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RESEARCH ARTICLE

Biology of *Automeris jucunda* (Lepidoptera: Saturniidae, Hemileucinae) with taxonomic notes on *A. hamata* subgroup

Lorenzo Comoglio^{1*} Luigi Racheli²

¹Departamento de Ciencias Biológicas, Universidad de los Andes, Bogotá, Colombia. ²Via Piero Carnabuci 29, I-00139 Rome, Italy. *Corresponding author: l.comoglio@uniandes.edu.co

Abstract: A female of *Automeris jucunda* (Cramer, 1779) was collected during a field expedition to Otanche, Colombia. The rearing of this species was conducted in captivity, *in situ* and in the laboratory, on different food plants as the larvae revealed to be polyphagous. In Colombia, the larval phase lasted six weeks on *Schizolobium parahyba* S. F. Blake, 1919 (Fabaceae), a natural host plant of *A. jucunda*. Instead, in the laboratory the larval phase lasted more than eight weeks on *Rubus fruticosus* Linnaeus, 1753 (Rosaceae), a replacement food plant for this species. The gregarious larvae developed between five to six instars and can also cause erucism. The immature stages of *A. jucunda* are described together with food plants. Furthermore, short taxonomic notes on the *A. hamata* subgroup, which includes *A. jucunda*, are provided.

Key words: Saturniid moth, preimaginal instars, immature stages, life history, food plants, erucism, South America.

Introduction

According to Lemaire (2002), the species *Automeris jucunda* (Cramer, 1779) belongs to subgroup of *A. hamata* Schaus, 1906 within the genus *Automeris* Hübner, 1819 with 135 known species. Based on the male and female genitalia morphology, Lemaire (2002) listed also the 11 following taxa as representatives of the above mentioned subgroup: *A. balachowskyi* Lemaire, 1966; *A. chacona* Draudt, 1929; *A. chacona cochabambae* Lemaire, 1971; *A. duchartrei* Bouvier, 1936; *A. goodsoni* Lemaire, 1966; *A. hamata*; *A. meridionalis* Bouvier, 1936; *A. rectilinea* Bouvier, 1927; *A. rostralis* Lemaire, 2002; *A. tamsi* Lemaire, 1966 and *A. wayampi* Lemaire & Beneluz, 2002. Recent taxonomic work on this genus proposed a total number of 356 species (BOLD 2016), based on the mt-DNA barcoding of

life results, obtained by examining the sequence diversity of cytochrome c oxidase subunit 1 (COI) gene, which facilitated the description of new taxa (Miller *et al.* 2016).

Amarillo-Suárez (2000) reported an estimated number of 118 species of the genus *Automeris* in Colombia.

The species *Automeris jucunda* (Cramer, 1779) is a known Saturniid moth recorded from the northern part of South America. Recently it is reported from Panama, Venezuela, Lesser Antilles (Saint Vincent and Grenada), Colombia and Ecuador (Lemaire 2002). It is found at elevations ranging from 40 m to 1500 m (Lemaire 2002; Decaëns *et al.* 2007) and appears to be a locally abundant and widely distributed species (Lemaire 2002). In Colombia, *A. jucunda* was already reported from Cundinamarca (Lemaire 2002; Gómez 2014); San José del Palmar, Chocó department (Decaëns *et al.* 2003); Quipama, Boyacá department (Decaëns *et al.* 2007); and Florencia, Caquetá department (BOLD 2016).

Recently, this species has also been listed from Honduras by Miller *et al.* (2012), but no recent collecting data was provided, suggesting this record might be based on an old unverified report or a misidentification.

A few notes on the larvae and food plants of this species were found in Gardiner (1982) but the specimen figured as *A. jucunda* is doubtful and possibly it refers to another species. In this paper, the early stages of *A. jucunda* are described and illustrated, given that no record on its biology was provided by Lemaire (2002), Lampe (2010) and Meister (2011), and neither was published before.

This species is crucial for clinical and epidemiological study. Many cases of erucism caused by Saturniid moths of the genus *Automeris* are rarely denounced (Gómez 2014). Erucism is the name given to envenomation by larvae in humans (De Roodt *et al.* 2000). All larvae of the genus *Automeris* possess stinging spines that can cause erucism if touched. This is followed by a burning and stinging sensation with an irritating rash that can last for hours. Sometimes dizziness and sweating can also be incurred (De Roodt *et al.* 2000; Gómez 2014).

Material and methods

Taxonomy

The taxonomic notes are based on the revision of Lemaire (2002), with a few additional studies taken into consideration, but excluding most of the new names introduced in recent times and based on DNA barcoding data only. The reason is that some of the new taxa described after Lemaire's (2002) revision remain very doubtful or based on spurious characters (Peigler 2013). DNA barcoding's use in taxonomy should always be united with morphological observations, combining both morphological and biological definitions of species (Decaëns & Rougerie 2008; Peigler 2013).

Collecting sites

The adults of *A. jucunda* were attracted at lights and collected at 896 m in Colombia, Boyacá Department, Otanche, Buenos Aires locality, near a ravine called "La Cobre", 5° 46' 48" N, 74° 10' 12" W, between July 25, 2013 and September 8, 2013. The town named Otanche is located on the foothills of the Eastern Cordillera of the Andes, into the valley of the Magdalena River, the principal river of Colombia, in the Western part of the department of Boyacá. Most of the area is characterized by premontane moist forest (Holdridge 1967), with frequent rainfall and average annual temperature above 24 °C.

For the night collecting, a mixed 160 W mercury vapor 3200K light was set up in front of a slope, with a vertical white sheet to reflect its rays.

Rearing

In Otanche (Colombia), some larvae have been reared as a control group. The larvae were reared on the branches of the natural host plant (*Schizolobium parahyba* S. F. Blake, 1919, Fabaceae) of the species, using net sleeves of 90 cm of length and 40 cm of diameter.

In the laboratory (Italy), the eggs were stored in a Petri dish, and misted with some hot water daily. Larvae were reared at average room temperature of 22°C and relative humidity of 50%. A standard breeding method was used. The host plant leaves were always washed and disinfected with a 1% sodium hypochlorite solution. The first and second instar larvae fed on the leaves of the food plant (*Rubus fruticosus* Linnaeus, 1753, Rosaceae), changed every day, in a transparent plastic box of 20 cm wide, 20 cm deep and 10 cm tall. The later instar larvae fed in a bigger box where a 50 cm length branch of the food plant could be introduced. The pupae were stored in a ventilated box of 40 cm wide, 30 cm deep and 80 cm tall and misted with water every 3 days.

Emerged imagos from this rearing are preserved in the research collections of the authors.

Results

The adults were on the wing between 9:00 pm to 2:00 am (sunset between 5:59 pm and 6:13 pm), with a peak among 11:00 pm to 11:30 pm. The males were more common at lights, and usually were attracted later than females, a common feature within Saturniidae (Lemaire 2002). On September 3, 2013, a female of *A. jucunda* was collected at lights. The female laid 62 eggs, 23 eggs hatched (37.10% hatched) and finally 11 specimens managed to emerge from the pupa (47.83% developed into an imago upon hatching).

Food plants

Automeris species are quite polyphagous (Gardiner 1982; Meister 2011). Natural host plants includes *Cecropia* spp. Loefling, 1758 (Urticaceae) and *S. parahyba* S. F. Blake, 1919, called “tambor” by local people. Attempts to feed the larvae on *Persea americana* Miller, 1768 (Lauraceae), avocado, revealed unsuccessful.

In the laboratory, the Saturniid larvae can generally feed on replacement food plants, different from the natural host plants of the species. In Europe, the larvae of *A. jucunda* fed on *R. fruticosus*; *R. idaeus* Linnaeus, 1753 and *R. ulmifolius* Schott, 1818. We found a preference for *R. fruticosus*: after the third instar, some larvae started dying on *R. ulmifolius* and stopped feeding on *R. idaeus*. In Colombia, the larval phase lasted as much as 6 weeks on *S. parahyba*, while in Europe, on *R. fruticosus*, this phase lasted approximately 8 weeks. Three larvae pupated after six instars, eight larvae after five instars. For those that pupated at the sixth instar, the larval phase continued for more than a week.

Descriptions

Eggs (Fig. 1A). Average 1.6mm long (SD=0.2, n=62), oval white eggs. Size is typical of *Automeris*, as well as the shape. Deposited in small clusters of 5 to 8 eggs. The characteristic green micropile of fertilized eggs darkens in about a week after oviposition. The unfertilized eggs are easily recognized then as the micropile stays green. The eggs

hatched in 21 to 25 days, a relatively long time for the Saturniidae species, but standard in the Hemileucinae subfamily (Gardiner 1982; Meister 2011).

First instar (Fig. 1B). Head: chestnut colour, with some white hairs on the front. Body: uniform yellow colour. Scoli base is yellow like the body, with darker tip, the spines are black, star-shaped and elongated. Length: average 8.0 mm (SD=0.4 mm, n=23). The freshly hatched larvae start feeding from their own egg shell. Then, after 24 to 36 hours they form small group of larvae and feed on plant leaves. Duration: 6 to 7 days.

Second instar (Fig. 1C). Head: brown, lighter colour compared to the L1. Body: chartreuse colour. Black scoli and thin, black spines. Length: average 13.1 mm (SD=0.7 mm, n=23). Duration: 7 to 8 days.

Third instar (Fig. 1D). Head: brown. Body: olive colour, greener than L2; dorsal dark green stripe. Yellow scoli and spines. Length: average 19.5 mm (SD=1.3 mm, n=19). Duration: 5 to 6 days.

Fourth instar (Fig. 1E). Head: green. Body: lime green colour, with a lateral broad white line bordered above with a fine black line, and below by a fine bright red line. The dense green spines cover all the thorax and the abdomen. Length: average 37.2 mm (SD=3.3 mm, n=14). Duration: 10 to 12 days.

Fifth instar (Fig. 1F). Head: same green colour as L4. Body: light green. Orange spiracles. The lateral broad white line is bordered above with a fine alternatively black and orange line, and below by a fine black line. Most spines are dark green; some are black; characteristic pine-tree ramification. Fleshy black and red prolegs are covered of white hairs. Red legs. White spots between the prolegs on a dark field. Length: average 59 mm (SD=3.1 mm, n=8). Duration: 13 to 19 days.

Sixth instar (Fig. 1G). Most larvae pupate at the fifth instar, but some do molt another time. These larvae look the same as the fifth instar larvae, but grow bigger. Length: average 63 mm (SD=4.6 mm, n=3). Duration: average 10 days.

Pupae (Figs. 1H-I). The pupa measures 24.2 mm (males, SD=4.1 mm, n=7) to 28.3 mm (females, SD=6.1 mm, n=4) in length. Dark brown as typical for most *Automeris* species. The larvae pupated in a delicate and thin cocoon, spun near the ground of the food plant or among the food plant leaves. Duration: 29 to 56 days.

Behaviour

Gregarious at all the instars, as typical of *Automeris* species (Gardiner 1982; Meister 2011), the larvae follow each other in a characteristic procession, head to tail, when searching for food. In Colombia and in the laboratory, due to the limited space provided in captivity, the larvae in some case pupated in bigger cocoons as a host for two to even three pupae.

Discussion

The *A. hamata* subgroup proposed by Lemaire (2002) must be extended combining the recent DNA barcoding results and morphological data of newly described taxa. At least two additional species must be included in the *A. hamata* subgroup, i.e. *Automeris sylviae* Decaëns, 2004 and *A. despicata* Draudt, 1929 given their relationship to *A. duchartrei* (Decaëns 2004; Bénénez 2013). It must be noticed that Lemaire (2002) assigned the name *duchartrei* to several forms and there are no doubts that more than a single species is involved in its arrangement.

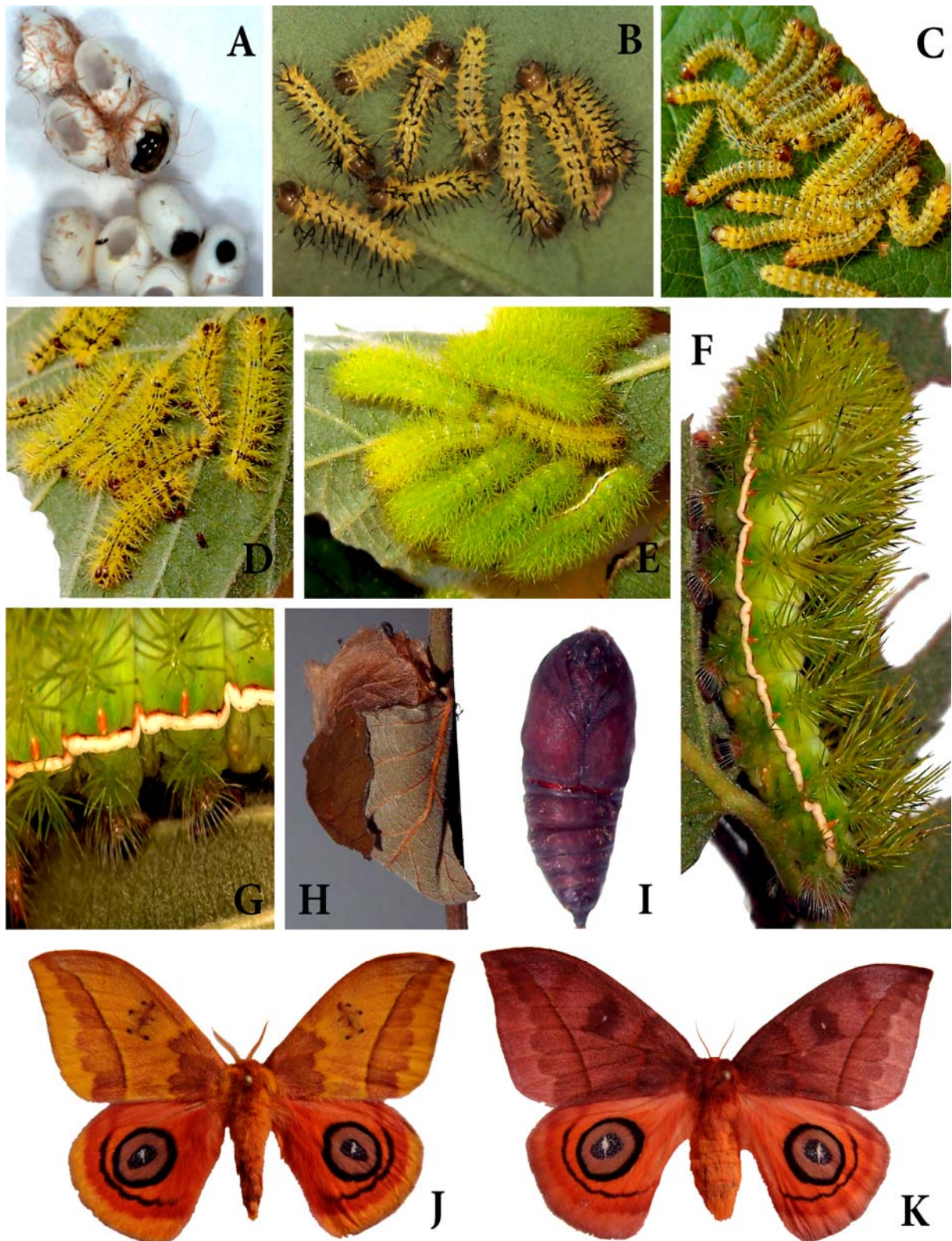


Figure 1. *Automeris jucunda* (Cramer, 1779) life cycle. **A**, eggs; **B**, larvae L1; **C**, larvae L2; **D**, larvae L3; **E**, larvae L4; **F**, larva L5; **G**, larva L6; **H**, cocoon; **I**, ♂ pupa; **J**, ♂ imago; **K**, ♀ imago.

Lemaire (2002) reviewed *A. jucunda* taxonomy and designated a Cramer's figured male specimen from Suriname as a lectotype. *A. jucunda* was placed in synonym with *A. titania* (Felder & Rogenhofer, 1874) from Panama; *A. flavomarginatus* Conte, 1906, *A. junionia* (Walker, 1866), *A. morescoides* Bouvier, 1929, *A. oblonga* (Walker, 1855) and *A. sinuatus* Conte, 1906 from Colombia. These types have a wide distribution among the three branches of the Colombian Andes. It is possible that the whole specimen types addressed as *A. jucunda* in Colombia, is instead a number of species. The broad distribution of this species requires further investigation. The male imagos phenotypic variation is also noticeable. The lectotype figured by Cramer showed the brown phenotype, while other types from Colombia were dominantly lighter yellow in colour (Lemaire 2002). However, evidence from DNA barcoding is needed to determinate whether some of these types can be elevated to full species status.

The material from this rearing should be sequenced in the future to make a further step towards understanding the taxonomy of this species and the *A. hamata* subgroup. Additional evidence is required to present a different arrangement to that of Lemaire (2002) using also information gathered from the biology of the species assigned to this subgroup.

A. jucunda larvae are polyphagous and gregarious in all instars as described in previous studies on the early stages of other species of this genus (Gardiner 1982; Meister 2011). It is to be expected that further studies will extend the knowledge of the food plants of this species. The gregarious behaviour of the larvae is typical of the genus and is well known by native Colombians, who attempt to avoid envenomation from the moth larvae that form noticeable groups on the host plants tree trunk. The pain caused by touching a final instar larva of *A. jucunda* is relatively mild and similar to the sensation experienced by touching other larvae of the genus, like *A. hamata* and *A. meridionalis*. A red irritable rash can occasionally appear, usually to the softer tissue of the hand, for example, the inside edge of fingers, back of hand and wrist. The sensation can last up to 6 hours. Such envenomation can be caused by various larvae and *A. jucunda* should be considered in erucism cases in the northern part of South America, where it has been recorded at relatively low elevations (Lemaire 2002; Decaëns *et al.* 2007; Gómez 2014).

The present description of immature stages is a further step towards the study and biology of the species assigned to this genus. The information available on the preimaginal instars of *Automeris* is limited compared to the total number of the species of this genus.

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Correspondence: Lorenzo Comoglio, e-mail: l.comoglio@uniandes.edu.co

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