



Functional response of *Acanthaspis quinquespinosa* (Fabricius) (Hemiptera: Reduviidae) on *Coptotermes heimi* (Wasmann)

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ABSTRACT: Functional response of *Acanthaspis quinquespinosa* (Fabricius) to the termite, *Coptotermes heimi* (Wasmann), was studied in the laboratory. The adults of *A. quinquespinosa* responded to the increasing prey density of *C. heimi* by killing more number of them than killed at lower densities, thus exhibiting type II functional response. The searching capacity of *A. quinquespinosa* increased with increasing termite density and this reflected its predatory potential.

KEY WORDS: *Acanthaspis quinquespinosa*, *Coptotermes heimi*, functional response, Reduviidae, termite

INTRODUCTION

Two important characteristics of natural enemies, their functional and numerical responses to varied prey densities, are thought to be central for successful suppression of pest populations. The functional response refers to the change in the number of prey consumed per unit time in relation to prey density (Solomon, 1949; Hassel, 1978). Reduviids are polyphagous and attack a greater number of prey at high prey densities than at lower prey densities (Ambrose, 1999, 2000, 2003; Claver and Ambrose, 2002; Claver *et al.*, 2003). *Acanthaspis quinquespinosa* (Fabricius) is a ground dwelling predator in scrub jungles, semi-arid zones and agroecosystems, especially in rice ecosystems (Ambrose, 1983). It is a voracious predator on termite species such as *Coptotermes*

heimi (Wasmann). *C. heimi* is a pest of growing trees. It feeds on the bark and lower portion of *Eucalyptus* spp., stem, surface area and soft portions of wood of forest trees and stem of sugarcane (Verma, 1993; Verma and Rathore, 1993; Javaid and Afzal, 2001; Salihak *et al.*, 2002) and structural materials (Harris, 1964; Salihak *et al.*, 2002) in India and Pakistan. In the present study, *A. quinquespinosa* was found feeding upon *C. heimi* on coconut, palm, banana and neem. To quantify the termite suppression efficacy of this reduviid, an attempt was made to study the functional response of *A. quinquespinosa* to *C. heimi* in the laboratory to determine which of the functional response models best fits and to assess the feasibility of utilizing this predator in IPM against termites.

MATERIALS AND METHODS

The nymphs and adults of *A. quinquespinosa* were collected from Pappankulam rice ecosystems (latitude 77°39'E 8°72'), Tirunelveli District, Tamil Nadu, South India. They were separately reared in the laboratory (28-34°C temperature; 12±1h photoperiod; 65-70% humidity) in plastic containers (14x22x10cm) on *C. heimi*.

The functional response experiments were conducted in plastic containers (14x22x10cm). The prey was first introduced into the container and allowed to acclimatize in the container. Thereafter, an adult predator pre-starved for 24h was introduced into the container. The functional response was studied at 10, 20, 30, 40 and 50 prey densities. After 24h, the number of prey consumed or killed by the predator was evaluated. The prey number was maintained constant throughout the experiment by replacing the dead or consumed prey with fresh prey. Disc equation of Holling (1959a) was used to find out the functional response. Disc equation was derived from the following equation which signified the effects of prey density on attack.

$$Y = a T_s x \text{-----} 1$$

where:

a = rate of discovery per unit of searching time [(y/x)/Ts]

Ts = time spent by the predator in searching prey

Y = total number of prey killed in a given period of time

x = prey density

But time available for searching is not constant. It is not reduced from the total time (Tt) by the time spent in eating (or) handling prey. If we presume that each prey requires a constant amount of time 'b' for consumption, then,

$$T_s = T_t - by \text{-----} 2$$

T_i = total time in days when prey was exposed to the predator

b = Tt/k = time spent for handling each prey by the predator

k = the maximum prey consumption

Substituting 1 in 2

$$Y' = a(Tt - by) x \text{-----} 3$$

(or)

$$Y' = \frac{Tt ax}{1 + abx}$$

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

RESULTS AND DISCUSSION

Predation by *A. quinquespinosa* on *C. heimi* yielded a curvilinear type II functional response (Holling, 1959a) (Fig. 1). Most predators consumed all or most of the prey provided at lower prey densities and showed a deceleration in rate of predation with greater variation at higher prey densities. This was further confirmed by the positive correlation obtained between the prey density and the prey killed ($Y = 4.598 + 0.7154 x$; $r = 0.98$) for the adult predators (Table 1). The maximum predation represented by K value was always found restricted to high prey density (K = 40). The searching time decreased as the prey density was increased. Negative correlations were obtained between prey densities and the searching times of the predator at all prey densities ($Y = 1.120 - 0.107x$; $r = -0.835$) (Table 1).

Its functional response reveal that prey consumption by a predator increased with increase in prey density, whereas per cent prey consumption decreased, which exemplifies Holling's Type II predatory response (1959a). Type II functional response is typical of most of the heteropteran predators (Cohen and Tong, 1997; Cohen, 2000). The present findings are in close agreement to those recorded for other reduviids (Ambrose, 1999, 2002; Ambrose and Claver, 1995, 1997; Ambrose and Kumaraswami, 1990; Claver *et al.*, 2003) and predatory coccinellid beetles (Omkar and James, 2001; Omkar and Srivastava, 2001). Hunger and time spent by the predator in searching and handling prey affect the prey consumption (pursuing, subduing and consuming the prey and then

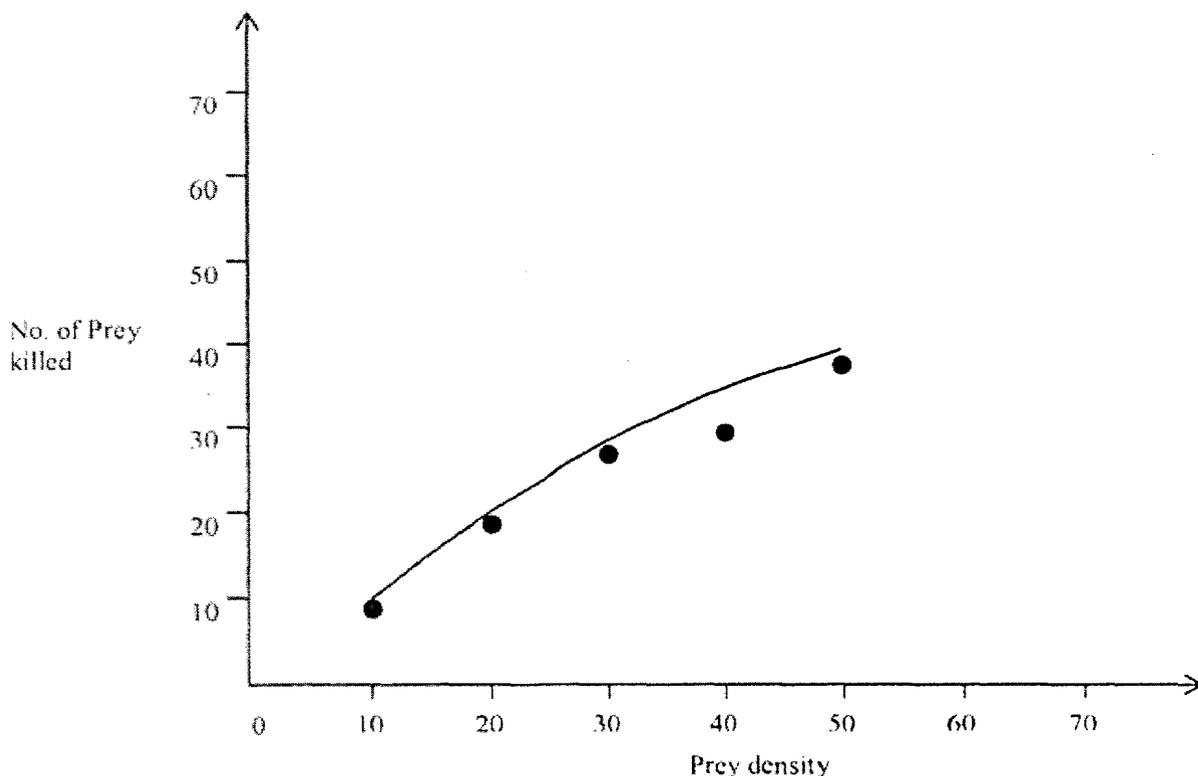


Fig 1. Functional response of *Acanthaspis quinquespinosa* to *Coptotermes heimi*

Table 1. Functional response of *Acanthaspis quinquespinosa* on termite *Coptotermes heimi* for 6 days (n = 7, ± SD)

Prey density (X)	Prey attacked (Y)	Max. Y (K)	Days/Y $b=Tt/k$	Days's all Y's (by)	Days searching $Ts=Tt-by$	Attack ratio y/x	Rate of discovery $y/x/Ts = (a)$	Discovery equation $Y'=a(Tt-by)x$	Y'
10	10	40	0.15	1.5	4.5	1	0.222	$Y' = 0.35(6-0.15y)x$	9.99
20	20			3.0	3.0	1	0.333		19.98
30	28.786			4.318	1.682	0.96	0.571		28.81
40	31.548			4.732	1.268	0.79	0.623		31.59
50	40			6.000	0	0.8	0		0

preparing itself for further search) (Houck, 1991).

Increased prey consumption at higher prey density might be due to different phenomena operating simultaneously in a predatory arena. Firstly, it results due to decrease in searching time

because the probability of contacts between the prey and predator increases at higher prey densities, which results in increased prey consumption. Secondly, the predator stays in an arena where the prey aggregates and continues to feed until satiation or even beyond (Williams and

Juliana, 1985; Claver and Ambrose, 2002). Handling time depends upon factors such as speed of pursuit of predator and prey escape or prey capture success (Akhtaruzzaman and Ahmed, 1998). The inversely proportional relationship found between the attack rate and prey level corroborates the earlier observations of Claver and Ambrose (2002) and Claver *et al.*, (2003). It is presumed that the predator required less time to search the prey and spent more time on non-searching activities at higher prey densities, which in turn might have caused perceptible decline in the attack rate until hunger was established. This releases the trade-off situations at higher prey density and closes the gap between optimal foraging and satiation (Jeschke *et al.*, 2002). Moreover, higher prey density also results in reduction of unsuccessful attacks of a predator on a prey, as there are less chances of escape when compared to those in scarce prey density, where there are more chances for the prey to escape from the predator (O'Neil, 1988).

At high prey density, less time was spent in searching, therefore more time was spent in handling, whereas at low prey density the searching time always dominated the handling time (O'Neil, 1988). Disturbance by another prey at higher prey densities also aggravated a hungry predator during feeding which resulted in killing of more prey individuals than normal. Heteropteran predators are adapted to feeding on larger prey. A predator that skims nutrient-poor, highly diluted liquids would be likely to kill as many prey as it could capture (Cohen, 2000). Moreover, satiation is a possible reason for decreased prey consumption at higher prey densities, since satiated reduviids spent more time in prey handling due to which rate of prey capture decreased (Ambrose, 1999, 2003; Claver and Ambrose, 2002). Thus, it is clear that the performance of biological control agents is also affected by their food sources. Therefore, the proper predator:prey ratio should be determined. The results from this study indicate that the searching efficacy and rate of consumption are maximum when the predator was searching at a density of 50 *C. heimi*. The predator consumed 40 prey at 50 prey density. Thus, predator-prey ratio of 1: 50 may be

optimal for the release of this predator to manage the termites.

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