

Biological Characteristics of *Chilocorus bipustulatus* L. and *Chrysoperla carnea* (Steph.) Reared on Soft Scale Insects under Laboratory Conditions

Hala A. El-Serafi*, A.A. Ghanim*, A.H. El-Heneidy** and M.K. El-Sherbenie**

* Economic Entomology Dept., Fac. of Agric., Mansoura Univ.

** Plant Protection Res. Inst., Agric. Res. Center, Dokki, Giza

ABSTRACT

Experiments were carried out at the laboratory of Economic Entomology Department, Faculty of Agriculture, Mansoura University to evaluate certain biological characteristics of the predatory species; *Chilocorus bipustulatus* L. and *Chrysoperla carnea* (Steph.) when reared on *Coccus hesperidum* L. and *Pulvinaria psidii* Mask. under $27 \pm 1^\circ\text{C}$ temperature and R.H $70 \pm 2\%$. Data revealed that, *C. bipustulatus* larval duration lasted an average of 17.33 days, and the larva consumed an average of 200.26 nymphs of *C. hesperidum*. Adult female lived 59.21 days consuming 637.54 individuals. Total eggs laid were 178.54 eggs/female. Adult male lived 45.61 days consuming 410.52 nymphs. When fed on *P. psidii* nymphs, the larval duration of the predator was 21.04 days, and the larva consumed an average of 177.46 nymphs. Adult female lived 60.01 days consuming an average of 720.32 individuals. Total eggs laid were 125.74 eggs/female. Adult male lived 45.87 days consuming an average of 458.96 nymphs. Larval duration of *C. carnea* lasted an average of 14.5 days when fed on *C. hesperidum* nymphs, while it was 13.07 days when reared on *C. hesperidum* adults. The predator larva consumed an average of 462.62 *C. hesperidum* nymphs and/or 26.42 adults during its total developmental period. Longevity of the predator female lasted 36.14 days when fed on *C. hesperidum* nymphs, and 35.18 days when reared on the adults. Number of deposited eggs per female was an average of 363.95 eggs when larva reared on *C. hesperidum* nymphs and 409.68 eggs when it was reared on adults. Longevity of the predator male was 18.37 days and 17.81 days, when its larvae were fed on the nymphs and adults of *C. hesperidum*, respectively. *C. carnea* larval duration lasted an average of 17.09 days when fed on *P. psidii* nymphs and 14.33 days when it was reared on the adults. Predator's larva consumed an average of 615.10 *P. psidii* nymphs and/or 420.05 adults during its developmental period.

Key Words: Biological characteristics, *Chilocorus bipustulatus*, *Chrysoperla carnea*, *Coccus hesperidum*, *Pulvinaria psidii*

INTRODUCTION

The efficiency of the two predators *Chilocorus bipustulatus* L. (Coccinellidae, Coleoptera) and *Chrysoperla carnea* (Steph) (Neuroptera: Chrysopidae) as biological control agents have been studied in different parts of the world (Schweig and Grunberg, 1936; Bodenheimer, 1951; Pasqualini, 1975; Panis, 1980; Abd El-Rahman, 1984; Hamed and Hassanein, 1991; Zaki *et al.*, 1999; Kuroda and Miura, 2003 and El-Sherbenie, 2004). The existence of *C. bipustulatus* and *C. carnea* on many citrus species, ornamental plants and field crops attracted our attention, especially because few previous studies have been carried out on their predacious efficiency. The predation activity and fecundity of the two common predatory insects; *C. bipustulatus* and *C. carnea* when fed on soft brown scale *Coccus hesperidum* L. and guava mealy scale, *Pulvinaria psidii* Mask. were studied under laboratory conditions.

MATERIALS AND METHODS

Biological characteristics of predatory insects

1. *Chilocorus bipustulatus* L.

Larval stage

Twenty newly hatched larvae of the predator were kept singly in Petri dishes (10 cm diameter). The dishes were provided with filter paper in their bottoms to facilitate the movement of predator larvae. Certain number of *P. psidii* and *C. hesperidum* nymphs or adults was introduced into the Petri dishes. The dishes were daily inspected, and consumed preys were recorded. Enough number of the prey was introduced into the Petri dishes every day. Durations of larval and pupal stages of the predator were recorded.

Adult stage

A laboratory culture from the predator larvae was established on scale insects to obtain a sufficient number of *C. bipustulatus*. After pupation and adult emergence of the predator, females and males were sexed and separated. The experiment comprised 20 replicates, 10 for males and 10 for females. Each Petri dish received one female or one male. The predator was fed on nymphs and/or adults of *P. psidii* and *C. hesperidum*. Five days later, each pair was placed into a new dish, and allowed to copulate for 24 hr.

Then, they were separated again and provided with the preys to complete their development. For females, pre-oviposition, oviposition, and post-oviposition periods were estimated and longevity of both females and males was calculated. Also, predation efficiency and fecundity of the predator on both preys were recorded.

2. *Chrysoperla carnea* (Steph.)

The predator and the prey individuals were obtained from a maintained culture in the insectary. Two scale insects namely: *C. hesperidum* and *P. psidii* were used as preys for *C. carnea*.

Larval stage

Newly hatched predator larvae were put singly in a Petri dish (10 cm diameter) with a filter paper on its bottom. Twenty replicates were used from each prey nymphs or adults. Adequate numbers from each prey were offered and devoured individuals were replaced daily. Consumed prey individuals were counted daily during the periods of the predator larval stadia. Duration of larval and pupal stages were recorded.

Adult stage

Two experiments, each included 10 pairs of newly emerged adults (female and male) have been prepared. A pair of the predator female and male was confined in a glass chimney. Each chimney was placed on a half-Petri dish (10 cm in diameter) and furnished with a moistened filter paper to provide humidity. A piece of cotton wool soaked with mixed solution of sugar and honey was placed inside the glass chimney as food for adults. Each chimney was covered with a piece of black cloth for encouraging females to oviposit. After copulation took place, adult females were kept singly to deposit their eggs and number of laid eggs/female during oviposition period was recorded daily. Preoviposition, oviposition and post-oviposition periods were also estimated.

The experiments were carried out in the laboratory of Economic Entomology Department, Faculty of Agriculture, Mansoura University under $27\pm1^{\circ}\text{C}$ temperature and R.H. $70\pm2\%$.

RESULTS AND DISCUSSION

Biological characteristics of *Chilocorus bipustulatus* L. when fed on:

1- *Coccus hesperidum* nymphs

Larval stage

Data presented in Table (1) show that the larval duration of the predator averaged 17.33 ± 1.75 days when fed on nymphs of *C. hesperidum*. The average total consumption during different larval instars of the predator was 30.86, 35.78, 53.97, and 79.65 nymphs, for the 1st, 2nd, 3rd and 4th larval instars, respectively. As indicated from the table, the greatest number of preys was consumed by the third and fourth instars (26.95 and 39.77%, respectively).

Pupal stage

The pupal period lasted an average of 5.98 ± 0.67 days as shown in Table (1).

Adult stage

Adult longevity lasted an average of 45.61 ± 2.87 days for male (Table 2). The predator adult male consumed a total average of 410.52 ± 15.0 nymphs with a daily rate of 9.00 nymphs of *C. hesperidum*. The predator female fed on a total average of 637.54 ± 20.8 nymphs, with a daily rate of 10.77 nymphs of *C. hesperidum* during its longevity period, which lasted 59.21 ± 2.57 days. The female fed on 1.55 times more than the male. Number of deposited eggs per predator female averaged 178.4 ± 7.35 eggs during the whole ovipositional period which lasted an average of 47.96 ± 2.10 days (Table 2).

Table (1): Duration and feeding capacity of *Chilocorus bipustulatus* L. larvae when fed on *Coccus hesperidum* nymphs under laboratory conditions.

Biological characters Immature stages	Duration period In days	Daily mean numbers consumed	Total mean numbers consumed	% of consumption
A: Larval stage:				
1 st instar	4.10 ± 0.21	7.53	30.86 ± 2.80	15.41
2 nd instar	3.24 ± 0.18	11.04	35.78 ± 3.10	17.87
3 rd instar	4.19 ± 0.22	12.88	53.97 ± 4.50	26.95
4 th instar	5.80 ± 0.37	13.73	79.65 ± 5.70	39.77
Total	17.33 ± 1.75	11.29	200.26	100
B: Pupal stage	5.98 ± 0.67	--	--	--

Table (2): Longevity, feeding capacity and fecundity of *Chilocorus bipustulatus* L. adults when fed on *Coccus hesperidum* nymphs under laboratory conditions.

Biological characters Adult stages	Duration In days	Daily mean numbers consumed	Total mean numbers consumed	Fecundity / female
A: Female:				
Pre-oviposition	5.46 ± 0.42	20.31	110.8±6.57	178.54±7.35
Oviposition	47.96 ± 2.10	10.14	486.35±18.40	
Post-oviposition	5.79 ± 0.50	6.96	40.32±4.80	
Longevity	59.21 ± 2.57	10.77	637.54±20.80	
B: Male: Longevity	45.61 ± 2.87	9.00	410.52±15.11	

The adult female is considered the most efficient predatory stage as it consumed a number of *C. hesperidum* nymphs about 3 times as much as that of the larva. This is may be due to the larger size and longer longevity of the adult (Schweig and Grunberg 1936 and El-Agamy et al., 1994).

2- *Coccus hesperidum* adults

Larval stage

Data presented in Table (3) show that the larval duration of the predator averaged 15.06±1.82 days when fed on adults of *C. hesperidum*. The average total consumption during the four larval instars was 22.19±4.10, 33.89±5.18, 45.92±6.40 and 72.62±8.10 adults, respectively. As indicated from the table, the highest numbers were consumed by the third and fourth instar 26.3, and 41.58%, respectively.

Pupal stage

The pupal period lasted an average of 5.65±0.58 days (Table 3).

Table (3): Duration and feeding capacity of *Chilocorus bipustulatus* L. larvae when fed on *Coccus hesperidum* adults under laboratory conditions.

Biological characters Immature stages	Duration In days	Daily mean numbers consumed	Total mean numbers consumed	% of consumption
A: Larval stage:				
1 st instar	3.89 ± 0.23	5.70	22.19 ± 4.10	12.71
2 nd instar	3.02 ± 0.20	11.22	33.89 ± 5.18	19.41
3 rd instar	2.98 ± 0.18	15.41	45.92 ± 6.40	26.30
4 th instar	5.17 ± 0.86	14.05	72.62 ± 8.10	41.58
Total	15.06 ± 1.82	11.59	174.62±15.84	100
B: Pupal stage	5.69 ± 0.58	--	--	--

Adult stage

Adult longevity was an average of 48.54±3.17 days (Table 4). The predator adult male consumed a total average of 302.68±8.5 adult individuals, with a daily rate of 6.24 of *C. hesperidum* adults. The predator female fed on a total average of 437.91±26.35 adult individuals, with a daily rate of 7.82 individuals during its longevity period which lasted 56.02±2.45 days. The female fed on 1.44 times more adults of *C. hesperidum* than the male. The number of deposited eggs per predator female averaged 244.80±15.43 eggs during the whole ovipositional period which lasted an average of 44.75±3.1 days (Table 4).

Ideally, the adult female is considered the most efficient predatory stage as it consumed a great number of prey individuals which was about 2.51 times as much as that consumed by the larva when fed on the adults of *C. hesperidum*. In conclusion, the fecundity of *C. bipustulatus* was higher when fed on *C. hesperidum* adults than when fed on its nymphs.

Table (4): Longevity, feeding capacity and fecundity of *Chilocorus bipustulatus* L. adults when fed on *Coccus hesperidum* adults under laboratory conditions.

Biological characters Adult stages	Duration In days	Daily mean numbers consumed	Total mean numbers consumed	Fecundity/female
A: Female:				
Pre-oviposition	5.10 ± 0.41	15.01	76.54 ± 3.50	244.80±15.43
Oviposition	44.75 ± 3.10	7.16	320.62 ± 9.60	
Post-oviposition	6.17 ± 0.54	6.60	40.75 ± 2.63	
Longevity	56.02 ± 2.45	7.82	437.91±26.35	
B: Male: Longevity	48.54 ± 3.17	6.24	302.68±8.50	

3. *Pulvinaria psidii* nymphs

Larval stage

Data presented in Table (5) show that total larval stage lasted an average of 21.04 ± 1.72 days when fed on nymphs of *P. psidii*. The average total consumption during the four larval instars were 25.73 ± 4.60 , 32.47 ± 5.10 , 45.76 ± 6.50 and 73.50 ± 8.40 nymphs of *P. psidii*, respectively.

Table (5): Duration and feeding capacity of *Chilocorus bipustulatus* L. larvae when fed on *Pulvinaria psidii* nymphs under laboratory conditions.

Biological characters Immature stages	Duration In days	Daily mean numbers consumed	Total mean numbers consumed	% of consumption
A: Larval stage:				
1 st instar	4.36 ± 0.37	5.90	25.73 ± 4.60	14.50
2 nd instar	4.52 ± 0.53	7.18	32.47 ± 5.10	18.30
3 rd instar	5.26 ± 0.84	8.70	45.76 ± 6.50	25.79
4 th instar	6.90 ± 0.86	10.65	73.50 ± 8.40	41.41
Total	21.04 ± 1.72	8.43	177.46 ± 8.35	100
B: Pupal stage	6.15 ± 0.80	--	--	--

As indicated in the table the highest numbers were consumed by the third and fourth instar 25.79%, 41.41%, respectively.

Pupal stage:

The pupal period lasted an average of 6.15 ± 0.80 days (Table 5).

Adult stage:

Adult longevity period lasted an average of 45.87 ± 3.15 days for male (Table 6). The adult male consumed a total average of 458.96 ± 12.98 nymphs, with a daily rate of 10.00 of *P. psidii* nymphs. The predator female fed on a total average of 720.32 ± 20.83 nymphs, with a daily rate of 12.00 nymphs of *P. psidii* during its longevity period which lasted 60.01 ± 4.97 days. The female fed 1.56 times more nymphs of *P. psidii* than the male. The number of deposited eggs per predator female averaged 125.74 ± 6.48 eggs during the ovipositional period, which lasted an average of 45.84 ± 1.80 days (Table 6).

Ideally, the adult female is considered the most efficient predatory stage as it consumed a high number of prey individuals, which was about 4.06 times as much as that consumed by the larva.

Table (6): Longevity, feeding capacity and fecundity of *Chilocorus bipustulatus* L. adults when fed on *Pulvinaria psidii* nymphs under laboratory conditions.

Biological characters Adult stages	Duration In days	Daily mean numbers consumed	Total mean numbers consumed	Fecundity/female
A: Female:				
Pre-oviposition	6.35 ± 0.40	15.49	98.37 ± 5.84	125.74 ± 6.48
Oviposition	45.84 ± 1.80	12.48	572.11 ± 15.36	
Post-oviposition	7.82 ± 0.62	6.37	49.84 ± 3.94	
Longevity	60.01 ± 4.97	12.00	720.32 ± 20.83	
B: Male: Longevity	45.87 ± 3.15	10.00	458.96 ± 12.98	--

4. *Pulvinaria psidii* adults:

Larval stage:

Data presented in Table (7) show that the larval duration of the predator averaged 18.26 ± 1.93 days when fed on adult individuals of *P. psidii*. The average total consumption during the four larval instars were 19.96 ± 3.50 , 27.50 ± 4.80 , 33.82 ± 5.40 and 58.49 ± 7.50 adult individuals of *P. psidii*, respectively. As indicated from this table, the highest numbers were consumed by the third and fourth instars 24.2 and 41.84%, respectively.

Pupal stage:

The pupal period lasted an average of 5.86 ± 0.75 days (Table 7).

Table (7): Duration period and feeding capacity of *Chilocorus bipustulatus* L. larvae when fed on *Pulvinaria psidii* adults under laboratory conditions.

Biological characters Immature stages	Duration In days	Daily mean numbers consumed	Total mean numbers consumed	% of consumption
A: Larval stage:				
1 st instar	4.21 ± 0.27	4.74	19.96 ± 3.50	14.28
2 nd instar	4.11 ± 0.24	6.69	27.50 ± 4.80	19.68
3 rd instar	4.68 ± 0.36	7.38	33.82 ± 5.40	24.20
4 th instar	5.36 ± 0.62	10.91	58.49 ± 7.50	4.84
Total	18.26 ± 1.93	7.65	139.77 ± 15.72	100
B: Pupal stage	5.26 ± 0.75	--	--	--

Adult stage

Adult longevity period lasted an average of 40.74 ± 1.56 days for the male, while the feeding capacity was 192.37 individuals/male (Table 8). The predator adult male consumed a total average of 192.37 ± 5.42 adult individuals, with a daily rate of 4.72 individuals of *P. psidii*. The predator female fed on a total average of 355.85 ± 10.90 adult individuals with a daily rate of 6.77 adult individuals during its longevity period which was 52.56 ± 1.83 days. The female fed 1.84 times more adults of *P. psidii* than the male. The number of deposited eggs per predator female averaged 164.75 ± 5.93 eggs during the ovipositional period, which lasted an average of 40.69 ± 0.73 days (Table 8).

Ideally, the adult female is considered the most efficient predatory stage as it consumed a high number of prey individuals which was about 2.54 times as much as that consumed by the larva.

Table (8): Longevity, feeding capacity and fecundity of *Chilocorus bipustulatus* L. adults when fed on *Pulvinaria psidii* adults under laboratory conditions.

Biological characters Adult stages	Duration In days	Daily mean numbers consumed	Total mean numbers consumed	Fecundity/female
A: Female:				
Pre-oviposition	5.12 ± 0.30	7.95	40.72 ± 2.60	164.75 ± 5.93
Oviposition	40.69 ± 0.73	7.00	284.63 ± 5.90	
Post-oviposition	6.75 ± 0.34	4.52	30.50 ± 2.10	
Longevity	52.56 ± 1.83	6.77	355.85 ± 10.90	
B: Male: Longevity	40.74 ± 1.56	4.72	192.37 ± 5.42	--

Biological characteristics of *Chrysoperla carnea* (Steph.) when fed on:

1. *Coccus hesperidum* nymphs

Larval stage

Data presented in Table (9) show that the larval duration period of the predator averaged 14.50 when fed on *C. hesperidum* nymphs. The three larval instars averaged 2.46 ± 0.12, 3.87 ± 0.18 and 8.17 ± 1.88 days, respectively. The average of total consumption during the three larval instars was 60.10 ± 3.75, 150.97 ± 5.60 and 462.62 ± 15.40 individuals, respectively. These findings agree with that of El-Agamy et al. (1994). The results also showed that the third larval instar proved to be the most efficient stage as it consumed 68.67% of the total number of *C. hesperidum* nymphs (Table 9). The second larval instar ranked second as it consumed 22.41%.

Table (9): Duration and feeding capacity of *Chrysoperla carnea* (Steph.) larvae when fed on *Coccus hesperidum* L. nymphs under laboratory conditions.

Biological characters Immature stages	Duration In days	Consumed / larvae		
		Daily mean numbers consumed	Total mean numbers consumed	% of consumption
A: Larval stage:				
1 st instar	2.46 ± 0.12	24.43	60.10 ± 3.75	8.92
2 nd instar	3.87 ± 0.18	39.01	150.97 ± 5.60	22.41
3 rd instar	8.17 ± 1.88	56.62	462.62 ± 15.40	68.67
Total	14.50	46.46	673.69	100
B: Pupal stage	7.10 ± 0.80	--	--	--

Pupal stage

The average period of the pupal stage was 7.10 ± 0.80 days (Table 9).

Adult stage

Preoviposition, oviposition, postoviposition and longevity periods of *C. carnea* were 8.10 ± 0.69 , 22.18 ± 1.98 , 5.86 ± 0.43 and 36.14 ± 2.97 days, respectively (Table 10). The total average number of eggs laid per female was 362.95 ± 6.26 eggs, with a daily rate of 16.36 eggs. The predator male longevity lasted 18.37 ± 1.85 days.

Table (10): Longevity and fecundity of *Chrysoperla carnea* adults when fed on *Coccus hesperidum* nymphs under laboratory conditions.

Biological characters Adult stages	Duration In days	Fecundity / female	
		Daily mean numbers consumed	Total mean numbers consumed
A: Female:			
Pre-oviposition	8.10 ± 0.69	16.36	362.95 ± 6.26
Oviposition	22.18 ± 1.98		
Post-oviposition	5.86 ± 0.43		
Longevity	36.14 ± 2.97		
B: Male: Longevity	18.37 ± 1.85	--	--

2. *Coccus hesperidum* adults

Larval stage

Data presented in Table (11) show that the larval duration of *C. carnea* averaged 13.07 when fed on *C. hesperidum* adults. The three larval instars averaged 2.17 ± 0.80 , 3.26 ± 0.10 and 7.64 ± 1.80 days, respectively. The average of total consumption during the three larval instars was 45.80 ± 2.75 , 125.84 ± 6.73 and 354.78 ± 20.61 individuals, respectively. These findings agree with that of El-Agamy et al. (1994). The results also showed that the third larval instar proved to be the most efficient as it consumed 67.39% of the total number of *C. hesperidum* adults (Table 11). The second larval instar came second, as it consumed 23.91%.

Table (11): Duration and feeding capacity of *Chrysoperla carnea* (Steph.) larvae when fed on *Coccus hesperidum* L. adults under laboratory conditions.

Biological characters Immature stages	Duration In days	Consumed / larvae		
		Daily mean numbers consumed	Total mean numbers consumed	% of consumption
A: Larval stage:				
1 st instar	2.17 ± 0.80	21.11	45.80 ± 2.75	8.70
2 nd instar	3.26 ± 0.10	38.60	125.84 ± 6.73	23.91
3 rd instar	7.64 ± 1.80	46.44	354.78 ± 20.61	67.39
Total	13.07	40.28	526.42	100
B: Pupal stage	6.84 ± 0.73	--	--	--

Pupal stage

The average period of the pupal stage was 6.84 ± 0.73 days (Table 11).

Adult stage

Preoviposition, oviposition, postoviposition and longevity periods of *C. carnea* were 6.98 ± 0.72 , 23.09 ± 2.10 , 5.11 ± 0.42 and 35.18 ± 2.56 days, respectively (Table 12). The total average number of eggs laid per female was 409.68 ± 8.57 eggs, with a daily rate of 17.74 eggs (Table 12). The predator male longevity was 17.81 ± 1.85 days.

Table (12): Longevity, and fecundity of *Chrysoperla carnea* adults when fed on *Coccus hesperidum* adults under laboratory conditions.

Biological characters Adult stages	Duration In days	Fecundity / female	
		Daily mean numbers consumed	Total mean numbers consumed
A: Female:			
Pre-oviposition	6.98 ± 0.72	17.74	409.68 ± 8.57
Oviposition	23.09 ± 2.10		
Post-oviposition	5.11 ± 0.42		
Longevity	35.18 ± 2.56		
B: Male: Longevity	17.81 ± 1.85	--	--

3. *Pulvinaria psidii* nymphs:

Larval stage

Data presented in Table 13 show that the larval duration of the predator averaged 17.09 ± 1.05 when fed on *P. psidii* nymphs. The three larval instar averaged 2.96 ± 0.16 , 4.65 ± 0.22 and 9.48 ± 0.90 days, respectively. The average of total consumption during the three larval instars larva was 52.54 ± 3.50 , 144.73 ± 6.5 and 415.83 ± 13.8 individuals, respectively. These findings agree with that of Mani and Krishnamoorthy (1990). The results also showed that the third larval instar proved to be the most efficient as it consumed 67.82% of the total number of *P. psidii* nymphs (Table 13). The second larval instar ranked second as it consumed 23.61%.

Table (13): Duration and feeding capacity of *Chrysoperla carnea* (Steph.) larvae when fed on *Pulvinaria psidii* nymphs under laboratory conditions.

Biological characters Immature stages	Duration In days	Consumed / larvae		
		Daily mean numbers consumed	Total mean numbers consumed	% of consumption
A: Larval stage:				
1 st instar	2.96 ± 0.16	17.75	52.54 ± 3.50	8.57
2 nd instar	4.65 ± 0.22	31.12	144.73 ± 6.50	23.61
3 rd instar	9.48 ± 0.90	43.86	415.83 ± 13.80	67.82
Total	17.09 ± 1.05	35.87	613.10 ± 18.90	100
B: Pupal stage	9.97 ± 0.80	--	--	--

Pupal stage

The average period of the pupal stage was 9.97 ± 0.80 days (Table 13).

Adult stage

Preoviposition, oviposition, postoviposition and longevity periods of *C. carnea* were 8.56 ± 0.46 , 20.16 ± 1.60 , 5.76 ± 2.60 and 34.48 ± 3.7 days, respectively (Table 14). The total average number of eggs laid per female was 265.52 ± 6.10 eggs, with a daily rate of 13.17 eggs (Table 14). The predator male longevity was 19.76 ± 1.52 days.

Table (14): Longevity, and fecundity of *Chrysoperla carnea* adults when fed on *Pulvinaria psidii* nymphs under laboratory conditions.

Biological characters Adult stages	Duration In days	Fecundity / female	
		Daily mean numbers consumed	Total mean numbers consumed
A: Female:			
Pre-oviposition	8.56 ± 0.46	0.0	0.0
Oviposition	20.16 ± 1.60	13.17	265.52 ± 6.10
Post-oviposition	5.76 ± 0.80	0.0	--
Longevity	34.48 ± 3.70	--	--
B: Male: Longevity	19.76 ± 1.52	--	--

4. *Pulvinaria psidii* adults

Larval stage:

Data presented in Table (15) show that the larval duration of the predator averaged 14.33 ± 0.91 days when fed on *P. psidii* adults. Three larval stadia averaged 2.51 ± 0.14 , 3.84 ± 0.20 and 7.98 ± 1.02 days, respectively. The average of total consumption during the three larval instars was 34.78 ± 2.10 , 99.70 ± 4.65 and 286.17 ± 9.75 individuals, respectively. The results also showed that the third larval instar proved to be the most efficient as it consumed 68.03% of the total number of *P. psidii* adults (Table 15). The second larval instar came second as it consumed 23.70%.

Pupal stage:

The average period of the pupal stage was 7.82 ± 0.60 days (Table 15).

Table (15): Duration and feeding capacity of *Chrysoperla carnea* (Steph.) larvae when fed on *Pulvinaria psidii* adults under laboratory conditions.

Biological characters Immature stages	Duration In days	Consumed / larvae		
		Daily mean numbers consumed	Total mean numbers consumed	% of consumption
A: Larval stage:				
1 st instar	2.51 ±0.14	13.86	34.78 ±2.10	8.27
2 nd instar	3.84 ±0.20	25.96	99.70 ±4.65	23.70
3 rd instar	7.98 ±1.02	35.86	286.17 ±9.75	68.03
Total	14.33±0.91	29.35	420.65	100
B: Pupal stage	7.82 ±0.80	--	--	--

Adult stage

Preoviposition, oviposition, postoviposition and longevity periods of the predator were 7.89±0.51, 21.18±1.86, 6.17±0.95 and 35.24±2.50 days, respectively (Table 16). The total average number of eggs laid per female was 326.00±8.56 eggs, with a daily rate of 15.43 eggs (Table 16). The predator male longevity was 18.86±1.95 days.

Table (16): Longevity and fecundity of *Chrysoperla carnea* adults when their larval fed on *Pulvinaria psidii* adults under laboratory conditions.

Biological characters Adult stages	Duration In days	Fecundity / female	
		Daily mean numbers consumed	Total mean numbers consumed
A: Female:			
Pre-oviposition	7.89 ± 0.51	15.43	326.74 ±8.56
Oviposition	21.18 ±1.86		
Post-oviposition	6.17 ± 0.95		
Longevity	35.24 ±2.50		
B: Male: Longevity	18.86 ±1.95	--	--

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خصائص بيولوجية للمفترسين (*Chilocorus bipustulatus* L. و *Chrysoperla carnea* (Steph.))

المرباة على نوعين من الحشرات القشرية الرخوة تحت الظروف المعملية

هالة الصيرفي*، عبد البديع غانم*، أحمد الهندي**، ميرفت الشربيني**
 *قسم الحشرات الاقتصادية، كلية الزراعة، جامعة المنصورة، مصر
 **معهد بحوث وقاية النباتات، مركز البحوث الزراعية، الجيزة، مصر

تم عمل تجارب معملية تحت الظروف المعملية ($27 \pm 1^\circ \text{C}$ ، $70 \pm 2\%$ رطوبة نسبية) لتقويم بعض الخصائص البيولوجية للمفترسين *Chilocorus bipustulatus* L. و *Chrysoperla carnea* (Steph.) عند تربيتها على الحشرات القشرية الرخوة *Coccus hesperidum* L. و *Pulvinaria psidii* Mask. استغرقت مدة الطور اليرقي للنوع *C. hesperidum* متوسط قدره 17.33 يوماً. استهلك اليرقة الواحدة في المتوسط 20.026 حورية. عاشت الأنثى الكاملة 59.21 يوماً تستهلك خلالها 637.054 فرداً. بلغ إجمالي عدد البيض الموضوع 178.054/أنثى. عاش الذكر الكامل 40.61 يوماً حيث يستهلك 41.052 حورية. بلغ إجمالي طول العمر اليرقي للمفترس 21.40 يوماً عند تغذيته على حوريات *P. psidii*. استهلك اليرقة الواحدة في المتوسط 177.46 حورية. عاشت الأنثى الكاملة 60.01 يوماً، تستهلك 72.032 فرداً. بلغ إجمالي عدد البيض الموضوع 120.074/أنثى. عاش الذكر الكامل 40.87 يوماً، يستهلك 40.96 حورية. بلغ طول العمر اليرقي للمفترس *C. carnea* 14.05 يوماً في المتوسط عند تغذيته على حوريات *C. hesperidum*، بينما كانت 13.07 يوماً عند تربيتها على الأفراد الكاملة. استهلك اليرقة المفترس طوال فترة نموها في المتوسط 26.42 فرداً من الأفراد الكاملة. بلغت طول حياة الحشرة الكاملة الأنثى 36.14 يوماً عند تغذيتها على الحوريات و 30.18 يوماً عند تربيتها على الأفراد الكاملة. بلغ متوسط عدد البيض الموضوع 362.95 بيضة/أنثى عند تربية اليرقة على حوريات *C. hesperidum* و 40.68 بيضة عند تربيتها على الأفراد الكاملة. بلغت طول حياة الحشرة الكاملة الذكر 18.37 يوماً و 17.81 يوماً عند تغذية يرقاته على الحوريات والأفراد الكاملة من *P. psidii*، على التوالي. بلغت فترة الطور اليرقي للمفترس متوسطاً قدره 17.09 يوماً عند تغذيتها على الحوريات و 14.33 يوماً عند تربيتها على الأفراد الكاملة. استهلك اليرقة طوال فترة نموها متوسط قدره 61.01 حورية أو 42.005 فرداً كاملاً.