Voracity and Predation Preference of Two Predators on the Two-spotted Spider Mite, *Tetranychus urticae* Koch (Acari: Tetranychidae)

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ABSTRACT: Voracity and predation preference of the predatory beetle, *Stethorus gilvifrons* Mulsant, predatory bug, *Orius albidipenis* Reuter, predatory thrips, *Scolothrips longicornis* Priesner and predacious mites, *Phytoseiulus macropilis* Banks, *Phytoseiulus persimilis* Athias-Henriot , were reared on both egg and motile stages of the two-spotted spider mite, *Tetranychus urticae* Koch under laboratory conditions. The daily consumption of certain predators on the stages of the prey was observed. It prevailed that all studied predators consumed eggs more than motile stages of *T. urticae*. The daily grand mean of consumed eggs were: 41.83, 33.20, 35.87, 28.07 and 26.30 eggs, whereas the daily grand mean of consumed motile stages were: 35.37, 27.17, 31.03, 23.33 and 21.73 individuals for *S. gilvifrons*, *O. albidipenis*, *S. longicornis*, *P. macropilis* and *P. persimilis*, respectively. The predatory beetle, *S. gilvifrons* was the most voracious one compared to other predators. The predation preference was not significantly for *S. gilvifrons*, whereas, *O. albidipenis* and *S. longicornis* were preferred egg than motile stage, while predaceous mites, *P. macropilis* and *P. persimilis* were preferred motile stages than egg stage of spider mites. Results indicated that all studied predators are effective on *T. urticae* stages and insectal predators preferred egg stage, while predacious mites preferred motile stages of the two-spotted spider mite.
Key words: comparative voracity, predation preference, predators and spider mite

INTRODUCTION

The two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae), is considered one of the most phytophagous species. It is a widespread agricultural pest, causing severe damage on most of vegetable and field crops. Spider mites are difficult to control with acaricides due to inaccessibility of lower leaf surfaces, short life cycle, high reproductive capacity, and ability to develop resistance to miticides (Naher *et al*., 2005 and Ibrahim *et al*., 2016). This species is adapted to various environmental conditions and is distributed worldwide, causing loss of quality and yield or the death of the plants by sucking out the contents from the leaf cells (Granham, 1985). The problem of spider mite increased when natural enemies are destroyed by applications of broad spectrum insecticide, applied against other pests.However, *T. urticae* has several important natural enemies that play important role in their ecology, including lady beetles (Coleoptera: Coccinellidae) (Mori *et al*. 2005), predatory anthocorids (Heteroptera: Anthocoridae) (Cocuzza *et al*., 1997), and predaceous mites (Acari: Phytoseiidae) (Gotoh *et al*., 2004, Abdel-Aziz, 2016). In addition, acarophagous thrips (Thysanoptera: Aeolothripidae, Thripidae) are important natural enemies, and have various degrees of specialization on various mites (Pakyari *et al*., 2011).

Acarophagous insects, including species of the *Stethorus* are obligate predators of spider mites (Rott and Ponsonby, 2000) and several species have been reported to be effective as biological control agents (Gotoh *et al*., 2004; Mori *et al*. 2005). They are known to be voracious predators with all motile stages feeding on all prey stages, having high host-finding and high dispersal potential, and long-living adults (Roy *et al*., 2005). Both larvae and adult beetles feed on all stages of spider mites. Adults can eat 50 mite eggs per day or 10 adults and can consume 240 spider mites during their developmental period. Among the predators used mainly in controlling spider mites is the specialist predatory thrips *Scolothrips longicornis* (Priesner), which consumes on all stages of spider mites (Kheradpir *et al*., 2013). The predatory mite *Phytoseiulus persimilis* Athias-Henriot has been studied extensively with respect to its potential for biological control of tetranychid mites on vegetables and ornamentals in greenhouses (Friese and Gilstrap, 1982, Van Lenteren and Woets, 1988, McMurtry and Croft, 1997). With the exception of larvae, all immature stages and adult of *P. persimilis* feed exclusively on tetranychid mite eggs, immatures, and adults (Chittenden and Saito, 2001); however, *P. persimilis* demonstrated a significant preference for eggs, it is a selective predator that is able to suppress spider mites rapidly, due to a high numerical and functional response (Blackwood *et al*., 2001). A bio control measure to be effective by predators, the knowledge on their feeding nature, feeding efficiency or voracity is very much essential (Haque, 2005; Parvin and Haque, 2008).

Measuring the voracity of predators is an important step in assessing the potential of biological control agents. Therefore, it is important to know the prey preference of the predator. Assessing preference by presenting the two prey species in equal numbers is an incomplete test because the predator response is strongly influenced by the ratio of the two preys presented. When tested with different prey ratios, a predator can show four types of response, i.e., (1) a constant preference for one prey species, (2) no preference, when the ratio of consumed prey is equal to the ratio of prey individuals in the environment, (3) a switching behavior, when the predator eats disproportionally more of the more abundant prey, and (4) an anti-switching behavior, when the predator eats disproportionally more of the less abundant prey (Chesson, 1984). Biological control is an alternative strategy for management of mites in agricultural systems. It is necessary to minimize the pollution hazards caused by huge amount of chemicals that have been used for management of various pests in different crops.

This study aimed to compare the voracity, predation preferences and efficiency of *S. gilvifrons*, *O. albidipenis, S. longicornis, P. macropilis* and *P. persimilis* towards the egg and motile stages of *T. urticae*.

MATERIALS AND METHODS

Maintenance of the colonies:

Culture of mite:

The two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) was collected from naturally infested Kidney bean, *Phaseolus vulgaris* (L.) fields in El-Hosainia plain district, El-Sharkia Governorate. A mass culture of the two-spotted spider mite was maintained on potted Kidney bean plants in the laboratory of Plant Protection Department at El-Hosainia Agricultural Research Station for more than six months. The method adopted by Guirguis *et al*. (1977) was employed for mass culture of the two-spotted spider mite.

Culture of predators:

The original samples of the predators; coccinellid predatory beetles, *Stethorus gilvifrons* (Mulsant) (Coleoptera: Coccinellidae), the predatory bugs, *Orius albidipenis* (Reuter) (Hemiptera: Anthocoridae), the predatory thrips, *Scolothrips longicornis* Priesner (Thysanoptera: Thripidae) and the phytoseiid predacious mites, *Phytoseiulus macropilis* (Banks), *Phytoseiulus persimilis* (Athias-Henriot) (Acari: Phytoseiidae), used in this experiment were collected from Castor bean plants, *Ricinus communis* in El-Hosainia plain district, where they appeared grown naturally in the area and brought to the laboratory. Later they were studied and identified at the laboratories of the Plant Protection Research Institute, ARC of Egypt.

The method adopted by Sarhan *et al*. (1989) was followed for rearing the predatory beetles; *S. gilvifrons*, the predatory bugs; *O. albidipenis* was reared according to the method of Isenhour and Yeargan (1981), the predatory thrips; *S. longicornis* was reared according to the method of Gotoh *et al*. (2004) and the method adopted by Heikal and Ali (1996) was employed for rearing the phytoseiid predaceous mites; *P. macropilis* and *P. persimilis*.

Voracity of certain predators:

Several pilot experiments were made with the predator to confirm their predation on the two-spotted spider mite. After being confirmed of their predation on mites they were released on potted bean plants that were infested earlier by the two-spotted spider mite. They were maintained for six months before testing their efficiency. Voracity of predators on egg and motile stage of the two-spotted spider mite was conducted in laboratory.

The experiments were conducted as follow:

1. In the first experiment, testing the voracity of *S. gilvifrons* on motile stage and egg of *T. urticae*. The test consisted of two treatments: one Adult of *S. givifrons* with 60 motile stage of spider mites and one adult of *S. gilvifrons* with 60 egg of spider mites.
2. In the second experiment, testing the voracity of *O. albidipenis* on motile stage and egg of *T. urticae*. The test consisted of two treatments: one adult of *O. albidipenis* with 60 motile stage of spider mites and one adult of *O. albidipenis* with 60 egg of spider mites.
3. In the third experiment, testing the voracity of *S. longicornis* on motile stage and egg of *T. urticae*. The test consisted of two treatments: one Adult of *S. longicornis* with 60 motile stage of spider mites and one adult of *S. longicornis* with 60 egg of spider mites.
4. In the fourth experiment, testing the voracity of *P. macropilis* on motile stage and egg of *T. urticae*. The test consisted of two treatments: one Adult of *P. macropilis* with 60 motile stage of spider mites and one adult of *P. macropilis* with 60 egg of spider mites.
5. In the fifth experiment, testing the voracity of *P. persimilis* on motile stage and egg of *T. urticae*. The test consisted of two treatments: one Adult of *P. persimilis* with 60 motile stage of spider mites and one adult of *P. persimilis* with 60 egg of spider mites.
6. In the sixth experiment, the control treatment without any predators containing only the prey (motile stage and egg) of *T. urticae.*

All the previously mentioned experiments were carried out based on three replicates.

The experiments were carried out on Kidney bean plants grown in a laboratory and cleared of all arthropods before the experiments. The equally-sized and undamaged of six plant leaves were prepared for each experiment. Plant leaves were placed on cotton bed in petri dish (2 cm high with a 9 cm diameter) facing under surface upward. Each species of predator having three replications were conducted simultaneously for each prey.

Sixty individuals of each prey were transferred on each leaf in each petri dish. The individuals were transferred to new leaves very carefully with the help of fine hairbrush. The tested predators were fed and then starved for 24 hrs. before the experiments. One predator was released per each leaf which containing preys. The Petri dishes were covered by muslin to avoid excessive moisture, then placed in an incubator (25°C, 65% R.H., L14:D10) during 24 hrs. The cotton bed was kept wet by soaking with water twice daily to maintain their freshness. Thirty six Petri dishes were used for all experiments, three replicates for each predator on each prey, including the replicates of control treatment. After 24 hours, the Petri dishes were placed in a refrigerator for 15 min and checked. The unconsumed preys were counted with a binocular microscope according to Sabelis (1985). The number of prey consumed per days by an individual of predators was recorded. After counting each consumption sufficient number of preys was added to the leaves to maintain the prey's number. Leaves were changed when necessary considering the freshness of them. The experiments were continued for three consecutive days.

Estimation of mite consumption:

The predation of each predator was conducted individually on an excised of kidney bean leaf. Analyses were carried out on the data adjusted with the control treatments using the following equation:

$$C = C_1 - T$$

Where C = number of preys consumed after 24 hr., C_1 = number of preys not found in the test, and T = number of preys not found in the control treatment.

Predation efficiency and prey preferences:

Five treatments, corresponding to five different ratios of prey, were presented to each tested predator, enclosed in an experimental set up as previously described. Each replicate contained the following treatments: one predator with 10 motile stage and 50 egg of spider mites, one predator with 20 motile stage and 40 egg of spider mites, one predator with 30 motile stage and 30 egg of spider mites, one predator with 40 motile stage and 20 egg of spider mites and one predator with 50 motile stage and 10 eggs of spider mites. For prey preferences, the dependent variable was the consumed spider mite ratio, i.e., the number of spider mites consumed over the total number of prey consumed. For the five treatments (egg/ motile: 10/50, 20/40, 30/30, 40/20, 50/10), the consumed spider mite ratios were compared to the proposed spider mite ratios. Confidence intervals of the mean consumed spider mite ratios were calculated at p = 0.05. The proposed spider mite ratio was then compared to the confidence interval of the corresponding consumed spider mite ratio. The mean consumed spider mite ratios were compared with a two-way ANOVA (prey ratio and predator species) using Manly's preference index (Manly *et al*., 1972). The Manly's preference index was the method that took into account the prey densities depletion by predation during experiments. Reviewing the literature on feeding preference. Sherratt and Harvey (1993) concluded accordingly Manly's preference index:

$$a = (r_1/n_1) / (r_1/n_1 + r_2/n_2)$$

Where a = feeding preference, r_1 = proportion of prey type 1 in the predators diet (where r_1 = egg of mite), n_1 = proportion of prey type 1 available (0.20, 0.50, 1.00, 1.50 and 5.00), and r_2 = proportion of prey type 2 in the predator diet (here r_2 = motile of mite), n_2 = proportion of prey type 2 available (5.00, 1.50, 1.00, 0.50 and 0.20). The predation efficiency was estimated from the total number of prey consumed by the predator for each initial ratio.

RESULTS AND DISCUSSION

Voracity of certain predators:

The daily means consumption of egg and motile stage of *T. urticae* by different predators for three consecutive days are presented in Table (1). During all days of the tested periods the predators consumed more egg than motile stage and vary significantly during different days except few exceptions.

The predation of *S. gilvifrons* on egg and motile stage of *T. urticae* differed significantly among different days. The means of consumption of *S. gilvifrons* were 41.83 and 35.37 individuals of egg and motile stage of *T. urticae*, respectively.

The daily means consumption of *O. albidipenis* on *T. urticae* varies significantly among the different days. The predator consumed more egg than motile stage of prey. The means of consumption of *O. albidipenis* were 33.20 and 27.17 individuals of egg and motile stage of *T. urticae*, respectively.

Table (1). The daily means consumption of egg and motile stage of *T. urticae* by certain predators

Tested predators	Prey *T. urticae*	*Means consumption of preys by certain predators ($C = C_1$-T)			Grand mean	Comparative voracity	LSD
		1st day	2nd day	3rd day			
S. gilvifrons	egg	43.5^a	40.3^c	41.7^b	41.83	100	1.32
	motile	36.2^a	34.6^c	35.3^b	35.37	100	0.63
O. albidipenis	egg	34.9^a	31.5^c	33.2^b	33.20	79.4	1.51
	motile	27.4^b	25.5^c	28.6^a	27.17	76.8	1.16
S. longicornis	egg	37.5^a	35.4^c	34.7^b	35.87	85.8	0.65
	motile	31.6^a	30.2^{ab}	31.3^a	31.03	87.7	1.41
P. macropilis	egg	30.5^a	26.3^b	27.4^b	28.07	67.1	2.73
	motile	24.7^a	21.5^c	23.8^b	23.33	65.9	0.81
P. persimilis	egg	28.4^a	26.2^b	24.3^c	26.30	62.9	1.85
	motile	23.1^a	20.4^{bc}	21.7^b	21.73	61.4	1.31
LSD					1.13		

*Means within rows followed by the same letters are not significantly different at P=0.05

The daily means consumption of *S. longicornis* on *T. urticae* varies significantly among the different days except predation of motile. The predator consumed more egg than motile stage of prey. The means of consumption of *S. longicornis* were 35.87 and 31.03 individuals of egg and motile stage of *T. urticae*, respectively.

The daily means consumption of *P. macropilis* on *T. urticae* varies significantly among the different days except predation of motile. The predator consumed more egg than adult stages of prey. The means of consumption of *P. macropilis* were 28.07 and 23.33 individuals of egg and motile stage of *T. urticae*, respectively.

The daily means consumption of *P. persimilis* on *T. urticae* varies significantly among the different days. The predator consumed more egg than motile stage of prey. The means of consumption of *P. persimilis* were 26.30 and 21.73 individuals of egg and motile stage of *T. urticae*, respectively.

In most of the cases daily consumption varies significantly among different days, predation rate of different predators on egg and motile stage of *T. urticae* differed remarkably. The voracity of all tested predators to egg and motile stage of *T. urticae* in first day of experiments are more than other days that may be due to its starved in the day before.

Predation efficiency:

The total number of prey consumed differed significantly according to predator's species and prey ratios (Table 2). The values of consumed egg ranged from 6.4 to 36.1 individuals for a ratio of 10 egg/50 motile and for ratio of 50 egg/10 motile mites, whereas values of consumed motile ranged from 35.6 to 5.8 individuals for a ratio of 10 egg/50 motile and for ratio of 50 egg/10 motile mite for the predator *S. gilvifrons*, respectively.

Table (2). Mean numbers of prey consumed in 24 hrs by 5 predators for different ratios of egg/ motile of spider mite, *T. urticae*

Proposed egg/motile of spider mite	*Mean number of prey consumed in 24 hrs (r_1/n_1)									
	S. gilvifrons		*O. albidipenis*		*S. longicornis*		*P. macropilis*		*P. persimilis*	
	egg	motile	egg	motile	egg	motile	egg	motile	egg	motile
10/50	6.4^e	35.6^a	6.1^d	27.5^a	7.3^e	30.7^a	4.5^e	25.1^a	3.2^d	21.5^a
20/40	12.5^d	31.4^b	13.5^c	24.6^b	14.5^d	27.4^b	7.1^d	20.7^b	6.1^d	18.2^b
30/30	23.1^c	22.5^b	23.7^b	21.3^c	22.1^c	20.5^b	13.4^c	15.3^c	11.5^c	12.3^c
40/20	30.7^b	13.1^d	31.5^a	10.4^d	31.7^b	11.3^d	17.8^b	11.5^d	15.2^b	9.4^c
50/10	36.1^a	5.8^e	32.3^a	5.7^e	37.2^a	4.7^e	25.3^a	5.2^e	23.1^a	3.2^d
Total	108.8	108.4	107.1	89.5	112.8	94.6	68.1	77.8	59.1	64.6
Average	21.76	21.68	21.42	17.90	22.56	18.92	13.62	15.56	11.82	12.92
Consumed egg+motile	43.44		39.32		41.48		29.18		24.74	

*Means within columns followed by the same letters are not significantly different at P<0.05

The values of consumed egg ranged from 6.1 to 32.3 egg for a ratio of 10 egg/50 motile and for ratio of 50 egg/10 motile mites, whereas values of consumed motile ranged from 27.5 to 5.7 individuals for a ratio of 10 egg/50 motile and for ratio of 50 egg/10 motile mite for the predator *O. albidipenis*, respectively.

The values of consumed egg ranged from 7.3 to 37.2 individuals for a ratio of 10 egg/50 motile and for ratio of 50 egg/10 motile mites, whereas values of consumed motile ranged from 30.7 to 4.7 individuals for a ratio of 10 egg/50 motile and for ratio of 50 egg/10 motile mite for the predator *S. longicornis*, respectively. The values of consumed egg ranged from 4.5 to 25.3 individuals for a ratio of 10 egg/50 motile and for ratio of 50 egg/10 motile mites, whereas values of consumed motile ranged from 25.1 to 5.2 individuals for a ratio of 10 egg/50 motile and for ratio of 50 egg/10 motile mite for the predator *P. macropilis*, respectively. The values of consumed egg ranged from 3.2 to 23.1 individuals for a ratio of 10 egg/50 motile and for ratio of 50 egg/10 motile mites, whereas values of consumed motile ranged from 21.5 to 3.2 individuals for a ratio of 10 egg/50 motile and for ratio of 50 egg/10 motile mite for the predator *P. persimilis*, respectively. The mean numbers of total consumed (egg plus motile) were 43.44, 39.32, 41.48, 29.18 and 24.74 individuals for *S. gilvifrons*, *O. albidipenis*, *S. longicornis*, *P. macropilis* and *P. persimilis*, respectively (Table 2). There were significant differences found between these extreme values. The total numbers of adults consumed decreased gradually as the proportion of egg increased. Also, total numbers of egg consumed decreased gradually as the proportion of motile mites increased.

Prey preference:

The Manly's preference index for different ratios of egg and motile of *T. urticae* over total prey proposed (egg plus motile of prey) for certain predators shown in Table (3). The means of preference index was not significantly for *S. gilvifrons*. While, *O. albidipenis* and *S. longicornis* more preferring egg than motile of spider mite with preference index (1.13, 1.17) for egg and (0.87, 0.83) for motile of spider mite, respectively. Whereas, the phytoseiid predaceous mites, *P. macropilis* and *P. persimilis* more preferring motile than egg of spider mites with preference index (1.17, 1.13) for motile and (0.83, 0.87) for egg of spider mite, respectively.

Table (3). Manly's preference index for different ratios of egg and motile of *T. urticae* over total prey proposed (eggs plus motile of prey) for certain predators

Proposed egg/motile of spider mite	*Manly`s preference index $a = (r_1/n_1) / (r_1/n_1 + r_2/n_2)$									
	S. gilvifrons		*O. albidipenis*		*S. longicornis*		*P. macropilis*		*P. persimilis*	
	egg	motile	egg	motile	egg	motile	egg	motile	egg	motile
10/50	0.15	0.85	0.18	0.82	0.19	0.81	0.15	0.85	0.13	0.87
20/40	0.28	0.72	0.35	0.65	0.35	0.65	0.26	0.74	0.25	0.75
30/30	0.51	0.49	0.53	0.47	0.52	0.48	0.47	0.53	0.48	0.52
40/20	0.70	0.30	0.75	0.25	0.74	0.26	0.61	0.39	0.62	0.38
50/10	0.86	0.14	0.85	0.15	0.89	0.11	0.83	0.17	0.88	0.12
Means	0.50	0.50	0.53	0.47	0.54	0.46	0.46	0.54	0.47	0.53
Preferences index	1.00	1.00	1.13	0.87	1.17	0.83	0.83	1.17	0.87	1.13

*Means within columns followed by the same letters are not significantly different at P<0.05

The obtained results cleared that the predatory beetles, *S. gilvifrons* is more voracious than other predators; the predatory bugs, *O. albidipenis*, the predatory thrips *S. longicornis* and the predaceous mites, *P. macropilis* and *P. persimilis*.

Also, the predators; *O. albidipenis* and *S. longicornis* are attacked egg more than motile stage of *T. urticae*, while, the predaceous mites, *P. macropilis* and *P. persimilis* are attacked motile stage more than egg of *T. urticae*, and vice versa. Rott and Ponsonby (2000) stated that *S. punctillum* is a voracious predator and is able to prevent outbreaks of mites, which may not be controlled by regular releases of predatory mites.

They also recommended that *S. punctillum* is considered a promising biological control agent against *T. urticae* in glasshouses. Ragkou *et al*. (2004) conducted laboratory experiments on daily consumption and predation rate of different *S. punctillum* instars feeding on *T. urticae* and reported that the first instar larva consumed 16.67, 18.56, 19.56 and 14.33 egg, larva, nymph and adult respectively of the prey *T. urticae*. Shih (1999) found that the early release of *S. sexmaculatus* suppressed the two-spotted spider mite population effectively in beans. Haque (2005) observed that an adult *S. sexmaculatus* consumed 78.80 adult, 38.47 immature and 114.33 egg of the two-spotted spider mite per day separately. Badriea *et al*. (2011) recorded that the population predates power values (PPP) of *S. gilvifrons*, *O. albidipenis*, *P. macropilis* and *P. persimilis* were 30.22, 16.78, 7.75 and 11.5 individuals of the two-spotted spider mite *T. urticae*/ individual predator/day, respectively. Latifian (2012) found that adult of *S. gilvifrons* consumed significantly more mites than larvae, the adult consumed 33.67 and 21.33, whereas predator larvae consumed 32.33 and 19.67 adult and larvae of 40 spider mites, respectively in 24 hrs. Parvin *et al*. (2010) prevailed that *S. sexmaculatus*, *P. persimilis* and *S. punctillum* consumed more egg and immature than adult stages of the two-spotted spider mite. Food selection and preference could be influenced by a previous exposure to one food type in phytophagous species. Therefore, prey acceptance and prey suitability are two important factors in prey selection (Papaj and Prokopy, 1989).

The insectal predators: *S. gilvifrons*, *O. albidipenis*, *S. longicornis*, preferred egg stage of the two-spotted spider mite while *P. macropilis* and *P. persimilis* are much predacious and effectiveness predators on *T. urticae* motile stages. These results are necessary for the recommendation of the biological control agents in the agro ecosystems open field and greenhouses.

REFERENCES

Abdel-Aziz, Safaa M. (2016). Evaluation of the predaceous mite, *Phytoseiulus persimilis* Athias-Henriot to control *Tetranychus urticae* on eggplant in Sohag Governorate. *ACARINES: Journal of the Egyptian Society of Acarology,* 10:37-39.

Badriea A. El-Esnawy, A. M. M. Sayed and M. M. S. Ibrahim (2011). Population predates power (PPP) in management of the two-spotted spider mite *Tetranychus urticae* Koch (Acari: Tetranychidae). *Bull. Ent. Soc. Egypt, Econ. Ser.*, 37: 107- 120.

Blackwood, J. S., P. Schausberger and B. A. Croft (2001). Prey stage preference in generalist and specialist phytoseiid mites (Acari: Phytoseiidae) when offered *Tetranychus urticae* (Acari: Tetranychidae) eggs and larvae. *Environmental Entomology*, 30: 1103-1111.

Chesson, P. L. (1984). Variable predators and switching behavior. *Theoretical Population Biology*, 26: 1–26.

Chittenden, A. R. and Y. Saito (2001). Why are there feeding and non-feeding larvae in phytoseiid mites (Acari: Phytoseiidae). *Journal of Ethology*, 19: 55-62.

Cocuzza G. E.; D. E. Clercq and P. Lizzio (1997). Life tables and predation activity of *Orius laevigatus* and *O. albidipennis* at three constant temperatures. *Entomologica Experimentalis et Applicata,* 85: 189-198.

Friese, D. D. and F. E. Gilstrap (1982). Influence of prey availability on reproduction and prey consumption of *Phytoseiulus persimilis*, *Amblyseius californicus* and *Metaseiulus occidentalis* (Acarina: Phytoseiidae). *International Journal of Acarology*, 8: 85-89.

Gotoh, T., M. Nozawa and K. Yamaguchi (2004). Prey consumption and functional response of three acarophagous species to eggs of the two-spotted spider mite in the laboratory. *Appl. Entomol. Zool*., 39: 97–105.

Granham, J. E. (1985). In: "Spider Mites. Their Biology, Natural Enemies and Control". *Eds., Helle W and MW Sabelis, Amsterdam, the Netherlands: Elsevier*, pp.: 367-370.

Gurguis, M. W., I. I. Mohamed and A. M. Abdel Rahman (1977). Development of resistance to Roger, Proclonol and Omite in a strain of *Tetranychus arabicus* Attiah in *Egypt. Bull. Ent. Soc. Egypt, Econ.* 10: 153-159.

Haque, M. M. (2005). Suppression of *Tetranychus urticae* Koch (Acari: Tetranychidae) population by *Scolothrips sexmaculatus* (Pergrande) (Thysanoptera: Thripidae). *Bangladesh Journal of Entomology*, 15(2): 87-91.

Heikal, I. H. and F. S. Ali (1996). Mass rearing of the predaceous mite, *Phytoseiulus macropilis* (Banks) (Acari: Phytoseiidae). *Egypt. J. Biol. Pest Control*, 6 (2): 143-145.

Ibrahim, M. M. S., Badriea A. EL-Esnawy and A. M. El-Adawy (2016). Biological and ecological fitness of the two-spotted spider mite, *Tetranychus urticae* koch (Acari: Tetranychidae) on certain host plants. *ACARINES: Journal of the Egyptian Society of Acarology,* 10:31-35.

Isenhour, D. J. and K. V. Yeargan (1981). Effect of temperature on the development of *Orius ididiosus*, with notes on laboratory rearing. *Ann. Entomol. Soc. Amer., 74:114-116.*

Kheradpir, N., M. Rezapanah; K. Kamali and Y. Fathipour (2013). Host plant affects the predation and oviposition rate of the predaceous thrips of spider mites, *Scolothrips longicornis. Munis Entomology & Zoology*, 8 (1): 285-293

Latifian, M. (2012). Voracity and feeding preferences of larvae and adult stages of *Stethorus gilvifrons* Mulsant. (Coleoptera:Coccinellidae) on larvae and adult of *Oligonychus afrasiaticus* McGregor (Acarina: Tetranychidae). *Int. J. Agric. Crop Sci*., 4 (9): 540-546.

Manly, B. F. J., P. Miller and L. M. Cook (1972). Analysis of a selective predation experiment. *American Naturalist*, 106: 719–736

McMurtry, J. A. and B. A. Croft (1997). Life-styles of Phytoseiid mites and their roles in biological control. *Annual Review of Entomology*, 42: 291-321.

Mori K., M. Nozawa, K. Arai and T. Gotoh (2005). Life-history traits of the acarophagous lady beetle, *Stethorus japonicus* at three constant temperatures. *BioControl*, 50: 35–51.

Naher, N., W. Islam and M. M. Haque (2005). Predation of three predators on two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae). *Journal of Life and Earth Science*, 1: 1-4.

Pakyari, H., Y. Fathipour and A. Enkegaard (2011). Effect of temperature on the life-table parameters of the predatory thrips, *Scolothrips longicornis* fed on two-spotted spider mites. *Journal of Economic Entomology* 104(3):799-805.

Papaj D. R. and R. J. Prokopy (1989). Ecological and evolutionary aspects of learning in phytophagous insects. *Annual Review of Entomology*, 34: 315– 350.

Parvin, M. M. and M. M. Haque (2008). Control of two-spotted spider mite, *Tetranychus urticae* (Koch) (Acari: Tetranychidae) by predators on potted plants. *University journal of zoology Rajshahi University,* 27: 51-54.

Parvin, M. M., M. A. Asgar and M. M. Haque (2010). Voracity of three predators on two-spotted spider mite, *Tetranychus urticae* Koch (Acari: Tetranychidae) and their developmental stages. *Res. J. Agric. & Biol. Sci.*, 6(1): 77-83.

Ragkou, V. S., C. G. Arthanassiou, N. G. Kavallieratos and Z. Tomanovic (2004). Daily consumption and predation rate of different *Stethorus punctillum* instars feeding on *Tetranychus urticae*. *Phytoparasitica*, 32(2): 154-159.

Rott, A. S. and D. J. Ponsonby (2000). Improving the control of *Tetranychus urticae* on edible glasshouse crops using a specialist coccinellid (*Stethorus punctillum* Weise) and a genera list mite (*Amblyseius californicus* McGregor) as biocontrol agents. *Biocontrol Science and Technology*, 10: 487-498.

Roy, M., J. Brodeur and C. Cloutier (2005). Seasonal activity of the spider mite predators *Stethorus punctillum* (Coleoptera: Coccinellidae) and *Neoseiulus fallacis* (Acarina: Phytoseiidae) in raspberry, two predators of *Tetranychus mcdanieli* (Acarina: Tetranychidae). *Biol. Control*., 34: 47–57.

Sabelis, M. W. (1985). Sampling techniques. In: W. Helle & M. W. Sabelis (eds), World Crop Pests, Spider Mites: their Biology, Natural Enemies and Control. *vol. 1 A. Elsevier Science Publishers, New-York*, pp. 337–350.

Sarhan, A. A., A. Shoukry and A. A. Sayed (1989). Biological studies on *Stethorus gilvifrons* Mulsant, predator of *Tetranychus urticae* (Koch) in Egypt. *3rd Nat. Conf. of pest & Dis. of Veg. and Fruits in Egypt and Arab Count*., pp.: 408- 421.

Sherratt, T. N. and I. F. Harvey (1993). Frequency-dependent food selection by arthropods: *a review. Biological Journal of the Linnean Society,* 48: 167–186.

Shih, C. I. T. (1999). Population ecology and its application on tetranychid and phytoseiid mite. *Chinese Journal of Entomology*, 126: 25-48.
Van Lenteren, J. C. and J. Woets (1988). Biological and integrated pest control in greenhouses. *Annual Review of Entomology*, 33: 239-269.

الملخص العربي

الشراهة والتفضيل الإفتراسى لبعض المفترسات على الأكاروس العنكبوتى ذو البقعتين
Tetranychus urticae Koch (Acari: Tetranychidae)

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تم دراسة الشراهة الافتراسية والتفضيل الافتراسى لخمسة مفترسات على البيض والأطوار المتحركة للأكاروس العنكبوتى ذو البقعتين *T. urticae* تحت الظروف المعملية. وتم حساب متوسط الاستهلاك اليومى من الفريسة.

أوضحت النتائج أن متوسط استهلاك المفترسات المختبرة للبيض كان أعلى مقارنة باستهلاكها من الأفراد المتحركة. كما وجد أن المفترس *S. gilvifrons* كان أكثر المفترسات شراهة فى إستهلاك الفريسة حيث كان متوسط إستهلاك البيض خلال ثلاثة أيام هو ٤١، ٣٣، ٣٥، ٢٨، ٢٦ بيضة ، بينما للأطوار المتحركة كان ٣٥، ٢٧، ٣١، ٢١، ٢١ فرد من الفريسة لكل من المفترسات المختبرة *S. gilvifrons*, *O. albidipenis*, *S. longicornis*, *P. macropilis*, *P. persimilis* على الترتيب.

كما أوضحت النتائج أيضا أنه لاتوجد فروق معنوية للتفضيل الغذائى للمفترس *S. gilvifrons* بين البيض والأطوار المتحركة بينما وجد أن المفترس *O. albidipenis* والمفترس *S. longicornis* أكثر تفضيلا لاستهلاك البيض عن الأطوار المتحركة. أما الأكاروسات المفترسة *P. macropilis*, *P. persimilis* كانت أكثر تفضيلا لاستهلاك طور البيض مقارنة بالأطوار المتحركة.

توضح الدراسة أن المفترسات الحشرية تفضل طور البيضة اما المفترسات الاكاروسية تفضل الاطوار المتحركة وهذا يجب ان يؤخذ فى الاعتبار عند وضع برامج المكافحة الحيوية للأكاروس العنكبوتى ذو البقعتين.