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First report of *Dolichozele koebelei* Viereck, 1911 (Hymenoptera: Braconidae) on larvae of *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae) in maize (*Zea mays* L.) under different cropping systems

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(With 1 figure)

Abstract

In the context of the modern agriculture, pest control is important in order to increase productivity in maize (*Zea mays* L.). However, this control should be done rationally, prioritising environmentally safer methods such as biological control. This paper aims to report the occurrence of *Dolichozele koebelei* Viereck, 1911 (Hymenoptera: Braconidae) in *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae) larvae collected in maize subjected to different cropping systems. The experiment was conducted at the Centro Nacional de Pesquisa de Milho e Sorgo (CNPMS) in Sete Lagoas, Minas Gerais State, Brazil, using organic and conventional production. Ten plants were sampled from each of the 24 plots and for each production system, three times a week during the entire cycle of maize (variety BR 106). In the laboratory, larvae were distributed in individual rearing containers with artificial diet until the end of the biological cycle. An increased number of *S. frugiperda* larvae was observed in organic single crop maize; hence a higher percentage of *S. frugiperda* larvae parasitised by Hymenoptera and Diptera also occurred in the maize under this production system. *Dolichozele koebelei* had not yet been described in association with larvae of *S. frugiperda*. The percentage of parasitism of *S. frugiperda* larvae was high in both experiments, indicating the importance of natural control agents in reducing the population density of *S. frugiperda*, and especially the importance of an appropriate crop management.

Keywords: agroecosystem, biological control, fall armyworm, parasitoid, Macrocentrinae.

Primeira ocorrência de *Dolichozele koebelei* Viereck, 1911 (Hymenoptera: Braconidae) em larvas de *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae) coletadas em milho (*Zea mays* L.) sob diferentes formas de cultivo

Resumo

No contexto agrícola moderno, o controle de pragas é importante para se obter aumento de produtividade na cultura do milho (*Zea mays* L.). No entanto, esse controle deve ser feito racionalmente, e deve priorizar métodos ambientalmente mais seguros, como o controle biológico. Este trabalho teve como objetivo relatar a ocorrência de *Dolichozele koebelei* Viereck, 1911 (Hymenoptera: Braconidae) em larvas de *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae) coletadas em milho sob diferentes formas de cultivo. O experimento foi conduzido no Centro Nacional de Pesquisa de Milho e Sorgo (CNPMS) em Sete Lagoas, Minas Gerais, Brasil, em áreas de produção orgânica e convencional. Durante todo o ciclo do milho (cultivar BR 106), três vezes por semana, foram amostradas em cada uma das 24 parcelas, 10 plantas, que foram avaliadas no laboratório. As larvas encontradas foram distribuídas individualmente em recipientes de criação com dieta artificial até o final do ciclo biológico. Maior número de larvas de *S. frugiperda* foi obtido no milho orgânico solteiro, com maior percentual de larvas de *S. frugiperda* parasitadas por Hymenoptera ou Diptera. *Dolichozele koebelei* ainda não havia sido descrita em associação com larvas de *S. frugiperda*. De uma forma geral nos dois experimentos o percentual de larvas de *S. frugiperda* parasitadas, foi alto, indicando a importância dos agentes de controle natural na redução da densidade populacional de *S. frugiperda* e, principalmente, a importância do manejo adequado da cultura do milho.

Palavras-chave: agroecossistema, controle biológico, lagarta-do-cartucho, parasitoide, Macrocentrinae.

1. Introduction

Maize (*Zea mays* L.) is one of the most important crops in Brazil, presenting record production and productivity. Nevertheless, there is still scope for increase. The production is mainly used in the animal production segment (feed and silage) and obtained in almost all Brazilian States, with lower expression in the North (Cruz et al., 2011).

Many pests are important in the maize agroecosystem, and are well known especially in conventional cultivation. The production of maize in the organic system still needs greater research effort to determine the exact occurrence and economic importance of each pest species (Macfadyen et al., 2009; Bengtsson et al., 2005). The fall armyworm, *Spodoptera frugiperda* (J. E. Smith, 1797) (Lepidoptera: Noctuidae), is especially important among these pests, and can reduce the production of grains in 15-73% under favourable conditions (Cruz and Turpin, 1982, 1983; Cruz et al., 1996, 1999; Hruska and Gould, 1997; Figueiredo et al., 2006a, b), with losses estimated at over 400 million dollars (Cruz et al., 1999).

In the context of modern agriculture, pest control is important to achieve higher productivity in maize. However, this control should be done rationally, aiming for the reduction in the use of pesticides and must prioritise other environmentally safer methods such as biological control, which enables the reduction in contamination of the producer, product, consumer and environment. This method can be lower in cost, and the wealth of the Brazilian fauna can be used to act as potential agents of pest control (Silva et al., 2011).

Knowledge of species and the flow of natural biological control agents in agricultural areas are essential to establish integrated management programmes. Among the insects of interest for use in biological control of *S. frugiperda*, parasitoids, due to their efficiency and specificity in relation to the host, have been considered the most important.

The subfamily Macrocentrinae Foerster (Hymenoptera: Braconidae) has about 150 described species; they can be solitary or gregarious, the gregarious species being polyembryonic. Most members of this subfamily have long legs and are koinobiont endoparasitoids of Lepidoptera larvae of the families: Gelechiidae, Noctuidae, Oecophoridae, Pyralidae, Tineidae, Tortricidae and Sesiidae (Achterberg, 1993).

The aim of this study was to report the occurrence of *Dolichozele koebelei* Viereck, 1911 (Hymenoptera: Braconidae; Macrocentrinae) in larvae of *S. frugiperda* collected in maize under different cropping systems.

2. Material and Methods

The experiments were conducted during the 2010/2011 season in the Cerrado region, in field trials and in the Laboratório de Criação de Insetos (Lacri) of the Centro Nacional de Pesquisa de Milho e Sorgo (CNPMS), in Sete Lagoas, Minas Gerais State, Brazil (19 ° 28' S and 44 ° 15' W).

2.1. Experiment I (conventional x organic maize)

This experiment was implemented on December 15, 2010. Two areas of approximately one hectare were cultivated in organic and conventional systems. The areas were isolated from one another by distances greater than 3,000 metres and both were under maize (BR 106) cultivation in the tillage system.

2.2. Experiment II (organic single crop maize x organic maize intercropped with beans)

This experiment was sown in May 23, 2011 in the area used for organic farming, divided in two areas of approximately one hectare, isolated from other areas of cultivation for about 3,000 metres. Maize (BR 106) was cultivated in one of them; in the other, maize and bean (*Phaseolus vulgaris* L., BRS Radiante) were sown in the same line, using the conventional tillage system.

In order to determine the initial occurrence and frequency of moths during each experiment, a delta trap (Ferocon 1C®) containing the synthetic sex pheromone of *S. frugiperda* (BIO SPODOPTERA® - Chem Tica Internacional, S.A.) sachet was installed in the centre of each experimental area soon after the emergence of maize plants (Cruz et al., 2010, 2012).

Each planting area was divided into 24 plots of equal size, and 20 samples were collected when the presence of *S. frugiperda* was detected in the traps. Ten plants at random per plot were collected, three times a week throughout the entire crop cycle, totalling 240 plants per sampling.

The plants were evaluated in the Lacri (acclimatised room at 25 ± 2 °C, RH 70 ± 10% and photoperiod of 12 hours), separating the larvae by species and placing them individually in plastic cups containing artificial diet (Cruz, 2009) where they remained until the end of the cycle. The pest stage in which each parasitoid emerged was annotated.

The parameters evaluated were: total number of larvae of *S. frugiperda*, the average number of larvae per sample; percentage of larvae parasitised by Hymenoptera or Diptera and participation of *D. koebelei* in the percentage of parasitised larvae.

3. Results

In Experiment I, 1124 larvae of *S. frugiperda* (Figures 1a-b) were collected in the conventional maize, being 56.2 the average number of larva per sample and 4.7% of the larvae was parasitised by Hymenoptera or Diptera. The participation of *D. koebelei* in the total number of parasitised larvae was 9.8%. In organic maize, 1112 larvae of *S. frugiperda* were collected, with an average number of 46.3 larvae per sample and 5.7% of the total number of larvae were parasitised by Hymenoptera or Diptera. The participation of *D. koebelei* in the total number of parasitised larvae was 11.1%.

In Experiment II (organic maize intercropped with beans) 1401 larvae of *S. frugiperda* were collected, with the average number of 70.0 larvae per sample. Considering

the total number of larvae, 16.7% were parasitised by Hymenoptera or Diptera. The participation of *D. koebelei* in the total number of parasitised larvae was 1.9%. In organic single maize, 1602 larvae of *S. frugiperda* were collected, with an average of 80.1 larvae per sample. Among the total number of larvae collected, 19.9% were parasitised by Hymenoptera or Diptera. The participation of *D. koebelei* in the total number of parasitised larvae was 1.2%.

The specimens of *D. koebelei* were identified by one of the authors of this work (A.M.P.D.) and are deposited in the Coleção Entomológica do Departamento de Ecologia e Biologia Evolutiva – DCBU, Universidade Federal de São Carlos – UFSCar in São Carlos, São Paulo State, Brazil, and in Lacri.

4. Discussion

Dolichozele koebelei (Figures 1c-f) has not been described in association with larvae of *S. frugiperda*. The presence of *D. koebelei* in conventional and organic maize, shows the potential of this parasitoid as a biological control agent for use in natural integrated pest management in this culture.

Many parasitoids are associated with *S. frugiperda*; some exclusively parasitise eggs, such as the idiobionts

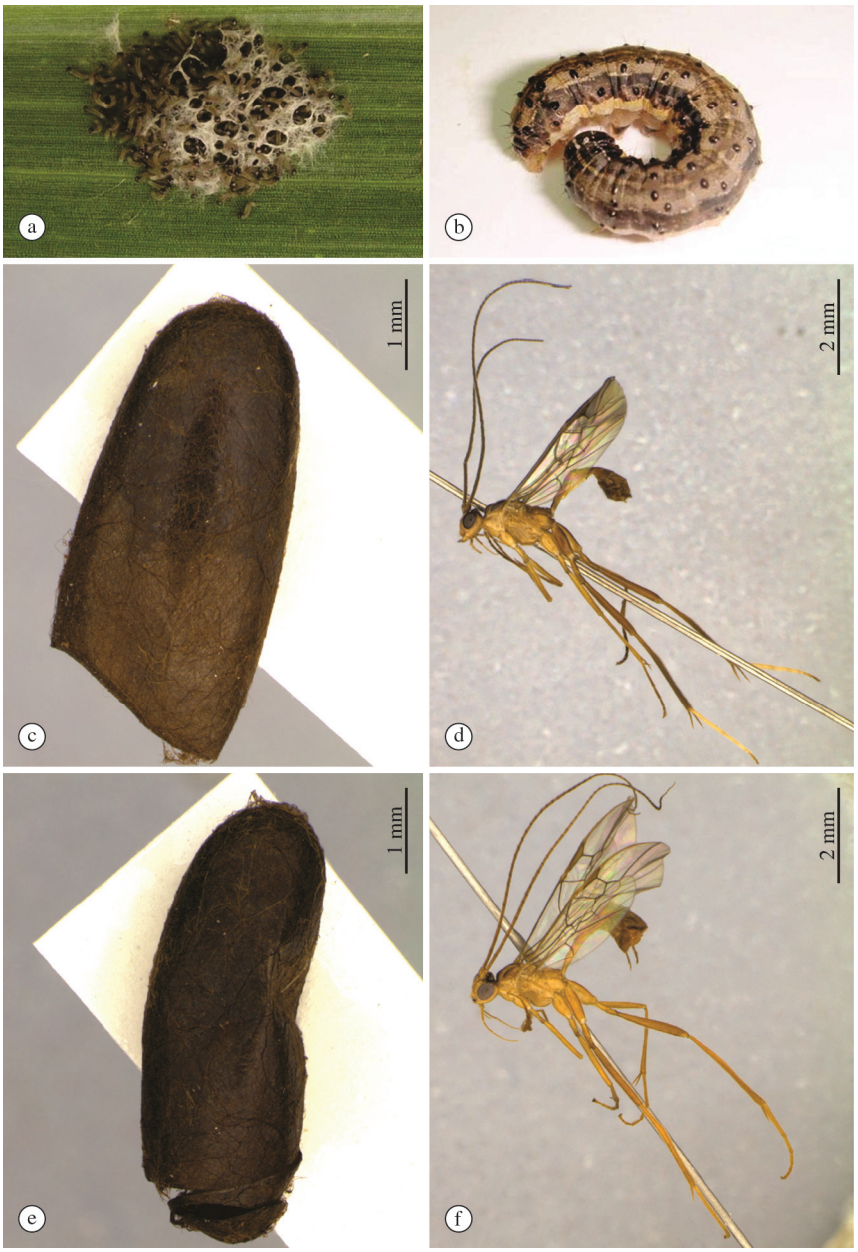

Figure 1. a) and b). Larvae of *S. frugiperda*; c) and d) Pupa and male adult of *D. koebelei*; e) and f). Pupa and female adult of *D. koebelei*.

Trichogramma spp. (Hymenoptera: Trichogrammatidae) (Cruz et al., 2011) and *Telenomus remus* Nixon, 1937 (Hymenoptera: Platygastridae) (Van Waddill and Whitcomb, 1982; Figueiredo et al., 1999, 2002).

Other known species are koinobiont parasitoids, like *Chelonus insularis* (Cresson, 1865) (Hymenoptera: Braconidae) (Rezende et al., 1994, 1995a, b, c), which also lays its eggs inside the egg of the pest, but allows embryonic development and hatching of the larvae of the host. *Campoletis flavicincta* (Ashmead, 1890) (Hymenoptera: Ichneumonidae) (Cruz et al., 1997; Matos Neto et al., 2004a, 2005), *Eiphosoma laphygmae* Costa Lima, 1953 (Hymenoptera: Ichneumonidae), *Ophion flavidus* Brullé, 1846 (Hymenoptera: Ichneumonidae) (Cruz et al., 2011), *Exasticolus fuscicornis* (Cameron, 1887) (Hymenoptera: Braconidae) (Figueiredo et al., 2006a; Penteado-Dias et al., 2006), *Colpotrochia mexicana* (Cresson, 1868) (Hymenoptera: Ichneumonidae) and *Cotesia flavipes* (Cameron, 1891) (Hymenoptera: Braconidae) (Cruz et al., 2011), as well as *Winthemia trinitatis* Thompson, 1963 (Diptera: Tachinidae) (Valicente and Barreto, 1999), operate exclusively on the larval stage of the host. There are also species that parasitise the larval stage of the pest, but only cause mortality of the insect host in its pupal stage, such as *Archytas marmoratus* (Townsend, 1915) (Diptera: Tachinidae) (Gross and Young, 1984).

Alternative systems of maize crop with a higher degree of sustainability require studies of the structure and functioning of the agroecosystems, with special attention to biodiversity and other factors which allow the use of an adequate crop management. The parasitism rates of *S. frugiperda* larvae was high in both experiments, indicating the importance of natural control agents in reducing the pest population density. The new association of *D. koebelei* with *S. frugiperda* represents the potential of this natural enemy to control this pest. The results showed the presence of parasitoids in a relatively high level in the area of organic production. Thus, the probability of successful adoption of integrated pest management (IPM) in these areas is great and should be encouraged.

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