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# Biology and Feeding Potential of *Chrysoperla zastrowi sillemi* (Esben-Peterson) on Eggs of *Corcyra cephalonica* (Stainton)

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**Abstract** The results on biological parameters revealed that the average incubation period was 2.38 ± 0.49 days, while the hatching percentage was 88.70%. The mean duration of first, second and third instar larva was 1.93±0.07, 2.86±0.63 and 2.73 ±0.70 days, respectively. The mean length of first, second and third instar larva was 2.81±0.14, 4.84±0.26 and 7.10±0.33 days, whereas breadth of these larva was 0.66±0.01, 1.00±0.06 and 2.33±0.08 days, respectively. The average pupal period and diameter of pupa were 6.61 ±0.84 and 3.01±0.23 days, as the mean pre-oviposition, oviposition and post oviposition period were 3.42±1.02, 12.52±2.87 and 10.23±2.97 days, respectively and the mean fecundity was found to the tune of 352.9 eggs / female. An average longevity of male was 29.20±1.46 and that of female was 33.90±3.24 days. The feeding potential of *C. zastrowi sillemi* on *C. cephalonica* eggs indicated that the larvae of first, second and third instar consumed 63.8±2.90, 268.5± 6.24 and 354.5±5.90 eggs, respectively. A single predatory larva consumed on an average 686.8±9.68 eggs during its developmental period.

**Keywords** Biology, *Chrysoperla*, *Corcyra cephalonica*, Fecundity, Feeding potential.

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## Introduction

Green lacewings, *Chrysoperla zastrowi sillemi* (Esben-Peterson) family Chrysopidae and order Neuroptera are an example of one of these species that is not predacious in the adult stage ; larval stage is predatory stage. Adults feed only on pollen, nectar and aphid honeydew. They are pale green, about 12—20 mm long with long antennae and bright, golden or copper-colored eyes. They have large, transparent, pale green wings and a delicate body. These adults are active fliers, particularly during the evening and night and have a characteristic, fluttering flight Mendal et al. [1], Zhang et al. [2].

The natural population of *Chrysoperla carnea* in the field is not adequate to suppress the pest population of their own. It becomes necessary to mass produce them in laboratory for release in the field. The concepts of Integrated Pest Management (IPM) with the use of predators and parasitoids can give a low cost plant protection, with environment friendly biological control. Green lacewing is recognized to be a voracious feeder of whiteflies, aphids and other soft bodied insects Hashami [3]. This predator has a tremendous predacious potential and can consume many species of insect pests, such as whiteflies, aphids, thrips and eggs of bollworms Atlihan et al. [4]. Therefore, in the present study, efforts have been made to test the biology and feeding potential of *C. zastrowi sillemi*. This information can be utilized for quality mass rearing of the predator and its utilization is an important component of IPM programs for the man-

agement of whiteflies, aphids, thrips and eggs of bollworms under field conditions.

## Materials and Methods

The culture of the predator was taken from laboratory reared *C. zastrowi sillemi* and to adopt the culture to the laboratory condition it was reared two generations continuously on Corcyra eggs at laboratory condition. The adults were provided with nutritional diet Jalali et al. [5]. The stalked eggs laid by the females on black cloth were destalked after 24 h by gently brushing with a piece of sponge and total 50 eggs were kept in individual plastic tube (5 × 2 cm). The counted numbers of *Corcyra* egg was provided to the larvae and after 24 h, the remaining eggs were removed from the vial and counted. Fresh eggs of *Corcyra* were provided daily in each individual plastic tube to the predatory larvae until cocoon formation. The adults emerged out from the cocoons was collected and transferred again in the oviposition cage containing nutritional diet.

### Observations recorded

Freshly laid eggs were collected and critically observed under microscope for their color change. Length and breadth as well as stalk length of individual egg was measured by using microscope. The incubation period and per cent hatching of eggs was also recorded. Number of larval instars along with their duration was determined on the basis of exuviae casted-off by the larvae. Head width of different larval instars was also measured. Feeding rate of the larvae at 24 h interval was recorded and on the basis of that total number of *Corcyra* eggs consumers and total number of *Corcyra* eggs consume per day was recorded. The date of pupation and date of adult emergence was recorded for individual pupa to work out the pupal period. Diameter of pupae was measured across with measuring scale. The laboratory reared adults was sexed as male and female on the basis of size and external genitalia. Longevity of males and females was studied separately. Fecundity, pre-oviposition, oviposition, post-oviposition periods and sex-ratio for female were also studied.

**Table 1.** Duration of different stages of *C. zastrowi sillemi* on fictitious host *Corcyra*.

| Sl. No. | Stage | Duration (days) Range | Mean |
|---|---|---|---|
| 1. | Egg | 2–4 | 2.38 ±0.49 |
| 2. | Larva | | |
| | 1st instar | 1–3 | 1.93 ±0.07 |
| | 2nd instar | 2–4 | 2.86 ±0.63 |
| | 3rd instar | 2–4 | 2.73 ±0.70 |
| | Total | 6–9 | 7.53 ±0.74 |
| 3. | Pupa | 6–9 | 6.61 ±0.84 |
| 4. | Adult | | |
| | Female | 8–25 | 18.09±2.57 |
| | Pre-oviposition | 2–7 | 3.42 ±1.02 |
| | Oviposition | 4–20 | 12.52±2.87 |
| | Post-oviposition | 5–21 | 10.23±2.97 |
| | Male | 7–15 | 12.35±1.90 |
| 5. | Entire life span | 28–41 | 35.52±2.39 |
| | Female | 28–41 | 33.90±3.24 |
| | Male | 22–33 | 29.20±1.46 |

## Results and Discussion

### Egg

*Pattern of egg laying, color and shape*

The study on site of egg laying indicated that the females of *C. zastrowi sillemi* laid their eggs individually on top of the hair-like foot-stalk either singly or in group of 9 to 12 (Tables 1 to 3). Freshly laid eggs were pale green in color and oval in shape, which turned pale whitish or pinkish grey in color just before hatching. These observations corroborate with the reports of Jagadish and Jayaramaiah [6].

*Incubation period and size*

The result indicated that the incubation period of egg stage lasted for 2 to 4 days with an average of 2.38±0.49 days. The incubation period of eggs was found 2 to 4 days by Bandhania et al. [7] and 3.40 days by Tesfaye and Gautam [8]. Measurement of eggs revealed that the length and breadth of eggs ranged from 0.82 to 0.92 and 0.37 to 0.39 mm with an average of 0.88 ± 0.03 and 0.38±0.01 mm, respectively. The length of foot-stalk was found to be 3.82 to 5.04 mm with an average of 4.17±0.22 mm.

**Table 2.** Measurement of different life stages of *C. zastrowi sillemi.*

| Stage | Lenge (mm) | | Breadth (mm) | | Head width (mm) | |
|---|---|---|---|---|---|---|
| | Range | Mean | Range | Mean | Range | Mean |
| Eggs | 0.82–0.92 | 0.88±0.03 | 0.37–0.39 | 0.38±0.01 | – | – |
| Eggs stalk | 3.82–5.04 | 4.17±0.22 | – | – | – | – |
| Larvae | | | | | | |
| 1st instar | 2.54–2.99 | 2.81±0.14 | 0.63–0.69 | 0.66±0.01 | 0.34–0.39 | 0.36±0.01 |
| 2nd instar | 4.27–5.28 | 4.84±0.26 | 0.83–1.13 | 1.00±0.06 | 0.58–0.67 | 0.61±0.02 |
| 3rd instar | 6.75–7.94 | 7.10±0.33 | 2.22–2.49 | 2.33±0.08 | 0.87–0.93 | 0.90±0.01 |
| Pupa diameter | 2.51–3.23 | 3.01±0.23 | – | – | – | – |
| Adult | | | | | | |
| Male | 8.07–8.41 | 8.21±0.08 | 18.00–26.00 | 21.24±0.33 | – | – |
| Female | 9.09–9.73 | 9.39±0.08 | 20.00–29.00 | 26.17±0.26 | – | – |

*Hatching percentage*

Result presented in Table 4 indicated that out of 772 eggs observed for their hatching, 176 (22.79%), 452 (58.54%) and 55 (7.12%) eggs hatched - out on first, second and third day of oviposition, respectively. Hatching percentage ranged from 84.89 to 93.47 with an average of 88.70%.

Larva

*Color, shape and duration*

The newly hatched young larvae were tiny, elegator shaped and pale to reddish in color, whereas the full grown larvae were elongated, spindle shaped, somewhat flattened with large tubercles on the side of swollen abdomen. The larvae passed through three distinct instars. Mean larval duration for first, second and third instar was 1.93 ± 0.07, 2.86 ± 0.63 and 2.73 ± 0.70 days, respectively. The total larval duration ranged from 6 to 9 days with an average of 7.53 ± 0.74 days. The duration of first, second and third instar larvae was found 3.04 ± 0.10, 1.89 ± 0.23 and 2.65 ± 0.56 days by Kapadia and Puri [9], 2.25, 2.05.

*Size*

Average range and length for first, second and third instar larva were 2.54 to 2.99, 4.27 to 5.28 and 6.75 to 7.94 mm and 2.81 ± 0.14, 4.84 ± 0.26 and 7.10 ± 0.33 mm, respectively (Table 2). The breadth of the first, second and third instar larva ranged from 0.63 to 0.69, 0.83 to 1.13 and 2.22 to 2.49 mm and their corresponding average breadth was 0.66 ± 0.01, 1.00 ± 0.06 and 2.33 ± 0.08 mm, respectively. Slight variation may be due to prey type or strain variation of *C. zastrowi sillemi* during the study. The larval head width of first, second and third instar ranged from 0.34 to 0.39, 0.58 to 0.67 and 0.87 to 0.93 mm, respectively. The average head width of the first, second and third instar was 0.36 ± 0.01, 0.61 ± 0.02 and 0.90 ± 0.01 mm, respectively in this study. These results corroborate with the reports of Sharma and Verma [10] who observed 0.57, 1.20 and 1.94 mm breadth of first, second and third instar larva, respectively.

Pupa

*Color and shape*

The full grown larvae spun a white colored spherical

**Table 3.** Sex ratio and fecundity of *C. zastrowi sillemi* when reared on eggs of *Corcyra* as fictitious host.

| No. of adults observed | Sex ratio | | | Fecundity (Eggs per female) | | | |
|---|---|---|---|---|---|---|---|
| | Male | Female | Sex ratio | No. of female observed | Min | Max | Mean |
| 36 | 15 | 21 | 1 : 1.40 | 30 | 280 | 376 | 352.9 |

**Table 4.** Hatching percentage of *C. zastrowi sillemi* eggs at different days.

| Sl. No. | No. of eggs observed | No. of eggs hatched 1st day | 2nd day | 3rd day | Hatching (%) |
|---|---|---|---|---|---|
| 1. | 113 | 29 | 61 | 11 | 89.38 |
| 2. | 138 | 34 | 78 | 17 | 93.47 |
| 3. | 183 | 39 | 113 | 9 | 87.43 |
| 4. | 146 | 31 | 88 | 10 | 88.35 |
| 5. | 192 | 43 | 112 | 8 | 84.89 |
| Total | | 176 | 452 | 55 | Average |
| % | 772 | 22.79% | 58.54% | 7.12% | 88.70% |

cocoon and pupated inside, which covered with silken threads. The cocoons became green in color in a day before adult emergence.

*Duration and size*

Pupal stage lasted for 6 to 9 days with an average of 6.61 ± 0.84 days which is in agreement with the reports of Ulhaq et al. [11] who observed duration of 5.80 to 8.69 days. The diameter of cocoon range from 2.51 to 3.23 mm with the mean of cocoon diameter was 3.01 ± 0.23 mm.

Adult

*Color and size*

Adults were soft bodied, usually light green in color with transparent wings. Wings held roof like over the body and extending to the end of the abdomen. In male, the abdomen was narrow and tapering, while in case of female it was 2 to 3 times broader than males. Compound eyes were copper or golden colored. The length and breadth (with expanded wings) of male adults ranged from 8.07 to 8.41 mm and 18.00 to 26.00 mm with an average of 8.21±0.08 mm and 21.24 ± 0.33 mm, whereas length and breadth (with expanded wings) of female ranged from 9.09 to 9.73 mm and 20.00 to 29.00 mm with an average of 9.39±0.08 and 26.17 ± 0.26 mm, respectively.

*Sea ratio*

Sex ratio worked out by observing there abdomen. In male, the abdomen was narrow and tapering while in case of female it was 2 to 3 times broader than males. In present study out of 36 adults observed among them 15 were males and 21 were females. That indicating the sex ratio (male : female) of *C. zastrowi sillemi* was 1 : 1.40. This result corroborate with the reports of Thite and Shivpuje [12] and Geethalakshmi et al. [13] who recorded sex ratio of 1 : 2.5 and 0.95 : 1 respectively.

**Table 5.** Feeding potential of different stages of *C. zastrowi sillemi* on eggs of *Corcyra*.

| Sl. No. | Stage | No. of eggs consume Range | Mean |
|---|---|---|---|
| 1. | 1st instar | 59–73 | 63.8 ± 2.90 |
| 2. | 2nd instar | 240–278 | 268.5 ± 6.24 |
| 3. | 3rd instar | 340–365 | 354.5 ± 5.90 |
| 4. | Total | 649–699 | 686.8 ± 9.68 |

*Pre-oviposition, oviposition and post-oviposition period*

The pre-oviposition, oviposition and post oviposition period ranged from 2 to 7, 4 to 20 and 5 to 21 days with mean periods were 3.42±1.02, 12.52±2.87 and 10.23±2.97 days, respectively.

*Fecundity*

Total number of eggs laid by an individual female varied from 280 to 376 with an average of 352.9 eggs per female. Highest (352.90 eggs per female) number of eggs laid by female in present study is supported by the reports of Sarode and Sonalkar [14] and Gurav et al. [15]. who registered a maximum of 350.75 and 385.2 eggs per female, respectively.

*Longevity*

The results indicated that the male adults lived for 7 to 15 days with an average of 12.35±1.90 days, while female was lived for 8 to 25 days with an average of 18.09±2.57 days.

*Total life cycle*

Entire lifespan from egg stage to the death of adult

irrespective of their sex ranged from 28 to 41 days with an average of 35.52±2.39 days. The entire life span for the male was varied from 22 to 33 days with an average of 29.20±1.46 days, while it was 28 to 41 days with an average of 33.90±3.24 days in female, when reared on *Corcyra*. Earlier, the total life cycle has been reported as 41 to 54 days by Patil and Dorge [16].

Feeding potential on eggs of *Corcyra*

Feeding potential of predator *C. zastrowi sillemi* on Corcyra was standardized which gave an idea about the exact quantity of prey required for mass culturing (Table 5). Larvae in all stages sucked out the contents of the prey leaving it as an empty shell. The 1st, 2nd and 3rd instar larva consumed 63.8±2.90, 268.5±6.24 and 354.5±5.90 eggs, respectively. The total consumption of *Corcyra* eggs ranged from 649 to 699 with an average of 686.8 ± 9.68 eggs (Table 5). The mean prey consumption of *C. zastrowi sillemi* larva, when fed on *Corcyra* was 721.80 Saminathan et al. [17] and 706.3 to 782.2 Chandrakumar et al. [18] eggs.

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