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# FEEDING POTENTIAL AND LIFE HISTORY CHARACTERISTICS OF THE GENERALIST PREDATOR CHRYSOPERLA CARNEA (STEPHENS) FED ON TWO HOSTS

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## Article Info

## Abstract

*Chrysoperla carnea (Stephens) (Neuraoptera: Chrysopidae) is a generalist predator of many small-bodied insects like aphids (Hemiptera: Aphididae), and Corcyra cephalonica (Lepidoptera: Phyralidae). Studies on the feeding potential of the 1st,2nd, and 3rd of C. carnea were evaluated on aphid adults and eggs of C. cephalonica under laboratory conditions. The incubation period of C. carnea was evaluated at various temperatures I.e., 24$^{o}$c, 27$^{o}$c, 30$^{o}$c. Suggests that the highest survival percentage was observed on 24$^{o}$c (78%). The predatory potential of the 1st,2nd, and 3rd instar of C. carnea on adult aphids and eggs of C, cephalonica was 66.6, 139.7, and 293.9. And 49.7, 138.33, and 204.6 respectively at (27$^{o}$c with 70±5% R.H). Highest feeding (293.9) was observed by the 3rd instar larvae having daily feeding efficacy of 69.97 on aphids, while the. Highest feeding (204.6) was observed by the 3rd instar larvae having a daily feeding efficacy of 35.96 on eggs of C. cephalonica. The survival percentage was found 78, 68, and 56 at 24±1°C, 27±1°C, and 30±1°C with 70±5°% R.H. The results show that the maximum number of aphids were consumed by C. carnea while feeding on it while the maximum hatching and survival percentage is found in 24±1°C. The developmental duration was significantly affected when the host and rapidly developmental duration was shorter when C. carnea fed on an aphid. The green lacewing, C. carnea is an effective biological control agent in immature stages while predating soft-bodied insects throughout the year mostly in cold areas.*



**Keywords:** *Biological control, biocontrol agent, Chrysoperla Carnea, Aphis gossypii, Corcyra Cephalonica.*

## Introduction

Biological control (BC) or biological pest control is a method of suppressing the insect pest population by the application of natural enemies like a predator, parasites, parasitoids, and pathogens [1]. BC agents keep the insect pest below the economic injury level [2]. BC of insect pests is the most effective component of Integrated Pest Management (IPM) [3].

For a long, farmers have relied on the application of insecticides for the management of insect pests but due to toxic effects on the non-target organisms and insecticide resistance issues, modern scientists have switched from chemical control to BC. Different countries applied a defensive plan to minimize around 50% use of insecticides that had an ill effect on the ecosystem) [4]. Augmentation biological control means adding natural enemies that are present in small numbers. BC method has significantly decreased the need for insecticides in greenhouses [5]. Through augmentation biological control increases the number and efficacy of natural enemies to control insect pest population in an area. Two different approaches Inoculative release and Inundative release are utilized. In inoculation release, a small number of natural enemies are inoculated at a critical time of season to minimize pest population for long-term control while in Inundative release, a large number of natural enemies are released to control pest population [6]. It is common knowledge that a low population of natural enemies is not sufficient for the management of pests. Therefore, they do not give desirable economic control of the pests.

A free-living animal that feeds on other animals (prey); it may attack prey in both its immature and adult stages; usually more than one prey individual is required for the predator to complete its life cycle". Robber flies, syrphid flies, dragonflies, praying mantids, antlions, aphid lions, reduviid bugs, belostomatid bugs, pentatomid bugs, ladybird beetles, green lacewing, carabid beetles, hunting wasps, and ants are all examples of predators among insects [7].

The Green lacewing *Chrysoperla carnea* Stephens. (Chrysopidae: Neuroptera) Is a generalist predator of soft-bodied insects [8]. It is an important biological control agent, being frequently utilized in combating soft-bodied and immature insects such as aphids [9]. *C. carnea* feeds on several insect pests such as aphids, leaf miners, mealybugs, thrips, whitefly armyworms, bollworms, cabbage worms, codling moths, corn borers, cutworms, fruit worms, leafhopper nymphs and eggs, potato beetle, scale insects and, spider mites [10]. Keeping in view the predatory behavior of *C. carnea* this research was conducted to achieve the following objectives;

- To observe the feeding potential of *C. carnea* by feeding on Cotton aphids and *Corcyra cephalonica*.
- To observe the life cycle duration of immature stages of *C. carnea* on Aphid and *C. cephalonica*.
- To observe the effect of different temperatures on the incubation period of C. carne.

## 1. Materials and methods

This study was conducted at IPMP (insect pest management program)-IPEP, NARC in a biological control lab during the summer of 2023 at two different host insects. The adult of *C. carnea* was reared in a transparent cage by feeding an artificial diet. The eggs were collected from a black sheet at the top of the transparent cage and placed in vials separately till hatching as shown in Figure 1.

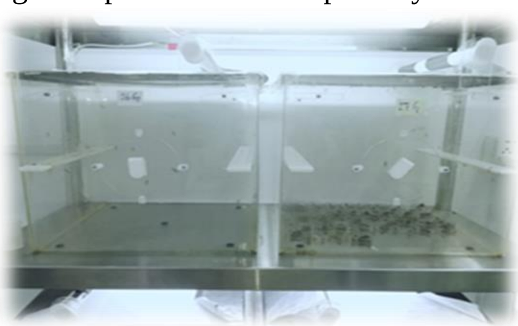

**Figure 1: Cage used for the rearing of *C. carnea***

### 2.1. Mass Rearing of *Chrysoperla carneae*

*C. carnea* is being commercially reared on different hosts including aphids, cotton mealybugs, and *Tribolium*. *Sitotroga cereallela* is one of the most common factitious hosts used for rearing *C.carnea* and can economically be reared on wheat grains. The major problem encountered during *Sitotroga cereallela* rearing is the contamination of culture thus I utilized *C. cephalonica*. The following materials are required for the rearing of *C. carnea* in the lab. Transparent plastic cages, Black sheets, Artificial diet for adult feeding, vertical cells for larvae, Petri dishes of different sizes, refrigerator, incubator, forceps, brushes, transparent tape, binocular microscope, table lamp, working table, and dropper.

### 2.2. Rearing Procedure

The *C. Carnea* adults were reared in the condition in transparent plastic cages of size (37 cm length, 12 cm diameter) Artificial food, containing, yeast + sugar + honey + water in a ratio ( 4:4:2:12) teaspoon was provided to adult *C. Carnea* daily in the transparent plastic cage as shown in figure 8. This food will fulfill the requirement of 15 adults per week.

The Eggs of *C. carnea* were collected from a black sheet at the top of the cage. The eggs were collected with razor blades and kept for hatching in plastic Petri dishes. Upon hatching the 1st stadium was transferred to other plastic petri dishes. *Corcyra* eggs were provided as food for larval development and survival. The newly hatched larvae were individually transferred to clear plastic petri dishes (10cm diameter +2.5cm length) with a fine brush. A filter paper was placed on the bottom of Petri dishes and a few drops of water were added for moisture. They are provided with host (aphid and *Corcyra* eggs) in the petri dish until pupation. They pupate in the same petri dish. Then pupae were collected and kept for adult emergence [11]

### 1.3. Rearing of the *Corcyra cephalonica*

For the rearing of *Corcyra cephalonica*, the materials utilized were fine brushes, rubber bands, culture (Wheat and rice grains), muslin cloth, a petri dish, scissors, glass jars, and, an aspirator. The adult of *C. cephalonica* is shown in Figure 2.

**Figure 2: Adult of *C. cephalonica***

### Rearing Procedure

Initially, the adults were collected from godown and then the adults were reared on rice and wheat grains. Grinded wheat and rice grains (cultures) were put in a glass jar. The grains were sterilized in the oven at high temperature or the grains may also be stored at freezing temperature to kill all other stored grain pests in the culture and then the grains were put in a glass jar (transparent).

The data was collected daily. The eggs from the previous culture and put into this culture. Larvae have emerged in 5 to 6 days. Larvae feed on grains and then pupate on the outer side of grains inside a jar.

Adults have emerged after 55 to 75 days at 28±1°C. Females lay eggs on muslin cloth at the top of a glass jar. Fresh eggs were collected daily and these eggs of "*C. cephalonica"* were used in the experiment.

**1.4. Feeding potential of *Chrysoperla carnea* on aphids and eggs of *Corcyra cephalonica***

In the experiment; there were 10 replicates for one host and a similar process was followed for another host. The aphid and egg of *C. cephalonica* were provided daily to 10 separate replicates of 1st instar larva. The predatory potential was noticed in each larva daily and fresh food for their feeding was provided.

The *C. carnea* passes through three larval instars. The differentiation between each larval instar was observed through the process of molting under a microscope. After that, the larva turned into a pre-pupa in which they stopped feeding and searched for a protective place for pupation. These pupae are kept in the same vile till adult emergence. The period of each instar of larva and its predatory potential, pre-pupal period, and pupal period were recorded. The data were statistically analyzed.

**1.5. To observe the incubation period of *C. carnea* at different temperatures**.

The present work is intended to bring some basic information on immature stages mortality and survival percentage of *C. carnea,* at three different temperature levels, three hours of fresh 50 eggs of *C. carnea* were collected from a black sheet at the top of the cages with a razor. Freshly collected eggs of *C. carnea* were counted and kept within transparent Petri dishes (6cm x 12cm). A total of 50 eggs were placed in separate Petri dishes kept under a growth chamber for hatching at three different temperatures 24±1°C, 27±1°C, and 30±1°C with 70±5 relative humidity. The incubation period was checked daily upon hatching the 1st instar larvae were kept separately in transparent vials for culture.

**3. Results**

**3.1. Developmental duration and feeding potential of larval instar *Chrysoperla carnea* on Aphid and *Corcyra cephalonica* eggs.**

Result of immature stages of *C. carnea* feeding on Aphid and *C. cephalonica* eggs 27°c with 70±5 and observation of incubation period on different temperatures.

**3.1.1. Developmental duration study**

The mean duration of 1st, the 2nd, and 3rd instar of *C. carnea* against aphid was found (3.5±0.1, 3.8±0.01, 4.1±0.29 days) and *C. cephalonica* eggs developmental duration was found (3.7±0.14, 3.9 ±0.10, 4.2±0.27). The viability of 1st, 2nd, and 3rd were 100% against aphids While 100, 90, and 100% against *Corcyra* eggs. The mean duration of larval stages was 12.6±0.04 and 11.7±0.51.

The pre-pupal and pupal periods of *Chrysoperla cornea* against aphid and *C. cephalonica* eggs were 2.16±0.15 and 4.75±0.28 days and 2.6±0.4,2.8±0.33 days respectively. The viability of pre-pupa and pupal stage were 100 and 100% respectively.

**3.2. Predatory potential of larva**

The mean predatory potential of *C. carnea* feeding on aphids and *C. cephalonica* eggs at 1st, 2nd, and 3rd instar were found 66.6, 139.7, and 293.9. And 49.7, 138.33, and 204.6 respectively at (27°c with 70±5% R.H) While the mean feeding efficiency of *C. carnea* against aphid and *C. cephalonica* per day of 1st 2nd, and 3rd instar larva is 19.02, 36.76 and 69.97 And 13.43, 35.46 and 49.9 respectively as shown in table 2 and 3. The higher availability of prey increases the consumption rate of the predator.

**3.3. Effect of temperature on egg incubation of *Chrysoperla carnea* under growth chamber**

The mean incubation period at T1 **(**T1= 24±1°C With 70±5°% R.H), T2 (T2= 27±1°C 70±5°% R.H), and T3 (T3= 30±1°C with 70±5°% R.H) is 4.5, 4.9, and 3.3 days respectively. The total no of egg survival at T1 **(**T1= 24±1°C.With 70±5°% R.H), T2 (T2= 27±1°C 70±5°% R.H) and T3 (T3= 30±1°C with 70±5°% R.H) with 39, 34, and 28 eggs, The Survival percentage is 78, 68 and 56% at 24±1°C, 27±1°C and 30±1°C with 70±5°% R.H. The mortality percentage at 24±1°C, 27±1°C and 30±1° 22, 32 and 44%. as shown table 3.

**Table 1: Mean duration in days± S.E, survival rate %age and mean feeding Efficiency of different immature stages of *Chrysoperla carnea* feeding on cotton aphid at (27°C with 70±5% R.H)**

| *Sr. NO.* | Developmental stage | Number (N) | Life duration in Days+S.E | Survival Rate %age | Mean Feeding Efficiency of larval instars | Mean Feeding Efficiency/days |
|---|---|---|---|---|---|---|
| *1* | Eggs | 10 | 4.9±0.03 | 100 | | |
| *2* | 1st instar | 10 | 3.5±0.1 | 100 | 66.6 | 19.02 |
| *3* | 2nd instar | 10 | 3.8±0.01 | 100 | 139.7 | 36.76 |
| *4* | 3rd instar | 10 | 4.1±0.29 | 100 | 293.9 | 69.97 |
| *5* | Total larval period | 10 | 11.4±0.13 | 100 | 500.2 | 39.6 |
| *6* | Pre-pupal period | 7 | 2.16±0.15 | 70 | | |
| *7* | Pupal period | 7 | 3.75±0.28 | 70 | | |

**Table 2: Mean duration in days± S.E, survival rate %age and mean feeding Efficiency of different immature stages of *Chrysoperla carnea* feeding on *Corcyra cephalonica eggs* at (27°C with 70±5% R.H)**

| *Sr. NO.* | Developmental stage | Number (N) | Life duration in Days± S.E | Survival Rate %age | Mean feeding efficiency of larval instar | Mean feeding efficiency/days |
|---|---|---|---|---|---|---|
| *1* | Eggs | 10 | 4.9±0.003 | 100 | | |
| *2* | 1st instar | 10 | 3.7±0.14 | 100 | 49.7 | 13.43 |
| *3* | 2nd instar | 9 | 3.9±0.10 | 90 | 138.33 | 35.46 |
| *4* | 3rd instar | 9 | 4.2±0.27 | 90 | 204.6 | 49.90 |
| *5* | Total larval period | 9 | 11.8±0.51 | 90 | 420.79 | 35.96 |
| *6* | Pre-pupal period | 9 | 2.6±0.4 | 90 | | |
| *7* | Pupal period | 9 | 3.8±0.33 | 90 | | |

**Table 3: To observe the incubation period, survival, and mortality %age of *Chrysoperla carnea* at three different temperatures.**

| *Sr.NO.* | Temperature (±1°C) | Mean incubation period (In days) | No of egg Used | Individual survived (No's) | Survival %age | Mortality %age |
|---|---|---|---|---|---|---|
| ***1*** | 24°C | 4.5 | 50 | 39 | 78 | 22 |
| ***2*** | 27°C | 4.9 | 50 | 34 | 68 | 32 |
| ***3*** | 30°C | 3.3 | 50 | 28 | 56 | 44 |

**4. Discussion:**

Biological controls are considered an important component of integrated pest management (IPM). For long many natural enemies have been utilized for the management of various insect pests. *C. carnea i*s considered an important predator of many soft-bodied insects including aphids, jassids, and thrips [12]. In Pakistan, several attempts have been made to establish *C. carnea*-rearing research projects for the feasibility of pest management programs. The current project was conducted to explore the rearing technique and its feeding potential on aphids and *C. cephalonica.*

This is the first study in life on *C. carnea* to observe the feeding potential of immature stages on aphids and eggs of *C. cephalonica* and observation of the incubation period, mortality, and survival percentage. The feeding potential increases from 1$^{st}$ to third larval instar of *C. carnea* on all species of praying aphids and all three larval instars of *C. carnea* are good predators of aphids than eggs of *C. cephalonica*. Rabinder [13] reported that aphid is the major prey of *C. carnea.* The current study shows that *Green lacewings* are voraciously on aphids which are major prey of *C. carnea* [14]. The various insect pests such as sucking and chewing attack the different crop parts from sowing to harvesting among them, aphid species are an important pest of various crops such as cabbage, cotton and potato **[11]**

Significant effect of temperature on the incubation period and survival rate of *C. carnea* at three different temperatures. The present study indicates that maximum hatching, survival, and minimum mortality percentage were found on 24°C while minimum hatching, survival, and mortality were found on 30°C (Table 3).

High temperatures can cause loss of moisture, increased desiccation, and overheating in females indicating a negative impact on the ability to reproduce [15]. Khan [16] reported the predatory efficiency of first, second, and third instar larvae of *C. carnea*, with 61±1.97, 113.6±2.42, and 239.2±6.87 aphids consumed, respectively. The feeding potential on eggs of *C.cephalonica* were 38.67±0.58, 118.33±6.36 and 212.67±3.48 respectively [17]. Pathan [18] also found similar results and reported that above 30°C and below 23°C temperature have a negative impact on hatching, survival, and mortality of *C. carnea*. Sharif [19] observed that temperature has a significant effect on the developmental duration, emergence of adults, and survival rate of immature stages of *C. carnea*. Temperature changes can affect body size, survival, immunity, feeding ability, fitness, and mating to better understand the comprehensive impact of temperature changes on insects' biology.

The result suggests that *C. carnea* is a better biological control agent against aphids and 24 °C is a suitable temperature for rearing the *C. carnea.*

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