

Effect of Female Weight on Reproductive Potential of the Predator *Brontocoris tabidus* (Signoret, 1852) (Heteroptera: Pentatomidae)

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ABSTRACT

The objective of this work was to determine the fecundity of the predator *Brontocoris tabidus* (Signoret) (Heteroptera: Pentatomidae) females of two weight classes aiming to define, which one presented higher productivity in the laboratory. Males and females of *B. tabidus* were reared from nymphs fed with *Tenebrio molitor* L. (Coleoptera: Tenebrionidae) pupae in laboratory. Females of *B. tabidus* weighting 95 to 150 mg and those with 160 to 220 mg constituted two treatments. Oviposition period and numbers of egg masses, eggs and nymphs per female of *B. tabidus* were higher in the treatment with heavier females, while the periods of preoviposition, between egg mass laying, egg incubation and number of eggs per egg mass, besides the percentage of nymphs hatched and adult longevity were similar between treatments. Heavier females of *B. tabidus* presented better productivity and for this reason they should be used in programs of mass rearing this predator.

Key words: Asopinae, predatory bugs, mass rearing, biological control, reproductive potential

INTRODUCTION

Generalist predators are important for biological control of pests because they can feed on many insect species, especially those that are present in high numbers. In addition, these natural enemies show colonization potential in different agroecosystems, even in periods of prey shortage (De Clercq and Degheele, 1990, Zanuncio et al., 2001). Nymphs and adults of *Brontocoris tabidus* (Signoret) (Heteroptera: Pentatomidae) prey on all stage insects of many orders (Barcelos et al., 1994). *Podisus nigrispinus* (Dallas) (Heteroptera: Pentatomidae) and *B. tabidus* are the most common and frequent predators in eucalyptus

plantations, while *Alcaeorrhynchus grandis* (Dallas), *Tynacantha marginata* Dallas, *Oplomus* sp. and *Supputius cincticeps* (Stal) are less frequent. For this reason, the first two species have been reared and released for biological control in agricultural and forest agroecosystems (Zanuncio et al., 1994, Zanuncio et al., 1996/1997a). *B. tabidus* and *P. nigrispinus* present good adaptation to laboratory conditions where they have higher productivity and short biological cycle. They are considered promising species for pest management programs in Brazil (Saavedra et al. 1997; Lemos et al. 2001).

Biological aspects of natural enemies vary with biotic and abiotic factors, which can affect their

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use in biological control programs (Saavedra et al., 1997; Zanuncio et al., 1996; Zanuncio et al., 2000; Torres and Zanuncio, 2001). Geographic origin affects the body size of *P. nigrispinus*, but no significant relationship between body size and fecundity was found for strains of *P. nigrispinus* from Surinam and Brazil, except in the first generation in laboratory (Mohaghegh et al., 1999). This suggested that higher fecundity and longevity of these predators could reflect its adaptation to the diet and to laboratory conditions. Other authors found that fecundity of predatory Pentatomidae varied with female body weight, with heavier females presenting better reproductive rate (Honek, 1993; Evans, 1982a, b; Zanuncio et al., 1992).

Positive correlation between female weight and fecundity of many insects and weight variation in the same population of *B. tabidus* suggest the need to study the effect of this factor on reproductive capacity of this predator. Hence, we studied the effect of female body weight on the reproduction of *B. tabidus* fed with *T. molitor* pupae, in order to improve fecundity of this species in mass rearing facilities.

MATERIALS AND METHODS

Adults of *B. tabidus* were obtained from nymphs fed with *T. molitor* pupae and seedlings of *Eucalyptus urophylla* maintained at 25 ± 2 °C, $65 \pm 10\%$ RH and 13 h photophase (Moreira et al., 1996/1997). Twenty-four hours after emergence, starved adults of *B. tabidus* were divided in two groups according to their body size. Group I (T_1) included females with body weight from 95 to 150 mg, while group II (T_2) had females with body weight from 160 to 220 mg. In both groups, male weight varied from 72 to 147 mg. These weight classes were used based upon the 45% of heavier and 45% lighter females in the *B. tabidus* population available in the laboratory.

Thirty pairs of *B. tabidus* were isolated in 30 plastic containers (2 l) with one pair/container. The cover of these plastic containers had a hollow where a plastic cup (40 ml) with the bottom substituted by a nylon mesh was inserted in which five *T. molitor* pupae/day were supplied. A plastic cup (500 ml) with a seedling of *E. urophylla*, changed every four days substituted the bottom of the plastic containers. Water was supplied in cylindrical tubes (2 ml) fixed to the containers

wall (Assis-Júnior et al., 1998). These containers were daily observed and egg masses of *B. tabidus* were collected and transferred to Petri dishes (9.0 x 1.2 cm) with a moist cotton ball (Barcelos et al., 1993).

The following biological parameters were evaluated: preoviposition, oviposition and post-oviposition periods, period between laying (rate between oviposition period and number of egg masses), number of egg masses, number of eggs per egg mass, number of nymphs per egg mass, number of nymphs, percentage of nymphs hatched, egg incubation period, egg viability and female longevity.

Dataset was submitted to Cochran and Bartlett and Lilliefors statistical tests to determine the variance homogeneity and normality, respectively. Data of the period between egg mass laying, number of eggs and eggs/egg mass were transformed in \sqrt{x} and the period of egg incubation in $\log x$. All data were submitted to the F test at 5% significance level.

RESULTS

Periods of preoviposition and between eggs mass laying were similar in groups T_1 and T_2 ($F, p \geq 0.05$), while oviposition period and number of egg masses were higher for heavier females ($F, p < 0.01$) (Table 1). Heavier females presented higher number of eggs and nymphs ($F, p < 0.01$), but the number of eggs/egg mass, percentage of nymphs hatched, post-oviposition period and female longevity were similar between T_1 and T_2 ($F, p \geq 0.05$) (Table 1).

Survival was higher for heavier females of *B. tabidus*, with about 50% of them alive when they were 35 and 45 days old, for lighter and heavier ones, respectively (Fig. 1). Heavier females showed higher daily and accumulated number of eggs and nymphs/female (daily average number of eggs and nymphs/female for each five days) besides longer survival (percentage of alive females every five days) than lighter ones (Figs. 2, 3).

Lighter females of *B. tabidus* showed higher egg production when they were about 15 days old, with oscillation between 25 and 35 days and decrease from 40 days older (Fig. 2). The beginning of the period with higher egg production for heavier females was close to their 15 days of

age, with low oscillation up to 30 days and accentuated decreasing when they were older than 45 days (Fig. 2). Nymph hatching began after 20 days for lighter females, with oscillations to about

30 days and constant decrease from 46 days, while nymph hatching for heavier females began after 15 days and extended up to 60 days (Fig. 3).

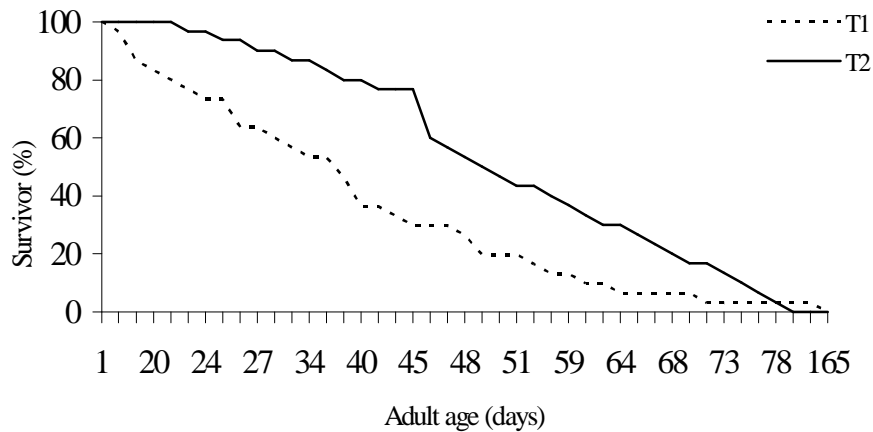


Figure 1 - Survival (%) of *Brontocoris tabidus* (Heteroptera: Pentatomidae) females with weight between 95 and 150 mg (T₁) and between 160 and 220 mg (T₂). 25 ± 2 °C, 60 ± 5% RH and 13 h photophase.

Table 1 - Biological parameters (mean ± sd) of *Brontocoris tabidus* (Heteroptera: Pentatomidae) females with weight between 95 and 150 mg (T₁) and between 160 and 220 mg (T₂). 25 ± 2 °C, 60 ± 5% RH and 13 h photophase.

Biological parameters evaluated	T ₁	T ₂
Preoviposition period (days)	16.53 ± 3.33	16.09 ± 2.57
Oviposition period (days)**	9.5 ± 2.90	23.03 ± 3.27
Number of egg masses/female*	0.90 ± 0.20	3.56 ± 0.57
Period between laying (days)	9.29 ± 2.61	5.62 ± 0.79
Number of eggs/female**	45.33 ± 11.09	182.89 ± 33.82
Number of eggs/egg mass	47.05 ± 6.87	51.48 ± 3.05
Egg incubation period (days)	5.52 ± 0.93	6.87 ± 0.25
Percentage of nymph hatching (%)	56.32 ± 10.68	52.50 ± 6.15
Number of nymphs/egg mass**	32.47 ± 9.82	101.56 ± 23.26
Post-oviposition period (days)	13.05 ± 3.59	16.33 ± 1.71
Longevity (days)	40.76 ± 5.31	52.89 ± 3.64

* significant at 5% probability for the F test. ** significant at 1% probability for the F test.

DISCUSSION

Positive correlation between body size and fecundity has been found for various insect species (Evans, 1982b). However, weight of these organisms can be influenced by genetic and non-genetic factors, such as environmental conditions (Honek, 1993). Similar results were observed for Pentatomidae predators, with non genetic factors affecting the weight of these insects including

qualitative and quantitative effects of food type, temperature, geographical origin, physical environmental conditions, frequency and mating age (Zanuncio et al., 1992; Molina- Rugama et al., 1998; Torres et al., 1998; Mohaghegh et al., 1999; Torres and Zanuncio, 2001). Evans (1982a) stated that differences in body weight of field collected adult predators were mainly due to predatory efficiency of the nymphs that arisen them. Heavier females of *B. tabidus* produced higher number of

eggs and nymphs which agreed with Evans (1982b), who found significant differences in the total egg production among females of different weight classes, with increasing egg production beginning at the 10th day after emergence of *Podisus maculiventris* Say (Heteroptera: Pentatomidae) adults. Higher reproductive capacity of *B. tabidus*, also, agreed with results of Zanuncio et al. (1992) that found higher productivity of heavier females of *P. nigrispinus* fed with *Musca domestica* L. (Diptera: Muscidae). Reproductive rate of *B. tabidus* females was about half of that described by Barcelos et al. (1994), because heavier females of this predator (179.9 mg) produced 182.89 eggs, while the lightest ones

(135.58 mg) produced 45.33 eggs. In addition, we found longer preoviposition period for both body weight groups (16.53 and 16.09 days) when compared with results of Barcelos et al. (1994). This can be due to the prey type because these authors used *Bombyx mori* L. (Lepidoptera: Bombycidae) caterpillars, which can be a more appropriate prey for this predator. Food quality has been one of the main factors affecting weight, size and reproductive capacity of predators (Evans, 1982b; De Clercq and Degheele, 1992; Legaspi and O'Neil, 1994; Zanuncio et al., 1996/1997b), because well fed nymphs arisen heavier adults with higher reproductive capacity (Molina-Rugama et al., 1997).

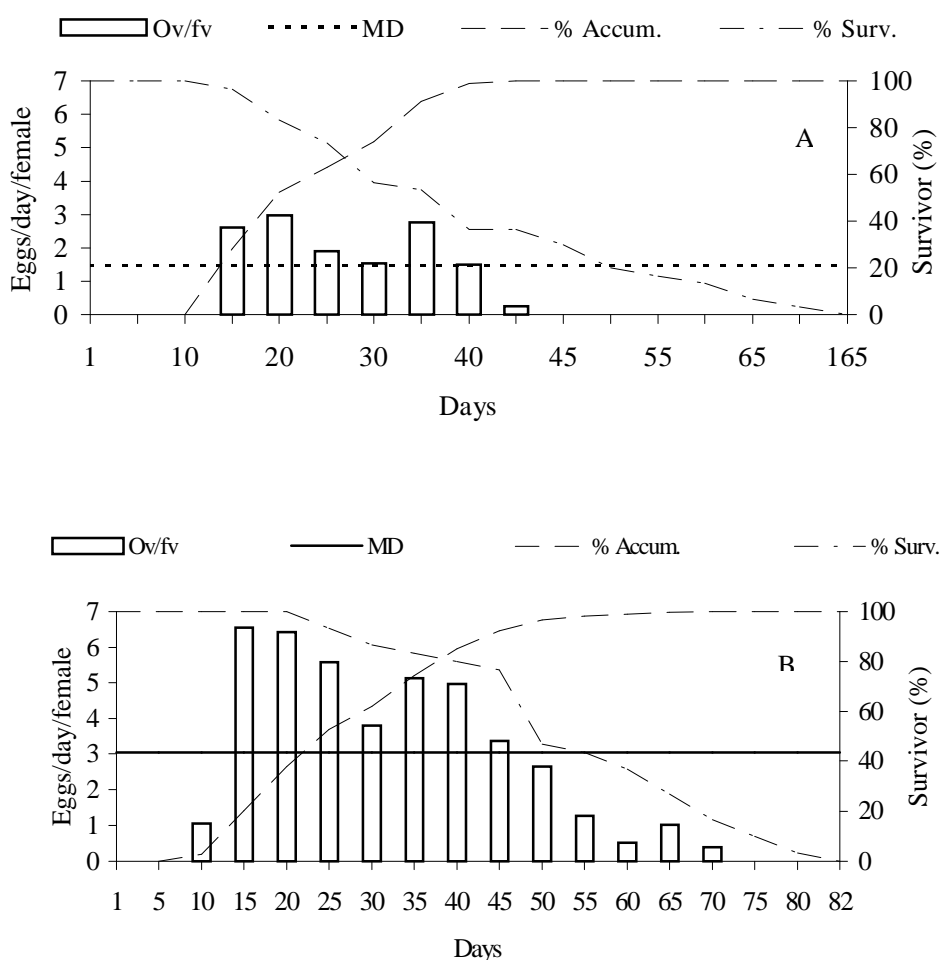


Figure 2 - Daily (ov/f), mean number of eggs/day (MD), accumulated rate of eggs/female every five days (% Accum) and survival every five days (% Surv.) of *Brontocoris tabidus* (Heteroptera: Pentatomidae) females with weight between 95 and 150 mg (A) and between 160 and 220 mg (B). 25 ± 2 °C, 60 ± 5% RH and 13 h photophase.

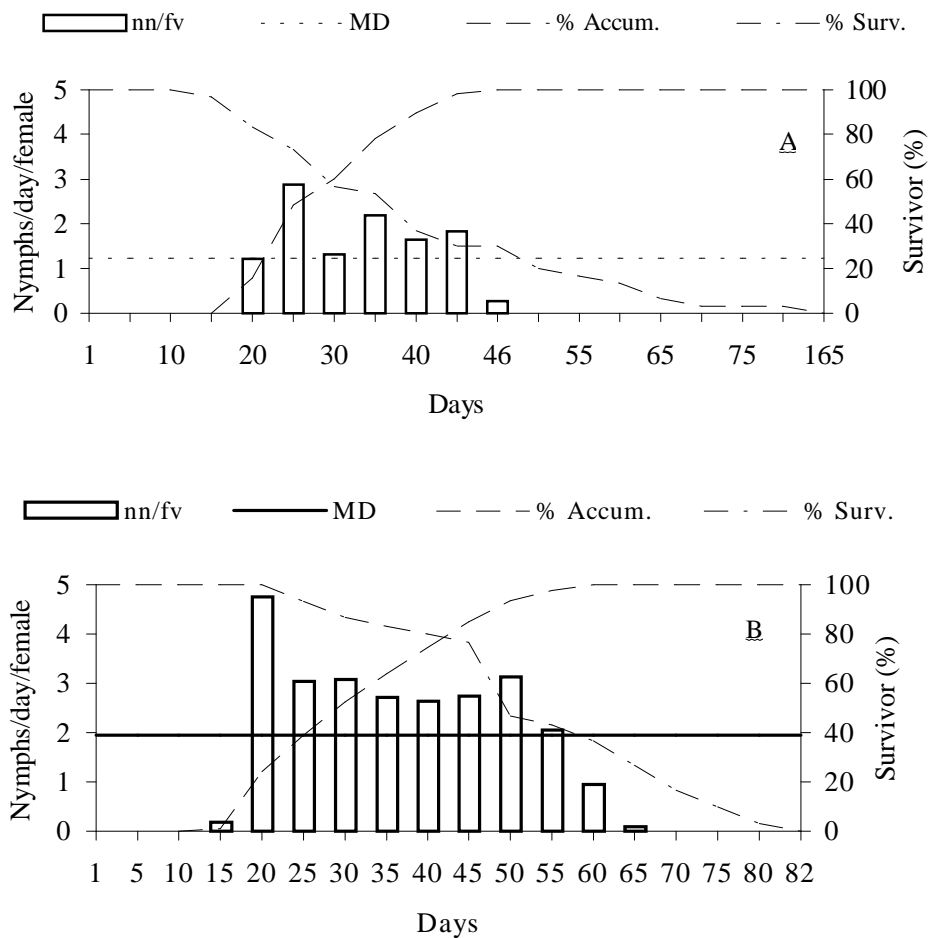


Figure 3 - Daily (nn/f), mean number of nymphs/day (MD), accumulated rate of nymphs/female every five days (% Accum.) and survival every five days (% Surv.) of *Brontocoris tabidus* (Heteroptera: Pentatomidae) females with weight between 95 and 150 mg (A) and between 160 and 220 mg (B). 25 ± 2 °C, $60 \pm 5\%$ RH and 13 h photophase.

Prey type and biological parameters of parental generation affect body weight of *B. tabidus*, because nymphs of this predator, fed with fresh *B. mori* caterpillars arisen heavier females (170 mg) than those fed with previously frozen caterpillars of this Lepidoptera species (Barcelos et al., 1991). Heavier *B. tabidus* females (T_2) had higher fecundity what can be related to their longer oviposition period and higher number of egg masses.

B. tabidus females of both weight classes showed similar longevity what could be explained by the fact that females of both groups might use similar amount of energy for their survival. Since lighter females should have lower amount of stored energy, they laid fewer eggs. In addition, these females could present longer periods between egg

mass laying and fewer numbers of egg masses and/or shorter oviposition periods. Barcelos et al. (1994) found that heavier females of *B. tabidus* fed on *B. mori* caterpillars produced higher number of eggs, egg masses and nymphs, besides having longer oviposition period and longevity, in a similar way of results herein presented for females of this predator fed on *T. molitor* larvae, suggesting that these biological parameters were not affected by prey type supplied to this predator. Reproductive rate was higher from the 10th to 45th days after emergence for heavier females, suggesting that *B. tabidus* females should be discarded after this period, in mass rearing programs, when the number of nymphs/female was lower than the average, which could decrease production of this predator. This agreed with

Rabinovich (1978) that pointed out that non-social insects usually presented an early period without reproduction followed by the reproductive phase and with a decrease after this period.

Heavier females of *B. tabidus* produced higher offspring number and for this reason they should be used for mass rearing this predator.

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RESUMO

Este trabalho apresenta a fecundidade de fêmeas do predador *Brontocoris tabidus* (Signoret) (Heteroptera: Pentatomidae) de duas classes de peso, objetivando avaliar qual delas apresenta melhor produtividade em criações mantidas em laboratório. Machos e fêmeas foram alimentadas, desde o estágio ninfal, com pupas do besouro *Tenebrio molitor* L. (Coleoptera: Tenebrionidae). Fêmeas de *B. tabidus* pesando entre 95 e 150 mg e entre 160 e 220 mg constituíram as duas classes de peso. O período de oviposição e os números de posturas, de ovos e ninfas por fêmea de *B. tabidus* foram maiores naquelas fêmeas pertencentes à classe mais pesada, enquanto os períodos de pré-oviposição, entre posturas, incubação dos ovos e número de ovos por postura, bem como a porcentagem de eclosão de ninfas e a longevidade dos adultos foram semelhantes entre ambas as classes de peso. Fêmeas mais pesadas de *B. tabidus* apresentaram maior número de ovos por fêmea e por esta razão devem ser utilizadas em programas de criação massal deste predador.

REFERENCES

- Assis-Junior, S. L.; Zanuncio, T. V.; Santos, G. P. and Zanuncio, J. C. (1998), Efeito da suplementação de folhas de *Eucalyptus urophylla* no desenvolvimento e reprodução do predador *Supputius cincticeps* (Stal) (Heteroptera: Pentatomidae). *An. Soc. Entomol. Brasil*, **27**, 245-253.
- Barcelos, J. A. V.; Zanuncio, J. C.; Santos, G. P. and Reis, F. P. (1991), Viabilidade da criação em laboratório de *Podisus nigrolimbatus* (Spinola, 1852) (Hemiptera, Pentatomidae) sobre duas dietas. *Rev. Árv.*, **15**, 316-322.
- Barcelos, J. A. V.; Zanuncio, J. C.; Nascimento, E. C. and Zanuncio, T. V. (1993), Caracterização dos estádios ninfais de *Podisus nigrolimbatus* (Spinola, 1852) (Hemiptera, Pentatomidae). *Rev. Bras. Entomol.*, **37**, 537-543.
- Barcelos, J. A. V.; Zanuncio, J. C.; Oliveira, A. C. and Nascimento, E. P. (1994), Performance em duas dietas e descrição dos adultos de *Brontocoris tabidus* (Signoret) (Heteroptera: Pentatomidae). *An. Soc. Entomol. Brasil*, **23**, 519-524.
- De Clercq, P. and Degheele, D. (1990), Description and life history of the predatory bug *Podisus sagitta* (Fab.) (Heteroptera: Pentatomidae). *Can. Entomol.*, **122**, 1149-1156.
- De Clercq, P. and Degheele, D. (1992), Influence of feeding interval on reproduction and longevity of *Podisus sagitta* (Heteroptera: Pentatomidae). *Entomophaga*, **37**, 583-590.
- Evans, E. W. (1982a), Timing of reproduction by predatory stinkbugs (Hemiptera: Pentatomidae): patterns and consequences for a generalist and a specialist. *Ecology*, **63**, 147-158.
- Evans, E. W. (1982b), Consequences of body size for fecundity in the predatory stinkbug, *Podisus maculiventris* (Hemiptera: Pentatomidae). *Ann. Entomol. Soc. Am.*, **75**, 418-420.
- Honek, A. (1993), Intraspecific variation in body size and fecundity in insects: a general relationship. *Oikos*, **66**, 483-492.
- Legaspi, J. C. and O'Neil, R.J. (1994), Developmental response of nymphs of *Podisus maculiventris* (Heteroptera: Pentatomidae) reared with low numbers of prey. *Environ. Entomol.*, **23**, 374-380.
- Lemos, W. P.; Medeiros, R. S.; Ramalho, F. S. and Zanuncio, J. C. (2001), Effects of plant feeding on the development, survival and reproduction of *Podisus nigrispinus* (Dallas) (Heteroptera: Pentatomidae). *Int. J. Pest Manage.*, **47**, 89-93.
- Mohaghegh, J.; De Clercq, P. and Tirry, L. (1999), Effects of rearing history and geographical origin on reproduction and body size of the predator *Podisus nigrispinus* (Heteroptera: Pentatomidae). *Eur. J. Entomol.*, **96**, 69-72.
- Molina-Rugama, A. J.; Zanuncio, J. C.; Torres, J. B. and Zanuncio, T. V. (1997), Longevidad y fecundidad de *Podisus nigrispinus* (Heteroptera: Pentatomidae) alimentado con *Musca domestica* (Diptera: Muscidae) y frijol. *Rev. Biol. Trop.*, **45**, 1125-1130.

- Molina-Rugama, A. J.; Zanuncio, J. C.; Zanuncio, T. V. and Oliveira M. L. R. (1998), Reproductive strategy of *Podisus rostralis* (Stal) (Heteroptera: Pentatomidae) females under different feeding intervals. *Bioc. Sci. Tech.*, **8**, 583-588.
- Moreira, L. A.; Zanuncio, J. C.; Picanço, M. C. and Guedes, R. N. C. (1996/1997), Effect of Eucalyptus feeding in the development, survival and reproduction of *Tynacantha marginata* (Heteroptera: Pentatomidae). *Rev. Biol. Trop.*, **44/45**, 253-257.
- Rabinovich, J. E. (1978), *Ecología de poblaciones animales*. Washington : Secretaria General de la Organización de los Estados Americanos.
- Saavedra, J. L. D.; Zanuncio, J. C.; Zanuncio, T. V. and Guedes, R. N. C. (1997), Prey capture ability of *Podisus nigrispinus* (Dallas) (Heteroptera: Pentatomidae) reared for successive generations on meridic diets. *J. Appl. Entomol.*, **121**, 327-330.
- Torres, J. B. and Zanuncio, J. C. (2001), Effect of mating frequency of *Podisus nigrispinus* on female reproductive output. *BioControl*, **46**, 469-480.
- Torres, J. B.; Zanuncio, J. C. and Oliveira, H. N. (1998), Nymphal development and adult reproduction of the stinkbug predator *Podisus nigrispinus* (Heteroptera: Pentatomidae) under fluctuating temperatures. *J. Appl. Entomol.*, **122**, 509-514.
- Zanuncio, J. C.; Bragança, M. A. L.; Díaz, J. L. S. and Sartório, R. C. (1992), Avaliação dos parâmetros de fecundidade de fêmeas de *Podisus connexivus* (Hemiptera: Pentatomidae) de diferentes pesos. *Rev. Ceres*, **39**, 591-596.
- Zanuncio, J. C.; Alves, J. B.; Zanuncio, T. V. and Garcia, J. F. (1994), Hemipterous predators of eucalypt defoliator caterpillars. *For. Ecol. Manag.*, **65**, 65-73.
- Zanuncio, J. C.; Saavedra, J. L. D.; Zanuncio, T. V. and Santos, G. P. (1996/1997a), Desarrollo y reproducción de *Supputius cincticeps* (Heteroptera: Pentatomidae) en dieta artificial por dos generaciones. *Rev. Biol. Trop.*, **44/45**, 247-251.
- Zanuncio, J. C.; Saavedra, J. L. D., Zanuncio, T. V. and Santos, G. P. (1996/1997b), Incremento en el peso de ninfas y adultos de *Podisus nigrispinus* (Heteroptera: Pentatomidae) alimentados com dos tipos de larvas. *Rev. Biol. Trop.*, **44/45**, 241-245.
- Zanuncio, J. C.; Zanuncio, T.V.; Guedes, R.N.C. and Ramalho, F.S. (2000), Effect of feeding on three *Eucalyptus* species in the development of *Brontocoris tabidus* (Het.: Pentatomidae) fed with *Tenebrio molitor* (Col.: Tenebrionidae). *Bioc. Sci. Tech.*, **10**, 443-450.
- Zanuncio, J. C.; Molina-Rugama, A. J.; Serrão, J. E. and Pratisoli, D. (2001), Nymphal development and reproduction of *Podisus nigrispinus* (Heteroptera: Pentatomidae) fed with combinations of *Tenebrio molitor* (Coleoptera: Tenebrionidae) pupae and *Musca domestica* (Diptera: Muscidae) larvae. *Bioc. Sci. Tech.*, **11**, 331-337.
- Zanuncio, J. C.; Saavedra, J. L. D.; Oliveira, H. N.; Degheele, D. and De Clercq, P. (1996), Development of the predatory stinkbug *Brontocoris tabidu*(Signoret) (Heteroptera: Pentatomidae) on different proportions of an artificial diet and pupae of *Tenebrio molitor* L. (Coleoptera: Tenebrionidae). *Bioc. Sci. Tech.*, **6**, 619-625.

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