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# THE BIOLOGY OF *BATESIA HYPOCHLORA* IN AN ECUADORIAN RAINFOREST (LEPIDOPTERA: NYMPHALIDAE)

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ABSTRACT.– Notes on the adult population biology and early stages of *Batesia hypochlora* are presented for the first time. The general natural history, population abundance, warning coloration, behavior, geographical distribution and hostplant use of *Batesia hypochlora* is discussed. Notes on the taxonomic relationship of *Batesia* and *Panacea* are also provided.

KEYWORDS: Amazon, *Batesia*, Bolivia, Brazil, *Caligo*, *Callicore*, *Catonephele*, Colombia, ecology, Ecuador, *Epiphile*, Euphorbiaceae, fruit-feeding nymphalids, hostplants, immature stages, larvae, life history, Neotropical, *Nessaea*, *Panacea*, Peru, population biology, pupae, seasonality, South America, warning coloration.

The Neotropical nymphalid butterfly genus *Batesia* Felder & Felder embraces the single, uniquely colored species *Batesia hypochlora* (Felder & Felder, 1862). This species inhabits lowland rainforests from central Colombia to eastern Ecuador through southeast Peru and western Brazil, and likely into northeast Bolivia; in effect, an upper Amazonian distribution. Despite the fact that *B. hypochlora* is easily identified in the field (see illustrations in Lewis, 1973; D'Abrera, 1987) and has long been popular with collectors, very little has been available on its natural history. There are two sources of information. Fruhstorfer's (1916) summary of *B. hypochlora* states, ". . . this genus consists only of a single species, a large butterfly with a most conspicuous colouring, living on the Upper Amazon and on the Rio Negro in Ecuador and not being very rare. There is nothing known about its habits." Second, although not citing the source of the observation D'Abrera (1987) recently asserted that, " The species when encountered is seen to be flying high at tree height with a slow, deliberate action". In sum, the available information on *B. hypochlora* indicates that the adults are conspicuously colored, that they fly slowly at tree height, and that the species is not rare. Thus rests our understanding of this spectacular Amazonian nymphalid butterfly.

As part of a long-term study on spatial and temporal diversity of fruit-feeding nymphalids (DeVries *et al.*, 1999; DeVries and Walla, unpubl.), we were able to study populations of *B. hypochlora* occurring in lowland Ecuadorian rainforest. This report summarizes our observations on the biology of its adults and early stages.

## Study Site

Observations presented here were conducted from August 1993 to August 1998 at the La Selva Lodge (hereafter abbreviated LSL), Sucumbíos Province, eastern Ecuador in the upper Amazon Basin 75 km ESE of Coca in an area bounded by the Rio Napo, and the oxbow lakes Garza Cocha and Mandi Cocha (0°29'50.3"S; 76°22' 28.9"W) near the settlement of Anyañgu. Most observations were concentrated within an approximately 1000 hectare section of forest around and between two oxbow lakes (Garza Cocha and Mandi Cocha). This area has been intensively sampled with canopy and understory traps in a study of fruit-feeding nymphalid diversity (see DeVries *et al.*, 1999). Rainfall data indicates between 3.5 and 4.0m precipitation per year, with a dry season from January to March. The area surrounding the study site includes at least 30,000 hectares of floodplain forest, and available evidence suggests that our study site represents old growth forest that has eluded severe disturbance by modern human civilization. Thus our observations should be broadly relevant to populations of *B. hypochlora* occurring within intact forest.

## Adults

We observed adults feeding only on juices of rotting fruits, wounds in trees, and very occasionally on fresh mammal dung or rotting mammal carcasses. During a five year period (DeVries *et al.*, 1999, and unpubl.), we trapped 104 individuals of *B. hypochlora* in the understory, and 37 in the canopy. A binomial test shows that canopy and understory abundances differ significantly ($p < 0.002$), suggesting that this butterfly seldom occurs in the forest canopy, and other observations (see below) indicate it is most frequent in the under to mid-story of the forest. Monthly samples from August 1993 through August 1998 showed that individual abundance was typically low each month, but that abundance varied seasonally and yearly (Fig. 1).

Adults were most frequently observed on sunny days flying from 2-12m above the ground in a slow glide, often describing lazy circles within lightgaps in the forest. As we frequently observed in members of the closely related genus *Panacea* Godman & Salvin, individual males of *B. hypochlora* would occasionally perch head down on tree trunks in light gaps. Even in the low light levels of the forest understory, the red band on the forewing of *B. hypochlora* is immediately visible, regardless of whether an individual is flying or at rest. When an individual is flying in direct sunshine, however, the red band almost glows, making it brilliantly obvious when viewed from either above or below. In short, the presence of this butterfly within any particular forest can easily be detected by even the most inexperienced of entomologists.

Oviposition events were typically observed between 1100h and 1400h on bright sunny days. *B. hypochlora* females were found to oviposit clusters of eggs on plants of various ages, ranging from saplings to mature trees, but only on individual plants with vigorously growing shoots.

## Hostplant

*Caryodendron orinocensis* (Euphorbiaceae). This large, distinctive rainforest tree occurs from Colombia and Venezuela south and west throughout most of the upper Amazon Basin. The oil-rich seeds are harvested widely by indigenous Amazonian people as prized, seasonally available food. The colloquial names for this tree are "mani del monte" in Ecuador, "inchi" in Colombia, and "meto huayo" in Peru (see Gentry, 1993).

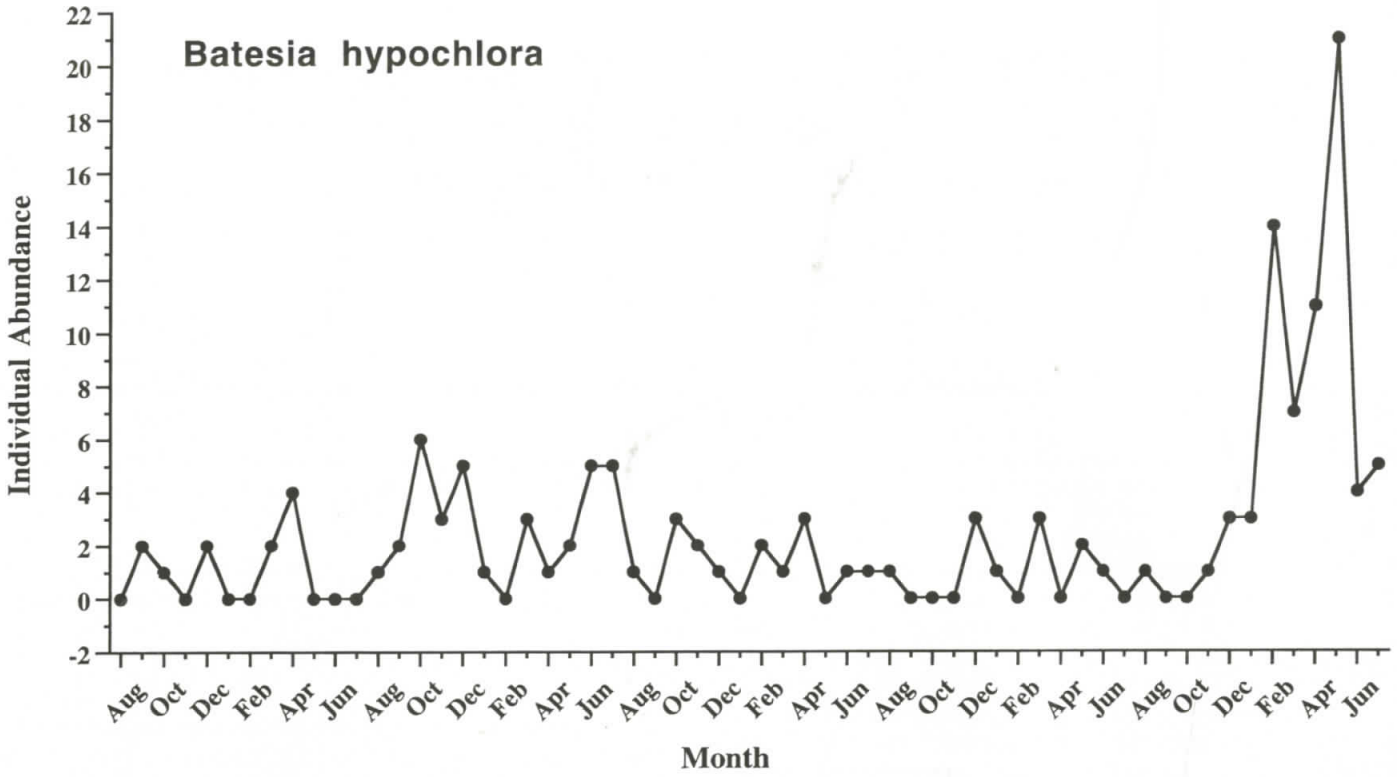



Fig. 1. Monthly abundance of *Batesia hypochlora* during five years sampling with traps at La Selva Lodge, Ecuador. Note seasonal and yearly variation in abundance.

## EARLY STAGES

**Egg** (developmental time = 7 days, n = 61, one cluster): creamy white; approximately round, micropylar region flattened; 16 vertical ribs (n = 4) adorned with spines that increase in length from the bottom to the edge of the micropylar region, where they form a crown; surrounding the micropylar region the vertical ribs are devoid of spines and connected by three horizontal ribs. The dorsum of the egg darkens noticeably 24 hrs before hatching.

**First instar** (duration = 2-5 days). Head: dark brown. Body: orange-green fading to orange-yellow towards the posterior end; body setae dark brown, long, inserted on dark brown pinnacula; thoracic legs dark brown; proleg shields dark brown; anal plate brown.

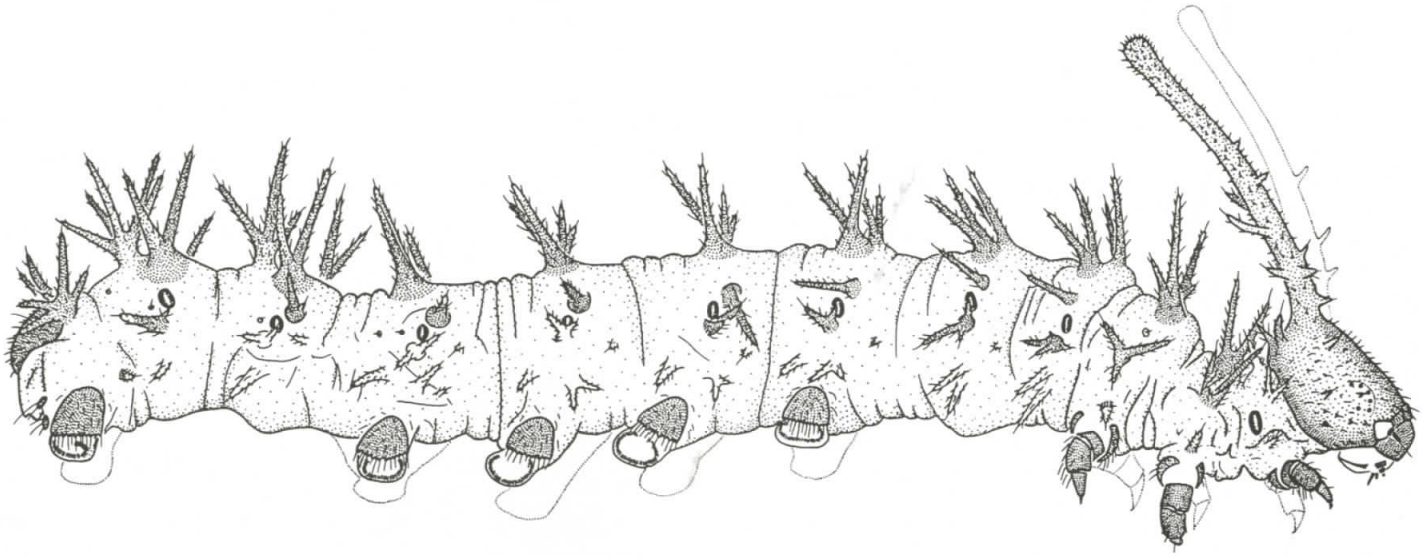
**Second instar** (duration = 2-3 days). Similar to first in both color and morphology, except larger.

**Third instar** (duration = 3 days). Head: dark brown bearing thick scoli (approximately half the height of head) with elongated terminal and lateral setae. Body: orange-green fading to orange-yellow towards the posterior end; prothoracic shield white, with two pairs of single scoli of the same color; thoracic legs dark brown; body scoli short and thick; scoli in the dorso-lateral series bifurcated, remaining scoli simple; A1-A7 with single unbranched dorsal scolus on a small chalaza located at mid-length on each segment; a bifurcated four- branched scolus located at midline along the posterior margin of A7 and A8 respectively; proleg shields dark brown; anal plate dark brown.

**Fourth instar** (duration = 3-5 days). Head: dark brown to black; head scoli (approximately as long as height of head) coated with minute tubercules, each bearing a short seta; small tubercules on proximal half of head scoli; post-genal region adorned with tubercules, one located near epicranial suture, two dorso-lateral, and one located just above the stemmatal region. Body: similar to third instar except uniformly orange and having longer scoli.

**Fifth instar** (duration = 5-9 days). Generally, the fifth is the final instar of development in butterflies, but some may undergo supernumerary instars (e.g., *Caligo*, pers. obs.). Our observations indicate that *B. hypochlora* may undergo up to seven instars before pupation. Excepting for being larger, the sixth and seventh instars were indistinguishable from the fifth.

**Sixth instar** (duration = 8-10 days; Fig. 2). Head: black with short setae, and adorned with a pair of dorso-lateral black scoli (approximately twice as long as height of head); scoli densely coated with small tubercules bearing a short seta, and 6-7 spines that are distributed haphazardly around the shaft from the base to one-half the length of the scoli; on each side of the head post-genal region adorned with spines, one near epicranial suture, two dorso-lateral, and one just above the stemmatal region and anterior to a cluster of large tubercules; gena adorned with a single spine equidistant from the base of head scolus and stemmatal region. Body: orange with a hint of green; thoracic legs, spiracles and proleg shields black; body scoli black on black chalazae (except where noted otherwise); branched body scoli devoid of a stem (except where noted otherwise); scoli long and sparsely coated with spinules; T1 with a creamy white prothoracic plate adorned with three unbranched creamy white scoli on each side (with or without a black tip), bifurcated creamy white supra-spiracular scoli (with or without a black tip) and simple sub-spiracular scoli (with a black tip); T2 with dorso-lateral chalazae fused dorsally, each bearing a four-branched scolus, cuticle in the anterior dorsal portion of T2 darkened and rough (particularly noticeable in preserved specimens), supra-spiracular scoli three-branched, sub-spiracular scoli simple; T3 with three-branched dorso-lateral and supra-spiracular scoli, simple sub-spiracular scoli; A1 to A7 with single unbranched dorsal scolus on a small chalaza located at mid-length on each segment; A7 and A8 with single dorsal scolus on a large chalaza located at the posterior margin of each segment, these scoli are unique in having three (A7) and five branches (A8) off a short stem; T3 to A8 with bifurcated dorso-lateral scoli which develop a very small stem in a gradient from T3 (no stem) to A8 (small stem); A1 to A8 generally with simple supra-spiracular scoli (sometimes bifurcated in A7-8); A1-A7 with three sub-spiracular scoli, (the first bifurcated, remainder simple) that are orange from A2 to A6 and black with orange tips on A1, and aligned vertically on A1-2 and A7, and horizontally on



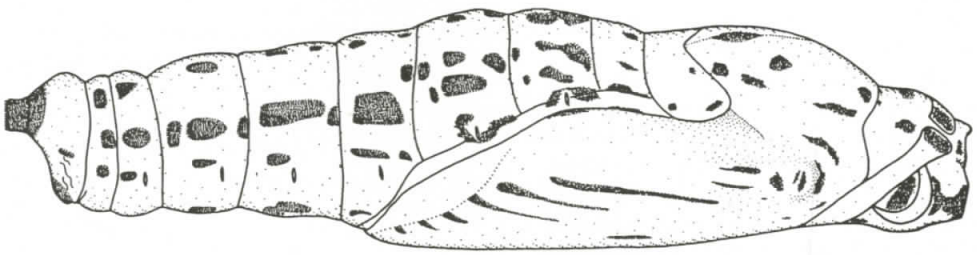


Fig. 2. *Batesia hypochlora*: mature caterpillar drawn from a preserved specimen (Ecuador, Sucumbios, Garza Cocha, La Selva Lodge and Biological Station, 27 Oct 1993).

Fig. 3. *Batesia hypochlora* pupa (reconstructed from preserved exuviae; same locality as Fig. 2, no date). Note that pupation may, at times, take place on the dorsal surface of leaves, and the pupa held horizontal to the substrate as seen, for example, in the nymphalid genera *Catonephele*, *Epiphile*, and *Callicore* (see DeVries, 1987)

A3-6; last sub-spiracular scoli on A7 and A8 with orange tips; A8 with dorsal, dorso-lateral and supra-spiracular chalazae fused; A9 with four-branched dorso-lateral scoli on chalazae fused to lateral portion of anal plate, and small sub-spiracular scoli; anal plate oval in shape, black, convex, with a pair of simple scoli located near dorsal margin.

**Pupa** (duration = 10-12 days, Fig. 3). Pendant, although pupation may take place on the dorsal surface of leaves, and the pupa may be suspended horizontal to the substrate. Overall creamy yellow with black spots and short stripes; elongate and cylindrical in shape, and without projections. Head with small oblique dorso-lateral crests; a spot located on anterior portion of crest is joined laterally by a short stripe that borders the upper edge of the eye; black spot on eye; base and tip of antennae with a black spot; first pair of legs with small spots (one at mid-length, another at tip); second pair of legs with a short stripe at base; segment T1 with a pair of spots; T2 with five dorso-lateral markings and a midline stripe located posterior to them; five spots on the wing tubercle and surrounding area, surface of wing with tracheal markings restricted to wing margin anteriorly and elongated into stripes towards the posterior end; T3 with dorso-lateral spots; abdomen adorned with blotches and short stripes forming incomplete longitudinal rows (dorsal, dorso-lateral, spiracular, ventro-lateral and ventral); cremaster black, broad and wide, cremaster crown narrow, exuvia holdfast tubercules black at tip.

## Discussion

There is a strong disparity between five years of monthly abundance data from LSL (Fig. 1) and Fruhstorfer's (1916) statement that *B. hypochlora* is common. Our observations at LSL and other sites suggest that *B. hypochlora* is rarely so abundant in Ecuador to be considered as common as other species that occur sympatrically in the same forests (e.g., *Panacea prola* (Doubleday, 1848), *Panacea divalis* (Bates, 1868), and *Nessaea hewitsoni* (Felder & Felder, 1859). However, given its conspicuous coloration and collector value, *B. hypochlora* may be well represented in museum collections, thereby suggesting an overestimation of its actual abundance in nature.

The contrasting color combination of red, yellow, dark blue and black, and the slow, lazy flight of *B. hypochlora* make this butterfly particularly conspicuous where it occurs. Furthermore, when alive the body is rubbery, resistant to pinching, and the wing-scales are not easily rubbed off upon handling, all which are well known characteristics of many unpalatable butterflies (e.g., Swynnerton, 1915, 1919; Poulton, 1908; Fisher, 1930; Chai, 1986, 1996). In light of its visual and physical characteristics, we are confident in concluding that *B. hypochlora* is clearly aposematic, and very likely to be unpalatable. The nature of *B. hypochlora* as an aposematic species will be treated elsewhere (DeVries, Penz and Hill, in prep.).

All larval instars of *B. hypochlora* fed gregariously. First instars fed only on the dorsal leaf tissues and did not eat any leaf veins (they skeletonized the leaf). All other instars consumed the entire leaf blade excepting the largest primary veins and petioles. While feeding, second to final instar caterpillars often formed groups on both the dorsal and ventral leaf surfaces.

When disturbed by an observer or attacked by vespid wasps, caterpillars would raise their anterior segments off the substrate and wave their heads erratically from side to side. This defensive display

did not deter vespid wasps from harvesting first and second instar caterpillars, but we suggest that such behavior might be effective against arthropod predators in later instars.

Molting typically occurred synchronously in all instars except the molt to pupa. We found no evidence that *B. hypochlora* pupates in groups. Synchronous pupation is unlikely, as prepupae of *B. hypochlora* pass through an active wandering phase whose duration may vary among individual caterpillars. We frequently found prepupal caterpillars dispersing haphazardly away from host trees, and pupating individually on vegetation in the forest mid and understory.

The close relationship of *Batesia* and *Panacea* has long been acknowledged (Fruhstorfer, 1916), and a recent phylogenetic study of adult and early stage morphology support this hypothesis (Penz, Hill and DeVries, in prep.). Strengthening this relationship is that we find *Panacea* also utilizes *Caryodendron orinocensis* as a hostplant at LSL (see also Montoya, 1991), and recently W. Haber (pers. com.) found *P. procilla lysimache* Godman & Salvin caterpillars feeding on a species of *Caryodendron* in Costa Rica. These observations in concert with basic patterns of host plant relationships among nymphalids suggest that *Caryodendron* may be utilized by *Batesia* and *Panacea* throughout their ranges. We suggest that a deeper understanding of the population ecology of *Batesia* and sympatric *Panacea* would be gained from field studies asking if these taxa share larval parasitoids and predators.

Compared to what has been available previously, the observations here represent a considerable advance in our understanding of the basic natural history of *B. hypochlora*. This in itself serves as a sad reminder that even large charismatic tropical species remain poorly known. We hope that this report stimulates further work toward a more profound ecological understanding of a butterfly whose striking appearance has been remarked upon for over a century (Salvin and Godman, 1868; Fruhstorfer, 1916, D'Abrera, 1987). However, given the ever increasing rate of tropical forest destruction, this small contribution may serve as an epitaph for a butterfly named in honor of the great naturalist Henry W. Bates when the Amazon was a less finite place.

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