Research Article

EFFECT OF DIFFERENT PREYS ON CERTAIN BIOLOGICAL CHARACTERISTICS OF GREEN LACEWING, *CHRYSOPERLA CARNEA* (STEPHENS) (NEUROPTERA: CHRYSOPIDAE) UNDER LABORATORY CONDITIONS

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ABSTRACT

The effect of different prey kind on certain biological characteristics of green lacewing, *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae),was studied at Bio control Laboratory, Entomology Division, NARC, Khumaltar, Lalitpur, Nepal from December, 2015 to February, 2016 under laboratory conditions. The experiment was conducted in Completely Randomized Design with eight treatments with four replicates. The treatments consist of different prey kind including different species of aphids and eggs of *Corcyra cephalonica* (Stainton), which were used as prey for predatory *Chrysoperla* larvae.The results of this study showed that duration of larvae was significantly affected when fed with different prey kind. There was no significant effect of different prey kind on pupal period of *Chrysoperla*. Natural food sources i.e. different soft-bodied aphid species could provide an alternative of *Corcyra* eggs, which is the most used food source to rear *Chrysoperla* in the laboratory. Among soft-bodied aphids, *Aphis craccivora* (Koch) can be utilized as an alternative natural food sources for mass rearing of *Chrysoperla* in laboratory. Further research is needed to compare detailed biological parameters of *Chrysoperla* when fed with different prey kind in field conditions to offer better utilization of *Chrysoperla* as an efficient IPM tool in pest management program in various crops under field conditions.

Key words: *Biological control, Green lacewing, prey, predator*

INTRODUCTION

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Aphids are small and soft-bodied homopteran insects. They damage the crop in several ways: directly on plant by sucking fresh sap, transmitting several viral diseases and indirectly on photosynthesis activity of plant; leading to more than 40% yield loss (Tilmon *et al.*, 2011). To manage the aphids' damage, farmer use insecticides that have detrimental effects on natural enemies, human and animal health and environment as well (Aktar *et al.*, 2009; Sharma and Singhvi, 2017). Therefore, alternatives of insecticides to manage insect pests are becoming a hot issue. One of the alternatives is use or encouragement of natural enemies (Bista *et al.*, 2015).

The green lacewing, *Chrysoperla carnea* (Stephens), a generalist natural predator or biocontrol agent, is known as aphid lion. The predatory *C. carnea* larvae voraciously feed on a wide range of soft-bodied insect pest including aphids, thrips, mealy bugs, white flies, spider mites, leaf hoppers, caterpillars, coccids, jassids and insect eggs (Ulhaq *et al.*, 2006; Sarwar and Salman, 2016; Alghamdi *et al.*,2018).Therefore, *C. carnea* can be used as an effective bio-control agent for successful, efficient implementation of integrated pest management (IPM) programs for the management of soft-bodied aphids based on biological control (Memon *et al.*, 2015; Rana *et al.*, 2017) and minimizes pesticide uses on crops (Saljoqi *et al.*, 2015).

Despite huge usefulness of *C. carnea* in the IPM program, there are issues with its laboratory rearing. Providing food sources for predatory larvae is important as success of rearing depends on it. Therefore, we examined the effect of different prey kind on certain biological characteristics of *C. carnea*. This research results can be utilized for the mass rearing of *Chrysoperla* and its utilization as an efficient tool in pest management programs for the management of different species of aphids in various crops under field conditions.

MATERIALS AND METHODS

The research was carried out at Bio control Laboratory, Entomology Division, NARC, Khumaltar, Lalitpur, Nepal from December 2015 to February 2016, to study the effect of different preys on certain biological characteristics of *C. carnea* under controlled conditions of 24±2^{0}C average temperature and 65±7% relative humidity. The specific methodology is described below.

Experimental procedure

The experiment was laid out in Completely Randomized Design (CRD) with eight treatments (Table 1) and each treatment had four replicates. The seven different soft-bodied fresh aphids were collected from agricultural field daily. The eggs of *Corcyra* and *C. carnea* were obtained from Bio control Laboratory, Entomology Division, NARC respectively. The different prey kinds collected above are used as food sources for *C. carnea*.

Table 1. Treatment details

S.N.	Treatments
1	T_1: Cowpea aphid, *Aphis craccivora* (Koch)
2	T_2 :Cabbage aphid, *Brevicorynae brassicae* (Linnaeus)
3	T_3 :Green peach aphid, *Myzus persicae* (Sulzer)
4	T_4 :Woolly apple aphid, *Eriosoma lanigerum* (Hausmann)
5	T_5 : Mustard aphid, *Lipaphis erysimi* (Kaltenbach)
6	T_6 : Black bean aphid, *Aphis fabae* (Scopoli)
7	T_7 : Rice moth, *Corcyra cephalonica* (Stainton)
8	T_8 : Sugarcane woolly aphid, *Ceratovacuna lanigera* (Zehntner)

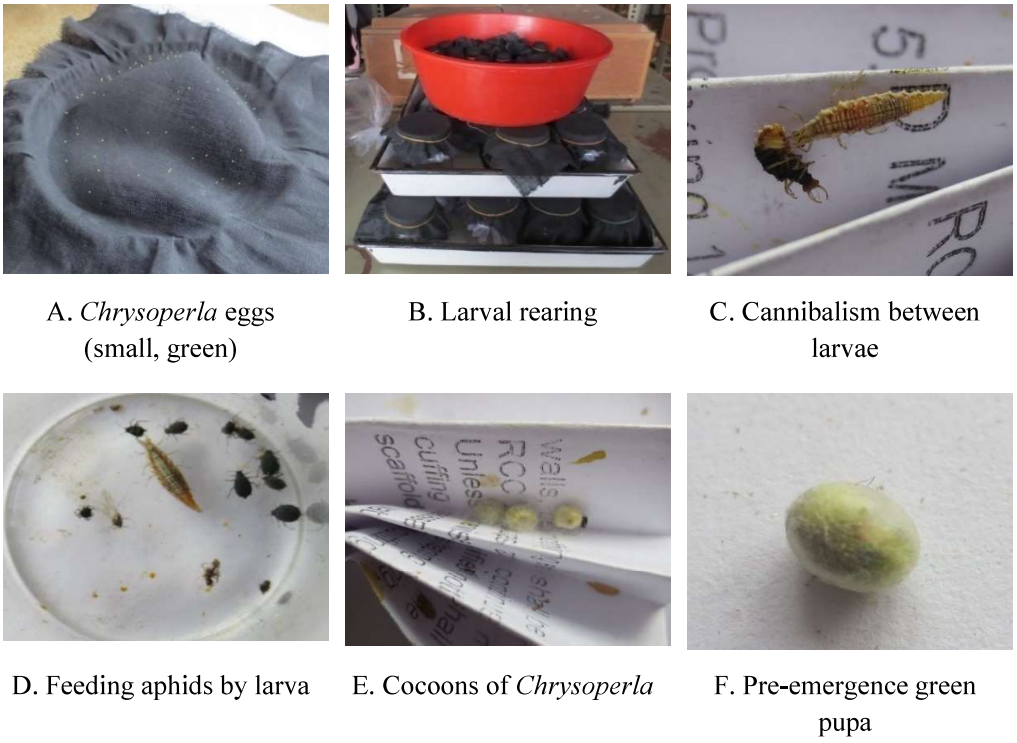
The eggs of *C. carnea* were detached from black muslin cloth with the help of sharp razor as described by Sattar and Abro (2009). The collected eggs were kept in plastic jars for incubation and observed daily. Five freshly hatched larvae of *C. carnea* were taken to keep in plastic jar (8 × 6 cm) for all eight treatments separately, using a soft and moist camel hair brush. Then, each treatment was provided 25 numbers of preys in early instar and 50 number of preys in later instar. The mouths of plastic jars were covered with a piece of black muslin cloth and tightened by rubber string after providing hosts. On the next day, for each treatment, a pre-determined number of above specified different hosts was provided after removing dead and live hosts and the process continued until pupation (Spinning of cocoon). The small piece of paper (10 × 8 cm), 3 to 4 times folded was used in each plastic jar to avoid cannibalism between *C. carnea* larvae as described in Chakraborty and Korat (2010) (Fig. 1). After pupation, the pupa was left undisturbed till emergence of adult.

Data collection

The developmental parameters including duration of each larval instars (days), larval and pupal period (days) and larval and pupal mortality (percentage) were examined daily. The larval period was considered from hatching till spinning of cocoon and period between cocoon formation to adult emergence of *C. carnea* as pupal period. The instars were differentiated by observing exuviae in the study.

Statistical analysis

The data obtained from the experiments entered and managed in Microsoft Excel. The treatment differences were statistically analyzed by using analysis of variance (ANOVA) ($p<0.05$). Mean comparison was done using Duncan's Multiple Range Test (DMRT) with the help of GenStat statistical package.



A. *Chrysoperla* eggs (small, green) | B. Larval rearing | C. Cannibalism between larvae

D. Feeding aphids by larva | E. Cocoons of *Chrysoperla* | F. Pre-emergence green pupa

Fig. 1: Laboratory setting to the study effect of different preys on certain biological characteristics of *Chrysoperla carnea*

RESULTS AND DISCUSSION

Larval period

The *Chrysoperla* larvae passed through three instars before transforming into pre-pupa. These larval instars were recorded to have different instar duration.The instar duration also found to vary significantly ($p<0.05$) depending on food sources feed to them as shown in Table 2. The shortest period (2.7±1.3days) of the first instar of *Chrysoperla* was recorded when fed with eggs of *Corcyra* and longest (4.6±0.42days) on *B. brassicae*. There was non-significant effect of prey species on the second instar duration of *Chrysoperla* however maximum instar period (2.87±0.73 days) was observed when *Chrysoperla* larvae were fed with eggs of *Corcyra* and shortest period (1.95±0.08 days) was recorded when fed with E. lanigerum. Similarly, non-significant effect was shown by the different prey kind on the third instar duration of *Chrysoperla* among which the longest (7.14±1.69 days) was recorded on *B. brassicae* and shortest (4.51±1.59 days) on *M. persicae*. The sequence of complete larval developmental period on different prey species were found to be in

decreasing order of *B. brassicae*>*C. cephalonica*>*L. erysimi*>*A. fabae*>*C. lanigera*>*A. craccivora*>*M. persicae*>*E. lanigerum*, respectively. The total larval developmental period of *Chrysoperla* was recorded maximum (14.38±1.79days) when fed with *B. brassicae* and minimum (10.63±1days) when fed with *E. lanigerum*. The statistical analysis showed that the different preys viz. *A. craccivora*, *M. persicae*, *E. lanigerum*, *L. erysimi*, *A. fabae* and *C. lanigera*, respectively were similar effect on larval period of *C. carnea*. The maximum (70%) larval mortality occurred when *Chrysoperla* larvae were fed with eggs of *Corcyra* and the minimum (25%) on *A. craccivora*. The present result indicated length of larval period was significantly affected by different preys which is in agreement with the reports of Hesami *et al.* (2011), Sattar *et al*. (2011), Kumari and Nikoshe (2016) and Shaukat (2018). The larval period *Chrysoperla* were 11.4±1.45 days while rearing on *A. craccivora* and the result was in the range of 9-12 days as reported by Mushtaq (2008). Similar observations were made on larval period at different constant temperatures rearing on *A. craccivora* (El-Saeady *et al*., 2011). Nandan *et al*. (2014) reported in line with our finding, where the authors reported the larval period of *Chrysoperla* were 11.92 days and 10.70 days when reared on *L. erysimi* and *M. persicae*, respectively.The total larval developmental period in the present study was observed 12.2±2.30 days when the *Chrysoperla* larvae were fed with eggs of *Corcyra*. Similar observations were made by Mushtaq (2008) and Manjunatha *et al*. (2018) however Chakraborty and Korat (2010) observed that the 6.92±0.13 days under similar feeding condition. The present study revealed that the total larval period of Chrysoperla was 10.63±1 days when the larvae fed with *E. lanigerum* however Maurya *et al*. (2013) has reported that the larval period of *Chrysoperla* was 13.33 days in controlled conditions whereas, in the room temperature condition, it was 28.67 days. Saeed and Razaq (2015) observed that the different larval period 15.72±0.02, 12.00±0.25, 11.12±0.12, 15.00±0.31, 16.24±0.35 days, respectively when feeding *Chrysoperla* with 1st, 2nd, 3rd, 4th and 5th instars nymph of *Amrasca devastans* (Dist.) while Kumar *et al*. (2019) showed 11.33±1.20,9.67±0.33 and 10.67±0.67 days of larval period of *Chrysoperla* on *A. gossypii* (Glov.), *A. craccivora* and *C. cephalonica*, respectively.The author Mudassar *et al*. (2014) also shows different larval period 8.45±0.14 and 9.28±0.14 days when *Chrysoperla* rearing on *Sitotroga cereallela* (Olivier) and *Phenococcus solenopsis* (Tinsley). Different duration of different instars and larval period were reported by different researchers that might have been occurred due to different hosts and different environmental conditions under which experiments were carried out (Khan *et al*., 2013; Manjunatha *et al*., 2016).

Pupal period

There was no significant difference among different prey species on pupal period of *Chrysoperla*. These results are in agreement with the report of Muhammad and Ashraf (2017) who have studied the effect of prey density on the biology and functional response of *Chrysoperla*. In the present study, the maximum (9.20±0.79days) pupal period of *Chrysoperla* was observed when the larvae of *Chrysoperla* fed with *Ceratovacuna lanigera* and minimum (6.83±3.95 days) when fed with *A. craccivora*. Mushtaq (2008) observed 7-10

days of pupal period rearing *Chrysoperla* on *A. craccivora*, similar in line with present finding. Nandan *et al*. (2014) recorded 6.70, 8.55 and 8.25 days of pupal period when *Chrysoperla* was fed with *A. craccivora*, *M. persicae* and *L. erysimi*, respectively similar with the present observation. In the present study, the pupal duration of *Chrysoperla* was recorded 8.5±0.5 days when reared on eggs of *Corcyra*. The previous authors reported in line with our finding, where the authors reported the pupal period of *Chrysoprela* were 5 to 8 days (Chakraborty and Korat, 2010) and 9-12days (Mushtaq, 2008) when reared on eggs of *Corcyra*. The pupal period of *Chrysoperla* was recorded in the present study support from the reports of Khanzada *et al*. (2018) rearing on eggs of *Corcyra* and *A. craccivora*, respectively and El-Saeady *et al*. (2011) rearing on *A. craccivora* at different constant temperatures.

Table 2. Effect of different prey species on developmental stages of *Chrysoperla carnea* under laboratory conditions

	Developmental stages (Means± S.D.) and mortality (%± S.D.)						
Preys	1st Instar	2nd Instar	3rd Instar	larval period	larval mortality*	Pupal period	Pupal mortality*
A. craccivora	4.25±0.32^{b}	2.38±0.50	4.76±1.55	11.4±1.45^{a}	25±21.79^{a}	6.83±3.95	47.5±35.61
B. brassicae	4.6±0.42^{b}	2.63±0.60	7.14±1.69	14.38±1.79^{e}	55±8.66^{cd}	8.91±0.59	33.33±20.41
M. persicae	4±0.00^{b}	2.32±0.34	4.51±1.59	10.83±1.31^{a}	55±16.58^{cd}	8.41±0.43	16.66±16.66
E. lanigerum	4±0.00^{b}	1.95±0.08	4.68±0.99	10.63±1^{a}	40±14.14^{ab}	8.77±0.83	20.83±21.65
L. erysimi	4.25±0.25^{b}	2.75±0.60	4.68±0.58	11.68±0.43^{a}	60±14.14^{cd}	8.83±0.95	41.66±25
A. fabae	3.97±0.38^{b}	2.31±0.40	5.33±1.77	11.62±1.34a	45±8.66^{abd}	8.41±0.59	33.33±23.57
C. cephalonica	2.7±1.3^{a}	2.87±0.73	6.62±1.47	12.2±2.30^{ab}	70±10^{e}	8.5±0.5	12.5±21.65
C. lanigera	3.65±0.55^{b}	2.66±0.49	5.12±0.80	11.43±0.89^{a}	60±14.14^{cd}	9.20±0.79	20.83±21.65
C.V. (%)	16.4	23.6	29.7	13.9	31.9	21	97.20
F-value	3.096	1.041	1.543	3.0	3.026	0.658	0.759
P-value	0.018	0.429	0.201	0.021	0.02	0.704	0.626

Note: C.V. = Coefficient of variation, Means (Compared by using DMRT) in column followed by the same letter are not significantly different from each other. * represents data treat with arcsine transformation (ASIN (SQRT (X/100)) x 57.296) for analysis as original data violates ANNOVA model assumptions.

Chrysoperla can be successfully reared on controlled environmental conditions using a wide range of food sources, as identified in the present study. All other natural prey species could be used as potential food sources for mass multiplication of *Chrysoperla* in laboratory conditions. Also, mass-reared *Chrysoperla* can be a potent bio control agent against different aphid species, used as prey treatment in the present study, however, most effective

control can be possible in the crop plant when infested by *A. craccivora* and other aphid species (Rana *et al*.,2017).

CONCLUSION

The larval duration of *Chrysoperla* larvae was significantly affected by different prey kind provided as food sources but there was no significant effect of these prey kinds on pupal period of *Chrysoperla*. Because of, short larval period and less larval mortality, *A. craccivora* can be used for mass multiplication and releasing of *Chrysoperla* in aphid infested field crops. Further research is needed to compare detail biological parameters of *Chrysoperla* when fed with the different host in field conditions to offer better utilization of *Chrysoperla* as an efficient IPM tool in pest management program in various crops under field conditions.

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