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Reproduction of *Palmistichus elaeisis* Delvare and LaSalle, 1993 (Hymenoptera: Eulophidae) in pupae of *Zophobas confusa* Gebien, 1906 (Coleoptera: Tenebrionidae)

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Abstract

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Zophobas confusa Gebien, 1906 (Coleoptera: Tenebrionidae) is a new alternative host for mass laboratory rearing the parasitoid *Palmistichus elaeisis* Delvare and LaSalle, 1993 (Hymenoptera: Eulophidae).

Additional key words: Mass rearing, alternative host, biological control, parasitoids.

Resumen

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Zophobas confusa Gebien, 1906 (Coleoptera: Tenebrionidae) es un nuevo hospedero alternativo para la cría masiva del parasitoide *Palmistichus elaeisis* Delvare and LaSalle, 1993 (Hymenoptera: Eulophidae) en el laboratorio.

Palabras clave adicionales: Control biológico, Cría masiva, hospedero alternativo, parasitoides.

The generalist endoparasitoid *Palmistichus elaeisis* Delvare and LaSalle, 1993 (Hymenoptera: Eulophidae) can develop in its host pupae, which overcome the hosts physiology and can therefore be used for biological control of agricultural and forest pests (Bittencourt and Berti Filho 1999, 2004; Pereira et al. 2008 b). The lack of artificial diets requires the use of alternative hosts for the mass production of these wasps in the laboratory (Pereira et al. 2009).

Alternative hosts suitable for mass rearing the parasitoid must be easily cultured at low cost and at an efficiency similar to that of natural hosts, which is essential for biological control programs (Bittencourt and Berti Filho 1999; Paron and Berti Filho 2000; Ramalho and Dias 2003; Pereira et al. 2009). Thus, research aimed to find alternative hosts is fundamental to improve mass rearing of natural enemies in the laboratory.

Zophobas confusa Gebien, 1906 (Coleoptera: Tenebrionidae) can be reared at a low cost and its behavioral characteristics are similar to that of *Tenebrio molitor* Linnaeus, 1758 (Coleoptera: Tenebrionidae), which is actually used for *P. elaeisis* in the laboratory (Zanuncio et al. 2008). Moreover, the size of *Z. confusa* may improve progeny and, therefore, the aim of this study was to evaluate reproductive characteristics of *P. elaeisis* in pupae of *Z. confusa* in the laboratory.

The research was carried out at the Laboratory of Biological Control of Insects, Department of Animal Biology, 'Universidade Federal de Viçosa', Viçosa, Minas Gerais State, Brazil.

Thirty 24 hours old pupae of *Z. confusa* (630.23 ± 41.51 mg) were separated in glass tubes (2.2 x 14.0 cm) and exposed to 12 females of 72 hours old *P. elaeisis* (determined by preliminary tests) during 24 hours. Pupae of *Z. confusa* were maintained in acclimatized chamber at 25 ± 2 ºC, 70 ± 10 % relative humidity and photoperiod of 14 hours. These hosts were observed daily until the emergence of the offspring.

Duration of life cycle (egg-adult); percentage of parasitism [(without the natural mortality of the host) (Abbott 1925)]; percentage of emergence of the progeny; number of parasitoids emerged per pupa of *Z. confusa*; sex ratio (calculated with the equation SR = number of females/ number of adults), longevity and cephalic capsule widths of males and females were obtained. The sex of the parasitoids emerged was determined based on the morphological characteristics of their antenna and abdomen (Delvare and Lasalle 1993). Size measurements were obtained with a micrometric ocular coupled to a stereomicroscope.

Percentages of parasitism, emergence and duration of life cycle of *P. elaeisis* in pupae of *Z. confusa* was 100.00 %, 64.28 % and 28.78 ± 1.47 days, respectively. The progeny was 133.78 ± 21.95 offspring per parasitoid pupa or 4.71 grams per host, and the sex ratio of 0.87 ± 0.03. Longevity of males and females of *P. elaeisis* emerged from pupae of *Z. confusa* was 12.31 ± 0.72 and 13.64 ± 0.95 days, respectively. Cephalic capsule width was 0.43 ± 0.06 mm in males and 0.54 ± 0.09 mm in females.

Pupae of *Z. confusa* were suitable to *P. elaeisis* resulting in parasitism in all pupae offered, which characterizes the general habit of this parasitoid (Pereira et al. 2008 b). Parasitism similar to the results of this study was obtained from pupae of *Spodoptera frugiperda* (JE Smith, 1797) (Lepidoptera: Noctuidae), *Diatraea saccharalis* (Fabricius, 1794) (Lepidoptera: Pyralidae), *Heliothis virescens* (Fabricius, 1781) (Lepidoptera: Noctuidae), *Anticarsia gemmatalis* Hübner, 1818 (Lepidoptera: Noctuidae) and *Thyrinteina arnobia* (Stoll, 1782) (Lepidoptera: Geometridae) parasitized by *P. elaeisis* or *Trichospilus diatraeae* Margabandhu and Cherian, 1942 (Hymenoptera: Eulophidae) (Paron and Berti-Filho 2000, Bittencourt and Berti Filho 2004, Pereira et al. 2008a).

The life cycle of *P. elaeisis* in pupae of *Z. confusa* was longer than pupae of *T. molitor*, *A. gemmatalis*, *D. saccharalis*, *S. frugiperda*, *T. arnobia* or *H. virescens* ranging from 18.9 to 23.42 days (Bittencourt and Berti Filho 2004, Pereira et al. 2008b, Zanuncio et al. 2008). This suggests the effect of host on development time of parasitoid as reported for other species of parasitoids (Zago et al. 2006, Pastori et al. 2008, Pereira et al. 2008b, Fávero 2009).

The progeny of *P. elaeisis* per gram of pupae of *Z. confusa* than in pupae of *T. arnobia* (one parasitoid/ 2.04 g of pupae), *A. gemmatalis* (one parasitoid/ 2.17 g pupa) and *T. molitor* (one parasitoid/ 1.33 g pupa) (Pereira 2006; Zanuncio et al. 2008). This indicates that there was relationship between host size and number of offspring produced. Nevertheless, this did not happen in pupae of *Z. confusa*, in spite of larger size of these latter.

The sex ratio of offspring of *P. elaeisis* in pupae of *Z. confusa* was lower than in pupae of *Bombyx mori* Linnaeus, 1758 (Lepidoptera: Bombycidae) (0.94-0.96), *A. gemmatalis* (0.96) and *T. molitor* (0.94), but similar to that found in *D. saccharalis* (0.89) (Bittencourt and Berti Filho 1999, Pereira 2006, Zanuncio et al. 2008). However, the sex ratio was satisfactory, because there was greater production of females of *P. elaeisis*, responsible for parasitism and production of future offspring (Gonzáles et al. 2004; Silva-Torres and Matthews 2003).

The longevity of males and females of *P. elaeisis* was lower than that found in *T. molitor*, but with a similar cephalic capsule width (Zanuncio et al. 2008), indicating influence of host longevity on this parasitoid. In releases of natural enemies, parasitoids should be used that are able to survive, find and parasitize their hosts in the field. Knowledge of longevity of the natural enemy is important for timing the releases, which should not be greater than the lifetime of the parasitoid.

Palmistichus elaeisis showed adequate reproductive performance in pupae of *Z. confusa*, thus concluding that this host can be used for mass rearing of *P. elaeisis* in the laboratory.

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