent, as well as the world, about 440,098 square kilometres in area. The capital is at the Kharga Oasis. To the best of the present authors' knowledge, studies conducted on biodiversity on this governorate are very scarce in spite of its large area and the area still virgin in this respect. So, the present paper is a part of an integrated study to fulfill this gap. It was designed to make a survey on scorpions inhabiting the New Valley governorate, as well as to make some morphometric measurements on the recorded species and to design a key for the recorded species.

## MATERIALS AND METHODS

### Collecting:

Scorpions were collected randomly from different locations at New Valley, Egypt (Fig. 1), using forceps, then preserved in 100 % ethanol. The geological nature of the land differs from one place to another. So, the places of collection varied in topography which included, rock, sandy soil, loose sand, shale sand soils containing chalk and limestone in excess. These types of topography help scorpions to hide.



**Fig.1:** Location map of New Valley Governorate, Egypt showing the study areas of El Kharja, El Dakhla, Balat, Paris and Farafra Oasis.

The survey was carried out to cover different habitats including El Kharja (25.4390° N, 30.5586° E), El Dakhla (25.5167° N, 29.1667° E), Paris (24°40'29.45"N, 30°36'3.52"E), Balat (25°33'38.67"N, 29°15'56.12"E) and Farafra Oasis (27.0567° N, 27.9703° E), Sherka 8 (25°31'42.81"N, 30°36'53.22"E), Monera villages (25°37'18.40"N, 30°38'40.02"E), Gormachi (24°31'25.91"N, 30°37'8.37"E), El-Kasr (25°42'17.02"N, 28°53'15.80"E), Tenida (25°29'33.39"N, 29°20'25.04"E, El Qalamo (25°32'52.80"N, 28°54'27.80"E), Shams

(25°34'38.52"N. 29°17'34.57"E), Zakira (25°33'6.95"N. 29°18'19.16"E), Mout (25°26'50.37"N, 28°59'8.16"E) and El Mouhoub (25°53'21.76"N, 28°35'53.50"E) (Table 1).

**Table 1:** Sites of collection at New Valley Governorate, Egypt

Scientific name of Scorpions	Total number	Location
<i>Leiurus quinquestriatus</i>	♂ 50; ♀ 70	El Kharja (Sherka 8- Sherka 55- Gormachi and Monera villages) El Dakhla (El-Kasr-El Mouhoub-Mout) Paris
<i>Androctonus amoreuxi</i>	♂ 45; ♀ 60	El Dakhla (El-Kasr - Tenida)- Balat
<i>Orthochirus innesi</i>	♂ 15; ♀ 16	El Dakhla (El Qalamon) Balat (Shams- Zakira)
<i>Buthacus leptochelys</i>	♂ 15; ♀ 15	Paris -Farafra Oasis

#### Meteorological Information (Table 2):

Provided by the El Kharja Meteorological Institute. These parameters included rainfall (mm), relative humidity (%), maximum and minimum temperature of the air, wind speed (km/h), evaporation and soil temperature in New Valley Governorate, Egypt.

**Table 2:** Available meteorological data of New Valley Governorate, Egypt from Egyptian Meteorological Authority (El Kharja).

Month	Apr	May	Jun	Jul	Aug
Rainfall (mm)	0.00	0.00	0.00	0.00	0.00
Rel. Humidity (%)	28.00	23.33	25.33	25.67	29.00
M. Max. Temp. (°C)	34.83	38.83	40.80	42.20	41.07
M. Min. Temp. (°C)	17.76	22.37	27.60	26.03	26.13
Average Temp. (°C)	26.57	31.27	33.63	34.37	34.33
Wind speed (km/h)	5.933	6.100	6.33	4.83	5.60
Evap.	13.48	18.00	20.31	17.587	18.11
Soil Temp. (°C) at 10 cm	29.8	34.6	36.8	38.6	38.2

Evap. = evaporation, M. = mean, Max. = maximum, Min. =minimum, Rel. = relative, Temp = temperature

#### Identification of Scorpions:

Identification of scorpions was based on El-Hennawy (1987, 1992), and Badry *et al.* (2017).

#### Morphological Parameters Measured (Tables 3, 4):

Some morphological measurements were taken: Carapace length, Carapace width (anterior and posterior regions), Mesosoma length, Metasomal segments (I, II, III, IV, V), Metasoma length, aculeus length, Pedipalp (femur, patella, chela) and total body length (Fig. 4).

#### Statistical Analysis:

Statistical analyses were carried out using Prism program, version 3.0 (graph pad software, Inc, San Diego. CA.USA). Differences between means were tested using ANOVA, and Variation between different variables of four species of scorpions was evaluated using least significant difference (LSD), variables amongst the groups were considered significant if  $p < 0.05$ .

**Table 3:** Least significant difference (LSD) on mean values of different parameters measured for four collected species, <sup>abc</sup> mean values of different superscript litter in the same row differ significantly  $P < 0.05$ ,  $n = 30$ .

Scorpion Measurement	<i>Leiurus</i> <i>quinquestriatus</i>	<i>Androctonus</i> <i>amoreuxi</i>	<i>Orthochirus</i> <i>innesi</i>	<i>Buthacus</i> <i>leptocheilus</i>
	Mean±SD	Mean±SD	Mean±SD	Mean±SD
Carapace, length	0.8467±0.19605 <sup>a</sup>	0.8600 ±0.17734 <sup>a</sup>	0.3373±0.06475 <sup>b</sup>	0.4767±0.08584 <sup>c</sup>
Carapace, anterior width	0.5367±0.19561 <sup>a</sup>	0.4667± 0.08442 <sup>b</sup>	0.1923±0.04297 <sup>c</sup>	0.3167±0.07466 <sup>d</sup>
Carapace, posterior width	0.9767±0.28000 <sup>a</sup>	1.0733±0.23332 <sup>b</sup>	0.3933±0.07958 <sup>c</sup>	0.5867±0.16132 <sup>d</sup>
Mesosoma, length	2.3233±0.52370 <sup>a</sup>	2.0467± 0.46143 <sup>b</sup>	0.8067±0.18182 <sup>c</sup>	1.2700±0.24656 <sup>d</sup>
Metasomal segment I length	0.6100±0.1348 <sup>a</sup>	0.5567 ±0.11943 <sup>b</sup>	0.1717±0.06737 <sup>c</sup>	0.3600±0.06215 <sup>d</sup>
Metasomal segment I width	0.440±0.09322 <sup>a</sup>	0.4867 ±0.13322 <sup>b</sup>	0.1950±0.03003 <sup>c</sup>	0.2433±0.05683 <sup>d</sup>
Metasomal segment II length	0.7067±0.14606 <sup>a</sup>	0.6667 ±0.14464 <sup>a</sup>	0.2297±0.04944 <sup>b</sup>	0.4433±0.08172 <sup>c</sup>
Metasomal segment II width	0.4033±0.07649 <sup>a</sup>	0.4900 ±0.13983 <sup>b</sup>	0.2307±0.04218 <sup>c</sup>	0.2333±0.05467 <sup>d</sup>
Metasomal segment III length	1.0133±1.51492 <sup>a</sup>	0.7433 ±0.16543 <sup>a</sup>	0.2740±0.06072 <sup>b</sup>	0.4767±0.11351 <sup>c</sup>
Metasomal segment III width	0.3600±0.09322 <sup>a</sup>	0.4933 ±0.14126 <sup>b</sup>	0.2713±0.06912 <sup>c</sup>	0.2100±0.05477 <sup>d</sup>
Metasomal segment IV length	0.8633±0.15196 <sup>a</sup>	0.8633±0.18659 <sup>a</sup>	0.3220±0.06504 <sup>b</sup>	0.4933±0.10483 <sup>c</sup>
Metasomal segment IV width	0.3067±0.07397 <sup>a</sup>	0.4300±.14890 <sup>b</sup>	0.3110±0.06870 <sup>a</sup>	0.1550±0.04974 <sup>c</sup>
Metasomal segment V length	0.9833±0.19491 <sup>a</sup>	0.9800±0.19010 <sup>a</sup>	0.3943±0.08365 <sup>b</sup>	0.6100±0.12134 <sup>c</sup>
Metasomal segment V width	0.2800±0.05509 <sup>a</sup>	0.3833±0.14162 <sup>b</sup>	0.3237±0.06403 <sup>c</sup>	0.1483±0.04997 <sup>d</sup>
Metasomal length	3.9967±0.76945 <sup>a</sup>	3.9267±0.74968 <sup>a</sup>	1.5700±0.25884 <sup>b</sup>	2.5600±0.58640 <sup>c</sup>
Aculeus length	0.5400±0.17140 <sup>a</sup>	0.5633±0.21413 <sup>a</sup>	0.2560±0.10108 <sup>b</sup>	0.3900±0.17090 <sup>c</sup>
Vecicle length	0.3900±0.10619 <sup>a</sup>	0.4267±.09072 <sup>b</sup>	0.1747±0.05063 <sup>c</sup>	0.2367±0.09279 <sup>d</sup>
Pedipalp, femur length	0.8233±0.16955 <sup>a</sup>	0.7000±0.18754 <sup>b</sup>	0.2877±0.09526 <sup>c</sup>	0.5400±0.19226 <sup>d</sup>
Pedipalp, patella length	0.9567±0.13309 <sup>a</sup>	0.2740±0.06905 <sup>b</sup>	0.2903±.07049 <sup>c</sup>	0.4733±0.10807 <sup>d</sup>
Pedipalp, chela length	1.1933±0.64001 <sup>a</sup>	1.4167±0.38335 <sup>b</sup>	0.4353±0.08748 <sup>c</sup>	0.6800±0.16897 <sup>d</sup>
Total body length	7.7933±1.49941 <sup>a</sup>	7.6467±1.54691 <sup>a</sup>	2.9833±0.52133 <sup>b</sup>	4.7933±0.72679 <sup>c</sup>

**Table 4:** Mean and standard deviation (Mean  $\pm$  SD) of different parameters measured of male and female of four collected species, (n= 30) individual (15males 15 females) in each species.

Scorpion Measurement	<i>Leiurus quinquestriatus</i>		<i>Androctonus amoreuxi</i>		<i>Orthochirus innesi</i>		<i>Buthacus leptochelys</i>	
	Male	Female	Male	Female	Male	Female	Male	Female
	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD	Mean $\pm$ SD
Carapace length	0.73 $\pm$ 0.17	0.96 $\pm$ 0.15	0.81 $\pm$ 0.17	0.91 $\pm$ 0.18	0.33 $\pm$ 0.07	0.35 $\pm$ 0.06	0.47 $\pm$ 0.07	0.48 $\pm$ 0.10
Carapace (anterior width)	0.45 $\pm$ 0.09	0.63 $\pm$ 0.23	0.43 $\pm$ 0.06	0.50 $\pm$ 0.09	0.19 $\pm$ 0.06	0.19 $\pm$ 0.03	0.28 $\pm$ 0.07	0.35 $\pm$ 0.06
Carapace (posterior width)	0.78 $\pm$ 0.25	1.17 $\pm$ 0.14	0.96 $\pm$ 0.19	1.19 $\pm$ 0.22	0.39 $\pm$ 0.08	0.39 $\pm$ 0.08	0.56 $\pm$ 0.12	0.61 $\pm$ 0.20
Mesosomal length	1.95 $\pm$ 0.34	2.69 $\pm$ 0.40	1.84 $\pm$ 0.35	2.25 $\pm$ 0.48	0.79 $\pm$ 0.21	0.82 $\pm$ 0.16	1.29 $\pm$ 0.27	1.25 $\pm$ 0.23
Metasomal segment I length	0.55 $\pm$ 0.14	0.67 $\pm$ 0.10	0.52 $\pm$ 0.09	0.59 $\pm$ 0.13	0.18 $\pm$ 0.05	0.17 $\pm$ 0.08	0.37 $\pm$ 0.06	0.35 $\pm$ 0.07
Metasomal segment I width	0.43 $\pm$ 0.10	0.45 $\pm$ 0.09	0.44 $\pm$ 0.09	0.53 $\pm$ 0.15	0.19 $\pm$ 0.04	0.20 $\pm$ 0.01	0.21 $\pm$ 0.03	0.28 $\pm$ 0.06
Metasomal segment II length	0.65 $\pm$ 0.16	0.76 $\pm$ 0.12	0.61 $\pm$ 0.11	0.73 $\pm$ 0.15	0.24 $\pm$ 0.06	0.22 $\pm$ 0.04	0.45 $\pm$ 0.06	0.44 $\pm$ 0.11
Metasomal segment II width	0.38 $\pm$ 0.07	0.43 $\pm$ 0.08	0.45 $\pm$ 0.09	0.53 $\pm$ 0.17	0.21 $\pm$ 0.05	0.25 $\pm$ 0.03	0.21 $\pm$ 0.03	0.26 $\pm$ 0.06
Metasomal segment III length	0.67 $\pm$ 0.14	1.35 $\pm$ 2.12	0.69 $\pm$ 0.11	0.80 $\pm$ 0.19	0.27 $\pm$ 0.08	0.28 $\pm$ 0.04	0.47 $\pm$ 0.06	0.48 $\pm$ 0.15
Metasomal segment III width	0.50 $\pm$ 0.07	0.42 $\pm$ 0.08	0.46 $\pm$ 0.10	0.53 $\pm$ 0.17	0.26 $\pm$ 0.07	0.29 $\pm$ 0.07	0.21 $\pm$ 0.03	0.21 $\pm$ 0.07
Metasomal segment IV length	0.78 $\pm$ 0.15	0.95 $\pm$ 0.11	0.79 $\pm$ 0.12	0.93 $\pm$ 0.22	0.31 $\pm$ 0.08	0.33 $\pm$ 0.05	0.51 $\pm$ 0.09	0.48 $\pm$ 0.12
Metasomal segment IV width	0.27 $\pm$ 0.06	0.34 $\pm$ 0.07	0.42 $\pm$ 0.14	0.44 $\pm$ 0.16	0.27 $\pm$ 0.05	0.35 $\pm$ 0.06	0.12 $\pm$ 0.04	0.19 $\pm$ 0.04
Metasomal segment V length	0.89 $\pm$ 0.22	1.07 $\pm$ 0.12	0.90 $\pm$ 0.13	1.06 $\pm$ 0.21	0.37 $\pm$ 0.09	0.42 $\pm$ 0.07	0.63 $\pm$ 0.10	0.59 $\pm$ 0.14
Metasomal segment V width	0.27 $\pm$ 0.06	0.29 $\pm$ 0.05	0.34 $\pm$ 0.13	0.43 $\pm$ 0.14	0.29 $\pm$ 0.05	0.36 $\pm$ 0.06	0.11 $\pm$ 0.03	0.19 $\pm$ 0.04
Metasoma length	3.65 $\pm$ 0.79	4.35 $\pm$ 0.58	3.61 $\pm$ 0.47	4.25 $\pm$ 0.85	1.53 $\pm$ 0.30	1.61 $\pm$ 0.22	2.51 $\pm$ 0.36	2.61 $\pm$ 0.76
Aculeus length	0.45 $\pm$ 0.13	0.63 $\pm$ 0.16	0.53 $\pm$ 0.13	0.59 $\pm$ 0.28	0.25 $\pm$ 0.11	0.26 $\pm$ 0.09	0.38 $\pm$ 0.12	0.40 $\pm$ 0.21
Vesicle length	0.33 $\pm$ 0.08	0.45 $\pm$ 0.09	0.40 $\pm$ 0.09	0.45 $\pm$ 0.08	0.18 $\pm$ 0.04	0.17 $\pm$ 0.06	0.23 $\pm$ 0.08	0.25 $\pm$ 0.11
Telson length	0.77 $\pm$ 0.18	1.09 $\pm$ 0.24	0.93 $\pm$ 0.184	1.05 $\pm$ 0.28	0.43 $\pm$ 0.15	0.43 $\pm$ 0.13	0.61 $\pm$ 0.19	0.65 $\pm$ 0.31
Pedipalp femur length	0.76 $\pm$ 0.18	0.89 $\pm$ 0.13	0.63 $\pm$ 0.13	0.77 $\pm$ 0.21	0.30 $\pm$ 0.11	0.28 $\pm$ 0.09	0.48 $\pm$ 0.14	0.60 $\pm$ 0.22
Pedipalp patella length	0.88 $\pm$ 0.11	1.03 $\pm$ 0.10	0.69 $\pm$ 0.13	0.85 $\pm$ 0.21	0.27 $\pm$ 0.07	0.31 $\pm$ 0.07	0.47 $\pm$ 0.08	0.48 $\pm$ 0.13
Pedipalp chela length	1.09 $\pm$ 0.62	1.29 $\pm$ 0.67	1.29 $\pm$ 0.37	1.55 $\pm$ 0.36	0.40 $\pm$ 0.10	0.47 $\pm$ 0.06	0.67 $\pm$ 0.13	0.69 $\pm$ 0.20
Total body length	6.93 $\pm$ 1.35	8.65 $\pm$ 1.12	7.02 $\pm$ 1.08	8.27 $\pm$ 1.72	2.83 $\pm$ 0.57	3.14 $\pm$ 0.43	4.81 $\pm$ 0.58	4.77 $\pm$ 0.87

## RESULTS

The study revealed that four species of scorpions were found at New Valley Governorate.

**1. *Leiurus quinquestriatus*:** Fig. 2 (a, b):

*Leiurus quinquestriatus* (Ehrenberg, 1828).

Its common name is the death stalker. The mean of the total length of male= 6.93  $\pm$  1.35 cm while female= 8.65  $\pm$  1.12 cm. Its color is orange-yellow. Prosomal carapace and metasoma segment V with dark coloration. It has a relatively elongated chela. Vesicle has a yellow color with brown aculeus at the end. It was collected from El Kharja (Sherka 8-Sherka 55- Gormachin and Monera villages) El Dakhla (El-Kasr-El Mouhoub)-Mout Paris (Table 1).

**2- *Androctonus amoreuxi*:** Fig. 2 (c, d):

*Androctonus amoreuxi* Audouin (1825), *Scorpio amoreuxi* (African fat tail scorpion).

Its common name is the yellow scorpion. The mean of total length of male=  $7.02 \pm 1.08$  cm and in female=  $8.27 \pm 1.72$  cm. Its color is generally brownish-yellow with a darker prosomal carapace. Metasomal segments are yellowish. Legs are yellow in color. Aculeus, in the end, is reddish and black. This species was collected from El Dakhla (El-Kasr - Tenida)-Balat (Table 1).

**3- *Orthochirus innesi*:** Fig. 2 (e, f):

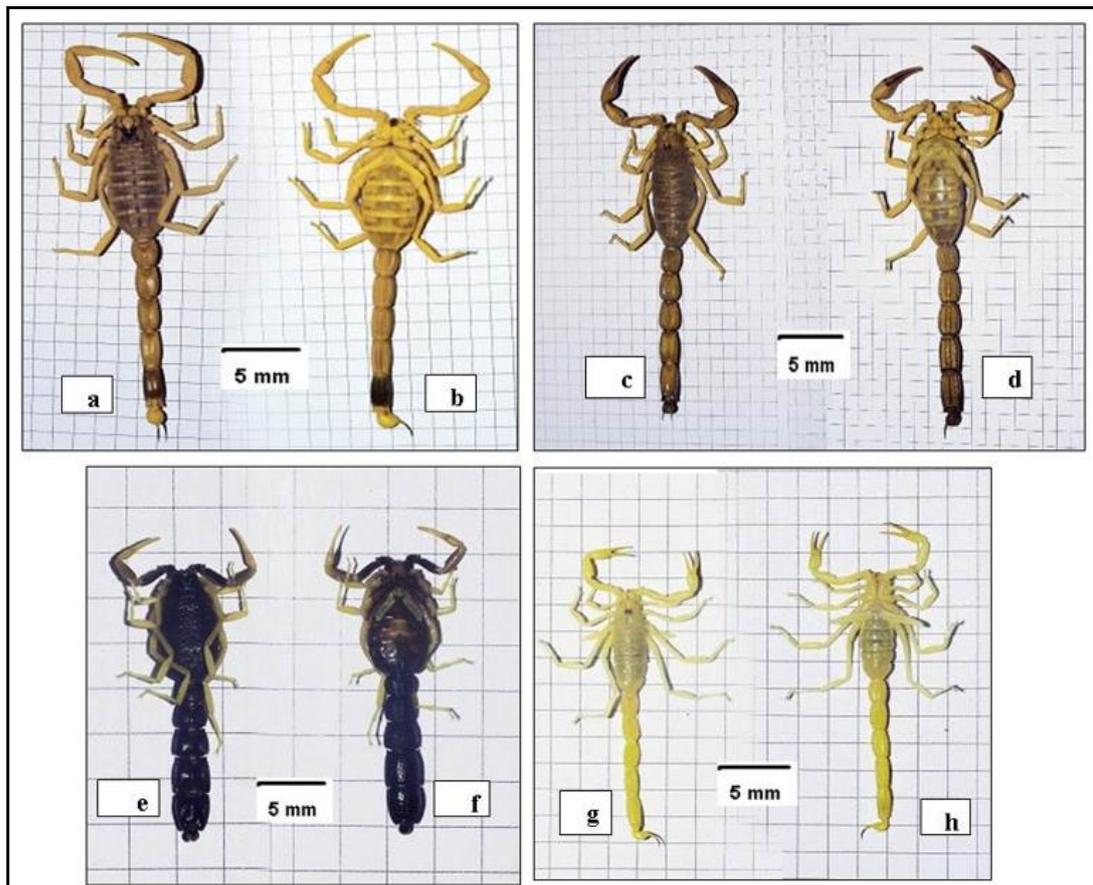
*Orthochirus innesi* Simon, (1910).

Its common name is the Egyptian pillar tailed scorpion or dwarf scorpion because it is a relatively very small scorpion. The mean of total length of male=  $2.83 \pm 0.57$  cm and in female=  $3.14 \pm 0.43$  cm. Its color is black on the dorsal side and blackish-green or yellowish-brown on the ventral side. Telson brown in color. The legs and chela have a yellow color. Metasomal segments IV and V punctate and relatively broader than segments I, II, III. The vesicle of telson punctate. It has an elongated and not bulbous vesicle. This species was collected from El Dakhla (El Qalamon) and Balat (Shams- Zakira) (Table 1).

**4- *Buthacus leptochelys*:** Fig. 2 (g, h):

*Buthacus leptochelys* (Ehrenberg, 1828).

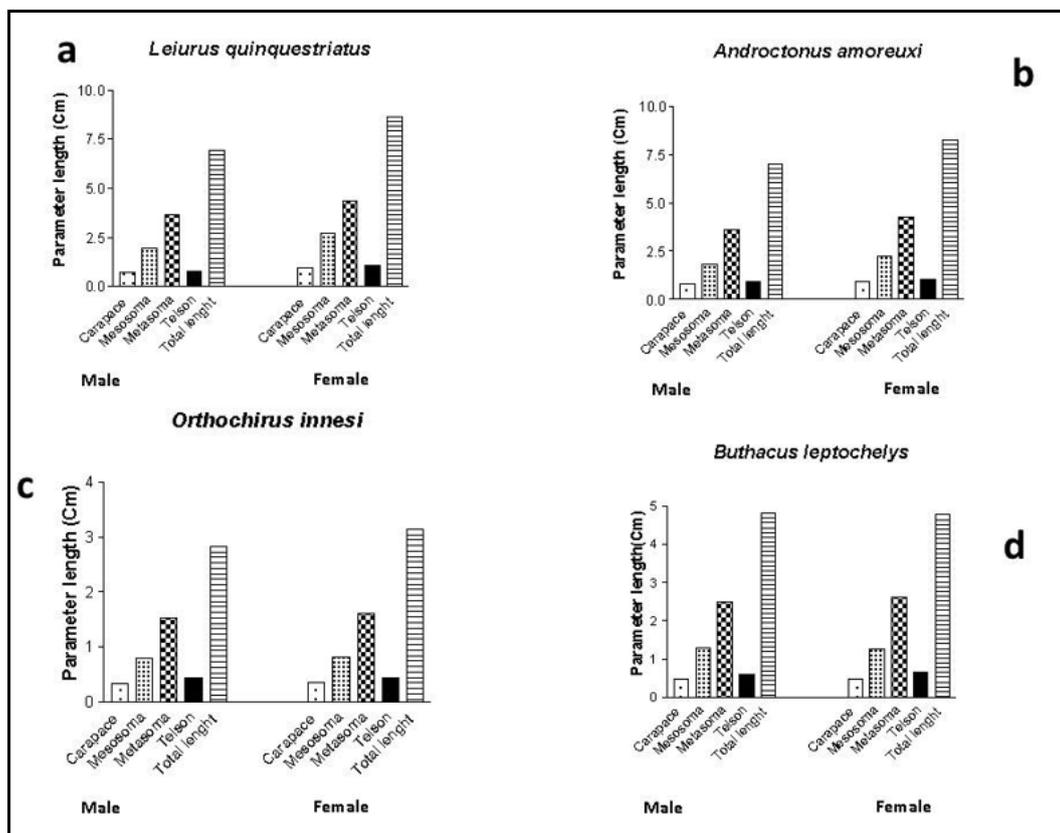
The mean of total length of male=  $4.81 \pm 0.58$  cm and in female=  $4.77 \pm 0.87$  cm. Its color is yellowish and with green color mesosoma. The carapace of this species has a densely granulated anterior median eye. Telson is brown in color and long curved aculeus than a vesicle. This species was collected from Paris - Farafra Oasis (Table 1).



**Fig. 2:** a: Dorsal view, b: Ventral view of *Leiurus quinquestriatus*. c: Dorsal view, d: Ventral view of *Androctonus amoreuxi*. e: Dorsal view, f: Ventral view of *Orthochirus innesi*. g: Dorsal view, h: Ventral view of *Buthacus leptochelys*.

**Applying Statistical Analysis Between Means of Different Parameters Measured, It Could Be Concluded:**

- There are significant differences between *Leiurus quinquestriatus* and *Androctonus amoreuxi* in all parameters except in (carapace length – metasomal segment II, III, IV, metasomal segment V length – metasomal length – aculeus length – total body length) (Table 3).
  - There are significant differences between *Leiurus quinquestriatus* and *Orthochirus innesi* in all parameters except in (metasomal segment IV width) (Table 3).
  - There are significant differences between *Leiurus quinquestriatus* and *Buthacus leptochelys* in all parameters (Table 3).
  - There are significant differences between *Androctonus amoreuxi* and *Orthochirus innesi* in all parameters (Table 3).
- There are significant differences between *Androctonus amoreuxi* and *Buthacus leptochelys* in all parameters (Table 3).
- There are significant differences between *Orthochirus innesi* and *Buthacus leptochelys* in all parameters (Table 3).
- In general, females of the four species of scorpions are longer than males in most parameters (Fig. 3) (Table 4).



**Fig. 3:** Some morphological parameters measured of scorpions.

Table (5) shows the frequency of occurrence of scorpion species at different locations. According to the system adopted by Weis-Fogh (1948) which depends on the percentage of occurrence of the species at different locations he classified species into three categories as follows:

Constant species: > 50%, accessory species: present in 20% - 50% and accidental species: less than 20%. So, *Leiurus quinquestriatus* (47.1 %) and *Androctonus amoreuxi* (23.5 %) are

accessory species while the other two species *Orthochirus innesi* (17.6 %) and *Buthacus leptochelys* (11.8 %) are accidental species (Table 6).

**Table 5:** Occurrence of different scorpion species at different sites during the period of collection.

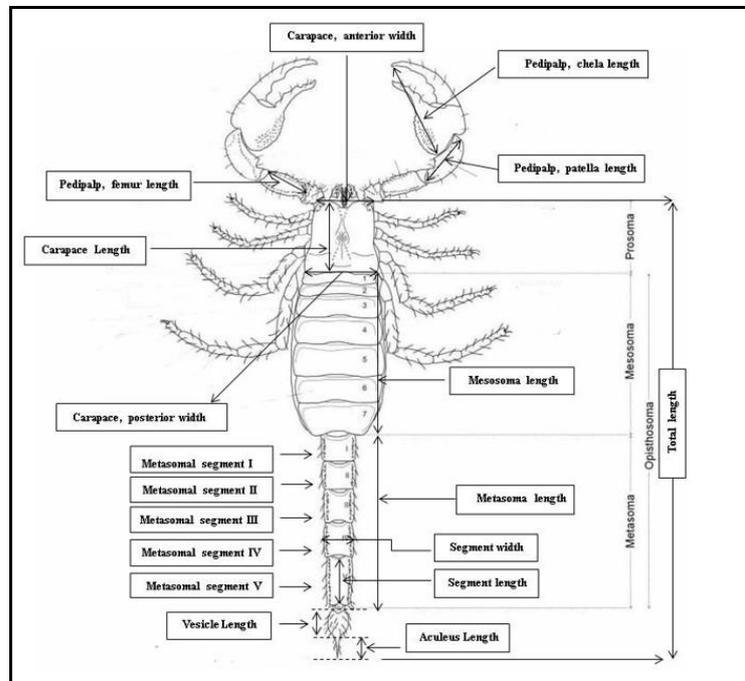
Scorpions species	El- Kharja				El-Dakhla					Balat		Paris	Farafra Oasis
	Sherka 8	Sherka 55	Gormachi	Monera Villages	El- Kasr	El- Mouhoub	El- Qalamon	Tenida	Mout	Shams	Zakira		
<i>Leiurus quinquestriatus</i>	+	+	+	+	+	+	-	-	+	-	-	+	-
<i>Androctonus amoreuxi</i>	-	-	-	-	+	-	-	+	-	+	+	-	-
<i>Orthochirus innesi</i>	-	-	-	-	-	-	+	-	-	+	+	-	-
<i>Buthacus leptochelys</i>	-	-	-	-	-	-	-	-	-	-	-	+	+

**Table 6:** Frequency of occurrence and percentages of different scorpion species during the period of study

Scorpions species	Frequency (F)	Percentage %
<i>Leiurus quinquestriatus</i>	8	★★★ 47.1 %
<i>Androctonus amoreuxi</i>	4	★★★ 23.5 %
<i>Orthochirus innesi</i>	3	★ 17.6 %
<i>Buthacus leptochelys</i>	2	★ 11.8 %
Total	17	

★★★ Accessory species

★ Accidental species



**Fig. 4:** Diagram showing different morphometric measurements taken for different scorpion species.

**Identification key to collected scorpions of New Valley, Egypt:**

1. Mesosoma: anterior (1<sup>st</sup> & 2<sup>nd</sup>) tergites with five crests ..... *Leiurus quinquestriatus* (Ehrenberg, 1828)



After El-Hennawy, 1987

-. Mesosoma: anterior (1<sup>st</sup> & 2<sup>nd</sup>) tergites with three crests or without crests ..... 2

2. Mesosoma: tergal crests distinct ..... *Androctonus amoreuxi* (Audouin, 1825)

-. Mesosoma: tergal crests indistinct or absent ..... 3

3. Metasoma: posterior segments with small depressions; Prosoma without crests but with deep depressions ..... *Orthochirus innesi* Simon, 1910.



After El-Hennawy, 1987

-. Metasoma: posterior segments without small depressions; Prosoma smooth .....

*Buthacus leptochelys* (Ehrenberg, 1829).

**DISCUSSION**

The survey of scorpions in the present study revealed the presence of four scorpion species belonging to four genera namely: *Leiurus*, *Androctonus*, *Orthochirus* and *Buthacus* which belong to the family Buthidae. Also, it showed the distribution of the recorded species at the New Valley, Egypt. According to the system adopted by Weis Fogh (1948) and followed by Hussein (1972), Obuid-Allah (2000), Abd Elwakeil (2005), Al Sanabani (2008) and Ramzy (2009) as follows: - Constant species: present in more than 50% of samples. Accessory species present in 20–50% of samples. Accidental species present in less than 20% of samples. Accordingly, no constant species of scorpions were detected in the present study while two accessory species were found namely: *Leiurus quinquestriatus* and *Androctonus amoreuxi*. The accidental species included two species namely *Orthochirus innesi* and *Buthacus leptochelys*. It is worthy to mention that *Leiurus quinquestriatus* is the most widespread species where it was found at: El Kharja (Sherka 8- Sherka 55- Gormachi and Monera villages), El Dakhla (El-Kasr-El Mouhoub), Mout and Paris. *Androctonus amoreuxi* was recorded at El Dakhla (El-Kasr - Tenida) and Balat. *Orthochirus innesi* was recorded at El Dakhla (El Qalamon) and Balat (Shams- Zakira). *Buthacus leptochelys* was found at Paris and Farafra Oasis. Badry *et al* (2017) recorded *Leiurus quinquestriatus* (Ehrenberg, 1828) in the New Valley at Farafra, Dakhla, Kharga, Baris, Abu Mingar. Also, he found the same species at different locations in Egypt which included: El-Dabaa, Gabal El-Maghara, Siwa, Wadi El-Natron, Eastern and western of Nasser Lake, Faiyum, Wadi Al-Tarfa, Wadi Nekheil, Wadi Halos, Wadi El Ranga, Wadi Khodaa, Bir Abra, Wadi El Rahaba, Abu Saafa, El Garf, Wadi El-De'ib, Gebel Elba, Wadi Aydeib, El Naqab desert, Wadi ElShafalah. On the other side, Saleh *et al* (2017) found *Leiurus quinquestriatus*, in the Western Mediterranean Coastal desert; Sinai Mediterranean coastal desert; Western inland desert; Nile Valley and Delta; Eastern inland desert and Sinai inland desert. Badry *et al* (2017) found *Androctonus amoreuxi* (Audouin, 1826), in the New Valley at Farafra, Dakhla. Also, he found the same species at different locations in Egypt which included: Siwa, Bahariya, Ghobet El Bous, Wadi El Ranga, Wadi El-De'ib, Ain Khodra. On the other side, Saleh *et al* (2017) recorded *Androctonus amoreuxi* in Western Mediterranean coastal desert; Sinai Mediterranean coastal desert; Western inland desert; Nile Valley and Delta; Eastern inland desert and Sinai inland desert. Badry *et al*. (2017) recorded *Orthochirus innesi* Simon, 1910 in the New Valley at Farafra. Also, he found the same species at different locations in Egypt which included: Siwa and Bahrain. On the other side, Saleh *et al* (2017) found *Orthochirus innesi* in the Western Mediterranean coastal desert; Western inland desert; Delta and Eastern inland desert. Badry *et al*. (2017) recorded *Buthacus leptochelys* (Ehrenberg,

1828) in the New Valley at Farafra, Kharga. Also, he found the same species at different locations in Egypt which included: Marsa Matruh, El-Dabaa, Wadi El-Natron, Wadi El Rayan, Bahariya, Faiyum, Wadi El Ranga, Bir Abra, Abu Saafa, Abu Ramad. On the other side, Saleh *et al* (2017) detected *Buthacus leptochelys*, in the Western Mediterranean Coastal Desert; Sinai Mediterranean Coastal Desert; Western Inland Desert; Nile Valley and Delta and Eastern Inland Desert.

In the present study some morphometric parameters were measured for the recorded scorpion species. Comparing the present results of the species *Leiurus quinquestriatus* with those measured by Lourenço *et al* (2006) for one male collected from Omdurman, Sudan, it could be concluded that nearly all studied morphometric parameters are the same as that measured by the above authors, where he recorded that total length = 6.8, Carapace length 0.82, Carapace anterior width 0.57, Carapace posterior width 0.92, Metasomal segment I length 0.62, Metasomal segment I width 0.49, Metasomal segment V Length 0.99, Metasomal segment V Width 0.34, Pedipalp Femur length 0.9, Pedipalp Patella length 1.02, Pedipalp Chela length 1.63, Vesicle width 0.35. On the other side, Ali (2013) studied some morphometric parameters in both male and female of *Leiurus quinquestriatus* (n= 40), collected from 4 locations in Egypt (Suize, Wahat, Aswan and South Saini). Comparing the results with those measured by the above author, it could be concluded that different morphometric parameters measured for males in the present study are nearly the same as those recorded by the above author while those recorded for females in the present study are comparatively higher than those measured by him. These differences could be due to that nearly all measured female specimens in the present study were carrying juveniles. He recorded the following measurements for male and female: total length= 7.2 in male and 6.8 in female, Carapace length (Anterior width) 0.46 and 0.44; respectively, carapace length (Posterior width) 0.72 and 0.68; respectively, metasomal I 0.53 and 0.49; respectively, metasomal II 0.42 and 0.3; respectively, metasomal III 0.42 and 0.41; respectively, metasomal IV 0.42 and 0.4; respectively, metasomal V 0.42 and 0.41; respectively, total length of telson 0.83 and 0.82; respectively, total length of pedipalp 3.34 and 3.35 respectively, pedipalp femur length 3.22 and 3.21; respectively, pedipalp patella length 0.76 and 0.75; respectively.

Seiter and Turiel (2013) studied some morphological parameters of two females of *Androctonus amoreuxi* from 2 locations in Egypt (Gizeh and Aswan). Comparing the present results with that of the above authors, one can conclude that the morphometric measurements of the present study are relatively lower than that measured by the above authors where they recorded the following measurements: total length= 0.4, carapace length 1.2, carapace anterior width 0.69, carapace posterior width 1.4, metasomal segment I length 0.82, metasomal segment I width 0.75, metasomal segment IV length 1.08, metasomal segment IV width 0.71, metasomal segment V length 1.2, metasomal segment V width 0.55, telson length 1.12, vesicle width 0.47, pedipalp femur length 0.86, pedipalp patella length 1.1, pedipalp chela length 1.7. Lourenço and Leguin (2011) investigated some common morphometric parameters of two females of *Orthochirus innesi* in Egypt (Wadi Degla, El-Omayed Protectorate west of Alexandria). They recorded that total length= 2.8, carapace length 0.34, carapace anterior width 0.25, carapace posterior width 0.48, metasoma, segment I length 0.21 metasoma, segment I width 0.32, metasoma, segment V length 0.4 metasoma, segment V width 0.35, telson length 0.36, femur length 0.27, patella length 0.33, chela length 0.47. Comparing the results of the above authors with the present results, it could be concluded that the majority of the morphometric measurements recorded in the present study are nearly the same as those measured by the above authors with some deviations. Lourenço (2006) described the new subspecies *Buthacus leptochelys algerianus* from Algeria (Beni-Abbès, Algerian Sahara). He recorded some morphometric parameters: total length 4.3 and 4.4;

respectively, carapace length 0.51 and 0.52; respectively, anterior width 0.32 and 0.32; respectively, posterior width 0.54 and 0.57; respectively metasomal segment I length 0.41 and 0.43; respectively, metasomal segment I width 0.31 and 0.32; respectively, metasomal segment V length 0.63 and 0.62; respectively, metasomal segment V width 0.22 and 0.23; respectively, vesicle width 0.17 in both male and female, pedipalp femur length 0.48 and 0.43; respectively, pedipalp patella length 0.56 and 0.54; respectively, chela length 0.81 and 0.76; respectively. Comparing the present morphometric measurements recorded in the present study with those measured above by Lourenço (2006) for the same species, one can conclude that most measurements were relatively lower than those measured by the above author. The differences in the morphometric measurements recorded between the studied species compared with the above-mentioned studies could be attributed to the number of the examined specimens in the above studies or could be attributed to the habitat from which specimens were collected.

The present results indicated that morphometric differences exist between the four recorded species and between males and females of the same or different species. In general, females of the four species of scorpions are longer than males in most parameters.

The present study showed significant differences between *Leiurus quinquestriatus* and *Orthochirus innesi* in all parameters except in metasomal segment IV width. The study showed significant differences between *Leiurus quinquestriatus* and *Buthacus leptochelys*, between *Androctonus amoreuxi* and *Orthochirus innesi*, between *Androctonus amoreuxi* and *Buthacus leptochelys*, between *Orthochirus innesi* and *Buthacus leptochelys* in all parameters.

In conclusion, measurements of morphometric parameters of scorpion species at New Valley showed variety in the measured morphometric measurements between male and female and it showed also a significant difference between different species of scorpions at New Valley in Egypt.

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