Journal of Biological Control, 24 (2): 175–178, 2010

Research Note

Functional response of *Rhynocoris fuscipes* (Fabricius) (Hemiptera: Reduviidae) to teak skeletonizer *Eutectona machaeralis* Walker (Lepidoptera: Pyralidae)

DUNSTON P. AMBROSE* and K. NAGARAJAN
Entomology Research Unit, St.Xavier's College, Palayankottai 627002, Tamil Nadu, India.
**Corresponding author E-mail*: eruxavier@gmail.com

ABSTRACT: The Harpactorine reduviid *Rhynocoris fuscipes* (Fabricius) exhibited type II Holling's curvilinear functional response to teak skeletonizer *Eutectona machaeralis* Walker. The predator's attack rate increased as the prey density was increased. The maximum predations represented by 'k' values were 5.67 and 4.67 for female and male predators, respectively. But the highest attack ratios (y/x) (2.53 and 2.36 for female and male predators) were obtained at 1 prey/predator density and the lowest attack ratios (0.70 and 0.58 for female and male predators) at 8 prey / predator density. Positive correlations were obtained between the prey density and the prey killed for both female and male predators. But negative correlations were obtained between the prey density and searching time for both female and male predators. At high prey density, the predators spent less time in searching, therefore spent more time in handling, whereas at low prey density it was found reverse. However, handling time varied due to factors such as rate of pursuit of predator and prey escape or prey capture success.

KEY WORDS: Functional response, *Rhynocoris fuscipes,* Reduviidae, *Eutectona machaeralis,* Pyralidae

(Article chronicle: Received: 19.02.2010; Sent for revision: 07.04.2010; Accepted: 06.05.2010)

INTRODUCTION

A wide variety of insects have been reported as parasitoids and predators of insect pests of teak (Chatterjee and Mishra, 1974; Sudheendrakumar, 1987). The key insect pests of teak *Tectona grandis* L., a fast growing tree genus (Family: Verbenaceae) are teak defoliator *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae), teak skeletonizer *Eutectona machaeralis* Walker (Lepidoptera: Pyralidae) and teak borer *Alcterogystia cadambae* (Moore) (Lepidoptera: Cossidae) (David and Ananthakrishnan, 2004).Four species of reduviid predators viz., *Euagoras plagiatus* Burmeister, *Endochus* sp., *Rhynocoris fuscipes* and *Sphedanolestes aterrimus* Distant were reported from the teak plantations in Kariem Muriem, Nilambur Forest Division, Kerala (Mohanadas,1996).

Claver and Ambrose (2002) reported *Rhynocoris fuscipes* (Fabricius) as a potential predator against insect pests of agroecosystems. Although, *R. fuscipes* is a generalist predator, it exhibits prey preference for soft bodied lepidopteran larvae followed by termites, bugs and beetles (Ambrose, 1999). Although, the biological control potential of *R. fuscipes* on many agricultural pests was studied, no information is available on forest pests. Hence, an attempt was made to understand the biocontrol potential of this predator on forest insect pests. This paper deals with the functional response of *R. fuscipes* on teak skeletonizer *E. machaeralis,* baseline information on biocontrol potential.

Collection and culture of predator

A laboratory culture of *Rhynocoris fuscipes* (Fabricius) was raised in the laboratory from the adults collected from Muppanthal Scrub Jungle of Mahendragiri Hills of Kanyakumarii district, Tamil Nadu, South India (altitude 150 MSL, latitude 77° 31' E and 8° 22'N) and its reared under the laboratory conditions (temp. 30-35°C, Rh 75-80%, photoperiod 11–13 hrs) on head crushed larvae of rice meal moth *Corcyra cephalonica* (Stainton). The 48 hr starved adults of *R. fuscipes* from the laboratory culture were used for the experiments.

Collection and Maintenance of teak pest

The larvae *E. machaeralis* were collected from teak plantations of Ramar hills, Alankulam near Courtallam Tropical rainforest, Western Ghats, Tamil Nadu, South India (altitude 150 MSL, latitude 77°55' E and 81° N) and reared in the laboratory in 5 L containers on fresh teak leaves. The fed leaves were removed daily and replaced with fresh leaves.

Experimental arena

The functional response experiments were conducted with 48 h starved adult males and females of *R. fuscipes* in plastic containers (16 x 11.5 x 4 cm) with *E. machaeralis* as prey to determine the relationship between the prey density and the number of prey consumed, searching time, attack ratio and handling time of the predator. The prey *E. machaeralis* (1.5cm) was first introduced into the container and was allowed to settle. After 10 minutes a predator was introduced into the container. The functional response was observed at varying prey densities *viz.,* 1, 2, 4, and 8 prey / predator for 6 days with female and male predators separately. Six replicates were maintained in each category. After every 24 hours, the number of prey consumed was monitored and the prey number was maintained constant by replacing them with fresh prey throughout the experiment. In the present study various parameters in the 'disc' equation of Holling (1959) was analysed to describe the functional response of *R. fuscipes*:

x = prey density; y = total number of prey killed in given period of time; y/x = the attack ratio; Tt = total time in days when prey was exposed to the predator; k-maximum predation; handling each prey by the predator, (Tt/k) and a = rate of discovery per unit of searching time [(y/x)/Ts].

The parameters a, b and k were directly measured in the present study. The handling time 'b' was estimated as the time spent for pursuing, subduing, feeding and digesting each prey. The maximum predations represented by 'k' values were restricted to higher prey density. Another parameter 'a' the rate of discovery was defined as the proportion of the prey attacked successfully by the predator per unit of searching time. Discovery was instantaneous, with little searching time being required. Although the parameter rate of discovery (a) was theoretically infinite, the predator did spent some time in searching the prey at lower prey density but no time at higher prey density. The extent of searching was clearly related to the degree of satiation (Holling, 1959).

Assuming that the predation is proportional to the prey density and the time spent by the predator in searching prey (Ts), the expression of the relationship is

y = a Ts x.............1

Since the time available for searching is not constant it is reduced from total time (Tt) by the time spent for handling the prey. If one presumes that each prey requires a constant amount of time 'b' for consumption, then

Ts = Tt - by...........2

Substituting 2 in 1

y = a (Tt - by) x 3

Regression analysis was made to determine the relationship between the prey density and the prey consumed, searching time and attack ratio (Gomez and Gomez, 1984).

The response of *R.fuscipes* to the increasing density of *E. machaeralis* by killing more number of prey than at lower prey densities, thus exhibiting type II curvilinear functional response (Holling, 1959) (Fig. 1). This was further confirmed by the positive correlations obtained between the prey density and the prey killed (Y = 2.6243 + 0.4021x; r = 0.9494 and Y = 2.8339 + 0.2629x; r = 0.7987 for female and male predators, respectively). Such a functional response was also observed in other reduviids (Claver and Ambrose, 2002; Claver *et al.,* 2003).

The maximum predation represented by 'k' value was always found restricted to higher prey density (k = 5.67 and 4.67) for female and male (Table 1). Because higher prey density enabled the predator to spend less time to search its prey and to utilize all its time in attacking and consuming. The attack ratio decreased with increasing prey density. The handling time (b) was shorter (1.05) in females than in males (1.28). Hunger and time spent by the predator in searching and handling the prey, i.e., pursuing, subduing and consuming the prey and then preparing itself for further search affect the prey consumption (Houck, 1991).

At high prey density, less time was spent in searching; therefore more time was available for handling, whereas at low prey density the searching time always dominated over handling time. Because, probability of the predator's higher prey contact at higher prey density would have enhanced the searching ability per unit area (Ravichandran and Ambrose, 2006). Nordland and Morrison (1990) reported that the handling time affects the type of functional response; the shorter it is the faster the curve reaches the asymptote. Besides handling time can influence other components such as attack rate and searching efficiency (Beddington, 1975). Ambrose and Claver (1997) obtained similar response for *R. fuscipes* to *S. litura* i.e., handling time decreased as the prey density was increased.

The searching time decreased as the prey density was increased. Uniformly negative correlations were obtained between the prey density and searching time of predator at all prey densities. It is presumed that the predators spent less time on searching activities which in turn might have caused perceptive decline in the attack rate until the hunger was established. Such indirectly proportional relationship found between the attack ratio and prey density was also reported in *Podisus maculiventris* (Say) (Mukerji and LeRoux, 1969). The present findings are in close agreement to those recorded for other reduviids

Table 1. Cumulative functional response of adults of *Rhynocoris fuscipes* to *Eutectona machaeralis* larvae (n = 6)

Sex	Prey density (x)	Prey attacked (y)	Max' y (k)	Days / y b = Tt / k	All y's days (by)	Searching days Ts = Tt - by	Attack ratio y/x	Rate of discovery (y/x) / Ts = (a)	Disc equation Y'= a (Tt -by) x
Female	1	2.53	5.67	1.05	2.65	3.35	2.53	0.75	Y' = 0.86 (6-1.05) x
	2	3.83			4.02	1.98	1.91	0.96	
	4	4.50			4.72	1.28	1.12	0.87	
	8	5.67			5.95	0.05	0.70	–	
								Mean = 0.86	
Male	1	2.36	4.67	1.28	3.02	2.98	2.36	0.79	Y' = 1.68 (6-1.28) x
	2	3.93			5.03	0.97	1.96	2.02	
	4	4.32			5.52	0.48	1.08	2.25	
	8	4.67			5.97	0.03	0.58	–	
								Mean = 1.68	

(Claver and Ambrose, 2002; Claver *et al.,* 2004). Hassel (1978) further attributed this response as the characteristic feature of type II functional response. However, intrinsic factors in the predator, the substratum where prey is found, environmental conditions or kinds of prey can lead to other types of response (Hassel *et al*., 1977). The different types of functional response can produce diverse effects upon the population dynamics of interacting predator and prey (Begon *et al.,* 1990).

A decrease of estimated searching time as a function of increased prey density was found for both female and male predators (Table1). According to Hassel *et al*., (1977) this decrease in searching time occurs because at high densities preys are more easily found. Ambrose and Claver (1995) also observed in newly emerged *R. fuscipes* preying *Riptortus clavatus* Thunberg and *S. litura* a decrease in attack rate and searching time when prey density was increased. The type II curvilinear positive functional response exhibited by *R. fuscipes* to *E. machaeralis* suggests its biocontrol potential against the pest. Further studies on its abundance, colonization, dispersal and prey as well as stage preference in forest ecosystem will enable one to employ it as biocontrol agent against *E. machaeralis*.

ACKNOWLEDGEMENTS

The authors are grateful to the authorities of St. Xavier's College for facilities and gratefully acknowledge the financial assistance received from Ministry of Environment and Forests, Govt. of India (MoEF. No. 23/ 12/2005-RE dated 16th December 2005).

REFERENCES

Ambrose, D. P. 1999. *Assassin bugs*. Oxford and IBH Publishing Company Private Limited, New Delhi, India, 337 pp.

Ambrose, D. P. and Claver, M. A. 1995. Functional response of *Rhynocoris fuscipes* Fabricius (Heteroptera: Reduviidae) to *Riptortus clavatus* Thunberg (Heteroptera: Alydidae). *Journal of Biological Control*, **9**: 74–77.

Ambrose, D. P. and Claver, M. A. 1997. Functional and numerical responses of the reduviid predator, *Rhynocoris fuscipes* F. (Het., Reduviidae) to cotton leaf worm *Spodoptera litura* F. (Lep., Noctuidae). *Journal of Applied Entomology*, **121**: 331–336.

Beddington, J. R. 1975. Mutual interference between parasites or predators and its effects on searching efficiency. *Journal of Animal Ecology*, **44**: 331–340.

Begon, M., Harpe, J. L. and Towsend, C. R. 1990. *Ecology: Individuals, populations and communities*. Oxford Blackwell Scientific Publications, 945 pp.

Claver, M. A. and Ambrose, D. P. 2002. Functional response of the predator, *Rhynocoris fuscipes* (Heteroptera: Reduviidae) to three pests of pigeonpea (*Cajanus cajan*). *Shashpa*, **9**: 47–51.

Claver, M. A., Ravichandran, B., Khan, M. M. and Ambrose, D. P. 2003. Impact of cypermethrin on the functional response, predatory and mating behaviour of a non-target potential biological control agent *Acanthaspis pedestris* Stål (Het., Reduviidae). *Journal of Applied Entomology*, **127**: 18–22.

Claver, M. A., Muthu, M. S. A., Ravichandran, B. and Ambrose, D. P. 2004. Behaviour, prey preference and functional response of *Coranus spiniscutis* (Reuter), a potential predator of tomato insect pests. *Pest Management in Horticultural Ecosystems*, **10**: 19–27.

Chatterjee, P. N. and Mishra, M. P. 1974. Natural enemy and plant host complex of forest insect pests of Indian region. *Indian Forest Bulletin*, **265**: 233.

David, B. V. and Ananthakrishnan, T. N. 2004. *General and Applied Entomology*. Tata McGraw-Hill Publishing Company Limited, New Delhi, 1161 pp.

Gomez, K. A. and Gomez, A. A. 1984. *Statistical procedure for agricultural research.* 2nd edition, John Wiley, New York, USA, 680 pp.

Hassel, M. P. 1978. *The dynamics of arthropod predator-prey systems*. Princeton University Press, Princeton, 237 pp.

Hassel, M. P. Lawton, J. H. and Beddington, J. R. 1977. Sigmoid functional response by invertebrate predators and parasitoids. *Journal of Animal Ecology*, **46**: 246–249.

Holling, C. S. 1959. Some characteristics of simple type of predation and parasitism. *Canadian Entomologist*, **91**: 385–398.

Houck, M. A. 1991. Time and resource partitioning in *Stethorus punctum* (Coleoptera: Coccinellidae). *Environmental Entomology*, **20**: 494–497.

Mohanadas, K. 1996. New records of some natural enemies of the teak defoliator, *Hyblaea puera* Cramer (Lepidoptera: Hyblaeidae) from Kerala, India. *Entomon*, **21**: 251–253.

Mukerji, M. K. and LeRoux, E. J. 1969. The effects of predator age on the functional response of *Podisus maculiventris* to the prey size of *Galleria mellonella*. *Canadian Entomologist*, **101**: 314–327.

Nordlund, D. A. and Morrison, R. K. 1990. Handling time, prey preference and functional response for *Chrysoperla rufilabris* in the laboratory. *Entomologia Experimentalis et Applicata,* **57**: 234–242.

Ravichandran, B. and Ambrose, D. P. 2006. Functional response of a reduviid predator *Acanthaspis pedestris* Stål (Hemiptera: Reduviidae) to three lepidopteran insect pests. *Entomon*, **31**: 149–157.

Sudheendrakumar, V. V. 1987. *Studies on the natural enemies of the teak pests*, Hyblaea puera *and* Eutectona machaeralis. KFRI Research Report No. 38, Kerala Forest Research Institute, Peechi - 680 653, Kerala, India. 28 p.