J. Biol. Control, 17(2): 113-119, 2003

Biology and prey influence on the postembryonic development of *Rhynocoris longifrons* (Stål) (Hemiptera: Reduviidae), a potential biological control agent

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ABSTRACT: ***Rhynocoris longifrons* (Stål) is a ferrugineous and griseously sericeous harpactorine, alate and multivolitine assassin bug inhabiting concealed microhabitats such as beneath the boulders and in small crevices. It lays eggs in batches and the eggs hatch in 7.8 ± 1.5 to 8.3 ± 1.0 day. The total nymphal development period ranges from 58.6 ± 2.2 to 72.6 ± 4.7 days. The females lived longer than the males. The sex ratio was female-biased. A brief description of egg, nymphal instar and a redescription of adult male are given. The prey influence on the incubation, developmental, pre-oviposition periods, sex ratio, adult longevity, fecundity and hatchability was studied on four different prey species such as *Corcyra cecphalonica* Stainton, *Odontotermes obesus* Rambur, *Clavigralla gibbosa* Spinola and *Helicoverpa armigera* (Hübner). *H. armigera* fed individuals exhibited shorter preoviposition, incubation and stadial periods and these parameters were extended in *C. cephalonica, C. gibbosa* and *O. obesus* fed *R. longifrons*. The nymphal longevity, fecundity and hatchability were greater in *H. armigera* fed individuals. The nymphal mortality was lower in *H. armigera* fed individuals.**

KEY WORDS: Biology, prey influence, *Rhynocoris longifrons*

INTRODUCTION

Reduviid predators are potential biocontrol agents against many insect pests and hence, they have the potential for an even greater role in Integrated Pest Management (Ambrose, 2000; Grundy and Maelzer, 2000). *Rhynocoris longifrons* (Stål) is a multivoltine, voracious harpactorine reduviid predator. It has been recorded as an efficient predator of pests of pigeonpea such as *Helicoverpa armigera* (Hübner), *Exelastis atomosa* (Walsingham), *Clavigralla gibbosa* (Spinola), *Nezara viridula* (L.), *Maruca vitrata* Geyer and *Riptortus pedestris* Thunberg (Ambrose and Claver, 2001) in the pigeonpea agroecosystems of Tamil Nadu, South India. So far no information is available on its biology and ecology. Hence, the present study was undertaken to understand biology and ecology with special reference to the influence of prey species on the predatory response, postembryonic development and reproductive potential of *R. longifrons*.

MATERIALS AND METHODS

The predator, *Rhynocoris longifrons* (Stål) was collected from the Sunkankadi scrub jungle (77°26' E and 8°16' N) and Muppanthal (77°31' E and 8°22' N) scrub jungle, in Kanyakumari District of Tamil Nadu, South India. They were maintained in round plastic troughs with netted lids (16mm diameter x 7cm height) in the Entomology Research Unit laboratory (28-34°C temperature, 12-13h photoperiod, 75-80% relative humidity). The reduviids mass reared in the laboratory were used for the experimental studies.

Different batches of eggs were allowed to hatch separately in 15ml plastic containers covered with netted lids. The newly hatched nymphs were isolated soon after eclosion. They were reared in the laboratory in plastic containers on rice moth (*Corcyra cephalonica* Stainton) larvae and field collected termites, *Odontotermes obesus* Rambur, *Clavigralla gibbosa* Spinola and *Helicoverpa armigera* (Hübner) larvae.

The containers were examined at regular interval for spermatophore capsules ejected after successful copulation as well as for the eggs laid. The nymphs were fed separately on four different hosts such as *H. armigera, C. gibbosa, C. cephalonica* and *O. obesus.* In each category, the adult males and females were kept together facilitating their mating. The number of batches of eggs and the total number of eggs laid were recorded for each mated female. Each batch of eggs was allowed to hatch in individual containers. The nymphs were reared and their developmental periods and nymphal mortality recorded. Camera lucida illustrations of the life stages were made with preserved specimens. Adult longevity was estimated by rearing the laboratory emerged adults till their death. The sex ratio was computed on the basis of laboratory emerged adults.

RESULTS AND DISCUSSION

Microhabitat

R.. longifrons was found to inhabit concealed microhabitats such as beneath the boulders and in small crevices in pairs. The nymphs were also found along with the adults. The adults were alate, crepescular, entomosuccivorous and polyphagous. They laid eggs in clusters. Though they laid eggs in clusters they never converted the egg mass into an ootheca as reported in some harpactorine species. The nymphs did not probe the eggshells immediately after eclosion. Eclosion and ecdysis occurred only in the afternoon as seen in most harpactorine species (Ambrose, 1999).

Description of egg

The egg of *R. longifrons* exhibits typical reduviid egg architecture with a distinct body, a neck or collar and operculum (Fig. 1). The body of the egg is characterized by numerous polygonal follicular areas. The anterior rim of the egg has a prominent collar. The chorionic filaments, which arise from the collar merge with the opercular extension as reported in other harpactorine reduviids (Ambrose, 1999).

Description of nymphal instars

Immediately after eclosion and ecdysis the nymphs are reddish in colour. After two hours they become reddish brown. Their antennae are four-segmented, the first flagellar segment is the shortest and almost equals to the pedicel. The rostrum is three segmented, stout and moderately curved. The middle segment is the longest and the tip of the rostrum reaches the prosternal groove. The prothorax is sculptured in the older instars. The middle leg is the shortest and the hind leg is the longest. Tibial combs are present in the fore- and midtibia. The tarsi are three-segmented. The basal tarsal segment is the shortest and the terminal segment is the longest. The orifices of three scent glands are seen in between 3rd and 4th, 4th and 5th, 5th and 6th abdominal segments. The abdomen is longer than broad in all the instars (Fig. 2-6).

Re-description of the adult male

The description of *R. longifrons* by Distant (1904) is found inadequate. Hence, it is redescribed. The entire length of the insect is 9.7 ± 1.0 mm, the width across eyes is 0.7 ± 0.1mm, the width across prothorax is 2.9 ± 0.1mm and the width across the abdomen is 2.8 ± 0.3 mm (Fig. 7). They are ferrugineous and griseously sericeous; the lateral areas behind the eyes are black. The abdomen beneath is black; the sternum is paler than the abdomen. The membrane and the abdominal margin are palely spotted.

The head is longer (2.5 ± 0.1mm) than the prothorax (2.4 ± 0.1mm). The anteocular region is distinctly longer (1.2 ± 0.02mm) than the postocular (0.8 ± 0.03mm) region. The anteocular area is always longer than the postocular and measures 0.17 times of the antennal length and about 0.3 times of the rostrum; head length exceeds 2.6 times that of anteocular region and 2.3 times that of postocular region; head width exceeds 3 times that of the eye, 2.5 times that between the eye and head length 0.47 times that of the antenna and almost equals that of the prothorax. The compound eyes are laterally protruded. A pair of prominent ocelli is present one behind each eye. The neck is not distinct. The antennae are four segmented and the terminal flagellar segment is the longest (1.8 ± 0.1mm) and the pedicel is the shortest (0.9 ± 0.02mm). The scape and the first flagellar segment are subequal in length. The first flagellar segment is about 0.4 times that of the scape in length. The scape (1.8 ±0.1 mm) is distinctly shorter than the head (2.5 ± 0.1mm). The rostrum is three-segmented. The basal rostral joint almost equals in length that of the anteocular region and the longest middle segment sub-equals to it. The terminal rostral segment is the shortest. The rostrum is bow-shaped and its tip reaches the prosternal groove. The rostral length exceeds 2.9 times that of the basal rostral and is about 2.0 times longer than the medial rostral segment. Fore- mid- and hind tibiae are about 1.5, 1.03 and 2.2 times longer than the prothorax, respectively.

The pronotum is longitudinally impressed and transversely divided into anterior and posterior regions of equal length. The anterolateral angles are slightly prominent. The anterior pronotal lobe bears a medial longitudinal sulcus. The posterolateral angles of the posterior lobe are anteriorly slightly lobate. The scutellum bears a conical tubercle. The legs are richly pilose. The

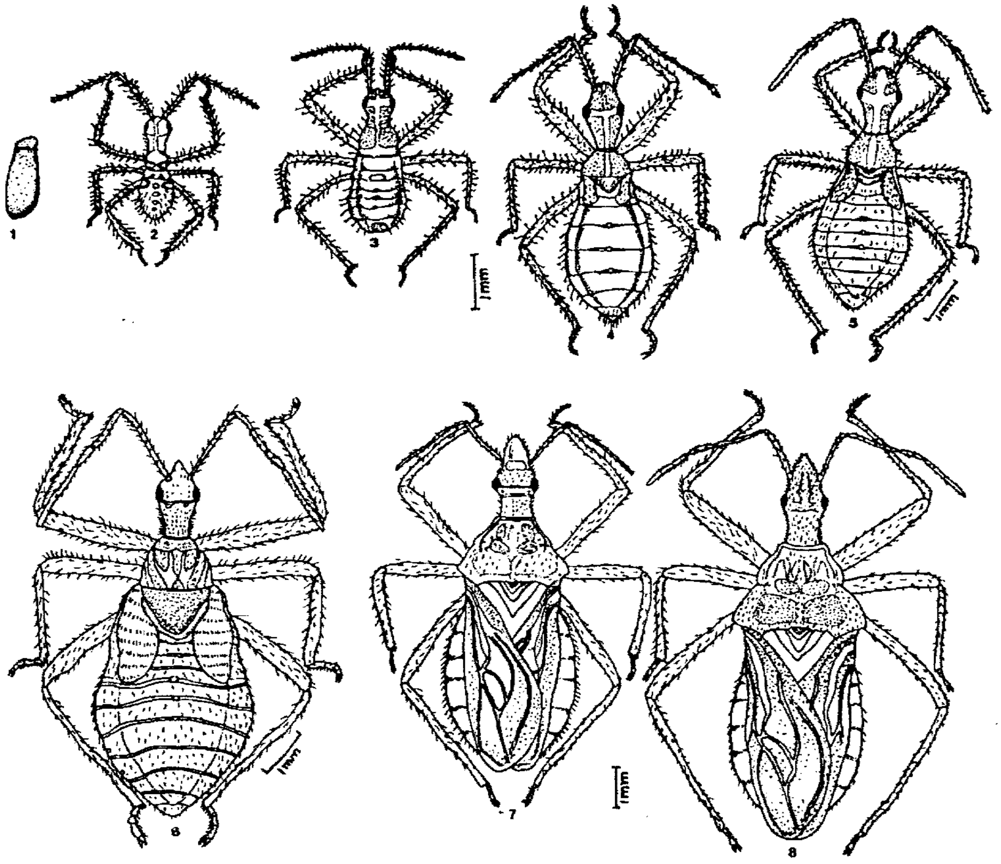

Fig. 1-8. Different stages of *Rhynocoris longifrons*

mid-leg is the shortest and the hind leg is the longest. The tarsi are three-segmented. The fore- and mid-tibiae bear rudimentary tibial pads and tibial combs. The connexivum is well deflected and it bears pale ochraceous spots. The wings are extended beyond the abdominal tip. The wing length measures up to 0.8 times that of the insect. The width of the abdomen is about 0.7 times that of its length and its length is about 0.5 times that of the insect length. Insect length exceeds 3.5 times that of its head, 1.7 times that of antennae, 4.3 times that of prothorax and about 3.3 and 2.3 times longer than fore and hind tibiae, respectively. The females are larger than the males (Fig. 8). The morphometric configurations are almost similar to those of its sister species *R. kumarii, R. marginatus* and *R. fuscipes* (Ambrose, 1999).

Biology

Under laboratory conditions the eggs of *R. longifrons* reared on *C. cephalonica* larvae hatch uniformly in 8 days. Hatching invariably occurs in the early morning, between 5 to 8 am. The duration of eclosion was 4 to 7 minutes. The nymphs start feeding 2-6 hours after emergence showing preference for small and sluggish prey. Each egg was attached to the substratum as well as to the previously laid ones, giving a polygonal shape to the complete egg mass. Seasonal influence on egg hatching was not observed in *R. longifrons*. Guarding the eggs by either parent as reported for *Rhynocoris albospilus* Signoret and *Zelus* sp. (Ralston, 1977) was not recorded in this species. A female laid on an average three batches of eggs. A minimum of 22 and a maximum of 56 eggs per batch were recorded. The mean hatchability was 72.01 ± 10.6 percent. The unfertilized eggs appeared to be shrunken.

The stadial periods of 1st, 2nd, 3rd, 4th and 5th nymphal instars lasted 7.1 ± 0.9, 6.9 ± 1.7, 9.4 ± 3.9, 14.1 ± 4.6 and 16.0 ± 3.9 days, respectively (Table 1). The total stadial period from I to V instars was 61.5 days. Males emerged earlier than females. Abnormal hatching and moulting resulted into nymphal mortality. The highest nymphal mortality (28%) was recorded in the I instar. In the V instar, no mortality was observed. The adult male and female lived for 42.4 and 69.5 days, respectively.

Table 1. Biology of *Rhynocoris longifrons* on *C. cephalonica* larvae in the laboratory

Biological parameters	Duration (days)	Mortality (%)
Incubation period	8.0± 0.0	28.0
I stadia	7.1± 0.9	9.9
II stadia	6.9± 1.7	10.8
III stadia	9.4± 3.9	13.3
IV stadia	14.1± 4.6	9.3
V stadia	16.0± 3.6	0.0
Adult longevity	66.8± 10.4	-
Sex ratio (Male: Female)	1: 1.02	-
Pre-oviposition period	14.3± 1.9	-
Post-oviposition period	12.6± 2.1	-
Fecundity	106.8±11.7	-
Hatchability	62.1± 6.3	-

(N=12)

Table 2. Impact of prey on the post-embryonic development of *R. longifrons* reared on different prey species

Biological parameters	*C.cephalonica* larvae		*O. obesus*		*C. gibbosa*		*H.armigera* larvae	
	Duration (%)	Mortality (%)	Duration (days)	Mortality (%)	Duration (days)	Mortality (%)	Duration (days)	Mortlity (%)
Incubation period	8.0±0.0	28.0	8.3±1.1	34.4	8.1±0.9	31.5	7.8±1.5	18.3
I Stadia	7.1±0.9	9.9	9.3±1.8	22.5	8.6±0.9	18.4	8.3±1.0	7.8
II Stadia	6.9±1.7	10.8	9.8±1.8	16.1	9.5±1.3	14.5	8.9±1.9	5.4
III Stadia	9.4±3.9	13.3	11.2±1.7	11.5	9.8±1.4	8.1	9.4±1.7	5.9
IV Stadia	14.1±4.6	9.3	12.9±1.4	5.8	10.8±1.3	4	10.1±2.4	4.3
V Stadia	16.0±3.6	0.0	21.2±1.5	0.0	15.2±1.7	0.0	13.9±1.5	0.0
Adult longevity	66.8±10.4		78.6±12.0		104.9±6.9		114.9±13.4	
Sex ratio (Male: Female)	1: 1.02		1: 1.14		1: 1.3		1: 1.3	
Pre-oviposition period	14.3±1.9		11.8±1.9		12.5±1.7		11.8±1.4	
Post-oviposition period	12.6±2.1		11.3±1.5		13.5±1.0		11.3±1.8	
Fecundity (no.)	106.8±11.2		41.8±20.9		148.8±18.8		159.3±22.4	
Hatchability (%)	62.1±6.3		75.3±14.9		77.1±6.2		81.0±11.5	

(N=12)

The sex ratio (male: female) was 1: 1.02. Laboratory breeding experiments indicated that *R. longifrons* was a multivoltine species.

Influence of prey on development

The incubation period of *R. longifrons* reared on *H. armigera* larvae was 7.8 ± 1.5 days and it extended to 8, 8.1 ± 0.8 and 8.3 ± 1.1 days in *R. longifrons* reared on *C. cephalonica* larvae, *C. gibbosa* and *O. obesus*, respectively. The total developmental period of *R. longifrons* reared on *H. armigera* was 58.6 ± 2.2 days and it extended to 61.5 ± 3.9, 61.9 ± 2.5 and 72.7 ± 4.7days, respectively when reared *on C. cephalonica* larvae, *C. gibbosa* and *O. obsess.*

Adult longevity was longer when *R. longifrons* was reared on *H. armigera* larvae (114.87 ± 13.4 days) than when reared on *C. gibbosa* (104.9 ± 6.9 days), *O. obesus* (78.6 ± 12.0 days) or *C. cephalonica* larvae (66.8 ± 10.4 days). The maximum number of eggs per female was observed in *R. longifrons* reared on *H. armigera* larvae (159.3 ± 22.4). The fecundity decreased to 148.8 ± 18.8, 141.8 ± 20.8 and 116.5 ± 11.7 in *C. gibbosa, O. obesus* and *C. cephalonica* larvae reared *R. longifrons* (Table 2). The highest mortality in I instar was observed in those reared on *O. obesus* (34.4%) and the lowest on those reared on *H. armigera* larvae (18.3%). The mortality in II instar was significantly greater in those fed on *H. armigera* larvae than those fed on *O. obesus* and *C. gibbosa*. The III instar nymphs reared on *H. armigera* larvae had 5.4 ± 1.1 per cent mortality and it increased to (14.5%) and (16.1 ± 3.45) when reared on *C. gibbosa* and *O. obesus*, respectively.

However, the mortality in IV instar reared on *H. armigera* larvae was lesser (5.9 ± 2.72) than in the case of the reduviid nymphs reared on *C. gibbosa* (8.1%). *O. obesus* (11.2%) and *C. cephalonica* larvae (13.3 ± 7.1%). Similarly the mortality of V instar reared on *H. armigera* larvae (4.3% ± 0.9) was lesser than those reared on *C. cephalonica* larvae, *O. obesus* and *C. gibbosa* (9.3 ± 1.3%, 5.8 ± 0.5% and 4.6 ± 1.1, respectively). The per cent hatchability of *R. longifrons* was maximum in *H. armigera* larvae fed category (81.2 ± 11.5%), compared to those reared on *C. gibbosa* (77.1 ± 6.2%), *O. obesus* (75.3 ± 14.9) and *C. cephalonica* larvae (62.1 ± 6.3%) (Table 2). In addition, the mean post-oviposition period was shorter for predators reared on *H. armigera* larvae (11.8 ± 1.4 days) than those reared on *O. obesus* (11.8 ± 1.9 days), *C. gibbosa* (12.6 ± 1.7 days) and *C. cephalonica* larvae (14.3 ± 1.9 days). Besides, the female biased sex ratio was also higher in *H. armigera* larvae fed category than in *C. gibbosa, O. obesus* and *C. cephalonica* fed categories.

Variations in the quantity of nutrients of prey species appear to have considerable effect on the feeding efficiency and the reproductive potential of the predator (Beddington, 1975). The shortest nymphal period observed for *R.longifrons* reared on *H. armigera* and *C. gibbosa* might be due to the minimum stress experienced during predation because they could satiate themselves with less number of prey due to their comparatively larger size. Such prey-size influenced predation was observed in other predators. For example, eggs and the first two larval instars of the beet army worm proved to be inadequate food for the pentatomid predator, *Podisus maculiventris* (Say), however, the IV instar larva provided adequate nutrients for completing the life cycle of the predator (DeClercq and Degheele, 1994). Similar prey influenced development was observed in other reduviids (Ambrose, 1999).

There were significant differences in the mean nymphal period, adult longevity and fecundity of *R. longifrons* reared on *H. armigera* larvae as compared to *C. gibbosa, O. obesus* and *C. cephalonica* larvae reared categories. Similar results of prey influence were also reported in a predatory bug, *Canthecona furcellata* (Wolff.) when fed on *Clostera fulgurita* Walker, *Spodoptera litura* Fabr. and *Ergolis merione* (Cram.) (Ray and Khan, 2001).

The pre-reproductive delay, fecundity and hatching (%) of insect predators are determined by the nutrient composition of the prey species (Fuller, 1988). The egg laying potential, hatching success and longevity of adults were at their maximum when *R. longifrons* was reared on *H. armigera* larvae than when other prey species. Reduced level of pre-oviposition delay, oviposition period and fecundity of predator *Cheilomenes sexmaculata* (Fabr.) was observed on the eggs of ants than on its natural host *Aphis craccivora* (Koch) (Agarwala and Choudhuri, 1995). Shorter oviposition period was recorded for the anthocorid, *Cardiastethus nazarenus*, reared on the eggs of cottony cushion scale, *Icerya purchasi* Mask than on purple scale *Lapidosaphes beekii* (Newm.) and Mediterranean fruit fly, *Ceratitis capitata* (Wied) (Awadallah *et al.,* 1976). Female biased sex ratio observed in *R. longifrons* reared on all the prey species is in conformity with the earlier reports of Venkatesan *et al.* (1997) and George *et al.* (1998). Further studies on the biochemistry of repugnatorial glands of pest species will explain the mechanism of host-plant interaction and pest preference.

ACKNOWLEDGEMENTS

The authors are grateful to Rev. Dr. A. Antonysamy, S.J., for facilities, the DST (HR/OY/Z-13/98) New Delhi for the young scientist award (MAC) and TNSCST (BS.030031) Chennai (DPA) for financial assistance.

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