

SURVIVAL AND REPRODUCTION OF *Podisus nigrispinus* (HETEROPTERA: PENTATOMIDAE): EFFECTS OF PREY SCARCITY AND PLANT FEEDING

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ABSTRACT

The spined soldier bug *Podisus nigrispinus* (Dallas) (Heteroptera: Pentatomidae) is a generalist predator that can alternatively feed on plant tissue to survive under prey scarcity. This research aimed to evaluate the effects of plant feeding forced by a shortage of prey on the survival and reproduction of *P. nigrispinus* on *Eucalyptus urophylla* S.T. Blake (Myrtaceae) plants in the field. *Podisus nigrispinus* adults were enclosed on branches of eucalyptus by using gauze bags. These adults were fed daily with *Tenebrio molitor* pupae (T1) or after 5 (T2), 10 (T3) or 15 (T4) days from mating to simulate prey shortage. The pre-oviposition period, number of egg masses, number and viability of eggs and longevity of females were evaluated. Females of *P. nigrispinus* had a longer pre-oviposition period and produced lower number of egg masses as the period of prey shortage increased. However, the average number of eggs per egg mass, emergence of nymphs and longevity of *P. nigrispinus* females were not affected by prey shortage. Females of *P. nigrispinus* can survive 15 days without prey by feeding on eucalyptus leaves and if it finds prey afterwards can still reproduce. This shows that plant feeding is a successful incidental strategy to survive periods of food scarcity (and thus increase the efficiency) of this predator as a biological control agent.

Key words: *Eucalyptus urophylla*, phytophagy, biological control, predator, Asopinae.

INTRODUCTION

Predator releases in agriculture and forest systems represent a critical stage in biological control programs because adverse conditions including prey shortage can reduce their biological and reproductive potential (Westich and Hough-Goldstein, 2001; Fialho *et al.*, 2009). However, some of these natural enemies can feed on plants as an alternative strategy what can, at least, partially compensate such situations (Zarpas *et al.*, 2007).

Heteroptera are mainly sap sucking but some species of the Pentatomidae family developed predatory habits and they are common during insect outbreaks (Ferreira *et al.*, 2008; Zanuncio *et al.*, 2008). However, these stinkbug predators can feed on plant that also can benefit then

(Azevedo *et al.*, 2007; Guedes *et al.*, 2007). Females of *Brontocoris tabidus* Signoret (Heteroptera: Pentatomidae) showed higher weight gain, oviposition rate, and longer longevity when *Eucalyptus* spp. plants were presented in addition to prey (Zanuncio *et al.*, 2000; 2006a; 2006b). *Supputius cincticeps* (Stål) (Heteroptera: Pentatomidae) also had higher reproduction with prey and *E. cloeziana* than with prey only (Zanuncio *et al.*, 2004).

The life cycle of predatory Pentatomidae depends on the amount and quality of the food ingested (Crum *et al.*, 1998; Lemos *et al.*, 2006). Depending on prey supply, these predators can reduce rate reproduction to maintain their survival within certain limits (Ramalho *et al.*, 2008). Weight gain and food quality and quantity can affect instar duration, number of egg masses, besides egg viability and longevity of adults of these natural enemy (Zanuncio *et al.*, 2002).

Prey shortage and plant feeding influence the insect life cycle and the predation efficiency of predatory Pentatomidae. Thus, the predator was induced to feed on *E. urophylla*, which is considered an alternative food source, during the prey scarcity. Hence, the objective of this research was to identify some costs and benefits of plant feeding towards its reproductive and survival consequences on the predator *Podisus nigrispinus* (Dallas) (Heteroptera: Pentatomidae).

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Received: 28 May 2008.

Accepted: 06 October 2009.

MATERIAL AND METHODS

The work was carried out at the Universidade Federal de Viçosa (UFV), Viçosa, Minas Gerais, Brazil. Average climatic conditions during the experiment (12 June to 19 September 2002), registered by the Department of Agricultural Engineering of the UFV, were temperature of 18.39 ± 0.17 °C, relative humidity of $75.01 \pm 0.73\%$ and photophase of 11.20 ± 0.39 h.

First instar nymphs of *P. nigrispinus* were obtained from the Laboratory of Forest Entomology of the Department of Animal Biology of UFV and reared in groups of 10 per gauze bag (30 x 20 cm) enclosing a branch of *E. urophylla* plants. These nymphs were fed with *Tenebrio molitor* L. (Coleoptera: Tenebrionidae) pupae until the adult stage (Zanuncio *et al.*, 2004). Newly emerged adults were weighed on a scale with a precision of 0.1 mg and separate by sexes according to the external appearance of their genitalia and body size. Ten *P. nigrispinus* pairs per treatment were formed on the second day after emergence and each pair was placed on a branch of eucalyptus after mating. The treatment was: T1: *P. nigrispinus* adults fed with *T. molitor* pupa every day, T2, T3 and T4: *P. nigrispinus* adults fed with *T. molitor* pupae every 5, 10 and 15 days after mating, respectively. Each treatment had by 10 replicates with a *P. nigrispinus* pair.

Pre-oviposition period, number of egg masses, eggs per mass and the survival of *P. nigrispinus* females were observed daily. Egg masses were removed from the gauze bags daily and placed in plastic Petri dishes (9.0 x 1.5 cm) with a piece of cotton wool soaked with distilled water for humidity and kept in the laboratory (25 ± 2 °C; 75 ± 10 RH and 12:12 h photoperiod) to obtain egg viability per female.

Preoviposition period, number of egg masses, number of eggs per egg mass and total longevity were transformed using log 10 values. Eggs per egg mass and egg viability were transformed to arcsine. The values were submitted to ANOVA and the averages compared by Tukey test ($p < 0.05$).

RESULTS

The preoviposition period of *P. nigrispinus* increased with time of prey scarce. Females that did not suffer prey scarcity, show a preoviposition period of 10 days, those that had prey scarcity for 5, 10 and 15 days, had this the period longer than 20 days (Figure 1A). However, the prey scarcity until 15 days did not reduce the number of eggs masses, eggs per mass and total eggs (Figures 1B, C, D and E). The longevity of *P. nigrispinus* females did not change with increasing period of prey scarcity (Figure 1F).

DISCUSSION

The negative effects of periods of prey scarcity shows that *P. nigrispinus* females delay their egg production with low food quality even with plant feeding in the field it demonstrates the necessity of frequent prey consumption to accumulate nutrients, with protein for reproduction (Legaspi and O'Neil, 1994).

Starvation periods on young *P. nigrispinus* females did not affect negatively the number of egg masses and the total number of eggs produced, but without reduction on the number of eggs per egg mass. This seems to be intrinsic to the species studied and it is not affected by adverse conditions including prey shortage, because oviposition would occur only after feeding on sufficient quantity and quality of prey to form egg masses (Shapiro *et al.*, 2000; Wittmeyer *et al.*, 2001). Similar egg viability between treatments shows that even with a cumulative effect of undernourishment or malnutrition, *P. nigrispinus* females did not reduce the egg viability if prey is found after 15 days of prey shortage.

The longevity of this predatory stinkbug was not affected by starvation periods. Then, we assume that plant feeding allows *P. nigrispinus* to survive during prey absence, increasing the probability of finding high quality food in the future. However, the improved survival renders the opportunity to resume reproduction when prey becomes available on a posterior stage. In addition, this predatory stinkbug can be capable of exploiting plants for its nutrients, increasing the plant feeding by prey scarcity (Gillespie and McGregor, 2000; Medeiros *et al.*, 2004). Several authors have been reported for other heteropteran predators, such as *Podisus rostralis* (Stål) (Molina-Rugama *et al.*, 1998) that feeding on plant material might be used only for survival whereas consumption of prey is needed for reproduction. Our findings show that *P. nigrispinus* presented a similar behavior. Thus, the facultative plant feeding by predators, called as zoophytophagy (Azevedo *et al.*, 2007), needs more researches to understand the role of enzymes present in the salivary glands of this predator (Azevedo *et al.*, 2003). Such information would contribute to understand the ecological and nutritional implications of the facultative phytophagy on foraging strategies shown by *P. nigrispinus*.

Predators compensate the food deficiency by reducing egg production. In natural conditions, this reduction will decrease the number of predators attacking the scarce prey and *P. nigrispinus* would not waste energy in searching for it. By minimizing the energetic costs, this predator would increase time for other activities such as plant feeding that would allow it to decrease water loss, oxygen consumption and metabolic rates (Wiedenmann

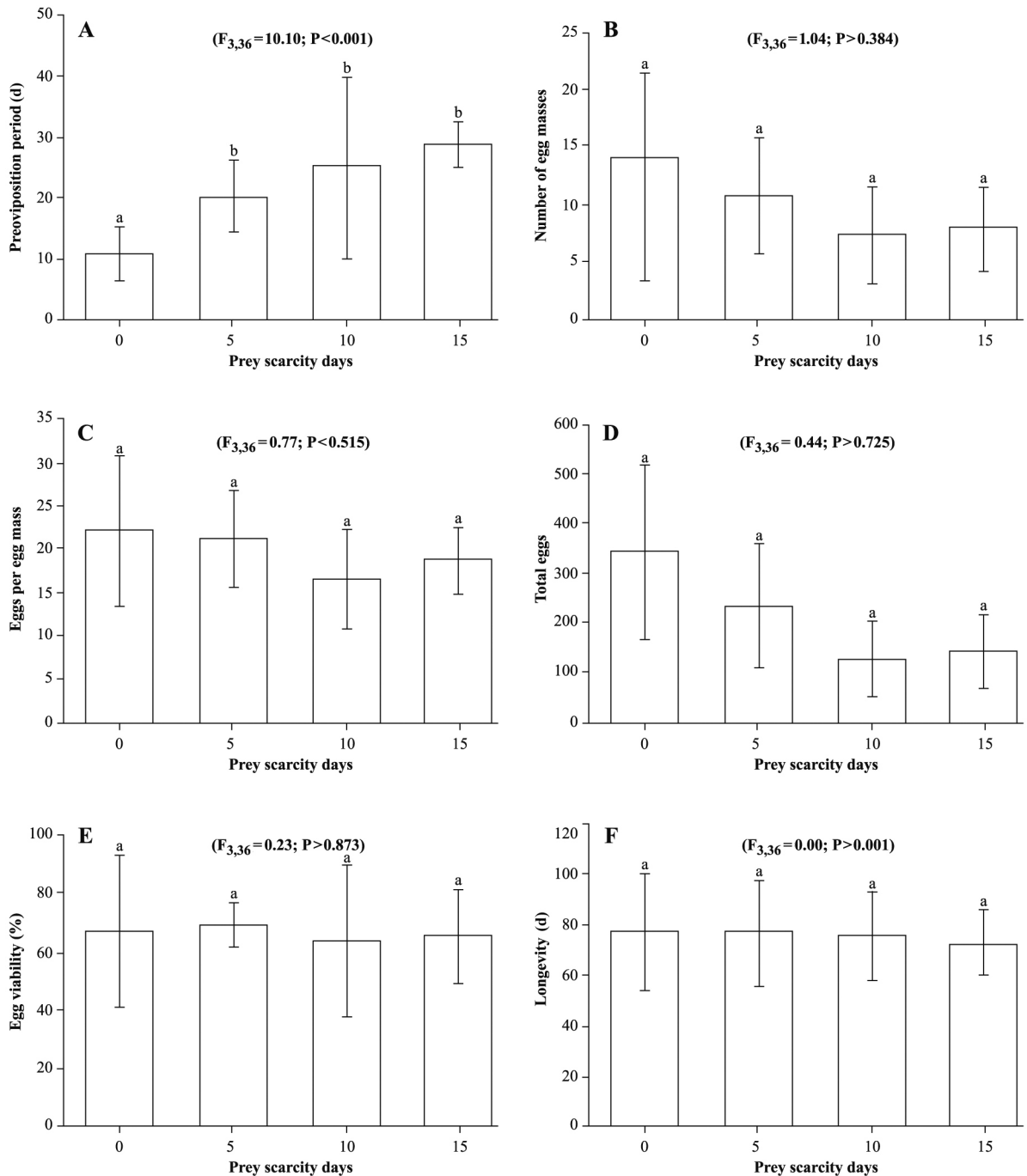


Figure 1. Effect of prey scarcity on biological parameters of *Podisus nigrispinus* (Heteroptera: Pentatomidae) on *Eucalyptus urophylla*. Means (\pm standard deviation) followed by the same letters are not different according to the Tukey test ($p > 0.05$).

and O'Neil, 1991). The generalist predators such as *P. nigrispinus* have better prey switching abilities without impairment of developmental and reproductive capacities and thus it is expected to have less difficulty subsisting under conditions of prey scarcity (Freitas *et al.*, 2006).

Predatory stinkbugs have a set of adaptations to low attack rates, including trade-offs in survival and reproduction, feeding on plants to maintain body weight and using stored lipids to survive periods of low prey availability (Legaspi and O'Neil, 1994).

Podisus nigrispinus females were able to maintain longevity but not their reproductive output under a food shortage what determines the importance of the herbivory in a trade-off between survival and reproduction. Lepidopteran defoliators are important in eucalyptus plantations (Zanuncio *et al.*, 1993; 2006), and this adaptive behavior would explain why this predator is found in high populations at the end of caterpillar outbreaks and its ability to survive in these plantations when prey becomes scarce in the (Zanuncio *et al.*, 2003). In this context, the trade-off between reproduction and survival buffers the population against food shortage or other factors that reduce reproduction. Therefore, understanding the nature of these adaptations we would be better able to use this predatory stinkbug in biological control or insect pest management programs.

CONCLUSIONS

The prey scarcity up to 15 days did not affect the reproductive capacity of the predator *P. nigrispinus* on plants of *E. urophylla*.

ACKNOWLEDGEMENTS

We thank the Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq), Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES) and Fundação de Amparo a Pesquisa do Estado de Minas Gerais (FAPEMIG) for financial support to the authors. We also thank T.V.M. Groot for his helpful discussion and comments on the manuscript.

RESUMEN

Supervivencia y reproducción de *Podisus nigrispinus* (Heteroptera: Pentatomidae): efectos de escasez de presas y alimentación vegetal. *Podisus nigrispinus* (Dallas) (Heteroptera: Pentatomidae) es un chinche depredador generalista que se alimenta alternativamente de tejidos vegetales para sobrevivir durante la época de escasez de sus presas. El objetivo de esta investigación fue evaluar los efectos de la alimentación forzada en condiciones de escasez de presa en la supervivencia y reproducción de *P. nigrispinus* en plantas de eucalipto *Eucalyptus urophylla* S.T. Blake (Myrtaceae) en campo. Adultos de *P. nigrispinus* fueron confinados en ramas de eucalipto usando bolsas de tela o gasa. Estos insectos fueron alimentados diariamente con pupas de *Tenebrio molitor* L. (Coleoptera: Tenebrionidae) (T1) o después de 5 (T2), 10 (T3) y 15 (T4) días después del cruzamiento para simular escasez de presa. Se evaluó el período de pre-oviposición, número de masas de huevos, número y

viabilidad de huevos y longevidad de hembras. Hembras *P. nigrispinus* tuvieron un período de pre-oviposición más largo y menor producción de masas de huevos a medida que aumentó el período de escasez de presa, aunque el número promedio de huevos por masa, emergencia de ninfas y longevidad de hembras de *P. nigrispinus* no fue afectado por la escasez de presa. Las hembras de *P. nigrispinus* pueden sobrevivir y reproducirse hasta 15 días sin presa utilizando las hojas de eucalipto como fuente de alimento. El hábito de ser eventualmente fitófago es una estrategia muy bien aprovechada para la supervivencia de este depredador en períodos de escasez de presas, el cual puede aumentar la eficiencia de ese depredador como agente de control biológico.

Palabras clave: *Eucalyptus urophylla*, fitófago, control biológico, depredador, Asopinae.

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