

NYMPHAL DEVELOPMENT AND FEEDING PREFERENCE
OF *Podisus maculiventris* (HETEROPTERA: PENTATOMIDAE)
ON EGGS OF *Ephestia kuehniella* (LEPIDOPTERA:
PYRALIDAE) PARASITISED OR NOT BY *Trichogramma
brassicae* (HYMENOPTERA: TRICHOGRAMMATIDAE)

OLIVEIRA, H. N.,^{1,3,4} DE CLERCQ, P.,² ZANUNCIO, J. C.,¹
PRATISSOLI, D.³ and PEDRUZZI, E. P.³

¹Departamento de Biologia Animal/BIOAGRO, Universidade Federal de Viçosa, CEP 36571-000,
Viçosa, Minas Gerais, Brazil

²Department of Crop Protection, Ghent University, Ghent, Belgium

³Laboratório de Entomologia, Departamento de Fitossanidade, Centro de Ciências Agrárias da Universidade Federal
do Espírito Santo, CEP 29500-000, Alegre, Espírito Santo, Brazil

⁴Bolsista PROFIX do CNPq-Brazil

Correspondence to: Harley Nonato de Oliveira, Departamento de Fitotecnia, Centro de Ciências Agrárias da UFES,
CEP 29500-000, Alegre, Espírito Santo, Brazil, e-mail: hnooliveira@insecta.ufv.br

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ABSTRACT

Predation by *Podisus maculiventris* nymphs, a predatory pentatomid, was evaluated with eggs of the flour moth *Ephestia kuehniella* (Pyralidae), parasitised or not by *Trichogramma brassicae* (pupae stage). Eggs of this pyralid were glued on rectangular cardboard and presented to nymphs of *P. maculiventris* as food. The pentatomid successfully reached adult stage when feeding on unparasitised eggs, indicating that flour moth eggs can be used as a factitious food for rearing this predator. Pentatomid nymphs that received only parasitised eggs died before reaching fourth instar. In choice tests, *P. maculiventris* showed a preference for preying on unparasitised eggs of *E. kuehniella* rather than those containing pupae of *T. brassicae*. These results show that it is possible to combine the use of *P. maculiventris* with releases of *T. brassicae* in control programs of lepidopteran pests.

Key words: *Trichogramma*, predator, feeding preference.

RESUMO

Desenvolvimento ninfal e preferência alimentar de *Podisus maculiventris* (Heteroptera: Pentatomidae) em ovos de *Ephestia kuehniella* (Lepidoptera: Pyralidae) parasitados ou não por *Trichogramma brassicae* (Hymenoptera: Trichogrammatidae)

Avaliou-se a predação de ninfas de *Podisus maculiventris* sobre ovos de *Ephestia kuehniella* parasitados (em fase de pupa) ou não por *Trichogramma brassicae*. Esses ovos foram colados em cartelas retangulares e oferecidos às ninfas de *P. maculiventris* como alimento. Esse Pentatomidae só atingiu a fase adulta quando se alimentou de ovos não parasitados desse Pyralidae, indicando que os mesmos podem ser usados como hospedeiro alternativo para criação desse predador. Ninfas de *P. maculiventris* que receberam ovos parasitados morreram antes do quarto estágio. Em teste de escolha, ninfas desse predador mostraram preferência por ovos não parasitados em vez de por aqueles parasitados que continham em seu interior uma pupa de *T. brassicae*. Esses resultados mostram que é possível associar o uso de *P. maculiventris* com liberações de *T. brassicae* em programas de controle de lepidópteros pragas,

Palavras-chave: *Trichogramma*, predador, preferência de alimentação.

INTRODUCTION

Pentatomid predators including species of the genus *Podisus* are natural enemies of many insect pests in North America (McPherson, 1980; De Clercq, 2000), Costa Rica, Panama, Peru and Bolivia, Argentina (Thomas, 1992), and Brazil (Zanuncio *et al.*, 1994, 2001; Torres & Zanuncio, 2001). In South America, the beneficial action of these natural enemies has been reported in plantations of *Eucalyptus* (Zanuncio *et al.*, 2000, 2001) and in many agricultural crops such as coffee (Gravena & Lara, 1982), and cashew (Silva, 1965), and passion fruit (Costa Lima, 1940). Predatory Pentatomidae are important agents in biological control of defoliating caterpillars and other insects either through natural occurrence or in programmed releases (Zanuncio *et al.*, 1994; De Clercq, 2000). However, success of biological control depends on a good knowledge of the interaction between predatory Pentatomidae and other natural enemies present in a crop.

Pentatomid predators prefer to attack soft bodied and slow moving insects such as Lepidoptera, Coleoptera, and Hymenoptera larvae but they can also attack individuals of other orders in different developmental stages, including eggs (McPherson, 1982; Schaefer, 1996; De Clercq, 2000). Nymphs of *P. maculiventris* have been reported as preying on eggs of *Epilachna varivestis* Mulsant, 1850 (Coleoptera: Coccinellidae) (Waddill & Shepard, 1975), *Leptinotarsa decemlineata* (Say, 1824) (Coleoptera: Chrysomelidae) (Hough-Goldstein & McPherson, 1996), *Helicoverpa zea* (Boddie, 1850) (Lepidoptera: Noctuidae) as well as *Heliothis virescens* (Fabr., 1781) (Lepidoptera: Noctuidae) (Lopez *et al.*, 1976), *Spodoptera exigua* (Hübner, 1808) (Lepidoptera: Noctuidae) (De Clercq & Degheele, 1994), and *Chrysodeixis chalcites* (Esper, 1789) (Lepidoptera: Noctuidae) (De Clercq *et al.*, 1998).

Generalist predators like *Orius*, *Geocoris*, and *Nabis* can attack lepidopteran eggs parasitised by *Trichogramma* spp. with losses up to 50% in corn and 91% to 98% in cotton (Smith, 1996), but predation by *Podisus* on parasitised eggs has not yet been reported. Anthocorid predators are more likely to accept unparasitised host eggs than those containing pupae of *Trichogramma*, although younger stages of *Trichogramma* are equally susceptible (Brower & Press, 1988). *Trichogramma* and *Podisus* may have potential for being used simultaneously in biocontrol

programs against lepidopteran pests but interactions between these natural enemies need to be addressed. The objective of the current research was to study feeding preference, development rate, and survival of nymphs of *P. maculiventris* reared with eggs of the flour moth *Ephestia kuehniella* (Zeller, 1879) (Lepidoptera: Pyralidae), parasitised or not by the parasitoid *Trichogramma brassicae* (Bezdenko, 1968) (Hymenoptera: Trichogrammatidae). Since *Trichogramma* have been released in host eggs containing pupae near hatching (Pinto & Parra, 2002), we used seven- to eight-day-old eggs of *E. kuehniella* with pupae parasitoids.

MATERIALS AND METHODS

This study was carried out in the Laboratory of Agrozoology, Department of Crop Protection, Ghent University, Belgium. All experiments were done at $23 \pm 1^\circ\text{C}$, relative humidity of $75 \pm 5\%$, and 16 h photophase. Nymphs of *P. maculiventris* were taken from a colony maintained in the Laboratory of Agrozoology; eggs of *E. kuehniella* parasitised or not by *T. brassicae* were obtained from Koppert Biological Systems, Berkel en Rodenrijs, The Netherlands. Parasitised eggs of *Ephestia* containing seven to eight-day-old parasitoids (i.e., pupae) were kept in a refrigerator at $4\text{--}6^\circ\text{C}$ for a maximum of seven days to avoid further development of the parasitoid.

In a first experiment, one-day-old second instar nymphs of *P. maculiventris* were placed in individual 9.2×1.5 cm Petri dishes with a slice of green bean for water supply. In the first treatment, 10 nymphs of the predator were fed *ad libitum* with eggs of *E. kuehniella* parasitised by *T. brassicae*; in the second treatment, 10 nymphs received unparasitised eggs of the pyralid. Lepidopteran eggs were glued on rectangular cardboards and fresh eggs were provided every 24 hours as needed. Duration of each instar and survival of *P. maculiventris* were monitored.

In a second experiment, 10 nymphs of *P. maculiventris*, in the first day of the second instar, were placed in 5.0×1.8 cm Petri dishes and kept during 24 hours without prey and with a slice of green bean for water supply. After this period, nymphs of this predator received, at the same time, two white cardboards of similar size (2.0×0.5 cm). The first cardboard had glued unparasitised eggs of *E. kuehniella*; the other contained eggs of *E. kuehniella* parasitised by *T. brassicae*. Observations were made up to 120 minutes after starting the

experiment to evaluate preference of *P. maculiventris* feeding.

An olphactometer was not used in these tests because this methodology does not permit the evaluation of feeding change on parasitised and unparasitised eggs of *E. kuehniella* by *P. maculiventris* over time.

Data from both experiments were submitted to analysis of variance; means were compared with the test of Wilcoxon with a 5% probability level.

RESULTS

The duration of the second instar of nymphs of *P. maculiventris* in the first experiment (4.4 days) was significantly shorter when they were fed with

unparasitised than parasitised eggs of *E. kuehniella* (6.0 days); it was 4.90, 4.25, and 6.62 days for the third, fourth, and fifth instars, respectively, when fed on unparasitised eggs (Table 1). Survival of *P. maculiventris* in the second instar was similar with eggs of *E. kuehniella* parasitised or not by *T. brassicae*. However, all nymphs of *P. maculiventris* fed on parasitised eggs died during the third instar.

In the second experiment, nymphs of *P. maculiventris* did not show any preference at the first attack for parasitised or unparasitised eggs of *E. kuehniella* glued on the rectangular cardboard. However, nymphs of this predator were seen in about 80% of the cases feeding on unparasitised eggs from 15 minutes after the start and up to the end of the experiment (Table 2).

TABLE 1
Development time in days (D) and percentage of nymph survival (S) of *Podisus maculiventris* fed on eggs of *Ephestia kuehniella* parasitised (T1) or not (T2) by *Trichogramma brassicae* at 23 ± 1°C, relative humidity of 75 ± 5% and a 16 h photophase.

Treatment	Second instar		Third instar		Fourth instar		Fifth instar	
	D	S	D	S	D	S	D	S
T1	6.00a	80a	–	0	–	0	–	0
T2	4.40b	100a	4.90	100	4.25	80	6.62	100

Means at the same column followed by the same letter do not differ by the test of Wilcoxon at 5% probability level.
– All nymphs died during the third instar.

TABLE 2
Predation by *Podisus maculiventris* on eggs of *Ephestia kuehniella* parasitised (T1) or not (T2) by *Trichogramma brassicae* in a choice test at 23 ± 1°C, relative humidity of 75 ± 5% and 16 h photophase.

Characteristic	T1	T2
First prey attacked (%)	36.8a	63.2a
Prey attacked (%) at different time intervals (min)		
15	23.5b	76.5a
30	23.5b	76.5a
45	17.6b	82.4a
60	23.5b	76.5a
75	16.7b	83.3a
90	18.7b	81.3a
105	14.3b	85.7a
120	7.1b	92.9a

Means within a row followed by the same letter do not differ by the test of Wilcoxon at 5% probability level.

DISCUSSION

The development period from second instar to adulthood of *P. maculiventris* with unparasitised eggs of *E. kuehniella* (20.2 days) was similar to that reported for this predator when fed with larvae of *Galleria mellonella* (L., 1758) (Lepidoptera: Pyralidae) (De Clercq & Degheele, 1992) and *S. exigua* (De Clercq & Degheele, 1994), which are considered good prey for this predator. Furthermore, 80% of nymphs successfully reached adult stage when exclusively fed on unparasitised *E. kuehniella* eggs. These findings suggest that flour moth eggs can be used as a factitious food to rear *P. maculiventris*.

The duration of second instar was prolonged by 36% when nymphs of *P. maculiventris* were fed with parasitised flour moth eggs, reflecting the poor quality of this diet. Nymphs of this predator showed high survival in the second instar with parasitised eggs of *E. kuehniella* but all of them died during third instar. This indicates that eggs with *T. brassicae* pupae do not constitute an adequate food for *P. maculiventris*.

In a choice situation, second-instar nymphs of *P. maculiventris* did not show a clear preference for either parasitised or unparasitised eggs at the first attack, but a significant difference was found after fifteen minutes when most predators were observed feeding on unparasitised eggs. Thereafter, predators were seen feeding on unparasitised eggs in 80% of the cases. This finding suggests that parasitised eggs of *E. kuehniella* were rejected by *P. maculiventris* after initial feeding, a preference which may be due to the fact that eggs of this Lepidoptera with pupa of *Trichogramma* have reduced acceptability by this predator. The predator *Xylocoris flavipes* (Reuter, 1875) (Heteroptera: Anthocoridae) preferred unparasitised host eggs to those containing pupae of the parasitoid *Trichogramma pretiosum* Riley, 1879, but host eggs containing parasitoids in earlier development phases were as susceptible to predation as unparasitised eggs (Brower & Press, 1988). *Orius insidiosus* (Say, 1832) (Heteroptera: Anthocoridae) showed a similar attack rate on parasitised or unparasitised eggs of *H. virescens* and degree of parasitization by *T. pretiosum* through consumption of their eggs was directly influenced by population density of this predator (Lingren & Wolfenbarger, 1976). Thus, the outcome of interaction between *P. maculiventris* and egg parasitoids of the genus *Trichogramma* may depend on developmental stage of the parasitoid.

It is important to understand predation by arthropod predators on host eggs parasitised by *Trichogramma* spp. because loss of these eggs in augmentative releases of *Trichogramma* may reach 50% in corn (Yu & Byers, 1994) and from 91% to 98% in cotton (Jones *et al.*, 1977). The findings of the current study suggest that *P. maculiventris* can be used in combination with releases of parasitoid wasps of the genus *Trichogramma* provided that the eggs of the lepidopteran host contain pupae of the parasitoid. However, further evaluation is recommended of feeding behavior of this and other predators when presented with eggs of different hosts containing parasitoids of different ages.

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