Vol.48, n. 5 : pp. 771-777, September 2005
ISSN 1516-8913 Printed in Brazil

BRAZILIAN ARCHIVES OF
BIOLOGY AND TECHNOLOGY

A N I N T E R N A T I O N A L J O U R N A L

Reproduction and Longevity of *Supputius cincticeps* (Het.: Pentatomidae) Fed with Larvae of *Zophobas confusa*, *Tenebrio molitor* (Col.: Tenebrionidae) or *Musca domestica* (Dip.: Muscidae)

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ABSTRACT

Reproduction and longevity of Supputius cincticeps *(Stål) (Heteroptera: Pentatomidae) fed on* Zophobas confusa *Gebien,* Tenebrio molitor *L. (Coleoptera: Tenebrionidae) or* Musca domestica *(L.) (Diptera: Muscidae) larvae were studied during two generations at 24.7 ± 1.1ºC, 70 ± 10% R.H. and 12 h of photophase. Body weight of newly-emerged adults, oviposition period, number of egg masses, total number of eggs and longevity of* S. cincticeps *were higher when fed on* Z. confusa *or* T. molitor *larvae than on* M. domestica *larvae. Regardless of diet,* S. cincticeps *showed better reproduction and longevity in the second generation in laboratory conditions.*

Key words: Asopinae, predatory stinkbug, fecundity, alternative prey

INTRODUCTION

Predatory stinkbugs of the subfamily Asopinae are distributed worldwide in many ecosystems (Thomas 1992). In Brazil, they reach high densities during outbreaks of defoliator Lepidoptera in eucalyptus plantations (Zanuncio et al. 1994). These predators are considered important biological control agents, feeding upon different developmental stages of Lepidoptera, Coleoptera, Diptera and Hemiptera (Zanuncio et al. 1994, De Clercq et al. 2002, Yocum and Evenson 2002, Lemos et al. 2003). Therefore, the biology, ecology, behavior and rearing methods of these natural enemies have been studied in order to improve their use in biological control programs (Westich and Hough-Goldstein 2001, Lemos et al. 2003, Medeiros et al. 2003).

Predatory Asopinae have been used in inundative and augmentative releases to suppress populations of herbivorous insects (Tipping et al. 1999). Since it is difficult to rear their natural preys in laboratory, it is necessary to have alternative ones with low cost, easy rearing and which permit high reproductive potential (Zanuncio et al. 1994, 2001, Lemos et al. 2003) and successive generations of these natural enemies (Hagen et al. 1976).

The use of adequate preys is important because they may affect development, reproduction and/or longevity of predatory insects (Zanuncio et al. 1997, 2001). Several prey species have been

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studied, in laboratory conditions, for predaceous pentatomids including pupae of *Tenebrio molitor* L. (Coleoptera: Tenebrionidae) for *Brontocoris tabidus* (Signoret) (Heteroptera: Pentatomidae) (Zanuncio et al. 1996); caterpillars of *Alabama argillacea* (Huebner) (Lepidoptera: Noctuidae) for *Podisus nigrispinus* (Dallas) (Heteroptera: Pentatomidae) (Lemos et al. 2001, 2003) and larvae of *Galleria mellonella* (L.) (Lepidoptera: Pyralidae) for *Podisus maculiventris* (Say) (Heteroptera: Pentatomidae) (De Clercq et al. 1998).

Supputius cincticeps (Stål) (Heteroptera: Pentatomidae), another Neotropical predator, is found in Brazilian eucalyptus plantations (Zanuncio T.V. et al. 1992). Researches with this natural enemy include studies aiming to establish its colonies in laboratory with preys or artificial diets (Zanuncio et al. 1996/1997). Didonet et al. (1996) studied thermal requirements to estimate the occurrence and to quantify the number of degree-days for *S. cincticeps* to complete its life span in natural conditions. Additionally, Assis Jr. et al. (1998) recommended the use of detached leaves of eucalyptus with prey to rear *S. cincticeps* in laboratory. This predator showed shorter nymph period and higher survival on *Zophobas confusa* Gebien (Coleoptera: Tenebrionidae) (Beserra et al. 1995). However, the reproductive capacity of *S. cincticeps* reared on this tenebrionid had yet to be investigated.

Thus, the objective of this research was to evaluate fecundity and longevity of *S. cincticeps* reared during two generations with *Z. confusa*, *T. molitor* or *Musca domestica* (L.) (Diptera: Muscidae) larvae and to determine the better prey to enhance reproductive capacity for augmentative rearing systems of this predator.

MATERIAL AND METHODS

This research was carried out at the laboratory illuminated by four lamps of 40 watts at 24.7 ± 1.1ºC, 70 ± 10% R.H. and photophase of 12 hours.

Egg masses of *S. cincticeps* were obtained from a mass rearing facility of the Forest Entomology Laboratory, Department of Animal Biology (UFV) and conditioned in Petri dishes (9.0 x 1.5 cm) with moistened cotton wicks. Second instar nymphs were maintained in groups of 10 in these dishes and fed on *Z. confusa, T. molitor* or *M. domestica* larvae. Newly molted third instar nymphs were transferred to plastic cups (500 mL) and reared in these containers until adult stage, which were weighted and mated between three to five days post-emergence (Zanuncio et al. 2001).

Twenty-two couples of *S. cincticeps* for each prey and generation were fed with two third or fourth instar larvae of *Z. confusa*, two fifth instar *T. molitor* or with three days old *M. domestica* larvae "*ad libitum*". Specimens of *Z. confusa* were sent to the "Instituto de Biocências of the Universidade de São Paulo" for identification. Adult weight (mg), pre-oviposition, oviposition and post-oviposition periods, numbers of egg masses, eggs per egg mass and eggs besides egg viability (%) and longevity of females of *S. cincticeps* were evaluated for each female during two generations.

Data were submitted to the Lilliefors and Cochran and Bartlett tests to verify if they showed normal distribution and homogeneity of variance, respectively. When necessary, these data were transformed in $\sqrt{x}$, $\sqrt{x+0.5}$ or log (x + 1). The analysis of variance was performed considering an entirely casualized design arranged as a 3 x 2 factorial constituted by prey type and number of generations, respectively. Significant differences of means among treatments were determined using Scott-Knott test and evaluated at 5% probability. Individuals of *S. cincticeps* were deposited at the Entomology Museum of the UFV.

RESULTS

The analysis of variance showed no significant interactions between preys (*Z. confusa*, *T. molitor* or *M. domestica*) and the number of generations in laboratory (two) of *S. cincticeps* for the characteristics evaluated (Table 1). For this reason, results are presented and discussed as function of significance of simple effect.

Performance of *Supputius cincticeps* in different preys

Prey type did not affect pre-oviposition and post-oviposition periods and the number of eggs/egg mass of *S. cincticeps* (Table 1), but newly emerged adults (males and females) of this predator were heavier with larvae of *Z. confusa* or *T. molitor* than with those of *M. domestica* (Fig. 1a). The oviposition period (Fig. 1b), number of egg masses (Fig. 1c), total eggs per female (Fig. 1d), egg viability (Fig. 1e) and longevity of *S. cincticeps*

(Fig. 1f) were similar with *Z. confusa* or *T. molitor* larvae, but higher than with those of *M. domestica*.

Performance of *Supputius cincticeps* after two generations

Adults of *S. cincticeps* were heavier in the second (F_2) than in the first (F_1) generation regardless of prey (Fig. 2a). Although pre-oviposition and post-oviposition periods (Fig. 2b) were longer in the F1, the oviposition period was similar between generations (Table 1). The number of egg masses (Fig. 2c) and total number of eggs per female (Fig. 2d) of *S. cincticeps* were higher in the F_2, but the number of eggs per egg mass, egg viability and longevity of females of this predator were similar between generations (Table 1).

Table 1 - Analysis of variance for the effect of prey (*Zophobas confusa*, *Tenebrio molitor* and *Musca domestica*) and number of generations in laboratory (two generations) on adult weight, reproductive characteristics and longevity of females of *Supputius cincticeps*.

Variables	Variation Sources (F-Values)			
	Prey (P)	Generations (G)	P x G	C.V. (%)
Weight of males (mg)[a]	11.50*	20.99*	1.08	12.77
Weight of females (mg)[a]	13.37*	5.75*	0.53	14.33
Pre-oviposition period (days)[b]	0.43	15.10*	0.89	11.33
Oviposition period (days)	10.98*	1.66	1.83	62.35
Post-oviposition period (days)[b]	0.90	10.60*	0.01	0.78
Number of egg masses[b]	7.63*	3.99*	0.78	30.57
Number of eggs/egg mass	2.23	0.53	0.98	29.96
Total number of eggs[b]	10.48*	4.15*	1.32	19.25
Egg viability (%)	15.58*	2.61	1.25	33.73
Longevity of females[c]	11.03*	0.63	1.78	22.32

(*) Significant at 5% probability level by F test; ([a]) Data transformed in $\sqrt{x}$; ([b]) Data transformed in log (x + 1); ([c]) Data transformed in $\sqrt{x+0.5}$

DISCUSSION

Performance of *Supputius cincticeps* with different preys

Weight of newly emerged adults of *S. cincticeps* was affected by the alternative preys used with males and females ca. 13% heavier when fed on *Z. confusa* or *T. molitor* than on *M. domestica* larvae. This suggested that larvae of the first two preys presented more nutrients (e.g., proteins) for nymphs of this predator, thus improving their development. These results were similar to those observed for *P. maculiventris* which had bigger body weight of newly-emerged adults when its nymphs were fed on *T. molitor* larvae than on *Junonia coenia* Hubner, *Vanessa cardui* (L.) (Lepidoptera: Nymphalidae) or *Manduca sexta* (L.) (Lepidoptera: Sphingidae) caterpillars (Strohmeyer et al. 1998). A positive correlation between the calorific value and larvae size of the alternative prey *G. mellonella* allowed obtaining heavier *P. maculiventris* females (Mukerji and LeRoux 1969). This helped to explain results obtained because larvae of both Tenebrionidae used were bigger than those of *M. domestica*. On the other hand this was not observed when comparing larvae of *M. sexta* and *T. molitor* (Strohmeyer et al. 1998), indicating that this should be done within the same species (Mukerji and LeRoux 1969, Santos et al. 1996). It was important to obtain heavier *S. cincticeps* females because predators such as *P. nigrispinus* and *Podisus rostralis* (Stål) (Heteroptera: Pentatomidae) also showed a direct relationship between body weight and fecundity (Mohaghegh et al. 1999, Zanuncio et al. 2002). Thus, the use of *Z. confusa* and *T. molitor* larvae as food allowed rearing adults of *S. cincticeps* with better quality. In addition, adults with higher body weight might have better chances to survive and suffer less under hostile conditions in the field such as periods of prey shortage (Molina-Rugama et al. 1998, Mohaghegh et al. 1999, Mourão et al. 2003).

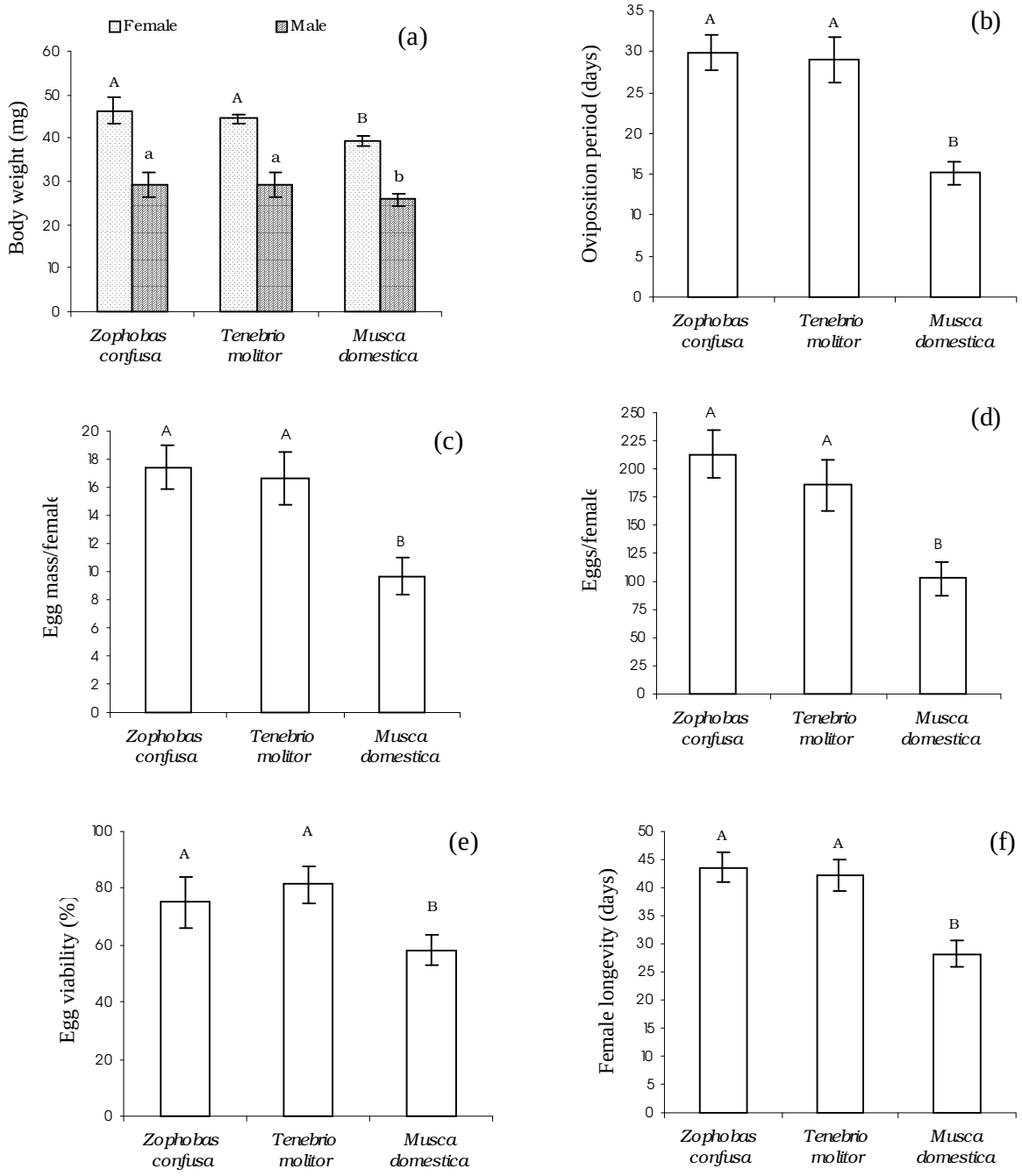

Figure 1 - Body weight (mg) (a), reproductive characteristics (b, c, d, e) and female longevity (f) of the predator *Supputius cincticeps* (Heteroptera: Pentatomidae) with the alternative preys *Zophobas confusa*, *Tenebrio molitor* (Coleoptera: Tenebrionidae) or *Musca domestica* (Diptera: Muscidae). Columns followed by the same capital or lower letter per figure do not differ between each other by Scott-Knott test (P > 0.05).

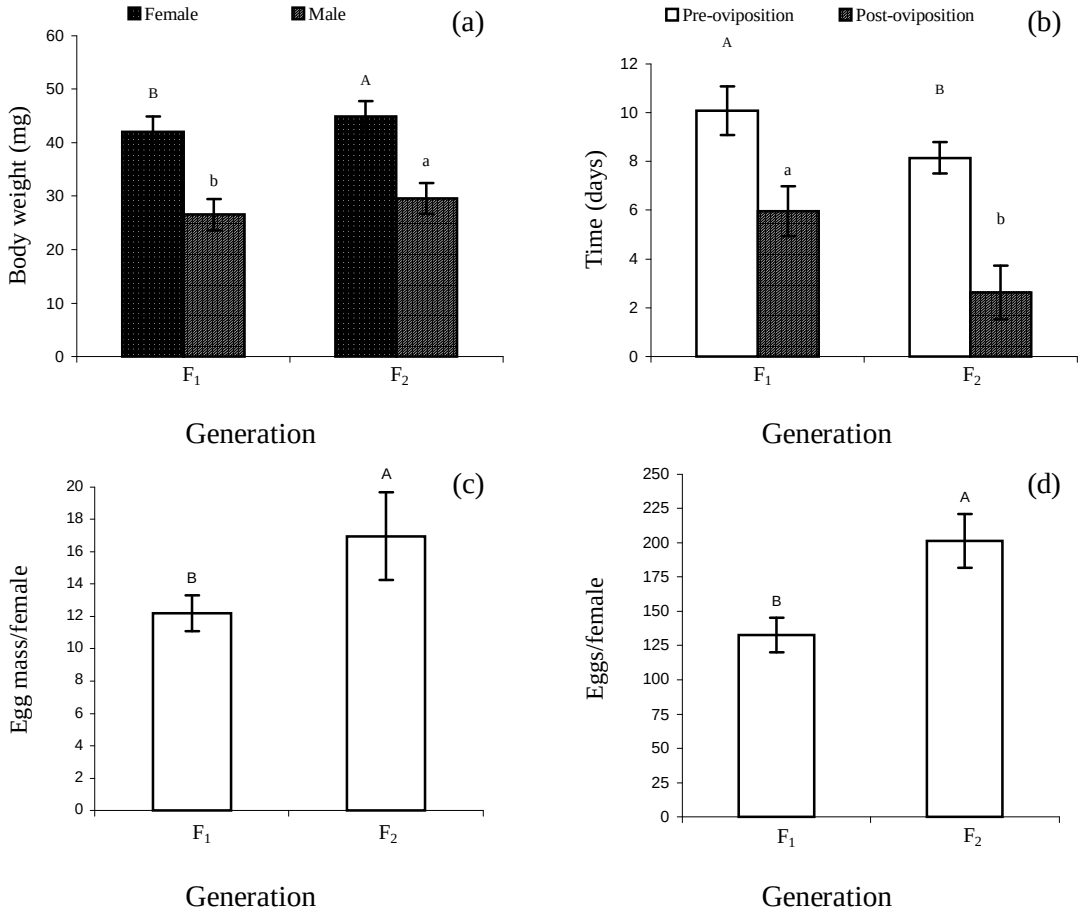

Figure 2 -Body weight (mg) (a) and reproductive characteristics (b, c, d) of the predator *Supputius cincticeps* (Heteroptera: Pentatomidae) after two generations in laboratory. Columns followed by the same capital or lower letter per figure do not differ from each other by the F test (P> 0.05).

Despite of the similarity that was found among the pre- and post-oviposition periods and the number of eggs/egg mass, with different alternative preys, the oviposition period, number of egg masses and total number of eggs per female of *S. cincticeps* had significantly lower values when reared on *M. domestica* larvae than on *Z. confusa* or *T. molitor* larvae.

These results showed direct relationship between body weight and fecundity of females of this predator and indirectly a possible better nutritional quality of larvae of both Tenebrionidae (Mohaghegh et al. 1999, Wittmeyer et al. 2001). Besides, the number of *S. cincticeps* nymphs hatched was ca. 20% lower on larvae of *M. domestica* than with the other preys. This may be attributed to the lower amount or poor quality of resources allocated by *S. cincticeps* females to form its egg masses when fed with larvae of housefly. This agrees with lower weight of the ovaries and quantity of fat bodies of *P. nigrispinus* females fed with *M. domestica* larvae (Lemos et al. 2003). Therefore, nymphs of predatory Pentatomidae fed with food of lower nutritional value will produce adults with reduced fertility (Wittmeyer et al. 2001). This shows a direct effect of the diet on total number of individuals produced by predatory Pentatomidae in the next generations. However, this negative impact tends to be overcomed or reduced when these natural enemies feed on better quality or different prey types (Wittmeyer et al. 2001, Zanuncio et al. 2001).

Longevity of *S. cincticeps* females was ca. 50% longer when reared on *Z. confusa* or *T. molitor* larvae compared to those on *M. domestica* larvae. This may also explain the higher fecundity showed by predators feeding on larvae of both Tenebrionidae because longer longevity allowed

better chances for producing higher number of eggs. However, it differed with predator and prey used because this effect was not pronounced enough to reduce egg production and longevity of *P. nigrispinus* females fed on *T. molitor* and *M. domestica* larvae (Zanuncio, T.V. et al. 1996). Thus, the acceptance of prey and nutritional requirements of predatory stinkbugs should be considered in mass rearing programs of these natural enemies.

Performance of *Supputius cincticeps* after two generations

Adults of *S. cincticeps* were heavier in the second than in the first generation regardless of prey. This showed an increasing food assimilation and adaptation of this predator to preys used. This behavior explained the better reproductive performance of *S. cincticeps* with a reduction of ca. 18% in the pre-oviposition period and an increase of approximately 40% on number of egg masses and eggs produced in the second generation. Higher fertility and shorter post-oviposition period showed a good adaptation of *S. cincticeps* to preys used and to rearing in laboratory such as found for the predator *P. nigrispinus* (Mohaghegh et al. 1999).

To conclude, *S. cinticeps* could be produced in laboratory with the alternative preys *Z. confusa* or *T. molitor* to be released in programs of biological control of insects, because it showed adequate body weight and reproductive capacity with both preys. However, it is recommended to determine rearing costs of *S. cincticeps* and to choose the best prey to rear this predator with lower costs.

ACKNOWLEDGEMENTS

We thank the "Conselho Nacional de Desenvolvimento Científico e Tecnológico (CNPq)", "Coordenação de Aperfeiçoamento de Pessoal de Nível Superior (CAPES)", "Federação das Indústrias do Estado de Minas Gerais (FIEMG)" and "Fundação de Amparo à Pesquisa do Estado de Minas Gerais (FAPEMIG)" for financial support to the authors. We also thank Sérgio A. Vanin of the "Instituto de Biociências da Universidade de São Paulo" for the identification of *Zophobas confusa*.

RESUMO

Foram avaliadas, em duas gerações, a reprodução e a longevidade de *Supputius cincticeps* (Stål) (Heteroptera: Pentatomidae) alimentado com larvas de *Zophobas confusa* Gebien, *Tenebrio molitor* L. (Coleoptera: Tenebrionidae) ou *Musca domestica* (L.) (Diptera: Muscidae) a 24,7 ± 1,1ºC, 70 ± 10% de U.R. e fotofase de 12 h. O peso de adultos recém emergidos, o período de oviposição, o número de posturas, de ovos totais e a longevidade de fêmeas de *S. cincticeps* foram maiores com larvas de *Z. confusa* ou *T. molitor* que com *M. domestica*. Independentemente do tipo de presa, *S. cincticeps* mostrou melhor performance reprodutiva e longevidade na segunda geração.

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Received: October 30, 2003;
Revised: April 28, 2004;
Accepted: September 21, 2004.