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TRABAJOS ORIGINALES

Early Stages of *Morpho amathonte* (Lepidoptera: Nymphalidae, Morphinae) and its Variation on the Pacific Coast of Costa Rica

Primeros estadíos de *Morpho amathonte* (Lepidoptera: Nymphalidae, Morphinae) y su variación en la costa del Pacífico Sur de Costa Rica

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Abstract

The Southern Pacific Coast of Costa Rica shows some local variations in its four *Morpho* species. The goal of this article is to compare the life cycle of *M. amathonte* from different areas in Costa Rica and South America. The immature stages were found on *Pterocarpus officinalis* Jacq. and then photographed and described so as to illustrate its morphology and behavior. It is clear, that M. *amathonte* from the South Pacific side of Costa Rica comes from one isolated population and demonstrates a cryptic nature between the two forms present in Costa Rica.

Keywords: Colombia; Corcovado National Park; Golfo Dulce; *Grasseia*; Isolated population; *M. godartii*; *M. helenor; M. menelaus*; *M. sulkowskyi; M. theseus;* Osa Peninsula; Tropical Rain forest.

Resumen

Las cuatro especies de Morpho de la costa Pacífica de Costa Rica muestra algunas variaciones locales. El objetivo de este artículo es comparar el ciclo de vida de *M. amathonte* de diferentes localidades de Costa Rica y Sudamérica. Los estadios inmaduros se encontraron en *Pterocarpus officinalis* Jacq. y luego fotografiados y descritos para ilustrar su morfología y comportamiento. Es evidente que *M. amathonte* del lado del Pacífico de Costa Rica proviene de una población aislada y demuestra una naturaleza críptica entre las dos formas presentes en Costa Rica.

Palabras clave: Colombia, Parque Nacional Corcovado, Golfo Dulce, Grasseia, Población aislada, *M. godartii*, *M. helenor*, *M. menelaus*, *M. sulkowskyi*, *M. theseus*, Península de Osa.

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Introduction

The early stages of most *Morpho* Fabricius species remain unknown mostly because the females are extremely difficult to see when flying high up in the forest canopy, the immature stages are not easy to find on their hostplants, the larvae are highly susceptible to viral diseases in captivity, and the complete life cycles, for most species, take considerable time (DeVries and Martinez 1993). For conservation purposes, it is a priority to understand the immature stages of the butterflies and their natural history. This is particularly critical priority in the tropics due to the accelerating rates of deforestation and habitat destructions (Constantino 1992).

In Costa Rica, there are six species of *Morpho* (Lamas 2004), all of which are associated to forest habitats from sea level to 1800 m with the greatest concentration of species in the mid-elevation forest of the Atlantic slope (DeVries 1987). In the South Pacific of Costa Rica occur the last moist and wet evergreen lowland forests that still exist on the Pacific coast of Central America and there are four species of *Morpho*. Three of them display drastic morphological differences (*M. helenor* Butler, *M. theseus, Deyrolle* and *M. amathonte* Deyrolle) in the area. Under this circumstance, there is not consensus about how many species and/or subspecies occur in Costa Rica.

Morpho amathonte was erected as a subspecies of *M. menelaus* (Linnaeus) by Lamas (2004). The recent interest in the phylogeny of *Morpho* revealed that *M. amathonte* and *M. menelaus* as true valid species (Blandin 2007a, Penz *et al*. 2012, Cassildé *et al*. 2012) with an estimated divergence between the Pliocene, both species having a disjunct distribution! (Penz *et al*. 2012).

Morpho amathonte extends from Honduras (Cusuco National Park), to Nicaragua (Chontales and Zelaya provinces) and through Central America to the lowlands of north-western Ecuador (Nakahara & Blandin 2010). In Costa Rica, it occurs from sea level to 800 m on both slopes, in association with rain forest habitats (DeVries 1987). Rolando Cubero was the first researcher to affirm morphology differences between *M. amathonte* in Costa Rica, which suggests that there are two species based on differences in life cycles and hue of bright blue color on the wings (per. com. 2016).

The first life cycle description and foodplant record of *M. amathonte* was done by DeVries (1987); however, the location of his discovery was not mentioned. Subsequently, Janzen & Hallwachs (2016) reported 28 host plants and photographed the immature stages of *Morpho amathonte* from the Área de Conservación Guanacaste (ACG) in the evergreen part of Northwestern Costa Rica.

Immature stages are an important source of information for butterfly systematic (Freitas & Brown 2004, Córdoba-Alfaro & Murillo-Hiller 2014) and fundamentally important for *Morpho* taxonomy. The goal of this article is to compare the life cycle of *M. amathonte* from Southern Pacific of Costa Rica with ACG and South America specimens.

Material and methods

Field observations were made on *Morpho amathonte* from October 4, 2015 to February 20, 2016 at the Finca Agroforestal La Tarde (08°34'47"N, 083°29'21"W) located at 150 m of altitude, on the South Pacific slope of Costa Rica in the Osa Peninsula. This location is surrounded by second-growth and primary rain forest. One mated wild-caught female and two males were collected and kept in captivity in a butterfly garden, at ambient temperature (26-27 °C). The immature stages were photographed with a Cannon PowerShot x35 and described. The specimens were deposited in the Insectopia Insect Museum of Puerto Jimenez, Osa Peninsula, Costa Rica. The host plant was identified, following Quesada-Quesada *et al*. (1997).

Results

Host plant: *Pterocarpus officinalis* Jacq.

Egg: The egg is hemispherical in shape, 1.3 mm in diameter, smooth in surface texture, pale green, laid singly and within two days after being deposited, develops a lateral reddish-brown band distinctly broken into small dots. The egg stage lasts 12 days.

First instar: The 1st instar is about 0.6 cm long just after hatching. The head capsule is broader than the width of the body and is velvet red and hairy. The face is hairy white with two vertical red bands. The body is bright yellow in base color, with dark-red lines and bands on the dorsum and sides. The lines on the dorsal forms two ovals interspersed with tufts of reddish-white hairs. The lateral areas on segments T-l and T-2, just behind the head, have two pairs of long tufts of reddish-white clusters of hairs curved forward. The dorsallateral areas on segments, A-l to A-2, A-4 to A-5 and A-7 to A-8 present a pair of tufts consisting of reddish-white hairs per segment, being the ones on segments A-l and A-2 being very short and completely red. The last segment on A-10 bears two short sclerotized caudal tails with translucent setae. There are also long lateral white hairs above the legs on each body segment. The 1st instar larva lasts 10 days.

Second instar: The second instar is about 2.cm long. The head capsule is now more densely, covered with bright maroon short seta. The second instar closely resembles the 1st instar, but the tufts of hair on segments A-4 to A-5 and A-7 to A-8 are longer and denser. The two yellow ovals are interspersed with dark red bands on segments T-l to T-3, A-4 to A-5 and A-7 to A-8. The second instar larva lasts 18 days.

Third instar (Fig. B-C): The third instar larva grows to about 3.8 cm. The head capsule is now pale red and sparsely hairy and the face with gray seta. The body is bright yellow but the lines and bands become darker, almost black. Thedorsal lateral tufts of hair are denser with more white hairs. The red band on segments T-l to T-3 is now divided by small yellow spaces. The third instar larva lasted 18 days.

Fourth instar (Fig. D-E): The fourth instar larva is about 7cm. The head capsule is now pale brown, sparsely hairy and with two unclearly gray vertical lines on the face. The head capsule is now less wide than the body. The overall body color is now yellow in the dorsal ovals and has a conspicuous ¨greyish four-pointed star¨ pattern between the two light green ovals. The lateral side of the body now has fine pale maroon patterns. Dorsal lateral tufts of shorter hair, especially on segments T-l to T-2 and A-1, which are completely maroon. The total fourth instar duration is 18 days.

Fifth instar (Fig. F-G)**:** The last instar larva has a body length of about 10cm. The body is now wider than the head. The general appearance of the fifth instar larva is very similar to that of the previous instar, but the body assumes a thicker profile, and the annules on the body segments are more prominent. The

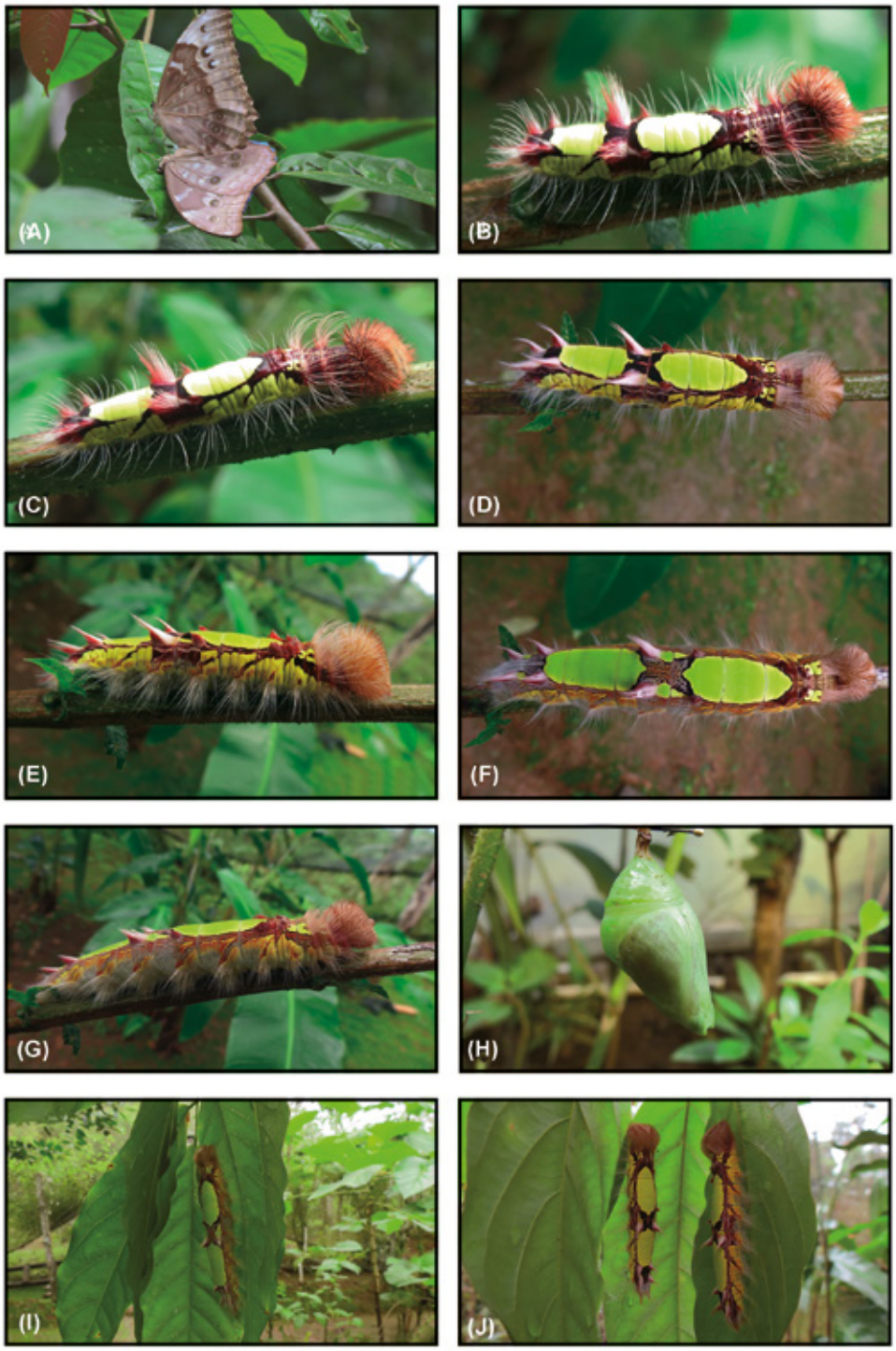

Figure 1. *Morpho amathonte* at Finca Agroforestal La Tarde, La Palma, Osa Península, Costa Rica (08°34'47"N, 083°29'21"W) by Jim Córdoba-Alfaro. (A). Copulation. Dorsal and ventral views respectively: (B-C). Third instar. (D-E). Fourth instar. (F-G). Fifth instar. (H): Pupa. (I-J). Larval shelters.

body now has lime-green ovals with dark red lines between the ovals and along the sides. The four-pointed star is less black. The lateral side of the body is still yellow, but with gray-maroon marks and patterns. The total fifth instar duration is 19 days.

Pre-pupa: At this stage, the larva stops feeding and loses all traces of yellow and red becoming completely dull green. The pre-pupal stage lasts four days.

Pupa (Fig. H): Pale green, ovoid. The head area is slightly bifid with two red short pointed projections. On both sites between the segments A3-A4, areas surrounding the spiracles are white. The remaining abdominal-spiracles are transparent. The segments A3-A5 are thicker, giving an impression ofa humpinthe pupa. There is no noticeable change in the coloration of the pupa as the adult develops, although usually within 24 hours of eclosion, the wing pads darken strongly, and the abdominal segment between A-5 and A-6 become loose and slightly separated. The pupal stage lasts 19 days.

Discussion

The description of life cycle of *M. amathonte* wrote by DeVries (1987) and the photographs of its immature stages illustrated by Janzen & Hallwachs (2016) for Costa Rica do not concordat. The latter instars illustrated by Janzen & Hallwachs (2016) from ACG and Constantino (1997) from western Colombia. They present two crisscrossed bands giving an appearance of "X" between the two yellowish dorsal ovals. This "X" pattern is highly variable in thickness and color, but it is really consistent in the

form "X". In addition, the pupae illustrated from ACG and western Colombia wear a semicircular white band that covers laterally the dorsal area of segment A-6. Besides, this conspicuous pupal feature was mentioned before and also it is present in *M. godartii* (Guerra-Serrudo & Ledezma-Arias 2008).

DeVries (1987) mentioned that the pupa and larva of *M. amathonte* resemble in shape and color to *M. helenor*. Probably the life cycle described by DeVries (1987) is from the same locality described here, since he conducted research in Corcovado National Park (1978). The larva of *M. amathonte* from the South Pacific of Costa Rica differs in the "X" pattern, which it resembles to a "grayish four-pointed star" between the two-light green dorsal ovals (Fig. 1: F-G) in the last instar. It is evident, that the larva from this part of Costa Rica is paler colored than samples from ACG and Colombia. In addition, the pupa illustrated in this article does not have the semicircular white band of segment A-6 (Fig. 1: H), and it is agreeing with the description given by DeVries (1987).

The larvae of *M. amathonte* from the South Pacific are often completely solitary but sometimes are seen sharing in small groups when they are resting. When they are not feeding in the day time, the larvae rest inside of a leaf shelter built by silk union (Fig. 1: I-J). This behavior had not been observed before in *M. amathonte* from Costa Rica and South America by previous studies. However, this behavior was previously observed in *M. sulkowskyi* Kollar (Heredia & Alvarez-Lopez 2007). Perhaps it is a widespread behavior in *Grasseia*; however, this is not observed if larvae are raised and handled individually.

The mountain ranges and volcanoes of Costa Rica and western Panama serve as a giant barrier that separate moist and wet lowland (Henderson 2010). The mountains have caused reproductive isolation between the population of *M. amathonte* that occurred on both slopes. Subsequently, from the central Pacific to north Pacific of Costa Rica and from the Southern Pacific of Costa Rica to Pacific Northern of Panama this species is limited by an ecological isolation as this area gives space to the tropical dry forest, which is absent! *M. amathonte* in northwestern Costa Rica is restricted to the volcanic slopes of Cordillera de Guanacaste under influence of the Caribbean side and it is retained by the Guanacaste lowland dry forest (Janzen & Hallwachs 2016). The similarity in the life cycles of *M. amathonte* between Colombia to Guanacaste is due to the fact that the rainforest extends continuously through the Caribbean of these countries.

Conclusion

It is clearly contended, that the *M. amathonte* from the South Pacific side of Costa Rica come from one isolated population; the larva and pupa patterns described here do not present major features shared with the same species in Costa Rica or South America. Thus, demonstrating a cryptic nature between the two forms present in this country and morphology evidence over the geologic time diverged.

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