# Rediscovery of *Copaxa sapatoza* and revealing of its immature stages (Lepidoptera: Saturniidae, Saturniinae)

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**Abstract:** *Copaxa sapatoza* of the Santa Fe de Bogota area in Colombia is rediscovered. Not seen in more than 50 years, some investigators considered it extinct. Our investigation revealed that *C. sapatoza* is one of the most common saturniids in its habitat, which is open country with stands of alder trees (*Alnus acuminata*), its hostplant in the wild. Larvae were very similar to those of *Copaxa semioculata* and in the laboratory also fed readily on *Persea americana*. Adults, immature stages and habitat are illustrated in color.

**Key words:** *Copaxa semioculata*, distribution, immature stages, larvae, Neotropical, Saturniidae.

**Redescubrimiento de *Copaxa sapatoza* y presentación de sus estadios inmaduros (Lepidoptera: Saturniidae, Saturniinae)**

**Resumen:** Se vuelve a descubrir la *Copaxa sapatoza* en el área de Santa Fé de Bogotá en Colombia. Como no se había visto en más de 50 años algunos investigadores lo consideraban extincto. Nuestras investigaciones revelaron que *C. sapatoza* es uno de los saturníidos más comunes en su habitat, que es campo abierto con alisares de *Alnus acuminata,* su planta huésped natural. Las larvas son muy similares a las de *Copaxa semioculata,* y en el laboratorio fácilmente aceptaron comer *Persea americana*. Se ilustran en colores los adultos, los estadios inmaduros y su habitat.

**Redécouverte de *Copaxa sapatoza* et présentation de ses stades larvaires (Lepidoptera: Saturniidae, Saturniinae)**

**Résumé:** *Copaxa sapatoza* a été redécouvert dans la région de Santa Fe de Bogota en Colombie. Etant donné l'absence d'observation de cette espèce depuis plus de 50 ans, certains chercheurs la considéraient éteinte. Nos recherches ont mis en évidence que *C. sapatoza* est l'un des saturniides les plus communs dans son habitat, constitué de parcelles cultivées parsemés d'aulnaies à *Alnus acuminata,* sa plante hôte naturelle. Les chenilles sont très similaires à celles de *Copaxa semioculata,* et acceptèrent facilement *Persea americana* en condition de laboratoire. Les stades adultes et larvaires ainsi que l'habitat sont illustrés en couleur.

**Die Wiederentdeckung von *Copaxa sapatoza* und die Beschreibung ihrer Präimaginalstadien (Lepidoptera: Saturniidae, Saturniinae)**

**Zusammenfassung:** *Copaxa sapatoza* (Westwood, [1854]) wurde in der Umgebung von Santa Fé de Bogotá, Kolumbien, erstmals seit mehr als 50 Jahren wiederentdeckt. Die Art war von manchen Bearbeitern schon wegen des langen Verschollenseins für ausgestorben gehalten worden. Unsere Untersuchungen zeigten, daß die Art zu den häufigsten Saturniiden in ihrem Habitat gehört. Der Biotop ist eine offene, feuchte Savannenlandschaft mit Erlenbeständen (*Alnus acuminata,* Betulaceae), der Hauptfutterpflanze im Freiland. Die Raupen fressen nur am Laub junger Schößlinge und Sämlinge, nicht in den Kronen älterer Bäume. Die Raupen waren denen von *Copaxa semioculata* (R. Felder & Rogenhofer, 1874) sehr ähnlich und fraßen in der Zucht auch an *Persea americana* (Lauraceae). Eine Hypothese zur möglichen Abstammung von *C. sapatoza* von *semioculata*-ähnlichen Vorfahren wird vorgetragen. Die Imagines, die Präimaginalstadien und das Habitat werden in Farbe abgebildet.

## Introduction

The diminutive Colombian moth, *Copaxa sapatoza* (Westwood, [1854]), appears mostly greenish or yellow with pink and black markings and distinctively large, angular, translucent discal spots on all wings. A very attractive insect, it is commonly represented in older entomological collections of the world's major museums, with data labels indicating the Santa Fe de Bogota area as the sole area of distribution. Many specimens were apparently provided by Friar Apollinaire-Marie (known in Colombia as Hermano Apolinar-María) in the 1920's–1940's. But since the destruction of his collection and library by fire during an armed rebellion in 1948, more recent specimens have not been seen by interested investigators. Some considered the species extinct, citing the WCMC (1990) definition of "extinct" as "species not collected or observed in the wild during the past 50 years." Human population growth and destruction of habitat in the expanding metropolitan area of Colombia's capital city were believed to be the cause.

However, during visits to Colombian insect collections in the 1990's, Wolfe found more recent specimens, including a male captured 21 June 1992 by J. F. Le Crom, at hotel lights near Duitama about 100 km northeast of Bogota, in habitat consisting mostly of pastures and eucalyptus trees. In the late 1990's, Bonilla and Decaëns, night collecting with lights, captured additional specimens at various locations near Bogota. While collecting larvae and cocoons of *Leucanella nyctimene* (Latreille, 1832) on alder trees, Bonilla and Ramírez found several unidentified cocoons that, upon adult emergence, proved to be of *C. sapatoza*. Subsequent searching yielded eggs, larvae and cocoons of *C. sapatoza* on small saplings of a native alder, *Alnus acuminata* Kunth 1817, family Betulaceae. Bonilla and Ramírez subsequently reared numerous specimens in the laboratory.

In July 2002, the present authors met to search for more clues to the abundance and life history of *C. sapatoza*. In teams of 2–4 we searched alder trees wherever we found them. Alder is one of the most common trees of our north-eastern Andean highlands target area. The topography in this area has resulted in three present day general habitats:

1. Broad, flat marshy grasslands (called in Spanish the "Sabana de Bogotá" or Savanna of Bogota), created by a huge ancient lake recently diminished and now artificially drained (Renjifo 1992);
2. low hills largely converted to potato fields and pasture;
3. steep mountains covered with chaparral and forest remnants.

Alder is found within all three habitats. Alder wood, resisting insects and decomposition, is frequently used for fenceposts which often sprout branches near the ground (Fig. 11) and may develop into trees. Alder trees are common along stream sides and stands of alder also sprout from seed in the wettest pockets of pastures. We found 190 eggs, various larvae in several stages, many empty cocoons and one cocoon from which hung a newly emerged male still drying its wings. A single attempt to capture flying adults at night with lights, in dangerous guerrilla-controlled territory during heavy rain, yielded three males just after dusk.

Based on our observations, we estimate that *C. sapatoza* is one of the most common saturniids of the Bogota valley, along with *L. nyctimene*, which also feeds extensively on alder. We found evidence of *C. sapatoza* almost everywhere there were alders, including larvae in the wide freeway median on the outskirts of Bogota.

Collected eggs were reared in the laboratory by Bonilla, Ramírez and Wolfe. Newly hatched larvae were offered leaves of *Alnus acuminata* and *A. rhombifolia* Nuttal (from western North America), all of which they immediately accepted. However, in both laboratories most first instar larvae feeding upon leaves from large or mature alder trees quickly died from tar-like diarrhea, and only larvae which were fed leaves of seedling or small-trunked trees survived. The thinner leaves of small trees apparently contain less toxic resins. This may explain the predominance of eggs found on small sprouted branches from fenceposts and wild small saplings rather than on mature trees.

## Immature stages

For this study, eggs and larvae were maintained at temperatures between 12 and 18 °C in the laboratory. Eggs were placed in a plastic-covered petri dish with a small piece of wet paper towel to provide moisture. Lid was misted with distilled water nightly as time of hatching neared. Eggs hatched in about 18 days and larvae fed on *Alnus* sp. for rearing of first generation. A second generation was divided with half reared on alder and half on avocado (*Persea americana* Miller 1768, Lauraceae), with little difference in development, until last instar when both groups were lost while Wolfe was traveling and unable to attend to them. Larvae were reared in plastic boxes with screened lids on cut branches based in water with food changed every 48 hours. Head capsules were collected to identify instar number, each instar was measured at full size, photographed in color and preserved in alcohol. Larvae completed five instars and required a minimum 54–65 days from oviposition to pupation. About two thirds of adults emerged in 35–45 days, with remaining one third of adults emerging over 6 months.

To obtain a second laboratory generation for experimentation to determine acceptable alternate hostplants, we attempted a mating between adult moths, which generally emerged before noon. We placed a ♂ and ♀ together at noon in full daylight, and they did not move until 17:35 h, just at dusk, when the ♂ began to fly, continuing until 17:55 h, when it suddenly mated with the ♀. Coupling lasted about one hour, when the ♀ began flying and ovipositing. During two nights the ♀ deposited 122 eggs, mostly the first night, in a paper bag.

**Egg** (Fig. 3): 1.9 mm long × 1.4 mm wide × 1.2 mm deep, somewhat flat ovoid, white, usually deposited in 2's and 3's with a maximum of 6 in no particular pattern, often separated.

**Larva: First instar** (Fig. 4): Head: 0.6 mm wide, dark reddish brown, frons black, primary setae white. Body: 7.1 mm max. length; color greenish white; undulating diagonal lateral lines, straight middorsal line and spiracular band dark grass green, 1st thoracic segment white on anterior border with orange shield; scoli greenish, surrounding area yellow; dorsal spines brownish yellow, remaining spines pale translucent; thoracic legs brown, abdominal prolegs and paranal lobes translucent light green.

**Second instar** (Fig. 5): Head: 1 mm wide, reddish brown. Body: 11 mm max. length; color similar to first instar but white areas more yellow, except white "collar." Scoli yellow, mostly crowned with translucent spines, but spines of dorsal scoli on thoracic segments longer dark brown and orange; central spine of lateral scoli a greatly elongated black whip with lanceolate tip.

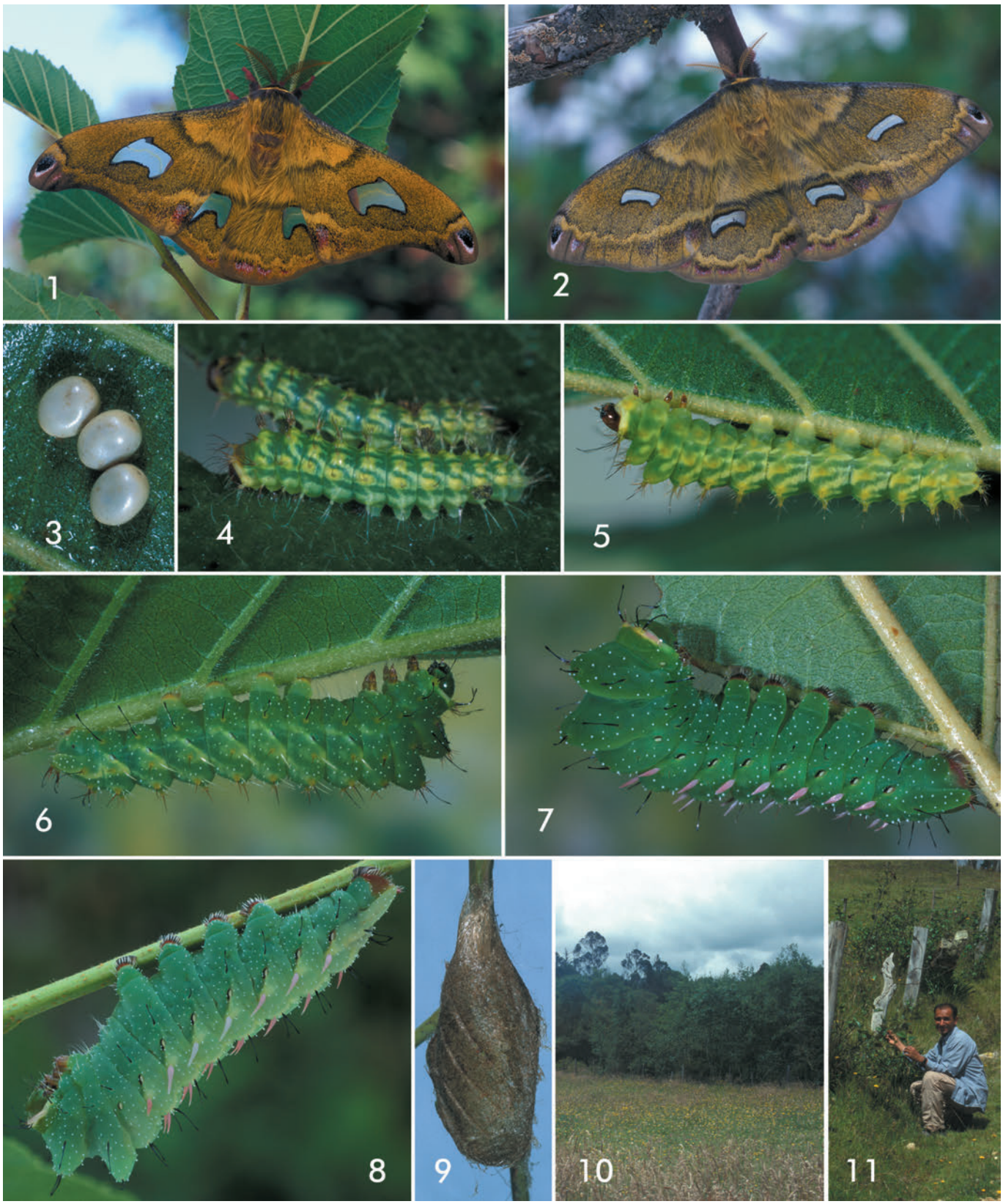
**Third instar** (Fig. 6): Head: 1.7 mm wide, green. Body: 16 mm; dark and light green with trace of color pattern of 2nd instar but contrasted areas now more blended; scoli yellow, most with reduced number of spines, now light yellowish brown; lateral scoli and those of first and last two segments each with a long, black whip-like hair terminating in lanceolate tip; entire integument irregularly dotted with tiny white mushroom-shaped setae; forward-arching flat spines, typical for *Copaxa*, are white, one each originating cephalad of dorsal and subdorsal scolus of abdominal segments 1–7; spiracles white anteriorly bordered diagonally black; abdominal legs yellow.

**Fourth instar** (Fig. 7): Head: 2.8 mm, green. Body: 23 mm max length; deep green, thoracic collar yellow, abdominal legs and caudal edge of paranal lobes brown, scoli submerged, most almost spineless; whip-like black spines and tiny white setae as in 3rd instar; forward-arching spines now bright pink; spiracles as in 3rd instar.

**Fifth instar** (Fig. 8): Head: 4 mm, color and setae as in 4th instar. Body: 48 mm × 4 mm thick; color and spination very similar to 4th instar, but most individuals paler in 5th. Larva, especially in later instars, present a sharp "crest" on the 2nd and 3rd segments, in which the dorsal scoli are almost completely fused.

**Pupa:** 22–24 mm long × 10–12 mm thick, light brown, smooth; cremaster with strong hooks.

**Cocoon** (Fig. 10): Dark reddish tan, mostly sealed but with areas of scattered, small round holes of variable size. Wild-found cocoons were usually attached parallel to a




**Figs. 1–11:** *Copaxa sapatoza.* **Fig. 1:** ♀, reared, on *Alnus* leaf. **Fig. 2:** ♂, reared. **Fig. 3:** Eggs. **Fig. 4:** First instar larva. **Fig. 5:** Second instar larva. **Fig. 6:** Third instar larva. **Fig. 7:** Fourth instar larva. **Fig. 8:** Fifth instar larva. **Fig. 9:** Cocoon. **Fig. 10:** Habitat: pasture with *Alnus acuminata*, Colombia, Cundinamarca, Villa Pinzón, 2700 m. **Fig. 11:** Bonilla finding eggs on sproutings from *A. acuminata* fencepost, *Ibid*.

main branch near the tip, wrapped in a live or dead leaf but often easily visible.

## Larval hostplants

**Wild:** *Alnus acuminata* (Betulaceae).

**Laboratory:** In addition to the above hostplant, larvae also fed on *Alnus rhombifolia* and *Persea americana* (Lauraceae).

## Distribution and flight period

*Copaxa sapatoza* is known only from highland open country of the eastern Cordillera of the Colombian Andes, from the area of Bogota in the south to Duitama, about 100 km northeast, although its range may extend much more in both directions. Altitudinally, it has been found only between 2600 and 3000 m elevation. Collecting data

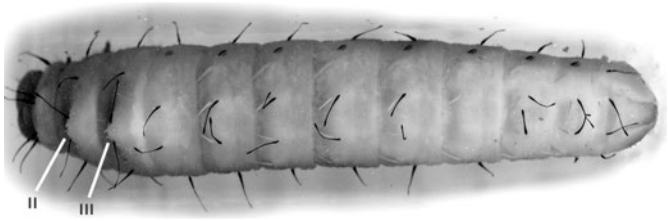



**Fig. 12:** *Copaxa sapatoza,* last instar larva. See the fused dorsal scoli on thoracic segments II and III.

and laboratory experience suggest that this species may fly throughout the year, with the great majority of individuals on the wing in June and July. ♂♂ emerge from the cocoon before noon, fly to disperse about a half hour before dark, then search for ♀♀. In Co-lombia, caged ♂♂ copulated with virgin ♀♀ ca. 20:00 h (about one hour after dark), and remained coupled for 45–60 minutes.

## Discussion

Larvae demonstrate the close relationship of *C. sapatoza* and its high altitude relatives with the group of *Copaxa canella* Walker, 1855, as suggested by Lemaire (1978). Larval shape, general color, spination, and especially black whip-like spines originating from certain scoli, are similar throughout the group, including *Copaxa lavendera* (Westwood, [1854]), illustrated by Wolfe (1993). However, larvae of the *C. sapatoza* group differ from the *C. canella* group in having the dorsal scoli of 2nd and 3rd thoracic segments almost completely fused instead of widely separated (Fig. 12).

Use of powerful mercury vapor lighting for night collecting of saturniids provided an unnatural opportunity for interspecies copulation. Two ♂♂ of *Copaxa semioculata* (R. Felder & Rogenhofer, 1874), normally mating diurnally (Wolfe et al. 2003), were attracted to pheromone-emitting virgin ♀♀ of *C. sapatoza*, which suggests a similar pheromone chemistry of both species. One ♂ was allowed to copulate, but eggs failed to hatch.

In fact, it is probable that *C. sapatoza* derived from an ancestor very close to *C. semioculata*, which is widespread in the eastern Andes. A number of special isolating factors encouraging speciation existed in the Bogota area. The prehistoric and historic lake which covered the Savanna of Bogota was one of the two largest in South America, at one time covering an estimated 2500 km² before geologic upheavals raised islands and eventually led to its demise (Renjifo 1992). Periodic advance and retreat of water levels allowed forests of alder trees to flourish. It is easy to imagine how, according to niche variation theory,

1. intra-specific individual food preference (Bolnick et al. 2002) could lead individual larvae of a *C. semioculata*-like insect to choose alder, the ubiquitous hydrophytic tree of the region, as alternate hostplant;
2. that this hostplant preference could be genetically inherited;
3. that populations with a high incidence of preference for alder feeding could become genetically isolated on lands or islands caused by rising water levels over a vast distance for many years;
4. resulting in rapid change due to a limited gene pool,
5. leading to genetic reproductive incompatibility when receding water or climatic conditions restored contact with the ancestral gene pool.

It is easy to understand how this may have happened in the Bogota area, even though *A. acuminata* ranges from Mexico to Argentina.

That *C. sapatoza* is an open country species is demonstrated by the fact that it is not found in mixed forest of steeper mountains within its range, where trees of *A. acuminata*, invading or introduced after deforestation, now struggle to survive under the newly shady conditions of regenerating humid forest growth.

Almost all reared specimens, including those emerged from wild-collected cocoons kept in the laboratory or outdoors in Bogota (which has a sharply warmer average temperature than it historically had, due in part to extensive paving and heat-absorbing buildings) were more yellow than wild-caught adults, which appear usually darker greenish. This is expected to be due to warmer temperatures under captive conditions. Janzen (1978) demonstrated that warmer temperatures during pupation causes lighter adult colors in *Rothschildia lebeau* (Guérin-Méneville, 1868), and Wolfe has noted similar examples in this and other species (unpubl. notes).

Incidence of parasitoidism was low in wild-collected material. Several as yet unidentified tachinid flies and one hymenopteran emerged from among 80 cocoons, and none of the larvae or eggs yielded parasitoids.

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Received: 6. iv. 2003

 ISSN 0723-9912