



Parasitoids associated with the black scale *Saissetia oleae* (Olivier) (Hemiptera: Coccidae) in olive trees in Minas Gerais State, Brazil

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ABSTRACT. Black scale, *Saissetia oleae* (Olivier) (Hemiptera: Coccidae) is an important pest of olive trees (*Olea europaea* L.) that requires the use insecticides for its control. Parasitoids are important regulating agents of this pest, but currently, no information on its complex of natural enemies and their impact on black scale in Brazilian conditions exists. This study focused on identifying parasitoid wasps that were associated with the black scale on olive trees to establish their relative abundance and rate of parasitism. Samplings were maintained in an olive orchard located in Maria da Fe, south of the state of Minas Gerais, Brazil, and infested branches were stored in emergence containers to recover parasitoids. Another group was kept in Flanders batteries to evaluate the rate of parasitism in approximately 100 scales. Sixteen parasitoid species were collected during the sampling period, and the most common species were *Coccophagus caridei* (Brèthes) (Hymenoptera: Aphelinidae), *Diversinervus elegans* Silvestri (Hymenoptera: Encyrtidae), and *Mesopeltita truncatipennis* (Waterston) (Hymenoptera: Pteromalidae), the latter of which was most abundant and frequent. Parasitism ranged from 3 to 31% with peaks in summer and autumn. This level could be considered insufficient to hold the black scale under the economic injury level; however, these parasitoids should be preserved for contributions to population regulation.

Keywords: black scale, natural enemies, olive, parasitism.

Parasitoides associados à cochonilha-preta *Saissetia oleae* (Olivier) (Hemiptera: Coccidae) em oliveira no Estado de Minas Gerais, Brasil

RESUMO. A cochonilha-preta, *Saissetia oleae* (Olivier) (Hemiptera: Coccidae), é uma praga importante da oliveira (*Olea europaea* L.) e, comumente necessita de adoção de medidas para seu controle. Os parasitoides são importantes agentes de controle dessa praga, porém, no Brasil, não há informações sobre o complexo dos inimigos naturais da cochonilha-preta e de seu impacto sobre as populações. Esta pesquisa objetivou conhecer os parasitoides associados à cochonilha-preta em oliveiras, frequência relativa e a taxa de parasitismo, mediante amostragens realizadas em um pomar localizado em Maria da Fé, Sul de Minas Gerais, Brasil. Parte dos ramos infestados foi acondicionada em baterias de recuperação para coleta dos parasitoides e o restante foi mantido em baterias de Flanders para avaliar a taxa de parasitismo em aproximadamente 100 indivíduos adultos. Foram coletadas 16 espécies de parasitoides, sendo as mais comuns: *Coccophagus caridei* (Brèthes) (Hymenoptera: Aphelinidae), *Diversinervus elegans* Silvestri (Hymenoptera: Encyrtidae) e *Mesopeltita truncatipennis* (Waterston) (Hymenoptera: Pteromalidae), sendo esta última a mais abundante e frequente. A taxa de parasitismo variou entre 3 e 31% e atingiu o acme durante o verão e outono. Tais níveis são considerados insuficientes para manter a cochonilha-preta abaixo do nível de dano econômico. Entretanto, as medidas de controle devem preservar esses parasitoides no pomar visando auxiliar na regulação da densidade populacional dessa praga.

Palavras-chave: Cochonilha-negra, inimigos naturais, oliveira, parasitismo.

Introduction

Black scale, *Saissetia oleae* (Olivier), is native to South Africa and presently found throughout the world (PRINSLOO, 1997; VIGGIANI, 1978). This scale is considered a major pest in many economic cultures and particularly in olive trees. As a world economic pest, black scale has been the target of numerous biological control programs with

relatively successful results (DAANE et al., 1991), and parasitoid introduction and release have been the main utilized strategy. In California, classical biological control programs against this pest by introducing natural enemies from different parts of the world, such as South America, dates from the late 19th century (DAANE et al., 1991). The occurrence of black scale in Brazil was reported in

1898 (COMPERE, 1939), and this organism colonizes a large number of hosts (SILVA et al., 1968). New plantings of commercial olives are increasing in Brazil, and this insect appears to be the main threat to the culture (PRADO; SILVA, 2006). Currently, no biological control program has been implemented in Brazil; therefore, the parasitoids that are reared from the black scale are either autochthonously or accidentally introduced with the pest or closely related insects.

Before the establishment of any biocontrol strategy, it is necessary to know the complex of natural enemies acting upon a pest under local conditions. The damage and importance of black scale is variable depending on climatic conditions, the host, and the impact of natural enemies; therefore, regional differences can be expected (PANIS, 1977). Studies of black scale parasitoids are abundant in the literature, but these studies have not been performed in Brazil.

Sixteen parasitoid wasps were recorded to be associated with this scale in Brazil (Table 1). However, some of these wasps have only been reported at the genus level, namely *Moranila* sp. (as *Tomocera* sp.), *Metaphycus* sp. (as *Euaphycus* sp.), *Eupelmus* sp., *Eurytoma* sp., (COMPERE, 1939), and *Moranila* sp. (as *Moranita* sp. "sic") (SILVA et al., 1968).

The aim of this study was to determine the parasitoid complex that was associated with the black scale of olive trees, their relative abundance, and the rate of parasitism in an insecticide-free orchard that was located southeast of Brazil.

Material and methods

Sampling

Infested olive branches were sampled from an insecticide-free orchard located in Maria da Fe (22° 17'

46" S, 45° 23' 5" W), which was south of the State of Minas Gerais, Brazil, during the period of September 2009 to February 2012.

Recovery

Infested olive twigs were kept inside a parasitoid emergence container, which was a modified, transparent plastic, gaseous bottle that was covered with aluminum foil. A glass tube was attached to the neck of the bottle so parasitoids would be attracted to the light. Emerging parasitoids were checked daily for 45 days, and their relative abundance was calculated based on the total number of recovered individuals.

Parasitism

A bouquet of olive branches was kept in a water container inside a cage (Flanders battery). After one month, 100 scales were examined for parasitoid presence or evidence, and the parasitism level was estimated. Parasitoids were identified by the first author (E.P.).

Results and discussion

Parasitism caused by the parasitoid complex ranged from 3 to 31% (Figure 1), which was a rather low value within the large range of parasitism that has been obtained for this insect (PEREIRA et al., 1998; TENA et al., 2008). This level of parasitism failed to maintain the black scale under the damage level and resulted in high infestation and the presence of sooty mold.

Sixteen species of wasp parasitoids belonging to the following families were collected: Aphelinidae (1), Pteromalidae (1), Eupelmidae (5), Encyrtidae (6), and Eulophidae (3). However, some species (not determined) could have been hyperparasitoids. The species that were recovered in this survey are listed in Table 2.

Table 1. Parasitoids that were previously recorded to be associated with the black scale in Brazil.

| Species | Family | Biology | Reference |
|---|---------------|-----------------------------|--------------------|
| <i>Diversinervus elegans</i> Silvestri, 1915 | Encyrtidae | Parasitoid | De Santis, 1979 |
| <i>Aloencyrtus saissetiae</i> (Compere, 1939) | Encyrtidae | Parasitoid | Silva et al., 1968 |
| <i>Coccophagus basalis</i> Compere, 1939 | Aphelinidae | Parasitoid | Compere, 1939 |
| <i>Coccophagus brasiliensis</i> (Compere, 1936) | Aphelinidae | Parasitoid | Compere, 1939 |
| <i>Coccophagus brethesi</i> De Santis, 1967 (= <i>C. lecanii</i> Brèthes, 1913) | Aphelinidae | Parasitoid | Silva et al., 1968 |
| <i>Coccophagus caridei</i> (Brèthes, 1918) | Aphelinidae | Parasitoid | Compere, 1939 |
| <i>Coccophagus fallax</i> Compere, 1939 | Aphelinidae | Parasitoid | Compere, 1939 |
| <i>Coccophagus lycimnia</i> (Walker, 1839) | Aphelinidae | Parasitoid | Compere, 1939 |
| <i>Coccophagus oculatipennis</i> (Girault, 1916) | Aphelinidae | Parasitoid | Compere, 1939 |
| <i>Coccophagus pallidiceps</i> (Compere, 1939) | Aphelinidae | Parasitoid | Compere, 1939 |
| <i>Chartocerus niger</i> (Ashmead, 1900) | Signiphoridae | Hyperparasitoid | Silva et al., 1968 |
| <i>Mesopeltila truncatipennis</i> (Waterston, 1917) | Pteromalidae | Egg predator and parasitoid | Prado et al., 2012 |
| <i>Scutellista caerulea</i> (Fonscolombe, 1832) | Pteromalidae | Egg predator and parasitoid | Compere, 1939 |
| <i>Lecaniobius utilis</i> Compere, 1939 | Eupelmidae | Parasitoid | Compere, 1939 |
| <i>Eupelmus coccidivorus</i> Gahan, 1924 | Eupelmidae | Hyperparasitoid | Compere, 1939 |
| <i>Gahaniella saissetiae</i> Timberlake, 1926 | Encyrtidae | Hyperparasitoid | Compere, 1939 |

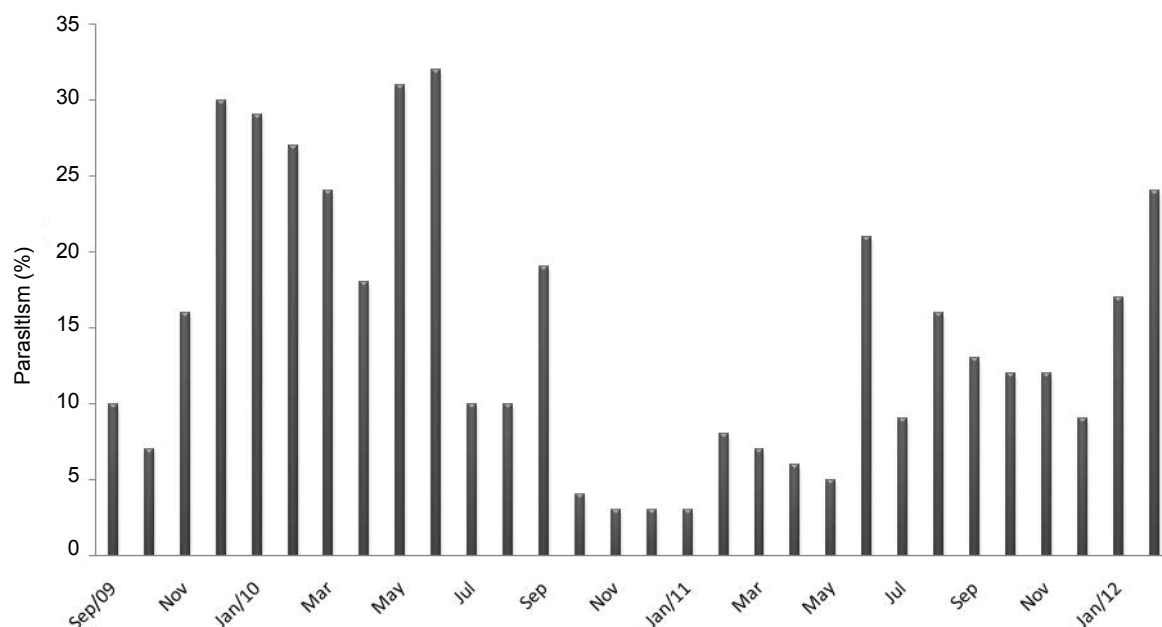


Figure 1. Parasitism of the black scale in olive trees. Maria da Fe, Minas Gerais, Brazil.

Table 2. Parasitoids recovered from black scale in Southeast Brazil and their relative abundance (2009-2012).

| Species | Family | Relative abundance (%) (*) |
|---|--------------|----------------------------|
| <i>Mesopeltita truncatipennis</i> (Waterston) | Pteromalidae | 47.2 |
| <i>Coccophagus caridei</i> (Brethes) | Aphelinidae | 29.8 |
| <i>Diversinervus elegans</i> Silvestri | Encyrtidae | 3.7 |
| <i>Lecaniobius utilis</i> Compere | Eupelmidae | 1.9 |
| <i>Metaphycus</i> sp.1 and sp.2 | Encyrtidae | 1.2 |
| Eupelmidae (several species) | Eupelmidae | 6.2 |
| Eulophidae (several species) | Eulophidae | 6.2 |
| Encyrtidae (several species) | Encyrtidae | 3.7 |

(*) n = 161 (total number of recovered parasitic wasps).

Mesopeltita truncatipennis (Pteromalidae: Eunotinae) (Figures 2 and 3A).

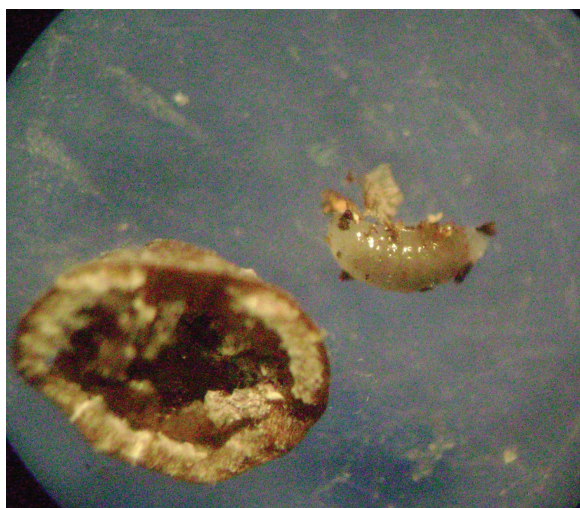


Figure 2. Larvae of *Mesopeltita truncatipennis* found preying on black scale eggs.

The members of this subfamily are mainly egg predators but may also act as scale parasitoids. This species is cosmopolitan (DAANE et al., 1991; MURÚA; FIDALGO, 2001; TENA et al., 2008), was initially reported in Brazil in 2012 (PRADO et al., 2012), and was the most abundant parasitoid that was collected in our survey. This species is very similar to and is easily confounded with another species of Eunotinae, *Scutellista caerulea* (Fonscolombe), which is one of the most frequent species associated with black scale in the world and has a similar feeding behavior (PRADO et al., 2003). However, members of Eunotinae were not recovered during this survey.

Coccophagus caridei (Aphelinidae)

This parasitoid is native to South America and is associated with many coccids of the genera *Pulvinaria*, *Saissetia*, *Coccus*, *Eulecanium*, *Ceroplastes*, *Pseudococcus*, and *Ischnaspis* (DE SANTIS, 1980; MURÚA; FIDALGO, 2001; PRADO et al., 2003). The date of the first occurrence of this wasp in Brazil is unknown, but the literature reports that it was introduced in California from Brazil and Argentina in 1935 (COMPERE, 1939; DAANE et al., 1991). In this study, this parasitoid ranked second in abundance but was present at a low density and frequency. *C. caridei* was collected mainly in December 2009, and only a few specimens were found on other dates. Another species, *C. fallax*, appeared to be the most numerous and commonly found during other studies (COMPERE, 1939); however, it was absent in this survey.

***Diversinervus elegans* (Encyrtidae) (Figure 3B)**

This parasitoid is non-specific for scales (Coccidae), particularly of nymphs and adults (PRINSLOO, 1985). The female has the peculiarity of ovipositing inside the hind intestine of its host through the aperture of the anus (COMPERE, 1931a). This organism has attracted great interest in biological control programs, and it has been introduced from Africa to other countries for controlling *S. oleae* (BARTLETT; MEDVED, 1966; COMPERE, 1931b; DAANE et al., 1991). However, its efficacy has been questioned due to the encapsulation of its eggs (VIGGIANI, 1978). Only a few of these specimens were reared from the black scale.

***Metaphycus* spp. (Encyrtidae) (Figure 3C)**

Only two specimens of different species of *Metaphycus* (unidentifiable due to the poor condition of the specimens) were collected in our survey. Species of this genus have been reported as effective against the black scale, particularly *M. helvolus* (Compere) and *M. lounsburyi* (Howard) (ARGOV; RÖSSLER, 1993; VIGGIANI, 1978; STRATOPOULOU; KAPATOS, 1998), and five species belonging to this genus have

been recorded in Brazil, but only *M. flavus* (Howard) has been associated with black scale (NOYES, 2013).

***Lecaniobius utilis* (Eupelmidae) (Figure 3D)**

This parasitoid is an egg predator of *S. oleae* and other soft scales such as *Ceroplastes* and *Lecanium*, and it was described in Viçosa, Minas Gerais, Brazil and posteriorly recorded from the states of Bahia, Mato Grosso, Minas Gerais, São Paulo and Rio de Janeiro (COMPERE, 1939; DE SANTIS, 1980; MYARTSEVA et al., 2010).

L. utilis was successfully introduced from Brazil and Argentina to California in 1935 for controlling *S. oleae* and *Saissetia nigra* (Nietner) (DAANE et al., 1991), and it has been considered an efficient parasitoid but sometimes also considered of low value (MURÚA; FIDALGO, 2001; MYARTSEVA et al., 2010) depending on local conditions. Only one specimen from this group was found in our survey of samples from October 2009.

The remaining parasitoid species were only sporadically collected and comprised several species of Eupelmidae, Eulophidae, and Encyrtidae.

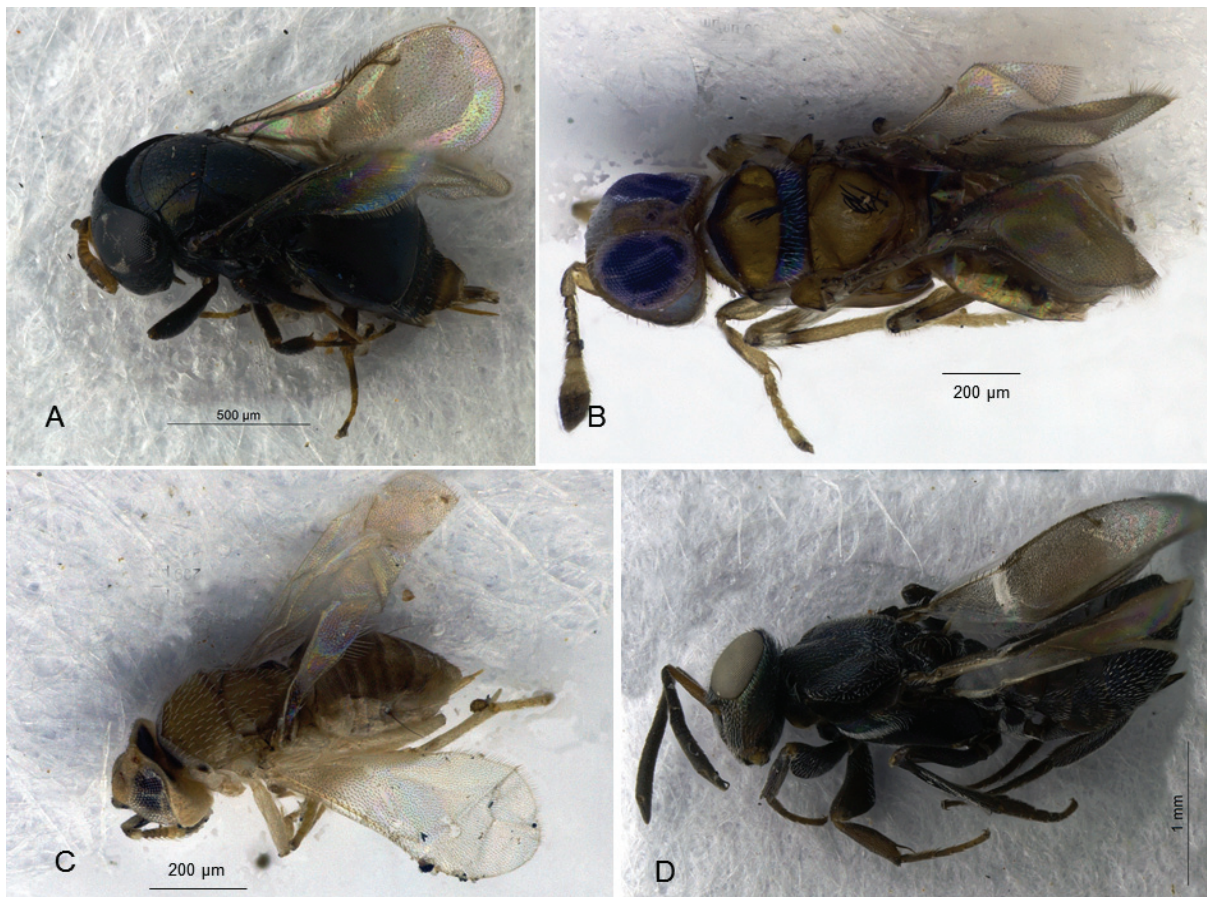


Figure 3. Four parasitoids of black scale. Maria da Fe, south of Minas Gerais, Brazil: A. *Mesopeltita truncatipennis*; B. *Diversinervus elegans*; C. *Metaphycus* sp.; D. *Lecaniobius utilis*.

Despite the number of parasitoids that were found, the contribution of parasitoid wasps seemed to be rather poor and had a low capacity for regulating the black scale population. The presence of these organisms was irregular between years, and few parasitoids were recovered during 2012. *S. caerulea* and species of the genus *Metaphycus* and *Coccophagus* are predominant in black scale around the world, and their absence and that of other important parasitoids with high potential as biological control agents opens the opportunity to improve the parasitoid complex by importing and releasing new natural enemies. It appears that the efficiency of each species of black scale parasitoid is highly dependent on local conditions, and a large number of wasp species should be desirable for introduction. The parasitoid wasp composition from this study showed a substantial difference from similar studies that were carried out in neighboring countries such as Argentina and Chile (MURÚA; FIDALGO, 2001; PRADO et al., 2003).

Conclusion

At least 16 species of parasitoids were associated with *S. oleae*, and four were most common. Among these species, *M. truncatipennis* was the most abundant and frequent.

A low level of parasitism, which ranked from 3 to 31% throughout the years, was found.

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