Universidade Federal Rural do Semi-Árido
Pró-Reitoria de Pesquisa e Pós-Graduação
https://periodicos.ufersa.edu.br/index.php/caatinga

ISSN 0100-316X (impresso)
ISSN 1983-2125 (online)
http://dx.doi.org/10.1590/1983-21252022v35n212rc

BIOLOGICAL ASPECTS OF *Ceraeochrysa everes* (NEUROPTERA: CHRYSOPIDAE) FED ON PINK HIBISCUS MEALYBUG[1]

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ABSTRACT - The invasive pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae), is a pest that threatens the production of fruits, vegetable, and ornamental plants in Brazil. It is a phytophagous insect with a wide range of hosts; thus, there is an increasing demand for sustainable environmental-friendly control methods, such as biological control. This study aimed to investigate biological parameters of *Ceraeochrysa everes* (Neuroptera: Chrysopidae) fed on 2nd instar nymphs of *M. hirsutus* and eggs of *Ephestia* (*Anagasta*) *kuehniella* (Zeller) (Lepidoptera: Pyralidae). The duration of the immature stages of *C. everes* was longer when the predator was fed on 2nd instar nymphs of *M. hirsutus*, compared to the control (*E. kuehniella*). The survival rate of immature *C. everes* was 82.5% and 100% when fed on 2nd instar nymphs of *M. hirsutus* and eggs of *E. kuehniella*, respectively. The type of food resource offered at the larval stage affected the pre-oviposition, oviposition, and post-oviposition periods and the longevity of *C. everes* females. Adult females *C. everes* from immature individuals fed an exclusive diet of *E. kuehniella* eggs had longer oviposition, fecundity (daily and total), fertility, and post-oviposition periods and longevity. *Ceraeochrysa everes* has the capacity for predation, development, and reproduction while having 2nd instar nymphs of *M. hirsutus* as food resource. Therefore, *C. everes* has a promising potential for controlling *M. hirsutus*.

Keywords: Biological control. Green lacewing. Invasive pest. *Maconellicoccus hirsutus*.

ASPECTOS BIOLÓGICOS DE *Ceraeochrysa everes* (NEUROPTERA: CHRYSOPIDAE) ALIMENTADA COM COCHONILHA-ROSADA-DO-HIBISCO

RESUMO - A cochonilha-rosada-do-hibisco, *Maconellicoccus hirsutus* (Green) (Hemiptera: Pseudococcidae) é uma praga exótica que ameaça a produção de frutas, hortaliças e plantas ornamentais no Brasil. Por ser um inseto fitófago com ampla gama de hospedeiros, há uma demanda crescente por métodos de controle ecologicamente corretos e sustentáveis, como o controle biológico. Neste estudo foi avaliado parâmetros biológicos de *Ceraeochrysa everes* (Neuroptera: Chrysopidae) alimentado com ninfas de 2º instar de *M. hirsutus* e ovos de *Ephestia* (*Anagasta*) *kuehniella* (Zeller) (Lepidoptera: Pyralidae). A duração dos estádios imaturos de *C. everes* foi maior quando o predador foi alimentado com ninfas de 2° instar de *M. hirsutus* em comparação ao controle (*E. kuehniella*). A taxa de sobrevivência de imaturos de *C. everes* foi de 82,5 e 100% quando oferecidas ninfas de 2º instar de *M. hirsutus* e ovos de *E. kuehniella*, respectivamente. O tipo de recurso alimentar ofertado na fase larval afetou os períodos de pré-oviposição, oviposição, pós-oviposição e a longevidade de fêmeas de *C. everes*. Fêmeas de *C. everes* advindas de indivíduos imaturos alimentados com dieta exclusiva de ovos de *E. kuehniella* apresentaram maior oviposição, fecundidade (diária e total), fertilidade, período de pós-oviposição e longevidade. Conclui-se que *C. everes* possui capacidade de predação, desenvolvimento e reprodução tendo como recurso alimentar ninfas de 2º instar de *M. hirsutus*. Portanto, *C. everes* é uma promessa potencial para o controle de *M. hirsutus*.

Palavras-chave: Controle biológico. Crisopídeo. Praga invasora. *Maconellicoccus hirsutus*.

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[1]Received for publication in 02/25/2021; accepted in 10/26/2021.
Paper extracted from the first author's Master's Thesis.
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INTRODUCTION

Pink hibiscus mealybug, *Maconellicoccus hirsutus* (Green, 1908) (Hemiptera: Pseudococcidae) is an exotic pest (OLIVEIRA et al., 2018), polyphagous, with more of 300 species of plants hosts in 78 families from 224 genera (GARCÍA MORALES et al., 2016), and distribution encompassing tropical and subtropical regions around the world (SILVA-TORRES; OLIVEIRA; TORRES, 2013).

In Brazil, *M. hirsutus* was first recorded in the state of Roraima in 2010 (MARSARO JÚNIOR et al., 2013). Then, this mealybug was detected in the states of Espírito Santo and Bahia and in the Lower Middle São Francisco Valley region (CULIK et al., 2013). In the state of Maranhão, it was recorded in 2017 in leaves and fruits of *Annona squamosa* L. (Annonaceae), *Spondias tuber* Arruda (Anacardiaceae), *Theobroma grandiflorum* Schum. (Malvaceae), and *Malpighia punicifolia* L. (Malpighiaceae), in the municipalities of Paço do Lumiar, São José de Ribamar, and São Luís (RAMOS et al., 2018).

Maconellicoccus hirsutus has a habit of being in protected parts of plants, such as petioles, slits, barks, and cracks; it presents a wax layer in the body and eggs inserted in an ovisack; these factors hinder the action of chemical products and make the control of this pest difficult (NOUREEN et al., 2016). The use of natural enemies has been adopted for the control of mealybugs (Pseudococcidae) as an alternative to the use of insecticides (MARSARO JÚNIOR et al., 2013); thus, it can also be used for the control of *M. hirsutus*. Predator natural enemies have been reported in the whole the world, predominantly from the Chrysopidae and Coccinellidae families and hymenoptera parasitoids (Encyrtidae), associated with *M. hirsutus* (CHONG; ARISTIZÁBAL; ARTHURS, 2015; PERONTI et al., 2016).

Insects known as green lacewings (Neuroptera: Chrysopidae) are widely recognized as key predators of soft-body arthropods, mainly aphids, mealybugs, and psyllids (ALBUQUERQUE; TAUBER; TAUBER, 2012). The green lacewings species have stands up in studies of biological control of pests, since their larvae are voracious and generalists, with high capacity of searching for preys, resistance to several insecticides, and high reproductive potential (FREITAS; PENNY, 2012).

Brazil presents the highest richness of *Ceraeochrysa* Adams, 1982 (Insecta: Neuroptera), with 33 species, from which 14 are endemic (MARTINS; MACHADO, 2020). Therefore, studies with *Ceraeochrysa* are important for the biological control of pests, since they are representative in several habitats and commonly associated with agricultural crops (ALBUQUERQUE; TAUBER; TAUBER, 2001). For example, *Ceraeochrysa everes* (Banks) (Neuroptera: Chrysopidae) is a native species that has presented a significant pre-adaptation against two exotic species of mealybug, *Ferrisia dasylirii* (Cockerell) and *Pseudococcus jackbeardsleyi* Gimpel and Miller (TAPAJÓS et al., 2016). In this context, the objective of this work was to evaluate biological parameters of *C. everes* fed on 2nd instar nymphs of *M. hirsutus* and eggs of *Ephestia* (*Anagasta*) *kuehniella* (Zeller) (Lepidoptera: Pyralidae).

MATERIAL AND METHODS

Obtaining and identification of *M. hirsutus*

Fruits and leaves of okra [*Abelmoschus esculentus* (L.) Moench], an alternative host, and roselle (*Hibiscus sabdariffa* L.) plants infested with *M. hirsutus* were obtained in a vegetable production center in Itapari (02º50'54"S; 44º02'94"W) in São José do Ribamar; in Pindoba (2º51'S; 44º09'W) in Paço do Lumiar; and in Cumbique (02º 46' 49" S and 44º 14' 46" W) in Raposa, Maranhão, Brazil. The samples were placed in paper bags, labeled, and identified by collection area. The confirmation of the identification of *M. hirsutus* was done in the Laboratory of Entomology of the State University of Maranhão (UEMA) by a Coccoidea specialist.

Stock rearing of *M. hirsutus*

After the screening and identification, the insects were transferred to healthy *A. esculentus* fruits previously disinfested and cleaned with a sodium hypochlorite solution and distilled water. The okra fruits infested with *M. hirsutus* were confined inside acrylic rearing cages (35 cm length, 30 cm width, 50 cm height) with a mesh lid made of white organza tissue. The rearing cages was maintained in the insect rearing room of the Laboratory of Entomology of the UEMA under temperature of 25±2 ºC, photoperiod of 12 hours, and relative humidity of 70±10%.

Obtaining and identification of *C. everes*

Adult *C. everes* (males and females) were captured with the aid of an entomological net in *A. esculentus* and *H. sabdariffa* plants infested with *M. hirsutus*. Insects at immature developmental stages (1st, 2nd, or 3rd larval instars) associated with *M. hirsutus* colonies were randomly collected in host plants. The larvae were then carefully placed in test tubes (2 cm diameter and 8 cm length), which were sealed with cotton. Debris incorporated to the back of immature of *C. everes* were removed to identify remains of *M. hirsutus* in their constituents in the Laboratory of Entomology of the UEMA. Immature *C. everes* were individualized in plastic Petri dishes

(10 cm diameter and 1.5 depth) with *E. kuehniella* eggs as a food resource and a cotton moistened with distilled water. Insects at pre-pupa and pupa stages were maintained in the Petri dishes up to the adult stage.

The adult specimens captured were placed in 340-mL plastic cages with a mesh lid (white organza tissue) and with a lateral opening through which a test tube containing distilled water sealed with cotton was introduced. Parafilm-M® films with an artificial diet based on honey and yeast (1:1) were placed in the lateral walls of each cage and fixed with transparent adhesive tape (BATISTA et al., 2017). The diet artificial of adults and the *E. kuehniella* eggs for the larvae were replaced every two days. All *E. kuehniella* eggs used as prey for *C. everes* were acquired from a commercial insectary (PROMIP). All Petri dishes and rearing cages were maintained in B.O.D. incubation chambers at 25±2 ºC, photoperiod of 12 hours, and relative humidity of 70±10% (BEZERRA et al., 2012).

The taxonomic identification of *C. everes* was confirmed in the Laboratory of Entomology by a Chrysopidae specialist. The specimens identified (voucher specimens) were preserved in test tubes immersed in alcohol (70%), pinned in entomological boxes, and deposited in the Iraci Paiva Coelho Entomological Collection (CIPC) of the UEMA.

Stock rearing of *C. everes*

Adult male and female *C. everes* insects present morphological characteristics in the posterior region of the abdomen that enables to identify their sex (FREITAS; PENNY, 2001; FREITAS; PENNY; ADAMS, 2009). Males and females were placed in 12-liter polypropylene organizer boxes (21 cm height, 24 cm width, and 35 cm length), previously modified to be used as rearing cages (Figure 1). The lid was also modified by removing 80% of its area and replacing it with white organza tissues to favor ventilation inside the cages. The organza tissues were attached in the margins of the lid with the aid of hot glue. A 9-cm diameter hole was opened in the lateral side of the cages and covered with white organza tissue arranged in a cylindrical form to facilitate the release or removal of insects. A plastic cup (100 mL) containing a flexible polyurethane sponge and hydrophile cotton, both saturated with distilled water, was placed inside the rearing cages. White A4 paper sheets were fixed in the internal lateral wall of the cages to serve as substrate for oviposition for *C. everes*.

Parafilm M® films with an artificial diet based on honey and yeast (1:1) were fixed with adessive tape inside the rearing cages. All cages were maintained in the insect rearing room of the Laboratory of Entomology of the UEMA under controlled temperature, photoperiod, and relative humidity conditions, as previously described.

The eggs obtained during the oviposition period were individualized in Petri dishes with lids (9 cm diameter and 1.5 depth). Recently-hatched larvae were individualized in Petri dishes with *E. kuehniella* eggs, provided *ad libitum*, and a cotton moistened with distilled water. Insects at pre-pupa and pupa stages remained in these same Petri dishes up to the adult stage. The green lacewings, *C. everes*, were multiplied in laboratory and second-generation insects (F2) were used for the bioassays.

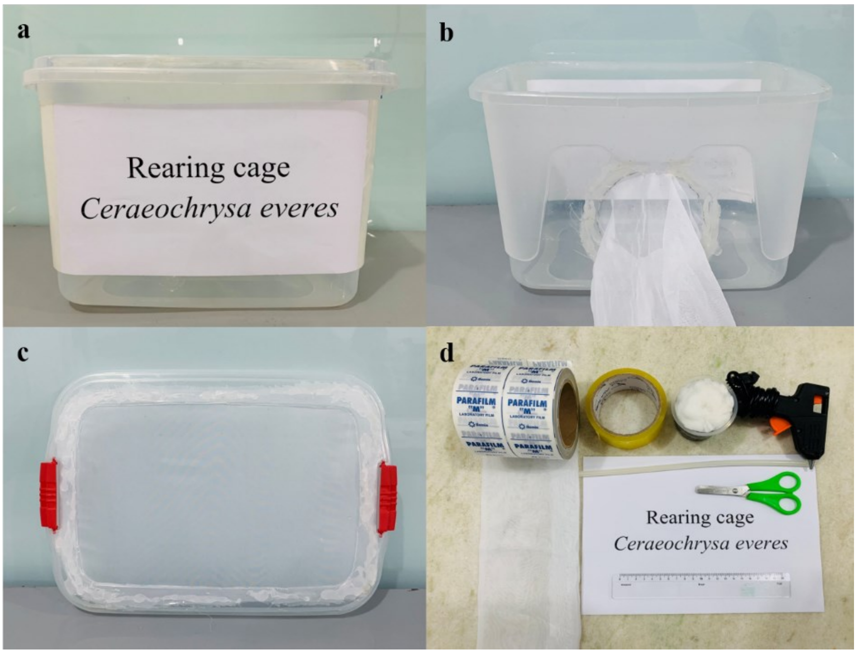

Figure 1. Phases of the development of rearing cages of *Ceraeochrysa everes*: a) frontal view of the rearing cage, finished and labeled; b) lateral view showing the circular opening and white organza tissue in the container internal wall; c) mesh lid with white organza tissue; and d) materials used for the development of the cage.

Biological aspects of *C. everes* on *M. hirsutus*

First, second, and third instar *C. everes* larvae were confined with 2nd instar nymphs of *M. hirsutus* (n=42) to evaluate the development time of immature stages, sexual ratio, pre-oviposition, oviposition, post-oviposition periods, oviposition occurrence (SILVA et al., 2007), egg viability, fecundity (total and daily), and adult female fertility and longevity. An additional treatment consisted of *E. kuehniella* eggs was offered *ad libitum* to *C. everes* at larval instars as a control.

The experimental units (n=40; for the two food resources offered to the predator) consisted of Petri dishes (14 cm diameter and 1.5 cm depth) without lids, with sections of *H. sabdariffa* leaves with petioles, involved in moistened cotton with distilled water to keep the leaf moisture to avoid the death of nymphs by lack of food or drying of leaves. Then, 2nd instar nymphs of *M. hirsutus* were placed in the leaf substrate in Petri dishes sealed with perforated polyvinyl chloride (PVC) films to enable ventilation. In the control treatment, *C. everes* at immature stages were fed *ad libitum* with *E. kuehniella* eggs up to the end of the larval period.

The predator larvae were monitored daily, and the instar change, pupation, mortality, and adult emergence dates were recorded. The *M. hirsutus* nymphs consumed were replaced daily, therefore, the availability of prays was maintained constant over the experiment (n = 42).

The sexing of the insects and formation of pairs was done at the *C. everes* adult emergence day. The pairs were then placed in 340-ml plastic cages with mesh lids (white organza tissue) and a paper sheet (white) covering the inside of the cage. Each cage had a lateral opening through which a test tube containing distilled water and closed with cotton was inserted. The adult insects were fed an artificial diet, as previously described (BATISTA et al., 2017). The adult artificial diet and distilled water were replaced every two days (JUMBO et al., 2019). The oviposition substrate (paper) was replaced daily and the number of eggs laid were counted (BIAGIONI; FREITAS, 2001). All cages were maintained in B.O.D. incubation chambers under temperature of 25±2 ºC, photoperiod of 12 hours, and relative humidity of 70±10% (BEZERRA et al., 2012).

The viability of eggs (fertility) was evaluated over the *C. everes* oviposition period, by daily withdraws of sample eggs in each rearing cage with adults. All egg samples were placed in plastic Petri dishes with lids (10 cm diameter and 1.5 cm depth) with paper filter and stored in B.O.D. incubation chambers in the Laboratory of Entomology of the UEMA under temperature, photoperiod, and relative humidity conditions as previously described. Daily evaluations were carried out to determine the hatching day and fertility of *C. everes* eggs.

Statistical analysis

A completely randomized design was used to evaluate the effect of the food resource on the duration of the 1st (n=40; both resources), 2nd (n=40; both resources), and 3rd (n=40; both resources) larval instars, pupal period (*E. kuehniella*: n=40; *M. hirsutus*: n=33), development time (*E. kuehniella*: n=40; *M. hirsutus*: n=33), reproduction parameters, and adult longevity of *C. everes* (n=20). The sex ratio was assessed with the chi-square test (χ^2). In addition, the percentage of viable eggs (fertility) was calculated over the oviposition period of *C. everes*.

The data were previously subjected to the Kolmogorov-Smirnov test to evaluate the normality of residues and by the Hurtley test to evaluate the homogeneity of variances (homoscedasticity). However, the data did not meet the assumptions for parametric statistical tests, and the use of the non-parametric Mann-Whitney U test was required. The statistical analyses were carried out in the R statistical program (R 4.0.2, R DEVELOPMENT CORE TEAM, 2020).

RESULTS AND DISCUSSION

The duration of the 1st larval instar of *C. everes* (n=40) was higher when the predator was fed on 2nd instar nymphs of *M. hirsutus* (6.80±0.08 days), compared to the control treatment (*E. kuehniella* eggs; 4.35±0.08 days) (U=0.00; Z=-8.04, P<0.001) (Table 1). Similarly, the duration of the 2nd larval instar of *C. everes* (8.05±0.18 days) was higher when they were fed on 2nd instar nymphs of *M. hirsutus*, compared to the control (3.75±0.07 days) (U=0.00; Z=-7.95, P<0.001) (Table 1). The 3rd larval instar of *C. everes* also presented higher duration when fed on 2nd instar nymphs of *M. hirsutus* (9.05±0.14 days) compared to the control treatment (4.48±0.08 days) (U=0.00; Z=-7.88, P<0.001) (Table 1). The pupal period (pre-pupa and pupa) of *C. everes* fed exclusively on *M. hirsutus* (13.88±0.10 days) was higher than that found for the standard diet composed of *E. kuehniella* eggs (12.05±0.14 days) (U=59.00; Z=-6.89, P<0.001) (Table 1). The total development of *C. everes* (1st larval instar to adult emergence) was higher when they were fed on 2nd instar nymphs of *M. hirsutus* (42.73±0.19 days) at immature stages, compared to the control treatment (29.53±0.14 days) (U=0.00; Z= -7.43, P<0.001) (Table 1).

Table 1. Effect of food resource on the duration and total development time (days) of immature stages of *Ceraeochrysa everes* under temperature of 25±2 ºC, photoperiod of 12 hours, and relative humidity of 70±10%.

C. everes stages	*E. kuehniella* eggs (mean±SE, days)	*M. hirsutus* 2nd instar nymphs (mean±SE, days)
1st larval instar	4.35±0.08 (n=40) b	6.80±0.08 (n=40) a
2nd larval instar	3.75±0.07 (n=40) b	8.05±0.18 (n=40) a
3rd larval instar	4.48±0.08 (n=40) b	9.05±0.14 (n=40) a
Pupal period	12.05±0.14 (n=40) b	13.88±0.10 (n=33) a
Total development	29.53±0.14 (n=40) b	42.73±0.19 (n=33) a

Means followed by different letters in the rows are statistically different according to the Mann-Whitney U test (P<0.05). SE = standard error. n = number of replications.

Despite *C. everes* is a generalist predator, it predated and reproduced while feeding on *M. hirsutus*. This indicates that this insect can be a promising agent for biological control of populations of this exotic mealybug. Although the present study used non-preference feed experiments, *C. everes* presented a high reproductive potential when fed on *M. hirsutus*, indicating that this predator can adapt to the such prey, since natural enemies select prey species from which they can obtain high reproduction success (WYCKHUYS et al., 2013).

The total development (days) of *C. everes* was higher when the three larval instars were fed on 2nd instar nymphs of *M. hirsutus*, compared to those fed on *E. kuehniella* eggs offered as preys. The duration (days) of all immature stages of *C. everes* (1st, 2nd, and 3rd larval instars and pupal period) fed exclusively on *M. hirsutus* was always higher than that obtained in the control treatment. Additional explanations for results contrasting of this study may be related to differences in biomass as well as energy and nutrient contents of the food resources tested. In this case, a higher consumption of *E. kuehniella* eggs would be required to satiate *C. everes* at immature stages due to their lower biomass when compared to 2nd instar nymphs of *M. hirsutus*. The *E. kuehniella* egg is a highly nutritive food for many green lacewings and commonly used in mass-production of these predators (LÓPEZ-ARROYO; TAUBER; TAUBER, 1999; TAUBER et al., 2000).

A survival rate of 82.5% and 100% was found when offered 2nd instar nymphs of *M. hirsutus* and *E. kuehniella* eggs, respectively, despite the different effects of treatments in the biology of immature *C. everes*. There was no change in the expected sex ratio of 1:1 for green lacewings (χ^2= 0.77, gl=1, P>0.05) caused by the effect of the feeding regimes tested.

The food resource offered to *C. everes* at immature stages affected reproduction parameters of adult females of this predator (Tables 2 and 3). The pre-oviposition (U=0.00; Z=3.82; P<0.0001), oviposition (U=0.00; Z=-2.99; P<0.001) and post-oviposition (U=13; Z=-2.78; P<0.01) periods and longevity (U=0.00; Z=-3.76; P<0.0001) of the females tested presented differences (Table 2). The pre-oviposition period of immature individuals fed exclusively on *M. hirsutus* was approximately 2.4-fold higher than that of females fed on *E. kuehniella* eggs at immature stages (Table 2). However, the duration of oviposition and post-oviposition periods and longevity were always higher for females fed exclusively on *E. kuehniella* eggs the larval stages (Table 2). The occurrence of oviposition was 100% in all pairs formed (Table 2).

Table 2. Effect of food resources offered in the larval stage on pre-oviposition, oviposition, and post-oviposition periods and longevity of adult females *Ceraeochrysa everes* under temperature of 25±2 ºC, photoperiod of 12 hours, and relative humidity of 70±10%.

C. everes	*M. hirsutus* (mean±SE, days)	*E. kuehniella* (mean±SE, days)
Pre-oviposition	10.30±0.42 (n=10) a	4.60±0.16 (n=10) b
Oviposition	17.20±0.89 (n=10) b	41.20±0.25 (n=10) a
Post-oviposition	24.70±1.33 (n=10) b	30.00±0.47 (n=10) a
Longevity	51.80±2.02 (n=10) b	75.80±0.44 (n=10) a

Means followed by different letters in the rows are statistically different according to the Mann-Whitney U test (P<0.05). SE = standard error. n = number of replications.

The food resources caused differences in total (U=0.00; Z=-3.75; P<0.0001) and daily (U=0.00; Z= -3.78; P<0.0001) fecundity and in fertility of eggs (*M. hirsutus* 85.70% and *E. kuehniella* 96.07%) (Table 3). Females fed on *E. kuehniella* eggs at immature presented higher fecundity (total and daily) and fertility (viable eggs) (Table 3).

The type and quality of the food ingested can affect the development time of predators, regardless specific characteristics of each species (TAPAJÓS et al., 2016). The larval stage duration of green lacewings may decrease when the predator is fed on preys with better nutritional quality (PANIZZI; PARRA, 2009). This was confirmed in this work by the faster development of immature stages fed on *E. kuehniella* eggs, which is considered as a high-quality food for mass-rearing of green lacewings in laboratory (BORTOLI et al., 2006). Predators at first contact with some preys require an adaptation time regarding the predation behaviour and use of the ingested content, mainly those with extra-oral digestion, as found in green lacewings larvae (GRENIER; DE CLERCQ, 2003). Therefore, it is expected an improvement in the performance of *C. everes* preying *M. hirsutus* in future generations.

Table 3. Effect of food resources offered in the larval stage on reproduction parameters of adult females *Ceraeochrysa everes* under temperature of 25±2 ºC, photoperiod of 12 hours, and relative humidity of 70±10%.

Reproductive parameters	M. hirsutus	E. kuehniella
Oviposition occurrence (%)	100 (10)	100 (10)
Total fecundity (mean±SE, eggs)	239.20±22.35 (n=10) b	780.50±5.64 (n=10) a
Daily fecundity (mean±SE, eggs)	13.85±0.84 (n=10) b	18.95±0.12 (n=10) a
Fertility of eggs (%)	85.70	96.07

Means followed by different letters in the rows are statistically different according to the Mann-Whitney U test (P<0.05). SE = standard error. n = number of replications.

The results found confirm those of Bortoli et al. (2012), who evaluated biological aspects of *Ceraeochrysa paraguaria* Navás (Neuroptera: Chrysopidae) on mealybugs [*Selenaspidus articulatus* Morgan (Hemipetra: Diaspididae) and *Praelongorthezia praelonga* (Douglas) (Hemipetra: Ortheziidae)], and found that only *S. articulatus* was adequate for the predator development, with a larval duration of 10.97 days and viability of 100% for 1st instar, 93.3% for 2nd instar, and 83.3% for 3rd instar insects. Contrastingly, Santa-Cecília, Souza, and Carvalho (1997) found that *Ceraeochrysa cubana* Hagen (Neuroptera: Chrysopidae) larvae fed on *Pinnaspis* sp. (Coccoidea: Diaspididae) presented duration of 20.5 days and viability of 95% for 1st instar, 68.4% for 2nd instar, and 15.4% for 3rd instar insects.

The quality of the prey species has a direct impact on the growth, development, and reproduction of predatory insects. Preys with high nutritional quality promote a fast development and allow green lacewings to reach their maximum reproductive potential (CUELLO et al., 2019). Regarding the parameters of the adult stage, the results showed that oviposition and post-oviposition periods, longevity, and fecundity of *C. everes* insects were higher when they were fed on *E. kuehniella* eggs, when compared to those fed on *M. hirsutus*. This is explained by the fact that *E. kuehniella* eggs are rich in proteins and lipids, whereas hemipters are slightly richer in carbohydrates (SPECTY et al., 2003).

The diet provided at larval stage to the predator affected the daily and total oviposition capacity of *C. everes.* Rousset (1984) reported that a deficient diet for larvae significantly affects the predator adult stage, because pre-vitellogenesis, which takes place over the pupal stage using reserves accumulated in the growth of ovaries. Bortoli et al. (2009) evaluated biological aspects of *Ceraeochrysa cincta* (Schneider) (Neuroptera: Chrysopidae) and found that the offering larvae and eggs of moths [*Diatraea saccharalis* (Fabricius) (Lepidoptera: Crambidae), *Sitotroga cerealella* Olivier (Lepidoptera: Gelechiidae), and *E. kuehniella* (=*Anagasta kuehniella*)] during the predator immature stage does not affect reproduction parameters, except for females from larvae fed on *E. kuehniella* eggs, which had a higher longevity than the others. Contrastingly, the present work showed that there are differences in pre-oviposition, oviposition, post-oviposition, longevity, and fecundity depending on the food resource provided to *C. everes*.

CONCLUSION

Ceraeochrysa everes can predate, develop, and reproduce while having 2nd instar nymphs of *M. hirsutus* as a food resource. Therefore, this predator can be considered as a potential agent of biological control of populations of this exotic mealybug.

ACKNOWLEDGEMENTS

The authors thank the Coordination for the Improvement of Higher Education Personnel (CAPES) for the scholarship for the first author. We also thank to Dr. Adriano Soares Rêgo for the identification of the *C. everes*; Dr. Albéryca Stephany de Jesus Costa Ramos for the identification of the pink hibiscus mealybug (*M. hirsutus*). This research was supported by the projects: FAPEMA UNIVERSAL (Process 01327/18) and DCR/ FAPEMA/ CNPq (Process DCR-03310/16).

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