



Effect of prey on predation, growth and biology of green lacewing (*Chrysoperla zastrowi sillemi*)

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ABSTRACT

The larvae of the polyphagous predator, green lacewing [*Chrysoperla zastrowi sillemi* (Esben-Petersen)] was reared on natural prey including cabbage aphid (*Brevicoryne brassicae*), bean aphid (*Aphis craccivora*), nymphs of okra jassid (*Amrasca biguttula biguttula*), eggs and neonate larvae of *Spodoptera litura* and eggs of *Corcyra cephalonica* to study the effect of prey regimes on the predation and the biology of the predator. The lacewing grub preyed significantly highest number of prey units (415.50 eggs/ grub) of *C. cephalonica* eggs which was significantly more than the *S. litura* eggs (250.60 eggs/ grub), *A. biguttula biguttula* (185.00 nymphs/ grub), *B. brassicae* (127.50 aphids/grub), *A. craccivora* (119.00 aphids/grub) and neonates of *S. litura* (62.25 larvae/grub). The larval duration varied from 7.50 to 15.235 days on different preys which was seven day less in the grubs reared on eggs than the grubs fed on insect as prey. Larval survival was significantly highest (97.82%) on *C. cephalonica* eggs. The pupal period varied from 7.50 days to 8.63 days. The grubs reared on eggs of *C. cephalonica* and *S. litura* showed longer pupal period. On insects as prey, the growth index (GI) of larvae was significantly less (5.56–8.58) compared to the larvae reared on egg-hosts. The weight of grubs preying on other hosts was 35–50% less compared to those reared on *C. cephalonica* eggs. Relative inadequacy of lepidopteran neonates and aphids except *B. brassicae* as prey for the young larvae adversely affected the larval survival, GI and adult emergence may be due to reduced nutritional support exerting adverse effect on growth and causing moulting distress.

Key words: Biology, *Chrysoperla zastrowi sillemi*, Growth index, Prey

The Indian green lace wing [*Chrysoperla carnea* (Stephens)] has been taxonomically confirmed as *Chrysoperla zastrowi sillemi* (Esben-Petersen) (Venkatesan *et al.* 2008, Henry *et al.* 2010) is a common predator, abundantly occurs in various agro-ecosystem. The grub of the lacewing is a potential predator of soft-bodied Hemipterans and inactive stages of Lepidopteran pests infesting wide range of field crops including the vegetables. It is an important biological control agent with high frequency of occurrence, broad prey range, effective searching ability and resistance to many widely used insecticides (Hoffman and Frodsham 1993) and tolerance to ecological factors (Ulhaq *et al.* 2006). The larva of *C. zastrowi sillemi* are voracious feeder of exposed eggs, small larva, aphids, jassids, thrips, white fly, scales, mealy

bug and mites. Although it can be easily mass reared in the laboratory on the natural preys, suitability of different prey for ideal biological parameters of the predators depends on array of factors.

The biological attributes which are very important for the fitness of the insect as an ideal bio-control agent is influenced by multiple factors. Cabbage aphid, (*Brevicoryne brassicae*), bean aphid (*Aphis craccivora*), jassid (*Amrasca biguttula biguttula*), and cabbage caterpillar (*Spodoptera litura*) are some of the common pests prevalent in the vegetable crops, predated by green lacewing, *C. zastrowi sillemi*. It is a general predator but their relative preference, biological parameters, growth and preying efficiency depends on the prey concern. Clearly, the investigation of the effects of different prey species on predator development are pre-requisite for utilization of the predators in biological control in a particular agro-ecosystem. In this back ground, a laboratory experiment was conducted at Indian Institute of Vegetable Research, Varanasi in 2007–08 to assess the extent of consumption by the grub and the biological attributes of *C. zastrowi sillemi* on several prey regimes including the natural preys prevalent in vegetable ecosystem and the laboratory prey used for mass rearing.

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MATERIALS AND METHODS

C. zastrowi sillemi grubs were obtained from the nucleus culture of the Bio-control Laboratory of Indian Institute of Vegetable Research, Varanasi and maintained on mass produced fresh eggs of rice moth (*Corcyra cephalonica*). Cabbage aphid (*Brevicoryne brassicae*) and cabbage caterpillar (*S. litura*), bean aphid (*A. craccivora*) and jassid (*A. biguttula biguttula*) were collected from insecticide-free crop of cabbage, cowpea and okra respectively. These preys were maintained in the laboratory inside the petriplates (9.5 cm dia × 1.5 cm depth) with fresh leaf and leaf discs (~ 8 cm dia) of respective host plants, kept over moist filter paper (5 cm dia) on the bottom to maintain optimum moisture and avoid dehydration of eggs and leaves of host plants of the prey. In case of *C. cephalonica* eggs, the eggs were placed inside the petriplates on a black blotting paper instead of leaves of the respective host plants. Freshly emerged nymphs, neonate larvae, 3–4 stadium aphids, and 1–2-day-old eggs were used as prey in the experiment. Prey population were collected daily from the respective host plants to replace the prey for *C. zastrowi sillemi*. *S. litura* was mass reared in the laboratory on castor leaves. The fresh egg masses obtained from the oviposition cages during the process of rearing were used for feeding the grubs of *C. zastrowi sillemi*.

The experiment was conducted in the laboratory at 28 ± 2 °C, 70–80% RH and a photoperiod of 13:11 (L:D) hr. Each treatment constituting 20 neonate lacewing grubs was replicated five times in completely randomised design (CRD). In each petriplate, four grubs were released along with cut white papers to avoid cannibalism. Five petriplates containing 20 grubs constitute one treatment. The lacewing larva was provided with a pre-determined number of appropriate prey units daily. The number of prey units provided per larvae varied with the type and stage of prey and stage of lacewing larvae which was 40–100 in case of *Corcyra* eggs, 20–80 in case of aphids and 10–50 in case of neonate larvae. Each lacewing larvae was examined daily for development and survival, the remaining prey units (aphids, eggs or neonate larvae) were removed, counted and the larvae were provided with fresh prey.

Prey consumption, larval and pupal period, larval and pupal weight, larval survival (%), emergence (%) and growth index (GI=% larval survival/ mean larval period) were recorded and analyzed and the means were distinguished using the least significant difference test (LSD) after a significant F-test at $P=0.05$.

RESULTS AND DISCUSSION

The number of prey units consumed by lacewing larvae during the larval development varied significantly on different preys (Table 1). The lacewing grub preyed significantly highest number of prey units (415.50 eggs/ grub) of *C. cephalonica* eggs which was significantly more than the *S. litura* eggs (250.60 eggs/ grub), *A. biguttula biguttula* (185.00 nymphs/ grub), *B. brassicae* (127.50 aphids/grub), *A. craccivora* (119.00 aphids/grub) and neonates of *S. litura* (62.25 larvae/grub). Except in case of eggs of *C. cephalonica* and *S. litura*, the preference of the lacewing grub for different aphid species was non-significant.

The development of larvae till the cocoon formation varied from 7.50 days to 15.35 days on different preys (Table 1). The larval duration was significantly shorter when the grubs fed on *C. cephalonica* eggs (7.5 days) which was at par with the larval period of grubs (9.00 days) perying on *S. litura* eggs. The larval duration on insect as prey varied from 11.00 to 15.25 days. The larval developmental period was significantly prolonged (15.24 days) on *A. craccivora* prey.

The grub period prolonged above 10 days being 15.25, 13.25 days, 12.00 days and 11.00 days in case of *A. craccivora*, *A. biguttula biguttula*, *S. litura* neonate and *B. brassicae* respectively as prey. Growth of larvae was significantly faster on eggs as host (7.50–9.00 days) whereas slower on insect as prey (11.00–15.25 days). The larval duration on eggs as host was seven days less than the grubs reared on insects as host. When fed on *C. cephalonica* eggs, significantly highest number of larvae (97.82%) survived, moulted and pupated indicating the suitability of *C. cephalonica* eggs as the ideal host of lacewing grubs. The larval survival on *B. brassicae* was also quite high (94.02%), while the survival of

Table 1 Prey consumption and biology of immature stages of *C. zastrowi sillemi* grubs fed on different preys

Prey	Stage	No. consumed/ grub	Larval period* (days)	Pupal period** (days)	Larval survival (%)	Emergence (%)
<i>Corcyra cephalonica</i>	Eggs	415.50 ^a	7.50 ^d	8.63 ^a	97.82(82.04) ^a	76.75(61.20) ^a
<i>Brevicoryne brassicae</i>	3–4 stadia	127.50 ^{cd}	11.00 ^{bc}	7.50 ^b	94.02(76.02) ^b	68.35(55.82) ^{bc}
<i>Amrasca biguttula</i>	Nymph	185.00 ^{bc}	13.25 ^{ab}	7.80 ^{ab}	89.04(71.24) ^c	60.46(51.04) ^d
<i>Spodoptera litura</i>	Neonate	62.25 ^d	12.00 ^{bc}	8.20 ^{ab}	87.19(69.15) ^{cd}	62.42(52.19) ^d
<i>Aphis craccivora</i>	3–4 stadia	119.00 ^d	15.25 ^a	8.02 ^{ab}	84.24(66.67) ^d	64.70(55.55) ^{cd}
<i>Spodoptera litura</i>	Eggs	250.60 ^b	9.00 ^{cd}	8.40 ^{ab}	88.61(70.33) ^{cd}	70.15(56.89) ^a
CD ($P=0.05$)		100.46	2.98	0.84	4.14	2.84

Figures in the parentheses are arc sine transformed values

larvae fed on other preys varied from 84.24 to 89.40%. The larvae which survived and completed their larval stage could successfully pupated, irrespective of the host or prey. On the basis of number of larvae survived from the neonate all could pupated successfully.

The effect of the hosts on duration of pupal stage was less as it was noted in case of development period of larvae (Table 1). The development period of pupae obtained from different preys varied from 7.50 days to 8.63 days. The grubs fed on eggs of *C. cephalonica* and *S. litura* showed longer pupal period, i e 8.63 days to 8.40 days respectively. The hosts with shorter larval period recorded longer pupal period and *vice versa*. The pupal period was shorter (7.50–8.02 days) in most of the insect hosts on which the larval duration was more prolonged.

The larval prey regimes exerted marked effect on growth index (GI) (Fig 1). On the basis of GI, *C. cephalonica* egg was the most suitable with significantly highest GI (13.35), followed by *S.litura* eggs with GI value of 9.87. The GI of larvae fed on insect host was significantly less (5.56–8.58) compared to the larvae reared on egg-hosts except in case of *B. brassicae* being at par with the GI of *S.litura* eggs. Bean aphid was the most inferior host of lacewing grubs with least GI (5.56) being at par with *A. biguttula biguttula*.

Similar trend of adult emergence (%) from pupae was observed as it was in GI. The adult emergence of pupa harvested from larvae fed on eggs of *C.cephalonica* and *S. litura* was significantly high (76.75 and 70.15% respectively) compared to other non-egg preys which varied from 60.46% on *A. biguttula biguttula* to 68.35 on *B. brassicae*.

The growth of grub on different hosts in terms of larval

weight had significant difference (Fig 1). The preys having significantly more favourable effect on larval weight gain recorded five days after feeding were 7.08 mg on *C. cephalonica* eggs, 6.75 mg on *B. brassicae* and 6.46 mg on *A. biguttula biguttula* nymphs. The weight of grubs fed on other hosts was 35–50% less compared to those fed on *C.cephalonica* eggs.

The weight of the cocoon taken two days after pupation showed significant variation (Fig 1). The pupae of the larvae fed on *C. cephalonica* eggs was significantly heavier (8.81 mg) compared to 7.70 mg to 7.50 mg in case of *S. litura* eggs and *B. brassicae* respectively. Significantly lowest pupal weight was recorded on the pupae obtained from *S. litura* neonate (5.6 mg) and *A. biguttula biguttula* (6.12 mg) as prey.

The variation in predatory potential of *C. zastrowi sillemi* grubs was quite prevalent among the insect hosts evaluated in this study. The quantity of prey consumed depends on prey species, size and the stages offered which regulates the total volume of feed. (Liu and Chen 2001). Besides, the larval prey quality has considerable influence on biology and behaviour of Chrysopids (Canard and Principi 1984). The grubs showed significantly higher preference for eggs as prey. Greater preference for predation on *C.cephalonica* was ascertained in earlier studies in which the consumption of *C.cephalonica* was more than the eggs and neonates of *Helicoverpa armigera*, eggs of *Earias vitella* and nymphs of *A. biguttula biguttula* (Saminathan *et al.* 1999, Sattar 2010). This would especially be important in a situation when the target prey remain susceptible to predation for sufficient duration because of its stationary nature which is true in case

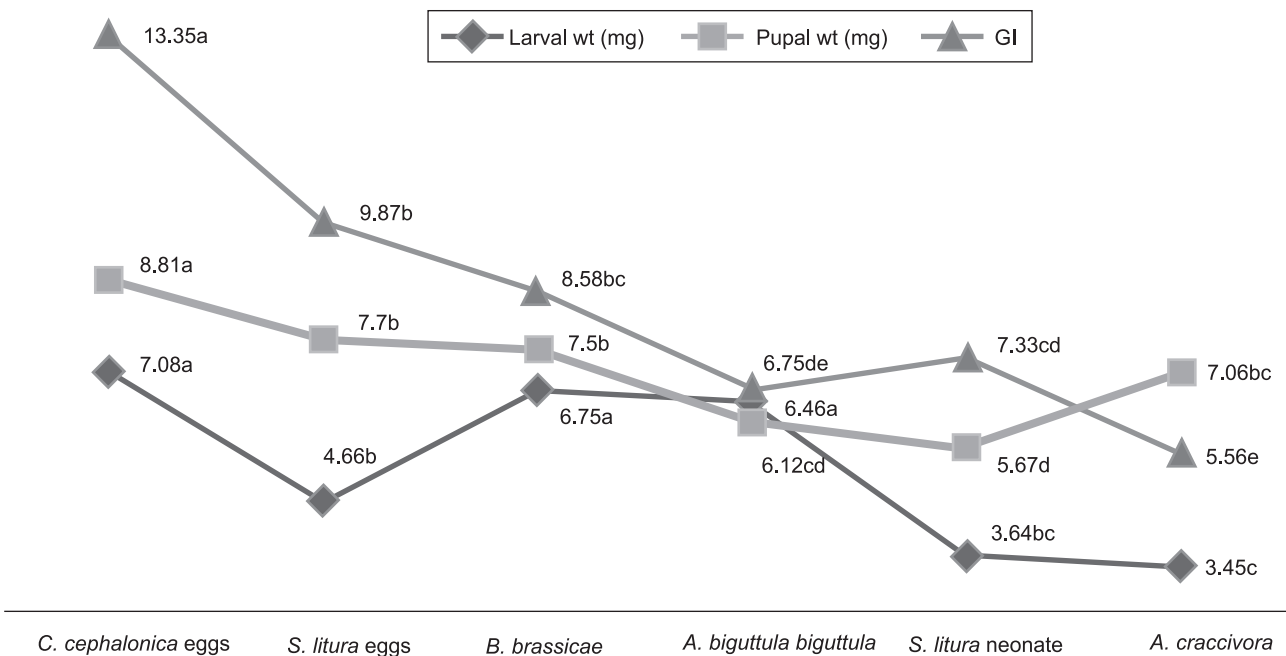


Fig 1 Larval and pupal weight and growth index of lacewing grub fed on different preys

of eggs but not in case of moving preys like aphids and neonate larvae.

The larval development of *C. zastrowi sillemi* grubs reared on *C cephalonica* eggs was faster as compared to other eggs and insect hosts (nymphs and neonates). The larval duration on *C cephalonica* eggs was 50% less. On the other hand, preying on insect-hosts considerably prolonged the larval period. The development of *C. carnea* grubs on eggs required less duration than the neonates of different lepidopterans and aphid species. This extended developmental period on neonates of lepidopterans in contrast to the eggs in which it was much shorter which might be due to the superior nutritive quality of eggs (Khulbe *et al.* 2005). The duration of pupal developmental period under different larval prey regime was less variable as it was noted in case of larval period.

The growth index was significantly reduced to as low as 5.56–7.35 when the larva were fed on *A. craccivora*, *A. biguttulla biguttulla* and *S. litura* (neonate) compared to 13.35 when the larvae was fed to *C cephalonica* eggs. The larval survival and adult emergence recorded the same trend.

Among the natural preys, other than *C. cephalonica* eggs the adequacy of *S. litura* eggs as prey was more prominent. Relative inadequacy of lepidopteran neonates and aphids except *B. brassicae* as prey for the young larvae adversely affected the larval survival, GI and adult emergence may be due to reduced nutritional support exerting adverse effect on growth and causing moulting distress (Hagen *et al.* 1976). The polyphagous predators are more specific in their host relations.

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