

**BIOLOGICAL AND MORPHOLOGICAL CHARACTERISTICS  
OF *Hylesia paulex* (LEPIDOPTERA: SATURNIIDAE) FED WITH  
*Eucalyptus urophylla* (MYRTACEAE)**

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**SUMMARY**

*Hylesia* spp. (Saturniidae), important moths for public health due to urticating bristles of their larvae and/or adults, are collected in different habitats with potential to defoliate plants in agriculture and forest systems. Biological and morphological characteristics of *Hylesia paulex* (Dognin, 1922) (Lepidoptera: Saturniidae) fed with *Eucalyptus urophylla* (Myrtaceae) were studied in the laboratory. Recently-emerged caterpillars of this species were separated in 10 plastic pots (500ml) with 30 of them per pot, and fed daily with fresh leaves of *E. urophylla* until they reached adult stage. The egg incubation period of *H. paulex* was  $32.00 \pm 1.19$  days with  $65.32$

$\pm 14.52\%$  viability, and the duration of the larval stage reached  $67.83 \pm 0.84$  days, with seven instars. The gregarious behavior is important to maintain a high survival rate during this stage for *H. paulex*. The pre-pupa and pupa stages of this insect lasted  $3.87 \pm 0.16$  and  $21.67 \pm 0.79$  days, respectively. The longevity of females of this species was longer ( $4.50 \pm 0.54$  days) than that of males ( $2.80 \pm 0.44$  days). The mean number of eggs per egg mass was 132.3. Moths of *H. paulex* completed its life cycle, satisfactorily, with leaves of *E. urophylla* in the laboratory.

**Introduction**

Insects can be of medical, agricultural or veterinary importance, but few groups

belong to more than one of these categories as Saturniidae moths do. Individuals of this family have defense structures with bristles that inject urticat-

ing substances and provoke burns in mammals (Fornés and Hernández, 2001; Gouveia *et al.*, 2005; Lorini *et al.*, 2007). They also have potential as

agricultural and forest pests (Borges *et al.*, 2003; Freitas *et al.*, 2005; Specht *et al.*, 2006a) and social importance as food for humans (Ande, 2003).

**KEYWORDS / Gregarism / Hemileucinae / Lepidopterism / Moth /**

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**CARACTERÍSTICAS BIOLÓGICAS Y MORFOLÓGICAS DE *Hylesia paulex* (LEPIDOPTERA: SATURNIIDAE) ALIMENTADAS CON *Eucalyptus urophylla* (MYRTACEAE)**

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**RESUMEN**

*Hylesia* spp. (Saturniidae), una polilla importante en salud pública debido a las cerdas urticantes de las larvas y/o de los adultos, son recolectadas en diferentes ambientes con potencial de defoliación de plantas tanto en agricultura como en sistemas forestales. Características biológicas y morfológicas de *Hylesia paulex* (Dognin, 1922) (Lepidoptera: Saturniidae) alimentados con *Eucalyptus urophylla* fueron estudiados en laboratorio. Larvas recién emergidas de esa especie fueron separadas en vasos plásticos (500 ml) con 30 individuos por vaso y alimentados diariamente con hojas frescas de *E. urophylla* hasta alcanzar el estado adulto. El periodo de incubación de los

huevos de *H. paulex* fue de  $32 \pm 1,19$  días con un  $65,32 \pm 14,52\%$  de viabilidad y duración del estado larval de  $67,83 \pm 0,84$  días, con siete instares. El comportamiento gregario es importante para mantener una alta tasa de supervivencia durante estos estados en *H. paulex*. Los estados de pre-pupa y pupa del insecto duraron  $3,87 \pm 0,16$  y  $21,67 \pm 0,79$  días, respectivamente. La longevidad de las hembras de la especie fue de  $4,50 \pm 0,54$  días y para machos de  $2,80 \pm 0,44$  días. El número medio de huevos por masa de huevos fue de 132,3. La polilla *H. paulex* completa su ciclo de vida, satisfactoriamente, con hojas de *E. urophylla* en laboratorio.

**CARACTERÍSTICAS BIOLÓGICAS E MORFOLÓGICAS DA *Hylesia paulex* (LEPIDOPTERA: SATURNIIDAE) ALIMENTADAS COM *Eucalyptus urophylla* (MYRTACEAE)**

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**RESUMO**

*Hylesia* spp. (Saturniidae), mariposas importantes para a saúde pública devido às cerdas urticantes de suas larvas e/ou adultos, são coletadas em diferentes habitats com potencial de desfolhar plantas em sistemas agrícolas e florestais. Parâmetros biológicos e morfológicos de *Hylesia paulex* (Dognin, 1922) (Lepidoptera: Saturniidae) alimentada com *Eucalyptus urophylla* (Myrtaceae) foram estudados em laboratório. Lagartas recém-emergidas dessa espécie foram separadas em 10 potes plásticos (500ml) com 30 delas por pote e alimentadas, diariamente, com folhas frescas de *E. urophylla* até o estágio adulto. O período de incubação dos

ovos de *H. paulex* foi de  $32,00 \pm 1,19$  dias com  $65,32 \pm 14,52\%$  de viabilidade e duração do estágio larval de  $67,83 \pm 0,84$  dias, com sete estádios. O comportamento gregário é importante para manter a alta taxa de sobrevivência durante esses estádios para *H. paulex*. Os estágios de pré-pupa e pupa desse inseto duraram  $3,87 \pm 0,16$  e  $21,67 \pm 0,79$  dias, respectivamente. A longevidade das fêmeas dessa espécie foi maior ( $4,50 \pm 0,54$  dias) que a dos machos ( $2,80 \pm 0,44$  dias). O número de ovos/postura foi de 132,3. Mariposas de *H. paulex* completaram seu ciclo de vida, satisfatoriamente, com folhas de *E. urophylla* em laboratório.

The majority of the studies on the Saturniidae family (Rodríguez-Morales *et al.*, 2005; Salomon *et al.*, 2005; Iserhard *et al.*, 2007; Lundberg *et al.*, 2007) refer to its capacity to cause dermatologic irritations as for *Hylesia* spp. (Saturniidae: Hemileucinae). They are small to medium size moths, found from Mexico to Argentina (Lemaire, 2002). The occurrence of these moths has also been recorded in population outbreaks in Brazil in agriculture (Camargo and Becker, 1999; Glasser *et al.*, 1993; Camargo, 2007; Iserhard *et al.*, 2007; Moreira *et al.*, 2007) and forest monocultures (Zanuncio *et al.*, 1998, 2001, 2006).

The genus *Hylesia* presents ~110 species (Lemaire, 2002) but the biology of most of them is poorly studied (Le-

maire, 2002; Camargo, 2007), except for research on *Hylesia nanus* (Walker) by Santos *et al.* (1996), *H. nigricans* (Berg) by Specht *et al.* (2006a) and *H. metapyrrha* (Walker) by Specht *et al.* (2007). However, other studies should be performed to obtain information on the behavior, life cycle and adaptability of other species of that genus to specific hosts. Such data is important to prevent lepidopterism and erucism cases (dermatitis provoked by moths and caterpillars, respectively) (Rodríguez-Morales *et al.*, 2005) and to develop combat strategies against them (Salomon *et al.*, 2005).

The present study had as a main goal the study the biological and morphological aspects of *H. paulex*, under laboratory conditions, fed with *Eucalyptus urophylla* (Myrtaceae) leaves.

**Material and Methods**

The study was carried out at the Laboratory of Biological Control, Institute of Applied Biotechnology to Agriculture (BIOAGRO), Federal University of Viçosa (UFV), Viçosa, Minas Gerais, Brazil.

Pupae of *Hylesia paulex* (Dognin, 1922) (Lepidoptera: Saturniidae) were collected in a *Eucalyptus* spp. (Myrtaceae) plantation, in an area of savannah of Minas Gerais State, Brazil, and individualized in Petri dishes (9.0×1.5cm) at  $25 \pm 2^\circ\text{C}$  temperature,  $60 \pm 10\%$  relative humidity and 12h photoperiod.

Recently-emerged *H. paulex* adults were maintained in screened wood cages  $60 \times 60 \times 60$ cm) under field conditions, ~30 pairs per cage, in order to obtain egg masses that were collected on dry cotton

and transferred to Petri dishes (9.0×1.5cm) and kept under climatized chambers under the same conditions as the pupa stage. Groups of 30 newly-hatched caterpillars of *H. paulex* were put in ten 500ml plastic pots, with a screened cover in the center, and fed daily with fresh leaves of *E. urophylla*. The petiole of each eucalyptus leaf was wrapped in a moistened cotton wad to avoid drying and inserted in a plastic tube of odontological type anesthetic (2.5ml) with distilled water.

The eucalyptus leaves were washed in running water and bathed in sodium hypochlorite solution (10%) before being supplied to *H. paulex*, and renewed every 48h. The pots were cleaned daily and substituted when necessary, while the material used by the caterpillars to weave its pre-pupa and pupa

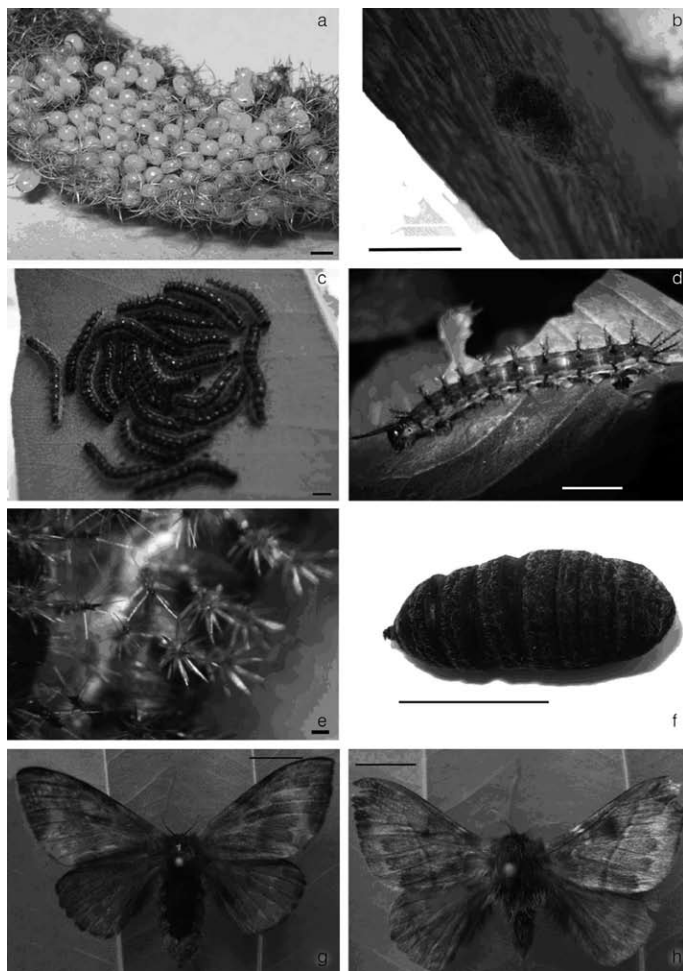


Figure 1. a: Clutch (bar: 2mm), b: eggs (bar: 10mm), c: third instar larvae (bar: 5mm), d: seventh instar larva (bar: 10mm), e: irritant hairs (bar: 2mm), f: pupa (bar: 10mm), g: adult female (bar: 10mm), and h: adult male (bar: 8mm) of *Hylesia paulex* (Lepidoptera: Saturniidae) fed with *Eucalyptus urophylla* (Myrtaceae) leaves, kept at 25 ±2°C, 60 ±10% relative humidity and 12h photoperiod.

stages shelter (branches and remains of leaves) was maintained.

The duration and number of specimens at each instar were obtained by measuring the head capsule of *H. paulex* with a stereoscopic microscope and micrometric ocular microscope. The duration of the pre-pupa and pupa periods, the weight of pupae and the sex rate of this insect were also recorded.

Thirty pairs of *H. paulex* were placed immediately after its emergency in five 30×30×30cm screened cages with wood bottom and glass cover under field conditions, to study the longevity and some reproductive parameters of this insect. Branches of *E. urophylla* were supplied in the interior of these cages wrapped in cotton wads soaked

with water to test if this substratum is preferred by *H. paulex* females to lay their eggs.

Egg masses were collected from each cage and placed in Petri dishes (9.0×1.5cm). The number of eggs, incubation period, viability of eggs, pre-oviposition period, number of eggs per egg mass, and longevity of males and females were recorded. Female specimens were dissected to determine the number of ova kept in the abdomen.

A second experiment was carried out to test the hypothesis that the gregarious behavior is important for survival of *H. paulex* in immature stages. Third instar caterpillars per treatment were maintained in plastic pots (500ml) with densities of: one (treatment T1), five (T2), 10 (T3), 20 (T4) or 30

(T5) caterpillars per pot. Leaves of *E. urophylla* were offered *ad libitum* every 24h and the development and survival of the insects, as well as the weight of male and female pupae were registered.

Adult specimens of *H. paulex* were deposited in the Department of Zoology, Federal University of Paraná, Paraná State, Brazil, and in the Museum of Entomology and Laboratory of Biological Control of BIOAGRO, UFV, Brazil.

## Results and Discussion

The eggs of *H. paulex* have an oval shape, round extremities, flat in their long axis, clear beige color, are deposited in layers and measure 1.71 ±0.07mm long by 0.61 ±0.04mm wide (Figure 1a). The values of the incubation period (32.00 ±1.19 days) and egg viability (65.32 ±14.52%) were intermediate between those of 21.8 ±0.6 days and 16.2 ±8.1% for *H. nanus* (Walker), 90.83 ±4.23 days and 78.28 ±5.84% for *H. nigricans* (Berg), and 31.8 ±5.8 days and 80.9 ±20.97% for *Lonomia obliqua* (Walker) (Lepidoptera: Saturniidae) reported by Santos *et al.* (1996), Specht *et al.* (2006a), and Lorini *et al.* (2004), respectively. Egg masses of *H. paulex* were always covered by urticating hairs (Figure 1b) removed from the lateral-areas of the abdomen of the females, which indicates a possible defensive adaptation to avoid parasitism and/or predation (Rodríguez *et al.*, 2004). However, non-mated *H. paulex*

females laid unfertile eggs that were not covered by hairs, as reported (Gardiner, 1967) for *Periphoba hircia* (Cramer) (Lepidoptera: Saturniidae).

The larval stage of *H. paulex* lasted 67.83 ±0.84 days with seven instars (Table I). Females of *Automeris randa* (Druce) (Lepidoptera: Saturniidae) and *H. nigricans* had an additional instar to those of males (Tuskes, 1985; Specht *et al.*, 2006a), which can be related to the sex dimorphism of these species, but this was not observed for *H. paulex*. The caterpillars of this species fed on the egg corium during the first hours of life, when they showed slow movements. Afterwards, they abandoned the egg mass and moved towards the *E. urophylla* leaves inside the pots. *Eucalyptus* spp. defoliators may prefer younger leaves mainly in their initial stages because they pose a lower physical impediment by being more turgid (Steinbauer and Matsuki, 2004). However, younger *H. paulex* larvae did not follow this pattern and preferred older *E. urophylla* leaves than younger ones, independently of instar, as found for most species of this plant in Brazil.

Recently-emerged *H. paulex* caterpillars presented a black head and a clear orange ventral abdomen area, while its dorsal surface was clear brown (caramel) or clear ash with yellowish thorn tufts. During development the ventral area turns whitish and the dorsal one darkens (Figure 1c). Fully developed caterpillars were 4.01 ±0.27cm long,

TABLE I  
DURATION OF EACH INSTAR, WIDTH OF THE HEAD CAPSULE AND GROWTH RATE OF *Hylesia paulex* REARED WITH *Eucalyptus urophylla* LEAVES, IN THE LABORATORY AT 25 ±2°C, 60 ±10% RELATIVE HUMIDITY AND A 12H PHOTOPERIOD

Stage	Duration (days) *	Width of the head capsule (mm) *	Growth rate
I	12.00 ±0.00	0.60 ±0.00	—
II	10.10 ±0.05	0.80 ±0.01	1.33
III	5.90 ±0.05	1.11 ±0.00	1.39
IV	8.77 ±0.20	1.47 ±0.01	1.32
V	7.37 ±0.21	1.95 ±0.01	1.33
VI	9.57 ±0.30	2.47 ±0.02	1.27
VII	14.10 ±0.73	3.52 ±0.03	1.42

\* Average ±standard error.

head of a brilliant red color, ash to black tegument, pronounced clear yellow tufts of thorns and small black stripes in the lateral parts (Figure 1d). The caterpillars of *H. paulex* presented a strong aggregation with few individuals dispersed from the group during the first instars. From the second to sixth instars they moved in single lines, during the night, in a similar pattern as that reported for *H. lineata* (Druce) by Fitzgerald and Pescador-Rubio

(2002), for *Dirphia avicula* (Walker) (Lepidoptera: Saturniidae) by Zanuncio *et al.* (1994), and for *Euselasia eucerus* (Lepidoptera: Riodinidae) by Zanuncio *et al.* (2008).

In the second experiment (Figure 2), the third instar *H. paulex* caterpillars placed individually in 500ml pots (treatment T1) did not reach the fourth instar, while none of those in treatment T2 (five caterpillars per pot) reached the pupa stage. The accumulated mortality of caterpillars was lower in T3 and T4 (10 and 20 caterpillars per pot) than in the T5 (30 per pot) in the maximum age of 50 days. The intraspecific competition for food in this last treatment may be higher due to the limited space. Besides, most caterpillars of *H. paulex* presented symptoms of bacterial

infection when 30 of them were reared per pot (T5), mainly in the last two instars, as also described for *H. metabus* (Cramer) (Lepidoptera: Saturniidae) by Osborn *et al.* (2002). This may have occurred due to horizontal transmission of pathogens, a negative characteristic of the gregarious behavior in insects (Cocroft, 2001). Caterpillars without infection completed satisfactorily the whole life cycle. The weight of pupae of each sex (Table II) did not differ between the treatments T3, T4 and T5 ( $F = 0.54$ ;  $P < 0.05$ ), suggesting that the survival of *H. paulex* is more affected by its gregarious behavior during its development than by nutrition conditions. The hypothesis that gregarious behavior benefits *H. paulex* was accepted, as found for other Lepidoptera species (Denno and

Benrey, 1997; Reader and Hochuli, 2003).

Where they stayed during the day, *H. paulex* from the late instars wove a shelter in the form of a sack with a mixture of silk threads and remnants of branches, leaves and feces, which may represent a kind of defensive behavior of this genus (Santos *et al.*, 1996; Specht *et al.*, 2006a). At night, they abandoned the shelter to feed. The caterpillars of *H. paulex* presented a strong perception to sound and physical contacts (Hogue, 1972). When upset, they regurgitated a dark liquid, arched the

posterior part of the body and they contorted wildly to defend themselves. The thorns at the back of *H. paulex* caterpillars have bunches, in pairs (Figure 1e), but without erucism, differing from other Saturniidae as *H. metabus* (Rodríguez-Morales *et al.*, 2005), *Lonomia obliqua* Walker (Lorini and Corseuil, 2001) and *Automeris illustris* Walker (Specht *et al.*, 2006b). This characteristic facilitated the manipulation of *H. paulex* in the laboratory and can be useful for manual control of this species in the field.

The pre-pupa stage of *H. paulex* lasted  $3.87 \pm 0.16$  days, with a considerable reduction of the corporal length, feeding arrest and search for a place to build a cocoon, mainly with silk threads, remnants of branches, leaves and feces. Several individuals of *H. paulex* pupate together in a single substratum mass, also suggesting aggregation in this stage as shown for the Hemileucinae *H. acuta* Druce (Wolfe, 1998).

The pupa stage of *H. paulex* (Figure 1f) lasted  $21.67 \pm 0.79$  days, with females being heavier and longer ( $385.75 \pm 12.69$ mg and  $1.90 \pm 0.89$ cm) than males ( $248.17 \pm 7.32$ mg and  $1.30 \pm 0.78$ cm), which

can be explained by the accentuated sexual dimorphism of this species. The pupa remained protected, externally, by the same protection structure as in the pre-pupa stage. The sex was differentiated in pupae examining with a magnifying glass (10 $\times$ ) the ventral part of the last abdominal segment.

The adults of *H. paulex* emerged from the larger width of the pupa, with a sex rate of 0.59. The wings were usually fully extended after a few hours from emergence. Some adults stayed immobile while others walked slowly to the bottom of the cages, in a similar behavior (Manley, 1993) as in *Automeris io* (Fabricius) (Lepidoptera: Saturniidae). Adults that did not spread their wings after 24h did not mate. The egg masses of *H. paulex* were laid preferentially in the superior part of the cages, without a defined schedule, while mating always took place at night. The eucalyptus leaves inside the cages were not used as substratum for oviposition, indicating that females of *H. paulex* prefer to lay eggs on the trunk and branches of *E. urophylla*, as it is frequently observed in the field. The pre-oviposition period of this insect was 2.1 days, with 132 eggs per egg mass and 112 ova kept in the abdomen per female. The individualization of *H. paulex* pairs in the cages might have propitiated a lower fertilization and, consequently, larger retention of ova in the abdomen. The retention of ova in the abdomen was also found in other species of this family, and it can be related to the polyandry of females (Gardiner, 1967; Wolfe, 1998) or to the conditions of the present study.

The longevity of *H. paulex* males was shorter ( $2.80 \pm 0.44$  days) than that of females ( $4.50 \pm 0.54$  days). Males and females did not feed during the adult stage and, for this reason, the higher longevity of females can be related to the need of finding partners for mating. Adults of *H. paulex* present different characteristics among sexes, such as the size of the abdomen, span and color of the wings, and antennae type, as in other Saturni-

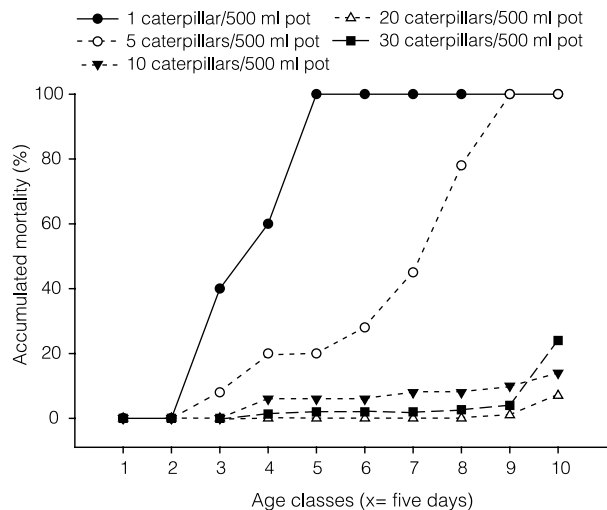


Figure 2. Accumulated mortality (%) of *Hylesia paulex* reared with *Eucalyptus urophylla* leaves from the third instar in 500ml pots at different densities: one (T1), five (T2), 10 (T3), 20 (T4), or 30 (T5) caterpillars, kept at  $25 \pm 2^\circ\text{C}$ ,  $60 \pm 10\%$  relative humidity and 12h photoperiod.

TABLE II  
WEIGHT\* OF PUPAE FROM DIFFERENT NUMBERS OF CATERPILLARS OF *Hylesia paulex* REARED WITH *Eucalyptus urophylla* LEAVES

Sex	Treatments				
	T1	T2	T3	T4	T5
Male	—	—	294.34 $\pm$ 15.15 aA	288.18 $\pm$ 10.31 aA	286.73 $\pm$ 9.48 aA
Female	—	—	392.29 $\pm$ 19.42 aB	411.83 $\pm$ 11.25 aB	397.48 $\pm$ 22.53 aB

\* Weight in mg; average  $\pm$  standard error. Means followed by a common lower case letter (lines) or capital letter (columns) do not differ (Tukey test;  $P = 0.05$ ). T1: one caterpillar, T2: two caterpillars, T3: 10 caterpillars, T4: 20 caterpillars, and T5: 30 caterpillars per 500ml pot, kept at  $25 \pm 2^\circ\text{C}$ ,  $60 \pm 10\%$  relative humidity and a 12h photoperiod.

dae (Wolfe, 1998; Santos *et al.*, 1996; Lorini and Corseuil, 2001; Camargo, 2007; Specht *et al.*, 2007). The abdomen of females (Figure 1g) is more robust than that of males (Figure 1h) with hairs covering, in both sexes, the lateral subsequent parts of their abdomen. Hairs of the abdominal area of *H. paulex* females had urticating effects, which can lead to public health problems, as found for *H. metabus* (Rodríguez-Morales *et al.*, 2005) and *H. nigricans* (Salomon *et al.*, 2005). The wing span of *H. paulex* was 5.04 ± 0.14cm for females and 3.70 ± 0.10cm for males. The wings of females of this species are gray and darker than those of males. Males have bipectinated antennae with a clear beige color, while those of females are filiform and with a dark color.

Species of the genus *Hylesia* developed satisfactorily with eucalyptus plants, as observed for *H. paulex* with *E. urophylla* in the present work. Thus, it is possible for this species to reach high population levels under monoculture conditions. Knowledge about the biological and morphological aspects of *H. paulex* are also useful for public health inspectors to develop measures to avoid dermatological damages by *Hylesia* moths in urban areas.

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