Scientific Note

First association of Ceraeochrysa cincta (Schneider, 1851) (Neuroptera: Chrysopidae) with Maconellicoccus hirsutus (Green, 1908) (Hemiptera: Pseudococcidae) and evaluation of predation

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Abstract. Maconellicoccus hirsutus (Green, 1908) (Hemiptera: Pseudococcidae) is a polyphagous pest introduced in Brazil in 2010. It has been successfully controlled in other countries by the employment of its natural enemies. Based in the economic importance of this pest plus the potential of chrysopids as its controlling agents, herein we report for the first time in Brazil the association of Ceraeochrysa cincta (Schneider, 1851) (Neuroptera: Chrysopidae) with this pseudococcid, evaluate the consumption of females of M. hirsutus by larvae of C. cincta, and the development of this predator when fed with that prey. Five hatched larvae of C. cincta from F2 generation were isolated in a Petri dish in controlled ambient, and fed with ten immature plus ten adult females of M. hirsutus offered and counted daily. The three instars of the predator were considered as distinct treatments. From five C. cincta larvae fed with M. hirsutus, only one had reached adulthood after 28 days. The mean duration of the C. cincta larval period was 20.73 days, with the 1st, 2nd and 3rd instars being 6.40, 5.33 and 9.00 days respectively, but without significantly differences. A mean of 80 immatures and ca. 17 adults of M. hirsutus were predated by the C. cincta in its larval period, with the 3rd instar being the phase of highest consumption of the prey. Based in our results, M. hirsutus is probably not a primary prey of C. cincta, but this chrysopid could be used as an alternative or complementary predator to control this pest.

Keywords: Biological control, green lacewing, natural enemy, pink hibiscus mealybug.

The pink hibiscus mealybug (PHM), Maconellicoccus hirsutus Green, 1908 (Hemiptera: Pseudococcidae), is an invasive pest, highly polyphagous, having achieved pest status on Hibiscus rosa-sinensis L. (Malvaceae), currently occurring in horticultural and agricultural crops and other woody ornamental plants throughout tropical and subtropical regions worldwide, with range expansion in the Americas and the Caribbean (Chong et al. 2015).

PHM was recorded for the first time in Brazil in late 2010 in the state of Roraima (Marsaro Júnior et al. 2013). After eight years this exotic species had been registered in other eight states, on 42 host species distributed in 20 families: Maranhão (Ramos et al. 2018), Pernambuco (Lopes et al. 2019; Sá & Oliveira 2021); Alagoas (Broglío et al. 2015), Bahia (Lopes et al. 2019), Espírito Santo (Culik et al. 2013; Martins et al. 2019), Mato Grosso (Moraes et al. 2015; Peres-Filho et al. 2017), São Paulo (Moraes et al. 2015; Peronti et al. 2016) and Santa Catarina (Martins et al. 2019).

Maconellicoccus hirsutus has been successfully controlled, especially in Florida, California and Hawaii (USA), Mexico and in the Caribbean Islands (Chong et al. 2015) by the employment of biological control programs that includes mainly the predator Cryptocephalus montrouzieri Mulsant, 1850 (Coleoptera: Coccinellidae) and the parasitoids Anagyrus kamali Moursi, 1948 and Gyranooseuda indica Shafee et al., 1975 (Hymenoptera: Encyrtidae). However other 88 species of natural enemies, 42 parasitoids and 46 predators, have been evaluated for the first time in Brazil the association of C. cincta with M. hirsutus, to evaluate the consumption of M. hirsutus nymphs and adult females by C. cincta larvae, and the development of this predator when fed with that prey.

For this purpose populations of C. cincta and M. hirsutus were rearing in BOD, with temperature 25 ± 2 °C, relative humidity of 70 ± 10% and 12 hours of photophase at “Laboratório de Biossistematização de Hemíptera” (LABHEM), of the Plant Protection Department of the Faculdade de Câncios Agrárias e Veterinárias / UNESP, where the whole experiment was conducted.

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The green lacewings were reared according to the methodology described by Freitas (2001). The nymphs and adults of PHM, collected on *H. rosa-sinensis* plants, were transferred to fruits of organic *Abelmoschus esculentus* (L.) Moench (Malvaceae). When the okra fruits exhibited signs of wilt, after approximately two weeks of infestation, the insects were transferred to a new fruit.

The three instars of the predator *C. cincta* were considered as distinct treatments, created continuously and maintained throughout the all cycle in the same Petri dish. Each of them was considered a repetition, being five in total, for the two evaluations performed.

The newly hatched predator larvae obtained from the F2 generation were individualized in Petri dishes of 10 cm diameter, and for each one offered, simultaneously, ten specimens of immature and ten of adult females of *M. hirsutus*.

Evaluations of predatory mealybugs and the duration of each instar of the predator were carried out every 24 hours, counting the number of mealybugs predated and observing the presence of exuviae to confirm the larval instar of the Chrysopidae. The number of prey was sufficient for predator feeding and maintained by the replenishment of the PHM preyed.

From all of five replicates of *C. cincta* fed with *M. hirsutus*, only one had reached adulthood after 28 days. Two died in the pupa phase, and two died at the end of the third instar (Tab. 1).

The mean duration of the three larval instars of *C. cincta* was 20.73 days, being the 1st, 2nd and 3rd of 6.40, 5.33 and 9.00 days respectively. The duration of the first and second instars was shorter than the duration of third instar, not differentiating between them. De Bortoli et al. (2009) evaluation of the biological aspects of *C. cincta* fed with larvae and eggs of *Sitotroga cerealella* Olivier, 1789 (Lepidoptera: Gelechiidae), *Diaatraea saccharalis* (Fabricius, 1794) and *Ephhestia kuehniella* (Zeller, 1879) (= Anagasta kuehniella) (both Lepidoptera: Pyralidae), and found that the larval period of this predator lasted 12.92, 13.25 and 14.79 respectively, when fed with these preys. One of the likely reasons for the difference of the larval period duration of *C. cincta* in the present study and that of De Bortoli et al. (2009) is the difference of preys utilized, herein we used the Hemipteran *M. hirsutus*, whereas De Bortoli et al. (2009) used three species of Lepidoptera. Another possible explanation to this difference is the number of repetitions used in the studies, which are greater in De Bortoli et al. (2009).

However, De Bortoli et al. (2005) studying the nutritional aspects of *C. cincta* fed with different coccoids species, including *Selenaspidus* spp. (Hemiptera: Diaspididae), *Coccus* sp. (Hemiptera: Coccidae) and *Praelongorthezia* sp. (= *Orthezia* sp.) (Hemiptera: Ortheziidae), verified that when fed on later prey, the second instar larvae of the green lacewing died after one to three days, probably due to the wax that recovers the body of these mealybugs, which could obstruct the predator’s mouth tube composed by the juxtaposition of maxilla and mandible. This may be a possible explanation for the non-finalization of the cycle of most *C. cincta* replicates fed with *M. hirsutus*, because it was possible to observe in the individuals of third instar a large amount of wax involving their mouth parts, which made its feeding difficult and reflected in poor development of this predator.

Another possible explanation to the high mortality of *C. cincta* fed with *M. hirsutus* is the inadequacy of the prey regarding the necessary nutrients to the development of this predator. Despite the chemical composition of the prey of Chrysteridae is similar in terms of nutrients, its concentrations and accessibility to the predator vary from species to species (Yazlovetsky 1952; Cohen 1998; Albuquerque 2009), which influences the development of these organisms and can be noted by the different performances exhibited by the same species when fed with different prey (Thompson & Hagen 1999; Albuquerque 2009).

The difference in consumption between immature and adult of *M. hirsutus* throughout the larval phase of *C. cincta* was significant. During the whole larval cycle of the green lacewing, an average of 80 immature coccoids was consumed, where only 17.07 adults were predated. The third instar of *C. cincta* was the phase of higher consumption of individuals (53.00), when compared to 20.40 and 23.67 of the first and second instars, respectively.

It was also the instar where it had a significant increase in the consumption of immature individuals, but adult consumption, despite being larger when compared with previous instars, did not differ from them. Gonçalves-Gervásio & Santa-Cecília (2001), studied the food consumption of the different stages of development of *Dysmicoccus brevipes* Cockerell, 1893 (Hemiptera: Pseudococcidae) by *Chrysoperla externa* (Hagen, 1861) (Neuroptera: Chrysopidae) and found a relatively higher nymphs consumption than those observed in the present study, being 135.8 individuals. However, the number of adults of *D. brevipes*, counted by these authors, was lower, 10 adults throughout the larval stage of the predator. The developmental period of the larval phase of *C. cincta* fed with *M. hirsutus* was longer when compared to other foods and in the present study most individuals failed to complete their cycle of life when fed just with this pseudococcid, surviving only up to the third instar, however a larger number of replicates may demonstrate different results.

This was the first report of *C. cincta* associated with *M. hirsutus*. Although this pseudococcid is not a primary prey of *C. cincta* this green lacewing could be used as an alternative or complementary predator, along with other natural enemies such as parasitoids and other predators.

In addition to the present study, other prey, mainly species that normally infest plants of *Hibiscus* spp. and other Malvaceae species could be testing as diet to *C. cincta*. Through the results of this study and confirmation of these interactions, plus information of other natural enemies associated with the pink hibiscus mealybug, management strategies can be suggested in the future.

### Table 1. Duration of instar of *Ceraeochrysa cincta* and number (average) of *Macnellicoccus hirsutus* preayed.

| Phase of development | Duration of instars (days) | Nymphs | Adults | Total |
|----------------------|---------------------------|--------|--------|-------|
| 1st instar           | 6.40 ab                    | 19.00 Ab | 1.40 Ba | 20.40 |
| 2nd instar          | 5.33 b                     | 20.67 Ab | 3.00 Ba | 23.67 |
| 3rd instar         | 9.00 a                     | 40.33 Aa | 12.67 Ba | 53.00 |
| Total               | 20.73                      | 80.00   | 17.07  | 97.07 |

* Averages followed by the same capital letter on the same line do not differentiate between them; averages followed by the same lowercase letter from the same column do not differentiate between them.

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### Author’s Contributions

JGA reared the populations of *C. cincta* and *M. hirsutus*, carried out the evaluation of amount of preyed mealybugs and the duration of each instar of the Chrysopidae, analyzed the data, and wrote the manuscript. CCM performed species identification, reviewed the literature and wrote the manuscript. ALP and NMM supervised the study, reviewed the literature and wrote the manuscript.
Conflict of Interest Statement

No potential conflict of interest was reported by the authors.

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