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Laboratory culture of early life stages of *Rhynocoris albopilosus*(F.) (Hemiptera: Reduviidae) using early life stages of Eri silkworm (Lepidoptera: Saturniidae)

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Development of early nymphal instars of a predator bug *Rhynocoris albopilosus* Signoret 1858 (Reduviidae: Harpactorinae) against first and second instar larvae of eri silkworm, *Samiacynthia ricini* Boisduval 1854 (Lepidoptera: Saturniidae) was investigated under laboratory condition. First-instar *R. albopilosus* nymphs were provided with larvae of eri silkworm as prey began feeding 6 to 12 hours after hatching and needed 8.67 days to complete their development (range 5-17 days), whereas second and third instar nymphs took 8.00 (range 4-10 days) and 6.67 (range 6-9 days) days respectively to complete their stadium. Observation reveals that first-instar *R. albopilosus* was not restrained from preying on siblings by kin recognition. Prey consumption was age specific and a higher number of preywas consumed on the fifth day of its first instar, third day in second instar and sixth day in third instar stadium of the predator. Nymphal survival was gradually declined from first instar to the third instar.

Keywords: Developmental period, predatory rate, reduviid predator, survival rate, *Samiacynthiaricini*

Le développement des premiers stadeslarvaires du prédateurd'insectesRhynocorisalbopilosusSignoret, 1858 (Reduviidae: harpactorinae) se nourrissant avec les premiers etdeuxièmesstadeslarvaires du ver à soie « eri », SamiacynthiariciniBoisduval, 1854 (Lépidoptères: Saturniidae) a étéétudiédans des conditions de laboratoire. Les larves de ver à soie « eri » ontétéfournies à des larves de premier stade de R. albopilosus qui ontcommencé à s'alimenter 6 à 12 heures après l'éclosion. Le premier stadelarvairedure, en moyenne, 8,67, alorsque les deuxièmesettroisièmesstadeslarvairesdurent, respectivement, 8,0 et 6,67 jours. L'observationrévèleque le premier stade R. albopilosusn'empêche pas la prédationsur les frères etsœurs par reconnaissance familiale. La consommation des proiesétaitspécifique à l'âgeet le nombre plus élevé de proiesconsomméesest le cinquième jour de son premier stade, le troisième jour du deuxièmestadelarvaire et la sixièmejournée du troisièmestadelarvaire du prédateur. La survie des nymphesa progressivementdiminué, passant du premier au troisièmestadelarvaire.
Mots-clés: Stade de développement, tauxprédateur, taux de survie, *Samiacynthiaricini*

1 INTRODUCTION

The Reduviidaeis a world–wide distributed predatory insect which comprise about 6, 300 described species; about 240 species have been described in India (Sahayaraj, 2012). All species are carnivorous, preying upon other invertebrates. Adults are either nocturnal or diurnal. The nocturnal species hide under bark or amongst foliage during daylight hours and emerge only during the night to seek their prey which usually consists of soft-bodied larvae, moths and bark – and foliage – dwelling insects. The diurnal predatory bugs usually inhabit flowers and foliage and attack flower–visitors, and insect pests.

The genus *Rhynocoris* counts about 150 species in the world fauna and belongs to the subfamily Harpactorinae. These species have been utilized by many scientists for pest management world-wide. *Rhynocoris albopilosus* Signoret 1858 (Reduviidae: Harpactorinae) is one of the common reduviid present in Africa (Kwadjo *et al.,* 2010; Lambert *et al.,* 2010). It is known to a common predator of *Dysdercus* spp. in cotton fields in Central Africa (Pierrard, 1972). In the Ivory Coast, *R. albopilosus* has been observed to attack *Dysdercus volkeri* Schmidt 1932 (Heteroptera: Pyrrhocoridae) and *Podagrica decolorata* Duvivier 1892 (Coleoptera: Chrysomelidae) on vegetables in crop fields and, therefore, may be considered an important natural enemy against pests in keeping their population low (Kwadjo*et al*., 2008). Later, Kwadjo *et al.* (2013) studied the biocontrol potential of this predator against *Tribolium castaneum* (Herbst 1797) (Coleoptera: Tenebrionidae) grubs under laboratory condition. However, a part of the general observations of Odhiambo (1959) and Hanney (1958) studied the life history of this species.

There is a need to mass rear the reduviid predator to supply and increase its population in the agro-ecosystems, a sense of urgency was proposed (Grundy & Maelzer, 2000; De Clercq *et al.,* 2014; Sahayaraj 2014). The balanced ratio between occurrence of the predator and herbivore infestation is important for the sound Integrated Pest Management (IPM) programme. Many factors have been regulating the development of reduviid predators (says Taylor & Schmidt, 1996). Among them, prey has an important role for the rearing of reduviid predator (Ambros *et al.,* 1991;Grundy *et al.,* 2000; Sahayaraj & Paulraj, 2001; Chandral *et al.,* 2005; Chandral & Sinazer, 2011). Eri silkworm *Samia cynthia ricini* (Jones) is an economically important specie, as its fiber is used in the textile industry and the pupae served as a delicacy. Though it has lots of economic value, no one has utilized it for rearing biological control agent like reduviid. Hence the experiment was undertaken with the following objectives: possibility of rearing early nymphal instars of *R. albopilosus* using early larvae of eri silkworm and find out nymphal developmental period of first, second and third nymphal instar of *R. albopilosus* against first and second instar larvae of eri silkworm; to record the food requirement and survival rate of early nymphal instars of *R. albopilosus* against eri silkworm.

2 MATERIAL AND METHODS

2.1 Environmental conditions

The study was conducted at the Crop Protection Research Centre, St. Xavier's College, Palayamkottai, Tamil Nadu, India. All insects rearing and experiments were carried out in an environmental controlled room temperature 29 ± 1°C, with a photoperiod of 11:13 (L:D) hour and 70-80% relative humidity, monitored with a hygrothermograph.

2.2 Insects culture

The reduviid predators used in the experiment were donated by Kwadjo, Nigeria from the stock-culture originally collected from cotton agro ecosystems of Ivory Coast, Africa. The predators were reared in small batches in plastic containers (12.5 cm diameter × 23.5 cm height) with a ventilated lid. The eri silkworm, *S. ricini*, larvae were provided daily as prey together with cotton ball saturated with water in a petri dish. *Samia cynthia ricini*, were reared in plastic troughs (15 × 23 × 8 cm) and were replenished daily. Individuals (first and second instar larvae) produced in this rearing system were used for experiments. Prior to the experiments, nymphs and adults were held in separate cages and fed *ad labium* with the *Corcyra cephaloinica* (Stainton, 1865). Nymphs were maintained under these conditions for 12 hours after molting to the 5th instar, while adults were equally maintained during 12–24 hours after their emergence, with diluted honey solution and without food.

2.3 Experimentation

Five newly hatched *R. albopilosus* were introduced into a plastic trough (15 x 14.5 cm) and placed in zig-zag folded paper for hiding. They were provided with equal proportion of first and second instar larvae of eri silkworm daily up to the completion of third instar larvae. First, second and third instar nymphs of *R. albopilosus* were provided with 10, 16 and 20 larvae daily respectively. Daily unfed larvae, molted skin, if any and dead reduviid were recorded and tabulated. For the data, individual nymphal developmental period, number of prey consumed by a predator per day, survival rate of individual nymphal instar were calculated.

2.4 Statistical analyses

All individual data were converted to mean and SE. Each individual instar data was subjected to one way ANOVA and Turkeys test and recorded df, F and P value using SPSS version 15.5.

3 RESULTS AND DISCUSSION

3.1 Food and feeding acts

Throughout the present studies, many observations on habits of this insect, such as capturing, killing and feeding have been made. Predatory acts were: approach – arousal – capturing – paralyzing – sucking the content of the prey – dropping the empty cases of the victim. Similar observation was recorded throughout the lifetime, both in nymphs and adults. However, the pattern and behaviors were slightly changed depending upon the type of prey encountered. A short summary of these follows. Adults and nymphs are attracted to prey by their movement. They approach a potential prey, quietly touching it gently with their antennae and then grabbing it with their front legs. Inserting its stylets into the softer parts of the victim, and injecting its venom. The prey is paralyzed within 0,1 to 5 minutes depending upon the age of both pest and predator. Feeding continues several minutes to hours during which the predator may change its feeding position to the head, thorax, or the abdomen.

3.2 Individual nymphal developmental period

Nymphal developmental period data (range, median and SE) collected for each early stadium of *R. albopilosus* are summarized in **Table 1**. Most of the first instar nymph took 5.0 days to complete their development. But it varied up to 17 days (**Figure 1**). However, in an average a predator took 8.67 days to complete its first stadium (df 6,137; F=142.541; P<0.0005). Second instar is the shortest nymphal stage than other instars. Most of the second instar nymphs took 8.00 days (**Figure 2**) to complete the stadium (df 3,38; F=21.11; P<0.0005), however, the developmental period ranged between 4 to 10 days.In an average, second instar nymphs took 7.74 days for their completion (**1**). Third instar predator took 6.67 days, but it was ranged between 6 to 9 days (df 3,39; F=25.791; P<0.0005). But most of the predators took 7 days (**Figure 3**) for completion of the development.

Table 1: Nymphal developmental period of *Rhynocoris albopilosus* during rearing with eari silkworm first and second instar larvae

Life stage of the predator	N	Range	Mean	Std. Error	df	F	Significance
First instar	218	5-17	8.62	0.21	6,137	142.541	0.0005
Second instar	144	4-10	7.74	0.13	6,137	267.862	0.0005
Third instar	42	6-9	6.67	0.11	2,39	25.791	0.0005

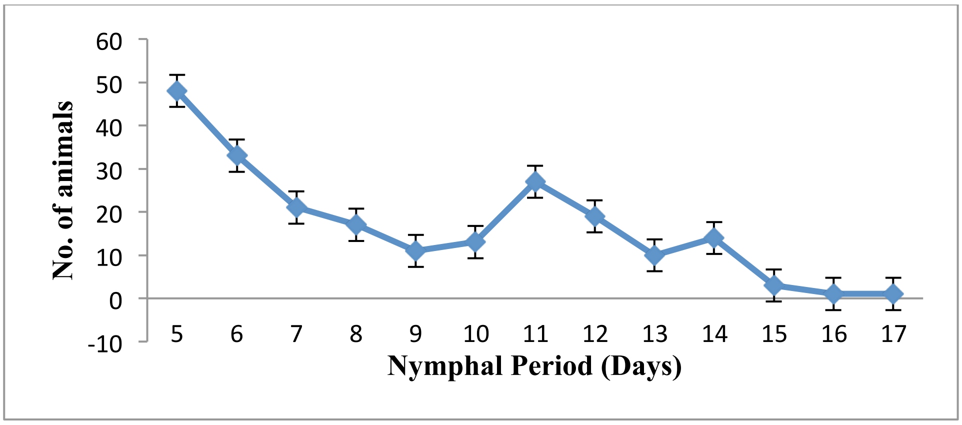

Figure 1: Number of days needed to complete the first nymphal instar of *Rhynocoris albopilosus* during rearing with ear silkworm first and second instar larvae.

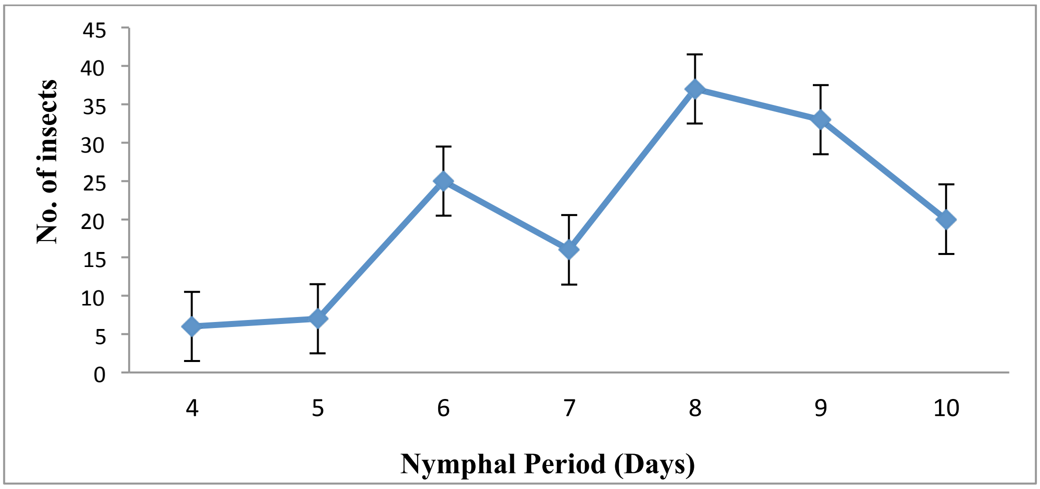

Figure 2: Number of days needed to complete the second nymphal instar of *Rhynocoris albopilosus* during rearing with ear silkworm first and second instar larvae.

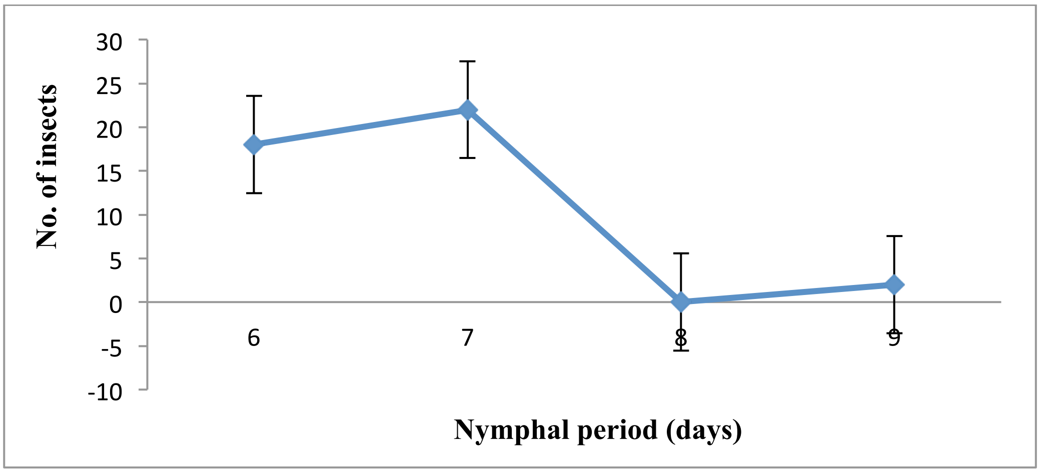

Figure 3: Number of days need to complete the third nymphal instar of *Rhynocoris albopilosus* during rearing with ear silkworm first and second instar larvae.

3.3 Survival rate

Of the 332 insects reared from first instar only 218 animals [range 36.36-80.00] (64.35%) attained in to second instar. Among them only 156 insects (71.56%) attained as third instar nymphs. However, only 26.92% predators were attained as fourth instar nymphs (**Table 2**).

Table 2: Number of ear silkworm first and second instar larvae consumed by early nymphal instar of *Rhynocoris albopilosus* during 24 hrs

Days after eclosion	Predator Life sages		
	Fist Stadium	Second Stadium	Third Stadium
1st	0.29±0.13	0.56 ±0.13	0.42±0.14
2nd	0.33±0.10	0.56 ±0.03	0.36±0.15
3rd	0.48±0.10	0.63±0.10	0.59±0.18
4th	0.65±0.07	0.54±0.16	0.41±0.01
5th	0.72±0.05	0.48±0.20	0.19±0.09
6th	0.69±0.13	0.34±0.21	0.78±0.21
7th	0.65±0.21	0.46±0.19	0.39±0.13
8th	0.55±0.13	0.26±0.09	0.38±0.21
9th	0.46±0.26	0.17±0.05	0.63±0.04
10th	0.64±0.03	0.75±0.03	
11th	0.17±0.06		
12th	0.19±0.03		
13th	0.23±0.02		
14th	0.26±0.01		
15th	0.03±0		
16th	0.15±0		
17th	0.57±0.03		

3.4 Predatory rate

Killed and or consumed preys were easily identified by seeing black colour at the pinning point and the consumed preys colour changed in to black. In first instar, peak prey consumption was recorded on the fifth day (0.72±0.05 preys / day / predator) after eclosion and minimum during fifteenth and sixteenth day. During second and third instar, peak prey consumption observed on the third day (0.63±0.10 preys / day / predator) and sixth day (0.78±0.21 preys / day / predator) respectively. Invariably just before the eclosion day, predator consumed more preys (0.57±0.03, 0.45±0.03 and 0.63±0.04 preys / day / predator) (**Table 2**). It is concluded that prey consumption gradually increased only up to certain period of time and after the physical development, predator consumed less number of preys, and again consume more number of preys' in order to meet their molting process.

4 DISCUSSION

Pierrard (1972) in his first reference to this insect stated "it is known as the common predator of *Dysdercus* spp. in cotton fields in Central Africa", and Kwadjo*et al*. (2008) gave a very brief

statement, "*R. albopilosus* attack *Dysdercus volkeri* and *Podagrica decolorata*on vegetable crops in crop fields". We recorded both nymphs and adults of *R. albopilosus* feeding on pest insects from Isoptera, Coleoptera, Hemiptera, Lepidoptera orders. The writer has had excellent success in rearing two successive generations of this insect on an artificial diet of meat, small and large larvae of *Corcyra cephalonica* (Stainton 1866) and adults of other insects like *Tribolium castaneum* and *Dysdercus cingulatus* (Fabricius 1775). Nymphs as well as adults of this insect were fed on cultured larvae and adults of the eri silkworm, when prey was scarce in the field during summer.
The process of capturing and killing the prey by this predator was similar to predatory reduviids (Sahayaraj, 2012, 2014; Javahery, 2013). Extensive feeding was observed during the pre-maturation stage. Cannibalism was observed in the nymphs and adult stage in the absence of prey. Additionally, first instar nymphs fed on other insects immature stages. This bug has not been known to be harmless to humans.
Nymphal development was similarly reported by Sahayaraj (2014) in his review. Survival rate of reduviid depends upon many factors: type of prey offered, nature of the prey, mobility of the prey, density of predators in rearing arena, stage of the predator etc. (Ambrose *et al.*, 1991; Sahayaraj, 2012). In the present study, we offered first and second instar eri silkworm larvae. Both of them are very tiny with minimum number of hairs. Mobility was not aggressive; as a result the predator did not face any problem to encounter its host larvae, this proved that some other factor govern the survival of the predator. It is evident from the data that predator feeding on their kin and siblings caused lot of mortality. Third instar nymphs were more aggressive for cannibalism that other nymphal instars tested in this experiment.

5 CONCLUSION

Though reduviids are distributed in many agro-ecosystems, many pest management professionalized have not been utilizing these group of predators because of then on-availability commercially. Commercial rearing is possible only with cheaper and easily available preys like eri silkworm. We tested the possible utilization of early eri silkworm for laboratory culture of early like stages of a predominant reduviid in cotton agro ecosystems of Ivory Coast, Africa. Results revealedthat first, second and third instar took 8.62, 7.74 and 6.67 days respectively by consuming 6.3, 4.3 and 3.6 preys during their individual stadium. This study paves the way for utilizing eri silkworm for rearing reduviid predators.

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