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Biological Characteristics of Three Predatory Insects Preyed on the Silverleaf Whitefly, *Bemisia argentifolii* Bellows and Perring under Controlled Conditions

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ABSTRACT

Laboratory experiments were carried out to evaluate the efficacy of larval and adult stages of *Coccinella undecimpunctata* L.; *C. septempunctata* L. and *Chrysopa septempunctata* Wesm. when reared on *Bemisia argentifolii* Bellows and Perring at 26±1 °C and 70±5% R. H. *C. undecimpunctata* larva consumed a total average of 553.5 whitefly individuals during its four larval instars. The predator female fed on a total average of 4898.11 individuals during its longevity (42.75 days). The total average number of eggs laid per female was 890.6, with a daily rate of 29.84 eggs. The predator adult male consumed a total average of 2848.53 individuals during its longevity (30.73 days). *C. septempunctata* larva consumed a total average of 787.05 whitefly individuals during its larval stage. The predator female fed on a total average of 6799.12 individuals during its longevity (50.86 days). The total average number of eggs laid per female was 1090.56 eggs, with a daily average rate of 33.27 days. The predator male consumed a total average of 3786.96 whitefly individuals during its longevity (35.78 days).The neuropteran predator; *Ch. septempunctata* larva consumed a total average of 1945.02 individuals during its three larval instars. The predator female fed on a total average of 2851.94 whitefly individuals during its longevity (39.11 days). The total average number of eggs laid per female was 715.6 eggs, with a daily average rate of 34.65 days. The predator male consumed a total average of 1708.43 whitefly individuals during its longevity (30.65 days). The results assured the predation activity of these predators when reared on whitefly and they can be recommended for using them as biological control agents for controlling *B. argentifolii*.

Key Words: *Bemisia argentifolii*, *Coccinella undicempunctata*, *Coccinella septempunctata*, *Chrysopa septempunctata*, Biology.

INTRODUCTION

It is necessary, before introducing any predator in a biological control program to indicate its efficacy under different environmental factors. Among these factors, prey type, temperature and relative humidity are considered the most important. Many coccinellids are well known predators, playing an important role as biological control agents in regulating the population of some insect pests, especially aphids and whiteflies. Several studies have been carried out in different parts of the world concerning the predation activity of many coccinellid species such as; *Coccinella undecimpunctata* L. and *C. septempunctata* L.. Among those who contributed much to these studies are (Ibrahim 1955; Ghanim and El-Adl 1987a; Ghanim, *et al.* 1988; Abdel Gawad, *et al.* 1990; Akhiles, *et al.* 1996; Mohamed 1996 and Mortada 1997).

The neuropteran predator *Chrysopa septempunctata* Wesm. has attracted considerable attention as a biological agent to control important agricultural pests. *Ch. septempunctata* is one of the few species among the chrysopids which both its larvae and adults are predaceous (Abou-Bakr, 1989). *Ch. septempunctata* exists in a wide range of plantations such as field crops, orchards, and ornamental plants (El-Haidari and Aziz 1976; Legaspi, *et al.* 1984; Ghanim and El-Adl 1987b and Abd El-Azez 1991).

Therefore, this investigation was outlined to study certain biological characteristics of the two coccinellids predators, *C. undecimpunctata*; *C. septempunctata* and the neuropteran predator; *Ch. septempunctata* when reared on *B. argentifolii* under laboratory conditions.

MATERIALS AND METHODES

A – Larval experiments:

Experiments were carried out at the laboratory of Economic Entomology Department, Faculty of Agriculture, Mansoura University under 26±0.2 °C temperature and 70±5.0 % R.H.. Silverleaf whitefly namely, *Bemisia argentifolii* Bellows and Perring was used as prey for the two coccinellid predators, *Coccinella undecimpunctata*; *C. septempunctata* and *Chrysopa septempunctata* Wesm.. The predators and the prey individuals were obtained from maintained cultures in the Insectary.

Newly hatched predator larvae, were placed individually, each from the three predators in a petri-dish (10 cm. diameter) with a filter paper on its bottom. Twenty replicates from silverleaf whitefly immature stages (eggs; nymphs and pupae) as prey for each predator were used. Known surplus number of prey was offered and the devoured individuals were replaced daily. Attacked prey individuals were counted daily throughout the periods of the predator larval stadia.

B- Adult experiments:

Three treatments, (20 petri-dishes; 10 cm diameter) each were prepared. Each treatment was confined to a specific predator. Immediately after adult emergence, each predator was introduced singly into a petri-dish. Known numbers of the silverleaf whitefly were offered daily on a plant leaflet to each predator. Counting and removing the un-devoured whitefly in each petri-dish were practiced before introducing the new whitefly. After five days of emergence, copulation takes place; the two sexes were separated and kept singly in the dishes. Daily number of laid eggs per predator female during its ovipositional period was counted. As well, the total number of eggs laid per predator female was estimated. The daily averages of prey consumption throughout adults longevities were calculated.

Statistical analysis of the data was fulfilled using a computer program.

RESULTS AND DISCUSSION

1- Biological characteristics of *C. undecimpunctata*:

A – Larval stage:

Data present in (Table 1) show that the duration period of *C. undecimpunctata* larvae lasted an average of 13.0 ±1.7 days when fed on the whitefly *B. argentifolii* .The averages of total consumption during different four larval instars of the predator were; 39.32±2.79; 56.03±4.56; 103.67 ± 6.52 and 354.48±12.8 individuals, respectively. A predator larva consumed a total average of 553.5 ± 16.95 whitefly individuals during its larval stage. The results also showed that the fourth larval instar proved to be the most efficient in its feeding capacity; it consumed 64.05 % of the total number of whitefly individuals throughout its larval period (Table 1). The third instar larva came in the second place, as it consumed 18.73 % from the total number of the prey. Ghanim and El-Adl (1987a) found that the larva of *C. undecimpuncta* consumed a total average numbers of 609.9 *Aphis gossypii* Glover during its larval period which lasted ten days. Ragab (1988) stated that *C. undecimpunctata* duration period of the larval stage was 8.32 ± 0.10 days and the total consumption was 269.64±5.42 aphid individuals when reared on mixed aphid species.

Table (1): Durations of larval instars of *C. undecimpunctata* and its feeding capacity when fed on *B. argentifolii* immature stages under laboratory conditions.

Larval instars	Duration in days	Daily average consumption	Total consumption per instar	% of consumption
1st	2.9±0.36	13.56±1.46	39.32±2.79	7.1
2nd	2.45±0.31	22.87±2.65	56.03±4.56	10.12
3 rd	2.76±0.34	37.56±4.46	103.67±6.52	18.73
4th	4.89±0.6	72.49±6.54	354.48±12.8	64.05
Total	13.0±1.7	36.62± 3.1	553.5±16.95	100

B- Adult stage:

Male longevity lasted, an average of 29.84±3.08 days. Adult male consumed a total average of 2848.53±25.42 individuals, with a daily average of 95.46±7.2 individuals (Table 2). The predator female fed on a total average of 4898.11±36.78 individuals, with a daily rate of 114.58±16.2 individuals of *B. argentifolii* during its longevity which lasted 42.75±5.82 days. The pre-ovipostional, ovipositional and post-ovipositional periods were 6.73±0.54; 28.98±2.57 and 7.05 ± 0.61 days, respectively (Table 2). The daily consumption averages were; 108.54±8.62; 122.75±13.56 and 86.56±5.47 whitefly individuals during these three periods, respectively. The total average number of eggs laid per female was 890.6±10.8, with a daily rate of 30.73 eggs. Ragab (1988) reported that *C. undicempunctata* female at a constant temperature of 25 °C devoured an average of 4240.8±379.68 mixed aphid species individuals during its longevity which lasted an average of 52.4±4.6 days. The total number of eggs laid per female ranged from 639 to 1954, with an average of 1318.2±251.76, with a daily rate of 29.03 eggs. The male longevity at 25 °C ranged from 40 to 55 days, with an average 46±2.69 days. During its life span, an adult male consumed 2598 to 3472 aphids, with an average of 2888.4±155.05 aphid individuals, at a daily rate 62.75 aphids.

2-Biological characteristics of *C. septempunctata*:

A – Larval stages:

Data present in (Table 3) show that the duration of the predator larval stage averaged 15.34±1.42 days when fed on the whitefly *B. argentifolii*. The average of total consumption during the four larval instars of the predator were; 54.4±2.63;

Table (2): Feeding capacity, longevity and fecundity of *C. undecimpunctata* adults when fed on *B. argentifolii* immature stages under laboratory conditions.

Adult stage	Period in days	Daily average consumption	Total consumption	No. of eggs	
				Daily	Total
A : Female					
Pre-oviposition	6.73±0.54	108.54±8.62	730.47±13.75		
Oviposition	28.98±2.57	122.75±13.56	3557.3±26.52	30.73	890.6 ±10.8
Post-oviposition	7.05±0.61	86.56±5.47	610.34±9.65		
Longevity	42.75± .82	114.58±16.2	4898.11±36.78		
B : Male					
Longevity	29.84±3.08	95.46±7.2	2848.53±25.42		

Table (3): Durations of larval instars of *C. septempunctata* and its feeding capacity when fed on *B. argentifolii* immature stages under laboratory conditions.

Larval instars	Duration in days	Daily average consumption	Total consumption per instar	% of consumption
1st	3.15±0.4	17.26±1.8	54.4±2.63	6.9
2nd	2.97±0.32	29.85±2. 5	88.65±3.2	11. 2
3 rd	3.76±0.43	45.86±3.78	172.43±5.86	21.8
4th	5.46±0.52	87.65±5.85	473.57±8.73	60.1
Total	15.34±1.42	51.31±6.2	787.05±12.75	100

88.65±3.2; 172.43±5.86 and 473.57±8.73 individuals, respectively. A predator larva consumed a total average of 787.05±12.75 whitefly individuals during its larval stage. The results also showed that the fourth larval instar was the most efficient in its feeding capacity, it consumed 60.1 % of the total number of whitefly individuals throughout the larval period (Table 3). The third instar larva came in the second place as it consumed 21.8 % from the total number of the preyed whitefly. These findings agreed with those of Hamalainen *et al.* (1975); Wetzel *et al.*, (1982) and Ghanim and El-Adl (1987b).

B- Adult stage:

Male longevity lasted an average of 35.78±1.92 days. Adult male consumed a total average of 3786.96 ± 10.56 individuals, with a daily average of 105.84±4.8 individuals (Table 4). The predator female fed on a total average of 6799.12±22.74 individuals, with a daily rate of 133.68±2.46 individuals of *B. argentifolii* during its longevity period which lasted 50.86±2.8 days. The pre-ovipostional ; ovipositional and post-ovipositional periods were; 8.56±0.5; 32.78±1.75 and 9.52±0.62 days ,respectively (Table 4). The daily consumption averages were; 135.67±2.6; 142.87±3.84 and 100.21±2.01 whitefly individuals during this three periods, respectively. The females of this predator consumed 1.8 times more than the males from *B. argentifolii*. This finding is in complete agreement with the results obtained by Ghanim and El-Adl (1987b). The total average number of eggs laid per female was 1090.56±22.7, with a daily rate of 33.27 eggs.

3- Biological characteristics of *Ch. septempunctata*:

A - Larval stage:

As seen in Table (5), the duration period of the predator larva lasted an average of 17.28±1.37 days when fed on the whitefly *B. argentifolii*. The average of total consumption during the three larval instars of the predator were; 156.2±8.7; 445.52±16.11; and 1343.3±22.4 individuals, respectively. A predator larva consumed a total average of 1945.02±36.6 whitefly individuals during its larval instars. The results also showed that the third larval stage was the most efficient in its feeding capacity; it consumed 69.06 % of the total number of whitefly individuals throughout the larval period. The second instar larva came in the second place as it consumed 22.91% from the total number of the preyed whitefly. Ghanim and El-Adl (1987b) estimated the efficacy of *Ch. septempunctata* larvae and found that the larva consumed a total average numbers of 698.7 *Aphis craccivora*; 637 *Gynaikothrips ficorum* (Marshal); 1017.2 eggs; 605.6 larvae of *Spodoptera littoralis* (Boisd), and 1630.14 *Saccharicoccus sacchari* (Cockerell) during its larval stage.

B- Adult stage:

Male longevity lasted an average of 30.65±2.56 days. Adult male consumed a total average of 1708.43±9.75 individuals, with a daily average of 55.74±2.15 individuals (Table 6). The predator female fed on a total average of 2851.94±14.65 individuals, with a daily rate of 72.93±2.65 individuals of *B. argentifolii* during its longevity period which lasted 39.11±3.75 days. The pre-ovipostional; ovipositional and post-ovipositional periods were; 10.5±0.6; 20.65±1.42 and 7.96±0.46 days, respectively (Table 6). The daily consumption

Table (4): Feeding capacity, longevity and fecundity of *C. septempunctata* adults when fed on *B. argentifolii* immature stages under laboratory conditions.

Adult stage	Period in days	Daily average consumption	Total consumption	No. of eggs Daily	No. of eggs Total
A : Female					
Pre-oviposition	8.56 ± 0.5	135.67 ± 2.6	1161.34 ± 7.56		
Oviposition	32.78 ± 1.75	142.87 ± 3.84	4683.79 ± 15.62	33.27	1090.56±22.7
Post-oviposition	9.52 ± 0.62	100.21 ± 2.01	953.99 ± 5.27		
Longevity	50.86± 2.8	133.68 ± 2.46	6799.12 ± 22.74		
B : Male					
Longevity	35.78 ± 1.92	105.84 ± 4.8	3786.96 ± 10.56		

Table (5): Efficiency and durations of larval stage of *Ch. septempunctata* reared on *B. argentifolii* immature stages under laboratory conditions.

Larval instars	Duration in days	Daily average consumption	Total consumption per instar	% of consumption
1 st	4.27± 0.35	36.58 ± 3.2	156.2 ± 8.7	8.03
2 nd	5.15 ± 0.44	86.45± 4. 8	445.52 ± 16.11	22. 91
3 rd	7.86 ± 0.85	170.65 ±8.54	1343. 3 ± 22.4	69.06
Total	17.28 ± 1.37	112.56 ± 6.25	1945.02 ± 36.6	100

Table (6): Feeding capacity , longevity and fecundity of *Ch. septempunctata* adults reared on *B. argentifolii* immature stages under laboratory conditions.

Adult stage	Period in days	Daily average consumption	Total consumption	No. of eggs Daily	No. of eggs Total
A : Female					
Pre-oviposition	10.5 ± 0.6	73.9 ± 2.4	775.95 ± 3.26		
Oviposition	20.65 ± 1.42	96.5 ± 3.62	1992.73 ± 8.95	34.65	715.6 ± 9.7
Post-oviposition	7.96 ± 0.46	10.46 ± 0.85	83.26 ± 1.75		
Longevity	39.11± 3.75	72.93 ± 2.65	2851.94 ± 14.65		
B : Male					
Longevity	30.65 ± 2.56	55.74 ± 2.15	1708.43 ± 9.75		

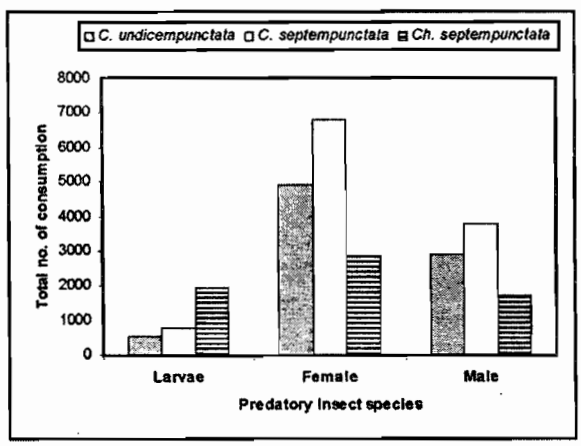

Fig. (1): Comparitive feeding capacity of the three predatory insect species when fed on *B. argentifolii* immature stages under controlled conditions.

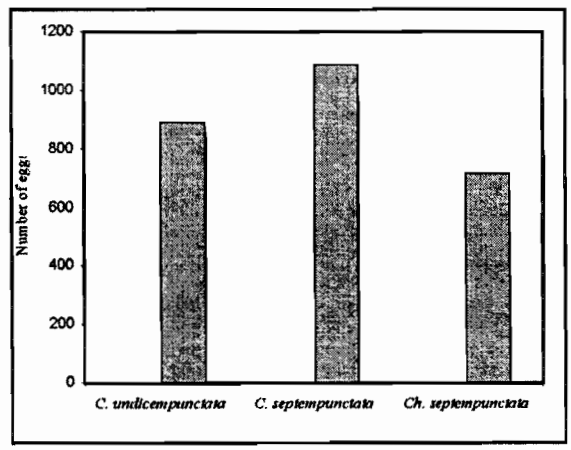

Fig. (2): Comparitive fecundity of the three predatory insect species when fed on *B. argentifolii* immature stages under controlled conditions.

averages were; 73.9±2.4; 96.5±3.62 and 10.46±0.85 whitefly individuals during the three periods, respectively. The female consumed 1.66 times more than the male from silverleaf whitefly. The total average number of eggs laid per female was 715. 6±9.7, with a daily rate of 34.65 eggs.

As shown in figure (1) feeding capacity of *Ch. septempunctata* larvae was higher than that of the two coccinellids, while the feeding capacity of *C. septempunctata* adults was the highst among the three predatory species.

Figure (2) shows fecundity of the three predatory insect species when fed on *B. argentifolii*. This figure clears that the fecundity of *C. septempunctata* female was higher than *C. undecimpunctata* and *Ch. septempunctata*.

The obtained results assured the predation activity of these predators when reared on whitefly and they can be recommended for using them as biological control agents for controlling this important insect pest.

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