J. Biol. Control, 21(Special Issue): 73-78, 2007

Feeding preference of anthocorid predators for parasitized and unparasitized eggs of *Corcyra cephalonica* (Stainton) and *Helicoverpa armigera* (Hübner)*

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ABSTRACT: Laboratory studies were conducted to check the feeding preference of anthocorid predators, *Orius tantillus* (Motsch.) and *Blaptostethus pallescens* Poppius for unparasitized eggs of *Corcyra cephalonica* (Stainton) and *Helicoverpa armigera* (Hübner) and those parasitized by *Trichogramma chilonis* Ishii. In a no-choice situation, *O. tantillus* and *B. pallescens* nymphs devoured more than 90 per cent of the unparasitized *C. cephalonica* eggs provided and only 1.6 and 10 percent, respectively, of the parasitized eggs, while such a preferential feeding was not observed in adults. Given a choice of parasitized and unparasitized *C. cephalonica* eggs, nymphs and adults of both the species of anthocorids preferred to feed on unparasitised eggs. In the experiments with *H. armigera* eggs, the significantly higher preference the nymphal and adult stages of both anthocorid predators for unparasitized eggs, indicated that it may be possible to integrate releases of anthocorids and trichogrammatids for biololgical control of lepidopteran pests/ thrips in different crop ecosystems.

KEY WORDS: Anthocorid predators, *Blaptostethus pallescens*, feeding preference, lepidopteran pests, *Orius tantillus*, thrips, *Trichogramma chilonis*

INTRODUCTION

Orius tantillus (Motsch.) (Hemiptera: Anthocoridae) is a potential predator of thrips (Muraleedharan and Ananthakrishnan, 1978) and lepidopteran eggs and larvae (Sigsgaard and Esbjerg, 1997). Anthocorid predator, *Blaptostethus pallescens* Poppius has been identified as a potential biocontrol agent against lepidopteran eggs and larvae in maize ecosystem in Egypt (Tawfik and El Sherief, 1969; Tawfik and El-Husseini, 1971; Tawfik *et al.*, 1974) and in India (Muraleedharan, 1977; Jalali and Singh, 2002). It has also been identified as a potential biocontrol agent of maize aphid *Rhopalosiphum maidis* (Fitch), eggs and early instar larvae of *Spodoptera litura* (Fabricius) and *Helicoverpa armigera* (Hübner) and of sucking pests like cotton aphid *Aphis gossypii* Glover and cabbage aphid *Brevicoryne brassicae* (Linnaeus) (Ballal *et al.*, 2003). In India, trichogrammatids are widely used against several lepidopteran pests. *Trichogramma chilonis* Ishii is the most popularly used trichogrammatid, which is released primarily against one of the most notorious pests, *Helicoverpa armigera* infesting crops like cotton and tomato (Singh *et al.*, 1994).

Combined releases of parasitoids and predators have been found to be effective in managing pests of several crops. For instance, *Trichogramma principium* Sugonyaeu and Sorokina and *Chrysoperla carnea* (Stephens) against cotton bollworms in Syria (Adnan Babi *et al.*, 2002), *Trichogramma* sp. and *C. carnea* against *Heliothis* spp. on cotton in USA (Ridgway *et al.*,

* Part of Ph. D. thesis of the senior author

1973), *T. chilonis* and *C. carnea* against cotton bollworms and sucking pests in India (Singh, 1994). If we are planning combined releases of any two bio-agents, it is necessary to make sure that the two agents do not interfere with each other's performances. Trichogrammatids and anthocorid predators may have to be released simultaneously in integrated biocontrol programs against lepidopteran and sucking pests on different crops. This experiment was conducted as a prelude to combined field releases of anthocorids and trichogrammatids and the main objective was to find the feeding preference of two anthocorid predators for parasitized and un-parasitized lepidopteran eggs.

MATERIALS AND METHODS

Cultures of *Trichogramma chilonis*, *Corcyra cephalonica* and *Helicoverpa armigera* were obtained from the Mass Production Unit at the Project Directorate of Biological Control, Bangalore. *C. cephalonica* and *H. armigera* eggs were glued on cards and exposed separately to *T. chilonis* females in the ratio 30 eggs: 1 female parasitoid for 24 hours in 15x2.5 cm test tubes. *O. tantillus* and *B. pallescens* were cultured in the laboratory following the techniques developed by Ballal *et al.* (2003). Seven to eight day old nymphs and newly emerged adults of these anthocorid predators were used for the experiment. Experiments were conducted at 26 ± 2°C and 70 ± 3 percent relative humidity and 12 hours photoperiod.

1. Feeding preference for parasitized and un-parasitized *Corcyra cephalonica* eggs

a. No-choice test: In no-choice experiment, twenty 6-day-old parasitized (parasitized eggs turn black in colour when they are six days old and thus parasitism could be confirmed) and fresh un-parasitized *C. cephalonica* eggs were pasted on separate cards. Each card was kept separately in small-ventilated round jewel boxes (7.5cm diam and 2.5cm height). *O. tantillus* nymph (7 to 8-day-old) was introduced at the rate of one per jewel box. The same set-up was repeated with freshly emerged *O. tantillus* adult, *B. pallescens* nymph and adult.

The following treatments were set up under no-choice

T_1-20 Unparasitized *C. cephalonica* eggs + 1 *O. tantillus* nymph

T_2-20 Parasitized *C. cephalonica* eggs + 1 *O. tantillus* nymph

T_3-20 Unparasitized *C. cephalonica* eggs + 1 *O. tantillus* adult

T_4-20 Parasitized *C. cephalonica* eggs + 1 *O. tantillus* adult

T_5- 20 Unparasitized *C. cephalonica* eggs + 1 *B. pallescens* nymph

T_6- 20 Parasitized *C. cephalonica* eggs + 1 *B. pallescens* nymph

T_7- 20 Unparasitized *C. cephalonica* eggs + 1 *B. pallescens* adult

T_8- 20 Parasitized *C. cephalonica* eggs + 1 *B. pallescens* adult

Each treatment was replicated six times. Observations were recorded on the number of eggs devoured or damaged by each predator in 3 days to find out the predation level of anthocorid predators on parasitized and un-parasitized *C. cephalonica* eggs in a no-choice situation.

b. Choice test: In the choice test, twenty 6-day-old parasitized eggs and twenty fresh eggs of *C. cephalonica* were pasted on separate cards and kept together in small-ventilated round jewel boxes. One predator each (nymph or adult) of each anthocorid species was released into each jewel box with the parasitized and unparasitized eggs.

The following were the treatments under the choice test

T_1- 20 Unparasitized + 20 Parasitized *C. cephalonica* eggs + 1 *O. tantillus* nymph

T_2-20 Unparasitized + 20 Parasitized *C. cephalonica* eggs + 1 *O. tantillus* adult

T_3-20 Unparasitized + 20 Parasitized *C. cephalonica* eggs + 1 *B. pallescens* nymph

T_4- 20 Unparasitized +20 Parasitized *C. cephalonica* eggs +1 *B. pallescens* adult

Each treatment was replicated six times. Observations were recorded at the end of 3 days on the number of eggs damaged by each predator. Data were subjected to one-way ANOVA.

2. Feeding preference for parasitized and un-parasitized *Helicoverpa armigera* eggs

The same experimental methodology was followed as was followed in the feeding preference studies on *C. cephalonica* eggs. But, *H. armigera* eggs were used in the place of *C. cephalonica* eggs.

A. No-choice test

The following treatments were set up under no-choice

T_1- 20 Unparasitized *H. armigera* eggs + 1 *O. tantillus* nymph

T_2- 20 Parasitized *H. armigera* eggs + 1 *O. tantillus* nymph

T_3- 20 Unparasitized *H. armigera* eggs + 1 *O. tantillus* adult

T_4- 20 Parasitized *H. armigera* eggs +1 *O. tantillus* adult

T_5- 20 Unparasitized *H. armigera* eggs + 1 *B. pallescens* nymph

T_6- 20 Parasitized *H. armigera* eggs +1 *B. pallescens* nymph

T_7- 20 Unparasitized *H. armigera* eggs + 1 *B. pallescens* adult

T_8- 20 Parasitized *H. armigera* eggs +1 *B. pallescens* adult

B. Choice test

The following treatments were set up under choice test

T_1-20 Unparasitized + 20 Parasitized *H. armigera* eggs +1 *O. tantillus* nymph

T_2-20 Unparasitized +20 Parasitized *H. armigera* eggs +1 *O. tantillus* adult

T_3-20 Unparasitized +20 Parasitized *H. armigera* eggs +1 *B. pallescens* nymph

T_4- 20 Unparasitized + 20 Parasitized *H. armigera* eggs +1 *B. pallescens* adult

In both no-choice and choice experiments, each treatment was replicated six times. Observations were recorded at the end of 3 days on the number of *H. armigera* eggs damaged by the nymphal/adult stages of each predator. Data were subjected to one-way ANOVA.

RESULTS AND DISCUSSION

1. Preference of anthocorids for un parasitized and parasitized *C. cephalonica* eggs

i. *Orius tantillus*

a. No-choice test: When parasitized and un-parasitized eggs were provided separately to *O. tantillus* nymph, it devoured significantly more number of unparasitized (18.6 ± 0.6) than parasitized eggs (0.3 ± 0.3). However, there was no significant difference in the number of un-parasitized (5.5 ± 1.0) and parasitized (2.6 ± 0.9) eggs consumed by the adult stage (Table 1).

b. Choice test: When both parasitized and unparasitized eggs were provided together, *O. tantillus* nymph consumed 10.3 ±3.1 unparasitized eggs in 3 days and it totally avoided feeding on parasitized eggs (Table 1). Adult *O. tantillus* too showed a clear preference for un-parasitized eggs, the average number of unparasitized and parasitized eggs consumed being 5.4 ± 1.2 and 0.5 ± 0.2, respectively.

ii. *B. pallescens*

a. No-choice test: *B. pallescens* nymphs preferred to feed on un-parasitized eggs (19 ± 0.5) over parasitized eggs (2 ± 1.1). However, *B. pallescens* adults showed equal preference for parasitized and un-parasitized eggs, the number of eggs consumed being 7.3 ± 1.3 and 6.5 ± 1.3, respectively (Table 1).

b. Choice test: Given a choice, *B. pallescens* nymphs devoured 100 percent of the unparasitized eggs and only 6.6 percent of the parasitized eggs. Adults too had a greater preference for unparasitized eggs, which was evident from the fact that 93.5 percent of the un-parasitized eggs and only 29 percent of the parasitized eggs were consumed (Table 1). Daily observations of the nymphal and adult treatments revealed that the predator moved to the parasitized eggs and consumed a few of them only after it had totally exhausted the stock of unparasitized eggs provided.

The results clearly revealed that nymphs and adults of both the species of anthocorids preferred to feed on un-parasitized eggs of *C. cephalonica*, when the anthocorids had an opportunity to choose between un parasitized and parasitized eggs. In the no-choice test too, the nymphs had a greater preference for un parasitized eggs. However, the adults of both species showed equal preference for unparasitized and parasitized eggs in a no-choice situation. There are earlier reports of some predators consuming both parasitized and unparasitized eggs. Smith (1996) reported that generalist predators like *Orius*, *Geocoris* and *Nabis* could attack eggs parasitized by *Trichogramma* spp. leading to losses of up to 50 per cent of parasitized eggs in corn and 91 to 98 per cent in cotton. Larvae of *C. carnea* and *Chrysopa scelestes* Banks were observed to readily attack parasitised lepidopteran eggs (Al-Rouchedi and Voegele, 1981; Krishnamoorthy and Mani, 1985). On caged tobacco plants, *O. insidiosus* could consume both parasitized (by *Trichogramma pretiosum* (Riley)) and unparasitized eggs of *Heliothis virescens* (Fabricius) (Lingren and Wolfenbarger, 1976).

Anthocorid predators are generally reared on either their target hosts (primarily thrips in the case of *Orius* spp.) or alternate laboratory hosts like *E. kuehniella*, *C. cephalonica* and *Sitotroga cerealella* (Ol.) (Alauzet *et al.*, 1992; Ballal *et al.*, 2003). *O. tantillus* and *B. pallescens* are being multiplied in our laboratory utilizing un parasitized *C. cephalonica* eggs. The results of the present study indicate that the adult stages of both anthocorids could feed well on parasitized *C. cephalonica* eggs in the absence of unparasitized eggs. Generally, five-day-old parasitized *Trichogramma* egg cards are shipped for field releases. Hence, an aspect that needs to be further investigated is regarding the possibility of using the un-utilized parasitized eggs for feeding the anthocorid adults. However, the effect of such feeding on the longevity, fecundity and other biological parameters of the anthocorids needs to be investigated.

2. Preference of anthocorids for un-parasitized and parasitized *H. armigera* eggs

i. *O. tantillus*

a. No-choice test: *O. tantillus* nymphs consumed significantly more number of unparasitized *H. armigera* eggs (9.3 ± 0.6) in comparison to parasitized eggs (0.3 ± 0.3). However, the adults consumed only unparasitized eggs (8 ± 1.5 in 3 days) and totally rejected the parasitized eggs (Table 2).

b. Choice test: When *O. tantillus* nymph had access to un-parasitized and parasitized eggs, the predator consumed 51.6% of the un-parasitized eggs and only a negligible quantity (1.6%) of the parasitized eggs. A similar trend with higher preference for unparasitized eggs was observed in the case of adult, the number of unparasitized and parasitized eggs consumed being 5.6 ± 0.8 and 0.6 ± 0.3, respectively.

ii. *B. pallescens*

a. No-choice test: When only un-parasitized *H. armigera* eggs were provided as feeding, *B. pallescens* nymph and adult fed 100 and 83.3 percent of the eggs provided, respectively, in 3 days. However, when only parasitized *H. armigera* eggs were offered to the nymph and adult, a very small percentage (1.6 and 3.3 percent, respectively) of the eggs provided were consumed (Table 2).

b. Choice test: The greater preference that *B. pallescens* nymph and adult had for un-parasitized *H. armigera* eggs was also evident in the choice test, wherein the average consumption by the nymph on un-parasitized and parasitized eggs was 13±4.4 and 0.7±0.3, respectively, and 13±1.7 and 0.7±0.3, respectively, by the adult (Table 2). Non-preference to parasitized eggs has been reported in the case of several predators. The predatory pentatomid, *Podisus maculiventris* (Say) showed a greater preference to unparasitized eggs of *E. kuehniella* than those parasitized by *Trichogramma brassicae* Bezdenko (Oliveira *et al.*, 2004), thus indicating the feasibility of combined releases of *P. maculiventris* and *T. brassicae* in bio-control programs. Coccinellid predators like *Axinoscymnus puttarudriahi* Kapur and Munshi and *Cybocephalus* sp. avoided feeding on nymphs of *Aleurodicus disperus* Russell parasitized by *Encarsia guadeloupae* Viggiani (Ramani and Bhumannavar, 2004). *H. zea* eggs parasitised by *T. pretiosum* were not accepted by *Chrysoperla externa* (Hagen) (Ciociola-junior *et al.*, 1998). Anthocorid predators *Xylocoris flavipes* (Reuter) and *O. insidiosus* had a greater preference for unparasitized host eggs in comparison to those parasitized by *T. pretiosum* (Brower and Press, 1988; Ruberson and Kring, 1991). The present study revealed that both the anthocorids under investigation, *O. tantillus* and *B. pallescens* preferred to predate on unparasitised eggs in comparison to parasitized eggs. There is a need to further investigate the exact reasons for the non-acceptance of parasitized eggs by the anthocorid predators. It would also be useful to study the effect of age of the parasitized eggs on the feeding preference of *O. tantillus* and *B. pallescens*. Before making combined releases of a predator and a parasitoid, it is very important to understand the two directional interactions, which should include not only the possibility of predator feeding on the parasitized eggs, but also the parasitoid parasitizing the predator eggs. The results of the present study give an indication that combined releases of *O. tantillus* / *B. pallescens* with *T. chilonis* may be feasible. But, before attempting field releases, more detailed investigations are required on the above-mentioned aspects.

Table 1. Feeding preference of anthocorid predators on eggs of *C. cephalonica*

Anthocorid predator	No-choice test			Choice test		
	Mean (±SEM) number of eggs consumed					
	Un parasitized	Parasitized	CD (P≤0.05)	Un parasitized	Parasitized (P≤0.05)	CD
O. tantillus nymph	18.6 ± 0.6 (93.3) *	0.3 ± 0.3 (1.6)	1.8	10.3 ± 3.1 (51.6)	0.0 (0.0)	8.8
O. tantillus adult	5.5 ± 1.0 (27.5)	2.6 ± 0.9 (13.3)	NS	5.4 ± 1.2 (27.7)	0.5 ± 0.2 (2.7)	2.7
B. pallescens nymph	19 ± 0.5 (95.0)	2 ± 1.1 (10.0)	3.5	20 ± 0.0 (100)	1.3 ± 0.3 (6.6)	0.9
B. pallescens adult	6.5 ± 1.3 (32.5)	7.3 ± 1.3 (36.6)	NS	18.7 ± 0.4 (93.5)	5.8 ± 2.1 (29.0)	4.5

*Values in parentheses are % eggs consumed

Table 2. Feeding preference of anthocorid predators on eggs of *H. armigera*

Anthocorid predator	No-choice test			Choice test		
	Mean (±SEM) number of eggs consumed					
	Un parasitized	Parasitized	CD (P≤0.05)	Un parasitized	Parasitized (P≤0.05)	CD
O. tantillus nymph	9.3 ± 0.6 (46.6) *	0.3 ± 0.3 (1.6)	2.0	10.3 ± 2.1 (51.6)	0.3 ± 0.3 (1.6)	6.1
O. tantillus adult	8 ± 1.5 (40.0)	0.0 (0)	4.2	5.6 ± 0.8 (28.3)	0.6 ± 0.3 (3.3)	2.6
B. pallescens nymph	20 ± 0.0 (100)	0.3 ± 0.3 (1.6)	0.9	13 ± 4.4 (65.0)	0.7 ± 0.3 (3.3)	12.1
B. pallescens adult	16.6 ± 1.6 (83.3)	0.6 ± 0.3 (3.3)	6.7	13 ± 1.7 (65.0)	0.7 ± 0.3 (3.3)	4.8

*Values in parentheses are % eggs consumed

ACKNOWLEDGEMENTS

The authors are grateful to the Project Director, Project Directorate of Biological Control, Bangalore, for providing the research facilities. They are also thankful to Mr. C. Bharathidasan (T-6) and Mr. P. Raveendran (T-3) for the supply of insect cultures as per need.

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