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Seasonal abundance of true spiders inhabiting perennial shrubs and evergreen herbs

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Abstract:

The present study was directed towards the habitat of various true spider species inhabiting different ornamental plants. A one-year study was conducted in the Orman garden; two groups of plants were selected, three evergreen herbs and three perennial shrubs. The results revealed that the evergreen herbs received a total of 261 individuals belonged to 21 genera, 25 species of 10 families, while the perennial shrubs received a total of 255 individuals belonged to 20 genera, 23 species of 10 families. Guild structure analysis revealed eight feeding guilds, the active hunting guild (Ambushers) comprised the largest portion (50.2 and 58.2%) followed by the stalkers guild (22.7 and 16.1%) then space weavers (14.5 and 17.2%) of perennial shrubs and evergreen herbs, respectively. Moreover, a survey over different ornamental plants revealed a total of 178 spiders grouped in 13 families belonging to 28 genera and 35 species collected from thirty ornamental plants. Five families contained 93.1% of the total collected spiders; they are Philodromidae, Salticidae, Theridiidae, Thomisidae and Cheiracanthiidae. The results indicated that the interaction of different communities of spider abundance and species richness depends on the type of plant dense vegetation, shade, and humidity; so, a slight difference was observed between the two categories located in the same location.

Introduction

The landscape of the Orman garden is often characterized by a wide range of diverse flowering plants comprising native and exotic plants. The spider diversity is affected by the different vegetation structure of plants; habitat structure is an important factor that influences the diversity, abundance and distribution of spider species (Evans, 1997 and Whitmore *et al*., 2002).

As the spiders were broadly distributed in high numbers, associated with the food web, they are used as virtuous predictor organisms (Wise, 1995; Willett, 2001 and Foelix, 2011). The abundance and/or composition of spider species were investigated in different agro-ecosystems (Carroll and Hoyt, 1984 and Wisniewska and Prokopy, 1997). In Egypt, the abundance and occurrence of spiders in different vegetation types and habitats were studied in different

Governorates (Ghallab, 2012 and Obuid-Allah *et al*., 2015). In addition, Hassan *et al* (2016) assessed the effect of different vegetation in public parks on the seasonal spider populations. Zaki *et al*. (2020) also studied the biodiversity of spiders concerning different vegetation structures. Few studies have compared the spider distribution in different categories of plants such as evergreen herbs, perennial shrubs, succulents, vines, hedges, palms and trees.

The present study aims to focus on the variation in spider's community inhabiting three evergreen herbs and three perennial shrubs of different ecological values. Concerning the relative abundance, species richness, guild composition, Shannon-Wiener index (H'), Simpson index (S), and evenness (e) to quantify the community structures of spiders among three categories of different vegetation types.

Materials and methods

1. Description of the study area and sampling:

The Orman garden consists of highly fertile cultivated land covered with numerous ornamental plants. Two categories of ornamental plants were selected. The first group consists of three evergreen herbs namely, *Ruscus aculeatus* L., *Pelargonium zonal* (Hėrtier) and *Ocimum basilicum* L., and the second group of three perennial shrubs namely, *Plumbago auriculata* Lam., *Acalypha hoffmannii* Müll and *Dodonaea viscosa* Jacq. Moreover, a survey of the spider community composition and diversity associated with different vegetation foliage was carried out.

The arboreal spiders live on foliage were collected by shaking plants on a sweeping net with a mesh bag. Samples were collected periodically every two weeks from the different host plants for a one-year study extended from January 2020 till the end of December 2020. Collected spiders were kept in glass vials containing 70% ethyl alcohol and some droplets of glycerine and examined under a stereo-zoom microscope in the laboratory.

2. Identification of spiders:

The adult spiders were identified, as possible, to species. The scientific names of spiders and their classification follow different specialized description keys.

3. Data analysis:

3.1. Spider community: The Shannon-Wiener Index "H'" is one of the most common ecological indexes; it may indicate of community stability under the balance of nature. A higher number of H' indicates a higher number of species, so, it means an increase in diversity. While Simpson Index "S" is a measure of dominance (Nestle *et al.*, 1993).

The two indices were calculated as described by Ludwig and Reynolds (1988):

$$H' = -\sum (n_i / n) \ln (n_i / n) \text{ and } S = \sum (n_i/n)^2$$

Where n_i *is* the number of individuals belonging to the i^{th} of "S" taxa in the sample and "n" is the total number of individuals in the sample."

3.2. Sørensen quotient of similarity: To compare the guild composition between microhabitats of the two categories of the ornamental plants (evergreen herbs & perennial shrubs), Sørensen's quotient of similarity (QS) (Sørensen, 1948) was applied to the number of species and individuals of the two group plants. It was used to determine the similarities of spider species composition among the communities. Sørensen's original formula was intended to be applied to presence/absence data, and it is:

$$QS = 2\,C / A + B.$$

Where A and B are the number of species in samples A and B, respectively, and C is the number of species shared by the two samples; QS is the quotient of similarity and ranges from 0-1.

3.3. Guild composition: The spiders collected were separate into eight guilds

according to spider's web-building and prey-catching behaviour as described by Uetz *et al.* (1999).

Results and discussion

In the present investigation, the total number of spiders collected was 694 individuals forming at least 42 species belonging to 33 genera that fall into 15 families.

1. Survey of spiders inhabiting three perennial shrubs:

Table (1) showed the abundance numbers and percentage of spiders inhabiting three ornamental shrubs, *P. auriculate*, *Acalypha wilkesiana hoffmannii* Müll (Twisting green acalypha) and *D. viscosa* (Green dodonaea) shrubs. A list of identified collected spiders was presented, a total of 255 spiders were collected; they belonged to 10 families, 20 genera and 23 species. Among the collected spiders, the most abundant families were Philodromidae represented 39.3 and 65.6% in *Plumbago* and *Dodonaea* shrubs, respectively, followed by Salticidae 34.8 and 22.8% in *Acalypha* and *Plumbago*, respectively, then Cheiracanthiidae 30.4% and Theridiidae 19.6 % collected from *Acalypha*. The abundance of adults was the highest in *Plumbago* (38 ♂: 27 ♀) and the lowest recorded in *Dodonaea* (4 ♂: 6 ♀), while juvenile stages were more abundant in *Plumbago* than *Acalypha* and *Dodonaea* recorded 80, 30 and 54 juvenile, respectively.

Of the most abundant species, 5 ranked in the top, *Pulchellodromus glaucinus* (Simon) (89 individuals), *Cheiracanthium isiacum* O.P. (25 individuals), *Thomisus spinifer* (Sundevall) (24 individuals), *Theridion melanostictum* O. P. (24 individuals), *Thyene imperialis* (Rossi). (22 individuals).

2. Survey of spiders inhabiting three evergreen herbs:

Table (2) listed the identified collected spiders inhabiting three herbs, *R. aculeatus*, *P. zonal* and *O. basilicum* and showed their abundance numbers and percentage. A total of 261 spiders was collected, they could be classified into 10 families, 21 genera and 25 species. Among the collected spiders, the most abundant families were Philodromidae represented 66.2, 35.9 and 31.2% in *Ruscus*, *Pelargonium* and *Ocimum* herbs, respectively, followed by Theridiidae 28.2% collected from *Pelargonium* then Salticidae 22.1% from *Ocimum* then Thomisidae 20.8% and Theridiidae 18.2% collected from *Ocimum*. The abundance of adults was the highest in *Ruscus* (19 ♂: 17 ♀) followed by *Ocimum* (13 ♂: 22 ♀) and the lowest recorded in *Pelargonium* (8 ♂: 5 ♀), while juvenile stages were abundant in *Ruscus* recorded 109 and those collected from *Pelargonium* and *Ocimum* herbs recorded 26 and 42 juvenile, respectively.

The most dominant species were *P. glaucinus* (115 individuals), *Kochiura aulica* (Koch) (19 individuals) *T. melanostictum* (15 individuals), *T. imperialis* (14 individuals), *Plexippus paykulli* (Audouin) (13 individuals), then *T. spinifer* (13 individuals).

Table (1): Spiders inhabiting three different perennial shrubs during a one-year study in Orman garden.

Family names & species	***Plumbago***			**∑**	**%**	***Twisted Acalypha***			**∑**	**%**	***Dodonaea***			**∑**	**%**	**Total**	**%**
	♂	♀	J			♂	♀	J			♂	♀	J				
Philodromidae																89	
Pulchellodromus glaucinus (Simon)	1+4s♂	7+2s♀	35														
Philodromus blankei	1s♂	1	4	57	**39.3**		1	2	3	**6.5**		1	36	42	**65.6**	10	**40**
Thanatus sp.		1	1										4				
													1			3	
Salticidae (spiderling)			3													3	
Thyene imperialis Rossi	3+1s♂	2	5				1	2			1s♂	1	6			22	
Thyene sp.		1														1	
Plexippus paykulli Audouin	1		5	33	**22.8**	1s♂	1	11	16	**34.8**				8	**12.5**	19	**22.3**
Bianor sp.	1+1s♂	3	2													7	
Heliophanus sp.	2s♂	1	1													4	
Hasarius adansoni Audouin	1															1	
Cheiracunthiidae					**4.8**				14	**30.4**				4	**6.3**		**9.8**
Cheiracunthium isiacum O.P.			7	7		1s♂	1	12					4			25	
Theridiidae																	
Theridion melanostictum O.P.	3	4	8			2+1s♂	2				1	1+1s♀	1			24	
Theridion sp. *??*					**14.5**				9	**19.6**	1s♂			6	**9.4**	1	**14.1**
Kochiura aulica Koch	2s♂	2		21		2s♂	2					1				9	
Euryopis episinoides Walckenaer	1s♂		1													2	
Araneidae																	
Neoscona sp.			1					1								2	
Araneus sp.			1	2	**1.4**				1	**2.2**				1	**1.6**	1	**1.6**
Larinia sp.													1			1	
Thomisidae																	
Thomisus spinifer O.P.	15	3	4	24	**16.5**	1			1	**2.2**	1s♂			1	**1.6**	24	**10.2**
Thomisus onustus Walckenaer			2													2	
Dictynidae, *Dictyna* sp.	1s♂			1	**0.7**											1	**0.4**
Uloboridae, *Uloborus* sp.								1	1	**2.2**			1	1	**1.6**	2	**0.8**
Lycosidae, *Trocosa* sp.									1	**2.2**						1	**0.4**
Oonopidae, *Orchestina* sp.												1		1	**1.6**	1	**0.4**
Total of alive individuals	25+13s♂	25+2s♀	80	**145**		3+5s♂	8	30	**46**		1+3s♂	5+1s♀	54	**64**		**255**	

Table (2): Spiders inhabiting three different evergreen herbs during a one-year study in Orman garden.

Family names & species	*Ruscus*			Σ	%	*Pelargonium*			Σ	%	*Ocimum*			Σ	%	Total	%
	♂	♀	J			♂	♀	J			♂	♀	J				
Philodromidae																	
Pulchellodromus glaucinus Simon	1+6s♂		78	96	66.2		1	9	14	35.9		2s♀	18	44	31.2	115	51.3
Philodromus blankei	2s♂		7													13	
Thanatus sp.			2			1s♂		3					4			26	
Salticidae (spiderling)													4			4	
Thyene imperialis Rossi		2	4					2			1+1s♂	3	1			14	
Thyene sp.		1											1			2	
Plexippus paykulli Audouin	1	1	5				1s♀	3					2			13	
Bianor sp.		1		18	12.4				7	17.9				17	22.1	1	16.1
Heliophanus sp.											1s♂	2	1				
Hasarius adansoni Audouin								1								1	
Afraflacilla spiniger		1														1	
Salticus scenicus		2														2	
Cheiracunthiidae				4	2.6				2	5.1				3	3.9		3.4
Cheiracunthium isiacum O.P.	1		3					2					3			9	
Theridiidae (spiderling)													1			1	
Theridion melanostictum O.P.	1	4	5			1	1					3				15	
Theridion sp. *??*	1	1	1	18	12.4		1		11	28.2				14	18.2	4	16.5
Kochiura aulica Koch	2					4+1s♂	1	2			3	3+1s♀	2			19	
Euryopis episinoides Walckenaer	3										1					4	
Araneidae, *Araneus* sp.			1	5	3.4				1	2.6				1	1.3		2.9
Neoscona sp.	1	1	2					1					1			6	
Thomisidae, *Thomisus* sp. *??*												1				1	
Thomisus spinifer O.P.						1		1	2	5.1	4+2s♂	3	2	16	20.8	13	6.9
Thomisus onustus Walckenaer												2	2			4	
Dictynidae, *Dictyna* sp.												2		2	2.6	2	0.8
Gnaphosidae, G ??			1	1	0.7			2	2	5.1						3	1.2
Oecobiidae, *Oecobius navus*		1		1	0.7											1	1.2
Linyphidae				2	1.4												
Gnathonarium dentatum Wider		2														20.8	
Total of alive individuals	11+8s♂	17♀	109	**145**		6+2s♂	4+1s♀	26	**39**		9+4s♂	18+4s♀	42	**77**		**261**	

3. Survey of spider of different ornamental plants in Orman Garden:

The survey study revealed the occurrence of spiders inhabiting thirty ornamental plants as shown in Table (3). A total of 178 spiders was collected belonged to 13 families, 28 genera and at least 35 species.

Table (4) summarized the spiders collected from the different ornamental plants; and showed their abundance numbers and percentage. Among the collected spiders, the most abundant families were Thomisidae 24.2%, Salticidae 23% and Theridiidae 23% then Philodromidae 10.7%. The collected males and females totalled 59.6%, (31.5% ♂: 28.1% ♀), while juvenile stages 40.5%. The sex ratio was 1 female: 1.12 male. The most dominant species were *T.spinifer* (35 individuals) followed by *K. aulica* (27 individuals), *P. paykulli* (15 individuals) and *P. glaucinus* (10 individuals).

4. Family richness and generic diversity:

Fifteen families were collected in the present study; the family Salticidae was the dominant family with maximum generic diversity composed of (8 genera 9species), followed by Theridiidae (4g. 7sp.), then Thomisidae (2g. 4sp.), Araneidae (3g. 3sp.), Philodromidae (3g. 3sp.), Lycosidae (2g. 2sp.), Uloboridae (1g. 2sp.), Linyphiidae (2g. 2sp.) and Dictynidae (2g. 2sp.). The six remaining families Cheiracanthiidae, Gnaphosidae, Oecobiidae, Oxyopidae, Pholcidae and Oonopidae were represented by only a single genus.

5. Rank abundance of spider families:

The abundance of collecting spiders was summarized by families in Table (5). Five families contained 93.1% of the total collected spiders; they are Philodromidae (36.7%), Salticidae (20.2%), Theridiidae (17.3%), Thomisidae (12.5%) and Cheiracanthiidae (6.5%). The greatest number of individuals was found in the family Philodromidae (255 individuals), then family Salticidae which ranked the second (140 individuals), family Theridiidae was the third (120 individuals), followed by family Thomisidae was the fourth (87 individuals) and family Cheiracanthiidae was the fifth (44 individuals). Three species were represented by only one individual, *Orchestina* sp. (Oonopidae), *Oecobius navus* Blackwall (Oecobiidae) and *Pholcus* sp. (Pholcidae).

Table (3): Survey of spiders on the different ornamental plants in Orman garden.

Scientific name of the host plant	Spider family	Scientific name of Spider	Stage			Total	Months by number
			♂	♀	J		
Acalypha macrophylla Müll (Red copperleaf acalypha)	Cheiracanthiidae	*Cheiracanthium isiacum*	1		1	2	6
	Salticidae	*Bianor* sp.		1	2	3	6
	Salticidae	*Thyene imperialis* (Rossi)	1			1	1
	Theridiidae	*Theridion melanostictum*		2		2	7, 9
	Theridiidae	*Kochiura aulica* Koch		1		1	1
	Lycosidae	*Trochosa* sp.			1	1	12
	Uloboridae	*Uloborus* sp.			1	1	10
Acalypha marginata Müll (Green single acalypha)	Salticidae	*Thyene imperialis* (Rossi)			1	1	8
	Salticidae	*Plexippus* sp.			1	1	8
	Salticidae	*Heliphanus* sp.			1	1	9
Ageratum mexicanum Müll	Cheiracanthiidae	*Cheiracanthium* sp.			1	1	6
	Theridiidae	*Kochiura aulica* Koch	1			1	3
	Thomisidae	*Thomisus spinifer* (Sund.)	6	1		7	3 to 7

Table (3): Continue

Scientific name of the host plant	Spider family	Scientific name of Spider	Stage			Total	Months by number
			♂	♀	J		
Alocasia macorrhiza (L.)	Philodromidae	*Philodromus* sp.			1	1	6
	Theridiidae	*Kochiura aulica* Koch	1s♂		1	2	6
Alyssum maritimum (L.)	Thomisidae	*Thomisus spinifer* (Sund.)	1s♂			1	6
Bougainvillea glabra Chois.	Theridiidae	*Steatoda paykulliana* Walck.		1		1	6
Canna indica L.	Salticidae	*Afraflacilla spiniger* (Pick.)		1		1	10
	Salticidae	*Plexippus* sp.			1	1	10
	Philodromidae	*Philodromus* sp.			1	1	11
	Theridiidae	*Kochiura aulica* Koch	1s♂		1	2	12
Catharanthus rosens (L.)	Philodromidae	*Philodromus* sp.			1	1	8
(=*Vinca roseaa*)	Thomisidae	*Thomisus spinifer* (Sund.)		1		1	5
Casuarina sp.	Salticidae	*Heliphanus* sp.			1	1	11
	Salticidae	*Salticus scenicus* (Clerck)			1	1	11
	Philodromidae	*Thanatus* sp.			1	1	12
Chamomile nobile (L.)	Thomisidae	*Thomisus* sp.	1s♂	2s♀		3	4
Chrysanthemum cornaria (L.)	Dictynidae	*Nigma* sp.	1	1		2	12
	Theridiidae	*Kochiura aulica* Koch	1s♂	1	1	3	12
	Philodromidae	*Pulchellodromus glaucinus*	1			1	12
	Philodromidae	*Thanatus* sp.			1	1	12
	Salticidae	*Plexippus* sp.			2	2	12
	Thomisidae	*Thomisus spinifer* (Sund.)	2			2	12
Clerodendron splendens	Pholcidae	*Pholcus* sp.		1		1	10
	Theridiidae	*Euryopis episinoides*	1			1	10
	Theridiidae	*Kochiura aulica* Koch		1		1	7
	Philodromidae	*Pulchellodromus glaucinus*	2s♂		3	5	7 ,12
	Gnaphosidae	G ?			2	2	12
Cordyline terminalis Kunth	Cheiracanthiidae	*Cheiracanthium* sp.			2	2	9
	Philodromidae	*Thanatus* sp.			1	1	9
	Salticidae	*Plexippus* sp.			1	1	8
	Salticidae	*Thyene imperialis* (Rossi)		1	1	2	10
	Theridiidae	*Theridion* sp.			1	1	10
	Thomisidae	*Thomisus spinifer* (Sund.)	3	1		4	8,9,11,12
Crinum asiaticum L.	Salticidae	*Heliphanus* sp.		1		1	10
	Salticidae	*Plexippus* sp.			2	2	8, 9
	Salticidae	*Hasarius adansoni* (Aud.)		1	1	2	8
	Philodromidae	*Philodromus* sp.			2	2	10
	Salticidae	*Thyene imperialis* (Rossi)			1	1	10
	Lycosidae	*Pardosa* sp.			1	1	8
	Uloboridae	*Uloborus plumipes* Lucas			1	1	10
Cycas revolute Thunb.	Salticidae	*Heliphanus* sp.		1		1	6
	Theridiidae	*Kochiura aulica* Koch		1s♀		1	7
	Thomisidae	*Thomisus spinifer* (Sund.)	1			1	8
Dimorphotheca ecklonis	Uloboridae	*Uloborus walckenaerius* Lat.		1		1	4
	Thomisidae	*Thomisus spinifer* (Sund.)	1			1	4
	Philodromidae	*Pulchellodromus glaucinus*		1		1	5
	Oxyopidae	*Oxyopies bilineatus* O.P.		1		1	5

Table (3): Continue

Scientific name of the host plant	Spider family	Scientific name of Spider	Stage			Total	Months by number
			♂	♀	J		
Dombeya burgessiae	Thomisidae	*Thomisus spinifer* (Sund.)	2			2	5
	Salticidae	*Plexippus paykulli* Audouin		1	2	3	7
	Salticidae	*Bianor* sp.	1			1	1
	Theridiidae	*Steatoda erigoniformis* Sund	1			1	9
Gerbera jamesonii Bolus	Lycosidae	*Pardosa inopina* (Pickard)	1			1	3
	Aranaeidae	*G ?*			1	1	12
	Salticidae	*Thyene* sp.			1	1	12
	Theridiidae	*Theridion* sp.			1	1	12
	Theridiidae	*Kochiura aulica* Koch	1			1	4
	Thomisidae	*Thomisus spinifer* (Sund.)	1		1	2	4
	Thomisidae	*Runcinia grammica* (Koch)	1			1	3
Helichrysum bracteatum	Thomisidae	*Thomisus spinifer* (Sund.)	2+1s♂			3	4, 5
	Philodromidae	*Pulchellodromus glaucinus*		1		1	4
Jasminum multiiflorum	Aranaeidae	*Araneus* sp.		1		1	5
	Dictynidae	*Nigma* sp.		1		1	6
	Cheiracanthiidae	*Cheiracanthium* sp.			2	2	11
	Gnaphosidae	G ?			1	1	10
	Theridiidae	*Kochiura aulica* Koch	1			1	5
	Thomisidae	*Thomisus spinifer* (Sund.)	1			1	10
	Oxyopidae	*Oxyopides bilineatus* O.P.			1	1	11
Jasminum sambac (L)	Cheiracanthiidae	*Cheiracanthium* sp.			3	3	10, 11
	Salticidae	*Hasarius adansoni* (Aud.)		1	1	2	8
	Salticidae	*Ballus* sp.			1	1	11
	Salticidae	*Plexippus* sp.			2	2	8, 9
	Theridiidae	*Kochiura aulica* Koch	1	1		2	8
Matricaria chamomilla L.	Thomisidae	*Thomisus spinifer* (Sund.)	1	2		3	4
Petunia axillaris (Lam.)	Theridiidae	*Kochiura aulica* Koch	1			1	6
	Thomisidae	*Thomisus spinifer* (Sund.)	1	2		3	4
	Thomisidae	*Thomisus* sp.	1s♂	1s♀	1	3	6
Pinus halepensis	Philodromidae	*Thanatus albini* (Audouin)			1	1	11
	Salticidae	*Plexippus paykulli* (Audouin)	1s♂			1	11
	Theridiidae	*Kochiura aulica* Koch		1		1	11
PLumbago	Philodromidae	*Pulchellodromus glaucinus*	1	1		2	2
	Salticidae	*Heliphanus* sp.	1			1	2
	Aranaeidae	*Araneus* sp.			1	1	1
Salvia splendens Sell.	Thomisidae	*Thomisus spinifer* (Sund.)	1			1	5
	Dictynidae	*Nigma* sp.		1		1	5
	Linyphidae	*Sengletus extricates*		1		1	5
Severina monophylla (L)	Theridiidae	*Theridion spinitrase*	1			1	8
	Theridiidae	*Theridion melanostictum*	1			1	7
	Aranaeidae	*Neoscona* sp.		1		1	7
	Theridiidae	*Kochiura aulica*		1		1	8
	Uloboridae	*Uloborus walckenaerius*		1	1	2	11
Tagetes crecta L.	Theridiidae	*Theridion melanostictum*	1			1	9
	Thomisidae	*Thomisus spinifer*		1	1	2	5
Thuya orientalis	Theridiidae	*Theridion* sp.		1	3	4	11, 12
	Salticidae	*Plexippus* sp.			2	2	11, 12
	Salticidae	*Thyene* sp.			2	2	11, 12
	Salticidae	*Hasarius adansoni*	1			1	11
	Theridiidae	*Kochiura aulica*	4	5	1	10	12
	Lycosidae	*Pardosa* sp.			1	1	12
Viola tricolor L.	Thomisidae	*Thomisus spinifer* (Sund.)		1		1	3
Total			**56**	**50**	**72**	**178**	

Table (4): Spiders collected randomly from the different ornamental plants.

Family names & species	Spider stages			∑	Total	%
	♂	♀	J			
Philodromidae, *Thanatus* sp.			4	4		
Pulchellodromus glaucinus (Sim.)	4	3	3	10	19	10.7
Philodromus sp.			5	5		
Salticidae						
Thyene imperialis Rossi	1	1	3	5		
Thyene sp.			3	3		
Plexippus paykulli Audouin	1	1	13	15		
Ballus sp	1		1	2	41	23
Bianor sp.	1	1	2	4		
Heliophanus sp.	1	2	2	5		
Hasarius adansoni Audouin	1	2	2	5		
Afraflacilla spiniger		1		1		
Salticus scenicus			1	1		
Cheiracanthiidae						
Cheiracunthium isiacum O.P.	1		1	2	10	5.6
Cheiracunthium sp.			8	8		
Theridiidae (spiderling)			2	2		
Theridion melanostictum O.P.	2	2		4		
Theridion spinitrase	1			1		
Theridion sp. *??*		1	3	4	41	23
Kochiura aulica Koch	11	12	4	27		
Euryopis episinoides (Walckenaer)	1			1		
Steatoda paykulliana		1		1		
Steatoda erigoniformis	1			1		
Araneidae			1	1		
Neoscona sp.		1		1	4	2.2
Araneus sp.		1	1	2		
Thomisidae						
Thomisus spinifer O.P.	24	9	2	35		
Thomisus onustus (Walckenaer)		1		1	43	24.2
Thomisus sp. *??*	2	3	1	6		
Runcinia grammica (Koch)	1			1		
Dictynidae						2.2
Nigma sp.	1	3		4	4	
Gnaphosidae, G ??			3	3	3	1.7
Lycosidae, *Trocosa* sp.			1	1		
Pardosa inopina	1			1	4	2.2
Pardosa sp.			2	2		
Uloboridae, *Uloborus* sp.			1	1		
Uloborus walckenaerius Latreille		2	1	3	5	2.8
Uloborus plumipes Lucas			1	1		
Linyphidae, *Sengletus extricates*		1		1	1	0.6
Oxyopidae						1.1
Oxyopies bilineatus O.P.		1	1	2	2	
Pholcidae, *Pholcus* sp.		1	0	1	1	0.6
Total of alive individuals	**56**	**50**	**72**	**178**	**178**	

Table (5): Rank abundance of spider families associated with the different vegetation structure.

Family names	Spiders of perennial shrubs	Spiders of evergreen herbs	Spiders of different vegetation	Total	%
Philodromidae	102	134	19	255	36.7
Salticidae	57	42	41	140	20.2
Cheiracanthiidae	25	9	10	44	6.5
Theridiidae	36	43	41	120	17.3
Araneidae	4	7	4	15	2.2
Thomisidae	26	18	43	87	12.5
Dictynidae	1	2	4	7	1.01
Uloboridae	2	-	5	7	1.01
Lycosidae	1	-	4	5	0.7
Oonopidae	1	-	-	1	0.14
Gnaphosidae	-	3	3	6	0.9
Linyphidae	-	2	1	3	0.4
Oecobiidae	-	1	-	1	0.14
Oxyopidae	-	-	2	2	0.3
Pholcidae	-	-	1	1	0.14
Total	**255**	**261**	**178**	**694**	

6. Species richness:

Among the 41 species of spiders collected during the study, 23 species of 10 families were recorded on perennial shrubs and 25 species of 10 families on evergreen herbs; while the spiders of different vegetation (survey) were at least 35 species of 13 families. Most of the families were presented on the three selected categories of vegetation except Oonopidae were unique in shrubs, Oecobiidae in herbs while Oxyopidae and Pholcidae were unique in the spider survey. A total of 25 species had a common occurrence in the three categories mentioned before. The dominant species were *P. glaucinus* represented by 89, 115 and 19 individuals in shrubs, herbs and survey, respectively. Followed by *T. spinifer* of 35, 24 and 13 individuals in survey, shrubs and herbs, respectively. Then *T. melanostictum* of 24, 15 and 4 in shrubs, herbs and survey, respectively. Then *K. aulica* of 27, 19 and 9 individuals in survey, herbs and hrubs, finally, *C. isiacum* recorded 25, 9 and 10 in shrubs, herbs and survey, respectively.

7. Spider guild composition:

The Ambusher spider guild was the dominant on the three categories representing 50.2, 58.2 and 34.8% in shrubs, herbs and different vegetation, respectively, and had the highest species richness, followed by the space weavers and stalkers 25.3 and 24.2% in different vegetation, then stalkers in shrubs of 22.7% and the space weavers of 17.2% in herbs as shown in Table (6). A total of 25 species were common, the most of them was 8 species of family Salticidae, and 4 species of family Theridiidae; while the unique species were two species *Orchestina* sp. (Oonopidae) and *Larinia sp.* (Araneidae) collected from the perennial shrubs and two species, *Gnathonarium dentatum* Wider (Linyphidae) and *O. navus* (Oecobiidae) collected from the evergreen herbs and twelve species collected from different vegetation three of them off family Theridiidae.

8. Faunal similarity of spiders:

In Table (6), the species richness of spiders collected from shrubs was (255 individuals) and that of herbs was (261 individuals). While, the number of spider species of shrubs was (23 species) and that of herbs was (25 species). Among the 29 genera obtained (In shrubs and herbs), only 4 were distributed in shrubs and 6 in herbs, whereas

the common genera were 19. To allow a comparison between the habitats of the two categories, the QS was calculated. It is concluded that community of shrubs and that of herbs have a high overlap as they recorded 80% of similarity.By comparing the community of shrubs and that of different vegetation, among the 31 genera obtained; only 5 were distributed in shrubs and 17 in the different vegetation, whereas the common genera were 18 species. By calculating the QS, the two communities were semi-similar as they recorded 60 % of similarity. By comparing the two communities of the herbs and the different vegetation, 31 genera were obtained; 4 species were distributed in the herbs only and 14 in the different vegetation, while the common genera were 21 species. By calculating the QS, the community of vegetation and herbs have a high similarity as they recorded 70%.

9. Spider's diversity:

Table (7) showed the comparison of the biodiversity of spider species in the different communities. The biodiversity index calculation indicated that the different vegetation of survey is the most diverse recorded the value (1.9), the bigger number is more diverse, and its species richness of spiders in different families were higher and evenness recorded (0.73); followed by spiders diversity in perennial shrubs (1.5) and species evenness (0.65). According to Simpson Index, it was found that diversity of spiders in evergreen herbs included the highest number of dominant species (0.33).

About 204 genera, 41 families reported from Egypt, so far (El-Hennawy, 2017), in this study, 41 species, 33 genera of 15 families were recorded from the Orman Garden. These 15 families represent 36.6% of the total families recorded in Egypt. The high species diversity of spiders collected from the survey of different ornamental plants (28 g. and 35 sp.) can be attributed to the high diversity of plants (30 host plants). The presence of diverse habitats like grassland, shrubs, herbs, trees, and palms in this ecosystem are further evidence of this. Diversity generally increases when a greater variety of habitat types are present (Ried and Miller 1989; Sudhikumar *et al*., 2005; Habashy *et al*., 2005 and Ghallab, 2012).

In the perennial shrub category, the most frequent families were Philodromidae (40%), followed by Salticidae (22.3%), Theridiidae (14.1%), then Thomisidae and Cheiracanthidae (10.2 and 9.8%), respectively; the least frequent were Dyctinidae, Uloboridae and Lycosidae (0.4% each); Araneidae was absent. In the evergreen category, Philodromidae was also the dominant (51.3%) followed by Theridiidae (16.5%), Salticidae (16.1%) then Thomisidae (6.9%); Dyctinidae and Linyphidae were the lowest (0.8% each). In the spider survey collected from different vegetation, family Thomisidae was the most abundant (24.2%) followed by Salticidae and Theridiidae (23% each) then Philodromidae (10.7%); the least frequent were Linyphidae, Oxyopidae, Gnaphosidae (0.6, 1.1 and 1.7%), respectively.

When spiders divided according to their functional groups there was a great effect of habitat on the diversity of these groups. Simberloff and Dayan (1991) cited that guilds are useful in the comparative study of different communities which enable to concentrate on specific groups with specific functional relationships. Guild structure varied considerably concerning the structural quality of vegetation. The hunting spiders or the ambushers were the prepotent feeding guilds; this was in accordance with Masson *et al*. (1997) who found that family Philodromidae was the most abundant spiders in the foliage of Western and Midwestern coniferous trees. It comprised 7 species of spiders of two families Philodromidae (3sp.) and Thomisidae (4sp.),

followed by the stalkers guild comprised 11 species of spiders belonging to three families Salticidae (9sp.), Oxyopidae (1sp.) and Oonopidae (1sp.). This group of spiders of considerable interest to pest manager of high polyphagous has a functional response to certain numerous preys (Nyffeler *et al*., 1994). Then families of the web building group (space weavers) comprised 9 species of spiders of two families Theridiidae (7sp.) and Dictynidae (2sp.).

Also, the evergreen herbs appeared to be suitable sites for ambusher spiders; this observation is in conformity with that of (Evans, 1977; Nentwig, 1993; De Souza and Martins, 2004 and Souza and Módena, 2004) where they found that crab spiders preferred the plant species with minor leaves and that the ambushers were anticipated in high frequency in flowering branches as spiders of the Thomisidae family were characteristic of inflorescences. This result showed the responses of spider abundances to different structural vegetation.

Foliage runners showed that only one species found in the study area (*Cheiracanthium isiacum*) of activity density 9.8% on perennial shrubs compared to evergreen herbs 3.4% and spiders of survey 5.6%. De Souza and Martins (2005) found that the foliage-runners constituted the dominant guild on the plant which have few branches as well as density of leaves per branch be strongly related to number of spiders. This data was in accordance with Hassan *et al.* (2016) who showed that *C. isiacum* was dominant in most plants in the Orman garden. Similarly, Sallam *et al*. (2010) demonstrated that the most frequent spider species associated with a field of cotton and maize plants were *C. isiacum* and *T. imperialis* of relatively frequent occurrence 20.45 and 12.5%, respectively.

Numerous workers have detailed the strong relationship between vegetation structure and the composition of spider communities (Wise, 1995 and Habashy *et al.* 2005). Consequently, it was expected that the diversity of spiders and the species composition of the dominant spiders in shrubs and herbs could reflect the different communities' ecological value when that value is defined by an index of quality integrating the vegetation architecture. The structure of vegetation and microclimatic conditions are important factors determining the composition and distribution of spiders (Uetz, 1999 and Ziesche and Roth, 2008).

The results indicated that the interaction of different communities of spider abundance, population fluctuation of spiders showed a slight difference between the two categories located in the same location.

Table (6): The functional groups of spiders to obtain their preys.

Foraging guild	Spiders of perennial shrubs			%	Spiders of evergreen herbs			%	Spiders of different vegetation			%	Common species	Total
	Sp. richness	No. of Sp.	Unique sp.		Sp. richness	No. of Sp.	Unique sp.		Sp. richness	No. of Sp.	Unique sp.			
Ambushers														
Philodromidae	102	3	-	**50.2**	134	3	-	**58.2**	19	3	-	**34.8**	3	3
Thomisidae	26	2	-		18	3	-		43	4	1		3	4
Foliage runners														
Cheiracunthiidae	25	1	-	**9.8**	9	1	-	**3.4**	10	1	-	**5.6**	1	1
Ground runners														
Lycosidae	1	1	-	**0.4**	-	-	-		4	2	1	**3.9**	1	2
Gnaphosidae	-	-	-		3	1	-	**1.2**	3	1	-		1	1
Stalkers														
Salticidae	57	6	-		42	8	-		41	9	1		8	9
Oxyopidae	-	-	-	**22.7**	-	-	-	**16.1**	2	1	1	**24.2**	-	1
Oonopidae	1	1	1		-	-	-		-	-	-		-	1
Orb weavers														
Araneidae	4	3	1	**2.4**	7	2	-	**2.7**	4	2	-	**5.1**	2	3
Uloboridae	2	1	-		-	-	-		5	2	2		1	3
Space weavers														
Theridiidae	36	4	-	**14.5**	43	4	-	**17.2**	41	7	3	**25.3**	4	7
Dictynidae	1	1	-		2	1	-		4	1	1		1	2
Sheet-web- builders														
Linyphidae	-	-	-	--	2	1	1	**1.2**	1	1	1	**0.6**	-	2
Oecobiidae	-	-			1	1	1		-	-	-		-	1
Scattered-line-weavers														
Pholcidae	-	-	-	--	-	-	-	-	1	1	1	**0.6**	-	1
Total	**255**	**23**	**2**		**261**	**25**	**2**		**178**	**35**	**12**		**25**	**41**

Table (7): Comparison of the biodiversity of spider species in the different communities.

Type of Index	Spiders diversity in perennial shrubs	Spiders diversity in evergreen herbs	Spiders diversity in different vegetation
Shannon–Wiener (H')	1.5	1.4	1.9
Species evenness	0.65	0.61	0.73
Simpson Index (S)	0.26	0.33	0.28

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