

Occurrence of Ootheca of Mantids and Their Natural Enemies in Citrus Orchards in Sohag, Egypt

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ABSTRACT

The giant African mantis, *Sphodromantis viridis* Forsskål, 1775 (Mantodea: Mantidae) was the most observed species of praying mantis in citrus orchards at Sohag Governorate, Egypt during 2017 and 2018 years. Besides, the Egyptian praying mantis, *Miomantis paykullii* (Stal, 1871) and the European mantis, *Mantis religiosa*, were observed in rare numbers. About 530 and 575 oothecae of mantis were collected in 2017 and 2018 respectively from about 46 hectares of citrus. The incubation of these oothecae resulted in complex fauna consisting of four hymenopteran parasitoids, *Podagrion* sp. (Torymidae: Hymenoptera), formicidae & Eupelmidae (Hymenoptera) and other hymenopteran specie, also four spider predators and *Scolothrips* sp. were found. Among the collected oothecae, totals of 28 and 25 oothecae hatched to mantis nymphs producing totals of 1536 and 1318 nymph/year for 2017 and 2018 years respectively. *Podagrion* sp. was the most common parasitic specie and the highest mean number of parasitoids/ootheca was in November with an average of 88 and 116 parasitoid/ootheca for 2017 and 2018 years respectively. Spiders were the most frequent among the oothecae fauna, as the spiders have emerged from the oothecae in the juvenile phase or adult. Incomplete parasitism was calculated after dissection of oothecae, the highest parasitism rate of oothecae was in May and March for 2017 and 2018 years, while the lowest rate was recorded in September for both years.

INTRODUCTION

Mantids are solitary species and may as it was connected with other individuals of the species when mating (Hurd, 1999). Both adults and nymphs are completely carnivorous. They are generalist predators feeding on an array of small animals such as moths, butterflies, wasps, flies, caterpillars and have even been seen to prey on adult hummingbirds (Lorenz, 2007). Their predaceous nature may be a negative attribute, they may be consumed beneficial organisms, such as pollinating wasps and bees (Hurd, 1999). Eggs are surrounded by a casing of liquid foam, which is an abdominal gland secretion that hardens to create a protective shell called an ootheca. Oothecae are exposed to many natural enemies, the most important of which is the parasitoids. The best-known parasitoids of mantis are torymid wasps that attack mantid oothecae (Breland 1941, Grissell and Goodpasture 1981). Although the ecological relationships between these egg parasitoids and

mantis have rarely been studied, other aspects of mantis life histories, population ecology, and community impacts have been well studied in a variety of habitats, including old fields and grasslands in the eastern US (Hurd and Eisenberg 1984a, b; Snyder and Hurd 1995; Moran and Hurd 1994, 1998), Europe (Lawrence 1992), and Japan (Matsura *et al.*, 1975 and Iwasaki 1996). *Podagrion* sp. has been reported as a parasitoid of oothecae of various mantis species, primarily *Mantis religiosa* (Grissell, 1995 and Askew *et al.*, 2001) and this parasitoid was recorded from India (Mani and Kaul, 1972, Pawar *et al.*, 1985, Farooqui, 1986 and Bakthavatsalam, 1995). The high rate of parasitization may be bringing down the population of the predator considerably in nature. Other parasitoids were obtained from mantis oothecae, the genus *Mantibaria* was recorded as egg parasitoids of praying mantids is represented all over the world (Oliveira and Schoeninnger 2017). Mineo & Szabó (1978) demonstrated that *M. solygiae* were reared from the ootheca of the mantid, *Soligia sulcatifrons* while *M. mantis* was reared from the ootheca of *Mantis religiosa*. Spiders are subject to intraguild predation (IGP) with other insectivorous (Hodge, 1999) and directly limit the populations of other predators (Wagner & Wise, 1996 and Wissinger *et al.*, 1996). No data dealing with the interaction between mantis and spider are available.

Most studies related to the mantis oothecae were mostly focused in the direction of either the biological studies of nymphs of mantis or for a specific type of parasitoid on the oothecae. This study aimed to provide more information about the occurrence and abundance of oothecae fauna and their natural enemies in citrus orchards located in Sohage throughout two successive years.

MATERIALS AND METHODS

About 1125 oothecae of the mantis (530 in the first and 575 in the second year were collected from about 46 hectares of citrus trees located in Sohag, Egypt (26°38'N- 31°39'E) throughout the period from January 2017 to December 2018, and were kept under laboratory conditions without direct exposure to sunlight

Fifty trees were always randomly selected for each sample (twice a month), four branches from the bottom of each tree were examined for the existence of oothecae. Often the oothecae were dipped around a small branch where this branch was cut on both sides of oothecae using scissors, sometimes the oothecae were on the side of a thick branch where the oothecae were scraped with part of the tree bark using a sharp knife. Mantis adults were observed and a sample of each specie was preserved with mummification and crucifixion, the identification of all specimens occurred at the survey and Classification Research Dep., PPRI, ARC, Egypt.

Oothecae were isolated in small bags and transferred to the laboratory and were incubated individually in plastic transparent containers (3 cm radius X 3 cm depth) fixed with fabric covers and kept moistened with wet paper towels under laboratory conditions. The examination was done daily and data of mantis nymphs or any of the parasitoids or predators emerging from the oothecae were recorded. Hatching nymphs or other arthropods were taken out of the containers that were returned to incubation and observation. Specimens were stored in ethyl alcohol 70% for identification in Insect Survey and Classification Department, PPRI, ARC, Egypt.

After complete hatching since the oothecae were collected, the internal oothecae contents were examined by dissection and the data were recorded for developed parasitoids only. Means and standard errors were calculated.

RESULTS

Fauna of mantis nymphs, parasitoids and predators inhabiting mantis oothecae were examined in Sohag, Egypt for two successive years of 2017 and 2018, respectively. The results of the daily examination of oothecae were monitored and recorded, after which the internal examination of ootheca was carried out by dissection and the number of parasitoids that evolved and did not succeed in getting out of the eggs was recorded. The giant African mantis, *Sphodromantis viridis* Forsskål, 1775 (Mantodea: Mantidae) was the most observed species of praying mantis in citrus orchards at Sohag Governorate, Egypt during both years of study. Specimens of *S. viridis* were found to be green or brown in color. Besides, the Egyptian praying mantis, *Miomantis paykullii* (Stal, 1871) and the European mantis, *Mantis religiosa*, were observed in rare numbers.

Abundance and Hatchability of Mantids Oothecae Within Two Years: Abundance of Oothecae and Hatched Nymphs of *S. viridis*:

Data presented in Table 1 show that totals of 530 and 575 oothecae/year with general averages 44.17 and 47.92 of oothecae/month were collected during 2017 and 2018 years, respectively. The highest number of monthly collected oothecae were in September, January, October and July with 59, 88, 56 and 56 oothecae for 2017 year and 86, 83, 62 and 58 oothecae for 2018 while, the lowest were in August and November with 28 and 32 oothecae for 2017 year and with 21 and 24 oothecae for 2018 year. Among the collected oothecae, totals of 28 and 25 oothecae hatched to mantis nymphs producing totals of 1536 and 1318 nymph/year with averages of 128 and 119.82 nymphs/month for 2017 and 2018 years respectively. Data also revealed that, during the month of July, the largest number of nymphs was recorded from 4 oothecae (hatched from July's sample) producing 324 nymphs for the year 2017. The same trend was observed in 2018, the largest number of nymphs were recorded in the month of July where 727 nymphs produced by 6 oothecae (hatched from July's sample). While the lowest number of nymphs were recorded in October with 7 nymphs hatched from one ootheca in 2017 and 5 nymphs hatched from 2 oothecae in 2018.

Natural Enemies of Mantis Oothecae:

Complex fauna inhabited oothecae of mantis that were collected from citrus orchards are presented in Tables (2&3). Four hymenopteran parasitoids, *Podagrion* sp. (Torymidae: Hymenoptera), formicidae & Eupelmidae (Hymenoptera) and hymenopteran species were reared from collected oothecae. In addition, four spider predators and *Scolothrips* sp. were emerged from collected oothecae. It was difficult to determine the period that the oothecae have remained exposed to the environment from oviposition to sample collection.

Torymidae Parasitoid, *Podagrion* sp.:

Podagrion sp. was the most common parasitic species emerged from most of the samples of mantis oothecae collected from citrus orchards in Sohag Governorate. Data given in Tables (2&3) and Fig (1) show that *Podagrion* sp. parasitoid was emerged from collected oothecae after winter in March and continued till November except for May, September and October for both study years (Tables 2&3). *Podagrion* sp. was frequented in samples for 16 and 13 times where, the highest mean number of parasitoids/ootheca was in November with an average of 88 and 116 parasitoid/ootheca for 2017 and 2018 years respectively, Fig (1) and Table (1) illustrated that hatching of mantis nymphs were completely absent at this time for both years. Also Fig. (1) illustrated that, four peaks of *Podagrion* sp. were detected in 2017 with 24.67, 19, 16 and 82 parasitoids in Aril, June, August, and November, respectively, meanwhile, three peaks were detected in 2018 with 27, 24 and 69 parasitoids in March, July, and November respectively. The incubation period of *Podagrion* sp. (the time between collection and emergence) reached about four months for samples of February and November 2017 and February and April 2018, even reached five months in a sample of

February 2018, probably because the samples were subjected to parasitism in the field before collection.

Spiders:

Three families including two species of spiders (Araneae) were recorded inhabiting oothecae, and these families were Salticidae, Eutichuridae, and Cheiracanthiidae, while, the species were *Pseudicius spinige* (Salticidae: Araneae) and *Cheiracanthium isiacum* (Cheiracanthiidae: Araneae). Emerged spiders were the most frequent among the oothecae fauna, as the spiders have emerged from the oothecae in the juvenile phase or adult. Data in Tables (2&3) indicated that the spiders emerged from all samples except in 2018 November's sample. These spiders were small in size and can get into oothecae through parasitoid holes. Usually, one or two spiders emerged from infested oothecae, but in July 2017, about 27 individuals were obtained from one ootheca as newly hatched juveniles. Salticidae was the most abundant family, which was represented by 27 and 25 samples including 18 and 13 samples of *Pseudicius spiniger* for 2017 and 2018 years, respectively. Eutichuridae family was represented by 6 and 7 samples in the first half of both years, respectively, however, this family was absent in the second half of both study years. Only one individual of *Cheiracanthium isiacum* was recorded in December 2017 and reappeared six times in 2018. All samples of *C. isiacum* emerged within the next week of collection for both study years except in sample of April 2018 however *C. isiacum* emerged from one ootheca in January 2019.

Ant (Formicidae: Hymenoptera):

The unidentified species of ant (formicidae: Hymenoptera) emerged in groups from incubated oothecae and frequented 5 and 7 times in 2017 and 2018 years respectively. The first emerged ants appeared on March 27, with 69 individuals from ootheca of February's sample, and the incubation period lasted about a month from the date of field collection. In the same year, the other four oothecae resulted in 54, 29, 29 and 21 of ants distributed on the dates of August 18&23, September 11 and October 8 for 2017 year respectively (Table 2). However, in 2018, the first emerged ants appeared on February 28, with 60 individuals from ootheca of February's sample. Moreover, the ant groups continued to appear for the other six dates and the numbers of ants fluctuated between a minimum of 6 in September 2 and a maximum of 116 on October 30 (Table 3). Data also revealed that the ant groups took varying periods of time to get out of the oothecae, which ranged between few days, as in the April sample, where the ants appeared after four days of collection and more than a month, as in the September sample, where the ants appeared at the end of October.

***Scolothrips* sp. (Thripidae: Thysanoptera):**

Data of 2017 year in Table (2) demonstrated that *Scolothrips* sp. emerged from two incubated oothecae with 9 and 6 individuals/ootheca for April and May samples respectively. While in Table (3) data of 2018 year revealed that, three oothecae of April samples were infested with 2, 14 and 19 individuals of *Scolothrips* sp. /ootheca.

Other Unidentified Hymenopteran Parasitoids:

Two un-identified hymenopteran parasitoids were found inhabiting mantis ootheca, the first (Unknown I) belonged to the Eupelmidae family and the other (Unknown II) was not identified to its family. Data in Table (2) showed that Eupelmid parasitoid (Unknown I) appeared five times on March 4&30, June 21&22 and December 1 with 1, 10, 1, 2 and 1 parasitoids /ootheca respectively, while the other hymenopteran parasitoid (Unknown II) appeared three times on March 29, July 5 and October 21 with 1, 2 and 1 parasitoids /ootheca, respectively. The same parasitoids were observed in the second year as shown in Table (3) where, Eupelmid parasitoid emerged in the rate of one parasitoid/ootheca for nine oothecae on February 26 (two oothecae were recorded), March 1&22, April 1 (two oothecae were recorded), June 13 &29 and October 27. Also, the other hymenopteran parasitoid

(Unknown II) emerged in 2018 year from five oothecae with two parasitoids /oothecae on July 5 and one parasitoid /oothecae on March 13 (two oothecae were recorded), August 26 and October 12.

Table 1: Hatched nymphs of mantis from oothecae collected from citrus orchards during 2017 and 2018 years

Collection date	2017				2018			
	Collected No. of oothecae	Hatching Date	Hatched No. of oothecae	No. of nymphs	Collected No. of oothecae	Hatching Date	Hatched No. of oothecae	No. of nymphs
January	58	March	2	140	83	March	2	54
February	45	February March	2	11 80	43	April	1	55
March	33	March April	4	295 56	47	April	3	205
April	39	April	3	116	36	April May	3	15 36
May	39	May July	4	65 250	50	June	2	15
June	44	June	4	138	32	July	2	83
July	56	July	4	324	58	July	6	58
August	28	September	2	155	21	September	1	727
September	59	September	1	28	86	September	1	100
October	56	October	1	7	62	October	2	19
November	32	February 2018	1	22	24		1	
December	41		0		33	February 2019	1	5
Total year	530		28	1536	575		25	
Mean Year	44.17		2.33	128	47.92		2.08	

* The minimum and maximum parasitoids/each parasitized oothecae
 ** Summation of parasitoids from each parasitized oothecae / No. of parasitized oothecae

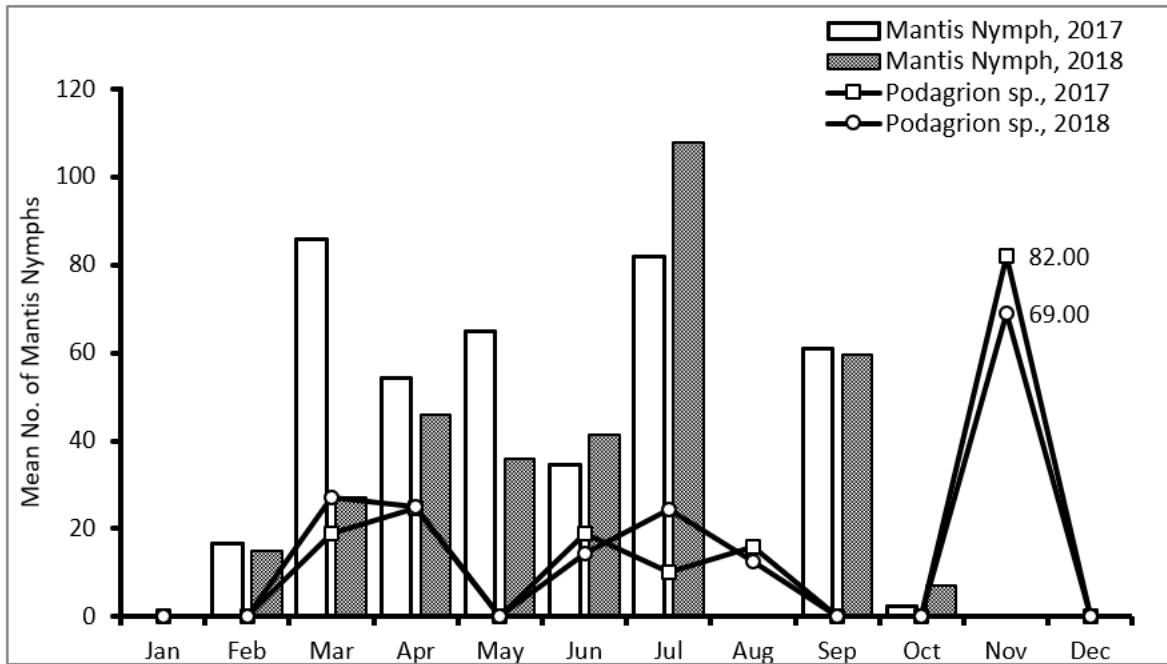


Fig. 1: Mean numbers of hatched nymphs of *S. viridis* and the oothecae parasitoid, *Podagrion* sp in 2017 and 2018 years

Table 2: Emerged parasitoids and predators from mantis oothecae collected from citrus orchards during 2017

Oothecae		Parasitoids				Predators			
Collecting date	Infested No. of oothecae	Emergence Date	No. of emerged	Scientific name	Family: order	Emerged Date	No.	Type	Family: order
January	2					Feb. 2 Apr 15	2 1	<i>Pseudicius spiniger</i> Eutichuridae	Salticidae: Araneae Order: Araneae
February	5	Mar. 4 Mar. 14 Jun. 14	1 19 12	<i>Un-Known I</i> <i>Podagrion</i> sp. <i>Podagrion</i> sp.	Eupelmidae: Hymenoptera Torymidae: Hymenoptera Torymidae: Hymenoptera	Mar. 27 Mar. 31	69 1	Ant <i>Pseudicius spiniger</i>	Formicidae: Hymenoptera Salticidae: Araneae
March	8	Mar. 29 Mar. 30 Apr. 6 Jul. 11 Aug. 1	1 10 1 10 22	<i>Un-Known II</i> <i>Un-Known I</i> <i>Podagrion</i> sp. <i>Podagrion</i> sp. <i>Podagrion</i> sp.	Order: Hymenoptera Eupelmidae: Hymenoptera Torymidae: Hymenoptera Torymidae: Hymenoptera Torymidae: Hymenoptera	Mar. 5 May. 3	1&1 2	Salticidae Eutichuridae	Order: Araneae Order: Araneae
April	7	Apr. 16 Apr. 30	41 32	<i>Podagrion</i> sp. <i>Podagrion</i> sp.	Torymidae: Hymenoptera Torymidae: Hymenoptera	Apr. 16 Apr. 18 Apr. 22 Apr. 28	2 1&2 1 9	<i>Pseudicius spiniger</i> <i>Pseudicius spiniger</i> Eutichuridae <i>Scolothrips</i> sp.	Salticidae: Araneae Salticidae: Araneae Order: Araneae Thripidae: Thysanoptera
May	9	Jun. 14 Jun. 22 Jul. 12	26 1 13	<i>Podagrion</i> sp. <i>Un-Known I</i> <i>Podagrion</i> sp.	Torymidae: Hymenoptera Eupelmidae: Hymenoptera Torymidae: Hymenoptera	May. 20 May. 21 May. 22 May. 22 May. 25	1 2&1 1 6 1	Eutichuridae <i>Pseudicius spiniger</i> Salticidae <i>Scolothrips</i> sp. Eutichuridae	Order: Araneae Salticidae: Araneae Salticidae: Araneae Order: Araneae Thripidae: Thysanoptera Order: Araneae
June	7	Jun. 21 Jul. 5 Jul. 5	2 7 2	<i>Un-Known I</i> <i>Podagrion</i> sp. <i>Un-Known II</i>	Eupelmidae: Hymenoptera Torymidae: Hymenoptera Order: Hymenoptera	Jun. 18 Jun. 21 Jul. 1	2 1 2&1	<i>Pseudicius spiniger</i> Eutichuridae <i>Pseudicius spiniger</i>	Salticidae: Araneae Order: Araneae Salticidae: Araneae
July	7	Aug. 3 Aug. 13	1 15	<i>Podagrion</i> sp. <i>Podagrion</i> sp.	Torymidae: Hymenoptera Torymidae: Hymenoptera	Jul. 7 Jul. 13 Jul. 16 Aug. 9 Aug. 18	2 1 27 1 54	Salticidae <i>Pseudicius spiniger</i> <i>Pseudicius spiniger</i> <i>Pseudicius spiniger</i> Ant	Order: Araneae Salticidae: Araneae Salticidae: Araneae Salticidae: Araneae Formicidae: Hymenoptera
August	6	Aug. 9	26	<i>Podagrion</i> sp.	Torymidae: Hymenoptera	Aug. 12 Aug. 23 Aug. 30 Sep. 4	1 29 2 1&1	<i>Pseudicius spiniger</i> Ant <i>Pseudicius spiniger</i> Salticidae	Salticidae: Araneae Formicidae: Hymenoptera Salticidae: Araneae Order: Araneae
September	4					Sep. 11 Sep. 16 Sep. 23 Oct. 8	29 2 2 21	Ant <i>Pseudicius spiniger</i> Salticidae Ant	Formicidae: Hymenoptera Salticidae: Araneae Order: Araneae Formicidae: Hymenoptera
October	4	Oct. 21 Nov. 9 Nov. 19	1 76 88	<i>Un-Known II</i> <i>Podagrion</i> sp. <i>Podagrion</i> sp.	Order: Hymenoptera Torymidae: Hymenoptera Torymidae: Hymenoptera	Oct. 8	1	Salticidae	Order: Araneae
November	3	Mar. 11, 2019	41	<i>Podagrion</i> sp.	Torymidae: Hymenoptera	Nov. 19 Nov. 19	1 1	Salticidae <i>Pseudicius spiniger</i>	Order: Araneae Salticidae: Araneae
December	3	Dec. 1	1	Un-Known I	Eupelmidae: Hymenoptera	Dec. 13 Dec. 26	1 1	<i>Cheiracanthium isiacum</i> <i>Pseudicius spiniger</i>	Cheiracanthidae: Araneae Salticidae: Araneae

Table 3: Emerged parasitoids and predators from mantis oothecae collected from citrus orchards during 2018

Oothecae		Parasitoids				Predators			
Collecting date	Infested No. of oothecae	Emergence Date	No. of emerged	Scientific name	Family: order	Emerged Date	No.	Type	Family: order
Jan	5	Mar. 13	13	<i>Podagrion</i> sp.	Torymidae: Hymenoptera	Jan. 22 Feb. 11 Feb. 20	1 1&1 1	<i>Pseudicius spiniger</i> <i>Pseudicius spiniger</i> Eutichuridae	Salticidae: Araneae Salticidae: Araneae Order: Araneae
Feb	11	Feb. 26 Mar. 1 Mar. 13 Jun. 12 Jul. 12	1&1 1 1&1 35 2	<i>Un-Known I</i> <i>Un-Known I</i> <i>Un-Known II</i> <i>Podagrion</i> sp. <i>Podagrion</i> sp.	Eupelmidae: Hymenoptera Eupelmidae: Hymenoptera Order: Hymenoptera Torymidae: Hymenoptera Torymidae: Hymenoptera	Feb. 6 Feb. 28 Mar. 5	1 60 1	<i>Pseudicius spiniger</i> Ant <i>Pseudicius spiniger</i>	Salticidae: Araneae Formicidae: Hymenoptera Salticidae: Araneae
Mar	8	Mar. 22 Apr. 1	1 1&1	<i>Un-Known I</i> <i>Un-Known I</i>	Eupelmidae: Hymenoptera Eupelmidae: Hymenoptera	Mar. 14 Mar. 19 Mar. 27 Mar. 29	1 2 1&1 21	<i>C. isiacum</i> Eutichuridae Salticidae Ant	Cheiracanthidae: Araneae Order: Araneae Order: Araneae Formicidae: Hymenoptera
Apr	9	Apr. 16 Aug. 1	25 14	<i>Podagrion</i> sp. <i>Podagrion</i> sp.	Torymidae: Hymenoptera Torymidae: Hymenoptera	Apr. 4 Apr. 30 May. 2 May. 17 May. 22 Jan. 30, 2019	12 2 1&1 14 19 2	Ant <i>Scolothrips</i> sp. Eutichuridae <i>Scolothrips</i> sp. <i>Scolothrips</i> sp. <i>C. isiacum</i>	Formicidae: Hymenoptera Thripidae: Thysanoptera Order: Araneae Thripidae: Thysanoptera Thripidae: Thysanoptera Cheiracanthidae: Araneae
May	8	Jun. 1 Jun. 13 Jun. 20 Jun. 29	6 1 2 1	<i>Podagrion</i> sp. <i>Un-Known I</i> <i>Podagrion</i> sp. <i>Un-Known I</i>	Torymidae: Hymenoptera Eupelmidae: Hymenoptera Torymidae: Hymenoptera Eupelmidae: Hymenoptera	May. 7 May. 8 Jun. 23 Jul. 2	9 1 2 1	Salticidae Eutichuridae Eutichuridae Salticidae	Order: Araneae Order: Araneae Order: Araneae Order: Araneae
Jun	5	Jul. 5	2	Un-Known II	Order: Hymenoptera	Jul. 3 Jul. 6 Jul. 10 Jul. 28	2 1 1 1	Salticidae <i>Pseudicius spiniger</i> Eutichuridae <i>Pseudicius spiniger</i>	Order: Araneae Salticidae: Araneae Order: Araneae Salticidae: Araneae
Jul	8	Jul. 15 Jul. 29 Jul. 30 Aug. 12	16 30 50 11	<i>Podagrion</i> sp. <i>Podagrion</i> sp. <i>Podagrion</i> sp. <i>Podagrion</i> sp.	Torymidae: Hymenoptera Torymidae: Hymenoptera Torymidae: Hymenoptera Torymidae: Hymenoptera	Jul. 22 Jul. 25 Jul. 26 Jul. 30	4 1 1 1	Ant Salticidae <i>C. isiacum</i> <i>Pseudicius spiniger</i>	Formicidae: Hymenoptera Order: Araneae Cheiracanthidae: Araneae Salticidae: Araneae
Aug	6	Aug. 26	2	Un-Known II	Order: Hymenoptera	Aug. 12 Aug. 11 Aug. 16 Aug. 18 Aug. 21	1 2 22 1 2	<i>Pseudicius spiniger</i> Salticidae Ant <i>Pseudicius spiniger</i> Salticidae	Salticidae: Araneae Order: Araneae Formicidae: Hymenoptera Salticidae: Araneae Order: Araneae
Sep	9					Sep. 2 Sep. 8 Sep. 17 Sep. 21 Oct. 30	6 1 1&1 2&1 116	Ant <i>Pseudicius spiniger</i> Salticidae <i>C. isiacum</i> Ant	Formicidae: Hymenoptera Salticidae: Araneae Order: Araneae Cheiracanthidae: Araneae Formicidae: Hymenoptera
Oct	5	Oct. 12 Oct. 27	1 1	Un-Known II Un-Known I	Order: Hymenoptera Eupelmidae: Hymenoptera	Oct. 3 Oct. 11 Oct. 29	1 2 2	Salticidae <i>Pseudicius spiniger</i> <i>C. isiacum</i>	Order: Araneae Salticidae: Araneae Cheiracanthidae: Araneae
Nov	2	Nov. 10 Nov. 20	116 22	<i>Podagrion</i> sp. <i>Podagrion</i> sp.	Torymidae: Hymenoptera Torymidae: Hymenoptera				
Dec	2					Dec. 4 Dec. 23	1 1	<i>Pseudicius spiniger</i> Salticidae	Salticidae: Araneae Order: Araneae

Incomplete Parasitism of Unhatched Oothecae:

Incomplete parasitism was calculated after dissection of oothecae and the obtained data were summarized in Table (4). Data revealed that the highest parasitism rate of oothecae was in May's sample with 69.23% of dissected oothecae resulted in a total of 158 parasitoids/oothecae that, were ranged from 4 to 33 parasitoids/ootheca with an average 14.3 ± 8.66 parasitoids, while the lowest rate was recorded in September's sample with 35.59% of dissected oothecae resulted in a total of 238 parasitoids/oothecae that, e ranged from 3 to 20 parasitoids/ootheca with an average 8.48 ± 4.07 parasitoids for 2017 year (Table 4). In the same table, data for 2018 showed that the highest parasitism rate of oothecae was in March's sample with 65.96% of dissected oothecae resulted in a total of 193 parasitoids/oothecae that ranged from 3 to 17 parasitoids/ootheca with an average 8 ± 3.54 parasitoids, while the lowest rate was recorded in September's sample with 30.23% of dissected oothecae resulted in a total of 178 parasitoids/oothecae that, were ranged from 2 to 21 parasitoids/ootheca with an average 9.15 ± 4.34 parasitoids. Generally, 54.72% and 47.13% of dissected oothecae were parasitized for 2017 and 2018 years respectively. Maximum monthly total numbers of extracted parasitoids from parasitized oothecae were recorded in July by 513 and 398 parasitoids with mean numbers of 11.06 ± 6.41 and 15.55 ± 11.3 parasitoid/ootheca for 2017 and 2018 years, respectively, while the minimum monthly total numbers of extracted parasitoids from parasitized oothecae were recorded in November by 57 and 101 parasitoids/ootheca for 2017 and 2018 years, respectively.

Table 4: percent of parasitized oothecae and mean number of incomplete parasitoids depending on dissected of un-hatched oothecae for 2017 and 2018 years

Collected date	2017						2018					
	No. of un parasitized oothecae	Parasitized oothecae		Extracted parasitoids			No. of un parasitized oothecae	Parasitized oothecae		Extracted parasitoids		
		No.	%	No.	Mean \pm SE**	Range /ootheca*		No.	%	No.	Mean \pm SE**	Range /ootheca*
January	30	28	48.28	289	11.36 \pm 4.55	4-21	49	34	40.96	318	9.52 \pm 8.15	3-26
February	14	31	68.89	200	9.97 \pm 4.98	3-20	21	22	51.16	309	11.73 \pm 10.3	1-35
March	14	19	57.58	248	10.16 \pm 6.25	3-22	16	31	65.96	193	8 \pm 3.54	3-17
April	19	20	51.28	77	13.2 \pm 8.45	3-32	19	17	47.22	264	4.53 \pm 2.4	1-9
May	12	27	69.23	158	14.3 \pm 8.66	4-33	29	21	42.00	386	7.52 \pm 3.03	2-13
June	14	30	68.18	135	9.47 \pm 3.75	4-19	14	18	56.25	284	7.5 \pm 3.85	3-18
July	20	36	64.29	513	11.06 \pm 6.41	3-27	25	33	56.90	398	15.55 \pm 11.3	5-57
August	12	16	57.14	110	9.25 \pm 4.02	3-18	9	12	57.14	148	9.17 \pm 3.85	3-17
September	38	21	35.59	238	8.48 \pm 4.07	3-20	60	26	30.23	178	9.15 \pm 4.34	2-21
October	32	24	42.86	283	12.21 \pm 5.42	5-23	32	30	48.39	293	9.43 \pm 5.08	3-23
November	17	15	46.88	57	6.73 \pm 2.77	3-12	15	9	37.50	101	6.33 \pm 2.05	3-10
December	18	23	56.10	191	7.39 \pm 3.6	3-19	15	18	54.55	170	9.52 \pm 8.15	
Total year	240	290		208.25			304	271		3042		
Mean Year	20	24.17		2499			25.33	22.58		253.5		

* The minimum and maximum parasitoids/each parasitized oothecae

** Summation of parasitoids from each parasitized oothecae / No. of parasitized oothecae

DISCUSSION

Based on the last systematic survey of Mantodea in Egypt, the recorded species of mantids *S. viridis*, *M. paykullii* and *M. religiosa* were confirmed by Mohammad *et al.*, (2011). In general agreement with hatched nymphs results, Zohdy and Younis (2003) in Egypt recorded the highest mean numbers of progeny production of *S. viridis* was 207.5 ± 5.7 nymph/ootheca and the lowest mean numbers were 62 ± 7.8 nymph/ootheca. Also, Rains (2010) recorded that, more than two hundred mantid nymphs may emerge from a single egg casing.

The parasitoid *Podagrion* sp. was previously recorded on oothecae of mantis by Mani and Kaul (1972), Pawar *et al.*, (1985), Farooqui (1986), Grissell (1995), Askew *et al.*, (2001) and Delvare (2005). Also, Cassar (2016) recorded oothecae belonging to *Mantis religiosa*, proved to be parasitized by *P. splendens*, representing a new record for Malta. This genus was previously recorded from Egypt by Masi (1935) and Westwood (1847), without a specific locality, but Gadallah *et al.*, (2014) described *P. klugianum* that collect from Egyptian clover. On the other hand, in general agreement with the parasitoid numbers, Bakthavatsalam (1995) recorded that, eggs of mantids, *T. aridifolia*, and *M. religiosa* were observed to be parasitized by *Podagrion* sp. with 28% (n=25) and 40.6% (n=32) of the oothecae, during 1987 and 1988 years, and the average number of parasitoids that emerged from each ootheca was 214, 2 and 198.2 during 1987 and 1988 respectively.

The presence of spiders with oothecae enhances the assumptions of intraguild predation (IGP), in which spiders interfere negatively, as indicated by this Hodge (1999) and directly limit the populations of other predators (Wagner & Wise, 1996 and Wissinger *et al.*, 1996). The identified spiders agree in terms of species and in terms of species abundance with Mohafez *et al.* (2010) and El-Gepaly *et al.*, (2018) in the same study environment where they concluded that Salticidae was dominant on citrus trees and continued to appear almost at any time in Sohag, Egypt. Also, Ahmed (2018) recorded individuals of *C. isiacum* and family Eutichuridae live in association with different insects and mites infesting orchards.

Regarding the presence of ants, this behavior is uncommon for ants' social life, and there are no available references regarding this point, but depending on Wikipedia, "Ants form colonies that range in size from a few dozen predatory individuals living in small natural cavities to highly organized colonies consist of millions of individuals." Therefore, these recorded ants might be from the first case in which ants live as small predatory groups. In a Ph.D. study, Sharaf (2005) presented some of the interactions between ants and some organisms and concluded that eggs of many arthropods are eaten by various genera of ants. No specific studies were found dealing with the interaction between ants and oothecae of the mantis. Also, there is no research study indicating a relationship between thrips and mantis, but it was reported that the thrips genus *Scolothrips* were well known as predators of mites on the leaves of plants (Gilstrap 1995).

For unknown parasitoids, the exact host of these unidentified parasitoids is not known, they might be hyper-parasitoids. An unidentified species of Eupelmidae was recorded from India on mantids oothecae by Veenakumari and Mohanraj (2017) when they studied the parasitoid *Mantibaria* sp. as egg-parasites of mantids. Also, Oliveira and Schoeninnger (2017) recorded *Mantibaria* sp. as egg-parasites of mantids.

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ARABIC SUMMARY

تواجد اكياس بيض فرس النبي واعدائها الطبيعية في بساتين الموالح في سوهاج, مصر

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كان فرس النبي الافريقي العملاق (*Sphodromantis viridis* Forsskål, 1775 (Mantodea: Mantidae) أكثر أنواع فرس النبي تواجدا في بساتين الموالح بمحافظة سوهاج بمصر خلال الاعوام ٢٠١٧ و ٢٠١٨. الي جانب ذلك لوحظ بندرة فرس النبي المصري (*Miomantis paykullii* (Stal, 1871) وفرس النبي الاوربي *Mantis religiosa*. تم جمع حوالي ٥٣٠ و ٥٧٥ من اكياس بيض فرس النبي في الاعوام ٢٠١٧ و ٢٠١٨ علي التوالي من حوالي ٤٦ هكتار من اشجار الموالح. نتج عن تحضين هذه الاكياس فونا معقدة مكونة من اربعة انواع تابعة لرتبة غشائية الاجنحة هم (*Podagrion* sp. (Torymidae: Hymenoptera) و *Eupelmidae* & *formicidae* (Hymenoptera) ونوع اخر غير معرف من رتبة غشائية الاجنحة, ايضا تم تسجيل اربعة انواع عناكب مفترسة والترس المفترس.

من بين اكياس البيض التي تم جمعها, ٢٨ و ٢٥ كيس بيض فقس لحوريات فرس النبي نتج عنهم ١٥٣٦ و ١٣١٨ للاعوام ٢٠١٧ و ٢٠١٨ علي الترتيب. كان الطفيل *Podagrion* sp. هو اكثر الانواع الطفيلية شيوعا وكان اعلي متوسط للطفيليات/كيس بيض في نوفمبر بمتوسط ٨٨ و ١١٦ طفيل/كيس بيض للاعوام ٢٠١٧ و ٢٠١٨ علي الترتيب. كانت العناكب هي الاكثر تكرارا بين فونا اكياس البيض حيث كانت تخرج العناكب في اطوارها الغير كاملة والكاملة. تم حساب النطفل الغير مكتمل بعد تشريح اكياس البيض وكان اعلي معدل تطفل علي اكياس البيض في مايو ومارس للاعوام ٢٠١٧ و ٢٠١٨ علي الترتيب, بينما سجل اقل معدل في سبتمبر لكلا عامي الدراسة.