

***Chrysoperla externa* (NEUROPTERA: CHRYSOPIDAE) AND *Utetheisa ornatrix* (LEPIDOPTERA: ARCTIIDAE) ON ORGANICALLY GROWN *Crotalaria juncea* (FABACEAE)¹**

Chrysoperla externa (Neuroptera: Chrysopidae) e *Utetheisa ornatrix* (Lepidoptera: Arctiidae) sobre *Crotalaria juncea* (Fabaceae) Cultivada Organicamente

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ABSTRACT - *Chrysoperla externa* (Neuroptera: Chrysopidae) larvae can avoid foraging on plants of *Crotalaria juncea* (Fabaceae) after the issuance of floral buds, when the prey of *Utetheisa ornatrix* (Lepidoptera: Arctiidae) incorporate toxic pyrrolizidine alkaloids from this plant. This reduces the predation and favors increasing the number of adults and eggs of this defoliator on crops of this plant. The aim of the present paper was to evaluate some biological and ecological aspects of *C. externa* and *U. ornatrix* on the organic crop of *C. juncea* in the EMBRAPA Maize and Sorghum in Sete Lagoas, Minas Gerais State, Brazil. *Chrysoperla externa* and *U. ornatrix* were more abundant in the vegetative and flowering stages of *C. juncea*, respectively, with caterpillars of this defoliator feeding on leaves and seeds of this plant. The duration of the stages/instars, survival, lifetime fecundity, and oviposition showed that the branches of *C. juncea* are a suitable food for *U. ornatrix*. The abundance of adults and larvae of *C. externa* was lower in the flowering and pods stages of *C. juncea*, respectively, when the postures of *U. ornatrix* are present, probably due to the toxicity of the eggs of this prey to this predator. During these stages, *C. externa* may be reared with alternative hosts, and when the crops of *C. juncea* are scarce, an artificial diet should be used for rearing this defoliator in the laboratory for biological research and the development of biological control tactics.

Keywords: biological control, crotalaria moth, green lacewing, green manure, Integrated Pest Management.

RESUMO - Larvas de *Chrysoperla externa* (Neuroptera: Chrysopidae) podem evitar o forrageamento sobre plantas de *Crotalaria juncea* (Fabaceae) após a emissão de botões florais, quando presas de *Utetheisa ornatrix* (Lepidoptera: Arctiidae) incorporam alcalóides pirrolizidínicos tóxicos dessa planta. Isso reduz a predação e favorece o aumento do número de adultos e ovos desse desfolhador sobre cultivos dessa planta. O objetivo deste trabalho foi avaliar alguns aspectos biológicos e ecológicos de *C. externa* e *U. ornatrix* sobre cultivo orgânico de *C. juncea* na EMBRAPA Milho e Sorgo, em Sete Lagoas, Minas Gerais, Brasil. *Chrysoperla externa* e *U. ornatrix* foram mais abundantes nos estádios vegetativo e de florescimento de *C. juncea*, respectivamente, com lagartas desse desfolhador se alimentando sobre folhas e sementes dessa planta. A duração dos estágios/estádios, sobrevivência, fecundidade de vida e oviposição mostraram que ramos de *C. juncea* é um alimento adequado para *U. ornatrix*. A abundância de adultos e larvas de *C. externa* foi menor nas fases de floração e vagens de *C. juncea*, respectivamente, quando posturas de *U. ornatrix* estiveram presentes, provavelmente devido à toxicidade de ovos dessa presa a esse predador. Durante esses estádios, *C. externa* pode ser criado com hospedeiros alternativos, e, quando cultivos de *C. juncea* são escassos, uma dieta artificial deve ser usada para criação desse desfolhador em laboratório, para pesquisas biológicas e desenvolvimento de táticas de controle biológico.

Palavras-chave: controle biológico, lagarta-das-crotalárias, crisopídeo, adubação verde, Manejo Integrado de Pragas.

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INTRODUCTION

Crotalaria juncea (Fabaceae) plants fix atmospheric nitrogen and are used as green manure, thereby suppressing weeds (Miyazawa et al., 2010; Queiroz et al., 2010). In addition, this plant presents antagonism to nematodes (Hooks et al., 2010) and to other harmful animals (Johnson et al., 1985; Ji et al., 2005), has the ability to grow in infertile soils, although it may not have good development (Monquero et al., 2009; Odhiambo, 2011), good resistance to drought (Meschede et al., 2007; Calonego & Rosolem, 2010), and its fibers are used in the paper industry due to their softness and resistance (Morris & Kays, 2005). The area cultivated with *C. juncea* in Brazil is 3,000 ha (Signoretto et al., 2008). However, the expansion of this crop is limited due to a shortage of seed supply (Wander et al., 2007) and few regions with a suitable photoperiod for its development (Martins et al., 2009).

Utetheisa ornatrix, 1758 (Lepidoptera: Arctiidae) is the most important defoliator of *Crotalaria* spp. (*Crotalaria anagyroides*, *Crotalaria falsajuncea*, *C. juncea*, *Crotalaria stipularia*, *Crotalaria usaramohensis*, and *Crotalaria vitellina*) (Fabaceae) in Brazil (Cogni & Futuyama, 2009; Dias et al., 2009), but damages other plant species in the northern and eastern Andes in South America (Argentina, Brazil, and Chile) (Diniz et al., 2010). Their caterpillars feed on floral buds, green pods, and seeds in the development of *Crotalaria* spp. (Ferro et al., 2006; Cogni, 2010).

Utetheisa ornatrix caterpillars incorporate pyrrolizidine alkaloids (PAs) after feeding on plants of *Crotalaria* spp. and keep these toxic substances in the body (Hartmann et al., 2004; Campo et al., 2005; Guimarães Junior et al., 2006). Adult females of this defoliator may transfer toxic PAs to their egg shells to favor protection against natural enemies, which are mainly the larvae of Chrysopidae and ants (Eisner et al., 2000). The number of larvae of Chrysopidae seems to be greater in the vegetative stage of *C. juncea*; *U. ornatrix* appears to have a higher number of adults and caterpillars after the issuance of floral buds of *C. juncea* (personal observation, Wagner de Souza Tavares). Chrysopidae larvae may feed on another prey in the vegetative stage of

C. juncea or migrate to crops of other species after the issuance of floral buds by this Fabaceae to avoid feeding on the toxic eggs of this defoliator (personal observation, Wagner de Souza Tavares).

The hypothesis tested was that *Chrysoperla externa* Hagen, 1861 (Neuroptera: Chrysopidae) avoid crops of *C. juncea* after the issuance of floral buds by this plant and, therefore, the number of adults and eggs of *U. ornatrix* could be higher in this stage.

The aim of the present paper was to evaluate some biological and ecological aspects of beneficial *C. externa* and harmful *U. ornatrix* on the organic crop of *C. juncea*.

MATERIALS AND METHODS

Crotalaria juncea has been cultivated in an area without pesticides during the last 15 years in the EMBRAPA Maize and Sorghum in Sete Lagoas, Minas Gerais State, Brazil.

The experiment was carried out in the field and laboratory of the EMBRAPA Maize and Sorghum. *Crotalaria juncea* was sown in December 28, 2006 (19°28'S, 44°15'W, 750 m above sea level) and no pesticides were used. Weeds were manually removed. Rainfall was the lowest in August (6.3 mm); the relative humidity was the lowest in August and September (62%) and the highest in December (78%), January and February (77%), with an annual amplitude of 16%. The maximum wind speed was the highest in September and October (2.1 m s⁻¹) and the lowest in April, May and June (1.5 m s⁻¹). This region can be characterized as semi-moist.

Two hectares with Red Yellow Latosol Distroferric-type soil were implanted with *C. juncea* in a space of 70 cm between rows and 10 cm between plants and divided in six plots of 200 m² (10 m wide x 20 m long) each. The predominant crop in this region is *C. juncea*, followed by *Zea mays* or *Sorghum bicolor* (Poaceae). Soil chemical analysis (upper 20-cm layer) showed pH (H₂O)= 5.8; H+Al⁺³= 5.6; Al⁺³= 0.0; Ca⁺²= 2.71; Mg⁺²= 0.51; SB= 3.43 and CTC= 9.03 cmol_c dm⁻³; K= 84 and P= 17 mg dm⁻³; M.O.= 3.94 dag kg⁻¹ and V= 38 and SatAl= 0. In the laboratory, the experiment was conducted in an acclimatized room at

25 ± 1 °C temperature, 70 ± 10% relative humidity, and 12 h photoperiod in the Laboratory of Insect Rearing (LACRI).

Larvae and adults of Chrysopidae and caterpillars of Lepidoptera were collected from the 12th day of plant emergence (vegetative stage) to the pods stage of *C. juncea*. These samples were collected every three days, in the vegetative, flowering (50% + a plant with flower) and pods (50% + a plant with pods) stages from 08:00 to 12:00 using an insect net. This insect net was passed in a zigzag motion in two lines of culture (Ábrahám et al., 2003). The insects collected were transferred to plastic bags (5 l) and taken to the laboratory.

Larvae of Chrysopidae were maintained until the adult stage with an artificial diet (45 g honey, 45 g yeast, and 10 mL distilled water) in *Polyvinyl chloride* (PVC) tubes (Tavares et al., 2011a). Specimens of these adults were sent to Dr. Sergio de Freitas (*in memoriam*) of the Faculdade de Ciências Agrárias e Veterinárias (FCAV), Universidade Estadual Paulista “Júlio de Mesquita Filho” (UNESP) in Jaboticabal, São Paulo State, Brazil, and identified as *C. externa*. Caterpillars of Lepidoptera were maintained until the adult stage with an artificial diet (130 g white beans, 30 g carrot, 20 g yeast extract, 40 mL vitamin solution, 2 mL Vitagold®, 1.6 g ascorbic acid, 0.6 g sorbic acid, 1.1 g nipagin, 0.4 mL propionic acid, 0.3 mg Tetrex®, 1 mL 40% formaldehyde in distilled water, 7 g agar, and 500 mL distilled water) in PVC tubes. The vitamin solution consisted of 1 mg niacinamide, 1 mg calcium pantothenate, 1 mg thiamine, 0.25 mg riboflavin, 0.25 mg pyridoxine, 0.25 mg folic acid, 0.02 mg biotin, 0.002 mg vitamin B12, and 20 mg inositol (Signorette et al., 2008). Pupae of these insects were placed in plastic trays covered with filter paper moistened daily, and their adults maintained with 10% honey in distilled water. Specimens of these adults were sent to the Departamento de Engenharia Florestal (DEF), Universidade Federal dos Vales do Jequitinhonha e Mucuri (UFVJM) in Diamantina, Minas Gerais State, Brazil, and identified as *U. ornatrix* by Dr. Sebastião Lourenço de Assis Júnior.

Newly-hatched caterpillars of the second generation were removed from the *U. ornatrix* colony and fed with leaves from the middle portion of branches in the vegetative stage of *C. juncea*. Leaves were replaced on a daily basis. The stems of these branches were placed in glass tubes with water to reduce leaf wilting. These caterpillars were maintained in PVC tubes, whose inner wall was covered with white A4 paper as a substrate for oviposition. The duration of the stages/instars, survival, lifetime fecundity, and oviposition; some parameters of ecology and morphology of eggs, larvae, pupae and adults of *U. ornatrix* were evaluated when their caterpillars fed on *C. juncea*.

The experimental design was a Complete Randomized Block (CRB) with six replications (each repetition, a 200 m² plot cultivated with *C. juncea*). The insect's abundance (*C. externa* and *U. ornatrix*) was assessed on the total of individuals collected in the plots. The data were transformed in $\sqrt{X+0.5}$ and submitted to variance analysis (ANOVA) with split plots. Each plot was represented by the six cultivated areas (200 m² each) and sub plots by the phenological stages of *C. juncea* (vegetative, flowering, and pods). The total number of insects by the phenological stage of *C. juncea* was compared by Tukey's test ($P < 0.05$) with the MSTAT-C software, version 2.1 (Supplier: EMBRAPA Maize and Sorghum) (Russel, 1989).

RESULTS

Utetheisa ornatrix has five instars on the plants of *C. juncea*, but some caterpillars of this species showed six instars; the number of individuals and survival of stages/instars of *U. ornatrix* after feeding with the plants of *C. juncea* were described (Table 1).

The duration of the stages/instars of *U. ornatrix* after feeding on the plants of *C. juncea* were placed (Table 2).

The lifetime fecundity of *U. ornatrix* was 459.3 with 10.3 of oviposition for 14 females (Table 3).

Utetheisa ornatrix eggs have circular shape with 0.66 mm diameter. The newest exhibit creamy yellow color, darkening with the age and become black near the hatching.



Table 1 - Number of individuals and survival (%) (mean \pm standard error of mean) of stages/instars of *Utetheisa ornatix* (Lepidoptera: Arctiidae) after feeding on *Crotalaria juncea* (Fabaceae) plants in the laboratory

Stages/instars	Ni	Su	R	Sa	R
Egg	108	–	–	–	–
1 ^o instar	108	100.0 \pm 0.00	0.00	100.0 \pm 0.00	0.00
2 ^o instar	107	99.0 \pm 0.01	0.02	99.0 \pm 0.01	0.02
3 ^o instar	105	98.1 \pm 0.96	1.92	97.2 \pm 0.97	1.94
4 ^o instar	105	100.0 \pm 0.00	0.00	97.2 \pm 0.97	1.94
5 ^o instar	105	100.0 \pm 0.00	0.00	97.2 \pm 0.97	1.94
Pupa	48	45.7 \pm 0.46	0.92	44.4 \pm 0.44	0.88
Adult	36	75.0 \pm 0.75	1.50	33.3 \pm 0.33	0.66

Ni= Number of individuals; Su= Survival; Sa= Survival accumulated; R= Range (%).

Table 2 - Maximum, minimum, and average (mean \pm standard error of mean) of duration of the stages/instars (days) of *Utetheisa ornatix* (Lepidoptera: Arctiidae) after feeding on *Crotalaria juncea* (Fabaceae) plants in the laboratory

Stages/instars	Duration (days)					
	Ma	R	Mi	R	Av	R
Egg	8 \pm 0.07	0.14	4 \pm 0.04	0.08	5.7 \pm 0.05	0.10
1 ^o instar	6 \pm 0.06	0.12	3 \pm 0.03	0.06	3.4 \pm 0.03	0.06
2 ^o instar	5 \pm 0.05	0.10	2 \pm 0.02	0.04	3.1 \pm 0.03	0.06
3 ^o instar	4 \pm 0.04	0.08	2 \pm 0.02	0.04	3.0 \pm 0.03	0.06
4 ^o instar	8 \pm 0.08	0.16	2 \pm 0.02	0.04	3.9 \pm 0.04	0.08
5 ^o instar	16 \pm 0.15	0.30	5 \pm 0.05	0.10	8.8 \pm 0.08	0.16
Pupa	20 \pm 0.42	0.84	8 \pm 0.17	0.34	12.6 \pm 0.26	0.52
Adult	27 \pm 0.75	1.50	5 \pm 0.14	0.28	11.4 \pm 0.32	0.64

Ma= Maximum; Mi= Minimum; Av= Average; R= Range (days).

Table 3 - Biological parameters (mean \pm standard error of mean) of *Utetheisa ornatix* (Lepidoptera: Arctiidae) after feeding on *Crotalaria juncea* (Fabaceae) plants in the laboratory

Parameters	Du (days)	R		
First eggs to adult deaths	51.9 \pm 1.44	2.88		
	Qu	Av	R	Nf
Lifetime fecundity	172 to 763	459.3 \pm 12.76	25.52	14
Oviposition	3 to 17	10.3 \pm 0.29	0.58	14

Du= Duration; Qu= Quantity; Av= Average; Nf= Number of females; R= Range (days/number).

First instar of *U. ornatix* caterpillars were 2 mm long; head with shiny black color and width greater than the body. Thorax and abdomen with yellow light color, with black spots, of which leave long bristles. Bristles of the back of caterpillar with black color and the sides, white. The prothorax has a large black spot. The color of thoracic legs was similar to

the head and the abdomen, similar to the body. The caterpillars are brown with light patches on the segments.

The head of the second instar of *U. ornatix* caterpillars is black and the body brown with light spots. Dorsal spots and two laterals per segment resembled the clearings lines

that accompanied the body. These segments had other white spots. Bristles arranged as in the first instar. Thoracic legs with dark color and the abdominal, with the same of body.

The head of the third and fourth instars of *U. ornatix* caterpillars is yellow, with dark spots. Body with opaque black color and thorax and the last abdominal segments with lighter shade and yellowish white patches. Black bristles and longs of the back, with the thoracic segments and the last abdominal segments the distal portion with white color.

Maximum length of the *U. ornatix* caterpillars in the fifth instar, 3 cm. Head with yellowish brown color and two dark spots near to the suture and in the region of the eyes. The size of these spots was variable and few caterpillars showed no staining. Bristles sparse in these spots. Body with black color and blotches that were united with those of segments resembling yellow lines along the entire the body length. These lines were in the dorsal region (one line) and lateral (two lines), with small yellow spots and white between them.

Fifth instar of *U. ornatix* caterpillars were black tubers with black bristles on the back of the caterpillar and white on the sides. Black bristles and long in the thoracic region to the last abdominal segments with white color in the distal portion. Caterpillars with light color in the belly. Thoracic legs with shiny black color and the abdominal with color similar to the body (Figures 1A and 1B).

The length of the *U. ornatix* pupae was from 1.2 to 1.5 mm with smooth texture and dark brown color. Thorax, abdomen, and wings with yellow spots. Dark respiratory stigmata on the yellow spots. Few small thorns and scattered by the segments. Eight thorns with a curved edge in the back of the abdomen (Figure 1C).

The width of *U. ornatix* adults was 4 mm. Head with white color and black spots. Type antennae: filiform; ocelli behind the antennae and white labial palps with black extremity. Thorax with white color with black spots and white abdomen. Forewings triangular type, with the upper face of pinkish and front edge with a narrow band red, interrupted of space to space by a gray stain with a black spot. A series of three black spots in the center of this

board, toward the center of the wing, and a red stripe on the lateral edge limited in both sides by a gray stain with a series of black spots. This board had white fringe. Females with wings darker than the male and live red with black spots on the underside of the wings and that corresponded, before, those ashes of the upper face. Hind wings wide and rounded with the upper face with white color stained of black and red spots on the front edge. Adults with white fringe on the edges, except in the anterior and inferior, who had the same color of the anterior. Belly adult body white, with black spots scattered around the thorax and forming two lateral series on the abdomen (Figures 1D, 1E, and 1F).

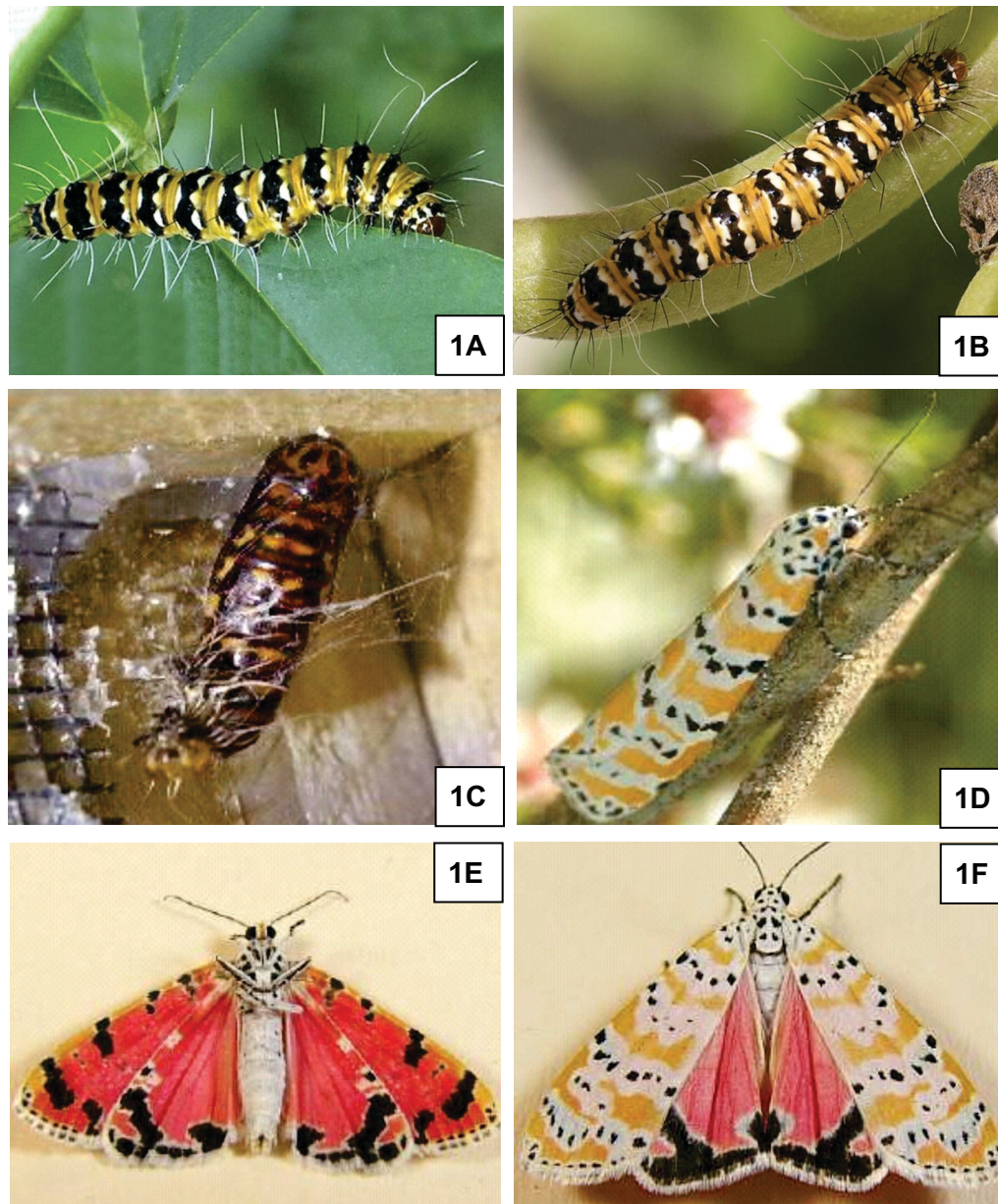
Unlike most moths, *U. ornatix* was, generally, diurnal. This pest damaged mainly the seeds of *C. juncea*, but fed also on the leaves of this plant. The females laid eggs on both sides of the leaves and in the concave portion of *C. juncea* pods. Eggs were grouped, side by side. The caterpillars feed on egg chorion after hatching and, posteriorly, started to feed on leaves. Caterpillars penetrated into the pods by a circular hole and devoured the seeds, leaving only droppings and other debris. Caterpillars abandoned this location by the same entrance hole after consuming the seeds. In the laboratory, caterpillars pupated at the top of the PVC cages and in the branches of the plants where they fed. The caterpillar spun a cocoon with silken threads, within which immobilized it to pass the pre-pupa and pupa. In the field, traces similar of exuvia to the laboratory were found, but no pupae were found, possibly due to the type of sampling used.

The abundance of *C. externa* was higher in the vegetative stage than of flowering and pods stages and of *U. ornatix* in the flowering stage of *C. juncea*. The vegetative stage of *C. juncea* had a similar abundance of these species. On the other hand, the abundance of *U. ornatix* was greater than the abundance of *C. externa* in the stages of flowering and pods of this culture (Table 4).

DISCUSSION

The development of *U. ornatix* with leaves of *C. juncea* was similar to an artificial





Figures 1 - Caterpillars (A and B); cocoon (C), and adults (D, E, and F) of *Utetheisa ornatix* (Lepidoptera: Arctiidae).

Table 4 - Total of individuals (mean \pm standard error of mean) of *Chrysoperla externa* (Neuroptera: Chrysopidae) and *Utetheisa ornatix* (Lepidoptera: Arctiidae) collected from plants of *Crotalaria juncea* (Fabaceae) in Sete Lagoas, Minas Gerais State, Brazil

Stage ^{1/}	<i>Chrysoperla externa</i>	R	<i>Utetheisa ornatix</i>	R
Vegetative	7.28 \pm 0.94 aA	1.88	8.52 \pm 0.58 bA	1.16
Flowers	4.06 \pm 0.52 bB	1.04	12.66 \pm 1.20 aA	1.40
Pods	0.88 \pm 0.11 cB	0.22	8.34 \pm 0.54 bA	1.08
VC (%)	34.67			

^{1/} Averages followed by the same small letter per column, or capital letter per line, do not differ by Tukey's test ($P < 0.05$). VC= Variation Coefficient. R= Range (number).

diet, showing no effect of the food offered to the caterpillars in the number of instars of this insect (Signoretti et al., 2008). Some caterpillars of *U. ornatix* had six instars, which suggest the effect of sex (male and female) in the number of them: caterpillars of *Thyrintina arnobia* Stoll, 1782 (Lepidoptera: Geometridae) have five and six instars that originated males and females of this species, respectively, with leaves of *Eucalyptus urophylla* (Myrtaceae) (Oliveira et al., 2005). An artificial diet rich in beans and brewer's yeast was adequate for *U. ornatix*, because the crops of *C. juncea* are only deployed during part of the year, enabling the delivery of plant material to the caterpillars (Wander et al., 2007; Martins et al., 2009). The rearing of *U. ornatix* with an artificial diet could enable the development of biological studies and of control methods with the parasitoid *Cotesia* sp. (Hymenoptera: Braconidae), often found parasitizing their caterpillars (Signoretti et al., 2008). Caterpillars of *U. ornatix* require plants of *Crotalaria* spp. as food, due to the presence of chemical compounds, such as hydroxydanalid, the precursor of their sex pheromone (Campo et al., 2007). Their females select males, who hijacked much of the alkaloid, which are larger and probably with a greater quantity of sperm to fertilize their eggs (Conner et al., 1990).

The longest duration of the egg and pupal stages of *U. ornatix* with the plants of *C. juncea* than with an artificial diet (4.5 and 10.3 days, respectively), suggests that a food rich in beans and brewer's yeast is suitable for the maintenance of this insect (Signoretti et al., 2008). On the other hand, the duration of the larval stage of *U. ornatix* was lower with plants of *C. juncea* than with an artificial diet (26.5 days). A nutritious artificial food reduces the larval period of this insect, when their caterpillars can be attacked by natural enemies (Signoretti et al., 2008). The duration of the larval stage of *U. ornatix*, of 25.92 and 21.05 days after feeding on leaves or seeds of *Crotalaria pallida* Aiton (Fabaceae), respectively, suggests that this defoliator prefers the seeds of this plant, with a higher content of PAs (Ferro et al., 2006). Younger adults of *U. ornatix* with a diet rich in alkaloids laid eggs earlier, and had a shorter duration from the larval to adult stage in the

laboratory, suggesting a loss of resistance and susceptibility to natural enemies (Campo et al., 2005; Partridge et al., 2005).

The higher viability of the egg stage of *U. ornatix* with the plants of *C. juncea* than with a diet rich in beans and brewer's yeast (84.2%) suggests the need of gradual adaptation to artificial food in future generations (Signoretti et al., 2008). The lower survival of *U. ornatix* caterpillars in the laboratory after predation on leaves than on the green seeds of *C. pallida* suggests the expenditure of energy to pierce the pods and reach the seeds. However, this can be offset because the caterpillars are better protected inside the pods against natural enemies. This was shown with a pupal survival of 89.3% and 70% with leaves or seeds of *C. pallida*, respectively (Ferro et al., 2006).

The number of eggs per female of *U. ornatix* with the plants of *C. juncea* was greater than this defoliator with an artificial diet (239.5 eggs) (Signoretti et al., 2008), leaves (244.4 eggs), or seeds (297.75 eggs) of *C. pallida* (Ferro et al., 2006) or leaves of *Crotalaria incana* (Fabaceae) (Cogni et al., 2010), indicating that native hosts are better for this Lepidoptera than those introduced. The number of eggs per eggs masses of *U. ornatix* (20 eggs) may have been an adaptation against predation by larvae of Chrysopidae, because eggs masses with three or fewer eggs were more predated. Eggs masses with four or more eggs of *U. ornatix* were on average three eggs inspected by the larvae of Chrysopidae, but were not preyed, which may be due to the presence of alkaloids on them (Eisner et al., 2000).

The characteristics and habits of the caterpillars of *U. ornatix*, including in the pods of *C. juncea* were similar to this insect that laid their eggs on the leaves and their caterpillars feeding on seeds in the green pods of *C. pallida* (Ferro et al., 2006). Adults from the caterpillars that fed on the green seeds were preyed less frequently by the spider *Nephila clavipes*, 1767 (Araneae: Nephilidae), when fed on the leaves of *C. pallida* (Ferro et al., 2006). Eggs of this insect have been rejected by Coccinellidae beetles (Dussourd et al., 1988), larvae of *Ceraeochrysa cubana*, 1861 (Neuroptera: Chrysopidae) (Eisner et al., 2000) and the ant *Leptothorax longispinosus*, 1863



(Hymenoptera: Formicidae) (Hare & Eisner, 1993). *Coleomegilla maculata* De Geer, 1775 and *Cycloneda sanguinea*, 1763 (Coleoptera: Coccinellidae), *Diabrotica speciosa*, 1824 and *Cerotoma arcuatus*, 1791 (Coleoptera: Chrysomelidae) and the unidentified larvae of Coccinellidae (Tavares et al., 2011b), also soil organisms have been observed in the cultures of *C. juncea* in Sete Lagoas, Minas Gerais State, Brazil (Tavares et al., 2011c), showing the importance of this culture as a refuge for harmful-insects and natural enemies. The green seeds of *C. pallida* have five times more PAs than their leaves, which were sequestered by the caterpillars and transferred to the adults of *U. ornatrix*; this may protect this insect, but this chemical defense did not prevent the fact that they were preyed by ants *Ectatomma quadridens*, 1793, *Camponotus crassus*, 1862 (Ferro et al., 2006) and *Camponotus blandus*, 1858 (Hymenoptera: Formicidae) (Guimarães Junior et al., 2006). Caterpillars of *U. ornatrix*, in the field do not come immediately in the pods of *Crotalaria* spp. after hatching, remaining in the early stages near the apex of the leaves, but the second or third, their caterpillars penetrate the pods (Ferro et al., 2006).

The greater abundance of *U. ornatrix* than of *C. externa* in the flowering and pods stages of *C. juncea* suggests that this predator avoids crops of this Fabaceae after the issuance of flowers. The content of total alkaloids in the plants of *Adenanthera intermedia* Merr and *Crotalaria spectabilis* Roth (Fabaceae), *Senecio jacobaea* L. (Asteraceae), *Senecio longilobus* Benth., *Senecio riddellii* Torr. & A. Gray and *Senecio spartioides* Torr. & A. Gray (Asteraceae) was maximum at the beginning of flowering or sprouting after cutting, thereby suggesting a greater possibility of the incorporation of these compounds by caterpillars of *U. ornatrix* in this period (Johnson et al., 1985). The abundance of adult and immature of *U. ornatrix* damaging leaves, flowers, and seeds of *Crotalaria breviflora* (Fabaceae) and *C. spectabilis* was higher in May of 2008 in Alagoas State, Brazil (Dias et al., 2009). Caterpillars of *U. ornatrix* migrated from the host plant for pupating in shelters in the bark of trees in the vicinity of the culture (Dias et al., 2009). Furthermore, they may move to other plants species in search of food after

the defoliated plants of *Crotalaria* spp., preferentially when the activity of predatory ants is low, for example, at sunrise (Ferro et al., 2006).

Some biological and ecological characteristics of *C. externa* and *U. ornatrix* on the organic crop of *C. juncea* were studied. The abundance of adults and larvae of *C. externa* was lower in the flowering and pods stages of *C. juncea*, respectively, when the postures of *U. ornatrix* are present. During these stages, *C. externa* may be reared with alternative hosts, and when the crops of *C. juncea* are scarce, an artificial diet should be used for rearing this defoliator in the laboratory for biological research and the development of biological control tactics.

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