Occurrence and biology of *Dinocampus coccinellae* (Schrank, 1802) (Hymenoptera; Braconidae: Euphorinae) parasitising different species of Coccinellidae (Coleoptera) in Neotropical region

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Abstract

Surveys on Coccinellidae (Coleoptera) in Sete Lagoas city, Minas Gerais state, Brazil, indicated the parasitism of adults of the species *Coleomegilla maculata* De Geer, 1775, *Eriopis connexa* (Germar, 1824) and *Olla v-nigrum* (Mulsant, 1866), by *Dinocampus coccinellae* (Schrank, 1802) (Hymenoptera; Braconidae: Euphorinae). Since then, the parasitoid have been maintained in its original hosts at the Insect Rearing Laboratory – LACRI of the Brazilian Agricultural Research Institution – Embrapa Milho e Sorgo. Besides the citation of occurrence in Brazil, this work also indicates the parasitoid preference for *C. maculata* (70% of parasitism), followed by *O. v-nigrum* (43.3% of parasitism) and *E. connexa* (36.7% of parasitism). Total life cycle of *D. coccinellae* was longer on *C. maculata* (32.4 ± 0.48 days), compared to *O. v-nigrum* (29.5 ± 0.49 days) and *E. connexa* (27.8 ± 0.4 days). Due to the relatively high percentage of field parasitism, *D. coccinellae* can reduce the efficiency of biological pest control by Coccinellidae predators especially in the case of *C. maculata.*

Keywords: biological control, ladybeetles, natural enemy, parasitoid, predator.

Ocorrência e biologia de *Dinocampus coccinellae* (Schrank, 1802) (Hymenoptera; Braconidae: Euphorinae) parasitando diferentes espécies de Coccinellidae (Coleoptera) na região Neotropical

Resumo

Estudando os Coccinellidae na região de Sete Lagoas, Estado de Minas Gerais, Brasil, foram encontrados adultos de *Coleomegilla maculata* De Geer, 1775, *Eriopis connexa* (Germar, 1824) e *Olla v-nigrum* (Mulsant, 1866) (Coleoptera: Coccinellidae), parasitados por *Dinocampus coccinellae* (Schrank, 1802) (Hymenoptera; Braconidae: Euphorinae). O parasitoide, desde então, tem sido mantido em adultos desses Coccinellidae, no Laboratório de Criação de Insetos – LACRI da Empresa Brasileira de Pesquisa Agropecuária – Embrapa Milho e Sorgo, em Sete Lagoas, MG, Brasil, onde o trabalho foi conduzido. Este trabalho relata a ocorrência de *D. coccinellae* em *C. maculata*, *E. connexa* e *O. v-nigrum*, e apresenta alguns aspectos biológicos desse parasitoide. *Coleomegilla maculata* apresentou maior suscetibilidade ao parasitoide, com 70% de adultos parasitados; *O. v-nigrum* e *E. connexa* apresentaram porcentagem de parasitismo de 43,3 e 36,7 %, respectivamente. O ciclo de desenvolvimento de *D. coccinellae* foi mais longo em *C. maculata* (32,4 ± 0,48 dias) em relação a *O. v-nigrum* (29,5 ± 0,49 dias) e *E. connexa* (27,8 ± 0,40 dias). A eficiência do controle biológico de pragas pelos predadores *C. maculata*, *E. connexa* e *O. v-nigrum* pode ser reduzida pela ocorrência do parasitoide *D. coccinellae.*

Palavras-chave: controle biológico, joaninhas, inimigo natural, parasitoide, predador.

1. Introduction

Coccinellidae species (Coleoptera), known as "ladybeetle", are considered useful natural enemies feeding on phytophagous insect species and regulating their populations in many agricultural systems involving commercial crops (Obrycki et al., 2009; Lundgren, 2009; Isikber and Copland, 2002). Their preys are species of mites and insects such as: greenflies, aphids, eggs and neonate larvae of Coleoptera and Lepidoptera (Stathas, 2000; Lu et al., 2002; Omkar and Singh, 2006; Silva et al., 2009, 2010).

Many Coccinellidae species are efficient predators and easily adapt to both changes in quantity and quality of their prey (Segonça et al., 2005; Weber and Lundgren, 2009). Although recorded from several ecosystems, some of them show variability in the level of establishment of their populations, which leads to the reduction of its effectiveness. Possibly such species may be under the action of one or more species of natural enemies. Therefore, a better understanding of the factors involved in its performance in the field, could explain the low rate of predation serving as a basis for the correct choice of the species to make the most efficient biological control (Katsarou et al., 2005; Riddick et al., 2009).

In Brazil, works addressing the natural enemies of Coccinellidae are still scarce, reporting only its occurrence. *Homolotylus flaminius* (Dalman, 1820) (Hymenoptera: Encyrtidae), *Phalacrotophora nedae* (Malloch, 1912) (Diptera: Phoridae) and *Dinocampus coccinellae* (Schrank, 1802) (Hymenoptera; Braconidae: Euphorinae) were reported as larval, pupal and adult parasitoid from *Cycloneda sanguinea* (L., 1763) (Coleoptera: Coccinellidae), respectively (Gravena, 1978). Santos and Pinto (1981) also reported *D. coccinellae* as parasitoid of adult *C. sanguinea*.

The braconids Euphorinae includes endoparasitoids of adult Coleoptera, of the genus *Dinocampus*, parasitising mainly Coccinellidae species and Curculionidae (Hodek, 1973). *Dinocampus coccinellae* is a telitokous parthenogenetic solitary parasitoid (Balduf, 1926; Obrycki, 1989; Phillips and Emberson, 1999; Okuda and Ceryngier, 2000; Hoogendoorn and Heimpel, 2002; Riddick et al., 2009), whose females do not discriminate hosts which have already been parasitised by other females of the same species (Geoghegan et al., 1998; Majerus et al., 2000; Koyama and Majerus, 2008).

This work reports the occurrence in Brazil, of *D. coccinellae* in association with Coccinellidae species, *Coleomegilla maculata* De Geer, 1775, *Eriopis connexa* (Germar, 1824) and *Olla v-nigrum* (Mulsant, 1866) and presents some biological aspects related to each host.

2. Material and Methods

During monitoring work toward Coccinellidae species in the region of Sete Lagoas, Minas Gerais state, Brazil, the parasitoid *D. coccinellae* was found in association with adults of *C. maculata*, *E. connexa* and *O. v-nigrum*. This parasitoid, since then, has been maintained in laboratory conditions at the Insect Rearing Laboratory (LACRI) of the Brazilian Agricultural Research (Embrapa Milho e Sorgo) in Sete Lagoas. The experiment for the study of the biological aspects of *D. coccinellae* was conducted in chambers set at 25 ± 1 °C, photoperiod of 12 hours and Relative Humidity of 70 ± 10%.

Three groups of eight females of *D. coccinellae* were kept in cages (glass container, 12 cm in diameter × 27 cm high), covered with PVC film. Drops of honey as food source for adult parasitoids were placed on the cage wall. In each cage, 30 adults of *C. maculata*, *E. connexa* or *O. v-nigrum* were introduced, which were obtained from LACRI.

The Coccinellidae remained in contact with parasitoids for 24 hours. After this period, they were removed from the cage and individually placed in a 50 mL plastic cup, covered with a transparent polystyrene lid. Adults were fed with artificial diet (Silva et al., 2009) and eggs of *Anagasta kuehniella* (Zeller, 1879) (Lepidoptera: Pyralidae).

Daily evaluations were based on the biological cycle of the parasitoid and behaviour of the hosts. Data were submitted to the non-parametric test of Kruskal-Wallis ($p < 0.05$) (Kruskal and Wallis, 1952).

3. Results

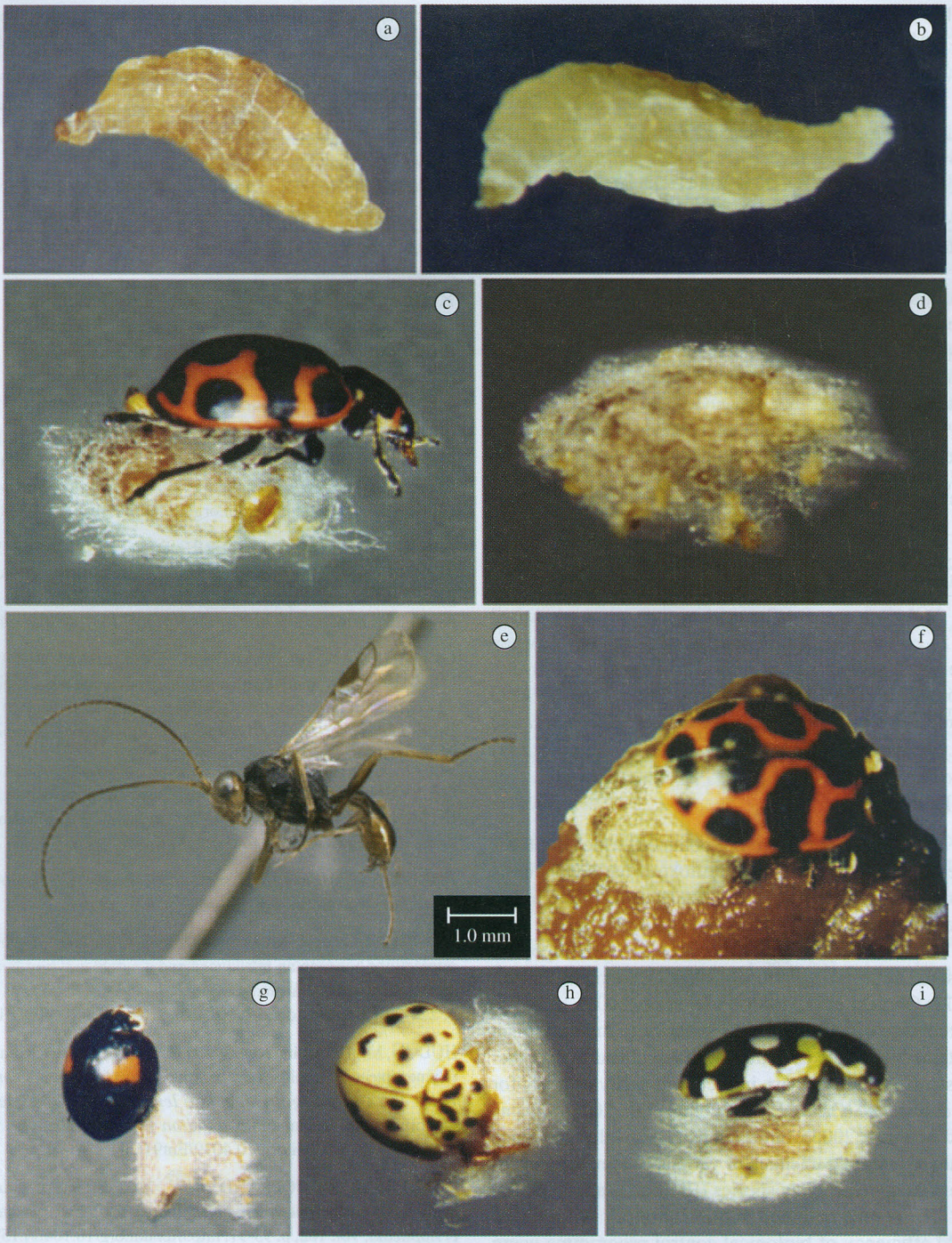
The specimens of *D. coccinellae* were identified by one of the authors of this work (A.M.P.D.) and are deposited in the Coleção Entomológica do Departamento de Ecologia e Biologia Evolutiva – DCBU, Universidade Federal de São Carlos – UFSCar in São Carlos, São Paulo state, Brazil, and in LACRI.

Dinocampus coccinellae reproduction is a telitokous partenogenetic species. The female starts the parasitism process approximately one hour after its emergence. She moves the abdomen, placing it between its legs, extending the ovipositor slightly to the front of its head. In this position, the female found its prey. The parasitoid exhibits preference for those specimens in motion. Finding the host, the ovipositor was inserted into the posterior abdomen region between the elytra and membraceous wings.

The incubation period of *D. coccinellae* eggs has not been quantified; however, the time for the parasitoid larva to exit from Coccinellidae body to begin the process of pupation was observed.

Larvae of the parasitoid (Figures 1a,b) are yellow whitish in colour, with cylindrical and slightly flattened body, without legs but with prominent head; emerging from posterior of the abdomen of host, under the elytra.

The parasitoid, in some cases, makes use of the legs of Coccinellidae host (Figure 1c) during the process of pupation, leaving it imprisoned and deprived of food, leading to death, possibly by starvation; even with the pupa of the parasitoid formed, the Coccinellidae host remained alive. The pupa (Figure 1d) was formed on the bottom of the plastic cups, and the Coccinellidae host remained alive and visually similar to non-parasitised specimens.



Figures 1. a) and b) Larvae of *D. coccinellae*; c) Adult of *C. maculata* trapped by the pupa of *D. coccinellae*; d) Pupa of *D. coccinellae*; e) Adult of *D. coccinellae*; f) Adult of *C. maculata* trapped by the pupa of *D. coccinellae*; g-h) Adults of *O. v-nigrum* trapped by the pupa of *D. coccinellae*; i) Adult of *E. connexa* trapped by the pupa of *D. coccinellae*.

Adults of *D. coccinellae* (Figure 1e) have transparent membranous wings, the anterior longer than posterior. Ovipositor stylize-form recorded from the ventral side of the abdomen.

Coleomegilla maculata (Figure 1f) presented high mortality index, probably due to adult imprisonment by the pupa of the parasitoid, unlike the other hosts, where the percentage of adults imprisoned *E. connexa* (Figure 1g) and *O. v-nigrum* (Figures 1h and 1i) was low.

The period of time between exiting from host and pupation was approximately five hours. Pupa stage period of *D. coccinellae* (Table 1) was similar when the predator

Table 1. Biological cycle (Mean ± Standard Error, SE) of *D. coccinellae* on different species of Coccinellidae, under acclimatised room (temperature of 25 ± 1 °C, Photoperiod of 12 hours and Relative Humidity of 70 ± 10%) in Sete Lagoas, Minas Gerais state, Brazil.

Hosts	Period of time (days)				
	Egg to pupa	Pupa	Egg to adult	Longevity	Total life cycle
C. maculata	18.1 ± 0.42[b]	7.4 ± 0.14[b]	25.5 ± 0.44[b]	6.9 ± 0.19[a]	32.4 ± 0.48[b]
E. connexa	13.6 ± 0.41[a]	7.1 ± 0.34[b]	20.7 ± 0.54[a]	7.1 ± 0.28[a]	27.8 ± 0.40[a]
O. v-nigrum	16.6 ± 0.33[a]	6.1 ± 0.24[a]	22.7 ± 0.51[a]	6.8 ± 0.19[a]	29.5 ± 0.49[a]

Means followed by the same letter, per column, do not differ ($p < 0.05$), by Kruskal-Wallis test.

was associated to *C. maculata* or *E. connexa* hosts. After the emergence, the adult parasitoids remained at rest for approximately one hour. If disturbed, they simulate a death condition, at the bottom of the plastic cup with the antennae and wings not expanded.

Egg-adult period of *D. coccinellae* (Table 1) varied according to hosts being shorter when associated to *E. connexa* or *O. v-nigrum*. However, adult longevity of *D. coccinellae* (Table 1) was similar between hosts.

The total life cycle of *D. coccinellae* (Table 1) was shorter when the insect was associated to *E. connexa* or *O. v-nigrum* than when in association to *C. maculata*.

Seventy percent of *C. maculata* adults were parasitised by *D. coccinellae*; parasitism was 43.3 and 36.7%, when the hosts were *O. v-nigrum* or *E. connexa*, respectively. Mortality over 94% was observed in *Coleomegilla maculata* compared to 60 and 22% in the case of, *E. connexa* and *O. v-nigrum* hosts, respectively.

4. Discussion

Male specimens were not obtained, which confirms literature information about telitokous parthenogenesis reproduction mode in *D. coccinellae* (Balduf, 1926; Phillips and Emberson, 1999; Okuda and Ceryngier, 2000).

Results confirmed that *C. maculata* is an important host to *D. coccinellae* (Hudon, 1959; Obrycki and Tauber, 1979; Obrycki et al., 1985; Firlej et al., 2005), since the percentage of parasitism was superior to the parasitism obtained when the parasitoid was associated to the other hosts. Coccinellids vary in their suitability as hosts for *D. coccinellae* (Orr et al., 1992; Firlej et al., 2006; Koyama and Majerus, 2008), but the mechanisms that influence realised rates of parasitism of various coccinellid species are unknown for many species (Riddick et al., 2009).

The results obtained in the laboratory suggest that field efficiency of biological control programme using the Coccinellidae species, *C. maculata*, *E. connexa* and *O. v-nigrum* can fail due to parasitism by *D. coccinellae*. On the other hand, the action of multiple natural enemies on this Coccinellidae can provide a greater impact on population dynamic than any one species acting alone.

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