

## ORIGINAL ARTICLE

# Description of the immature stages of a rare Andean paramo butterfly *Lymanopoda caracara* Pyrcz, Willmott & J. Hall, 1999 (Lepidoptera: Nymphalidae)

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**Abstract** Immature stages of *Lymanopoda caracara* Pyrcz, Willmott & Hall, an endemic butterfly from the paramo life zone in the Andes of Ecuador, are described and compared with those of *L. schmidtii* Adams from Colombia. Larval morphology is illustrated for four instars. Drawings of head chaetotaxy and setal maps are provided for the first time for the genus. The host plant is identified as a dwarf bamboo *Chusquea villosa* (Clark) (Poaceae). Striking individual variation among adults of *L. caracara* is discussed.

**Key words** Caterpillar, Neotropic, chaetotaxy, Satyrinae.

## 1 Introduction

Butterflies belonging to the genus *Lymanopoda* Westwood, 1851, within the neotropical subtribe Pronophilina (Nymphalidae: Satyrinae: Satyrini), are typically montane, and distributed in mid and high elevation habitats (elev. 800–4000 m). They are found almost exclusively in the Andes, including their peripheral ranges, except for two Mesoamerican species (Pyrcz *et al.*, 2018). Currently, the genus contains 64 described species, and four further identified but as yet undescribed species (Pyrcz *et al.*, 2018). The genus *Lymanopoda* can be considered as one of the better-known genera among South American satyrines. A number of papers have been published, especially in the last two decades, about its taxonomy and distribution (Pyrcz, 1999, 2003, 2004, 2005, 2012; Pyrcz & Boyer, 2011; Pyrcz & Rodríguez, 2006; Pyrcz *et al.*, 1999, 2009, 2010, 2016, 2018), phylogenies (Casner & Pyrcz, 2010; Pyrcz *et al.*, 2016), and ecology (Pyrcz & Wojtusiak, 2002; Pyrcz & Garlacz, 2012).

*Lymanopoda caracara* Pyrcz, Willmott & J. Hall, 1999 was described on the basis of seven specimens collected in a single locality situated along the Gualaceo-Chiguinda road at elev. 3300 m, in the Morona-Santiago department, very close to the area where we found the early stages. Other specimens were also collected in the Reserva Ecológica Cayambe Coca (Napo) (Casner & Pyrcz, 2010), on the slopes of the Tungurahua volcano (Tungurahua) (Butterflies of Sangay, Petit & Boyer, 2019). This is a rare and extremely localized species occurring exclusively in paramo—high elevation grasslands, slightly above the timberline (Pyrcz, *et al.*, 1999).

Although most *Lymanopoda* are known to occur in association with *Chusquea* and *Swallenchloa* bamboo (Pyrcz *et al.*, 1999), their biology remains mostly unknown. Only two articles on this subject have been published, including one many years ago by Schultze (1929), who was the first to describe the immature stages of *L. samius* Westwood, 1851, from the

highlands of the Andean Eastern Cordillera in the area of Bogota in Colombia. Montero & Ortíz (2012) described the immature stages of *L. schmidt* Adams, 1986, from the Páramo del Tablazo, from the same area of Colombia, and they identified its hostplant as *Chusquea* aff. *scandens*. In addition to these, there are some reports of possible hostplants, including by Beccaloni *et al.* (2008), who listed *Chusquea* nr. *scandens* for *L. obsoleta* Westwood and *L. panacea* Hewitson, and *Swalenchloa* sp. for *L. paramera* Adams & Bernard.

Here, we firstly describe for the first time the immature stages of *Lymanopoda caracara*, an endemic species from Ecuador, and give details of its host plant. Information about immature stages and host plant association in Lepidoptera is essential for a better understanding of the patterns of distribution of species, and also can help us to resolve its systematics (Willmott & Freitas, 2006), understand its evolution (Freitas & Brown, 2004), and its ecology (Walla & Greeney, 2012).

## 2 Materials and methods

### 2.1 Study area

Immatures were collected at Páramo de Matanga, in the road from Sigsig to Chiguinda, Azuay Province, Ecuador, 3.189438°S, 78.791417°W, on November 16 2018, elev. 3342 m. This area is located in a ridge in the eastern cordillera, characterized by the presence of constant fog and rain during most months of the year (Fig. 1). Larvae were found by the first author at noon, while looking for immature stages in a patch of *C. villosa* (Clark) (Poaceae) (Fig. 1). Sixteen larvae at



Figure 1. *L. caracara* in situ and host plant *Chusquea villosa* (L.G. Clark). A. Last instar active feeding on leaves. B. Detail of the camouflage. C. Detail of leaves and inflorescences. D. Plants in situ in the paramo ecosystem.

different stages of development were found and kept in plastic bags, most of them having been located on the tip of young leaves, where they were resting or actively feeding (Fig. 1). After collecting they were taken back to Cuenca city at 2500 m where they were reared in plastic containers. Larvae were checked and fed daily.

## 2.2 Morphology

For description of the larval chaetotaxy and general morphology of immature stages, we followed the terminology of Stehr (1987). Photos were taken using a Canon 5D Mark III DSLR camera with Canon MP-E 65mm f/2.8 1-5x Macro Photo Lens. For morphological measurements, a Fowler Sylvac Euro-Cal "Mark III" Digital Caliper was used. Illustrations were made using the preserved specimens and photos with the help of Bamboo Wacom on Inkscape software. Voucher specimens of the immature stages were deposited in the Museo de Zoología de la Universidad del Azuay, Cuenca, Ecuador.

## 3 Results

### 3.1 Egg

Not reported.

### 3.2 First instar

Not reported.

### 3.3 Second instar ( $n=2$ )

Larvae colour green (PANTONE 2291 C), with black setae that arise from white chalazae, forming lines from the head to the tail. Scoli (horns) were present in the head capsule along with two "tails" in segment A10. Average head capsule length: 2.15 mm and average head capsule width: 1.68 mm; average tail length: 1.70 mm; average length of body without head and tails: 5.78 mm.

### 3.4 Third instar ( $n=1$ )

Larvae colour same as the second instar, head capsule length: 2.63 mm and head capsule width: 2.06 mm; tail length: 2.03 mm; length of body without head and tails: 8.51 mm.

### 3.5 Fourth instar ( $n=2$ )

Larvae colour same as the third instar, head capsule length: 3.05 mm and head capsule width: 2.33 mm; tail length: 2.82 mm; length of body without head and tails: 13.75 mm.

### 3.6 Fifth instar before pupa ( $n=4$ )

Larvae colour same as the fourth instar, head capsule length: 3.21 mm and head capsule width: 2.46 mm; tail length: 2.98 mm; length of body without head and tails: 17.21 mm (Figs 2–3).

### 3.7 Pupa ( $n=2$ )

The pupa has a long conical shape and the colour is light green (PANTONE 2285 C) with a melon coloured line (PANTONE 1485C) running from the head to A10. In the upper part of the lateral line, the colour is more intense, with a lighter colour in the lower part. From T1 to A3 the lateral line crosses the wing case, and in A4 to A7 the line is more strongly marked. A1 to A4 are partially covered by the wing cases, and the spiracle is not visible in A1 and A8 (Fig. 4).

### 3.8 Adult

Adults of *L. caracara* present a particularly pronounced individual variation (Fig. 5). Within a single population,

specimens with sharply different colour patterns and sizes can be observed. The colours on the upperside vary between tan brown and deep coffee brown with all the intermediate forms. Forewing light dots are always present but barely noticeable in paler coloured specimens. Generally, darker specimens are also smaller than lighter ones, and have less acute forewing apices. This is not an exceptional phenomenon among Pronophilina satyrines, and occurs also in other species of *Lymanopoda*, such as *L. labineta* Hewitson, 1870, as well as in various species of *Steromapedaliodes* Forster, 1964 (Pyrz *et al.*, 2017). It is, however, restricted to species occurring in the forest-paramo ecotone, and we hypothesize that it may be the result of adaptation to various types of microhabitats in a heterogeneous environment, where grasslands are intermixed with patches of forest vegetation (Pyrz, 2010).

Adults of *L. caracara* behave similarly to other species in this genus. They need strong sunshine to be active. They fly very close to the clumps of *Chusquea* and not too high from the ground. Females occasionally perch on the leaves of *Chusquea*, but when the sun disappears, they also disappear at once. *L. caracara* only rarely visit flowers, but they come to fish bait. In the area where larvae were found adults of *Steremnia umbracina umbracina* (Butler, 1873), *Altopedaliodes perita perita* (Hewitson, 1868) and *Altopedaliodes zsolti citra* Pyrcz, 2004, were active flying during sunny time.



Figure 2. Fifth instar of *L. caracara*.

### 3.9 Host plant

The host plant was identified as *Chusquea (Neurolepis) villosa* (Clark) (Poaceae), a dwarf bamboo endemic to South Ecuador (León-Yáñez, *et al.*, 2011). This species grows in high altitude grasslands (paramo ecosystem) in which it is found in dense aggregations. Several groups were located in a moist and swampy area, surrounded by grasses of the genus *Stipa* (Poaceae) (Fig. 1). The genus *Chusquea* Kunth is considered the most diverse genus of Neotropical woody bamboos and currently includes approximately 169 described species distributed in mountainous regions (Fisher, *et al.*, 2014).

## 4 Discussion

The imbalance in our knowledge of Palearctic and Neotropical butterflies, not least in the subfamily Satyrinae, is reflected less in the information available on their taxonomy, distributions and even phylogenies, than in what we know about their biology and immature stages. Full or partial information on larval morphology exists for only a small fraction of species of Neotropical Satyrinae. From among more than 600 species of the species-rich subtribe Pronophilina larval data for less than 5% have been published. In the case of the genus *Lymanopoda*, the relevant data is known for just three species.

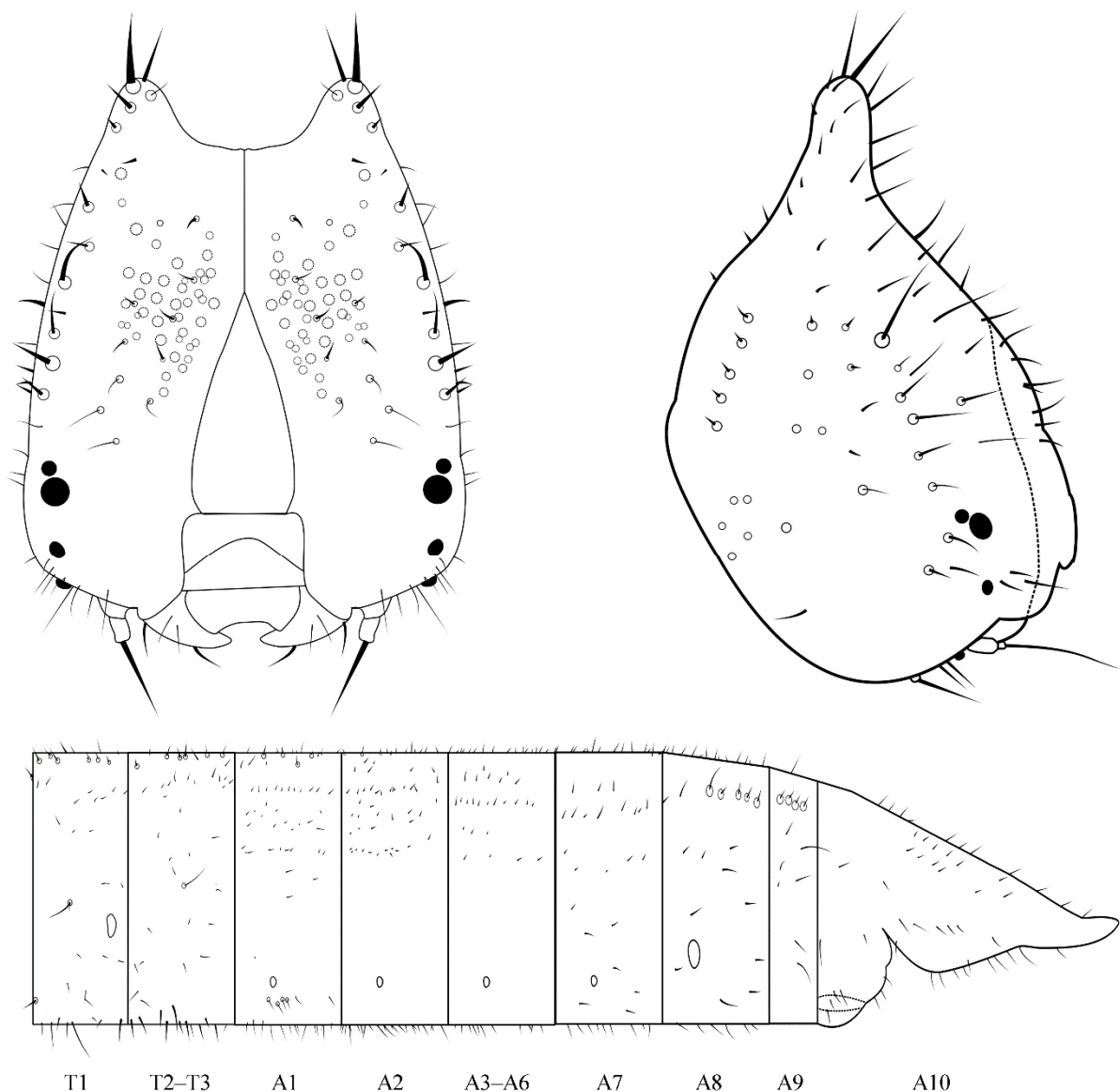


Figure 3. Head chaetotaxy and setal maps of *L. caracara*, fifth instar, in anterior and lateral view (not to scale).

In particular, information about the immature stages of species occurring in high elevation paramo habitat in the Andes, not just of Satyrinae but of all butterflies, is extremely difficult to obtain. For success, breeding has to be carried out in situ in order to comply with the natural conditions required for larval development, including freezing temperatures at night, coupled with high humidity and particular atmospheric pressure. Such conditions are very difficult to reproduce in laboratories at the best of times, and the highly sophisticated equipment needed is not generally available in the Andean countries. This significantly hampers any attempt to use larval morphology, including chaetotaxy for phylogenetical considerations.

It also has to be recognized, however, that the larvae of Satyrinae, as compared to those of other groups of Lepidoptera, tend to be little informative. Caterpillars of Palearctic species rich groups such as *Erebia* Dalman, 1816, *Hipparchia* Fabricius, 1807, or *Melanargia* scarcely differ at the infrageneric level, and the same is often the case even as between genera within higher taxonomic groups. As an exception, and interestingly, the larvae of the genus *Daedalma* Hewitson, 1858, stand apart in this respect as they present several unique morphological features and are readily recognized even from presumably closely related genera such as *Junea* Hemming, 1964 (Pyrz *et al.*, 2011).

Phylogenetically, *L. caracara* and *L. schmidtii* belong to different sections within the genus *Lymanopoda*. *L. caracara* is closely related to a number of other paramo specialists occurring in Ecuador and Colombia, including *L. huilana*, *L. melia*,



*L. tolima*, *L. casneri* and *L. flammigera* (Pyrz *et al.*, 2018). COI data for *L. schmidtii* (Triviño, unpubl. Master Thesis) confirm its position, based on morphological data (Pyrz, 2010), in a large clade containing a number of cloud forest and forest-paramo species distributed throughout northern Andes. The closest relative of *L. schmidtii* is most probably its immediate lower parapatric replacement, *L. excisa*. A hypothesis of the phylogeny of *Lymanopoda* based on calibrated molecular data, suggests that the two clades diverged some 12 MYA (Casner & Pyrcz, 2010). Such an early divergence is, however, not reflected in the morphological difference of the larvae, which show far reaching similarities.

The most notable difference between the early stages of *L. caracara* and *L. schmidtii* is at the pupal stage. The pupae of both have melon coloured lateral lines. However, pupae of *L. schmidtii* also have six fine, dotted light lines dorsally, and in T3 a thick middorsal line, similar to the melon coloured lateral lines (Montero & Ortíz, 2012). *L. caracara* pupae on the other hand do not show these fine dorsal lines, and the only wide melon colour lines are lateral, not mid-dorsal. The venation of the wings is not clearly shown, unlike *L. schmidtii* where the venation is visible in pale-yellow (Montero & Ortíz, 2012).

Finally, it is interesting to point out that the Satyrinae caterpillars generally have six stemmata with the third stemma being bigger than the others (Stehr, 1987). *L. caracara* however, has only four stemmata with the second rather than the

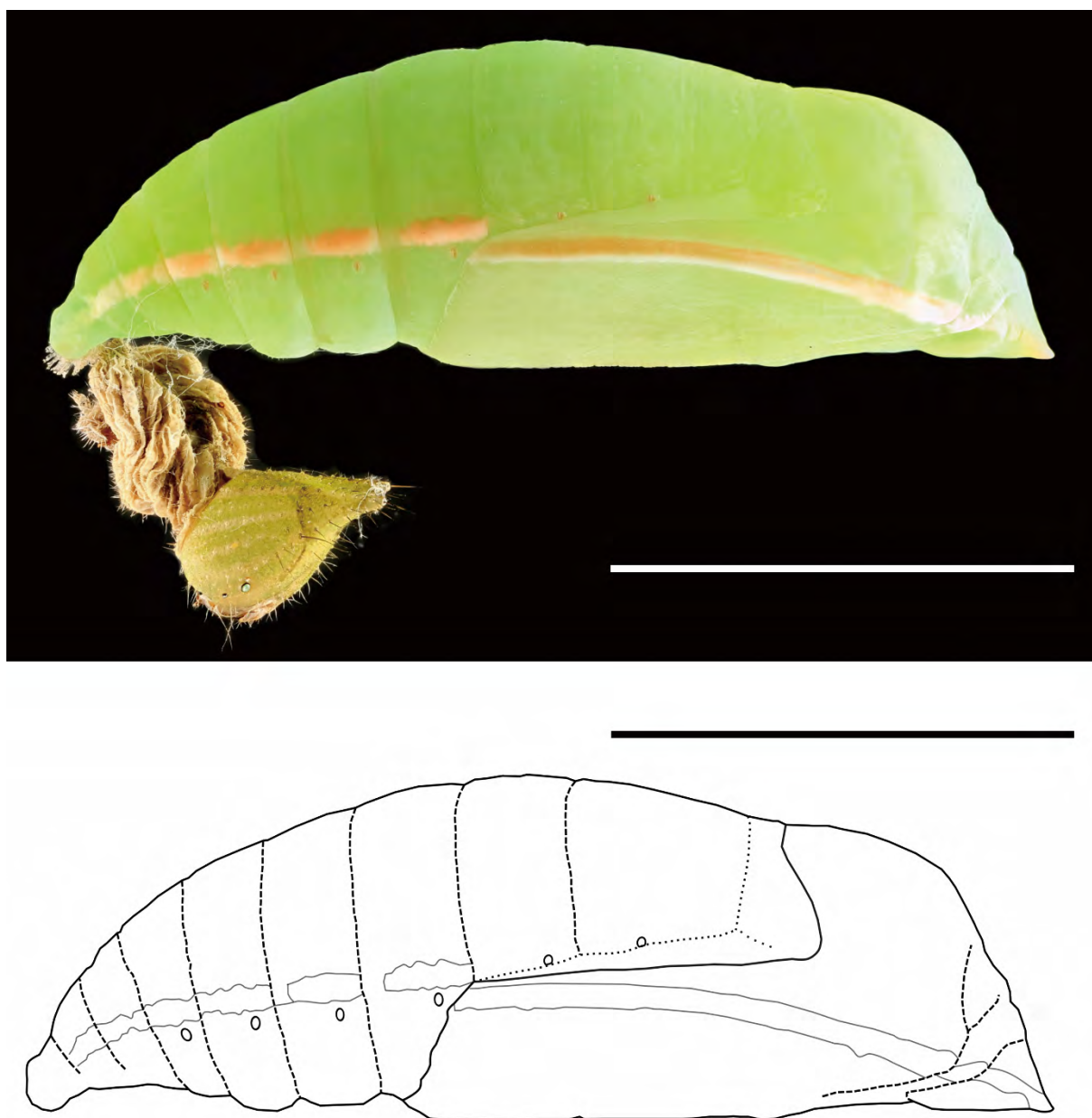


Figure 4. Pupa of *L. caracara* in lateral view. Scale bars = 1 cm.



Figure 5. Variation of wing pattern among males of *L. caracara* (all from the same locality—Maylas along the Gualaceo-Limón road, and collected at the same time).

third twice the size of the others, instead of the third. The reduction of stemmata is commonly found on leaf miners Lepidoptera (Stehr, 1987), and is possibly an adaptation for living in plant leaf tissue. As it happens the larvae of *L. caracara* do not exhibit such behavior, but we speculate that when not feeding they enter the hollow stem of bamboo and remain in this shelter. This may help explain the reduction of stemmata as well as why larvae are so difficult to find. Many larvae of Satyrinae are nocturnal (Montero & Ortíz, 2013). This is not the case for *L. caracara* whose larvae were found feeding at noon, a behavior also reported for *L. schmidtii*, which feed mainly at midday and afternoon (Montero & Ortíz, 2012). This could be an adaptation to harsh climatic conditions, with night temperatures dropping well below 0°C in the area where this species is found.

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