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# Aspects of Reproductive Biology of *Delphastus pusillus*, A Coccinellid Predator of Glasshouse Whitefly, *Trialeurodes vaporariorum*

K.S. Hemachandra and M.J.W. Copland[1]

Department of Agricultural Biology
Faculty of Agriculture
University of Peradeniya
Peradeniya.

***ABSTRACT.*** *Fecundity, oviposition rate, longevity and influence of copulation and population density on oviposition were examined in Delphastus pusillus (Leconte) to assess its suitability as a biological control agent of Trialeurodes vaporariorum (Westwood). Adults fed either on eggs or nymphs of T. vaporariorum showed no significant difference in their longevity, fecundity, and oviposition rate. Females were oviposited throughout their adult life. Since D. pusillus was synoovigenic, copulation was a prerequisite for oviposition. Increased population density suppressed oviposition and the development of eggs. Overall findings of this study revealed the potential of D. pusillus as a biological control agent of T. vaporariorum.*

## INTRODUCTION

Glasshouse whitefly, *Trialeurodes vaporariorum* (Westwood) is one of the key pests of vegetables and ornamentals, and has become an increasing problem in outdoor plants in tropical environments (Elhag and Horn, 1983; Johnson *et al.*, 1992; Fransen and Lenteren, 1993). Damage caused is due to the insect feeding on plant sap and production of honeydew (Byrne *et al.*, 1990). Management of glasshouse whitefly is mainly through the use of pesticides and the parasitoid, *Encarsia formosa* Gahan. Control of this pest has become difficult due to the development of resistance by the insect to pesticides. Multiple application of pesticides has become necessary (Elhag and Horn, 1983). Furthermore, *E. formosa* has become less effective at high population densities of whitefly and at low temperatures (Albert, 1990). Hoelmer *et al.* (1993) suggested that *Delphastus pusillus* (Leconte) is a

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[1] Wye College, University of London, Wye, Ashford, Kent TN25 5AH, UK.

potential coccinellid predator to be used in the biological control of *Bemicia tabaci* (Gennadius) and that it also preyed on many species of whiteflies including those in the genus *Trialeurodes*. Effective biocontrol agents of insect pests must have a high potential increase rate which is expressed in terms of fecundity (Bach, 1964; Emden, 1966). This study examined the aspects of fecundity and longevity of *D. pusillus* when feeding either on eggs or nymphs ($N_2$ and $N_3$) of the glasshouse whitefly to assess its suitability as a biocontrol agent.

## MATERIALS AND METHODS

Newly emerged (one day old) *D. pusillus* were obtained for experiments from previously collected pupae from a parent culture. The parent culture was established with a sample received from Applied Bionomics, Canada; and the coccinellids were maintained on the glasshouse whitefly on tobacco (*Nicotiana tobacum cv.* White Burley) at 26°C.

Copulation is considered as one of the prerequisites for oviposition of *D. pusillus*. This hypothesis was examined by dissecting females (n=10) with 4 different histories (a-d) maintained on excess eggs of *T. vaporariorum* : (a) 1 day old females (b) 10 day old females allowed to copulate (c) 10 day old females not allowed to copulate (d) 17 day old females allowed to copulate 10 days after emergence. Females were observed daily for oviposition and egg development on dissection.

Fecundity and longevity of *D. pusillus* were examined by caging females in petridishes (9 cm diam.). Copulation was ensured by caging one female with two males in the petridish and one male was removed after the female had started oviposition. Coccinellids were fed either on excess eggs or nymphs ($N_2$ and $N_3$) of *T. vaporariorum* and oviposition was recorded daily (n=13).

Influence of population density on oviposition and egg development of *D. pusillus* were next examined. Newly emerged, mated females (4 days old) were caged in petridishes as 1, 2, 4, 8 and 15 females per petridish ($n \geq 4$) and were maintained for 16 days on excess eggs of *T. vaporariorum*. Subsequently, 10 females were selected randomly to be dissected and examined for development of eggs. Another group of newly emerged, mated females (4 days old) were maintained at population densities of 1, 2, 4, 8, 12 and 20 females per petridish (n=4) for 14 days on excess eggs of *T. vaporariorum*. Those coccinellids were observed daily for oviposition.

Experiments were conducted at 26°C, 50% RH, 18L:6D at Wye College, University of London, UK. Dissection of coccinellids and counting of coccinellid eggs were done under a dissecting microscope (10 X 4). The data were analysed using Mann-Whitney test in Minitab.

## RESULTS AND DISCUSSION

*D. pusillus*, a coccinellid predator of whitefly belongs to the tribe Seranginii (Hoelmer *et al.*, 1993). Newly emerged beetles were less pigmented, but later became shiny black with a body length of 1.3-1.4 mm. The head of the male was orange and that of the female was black. Females laid eggs singly, mostly along the veins of leaves, among the eggs or nymphs of the glasshouse whitefly. Eggs are creamy white and 0.5 mm (mean) long. The larva is pale yellowish white.

Examination of females with different histories by dissection and microscopic examination showed the necessity for copulation to initiate oviposition. Ovarioles of newly emerged beetles did not have any mature or immature eggs. Both mated and virgin females possessed mature eggs (3.0±0.6 and 1.5±0.4 eggs/female) and immature eggs, (6.6±0.8 and 5.3±1.0 eggs/female) respectively. This indicated that eggs developed irrespective of copulation. Only in mated females, oviposition began 4-5 days after emergence with the deposition of 4.9±0.6 eggs/female/day. Females that were allowed to mate 10 days after emergence oviposited subsequently. Development of eggs and oviposition in insects are influenced by many factors, mainly the physiological condition of the insect, food and environment factors (Davey, 1980 and 1985). A mated female releases a neuro secretary myotropin from the pars intercerebralis, the release of which leads to oviposition. Failure to release the hormone leads to retention of the eggs in the ovary and the release of an antigonadotropin which antagonises the action of the juvenile hormone on the follicle cells (Davey, 1980).

*D. pusillus* is known to have great potential as a biocontrol agent of *B. tabaci* due to its high reproductive rate (Bellows *et al.*, 1992). *D. pusillus* showed the ability to survive and reproduce when fed either on eggs or nymphs ($N_2$ and $N_3$) of *T. vaporariorum*. The mean realized lifetime fecundity of *D. pusillus* fed on eggs and nymphs of *T. vaporariorum* were 322.7±23.5 and 343±33.8, respectively. The mean daily oviposition rate per female for females fed on eggs and nymphs of *T. vaporariorum* were 4.2±0.4 and 5.0±0.4 eggs, respectively. These values were not significantly different. Oviposition of *D. pusillus* at quarterly basis of lifetime indicated continuous oviposition through out life (Figure 1). However, significantly low fecundity at the 4th quarter of the beetles fed on whitefly eggs was observed. Highest oviposition was observed in the second quarter of life of the females fed on whitefly nymphs. Hoelmer *et al.*, (1993) studied the reproductive behaviour of *D. pusillus* fed on *B. tabaci* where the mean total fecundity was 183.2±88.9 eggs. Daily mean oviposition in the first and second half of *D. pusillus* life had been reported as 1.82 and 1.67 eggs/day/female (Hoelmer *et al.*, 1993). The results of this study gave a fecundity of 5.2 and 2.8 eggs/day/female in the firdt and second halves of *D. pusillus* life, respectively when fed on eggs of glasshouse whitefly *T. vaporariorum*. This indicated the prevalence of a high reproductive potential of *D. pusillus* fed on eggs of glasshouse whitefly.

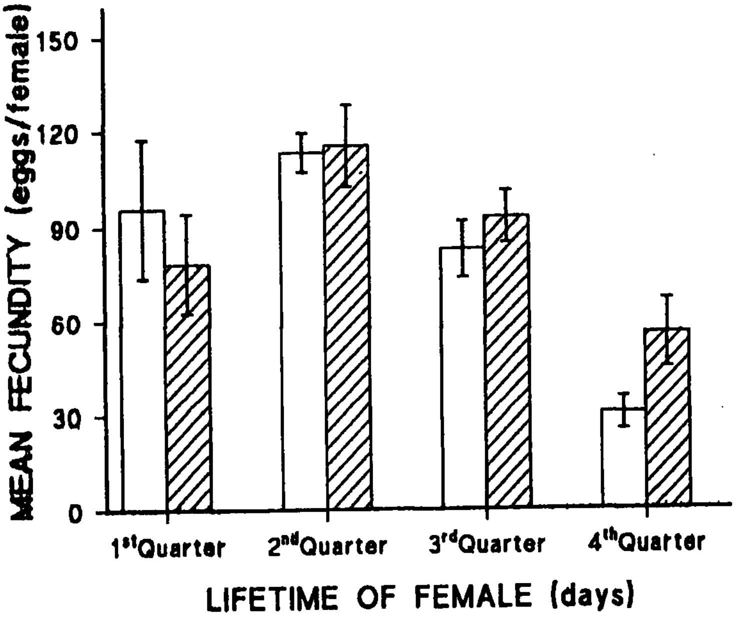

Figure 1. **Fecundity of *Delphastus pusillus* during each quarter of its lifetime when kept with males and fed on eggs (n=13) or nymphs ($N_2$ and $N_3$ (n=13) of *Trialeurodes vaporariorum*.**

The longevity of the females fed on eggs and nymphs of *T. vaporariorum* was 79.3±7.1 and 71.4±9.4 days respectively. There was no significant difference in longevity between the two groups. Adult, female longevity of *D. pusillus* had been recorded as 50 days when fed on *B. tabaci* (Hoelmer and Osborne, 1990). The females successfully reproduced when fed on nymphs ($N_2$ and $N_3$) of *T. vaporariorum* confirming the suitability of *T. vaporariorum* as host. *D. pusillus* had not reproduced when fed on nymphs of *B. tabaci* (Hoelmer *et al.*, 1993). In this study, *D. pusillus* showed a reduction in the number of developed eggs and oviposition at higher population densities of females. Egg development in females was significantly suppressed at the population density of 15 females per dish, which was the highest population density examined for eggs development (Figure 2). Oviposition was lowest in females held at the highest population density of 20 females per dish (Figure 3).

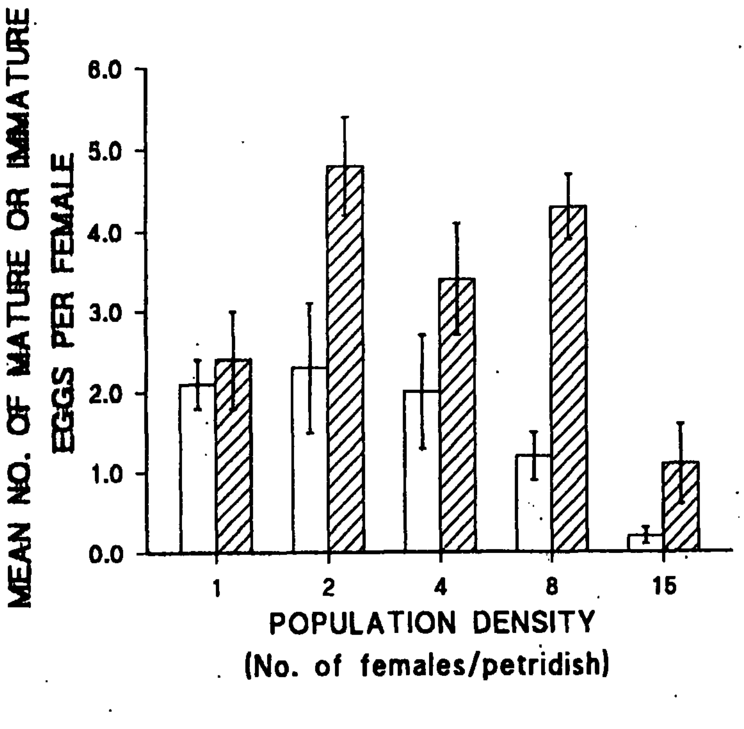

**Figure 2.** **Number of mature and immature eggs in *Delphastus pusillus* females 20 days after emergence at different population densities.**

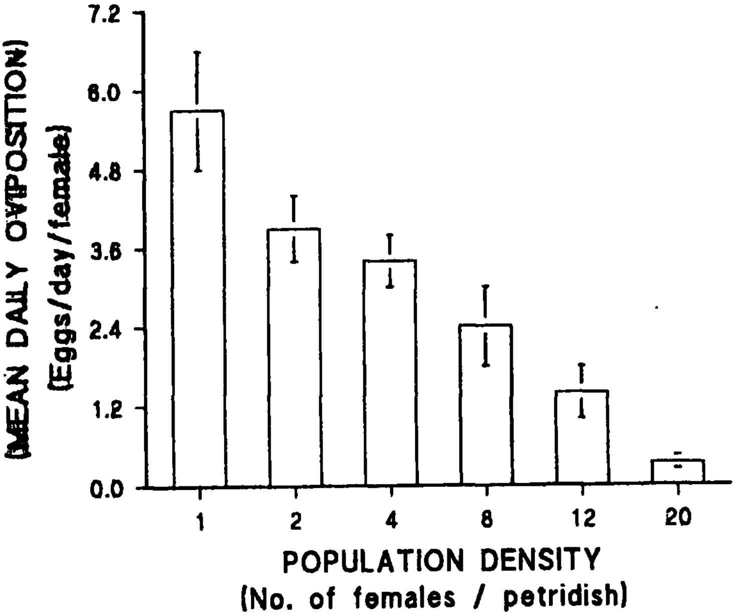

**Figure 3.** Oviposition in *Delphastus pusillus* at different population densities over a period of 14 days.

The highest mean daily oviposition, over a period of 14 days of individually caged females was 5.7±0.9 eggs per day. Hoelmer *et al.* (1993) reported that *D. pusillus* female which consumed less than 100 eggs per day produced no progeny. In the present study, the whitefly egg density used was 75-100 eggs/cm$^2$ of leaf and hence, less likely to have a limitation on food even at the highest beetle population used. Suppression of egg development may have occurred due to a limitation of space. These results indicated the optimum population density to be used in the mass rearing of beetles which is around 8 beetles per 64 cm$^2$. Further experimentation is required to confirm the optimum population density to be used in mass rearing.

## CONCLUSIONS

*D. pusillus* proved its potential as a successful biological control agent of *T. vaporariorum* in terms of its reproductive capacity. *D. pusillus* is synoovigenic. Hence, the development of eggs takes place after emergence. Adults can survive and reproduce on both eggs and nymphs of *T. vaporariorum*, which avoids the need for precise timing when introducing adults into the field. However, copulation is a prerequisite for oviposition; therefore, the introduction of mated females is advantageous. High longevity of adults avoids the need for frequent release of the biocontrol agent into the field in one season. Consistent oviposition throughout the adult life and its high oviposition rate ensure the population build up of *D. pusillus*. Influence of population density on oviposition behaviour is important in mass rearing. The optimum population density for mass rearing was about 8 females per 64 $cm^2$ under laboratory conditions. Apart from the reproductive capability other parameters such as, reproductive behaviour, feeding behaviour, ecological adaptation and interaction with other insects in the field *etc.* have to be examined to confirm the successfulness of *D. pusillus* as a biocontrol agent of *T. vaporariorum*.

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