Indian Journal of Agricultural Sciences **80** (1): 95–8, January 2010

Functional response of *Chrysoperla carnea* larvae (Neuroptera: Chrysopidae) to *Aphis pomi* and *A. craccivora* (Homopetera: Aphididae)*

TAHMINA MUSHTAQ[1] and AKHTAR ALI KHAN[2]

Sher-e-Kashmir University of Agricultural Sciences and Technology of Kashmir
Shalimar Campus, Srinagar 191 121 (Jammu and Kashmir)

Received: 25 March 2009; Accepted: 7 October 2009

Key words: *Aphis pomi*, *Craccivora*, *Chrysoperla carnea, Corcyra cephalonica*, Functional response, Handling time, Search rate

Chrysoperla carnea (Stephens) (Neuroptera:Chrysopidae) is a generalist predator of soft-bodied arthropods and has been effectively used to encounter various aphid species in different agro-ecosystems.

One of the fundamental aspects of predator-prey interactions is the relationship between prey density and predator consumption. The functional response of a predator is a key factor in regulating the population dynamics of predator-prey systems and describes the rate at which predator kills its prey at different prey densities. Functional response has been studied in a few species of coccinellid predators (Dixon 2000, Agrawala *et al*. 2001). But in case of different stage of *C. carnea* at different densities of *Aphis craccivora* Koch and *A. pomi* De Geer is not taken into account. Therefore, the present study is aimed at evaluating the functional response of different stage of *C. carnea* to different densities of *A. craccivora* and *A. pomi*.

Eggs of *C. carnea* were collected from aphid colonies with *A. pomi* in apple orchard and *A. craccivora* in bean plants in fields. Eggs of *C. carnea* were maintained in Petri-dishes (15 cm diameter) and observed daily for hatching. Newly emerged larvae were reared individually on *A. pomi* and *A. craccivora* in separate Petri-dishes and provide sufficient prey. Aphids were collected from bean plants and apple trees, respectively, at the research farm of SKUAST-K Shalimar, Srinagar and were maintained separately in cages (18cm ×18 cm ×18 cm) on their respective hosts, *A. pomi* on apple twigs and *A. craccivora on* germinated bean plants in the culture room at 25±5°C temperature, 60±10% relative humidity and a photoperiod of 14 hr light: 10 hr dark.

The study on functional response was carried out under culture room on two aphid species, i e *A. craccivora* and *A. pomi*. The required stages of *C. carnea* (second and third instars) and aphid species were taken from the culture. The *C. carnea* larvae were starved for 24 hr to minimize differences in individual hunger levels. Thereafter, they were transferred to clear plastic jars (15 cm diameter and 20 cm height) with the help of fine soft brush. A small twig of either apple for *A. pomi* and beans for *A. craccivora* prior fitted into a conical flask containing water, were placed inside each jar. The open end of the jar was then covered with muslin cloth tightly with the help of rubber band. The functional response was evaluated at prey densities of 2, 4, 8, 16, 32, 64 and 128 aphids/predator/jar on aphid species; *A. craccivora* and *A. pomi*. Each experiment was repeated 3 times with 5 replicate and number of aphids (Mean±SE) consumed by second and third of *C. carnea* larvae in each case were recorded after 24 hr. The number of aphids left unpreyed was removed and known number of fresh aphids was provided daily in the experiment.

The data for functional response were computed after taking observations strictly according to the procedures followed by various workers such as Mills (1982) and Holling (1961). The functional response of different larval instar of *C. carnea* on two different aphid species with different densities was described by fitting Holling's disc equation to the data (Holling 1959).

$$N_a = \frac{a\left(N/V\right)T_t}{1+aT_h\,(N/V)} \qquad (1)$$

where N_a, the number of prey consumed/predator; *a*, the rate of successful search; V, volume of plastic jar; *N*, the density of prey; T_t, the handling time, and T_h, the total time prey and predator are exposed to each other.

---

*Short note

Based on complete information of M Sc thesis of the first author submitted to S K University of Agricultural Sciences and Technology of Kashmir during 2008.

[1]MSc Student [2]Assistant Professor (e mail: akhtaralikhan47 @rediffmail.com), Division of Entomotogy.

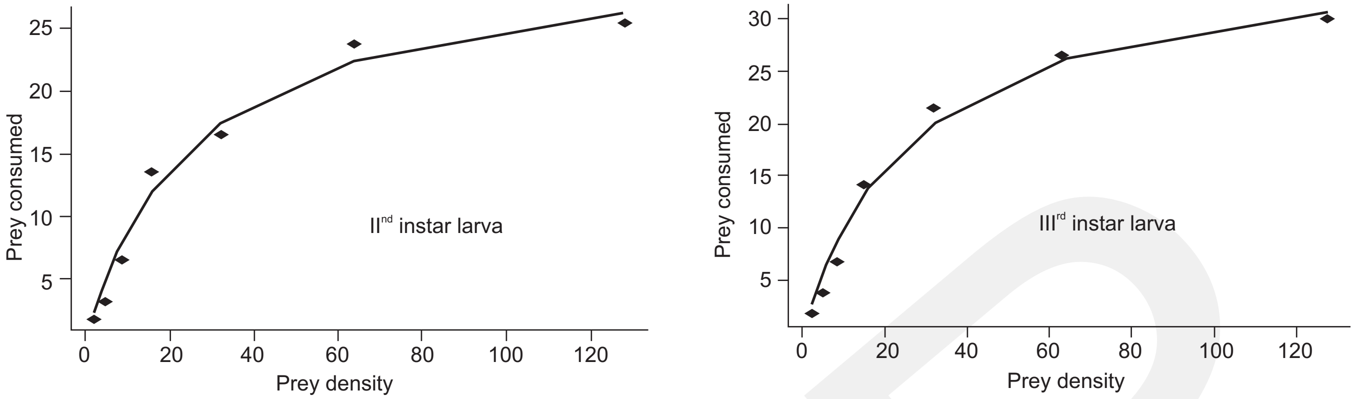

Fig 1 Functional response of *C. crnea* second and third instar larva at different prey densities of *A. pomi*

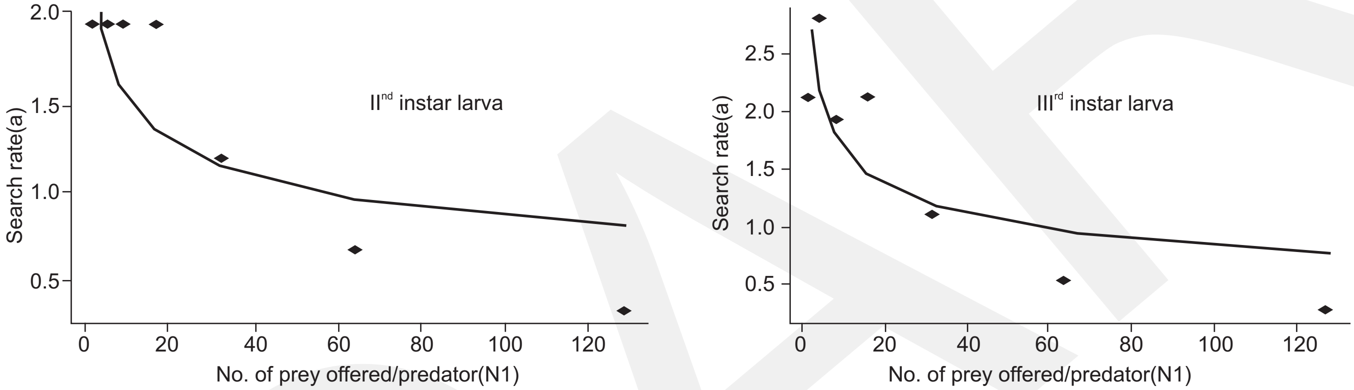

Fig 2 Search rate of *C. carnea* second and third instar larva at different prey densities of *A. pomi*;

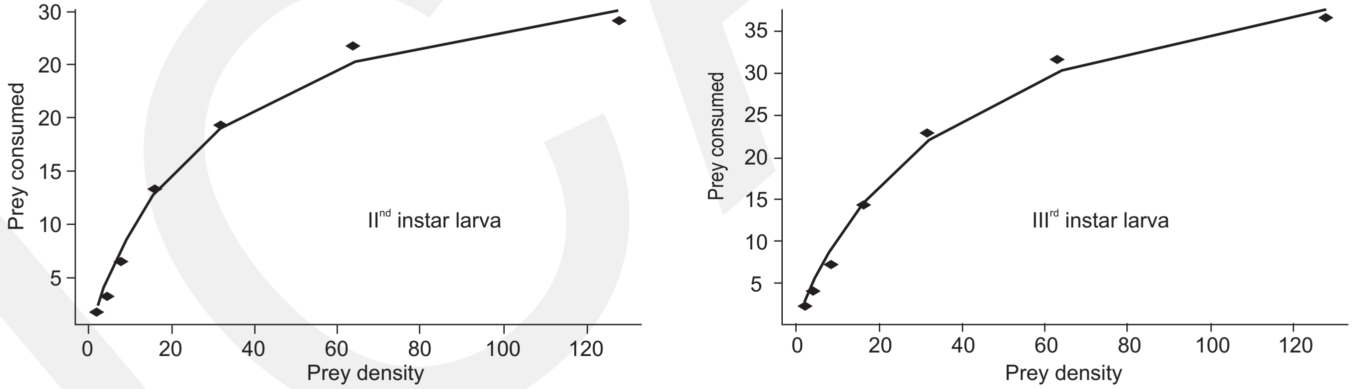

Fig 3 Functional response of *C. carnea* second and third instar larva at different prey;

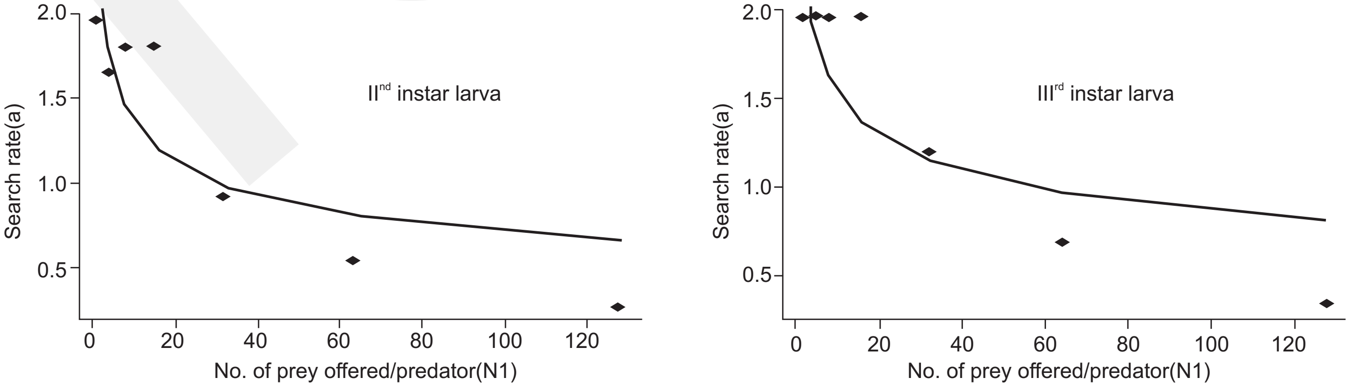

Fig 4 Search rate of *C. carnea* second and third instar larva at different prey densities of *Aphis craccivora*

Table 1 Consumption rate of *Chrysoperla carnea* at different prey densities of *Aphis pomi* and *A. craccivora*

Treatment	No. of aphids used in each replication	No. of *C. carnea* larvae used in each replication	Consumption rate of *C.carnea* larvae on *A. pomi* (%)		Consumption rate of *C. carnea* larvae on *A. craccivora* (%)	
			Second	Third	Second	Third
T_1	2	1	88.0	88.0	86.0	86.0
T_2	4	1	78.0	94.0	81.0	86.0
T_3	8	1	80.5	85.5	83.5	86.0
T_4	16	1	84.2	88.0	83.5	86.0
T_5	32	1	51.7	66.7	60.4	69.7
T_6	64	1	37.1	41.1	41.6	49.4
T_7	128	1	19.8	23.4	22.7	28.5

Table 2 Co-efficient of attack rate *(a)* and handling time *(Th)* of *C. carnea* derived from Type II functional response using *A. craccivora*, and *A. pomi* as prey

C. carnea (instars)	Aphid species used	Parameters	Estimate±SE	*t*-value	*P*-value	Residual standard error	Correlation r^2 at <0.00
Second instar	*A. craccivora*	*a*	2.39±0.22	10.76	0.000120^{***}	1.09	0.74
		Th	0.64±0.33	19.16	0.000071^{***}		
Third instar		*a*	2.37±0.18	12.99	0.000048^{***}	1.11	0.78
		Th	0.48±0.02	19.84	0.000006^{***}		
Second instar	*A. pomi*	*a*	2.35±0.28	8.41	0.00039^{***}	1.22	0.73
		Th	0.75±0.047	16.09	0.000016^{***}		
Third instar		*a*	2.62±0.24	10.75	0.000121^{***}	1.12	0.74
		Th	0.63±0.03	19.97	0.000005^{***}		

The search rate of *C. carnea* in experiments was computed as follows:

$$a=\frac{1}{P}\ln\left(\frac{N_1}{N_1-N_2}\right) \qquad (2)$$

where *a*, search rate; *P*, number of predator used; N_1, number of prey used; N_2, number of prey consumed.

Each of the above mentioned analysis was conducted by using non-linear function nls () provided by the R-software (R Development Core Team 2008).

The results of this study showed that both the larval instar of *C. carnea* exhibited curvilinear response curve Type II functional response when fed on *A. craccivora* and *A. pomi*. The asymptote in the curves revealed the point of maximum consumption. Prey consumption of *C. carnea* larvae increased with increasing prey density. The consumption/ day by second instar larvae varied from 1.72 to 29.08±0.83 and 1.76 to 25.44±0.58, respectively, on *A. craccivora* and *A. pomi* (Figs 1, 3). In case of third instar larvae, the consumption/day varied from 1.72 to 36.48±0.60 and 1.76 to 30.04±0.37, respectively, on the 2 aphid species. In general, *A. craccivora* aphids were consumed more by a larva than compared to *A. pomi* aphids. Bigger size third instar larvae consumed more prey than that by small size second instar larvae. Thus, it may be concluded that the quantity of prey consumed by *C. carnea* depends on the larval size and age of larvae, density of the prey and prey species offered. Athhan *et al*. (2004) documented that prey density has a considerable effect on consumption rate and rather more aphids were killed by third instar larvae of *C. carnea* as compared to second instar larvae. Similar to our results. Dixon (2000) documented that rather more aphids were killed by third instar than by other instars of *C. carnea* larvae.

It is evident from functional response curve that the relative rate of prey consumption by *C. carnea* larvae was higher at lower prey densities on the 2 aphid species, indicating that it could be more effective at lower prey densities (Table 1). It exhibits a significant decline in consumption rate at higher prey densities, which might be due to attainment of satiation or interference stimulation, which can lead the predator to reject the prey (Mills 1982).

The co-efficient of total attack rate *(a)* and handling time *(Th)* were the parameters used to find out the magnitude of these responses. Their *t* values differed significantly between second and third instars of *C. carnea*, when exposed to the 2 aphid species, viz *A. craccivora* and *A. pomi,* which indicate that they have different abilities to respond to increasing prey densities. The fact that these parameters differed significantly and the stages of *C. carnea* posses different capacities to pursue prey at increasing densities. It also shows that different stages of predator manifesting similar quantitative response curve effect on the *A. craccivora* and *A. pomi*. The values of different parameters varied due to the different size, satiation time, hunger levels, digestive power and searching speeds (Khan 2009). The important components of functional response are searching rate *(a)* and handling time *(Th)*, time spent in dominating, eating and digesting the prey. The estimated search rate *(a)* decreased at higher density as at high density prey (Figs 2, 4) is more easily found. According to Holling (1961) time spent in handling reduces search rate at higher densities, which can be attributed to proportional higher consumption at lower densities besides limit imposed by satiation at higher densities. The total handling time *(Th)* affect the type of functional response, the shorter it is the faster the curve is asymptote (Rocha and Radaelli 2004, Khan and Zaki 2008). Besides, handling time *(Th)* can also influence search rate. *C. carnea* second instar larvae at higher prey densities of *A. craccivora* and *A. pomi* spend more time in handling the prey, producing a slowest consumption acceleration that contrast with third instar larvae (Table 2).

Larvae size, searching area, and types of prey certainly affect the attack rate and handling time of *C. carnea* at different prey densities. Similar results obtained in experiments with *C. carnea* predators revealed that the estimated handling time (0.106) was somewhat lower for third instar larvae because of the higher aphid consumption when 40, 80, 160 and 250 nymphs were provided, experimental arena and size of predator also affect the searching ability handling time at different prey densities (Athhan *et al.* 2004). According to the results obtained for functional response of *C. carnea* on *A. craccivora* and *A. pomi*, it seems that third instar larvae have considerable potential for the biocontrol of *A. craccivora* and *A. pomi.* However, before drawing firm conclusions about the effectiveness of *C. carnea* on aphid populations, further experiments are needed under various ecological conditions, especially in the field.

SUMMARY

Functional response of IInd and IIIrd instar larvae of *Chrysoperla carnea* (Stephens) were evaluated on the aphid prey *Aphis pomi* De Geer, *A. craccivora* Koch at prey densities 2, 4, 8, 16, 32, 64 and 128 aphids/larvae/day. The studies revealed that behaviour of both the larval instars matched Holling's Type II functional response. The consumption of IIIrd -instar larvae of C. *carnea* was higher than IInd instar larvae on *A. craccivora* as compared to *A. pomi.* The consumption rate of larvae responded to increasing prey densities with increasing food consumption with deceasing consumption rate and IIIrd instar larvae displayed a higher rate of predation against the 2 aphid species. The maximum attack rate *(a)* with lowest handling time *(Th)* is determined by r^2 value which was found to be highest for IIIrd instar larvae (r^2=0.78) against *A. craccivora* followed by IInd instar larvae (r^2= 0.75) against same aphid species.

REFERENCES

Agarwala B K, Bardhanroy P, Yasuda H and Takizawa T. 2001. Prey consumption and oviposition in aphigophagous predator *Menochilus sexmaculatus* (Coleoptera: Coccinellidae) in relation to prey density and adult size. *European Journal of Entomology* **30**: 1182–87.

Athhan R, Kaydan B and Ozgokce M S. 2004. Feeding activity and life history characteristics of the generalist predator, *Chrysoperla carnea* (Neuroptera: Chryspidae) at different prey densities. *Journal of Pest Science* **77**: 17–21.

Dixon A F G. 2000. *Insect Predator-Prey Dynamics: Ladybird Beetle and Biological Control.* pp. 257. Cambridge University Press.

Holling C S. 1959. Some interactions of simple types of predation and parasitism. *Canadian Entomologist* **9**: 385–98.

Holling C S. 1961. Principles of insect predation. *Annual Review of Entomology* **6**: 163–83.

Khan A A and Zaki F A. 2008. Predatory response of *Chrysoperla carnea* (Stephens) (Neuroptera: Chrysopidae) feeding on the *Euonymus* aphid, *Aphis fabae* Solenella Theobald (Hemoptera: Aphididae) in Kashmir. *Journal of Biological Control* **22**: 149–154.

Khan A A. 2009. Functional response of *Adalia tetraspilota* (Hope) (Coleoptera: Coccinellidae) on cabbage aphid, *Brevicoryne brassicae* (L.) (Homoptera: Aphididae). *Journal of Biological Control* **23** (3): (in press).

R Development Core Team. 2008. *R: A Language and Environment for Statistical Computing*. R Foundation for Statistical Computing, Vienna, Australia. ISBN 3–900051–07–0, URL *http: //*WWW.R-project.org.

Rocha L and Redaelli L R. 2004. Functional response of *Cosmoclopius nigroannulatus* (Hem: Reduvidae) to different densities of *Spartocera dentriventris* (Hemiptera Coreidae) nymphae. *Brazilian journal of Biology* **64**: 309–16.