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Mortality of the defoliator *Euselasia eucerus* (Lepidoptera: Riodinidae) by biotic factors in an *Eucalyptus urophylla* plantation in Minas Gerais State, Brazil

JOSÉ C. ZANUNCIO[1], JORGE B. TORRES[2], CAMILLA A.Z. SEDIYAMA[3], FABRICIO F. PEREIRA[1], PATRIK L. PASTORI[3], EDUARDO D. WERMELINGER[4] and FRANCISCO S. RAMALHO[5]

[1]Departamento de Biologia Animal, Universidade Federal de Viçosa
Av. P.H. Rolfs s/n, Centro, 36571-000 Viçosa, MG, Brasil
[2]Departamento de Agronomia e Fitossanidade, Universidade Federal Rural de Pernambuco
Av. Dom Manoel de Medeiros s/n, Dois Irmãos, 52171-900 Recife, PE, Brasil
[3]Departamento de Fitotecnia, Universidade Federal de Viçosa
Av. P.H. Rolfs s/n, Centro, 36571-000 Viçosa, MG, Brasil
[4]Departamento de Ciências Biológicas, Escola Nacional de Saúde Pública, Fundação Oswaldo Cruz
Rua Leopoldo Bulhões, 1.480, Manguinhos, 21040-360 Rio de Janeiro, RJ, Brasil
[5]Embrapa Algodão/Unidade de Controle Biológico, Rua Oswaldo Cruz, 1.143
Centenário, 58107-720 Campina Grande, PB, Brasil

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ABSTRACT

Euselasia eucerus (Hewitson, 1872) (Lepidoptera: Riodinidae) is a Brazilian native species commonly found in *Eucalyptus* plantations. Biotic mortality factors of this defoliator were studied in a *Eucalyptus urophylla* plantation in Minas Gerais State, Brazil aiming to identify natural enemies and their impact on this insect. *Euselasia eucerus* had biotic mortality factors during all development stages. The most important were *Trichogramma maxacalii* Voegelé and Pointel, 1980 (Hymenoptera: Trichogrammatidae) during egg stage (48.9%), a tachinid fly (Diptera: Tachinidae) during larval stages (10%) and *Itoplectis* sp. (Hymenoptera: Ichneumonidae) during pupal stage (52.2%). The parasitism rate was higher in the basal part of the plant canopy (37.8%).

Key words: Eulophidae, fungus, Ichneumonidae, Pentatomidae, Scelionidade, *Trichogramma*.

INTRODUCTION

Lepidoptera pests can cause significant damage to eucalyptus plantations in Brazil (Zanuncio et al. 1993, 1998, 2001, Bernardino et al. 2007). *Euselasia eucerus* (Hewitson, 1872) (Lepidoptera: Riodinidae), also reported as *Euselasia apisaon* (Dalman, 1823) (Zanuncio et al. 1990, Murta et el. 2008), is a Brazilian native insect and its caterpillars are commonly found in *Eucalyptus* spp. plantations in São Paulo, Rio Grande do Sul, Santa Catarina and Minas Gerais States, Brazil in outbreaks conditions (Zanuncio et al. 1994). The entire developmental cycle of *E. eucerus* takes place on *Eucalyptus* trees, this insect lays its egg clusters on their leaves and its caterpillars are gregarious and pupate on leaves of *Eucalyptus* spp. (Zanuncio et al. 1990). *Euselasia eucerus* eggs are parasitized by *Trichogramma maxacalii* Voegelé and Pointel, 1980, *Trichogramma demoraesi* Nagaraja, 1983 and *Trichogramma acacioi* Brun, Moraes and Soares, 1984 (Hymenoptera: Trichogrammatidae); its caterpillars and its pupae are predated by *Podisus nigrispinus* (Dallas, 1851), *Brontocoris tabidus* (Signoret, 1852), *Supputius cincticeps* (Stål, 1860)

Correspondence to: José Cola Zanuncio
E-mail: zanuncio@ufv.br

and *Alcaeorrhynchus grandis* (Dallas, 1851) (Heteroptera: Pentatomidae) and its pupa are parasitized by the fungus *Paecilomyces fumosoroseus* (Wize) (Brun et al. 1983, Oliveira et al. 2000, Murta et al. 2008). However, pupal parasitism of *E. eucerus* and the impact of other biological factors (Zanuncio et al. 1998a, b) on mortality of this pest have not been studied.

The importance of each natural enemy species on the biological control of insect pests can be estimated by evaluating their attack rate (Zanuncio et al. 1998a, b, Landis et al. 2000, Kean et al. 2003, Thies et al. 2003, Soares et al. 2007). However, sampling after parasitoid releases to determine the percentage of individuals attacked may not be adequate to estimate parasitism rate (van Driesche et al. 1991, Pastori et al. 2007). Problems occur when parasitism relationships such as stage or susceptible instars, and size or habitat are not known or when mortality factors including predation and parasitoid emergence occur in a different stage from that attacked (Pratissoli et al. 2003). Another problem can occur when host mortality during handling time by natural enemies and losses by migration are not considered. Therefore, samples taken at different stages of the pest in its habitat can show the frequency, the diversity and the potential impact of each factor on pest population, which is frequently limited by parasitoids and predators (Hawkins 1988, Kruess and Tschantke 1994, Michaud 2004).

The objective of this work was to identify parasitoids and predators and to quantify their impact on different stages of the defoliator *E. eucerus* in a plantation of *E. urophylla* in the Municipality of Caeté, Minas Gerais State, Brazil.

MATERIALS AND METHODS

This work was carried out in a two- to three-year-old (*ca.* 5.0 m height) *E. urophylla* plantation in the Municipality of Caeté, Minas Gerais State, Brazil (19°52′48″S 43°40′12″W). The impact of biotic factors (natural enemies) on mortality of eggs, caterpillars and pupae of *E. eucerus* was evaluated in a second- to third-generation outbreak of this pest. The first sampling (September 1997) collected individuals of *E. eucerus* at all development stages, from leaves and branches of the basal part of nine *Eucalyptus* plants from each three plots with a total of 27 plants. All material collected was brought to the laboratory where it was reared to the end of each stage in order to identify mortality causes per stage of *E. eucerus*.

A second sampling was made in the same area and plots in January 1998. Plant levels of *Eucalyptus* trees were divided into upper, middle and lower thirds to study the distribution of eggs, caterpillars and pupae mortality factors of *E. eucerus* as function of plant height. One branch per plant ($\pm$100 leaves) containing different developmental stages of *E. eucerus* was collected in each of these parts. The samples were collected from nine plants and from three plots at the same place where the first sampling was performed.

The egg clusters of *E. eucerus* were individualized in glass tubes closed with plastic film Magipack^{TM}, until eclosion of caterpillars or egg parasitoids. Pupae of *E. eucerus* were isolated in 9.0 $\times$ 1.2 cm Petri dishes until emergence of adults of *E. eucerus* or parasitoids. Finally, caterpillars of this pest were counted and maintained in groups, in nylon mesh cages with branches of *E. urophylla* until its pupation or death. Pupae were then maintained in similar conditions until emergence of *E. eucerus* or parasitoids.

The relationship between egg parasitism and size of egg clusters of *E. eucerus* was analyzed by simple linear regression and that of oviposition of this pest and parasitism rate as a function of *Eucalyptus* plant height was studied by analysis of variance and the test of Tukey.

Egg parasitoids were sent to Dr. Roberto A. Zucchi from the University of São Paulo, São Paulo State, Brazil, and hymenopteran pupae parasitoids were separated into morphospecies and sent to Dra. Angélica M. Penteado-Dias from the Federal University of São Carlos, São Carlos, São Paulo State, Brazil, for identification.

RESULTS

In the first sampling, 10,046 eggs of *E. eucerus* were collected with an average of 54.6 $\pm$ 20.2 eggs per egg cluster (mean $\pm$ SD). A total of 4,778 eggs (52.1%) did not yield caterpillars; 91.4% of them were parasitized by *T. maxacalii* and 8.6% did not show embryonic development. Egg parasitism was positively correlated with

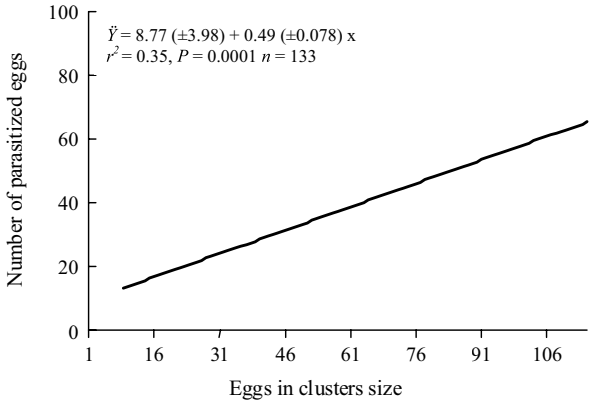

Fig. 1 – Effect of egg cluster size of *Euselasia eucerus* (Lepidoptera: Riodinidae) on natural parasitism by *Trichogramma maxacalii* collected in the Municipality of Caeté, Minas Gerais State, Brazil.

the size of egg clusters ($y = 8.77 + 0.49x$, $r^2 = 0.35$, $F = 67.6$, $P < 0.001$, $n = 133$) (Fig. 1).

Mortality of *E. eucerus* caterpillars by biotic factors may be from either predation by Pentatomidae or from larval/pupal parasitism by Tachinidae flies. Tachinid parasitoids were responsible for 7.5 and 2.1% mortality of caterpillars and pupae of this pest, respectively (Table I), and no parasitoids were observed emerging from caterpillars. The number of caterpillars killed by pentatomid predators was not quantified since the sampling was carried out in a fixed time and the total population of *E. eucerus* caterpillars was not estimated. Moreover, prey carcasses or fragments are difficult to distinguish in the field. Therefore, all such observed data arise from five males, four females and one fifth instar nymph of *B. tabidus*. One male and two females of *S. cincticeps* were also found preying caterpillars of *E. eucerus*. Six eggs clusters of *B. tabidus* (237 eggs) were found and 34.4% of which yielded nymphs and 60.0% were parasitized by *Trissolcus brochymenae* (Ashmead, 1881) (Hymenoptera: Scelionidae).

Of 105 *E. eucerus* pupae collected, 52.5% were parasitized by *Itoplectis* sp. (Hymenoptera: Ichneumonidae), 2.5% by *Galeopsomyia* sp. (Hymenoptera: Eulophidae) and 10.0% by a fungus, respectively. Besides this, 7.5% of pupae of this insect were unviable due to unknown factors.

The number of eggs per egg cluster of *E. eucerus* was similar in the three levels of the *Eucalyptus* trees, 54.2 ± 23.1, 49.8 ± 20.6 and 47.4 ± 21.3 in the basal, middle and apical levels of the plants, respectively. The parasitism by *T. maxacalii* on 27, 40 and 47 egg clusters showed higher values, 37.8 ± 26.1% in the apical third and 29.9 ± 39.8% in the medium third than the 18.3 ± 34.5% in the lower third of *Eucalyptus* trees.

Mortality due to parasitism of *E. eucerus* pupae by *Itoplectis* sp. was greater than any other factor, with 47.7, 61.7 and 29.3% in the basal, middle and apical levels of the plants, respectively. Ranking of pupae mortality factors was an unknown factor, a fungus species, and parasitism by *Aprostocetus* sp. (Hymenoptera: Eulophidae), a tachinid fly and a *Quadrastichus* sp. (Hymenoptera: Eulophidae) (Table I). The parasitoid *Galeopsomyia* sp. (Hymenoptera: Eulophidae) was not found during the second sampling.

DISCUSSION

The high parasitism rate of *E. eucerus* eggs by *T. maxacalli* indicates that the oviposition behavior (laying its eggs in clusters) of this pest favors the impact of this parasitoid which can parasitize most eggs of a cluster as happened in this study and with high impact on populations of this herbivore (Murta et al. 2008). This is similar to that observed for *Trichogramma* species (Hymenoptera: Trichogrammatidae) on eggs of *Choristoneura fumiferana* (Clemens, 1865) (Lepidoptera: Tortricidae) and *Diaphania nitidalis* (Stoll, 1781) (Lepidoptera: Pyralidae) as the most important and the key mortality factor of these pests, possible due to the fact that this species lay its eggs in clusters (Quayle et al. 2003). On the other hand the *Trichogramma* species did not represent an important mortality factor of *Tortrix viridana* (Linnaeus, 1758) (Lepidoptera: Tortricidae) which lay eggs isolated and dispersed (Du Merle 1983) and *Traumatocampa ispartaensis* (Do Ganlar and Avci 2001) (Lepidoptera: Notodontidae) duet to a protection by a cement like substance (Avci 2003).

Although predation rates by pentatomid predators did not allow a good evaluation of their efficiency, their importance in this ecosystem is suggested by:

1) the number of *B. tabidus* pairs mating or preying on caterpillars of *E. eucerus* in *Eucalyptus* plants and in the understory vegetation and;

TABLE I

Percentage mortality of caterpillars and pupae by different factors and adult emergence of *Euselasia eucerus* (Lepidoptera: Riodinidae) collected in an *Eucalyptus urophylla* plantation in the Municipality of Caeté, Minas Gerais State, Brazil.

Factors	Sampling size	Part of tree canopy		
		Lower	Middle	Upper
Egg parasitism	5635 eggs			
Trichogramma maxacalii		37.8	29.9	18.3
Non eclosion of caterpillars		19.4	1.1	2.4
Caterpillar/pupae parasitism by	483 caterpillars			
Tachinidae flies		7.5	2.1	0.0
Pupae parasitism by	105 pupae			
Itoplectis sp.		47.7	61.7	29.3
Aprostocetus sp.		10.1	4.3	0.0
Quadrastichus sp.		2.0	0.0	0.0
Unknown factors		20.1	21.3	15.9
Fungus		10.5	6.4	0.0
Emergence of adults		2.5	4.3	51.0

2) the finding of six egg clusters of this predator, being 60.6% of them parasitized by *T. brochymenae*.

The high population level of this parasitoid suggests that *B. tabidus* had been present in the area for several generations because egg clusters of *P. nigrispinus* showed a parasitism rate of 27.5% by *Telenomus podisi* Ashmead, 1893 (Hymenoptera: Scelionidae) and *T. brochymenae* in areas with previous releases of this pentatomid. Comparatively, areas with limited releases of this predator only during the sampling period and areas without release showed parasitism rates of 8.8 and 2.4% (Torres et al. 1996/1997, Zanuncio et al. 2000).

The Hymenoptera parasitoids *Itoplectis* sp. and *Galeopsomyia* sp. were not previously recorded in pupae of *E. eucerus* or in any other *Eucalyptus* defoliator caterpillar species in Brazil (Brun et al. 1983) but species of this group have been collected in the others eucalypt species (Zanuncio et al. 2008, Pereira et al. 2008 a, b). Tachinidae adults emerging during the pupal stage of *E. eucerus* accounted for 10.0% of pupa mortality of this pest. *Trichogramma soaresi* (Nagaraja, 1983), *T. acacioi* and *T. maxacalii* (Hymenoptera: Trichogrammatidae) are known as egg parasitoids of *Euselasia* species. *Trichogramma maxacalii* has previously been found parasitizing eggs of *Euselasia euploea eucerus* (Hewitson, 1872), *Euselasia hygenius occulta* Stichel, 1919 and *E. eucerus* (Lepidoptera: Riodinidae) (Oliveira et al. 2000).

Pupal parasitism by a fungus of the genus *Paecilomyces* and by a tachinid fly also occurred. The factors that determine the diversity and the impact of parasitoids on 285 moth species in the United Kingdom showed that the number of studies conducted on the host species, the host habitat and the host plant architecture were correlated. Among eight variables, habitat and plant architecture presented higher correlation with the impact of the parasitoids. This author also pointed out that the number of generations per year of a Lepidoptera pest showed positive correlation with parasitoid diversity. He also discusses 74 cases of biological control by parasitism of Hymenoptera and Diptera species with values above 40%. Although parasitism rate around 90% was not enough to control pests in many cases, this was mainly due to the non-synchronization of the parasitoid with its host. For this reason, successful control of these moths was achieved only in restricted areas (Hawkins 1988). This shows that pest management strategies to increase natural mortality of insect pests should include conservation or augmentative impact of natural enemies (Bragança et al. 1998a, b, Jahnke et al. 2006).

Euselasia eucerus suffers considerable mortality during all development stages in *Eucalyptus* plantation

in Brazil including egg mortality by *T. maxacalii* and pupae mortality by *Itoplectis* sp. The role of predatory Pentatomidae as control agents against caterpillars of *E. eucerus* has high potential against defoliator pests in eucalyptus plantations in Brazil but needs to be studied further (Zanuncio et al. 1994).

Biotic mortality factors of *E. eucerus* were found during all developmental stages of this pest in an *E. urophylla* plantation in the Municipality of Caeté, Minas Gerais State, Brazil. Most important ones were *T. maxacalii*, tachinid flies and *Itoplectis* sp. during egg, larvae, and pupae stages of this pest, respectively.

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RESUMO

Euselasia eucerus (Hewitson, 1872) (Lepidoptera: Riodinidae) é uma espécie brasileira nativa, comumente encontrada em plantios de *Eucalyptus*. Um estudo da mortalidade por fatores bióticos desse desfolhador foi feito em um plantio de *Eucalyptus urophylla* no Estado de Minas Gerais, Brasil, com o objetivo de identificar os inimigos naturais e seu impacto sobre esse lepidóptero. *Euselasia eucerus* possui fatores bióticos de mortalidade durante todas as suas fases de desenvolvimento. Os mais importantes foram *Trichogramma maxacalii* Voegelé e Pointel, 1980 (Hymenoptera: Trichogrammatidae) durante a fase de ovo (48,9%), um Diptera: Tachinidae durante a fase de larva (10%) e *Itoplectis* sp. (Hymenoptera: Ichneumonidae) durante a fase pupal (52,2%). A taxa de parasitismo foi mais elevada na parte basal de plantas de eucalipto (37,8%).

Palavras-chave: Eulophidae, Fungos, Ichneumonidae, Pentatomidae, Scelionidade, *Trichogramma*.

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