

Predation Capacity and Some Biological Parameters of *Chrysoperla Carnea* (Stephens) On *Aphis Craccivora* Koch under Laboratory Conditions

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Abstract

Laboratory experiments were conducted to study some biological aspects and feeding capacity of aphid lion, *Chrysoperla carnea* under laboratory conditions. At 25 ± 2 °C and 65 ± 5 R.H., the results indicated that the eggs incubation period of *Ch. carnea* was 4.00 days (eggs resulted from females reared in larval stage on *A. craccivora* and in adult's on artificial diet). The hatchability percentage of the deposited eggs reached 86.00%, indicating 14.00% mortality percentage. Also, durations of the three larval instars, and pupae were 2.04, 2.36, 4.88 and 8.24 days respectively. The sex ratio was (56.00% female: 44.00% male). The pre-oviposition period of the females lasted 3.80 days, while the oviposition and the post-oviposition lasted 13.93 and 3.60 days, respectively. Larva of the 3rd instar fed on 395.64 aphids of 4th instar nymphs of *A. craccivora*, being the highest voracious feeder as compared to the first two larval instars which consumed the means of 40.04 and 83.28 individuals, respectively. When fed on *A. craccivora* nymphs, female lived longer (21.40 days) than male (17.73 days). Also, by feeding on *A. craccivora* nymphs throughout the larval stage and on semi-artificial diet during the adult stage, a single *Ch. carnea* female deposited a total of 268.8 eggs.

Key words: *Chrysoperla carnea*, *Aphis craccivora*, feeding capacity.

Introduction

Introduction and release of predatory insects accounts for up to one third of the successful bio-control programs in the world. Among the predacious insects, the aphid lion, *Chrysoperla carnea* (Stephens) (Chrysopidae: Neuroptera) is one of the widely distributed, and most frequently used species (Athhan *et al.*, 2004). The green lacewing adults feed on pollen, nectar and honeydew, while larvae are voracious predators of wide varieties of plant pests such as aphids, whiteflies, leaf miners, psyllids, thrips and caterpillars (Mansoor *et al.*, 2013 and Saleh *et al.*, 2017). This predator's adaptation to diverse environments, broad range of prey, high ability to find prey, and high resistance to commonly applied insecticides make it a valuable biological control agent (Sablon *et al.*, 2013). Larvae are predacious, whereas adults feed solely on carbohydrate diets consisting of pollen. Since adults are winged and not predacious, they are likely to fly away from target areas. This is why the predacious larvae are released for biological control and not adults. Larvae consume soft-bodied pests, notably aphids (Fletcher, 2016).

Many laboratory studies were undertaken for rearing *Ch. carnea*, in order to used for controlling insect pests (El-Arnauty and Sewify, 1998; Balakrishnan *et al.*, 2005 and El-Saeady *et al.*, 2011). Biology and feeding potential of the predator *Ch. carnea* on different preys under laboratory conditions has been studied by several authors (El-Saeady *et al.*, 2011; Khanzada *et al.*, 2018 and Kumar *et al.*, 2019).

The aim of this work was to study some biological aspects and feeding capacity of aphid lion, *Ch. carnea* (Stephens) on *A. craccivora* (Koch) under laboratory conditions.

Materials and Methods

Rearing of the Legume aphid, *A. craccivora*:

Individuals of *A. craccivora* on faba bean seedling were obtained from the "Mass rearing unit" at Syngenta Company for agrochemicals and seeds, Qaha, Qalioubia Governorate. Infested plant parts were transferred to the biological laboratory for mass-rearing of aphids and beneficial bio-agent. Stock culture of this aphid was maintained in the laboratory on faba bean seedlings grown in wet sawdust placed in plastic pots (10 cm. diameter and 7 cm. height) (Plate, 1-A), the planted pots were placed in muslin screen cages (Plate, 1-B), and kept under the laboratory conditions (25 ± 2 °C and 65 ± 5 % R.H.).

A. craccivora rearing was carried out in 3 steps:

1. Broad bean (*Vicia faba* L.) seeds were sown at 1-2 cm depth in plastic pots (10 cm. diameter and 7 cm. height) containing wet sawdust and It was irrigated daily. Then they were transported to muslin screen cages (55cm. length, 70cm.width and 65cm.height).
2. When the first leaves began to appear (about 5-6 days after planting), the infested parts of broad bean plants that were brought from Syngenta Company were cut with scissors and placed, gently, between the new seedlings. And within a

few hours, the old cut seedlings wilt and, soon, the aphids moved and climbed the new seedlings and multiplied on it.

3. The infested pots were daily monitored until the population of *A. craccivora* increased and



Plate (1):- A: Broad bean seedlings grown in pots and heavily infested with *A. craccivora*
B: Muslin cage, for mass-production of aphids

Rearing of green lacewing, *Ch. carnea*:

Larvae of *Ch. carnea* were obtained from biological control laboratory, at Plant Protection Research Institute Dokki, Giza. Larvae were placed in a plastic containers, of (30cm.length, 20cm.width and 15cm.height) covered with a black piece of muslin cloth and fed them on individuals of *A. craccivora* until pupation. Every one day, fresh individuals of aphids were provided in each plastic container. This process was continued up to cocoon formation. Cocoons were kept in a new plastic container until adult's emergence. Adults of *Ch. carnea* (males and females) were placed in a plastic containers of (30cm.length, 20cm.width and 15cm.height) (**Plate, 2**), covered with a piece of black cloth for oviposition. Droplets of semi-artificial diet consists of [2gm. of dried active yeast, 1gm. of honey and 1ml. of distilled water] were provided on wax paper for adult's nutrition. The piece of black cloth is replaced daily and put a new one and the eggs were collected daily. The collected eggs were placed in another plastic containers, until hatching. A newly hatched larvae were provided with planted faba bean seedlings infested with adequate number of *A. craccivora* individuals to serve as food.

So, enough quantities of aphids and larvae of *Ch. carnea* were always available for achieving the desired experiments.



Plate (2): Plastic container used for rearing adults.

became enough to be used as prey for feeding the *Ch. carnea* larvae.

This culture of *A. craccivora* became available for rearing *Ch. carnea* and the following needed experiments.

3- Biological parameters of Aphid lion:-

Experiment (1): Duration of egg stage (incubation period):-

100 freshly deposited eggs, resulted from adult females used in this experiment. Each egg was isolated alone and placed individually in a small jar (5 cm. diameter and 5 cm. height) covered with a piece of muslin cloth and followed up daily until hatching. The eggs were separated by cut the black cloth by using scissors to isolate each egg alone (**Plate, 3**).

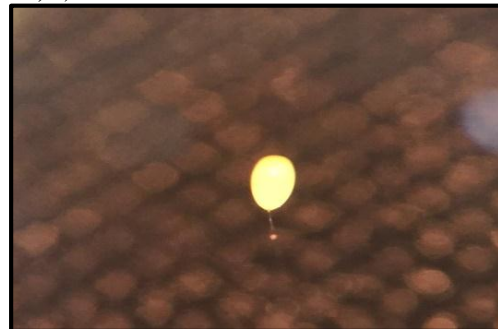


Plate (3): An individual egg of *Ch. carnea*.

Experiment (2): The larval and pupal durations:-

For calculating the larval and pupal durations, twenty-five newly hatched larvae were taken (**Plate, 4-A**), and each larva of *Ch. carnea* was kept in a small jar (5 cm. diameter and 10 cm. height) covered with a piece of muslin cloth (**Plate, 4-B**). A number of *A. craccivora* nymphs were added according to the larval instar of *Ch. carnea* (15 nymphs were put in the 1st day of the experiment and then afterwards (200) nymphs were provided / Larva till cocoon formation.

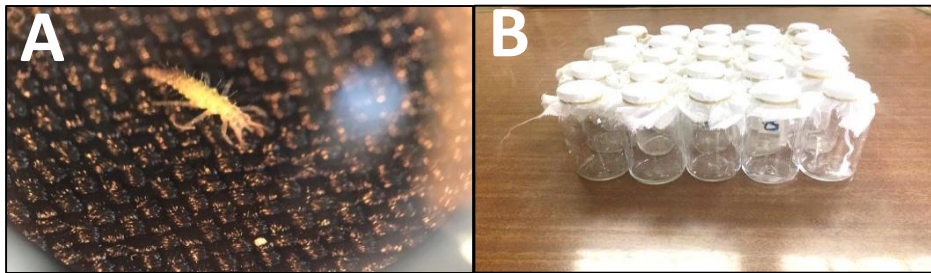


Plate (4):- A: *Ch. carnea* larva.
B: Small jars used for rearing larvae and pupae of *Ch. carnea*.

(3) Estimation of feeding capacity of larvae:-

For calculating larval feeding capacity, also 25 newly larvae hatched were kept, individually, in a small jar (5 cm. diameter and 10 cm. height) and covered with a piece of muslin cloth. A number (15 - 200 nymphs) of *A. craccivora* 4th instar was placed daily in each jar. Remains of *A. craccivora* were counted daily and removed before providing a new supply of aphids. Total numbers of aphids consumed were counted daily.

Experiment (4): The adult longevity:-

Fifteen newly emerged pairs of predatory species (15 replicates) were isolated in small glass a chimney (10

cm. diameter and 20 cm. height) (**Plate, 5-A**), covered with a piece of black cloth, in the middle of the cloth, a sticker has been placed that contains the diet for feeding (**Plate, 5-B**). Adults of *Ch. carnea* were fed on the semi-artificial diet. The experiment was conducted at 25±2°C and 65±5% R.H. as done by **Ashfaq et al., (2002)**.

Daily observations were done to record number of eggs (fecundity), percent of egg hatching, the incubation period, percent survived larvae, larval duration, percent pupation, pupal duration, percent adult emergence, sex ratio, adult longevity, per-oviposition, oviposition, and post-oviposition periods.



Plate (5):- A: Glass chimney cage in each of them placed a pair of adults.
B: Black cloth, in the middle of the cloth, a sticker has been placed that contains the diet for feeding.

Statistical analysis:

All the previous biological parameters and feeding capacity were statistically analyzed using one-way ANOVA using SPSS, ver. 22 (IBM Corp. Released 2013). Data were treated as a complete randomization design according to **Steel et al., (1997)**. Multiple comparisons were carried out applying **Duncun** test the significance level was set at < 0.05.

Results and Discussion

Biological parameters of *Ch. carnea*

This study was carried out to estimate some of the biological characteristics of the predator, *Ch.*

carnea when fed on the legume aphids, *A. craccivora*, under the laboratory conditions of 25±2 °C and 65±5%R.H.

1- Duration of egg stage (incubation period)

As shown in **Table (1)**, means of incubation period of *Ch. carnea* eggs obtained after rearing larvae on *A. craccivora* and adults on artificial diet at 25±2 °C and 65±5%R.H., was 4.00 days. Also, as shown in **Table (1)**, the hatchability percentage from the deposited eggs reached 86.00%, indicating 14.00% mortality percentage.

In similar studies, **Balakrishnan et al., (2005)** observed that the egg hatchability of *Ch. carnea* was 80.88 percent with an egg incubation period of (2.70

days) after rearing on *A. craccivora*. **Khanzada *et al.*, (2018)** indicated that the egg hatchability was 76.0±2.45% with an incubation period of 3.4±0.24

days, and **Kumar *et al.*, (2019)** revealed that the incubation period for the eggs was 3.33±0.33 days.

Table 1. Incubation period of *Ch. carnea* eggs, (100 eggs) hatchability, and mortality percentage among eggs under laboratory conditions of 25±2 °C and 65±5% R.H.

Egg parameter	
Incubation period (Days)	4.00±0.58
Hatchability %	86.00±3.46
Mortality %	14.00±3.46

The larval and pupal durations :

In this experiment, the freshly hatched larvae of *Ch. carnea* were fed on the 4th instar nymphs of *A. craccivora* throughout the whole larval period. Data in **Table (2)**, indicate that the first two larval instar durations were nonsignificantly, affected by feeding on the 4th instar nymphal of *A. craccivora* being (2.04 and 2.36 days, for the 1st and 2nd larval instar, respectively), only the 3rd larval instar showed significant elongation in duration compared to either of the two larval instars, being (4.88 days). Also, means of the total larval duration lasted 9.28 days. The mean period of *Ch. carnea* pupae resulted from larvae reared on the 4th instar nymphal of *A. craccivora* was 8.24 days **Table (2)**. Also, at 25±2 °C and 65±5% R.H., the *Ch. carnea* total larval and pupal periods for females and males were 9.21, 9.36, 8.14 and 8.36, days respectively. This indicating that female's larvae recorded shorter periods than male's

larvae when fed on *A. craccivora* nymphs. The percentage of adult's emergence from pupae obtained after rearing on aphid nymphs during the larval stage **Table (2)** was (1.1 ♀: 0.9 ♂) emergence of adults on *A. craccivora*.

Also, data presented in **Table (2)** indicated that the sex ratio (females: males) was 56% ♀: 44% ♂. The ratio indicated increase percentage of *Ch. carnea* females by rearing on *A. craccivora* and this very important for mass rearing of this predator.

These results were similar to those of **Kumar *et al.*, (2019)**, which indicated that, when *Ch. carnea* larvae reared on aphids the duration of first instar maggot was completed in 2.00±0.00 and the second instar larvae completed in 3.33±0.33 and the third and final instar larvae completed in 4.33±0.33 and the total larval period completed in 9.67±0.33 and the pupal period in 8.67±0.33 days.

Table 2. Larval and pupal durations (days) of *Ch. carnea* when fed on the 4th nymphal instar of *A. craccivora* at 25±2 °C and 65±5% R.H.

Sex	Durations of Larval instars			Total larva period	Average Pupal period	Sex ratio %
	1 st	2 nd	3 rd			
Female	2.14±0.10 ^{ab}	2.36±0.17 ^{ab}	4.71±0.30 ^{aa}	9.21±0.38 ^a	8.14±0.27 ^a	56% ♀: 44%
Male	1.91±0.09 ^{ac}	2.36±0.15 ^{ab}	5.09±0.28 ^{aa}	9.36±0.36 ^a	8.36±0.31 ^a	♂
Mean	2.04±0.07 ^B	2.36±0.11 ^B	4.88±0.21 ^A	9.28±0.26	8.24±0.20	(1.1 : 0.9)
LSD at 0.05	Sex (S) 0.33	Age (A) 0.40	S*A 0.57	1.14	0.88	

a, b & c: There is no significant difference ($P>0.05$) between any two means, within the same column have the same superscript letter.

A, B & C: There is no significant difference ($P>0.05$) between any two means for the same attribute, within the same row have the same superscript letter.

3- Feeding capacity of larvae:

Data in **Table (3)** show the predation capacity of different larval instars of *Ch. carnea* when fed on *A. craccivora* (4th instar nymphal) under 25±2 °C and 65±5% R.H. The consumption rate / larva of *Ch. carnea* increased as the predator larvae grew older to the subsequent instar. When fed on the 4th instar nymphal, of *A. craccivora* a single larva consumed 40.04, 83.28 and 395.64 nymphs during the 1st, 2nd and 3rd larval instar of the predator respectively. Throughout the total larval stage, a single *Ch. carnea* larva consumed a mean 518.96 *A. craccivora* 4th instar nymphs. Also, obtained data revealed that the mean total consumption by a single larva of female and male was 498.57 and 544.91 nymphs,

respectively. This is indicated that males consumed higher number than females with non significant differences. In this respect **El-Saeedy *et al.*, (2011)** indicated that at a temperature 25° the 1st instar larva of *Ch. carnea* consumed 12.88±5.14 when the larvae of predator reared on the *A. craccivora*, and the 2nd instar larva consumed 40.50±16.82 and the 3rd instar larva consumed 291.63±26.21, and the total consumed aphids throughout the total larval period 345.0±30.80. While, **Kumar *et al.*, (2019)** indicated that the 1st instar larva of *Ch. carnea* was consumed 30.67±2.40 and the 2nd instar larva consumed 53.00±1.16 and the 3rd instar larva consumed 123.00±3.79, and the total consumed aphids throughout the total larval period 206.66±1.86.

Table 3. Predation capacity of larval instars of *Ch. carnea* reared on *A. craccivora* (4th instar nymphal) under 25±2 °C and 65±5% R.H.

Sex	Larval feeding capacity			Total predation
	1 st	2 nd	3 rd	
Female	41.71±3.53 ^{aC}	85.57±9.41 ^{aB}	371.29±27.55 ^{aA}	498.57±32.29 ^a
Male	37.91±2.36 ^{aC}	80.36±5.68 ^{aB}	426.64±18.11 ^{aA}	544.91±17.67 ^a
Mean	40.04±2.23 ^C	83.28±5.75 ^B	395.64±17.94 ^A	518.96±19.89
LSD at 0.05	Sex (S) 24.15	Age (A) 29.58	S*A 41.83	84.37

a, b & c: There is no significant difference (P>0.05) between any two means, within the same column have the same superscript letter.

A, B & C: There is no significant difference (P>0.05) between any two means for the same attribute, within the same row have the same superscript letter.

Ovipositional period and longevity of *Ch. carnea* adults:

After rearing *Ch. carnea* adults (♀ and ♂) on semi-artificial diet (dried yeast + honey + distilled water), the females started egg-laying after pre-oviposition period of 3.80 days. As for the oviposition period, it lasted 13.93 days, while the post-oviposition period was 3.60 days. Also, as shown in **Table (4)** the total number of eggs laid by a female throughout its oviposition period was 268.8 eggs. Data presented in **Table (4)** indicated that adult females of *Ch. carnea* lived longer (21.40 days) than males (17.73 days) fed on semi-artificial diet. In this

respect **Khanzada et al., (2018)** indicated that the pre-oviposition period of *Ch. carnea* lasted for 5.6±0.25 days and the oviposition period was 23.6±1.04 days. The total number of eggs laid by a single female throughout its oviposition period was 299.0±5.50 eggs. Female's longevity was 37.0 ± 0.89 days being longer than males 31.0 ± 0.71 days when reared in laboratory. Also, **Kumar et al., (2019)** revealed that the oviposition period of *Ch. carnea* female was 22.67±0.33 days and the female's longevity was 26.00±1.53 days being longer than males 17.67±0.88 days.

Table 4. Ovipositional periods, longevity and fecundity of *Ch. carnea* females when fed on artificial diet under 25±2 °C and 65±5% R.H.

Ovipositional periods and adults longevity of <i>Ch. Carnea</i>		
Ovipositional periods	Pre-oviposition	3.80±0.20
	Oviposition	13.93±0.45
	Post-oviposition	3.60±0.21
fecundity (No. of eggs /female)		268.8±6.16
Adult longevity	Male	17.73±0.49
	Female	21.40±0.56

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قدرة الافتراس وبعض الصفات البيولوجية لمفترس أسد المن على من البقوليات تحت الظروف المعملية.

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أجريت التجارب المعملية لدراسة بعض الصفات البيولوجية و الكفاءة الافتراسية لمفترس أسد المن ، تحت الظروف المعملية. عند $25 \pm$ درجة مئوية و $65 \pm 5\%$ رطوبة نسبية ، أظهرت النتائج أن فترة حضانة البيض لمفترس أسد المن كانت (4.00 أيام) (البيض الناتج عن الإناث المرباة في مرحلة اليرقات على حوريات حشرات من البقوليات وفي الحشرات الكاملة عند التربية على البيئة الصناعية). بلغت نسبة الفقس في بيض المفترس 86 % ، و 14% نسبة الم، وكانت فترات الأعمار اليرقية الثلاثة ، والعداري 2.04 ، 2.36 ، 4.88 و 8.24 يوماً على التوالي. وكانت النسبة الجنسية (56% إناث: 44% ذكور). استمرت فترة ما قبل وضع البيض للإناث 3.8 يوماً ، بينما كانت فترة وضع البيض وفترة ما بعد الوضع 13.93 و 3.60 يوماً على التوالي. وكانت الكفاءة الافتراسية للعمر اليرقي الثالث 395.64 حورية من حوريات العمر الرابع لمن البقوليات، ويعتبر العمر الأكثر شراهة مقارنة بالعمرين الأول والثاني 40.04 و 83.28 حوريه من حوريات من البقوليات على التوالي. كانت طول فترة حياة الأنثى 21.40 يوماً وهي أطول من فترة حياة الذكور والتي بلغت 17.73 يوماً عند التغذية على الحوريات والحشرات الكاملة لمن البقوليات. كما انه بالتغذية على حوريات من البقوليات خلال الطور اليرقي و على البيئة الصناعية خلال طور الحشرات الكاملة كان متوسط عدد البيض الكلي الذي وضعته الأنثى الواحد خلال فترة حياتها 268.8 بيضة / الانثى.