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Population Dynamics of Terrestrial Spiders (Arachnida) at Qena Governorate, Upper Egypt

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Abstract: In the present study, monthly and seasonal fluctuations of densities of terrestrial spiders were recorded in six different sites at Qena Governorate during the period of one year (February, 2012 - January, 2013). The study revealed the occurrence of 1247 specimens belonging to 14 families and including 23 species of order Araneae. Family Salticidae recorded the highest number during the whole period of study (278 specimens) while family Agelenidae recorded the lowest number in the same period of study (4 specimens). It was observed that the maximal number was collected from Thanatus albini (199 specimens), while Halodromus barbarae was the least species in number since only 2 specimens were collected. The densities of the recorded spiders varied seasonally and the general seasonal peak was recorded during autumn (363 specimens), while the lowest density was observed during winter (215 specimens). Regarding the sex ratio of the collected spiders from all sites, it was clear that there were 213 adult male specimens, whereas the adult females were represented by 440 specimens. Ecological factors which may influence the distribution of the recorded spiders were also recorded; Air temperature (oC), relative humidity (%), evaporation (mm) and wind velocity (Knots).
Keywords: Spiders, Population dynamics, Qena governorate, Upper Egypt.

1 Introduction

Spiders are members of the phylum Arthropoda, the large group of animals with jointed legs and a hard outer skeleton. They belong, more specifically to class Arachnida, which includes animals with four pairs of legs, no antennae or wings, and only two body regions; a cephalothorax which contains (the brain, poison glands and stomach) carapace, sternum, eyes, chelicerae, mouthparts, legs and palps) and the abdomen (spinnerets, genitalia, lungs and respiratory tracheae) [1].

Spiders are the most abundant insectivorous predators of terrestrial ecosystems [2,3,4]. Spiders are among the highest ranked predators in food chains, and their phenology and community structures are closely affected by disturbance and vegetation structures compared with species inhabiting undisturbed temperate areas. Species in habitats subjected to a high level of disturbance tend to have more than one generation per year [5,6]. Habitats exhibiting a higher level of spatial heterogeneity are associated with high abundance and species richness of spiders [7,8].

The importance of spider predation in regulating specific prey populations is controversial [9, 2]. However, there are some studies that suggest a significant control of specific prey populations by an assemblage of spiders [10, 11]. In the form of a multi-specific assemblage, spiders live in different habitats and present different body dimensions and predatory behaviors, all of which increase the probability of encountering potential prey. Many researchers have provided descriptions of spider species abundance or composition in a variety of agro ecosystems [12]. Other researchers provided quantitative observations on the abundance of spiders [13] or recorded spider predation events [11].

Concerning diversity; spiders have been reported to occur in peak numbers of more than 1,000 individuals per m^2 [14]. At the same time, they are one of the most diverse arthropod orders and exhibit a great variety of foraging strategies [15,16]. The spiders' diet is made up primarily of insects from various taxa, and also of other spiders [17]. Eggs, larvae, and adults of many different insect pests are

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eaten by spiders [18,19,20]. Because of their high abundance and insectivorous feeding habits, spiders are suspected of playing an important role in the balance of nature [18,21,22,20,3,23,24].

On reviewing literature that focused on the Egyptian spider fauna, it could be concluded that it stills incompletely known due to scarcity of studies on this group especially in Upper Egypt. So, the present work was focused on Qena Governorate (26.170 N, 32.70 E) to study population dynamics of spiders in different habitats of this region as well as effects of some physical factors on the abundance of the collected taxa.

2 Material and Methods

In the present study, samples were collected every 2 weeks during a period of one year (from February, 2012 till January, 2013) from different six sites. These sites were chosen to cover all parts of Qena governorate and illustrated in the map (Fig.1). Three sampling methods were used in the present study as follows; hand pick-up, sweep net and pitfall trap. Specimens of collected spiders were put in a 10 centimeters diameter Petri-dish filled with 70% ethyl alcohol. Examination was carried out with the aid of binocular stereomicroscope. Specimens were labeled for: date, habitat, locality, trapping method by a pencil on a slip of paper attached to specimen inside the preserved tube. The collected specimens were identified to the species level whenever possible and others on genus or family level. Identification of the specimens was done by the help of the following keys, description, catalogues and literature; [25,26,27,28,15, 29,30,31,32,33,34,35,36,37] and finally, species identification was confirmed by Mr. H. K. El-Hennawy the expert in spider's identification in Egypt. The recorded data of the weather parameters included temperature (oC), relative humidity (%), evaporation (mm) and wind velocity (Knots), which labeled as (Tmin, Tmax, R.H.min, R.H.max, Evab. And W.V.), were obtained from South Valley University-meteorological research station (SVU-meteorological research station). Analysis of Variance on SPSS software package (SYSTAT statistical program, version 17) was used to test the present data.

Table 1. The monthly mean of weather factors for the study area during the period of investigation.

Months	T.(Min)	T.(Max)	Mean Temp.	R.H.(Min)	R.H.(Max)	Mean R.H.	Evap.	W.V.
February- 2012	10.1	24.8	13.9	19.4	55.7	43.0	7.6	65.6
March-2012	11.8	27.1	19.6	15.8	51.4	30.8	9.5	53.3
April-2012	18.8	35.3	27.0	6.7	31.2	19.0	15.0	45.4
May-2012	23.4	38.8	31.1	7.6	29.2	18.4	17.8	56.1
June-2012	26.0	41.3	33.7	7.1	30.6	18.8	18.9	66.8
July-2012	27.0	41.0	34.0	11.5	35.4	23.5	19.6	93.0
August-2012	25.7	40.0	32.9	10.7	37.4	24.1	20.4	88.7
September-2012	23.2	37.6	30.4	15.5	47.2	31.4	17.1	102.3
October-2012	21.4	35.8	28.6	14.5	42.8	28.7	14.3	81.2
November-2012	16.3	29.6	22.9	23.5	57.4	40.5	10.4	86.3
December-2012	9.8	23.4	16.6	28.5	74.0	51.2	6.7	72.1
January - 2013	5.8	20.7	13.2	28.3	69.7	49.0	5.7	57.2
Mean – 2012 / 2013	18.28	32.95	25.32	15.76	46.83	31.52	13.6	72.33

T (Min) = Minimum of temperature °C, T (Max) = Maximum of temperature °C, R.H (Min) = Minimum of relative humidity (%), R.H (Max) = Maximum of relative humidity (%), Evap. = Evaporation (mm), W.V. = Wind Velocity (Knots).

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Table 2. The identified families and species from all sites during the period of investigation.

No.	Family	Species	No.	Family	Species
1	**Agelenidae** [38]	Benoitia lepida [39]	13	**Oxyopidae** [52]	Peucetia sp.
2	**Araneidae** [40]	Argiope trifasciata [41]			
3		Cyrtophora citricola [41]	14	**Philodromidae** [52]	Halodromus barbarae [53]
4		Larinia sp.	15		Thanatus albini [45]
5	**Eutichuridae** [42]	Cheiracanthium siwi [43]	16	**Pholcidae** [54]	Artema atlanta [55]
6	**Gnaphosidae** [44]	Trachyzelotes lyonneti [45]	17	**Salticidae** [56]	Heliophanillus sp.
7		Zimiris doriai [46]	18		Plexippus paykulli [45]
8	**Linyphiidae** [47]	Erigone dentipalpis [48]	19		Thyene imperialis [57]
9	**Lycosidae** [49]	Pardosa sp.	20	**Sparassidae** [58]	Eusparassus walckenaeri [45]
10		Wadicosa fidelis [50]	21	**Theridiidae** [49]	Paidiscura dromedaria [59]
11	**Oecobiidae** [51]	Oecobius putus [39]	22		Theridion sp.
12	**Oxyopidae** [52]	Oxyopes sp.	23	**Thomisidae** [49]	Thomisus spinifer [60]

Table 3. Total number (N) and percentage (%) of sex ratio for all species collected from all sites during the period of investigation.

Sex ratio	Male		Female		Total	
Sites	N.	%	N.	%	N.	%
Site I	33	34.0	64	66.0	97	14.9
Site II	20	24.4	62	75.6	82	12.6
Site III	23	27.1	62	72.9	85	13.0
Site IV	43	36.4	75	63.6	118	18.1
Site V	49	40.2	73	59.8	122	18.7
Site VI	45	30.2	104	69.8	149	22.8
Total	213	32.6	440	67.4	653	100.0

Table 4. Total number (N) and percentage (%) of sex ratio for all species collected from all seasons during the period of investigation.

Sex ratio	Male		Female		Total	
Seasons	N.	%	N.	%	N.	%
Winter	35	16.43	82	18.64	117	17.92
Spring	56	26.29	120	27.27	176	26.95
Summer	63	29.59	111	25.23	174	26.65
Autumn	59	27.69	127	28.86	186	28.48
Total	213	32.60	440	67.40	653	100.0

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3 Results

From the meteorological data analysis (temperature, relative humidity, wind speed and direction, cloud cover and sunshine hours), one can conclude that, Climate of Qena is very hot dry in summer and cold in winter. It rarely rains. Also, it receives a large quantity of solar radiation, especially in summer, dry and quiet along the year. Weather characteristics change markedly from one season to the other [61] (table 1). The results of the study indicated that the total catch of all taxa collected during the period of investigation was 1247 specimens belonging to 14 families and including 23 genera and 23 species. All of them belong to order: Araneae (Araneida). These families were; Agelenidae, Araneidae, Eutichuridae, Gnaphosidae, Linyphiidae, Lycosidae, Oecobiidae, Oxyopidae, Philodromidae, Pholcidae, Salticidae, Sparassidae, Theridiidae and Thomisidae. The species collected were: Benoitia lepida, Argiope trifasciata, Cyrtophora citricola, Larinia sp., Cheiracanthium siwi, Trachyzelotes lyonneti, Zimiris doriai, Erigone dentipalpis, Pardosa sp., Wadicosa fidelis, Oecobius putus, Oxyopes sp., Peucetia sp., Halodromus barbarae, Thanatus albini, Artema atlanta, Heliophanellus sp., Plexippus paykulli, Thyene imperialis, Eusparassus walckenaeri, Paidiscura dromedaria, Theridion sp., Thomisus spinifer as shown in table (2). These families varied in their numbers and frequencies of occurrence according to the site, type of plants, methods of collection and the date of collections (climatic conditions) (fig.2). Family Salticidae was present at the highest number during the whole period of study (278 specimens), constituting 22.29% from total number of collected taxa but family Agelenidae was present at the lowest number in the same period of study (4 specimens), constituting 0.32 % from the total number. Considering the species number of spiders collected from all sites, it was observed that the maximal number was collected from Thanatus albini (199 specimens), constituting 16.0% from total number, while Halodromus barbarae was the least species number (2 specimens), constituting 0.16 % from the total number (fig.3). Regarding sex ratio of collected spiders from all sites, it was clear that there were 213 adult male specimens, constituting (32.60% from the total number), whereas the adult females were represented by 440 specimens, constituting (67.40% of the total number) (table 3). According to the seasonal fluctuation of sex ratio, it was clear that the maximal number of adult male and female was collected in autumn (186 specimens constituting 28.48% of the total number), where the lowest one was collected during winter (117 specimens, constituting 17.92% from the total number) (table 4). Regarding the monthly number of spiders collected from all sites, it was found that the maximal number was collected during June and October (128 specimens), constituting 10.26% of the total number for each of them, where the lowest one was collected during January (59 specimens), constituting 4.73% from the total number. Generally, the total catch of 23 taxa from all sites showed its maximal value in autumn (363 specimens constituting 29.11% of the total number), followed by spring (336 specimens constituting 26.94%), then summer (333 specimens constituting 26.70%), whereas the least catch was recorded in winter (215 specimens constituting 17.24%) of the total number.

Figure 1. A map of Qena governorate showing the sites of collections.

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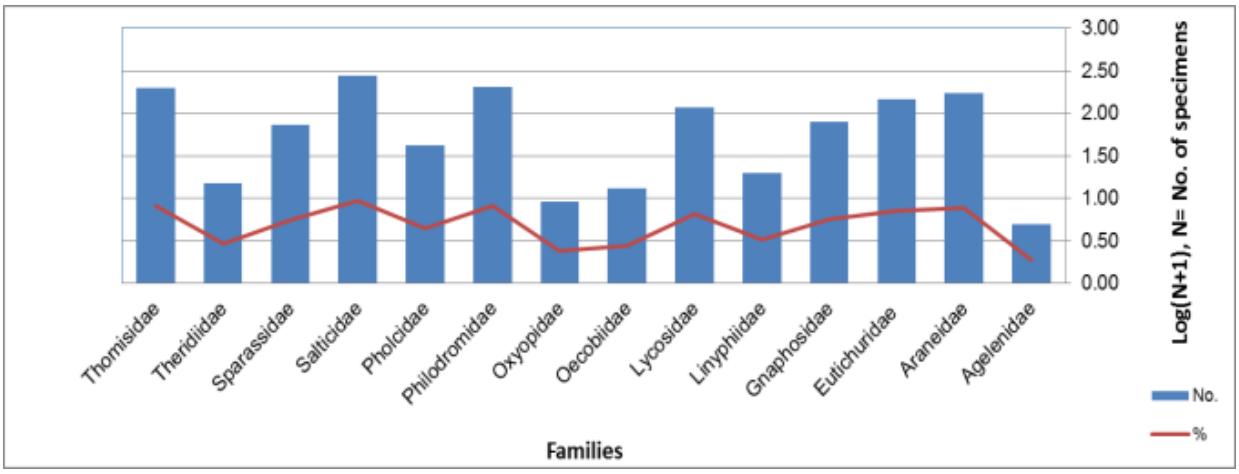

Figure 2. Total numbers (N) and percentage (%) of collected families from all sites during the period of investigation.

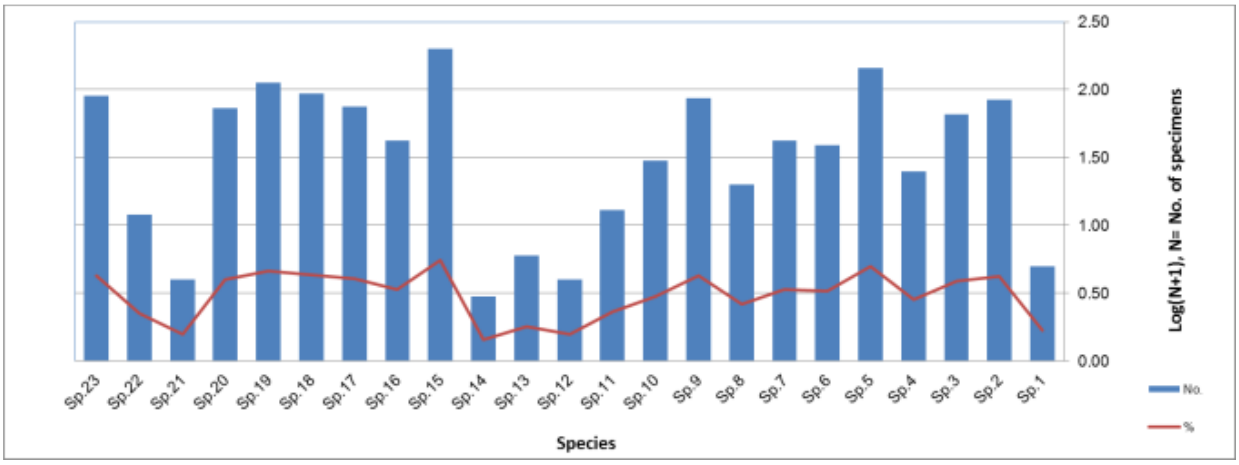

Figure 3. Total numbers (N) and percentage (%) of each specimen from all sites during the period of investigation.

4 Discussion

To the best of the present authors' knowledge and as far as can be ascertained, the present study is the first of its kind carried out at Qena governorate and is one of the few studies on spider communities in Egypt indicating diversity of spider's fauna inhabiting plants. Spiders are one of the more diverse arthropod taxa, ranking seventh in global diversity [15], which makes them a fascinating group to study. There are many environmental factors like seasonality, spatial heterogeneity, competition, predation, habitat type, environmental stability and productivity that can affect species diversity [11]. In the present study, significant differences in the diversity, evenness and richness between different seasons were recorded. The results indicated that all seasons showed different species composition. It might be expected that climatic changes through seasons would influence the abundance of spiders [62]. Most spiders are limited to a certain extent by environmental conditions. In general, different species have varying humidity and temperature preferences and are limited to those seasons which offer a microclimate within the range of their physiological tolerances. So, the difference in species diversity between two seasons is likely to be due to the difference in the amount of rainfall and temperature in these seasons. Diversity analysis determines the significance of observed differences in community structure between different crop growth stages and two seasons based on the species abundance distributions [63]. A diversity index incorporates both species richness and evenness in a single value [64]. The present study indicated that there were different abundant species in different seasons of collections at all sites (363 specimens in autumn, 336 specimens in spring, 333 specimens in summer and 215 specimens in winter). From these results, the populations of

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spiders reached high numbers in autumn (suitable weather and the high population of insect larvae during these periods i.e. abundance of their prey). This result agrees with [65] who indicated that the population of spiders showed stable numbers throughout summer and a smaller increase in the autumn as a general trend. On the other hand, the population of spiders in the present study was lowest in winter, this result agrees with the results obtained by [66] who studied the ecology of spiders of the river-terrace forest in western Tennessee and indicated that physical factors were the dominant forces in the activities of the spiders during winter and the habitat is essentially reduced to a single layer, the ground-leaf stratum. Activity is reduced to a minimum during hibernation except on warm days when certain species move about on the dead leaves and herbs but even then evidence of predatory activity is lacking. [67] indicated that hibernation is a general downward migration of the spiders, also [65] indicated that winter and early spring had lower numbers of spiders than late spring, summer and autumn. The results of the present investigation indicated that similar species are present at a specific stage of crop growth. Thus, vegetation structure may be a more important determinant than the seasonal variation alone. This provides valuable insights as to why certain species may dominate at different times of the season. The above results are supported by the view of [7, 68] who concluded that vegetation structure seems to influence spider composition on family level because similar families cluster within a similar habitat type. Also, the above two authors added that vegetation architecture plays a major role in the species composition found within a habitat. [69,70] indicated that the final stage of the crop results in a habitat that is more complex and can support higher diversity. The above authors observed that surveys have demonstrated that spiders respond numerically to the diversity and complexity of the vegetation. [71] reported that spider populations exist in a certain extent sense within a community and they found that a certain plant community would support an abstract spider population, also [72] noticed that comparing among different sites revealed that on average, species composition was much more similar within the same vegetation type than among different vegetation types. It is also worthy to note that spiders are sensitive to microhabitat variation [16]. This explains the occurrence of certain species of spiders in selected habitat, governed by particular species of plants [73,74]. The present study agrees with the above studies since it was noticed that Thanatus albini was dominant species in sites II, IV and V, where these sites were cultivated by the same plant namely Trifolium alexandrinum L. (Family: Leguminosae). Also, Cyrtophora cirticola was collected during all period of investigation from different sites from the same plant; Phoenix dactylifera L. (family: Palmae). From the present results, it was clear that the maximal number for monthly fluctuations of spiders was collected during June and October (128 specimens), constituting 10.26% of the total number for each of them. [75] mentioned that although population size of spiders varied greatly throughout the growing seasons of clover, there was gradual increase until late May when a peak activity was reached, also [65] indicated that April showed a distinct peak in fluctuation numbers of spiders. It was found that the relative abundance of the collected species mostly related to temperature followed by relative humidity; while the rest of the studied environmental variables have relatively small effects on the collected species, especially evaporation. The results cleared that temperature has obvious effect on the relative abundance of different species such as Plexippus paykulli, while the relative humidity affects relative abundance of other species like Wadicosa fidelis. [76] indicated that there were many environmental factors that affect species diversity. [77] reported that spiders generally have humidity and temperature preferences that limit them to areas within the range of their “physiological tolerances” which make them ideal candidates for land conservation studies. Based on the present results and compared with other results carried out in other different Governorates of Egypt like: [78,79,80, 81,82,83,84,85,86,87,88,89,90,91]. It is clear that there are differences in the diversity and in the relative abundance of taxa between these studies and the present study. These differences may be attributed to the effect of one or more of the following variables like: environmental factors for the collected sites, habitat type, methods of collection, natural enemies, types and nature of crops, abundance of prey and human effects.

5 conclusion

The present study was focused on Qena Governorate (15-260 N, 32-500 E) to make a survey of spiders in different habitats of this region and to study the population dynamics of these spiders. Survey result revealed the occurrences of 1247 specimens belonging to 14 families that included 23 genera and 23 taxa. Generally, the total catch of 23 taxa from all sites showed its maximal value in autumn (363 specimens constituting 29.11% of the total number), whereas the least catch was recorded in winter (215 specimens constituting 17.24%) of the total number. It was clear that there were 213 adult male specimens, constituting 32.60% from the total number, whereas the adult females were represented by 440 specimens, constituting 67.40% of the total number.

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