

Production and Use of Heteroptera Predators for the Biological Control of *Eucalyptus* Pests in Brazil

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Abstract

The Asopinae predators of *Eucalyptus* spp. (Myrtaceae) pests in Brazil include *Brontocoris tabidus*, *Podisus distinctus*, *Podisus nigrispinus*, and *Supputius cincticeps* (Heteroptera: Pentatomidae). These insects feed on the larvae and pupae of Coleoptera and Lepidoptera defoliators. Asopinae predators are reared in the laboratory in wooden cages with wood screens on the upper and lateral sides and the front closed with a glass door, whereas, in the field they are raised in organza bags with branches of *Eucalyptus* spp. or *Psidium guajava* (Myrtaceae). An alternative prey, such as *Tenebrio molitor* (Coleoptera: Tenebrionidae) pupae and *Musca domestica* (Diptera: Muscidae), or *Bombyx mori* (Lepidoptera: Bombycidae) larvae, or the natural prey *Anticarsia gemmatilis* (Lepidoptera: Noctuidae), and *Thyrinteina arnobia* and *Thyrinteina leucocerae* (Lepidoptera: Geometridae) caterpillars may be provided to the nymphs of predators in cages and/or rearing bags. Vallourec & Mannesmann Forest Ltda. has two laboratories to mass rear *M. domestica* to produce annually 300,000 individuals of *P. nigrispinus* which are released with or without pests in the field. In the first case, predators are released after detection of the pest by a monitoring process, which is the first major step in integrated pest management (IPM). This predator is efficient when the pest population level is below the economic injury level, i.e., nine caterpillars/100 leaves of *Eucalyptus* spp. Releasing are made in outbreaks every 10 m and the population increase of this predator can control pests. *Podisus nigrispinus* usually prey on 4-5 first and second instars larvae or 2-3 fourth and fifth instar caterpillars per day. Asopinae predators are reared and released in the field to control pests in the *Eucalyptus* spp. plantations of the Vallourec & Mannesmann Forest Ltda. in Brazil.

Keywords: Asopinae, biodiversity, biological control, predators, sustainability.

Zanuncio JC, Tavares WS, Fernandes BV, Wilcken CF, Zanuncio TV (2013) Production and Use of Heteroptera Predators for the Biological Control of *Eucalyptus* Pests in Brazil. *Ekoloji* 23(91): 98-104.

INTRODUCTION

Asopinae predators of *Eucalyptus* spp. (Myrtaceae) pests in Brazil include the *Brontocoris tabidus* Signoret, 1852, *Podisus distinctus* Stål, 1860, *Podisus nigrispinus* Dallas, 1851, and *Supputius cincticeps* Stål, 1860 (Heteroptera: Pentatomidae) (Lemos et al. 2010a, Soares et al. 2011) (Fig. 1). These insects feed on the larvae and pupae of Coleoptera and Lepidoptera defoliators and on the nymphs and adults of *Thaumastocoris peregrinus* Dellape & Carpintero, 2006 (Hemiptera: Thaumastocoridae) (Souza et al. 2012).

MATERIAL AND METHODS

The Asopinae predators are reared in wooden

cages (30 cm × 30 cm × 30 cm) with a wood screen on the upper and lateral sides with the front enclosed with a glass door. The bottom of the cages are lined with paper to facilitate cleaning. Branches of *Eucalyptus* spp. are placed in the cages for *S. cincticeps* because this species needs plants (Lemos et al. 2009b). The Asopinae predators can also be reared in the field in organza bags with branches of the *Eucalyptus* spp. or *Psidium guajava* L. (Myrtaceae) (Lemos et al. 2009a, 2010b). The egg masses of these insects are removed daily from the cages and/or bags and maintained in Petri dishes until the nymphs reach second instar (Fig. 2).

Food is provided according to the rearing need to

Received : 09.09.2012 / Accepted: 02.02.2013

reduce cannibalism (Pires et al. 2011). The prey are placed on the top and bottom of rearing cages with moistened cotton as a water source. Alternative prey, such as the pupae of *Tenebrio molitor* L., 1785 (Coleoptera: Tenebrionidae), the larvae of *Musca domestica* L., 1758 (Diptera: Muscidae), and the *Bombyx mori* L., 1758 (Lepidoptera: Bombycidae) (Zanuncio et al. 2005, Neves et al. 2010) (Fig. 3) or the caterpillars of natural prey, such as the *Anticarsia gemmatalis* Hübner, 1818 (Lepidoptera: Noctuidae), *Thyrinteina arnobia* Stoll, 1782, and *Thyrinteina leucocerae* Rindge, 1961 (Lepidoptera: Geometridae) (Ferreira et al. 2008, Oliveira et al. 2011) may be provided to the nymphs of predators in the cages and/or rearing bags. The nymph period of *P. nigrispinus* was similar to the *T. molitor* pupae (T1) and *M. domestica* larvae (T2) or with both prey simultaneously (T3) or in alternated days (T4) with an average viability of 75%. Females were heavier in T1 and T4, although with similar reproductive rate. Females of these predators produced the highest number of eggs and nymphs with both preys simultaneously (Zanuncio et al. 2001).

Tenebrio molitor can be reared in plastic trays of different sizes with 95% wheat bran (high carbohydrate) and 5% beer yeast (rich in proteins). Slices of *Sechium edule* (Jacq.) Swartz (Cucurbitaceae) and *Saccharum* spp. (Poaceae) are placed on the substrate as a moisture source with a paper towel covering it to reduce brightness.

Three hundred grams of *M. domestica* pupae are needed to start a rearing facility with a capacity of 10,000 flies. This material can yield 2.5 to 3 kg of larvae per day with young adult flies fed with milk and sugar. A tray with moistened wheat bran with water and milk is placed inside the nursery as an oviposition site. The tray with the substrate with postures is removed the next day and its contents placed in a rearing tray with slightly moistened wheat bran. The larvae can be transferred with a trowel the next day and offered to the predators.

Vallourec & Mannesmann Forest Ltda. have trained personal to detect outbreaks of pests in the *Eucalyptus* spp. plantations. Natural enemies [*P. nigrispinus* and/or *Palmistichus elaeisis* Delvare & LaSalle, 1993 (Hymenoptera: Eulophidae)] are released in these areas when monitoring detects and indicates population levels of larvae and/or the pupae of insect pests. The predator *P. nigrispinus* is released in plantations with larvae of defoliators and

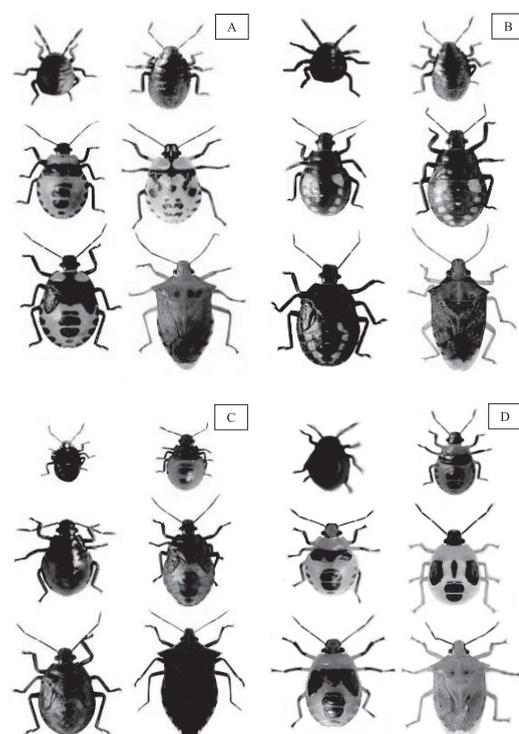


Fig. 1. Nymphs of first, second, third, fourth, and fifth instar and adults of (A) *Brontocoris tabidus*, (B) *Podisus nigrispinus*, (C) *Podisus distinctus*, and (D) *Supputius cincticeps* (Heteroptera: Pentatomidae).

P. elaeisis when pupae are present.

The natural enemies are transported to the field in coolers. *Podisus nigrispinus* is usually released in outbreaks of caterpillars. Then 2,000 to 5,000 third instar nymphs of *P. nigrispinus* are released per week from 8:00 to 16:00.

Pest population fluctuation is monitored weekly and the data recorded until caterpillar outbreaks are finished. A population survey and level of economic damage are determined in nine *Eucalyptus* spp. trees homogeneously distributed inside the area. A total of 100 leaves per plot are taken from the lower-middle part of small trees or those with a dominate canopy. The number and stage of larvae on these leaves are evaluated. If the number of natural enemies available is more than those necessary for release in caterpillar outbreaks they are released in areas with a history of pest occurrence, even in the absence of them.

RESULTS AND DISCUSSION

Lepidoptera defoliators can be controlled at egg and larva stages in the field by nymphs and adult Asopinae predators. Pupae of these pests can also be controlled by nymph and adult predators (Zanuncio



Fig 2. (A) Petri dish with eggs on pieces of cotton, (B) wooden cages with branches of *Eucalyptus grandis* W.Hill ex Maiden (Myrtaceae), and (C) organza bags involving branches of this plant in the field to rearing Asopinae predators.

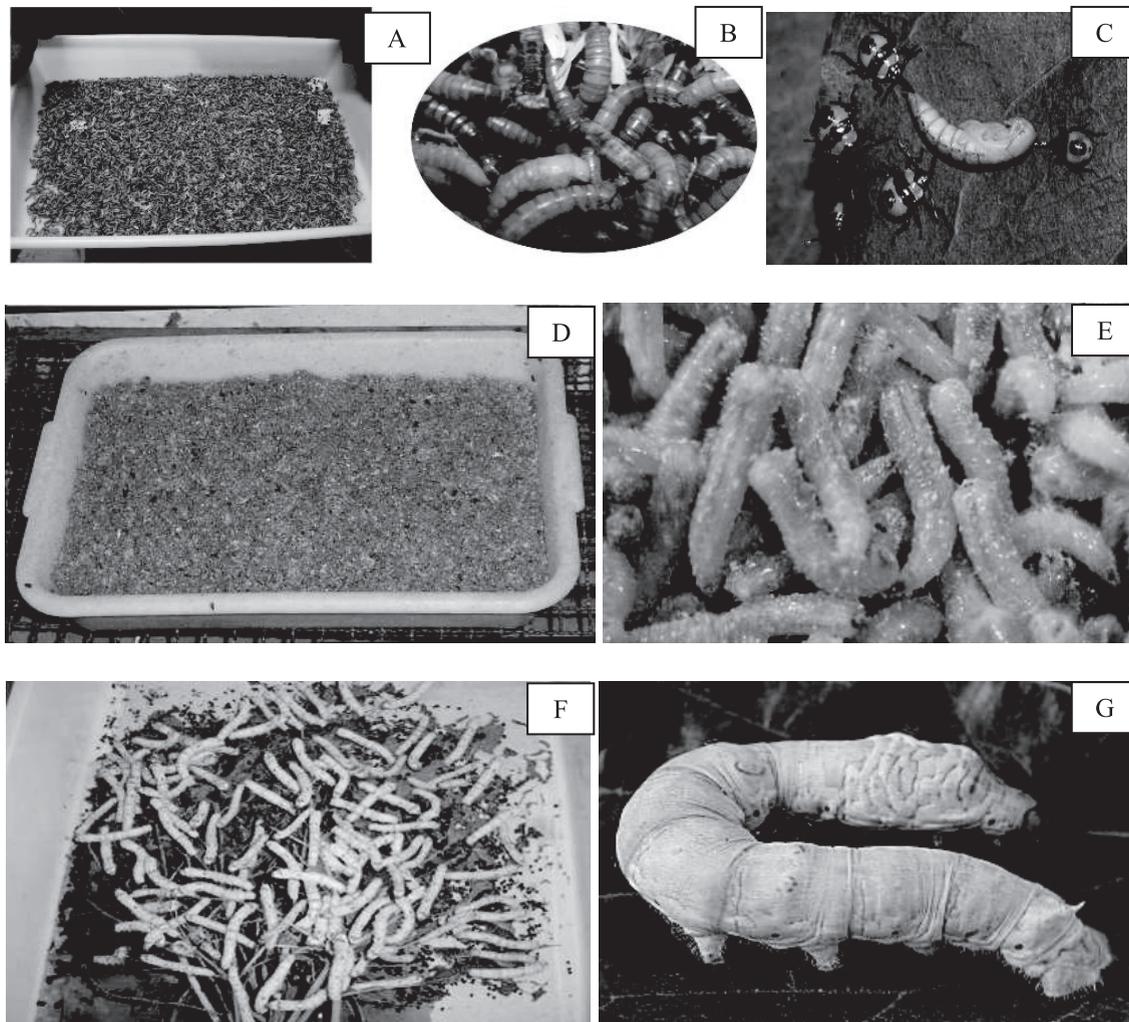


Fig 3. (A) Plastic tray with (B) larvae and pupae of *Tenebrio molitor* (Coleoptera: Tenebrionidae) and *Brontocoris tabidus* (Heteroptera: Pentatomidae), (C) nymphs preying on larvae of this prey, (D) Plastic tray with (E) *Musca domestica* (Diptera: Muscidae) larvae, and (F) Plastic tray with branches of *Morus* sp. (Moraceae) as a substrate to feed (G) *Bombyx mori* (Lepidoptera: Bombycidae) caterpillars.

et al. 2008) (Fig. 4) and by parasitoids as *P. elaeisis* and *Trichospilus diatraeae* Margabandhu and Cherian, 1942 (Hymenoptera: Eulophidae) (Pereira et al. 2008, Andrade et al. 2010). *Brontocoris tabidus* is the

first to arrive in areas infested by defoliating caterpillars, followed by other predatory species, especially *P. nigrispinus*. These natural enemies build large populations when egg parasitoids start to

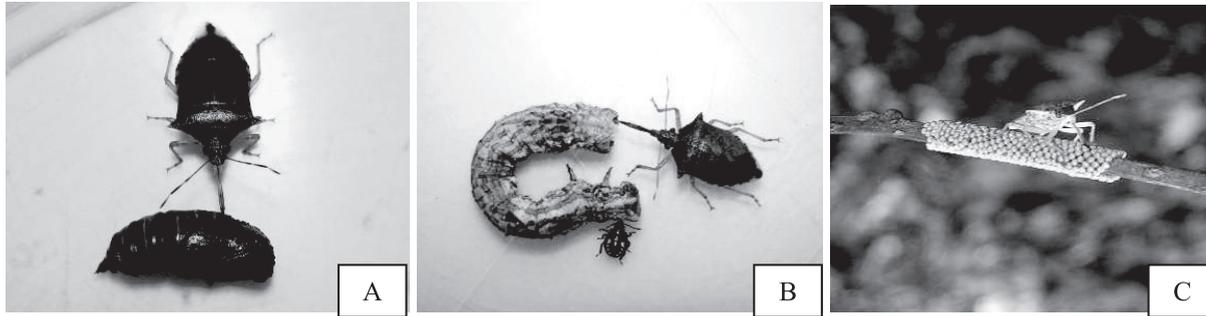


Fig. 4. (A) Asopinae predators feeding on pupa and (B) caterpillar in the laboratory, and (C) eggs of Lepidoptera defoliators in the field.

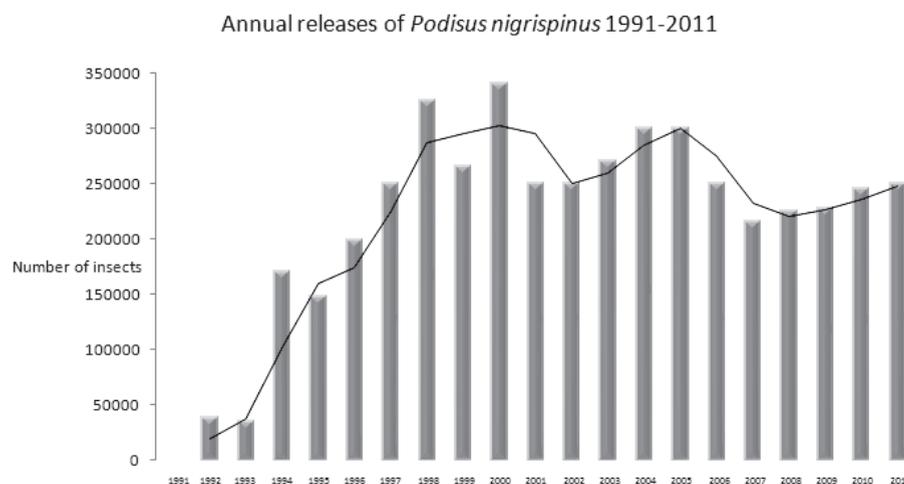


Fig. 4. Number of individuals of *Podisus nigrispinus* (Heteroptera: Pentatomidae) released from 1991 to 2011 in the *Eucalyptus* spp. (Myrtaceae) plantations of the Vallourec & Mannesmann Forest Ltda. in Minas Gerais State, Brazil.

reduce their populations (Soares et al. 2009). Barriers with spraying products based on *Bacillus thuringiensis* Berliner, 1915 (Bacillales: Bacillaceae) (Polanczyk et al. 2009) are made around pest outbreaks to reduce its spread.

The diversity of natural enemies is an alternative in integrated pest management (IPM). The emergence and the cycle from egg to adult of *P. elaeisis* parasitizing pupae of *T. molitor* predated by *P. nigrispinus* for 48 h showed lower values compared to 24 h, but the female parasitoid that emerged had a longer lifespan. Predation of pupae parasitized by *P. elaeisis* reduced the emergence and sex ratio, but the increased longevity of this parasitoid, may reduce its populations in the field. Moreover, shorter immature stage and increased longevity of *P. elaeisis* could benefit the impact of this parasitoid in the field with the predator *P. nigrispinus* (Soares 2010).

Vallourec & Mannesmann Forest Ltda. is a

pioneer company in Brazil using biological control for pest management in the *Eucalyptus* spp. plantations. The first laboratory of biological control was built at the Support Centre for Research and Forest Development (CAPEF) in Paraopeba, Minas Gerais State, Brazil in 1989 to mass produce and release *P. nigrispinus* to control outbreaks of *Apateodes sericea* Schaus, 1896 (Lepidoptera: Eupterotidae), *Glena* spp. (Lepidoptera: Geometridae), *Psorocampa denticulata* Schaus, 1901 (Lepidoptera: Notodontidae), and *T. arnobia*, besides other lepidopteran species (Zanuncio et al. 2003, Freitas et al. 2005). This is important because yield losses between 5 and 10% were recorded for trees with 75 and 100% defoliation, respectively, and therefore pest control is important to maintain wood productivity. Biological control is an effective and sustainable pest management method because it reduces the population levels of pests and the number of chemical applications (Elek et al. 2003,

Mansfield et al. 2006).

Podisus nigrispinus is preferable for mass rearing and pest control in *Eucalyptus* spp. plantations because it presents a well developed and efficient production technique compared to other Asopinae, besides having more eggs per female with higher predation rates and short life cycle and it can be fed an artificial diet during periods of prey shortage (Ramalho et al. 2008). Vallourec & Mannesmann Forest Ltda. has two laboratories to mass rear *M. domestica* with an average annual production of 300,000 predators (Fig. 5). Environment conditions affect the duration of the life cycle of predators and, therefore, temperature, relative humidity, and photoperiod should be controlled (Medeiros et al. 2003, 2004).

Podisus nigrispinus is released with or without pests in the field. In the first case, predators are released after detection of the pest by the monitoring process, which is the first major step in IPM. This predator is efficient when pest population level is below the economic injury level, i.e., nine caterpillars/100 leaves of *Eucalyptus* spp. Releases are made in outbreaks every 10 m. *Podisus nigrispinus* usually prey on four to five first and second instars larvae or two to three fourth and fifth instar caterpillars per day. A total of 1.500 ha of *Eucalyptus* spp. with an outbreak of the defoliating

caterpillars *Thyriniteina* spp. and *Glena* spp. was controlled with *P. nigrispinus* in the first three months of 2012. It is necessary to point that this control prevented an increase in the area damaged by defoliating caterpillars and to adjacent eucalyptus plantations.

Occurrence of larvae and damage is usually more severe in *Eucalyptus* spp. from seeds when the plants are between three and four years old. On the other hand, plantations with clones, such as most grown in Brazil, have a more advanced technological level and are generally infested by defoliator caterpillars when they are one to two years old. Therefore, prevention measures against caterpillar defoliators are higher in clone plantations of *Eucalyptus* spp. These insects, normally, have larger populations during months of low rainfall, water deficit, and lower relative humidity.

Asopinae predators are reared and released in the field to control pests in *Eucalyptus* spp. plantations of the Vallourec & Mannesmann Forest Ltda. in Brazil.

ACKNOWLEDGEMENTS

To the Brazilian agencies “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.

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