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Feeding potential of *Chrysoperla zastrowi arabica* (Henry *et al.*) on different prey hosts

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Abstract

The investigation on the Feeding potential of the green lacewing, *Chrysoperla zastrowi arabica* (Henry *et al.*) was conducted to find predatory efficiency of the eggs and neonate larvae of *Corcyra cephalonica* (Staint.) and nymphs of five species of aphids *viz.* Aak aphid, *Nyzus nerii* (Boyr.), Mustard aphid, *Lipaphis erysimi* (Kalt.), Cotton aphid, *Aphis gossypii* (Glov.), Bean aphid *Aphis craccivora* (Koch.), Barley aphid *Rhopalosiphum maidis* (Fitch.) during October 2014 to March 2015. Larval stage of *C. zastrowi arabica* preferred the eggs of *C.cephalonica* with the highest consumption of 298.24 eggs followed by the neonate larvae of *C.cephalonica* with the consumption of 250.59 and *A. gossypii* with the consumption of 229.93 nymphs. Whereas, *N. nerii* was the least preferred host with the consumption of 154.58 nymphs. There was a significant difference between instar's efficiency when offered different hosts. Considering the consumption of *C. zastrowi arabica* adults, the females consumed more prey than males and the highest consumption was obtained when reared on the eggs of *C.cephalonica* with the highest pupal weight of 10.39 and 10.73 mg, maximum growth rate index of 113.18 and 99.72 and maximum adult emergence of 92.05 and 95.84 percent in male and female, respectively. The larval development period of *C. zastrowi arabica* was shorter on eggs and neonate larvae of *C.cephalonica* i.e. 9.18, 10.76 days; 9.36, 10.24 days and *A. gossypii* i.e.9.64, 11.38 days in male and female, respectively. *C. zastrowi arabica* adult longevity was greater on eggs, neonate larvae of *C. cephalonica* i.e. 26.99, 34.78; 23.45, 32.29 days and on *A. gossypii* i.e.28.99, 38.93 days in male and female, respectively.

Keywords: Feeding potential, green lacewing

1. Introduction

The green lacewings, *Chrysoperla zastrowi arabica* Henry *et al.* (Neuroptera: Chrysopidae) is a cosmopolitan polyphagous predator, commonly found in agro ecosystems in different parts of the world. Chrysopids are the most intensively studied predators because of their wide geographical distribution, broad habitats with high relative frequency of occurrence, good searching ability and easy rearing in the laboratory. The larvae of Lacewings feed on various aphid species, including *Aphis glycines* Matsumura [13], *Myzus persicae* Sulzer [12].

It has been recorded that the larvae of green lacewings as an effective generalist predator, are known to feed on over 80 species of insects (aphids, coccids and mealy bugs) and 12 species of *Tetranychid* mites [7, 24].These pests cause severe damage to various field crops, fruits and vegetables [21, 8, 23]. *C.*spp has been widely used for aphid bio-control [20] and other insect pests [11] because of its ubiquitous nature, polyphagous habits, and compatibility with selected chemical insecticides, microbial agents and amenability to mass rearing [15, 11, 19].

The present study was undertaken to know feeding potential of *Chrysoperla zastrowi arabica* Henery *et al*. on the eggs and neonate larvae of *Corcyra cephalonica* (Staint) and five different aphid insect pests, Aak aphid *Nyzus nerii (Boyr.),*Mustard aphid *Lipaphis erysimi (*Kalt.),Cotton aphid *Aphis gossypii* (Glov.), Bean aphid *Aphis craccivora* (Koch.), Barley aphid *Rhopalosiphum maidis* (Fitch.). The results help in designing integrated pest management (IPM) programs involving the use of *C. zastrowi arabica* as a biocontrol agent of pests on various crops.

2. Material & Methods

Present investigation was carried out at Biocontrol Laboratory, Department of Entomology of Rajasthan College of Agriculture, Udaipur during October 2014 to March 2015. The feeding potential of *C. zastrowi arabica* at the larval stages on different hosts and the effect of these hosts on its biology were investigated by feeding the larvae with different aphid species, eggs of *C. cephalonica* and neonate larval stages of *C. cephalonica*.

The experiment on the feeding potential of *Chrysoperla zastrowi arabica* was conducted in the Completely Randomized Design (CRD) with four replications. Each treatment replicate contains ten larvae; the larvae were kept individually in plastic jars and allowed to fed *adlib.* on the nymphs of five different species of aphids, eggs and neonate larvae of *C. cephalonica* mentioned as below:

T_1 - The Eggs of *Corcyra cephalonica* (Staint.)
T_2 - The neonate larvae of *Corcyra cephalonica* (Staint.)
T_3 - The nymphs of aak aphid, *Nyzus nerii* (Boyr.)
T_4 - The nymphs of mustard aphid, *Lipaphis erysimi* (Kalt.)
T_5 - The nymphs of cotton aphid, *Aphis gossypii* (Glov.)
T_6 - The nymphs of beans aphid, *Aphis Craccivora* (Koch.)
T_7 - The nymphs of barley aphid, *Rhopalosiphum maidis* (Fitch.)

The leaves/twigs of different host plants infested with different aphid species were collected from plants and were counted. They were placed over a thin layer of moist soil and wet blotting paper in plastic containers so as to keep the leaf turgid. The newly hatched or moulted larvae (1-4 hour) were maintained in separate tubes and released on different collected aphids. After every 24 hour period, such different aphids will be again counted and changed. The numbers of aphids consumed daily during the period of study were recorded in each treatment.

Eggs and Larvae of *C. cephalonica*

To study the feeding potential of *C. zastrowi arabica* on *C. cephalonica* the newly emerged or moulted larvae of *C. zastrowi arabica* were exposed to definite number of eggs of *C. cephalonica* for predation. The numbers of eggs consumed by the larvae in 24 hours were counted. The egg masses of different insects were placed daily with fresh ones. As such the numbers of eggs consumed by the larvae during the different instars were recorded. The feeding potential was also likewise investigated on the neonate larvae of rice moth.

Effect of larval food quality on larval period, weight of the cocoon and the growth rate index

The type of food was offered at the larval stage had considerable influence on the pre-imaginal developmental time and cocoon weight. The newly hatched larvae were offered food of different soft bodied insects. The time duration from the emergence of larva from the eggs till spinning of cocoon was recorded on each host diet. The weight attained by the cocoon on different foods was also recorded. The growth rate index (G.R.I) in each treatment was calculated as under:

$$\text{G.R.I} = \frac{\text{Weight of cocoon (mg)}}{\text{Total larval duration (days)}} \times 100$$

This index enables to note the differences in utilization of various diets.

3. Result & Discussion

Observations recorded from effect of different prey hosts on the biology of *C. zastrowi arabica* showed that both male and female has maximum and minimum larval period days feeding on nymphs of *Aphis craccivora* (Koch.) and nymphs of *Nyzus nerii* (Boyr.) respectively whereas maximum pupal period was in the case nymphs of *Aphis craccivora* (Koch.) and minimum was while feeding of nymphs of *Rhopalosiphum maidis* (Fitch). Percentage adult emergence was heist in while feeding eggs of *Corcyra cephalonica* (Staint.) and minimum on nymphs of *Aphis gossypii* (Glov.) as given in Table 1 and 2.

All the three larval stages of *C. zastrowi arabica* were fed on small, comparatively soft bodied insects. The total consumption of different prey hosts were recorded and have been presented in Table-3 and 4. The data indicates that significantly the *C. zastrowi arabica* consumed maximum *i.e.* 298.24 eggs of *C. cephalonica,* while, *C. zastrowi arabica* consumed minimum 154.48 nymphs of *N. nerii*. The maximum growth rate index (GRI) of *C. zastrowi arabica* was observed on the eggs of *C. cephalonica* with mean of 113.18 and 99.72 in male and female respectively. The minimum growth rate index (GRI) of *C. zastrowi arabica* was recorded on *A. craccivora* which was 78.22 and 77.82 for male and female, respectively.

Table 1: Effect of different prey hosts on the biology of *Chrysoperla zastrowi arabica* (Henery *et al.*) Male

Treatments Prey (Hosts)	Egg incubation period in (days)	Average larval period male (days)			Total larval period male (days)	Pupal period male (days)	% Adult emergence (male)
		I Instar	II instar	III instar			
Eggs of *Corcyra cephalonica* (Staint.)	3.77	3.89	2.90	3.39	9.18	9.42	92.05 (73.62)*
Larvae of *Corcyra cephalonica* (Staint.)	3.54	3.51	2.78	3.07	9.36	9.29	85.46 (67.59)
Nymphs of *Nyzus nerii* (Boyr.)	4.50	3.39	2.64	2.90	8.93	9.16	84.47 (66.79)
Nymphs of *Lipaphis erysimi* (Kalt.)	3.59	4.25	3.03	3.74	11.01	10.12	78.82 (62.60)
Nymphs of *Aphis gossypii* (Glov.)	4.07	4.17	3.10	3.78	11.04	9.46	71.28 (57.61)
Nymphs of *Aphis craccivora* (Koch.)	3.95	5.14	3.45	4.45	13.04	10.51	89.92 (71.49)
Nymphs of *Rhopalosiphum maidis* (Fitch)	3.80	3.82	2.85	3.35	10.03	8.90	90.90 (72.45)
S.Em. ±	0.09	0.08	0.07	0.07	0.18	0.09	1.98
C. D. at 5%	0.27	0.22	0.19	0.22	0.52	0.25	5.83

*Figures in parenthesis are angular retransformed values

Table 2: Effect of different prey hosts on the biology of *Chrysoperla zastrowi arabica* (Henery *et al*.) Female

Treatments Prey (Hosts)	Egg incubation period in (days)	Average larval period female (days)			Total larval period female (days)	Pupal period female (days)	% Adult emergence (female)
		I instar	II instar	III Instar			
Eggs of *Corcyra cephalonica* (Staint.)	3.77	4.19	2.99	3.58	10.76	10.11	95.84 (78.23)*
Larvae of *Corcyra cephalonica* (Staint.)	3.54	3.95	2.90	3.39	10.24	9.48	88.98 (70.61)
Nymphs of *Nyzus nerii* (Boyr.)	4.50	3.80	2.80	3.30	9.90	9.67	87.94 (69.68)
Nymphs of *Lipaphis erysimi* (Kalt.)	3.59	4.13ss	3.02	3.59	10.73	10.38	82.06 (64.94)
Nymphs of *Aphis gossypii* (Glov.)	4.07	4.30	3.35	3.93	11.38	9.64	74.21 (59.48)
Nymphs of *Aphis craccivora* (Koch.)	3.95	5.56	3.80	3.99	13.35	10.73	93.62 (75.37)
Nymphs of *Rhopalosiphum maidis* (Fitch)	3.80	4.11	2.96	3.48	10.54	9.16	94.65 (76.62)
S.Em. ±	0.09	0.06	0.07	0.11	0.16	0.11	2.06
C. D. at 5%	0.27	0.17	0.22	0.32	0.48	0.3113	6.07

*Figures in parenthesis are angular retransformed values

Table 3: Effect of different prey hosts on the feeding potential of *Chrysoperla zastrowi arabica* (Henery *et al*.) Male

Treatments Prey (Hosts)	Average no. of prey consumed during total larval period			Average no. of prey consumed by different larval instars	Average larval period (days) male	Weight of cocoon (mg) male	Growth rate index male
	I	II	III				
Eggs of *Corcyra cephalonica* (Staint.)	24.65	75.43	198.17	298.24	9.18	10.39	113.18
Larvae of *Corcyra cephalonica* (Staint.)	20.53	54.75	175.29	250.59	9.36	9.97	106.51
Nymphs of *Nyzus nerii* (Boyr.)	20.13	48.50	85.96	154.58	8.93	8.79	98.54
Nymphs of *Lipaphis erysimi* (Kalt.)	36.25	77.55	91.55	205.35	11.01	9.78	88.82
Nymphs of *Aphis gossypii* (Glov.)	50.50	88.90	90.52	229.93	11.04	10.30	93.29
Nymphs of *Aphis craccivora* (Koch.)	36.37	75.50	89.59	201.47	13.04	10.19	78.22
Nymphs of *Rhopalosiphum maidis* (Fitch)	37.25	79.56	87.95	204.76	10.03	9.16	91.42
S.Em. ±	0.43	1.69	0.06	0.06	0.18	0.10	0.15
C. D. at 5%	1.27	4.96	0.18	0.18	0.52	0.30	0.43

Table 4: Effect of different prey hosts on the feeding potential of *Chrysoperla zastrowi arabica* (Hener y *et al*.) Female

Treatments Prey (Hosts)	Average no. of prey consumed during total larval period			Average no. of prey consumed by different larval instars	Average larval period (days) female	Weight of cocoon (mg) female	Growth rate index female
	I instar	II instar	III instar				
Eggs of *Corcyra cephalonica* (Staint.)	24.65	75.43	198.17	298.24	10.76	10.73	99.72
Larvae of *Corcyra cephalonica* (Staint.)	20.53	54.75	175.29	250.59	10.24	10.13	98.92
Nymphs of *Nyzus nerii* (Boyr.)	20.13	48.50	85.96	154.58	9.90	9.09	91.81
Nymphs of *Lipaphis erysimi* (Kalt.)	36.25	77.55	91.55	205.35	10.73	10.20	95.06
Nymphs of *Aphis gossypii* (Glov.)	50.50	88.90	90.52	229.93	11.38	10.56	92.79
Nymphs of *Aphis craccivora* (Koch.)	36.37	75.50	89.59	201.47	13.35	10.39	77.82
Nymphs of *Rhopalosiphum maidis* (Fitch)	37.25	79.56	87.95	204.76	10.54	9.73	92.31
S.Em. ±	0.43	1.69	0.06	0.06	0.16	0.06	0.12
C. D. at 5%	1.27	4.96	0.18	0.18	0.48	0.18	0.34

Table 5: Effect of different prey hosts on the reproductive potential of *Chrysoperla zastrowi arabica* (Henery *et al*.) Female

Treatments Prey (Hosts)	Larva	Pupa	Adult longevity		Female (days)			Fecundity (Eggs/ female)	Egg hatching (%)	Sex ratio (M : F)
			Male	Female	Pre-Oviposition	Oviposition	Post-oviposition			
Eggs of *Corcyra cephalonica* (Staint.)	10.76	10.11	26.99	34.78	3.64	24.31	7.90	575.50	94.99 (77.06)*	1 : 1.50
Larvae of *Corcyra cephalonica* (Staint.)	10.24	9.48	23.45	32.29	2.94	24.29	6.91	368.95	89.74 (71.32)	1 : 1.33
Nymphs of *Nyzus nerii* (Boyr.)	9.90	9.67	22.52	30.15	10.68	26.22	5.84	348.92	88.95 (70.58)	1 : 1.40
Nymphs of *Lipaphis erysimi (*Kalt.)	10.73	10.38	24.72	35.43	5.50	19.21	5.79	362.39	93.59 (75.33)	1 : 1.35
Nymphs of *Aphis gossypii* (Glov.)	11.38	9.64	28.59	38.93	3.72	25.54	8.47	415.59	94.68 (76.66)	1 : 1.42
Nymphs of *Aphis craccivora* (Koch.)	13.35	10.73	27.93	36.58	3.89	24.85	7.84	274.73	90.81 (72.35)	1 : 1.46
Nymphs of *Rhopalosiphum maidis* (Fitch)	10.54	9.16	24.66	33.78	8.19	20.79	7.43	280.96	92.60 (74.21)	1 : 1.39
S.Em. ±	0.16	0.11	0.16	0.48	0.07	0.07	0.07	0.07	0.10	0.06
C. D. at 5%	0.48	0.31	0.48	1.40	0.21	0.20	0.22	0.20	0.29	0.18

*Figures in parenthesis are angular retransformed values

Results indicated that the predatory efficiency of *C. zastrowi arabica* increased with the development of grub. As the grub grew from first instar to third instar, the consumption rate was increased in all the species of aphids and other hosts used as prey. Similar observations have been reported by Chakraborty and Korat (2010) [3] who reported that the predatory efficiency of *C. carnea* increased with its larval instars. Relatively, Gupta and Mohan (2012) [6] studied that the 3rd instar larvae are more voracious eater of aphids. Accordingly, Solangi *et al*. (2013) [17] also observed that the 3rd instar larvae voraciously fed on 3rd instar nymphs of all sucking pests. Similarly, Batool *et al*., (2015) [1] also observed that the daily predation rate of *C. carnea* increased slowly during the first two instars and reached to its peak in the third larval instar. In the present findings also a good range of hosts were preferred, however, the quantity of the prey consumed by different larval instars of *C. zastrowi arabica* during their development differed from the observations of other workers to a great extent.

Among the diets of different prey hosts, the predation of larvae was maximum 298.24 when fed on the eggs of *C. cephalonica* followed by the neonate larvae of *C. cephalonica* 250.59. These findings of the present investigation get support from the observations of earlier workers Thite *et al*. (1999) [18] who recorded that the first, second and third instar larvae of *C. carnea* consumed 36.77, 78.10, 146.10 eggs / day. Similarly, Nandan *et al*. (2014) [9] also showed that *C. zastrowi sillemi* consumed highest number of *C. cephalonica* eggs.

Among the aphids, the maximum consumption of 229.92 aphids was recorded on *A. gossypii* followed by *L. erysimi* 205.35, while minimum on *N. nerii* 154.58. This finding is in confirmation with the studies of Chakraborty and Korat (2010) [3] who reported that *C. carnea* consumed maximum number of nymphs of *A. gossypii* with 22.47 ± 10.66 / day among the rest of the aphid species. Similarly Solangi *et al*. (2013) [17] also reported maximum consumption of *C. carnea* on *A. gossypii* with 66.14 aphids. In contrast Gosalwad *et al*. (2010) [5] revealed that the predator larvae of consumed maximum number of aphids when fed *on A. craccivora*, followed by *A. gossypii* and *C. cephalonica* eggs.

The change in food consumption has been attributed to variation in temperature, is also suggested by Zaki (1987) [22] and feeding stimulating kairomones Nordlund *et al*. (1977) [10] and overcrowding of the host Canard (1984) [2]. It is therefore clear that the methodology for quantifying food consumption generally needs more critical appraisal, only then, a proper comparison can be made. The data indicates that *N. nerii* was the least preferred host, moreover its predation also affected the development and other vital functions of the predator. El-Serafi *et al*. (2000) [4] suggested that the food preference for the predator larvae among the tested aphid species *A. gossypii* came first followed by *S. avenae*, *R. maidis* and *A. nerii*.

The maximum growth rate index (GRI) of *C. zastrowi arabica* was observed on eggs of *C. cephalonica i.e*. 113.18 and 99.72 in male and female respectively, The minimum growth rate index (GRI) was recorded on *A. craccivora i.e*. 78.22 for male and female respectively. The present finding corroborates with the reports of Satpathy *et al*. (2012) [16] who reported that the growth index (GI) of lacewing grub was higher when reared on egg-hosts.

Observations related to effect of different prey hosts on the reproductive potential of *Chrysoperla zastrowi arabica* (Henery *et al*.) showed that adult longevity of female was maximum on nymphs of *Aphis gossypii* (Glov.) and minimum in the case of nymphs of *Nyzus nerii* (Boyr.) and fecundity (Eggs/ female) showed maximum in the case of eggs of *Corcyra cephalonica* (Staint.) and minimum on nymphs of *Aphis craccivora* (Koch.) and percentage egg hatching was maximum on Eggs of *Corcyra cephalonica* (Staint.) while minimum on Nymphs of *Nyzus nerii* (Boyr.) as described in Table 5.

4. Conclusion

From the above, it can be concluded that the eggs of *C. cephalonica* as host are found to be most suitable for laboratory rearing of *C. zasrrowi arabica*. The neonate larvae of C. *cephalonica*, *A. gossypii* and *L. erysimi* can be substituted as host in case of dearth of *Corcyra* eggs. Rana *et al*. (1998) [14] suggested that the eggs of rice grain moth *C. cephalonica* are best for the laboratory rearing of *C. carnea*. Accordingly, Nandan *et al*., (2014) [9] also suggested that the eggs of *C. cephalonica* are most suitable for laboratory rearing of *C. zastrowi sillemi* followed by *A. gossypii* and *A. craccivora*.

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