

REDISCOVERY OF *HYALOPHORA EURYALUS CEDROSENSIS*
(SATURNIIDAE), WITH DESCRIPTIONS OF THE
ADULT AND LARVAL STAGES

MICHAEL J. SMITH¹

7428 Holworthy Way, Sacramento, California 95842

AND

RALPH E. WELLS

303 Hoffman Street, Jackson, California 95642

ABSTRACT. We report the rediscovery of *Hyalophora euryalus cedrosensis* (Cockerell) from Isla de Cedros, a small island off the western coast of Baja California, Mexico. The adult and larval stages are described and compared with nominotypical *H. e. euryalus* (Boisduval). The known distribution of *H. euryalus* on the peninsula of Baja California, Mexico is reviewed.

Additional key words: Mexico, California, Baja California, Isla de Cedros, endemism.

Since its brief description in a footnote by T. D. A. Cockerell (Packard 1914:226), the taxonomic status of *Hyalophora euryalus cedrosensis* has been uncertain. It was described from a "suffusedly blackened" male collected on "Cedars Island," Mexico. Cockerell characterized this subspecies as follows:

"Male. Margins of upper side of wings broadly and suffusedly blackened, the submarginal markings almost entirely lost; ocellus of primaries smallish; discal mark on hind wings longer and more slender than in *kasloensis*; beneath the wings are very black, but the region basad of the bands is suffused with brownish vinaceous."

The type locality of this taxon is most certainly Isla de Cedros, situated off the west coast of Baja California, Mexico, about halfway down the peninsula (west of Guerrero Negro). The type specimen could not be found and no specimen labelled "Cedars Island" or "Isla de Cedros" could be located in any of the major U.S. museum collections (Ferguson 1972). Sweadner (1937) treated *H. euryalus cedrosensis* as a separate species (i.e., *Platysamia cedrosensis*) but commented that it was only a "list" name due to the lack of a type or other specimen from the presumed type locality. Hoffmann (1942) and Rindge (1966) treated *H. e. cedrosensis* as a subspecies. Bouvier (1936), Ferguson (1972), and Lemaire (1978) treated *cedrosensis* as a synonym of *H. euryalus eu-*

¹ Research Associate, Nevada State Museum & Historical Society, Las Vegas, Nevada.

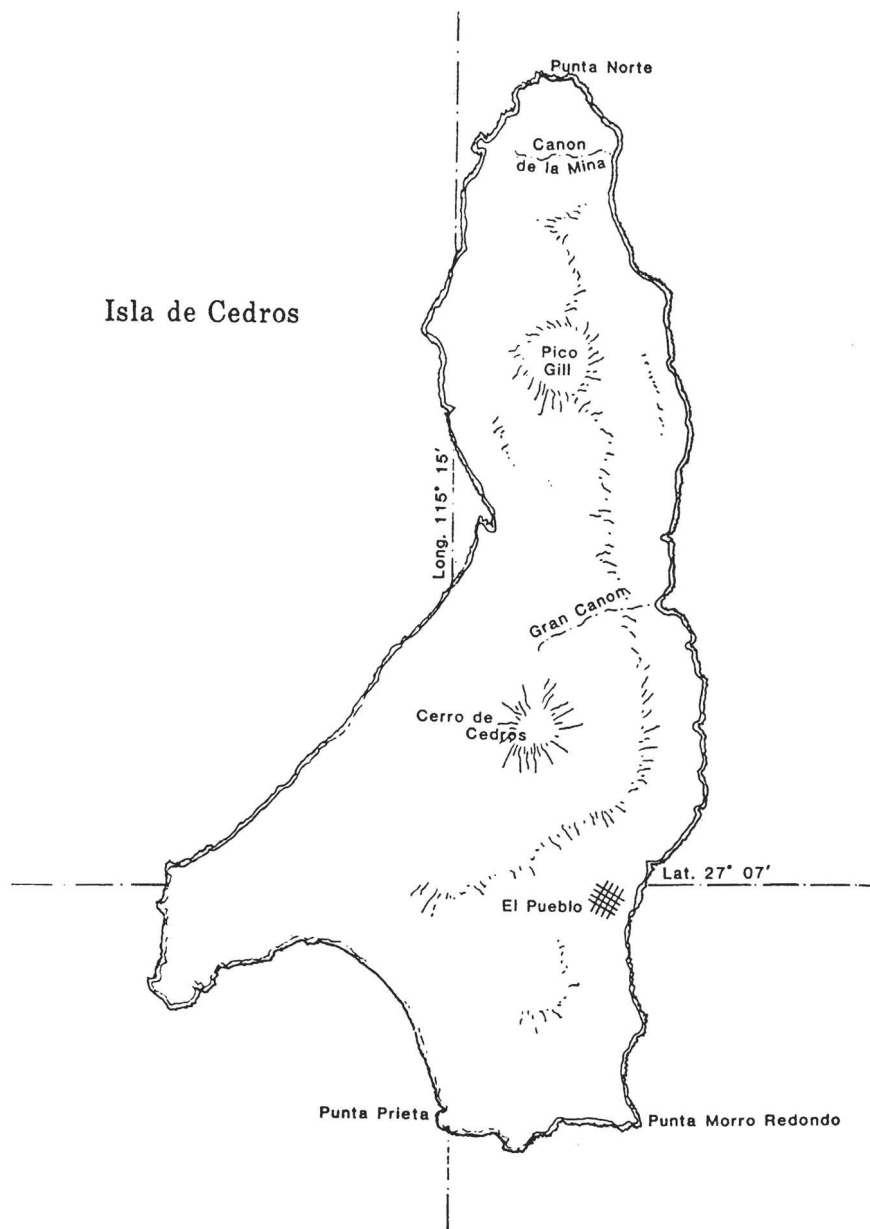


FIG. 1. Map of Isla de Cedros, Baja California Norte, Mexico.

ryalus primarily owing to the absence of a type specimen or any other material available from Isla de Cedros.

During a trip to Isla de Cedros in May 1986, one of us (REW) discovered cocoons of *H. euryalus* on shrubs at the mouth of the Gran Canyon on the east side of the island. On a later trip in January 1987, a female *H. euryalus* was attracted to a propane camp light at the mouth of Gran Canyon. Since then, a total of three males and two females have been collected at light at the mouth of Gran Canyon by R. Wells. Also, a series of adults has been reared from four larvae collected in the Gran Canyon area or from eggs obtained from field collected adults. Examination of these specimens and comparison with adults and larvae of *H. e. euryalus* from California and peninsular Baja California have allowed us to confirm the integrity of *H. e. cedrosensis* as a distinct subspecies of *H. euryalus*, and to provide a more thorough description of this insular subspecies.

TYPE LOCALITY

Isla de Cedros (Fig. 1) is a mountainous island of 348 square km located off the west coast of Baja California. It is 34 km long and 4–15 km wide. The north-south mountain spine contains a few prominent peaks, the highest of which is Cerro de Cedros at 1200 m. The largest intrusion into this mountain chain is the Gran Canyon located midway on the east side of the island. The island's geographic position results in inconsistent and infrequent moisture from northern winter storms and from southern tropical summer storms ("chubascos"). The island receives frequent moisture from dense fog year-round (Libby et al. 1968, Lewis & Ebeling 1971). The habitat at Gran Canyon, where *H. e. cedrosensis* has been collected, has a fairly impoverished flora that includes buckwheat (*Eriogonum fasciculatum* Nutt., Polygonaceae), lemonadeberry (*Rhus integrifolia* [Nutt.] Rothr., Anacardiaceae), laurel sumac (*Malosoma laurina* Nutt., Anacardiaceae), California juniper (*Juniperus californica* Carr., Cupressaceae), elephant tree, (*Pachycormus discolor* [Benth.] Cov., Anacardiaceae) and agave (*Agave shawii* var. *sebastiana* [Greene] Gentry, Agavaceae) (Wells pers. obs.).

Geologically, Isla de Cedros represents the northern extension of the extensive Sierra Vizcaino of the Baja mainland (Gentry 1950, Wiggins 1980). However, the island's flora and butterfly fauna have strong affinities with the Californian Biotic Province that occurs considerably further north (Moran 1972, Gould & Moran 1981, Brown & Donahue 1989, Brown & Faulkner 1989, Langston 1980). The island supports many plants typical of the Vizcaino-Magdalena Province of the adjacent mainland, including the elephant tree and agave (mescal). However, the number of Californian Province elements reaching their southern

limits on Isla de Cedros demonstrates that the primary relationship of the island's flora is to the north, with the Californian Province, a phytogeographic region that extends from the California border south to the vicinity of El Rosario, Baja California Norte. Remnants of this habitat also are found on some mainland Baja California mountain peaks south of El Rosario (Gould & Moran 1981, Brown & Faulkner 1989).

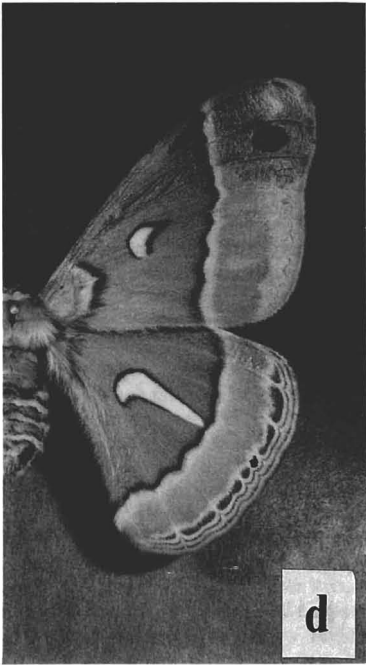
During two visits to the Gran Canyon by the junior author, the island was in the midst of a drought. Evergreen shrubs, such as *Rhus*, *Juniperus*, and a few others, comprised the only green vegetation. Flowers were virtually absent and only 14 species of butterflies were collected. The windward west side and north end of the island were greener because tall vegetation there precipitates water from the fog.

SYSTEMATICS

Hyalophora euryalus cedrosensis Cockerell

The description below is based on two males and two females collected as adults or cocoons on Isla de Cedros, and an additional eight males and ten females reared from eggs obtained from wild collected females, all by the junior author. Measurements are from the four collected adult specimens; descriptions of color pattern are based on wild collected and reared specimens because there was no observable color variation.

Male (Fig. 2a). Forewing length 48.6 mm and 59.0 mm, $n = 2$. *Antenna*: Brown, very fan-shaped. *Head*: Covered with dark lavender hair. *Thorax*: ground color dark lavender-brown hairs, white collar behind head, bordered with darker, longer lavender hairs posteriorly. Legs covered with lavender-brown to lavender hairs. Band of light tan hair at posterior edge of thorax. *Abdomen*: Base color dark lavender-brown, each segment ringed by a partial to full band of white hairs. *Dorsal wing surface*: Deep maroon-red; white antemedial and postmedial lines variably obscured by black scales, creating dark gray color in most specimens. Central portion of forewing postmedial line most heavily obscured, nearly obliterating postmedial line in most specimens. Black line basal to postmedial line wavy. Forewing discal spot creamy white, small; hindwing discal spot concolorous with FW spot, elongate, often extending distally to postmedial line. Dorsal hindwing discal spot in strong contrast with dark ground color. Usually a black submarginal spot in cell M_1 - M_2 ; often less distinct submarginal spots in M_3 - Cu_1 and Cu_1 - Cu_2 , occasionally also in M_2 - M_3 . Apical black spot relatively large and prominent in margin of dorsal FW. Apical eyespot in cell R_5 - M_1 nearly uniform black, with a thin bluish line in basal section. Outer half of margin variable from light to dark brown, depending on degree of black scaling on wing surface. Veins connected by a sharply delineated black line immediately basal to margin. Spot R_{3+4} - R_5 with whitish S-shaped line between black apical spot and eyespot. Hindwing margin brown with blackish spots and dashes at posterior end of each cell. *Ventral wing surface*: Dark, almost mahogany brown. Costal region and area distal to postmedian line heavily sprinkled with white. Submarginal band essentially concolorous with ventral wing ground color. Margin medium brown, with blackish to dark brown dashes at posterior end of each cell. Eyespot in cell R_5 - M_1 blackish with blue shadow in basal half.



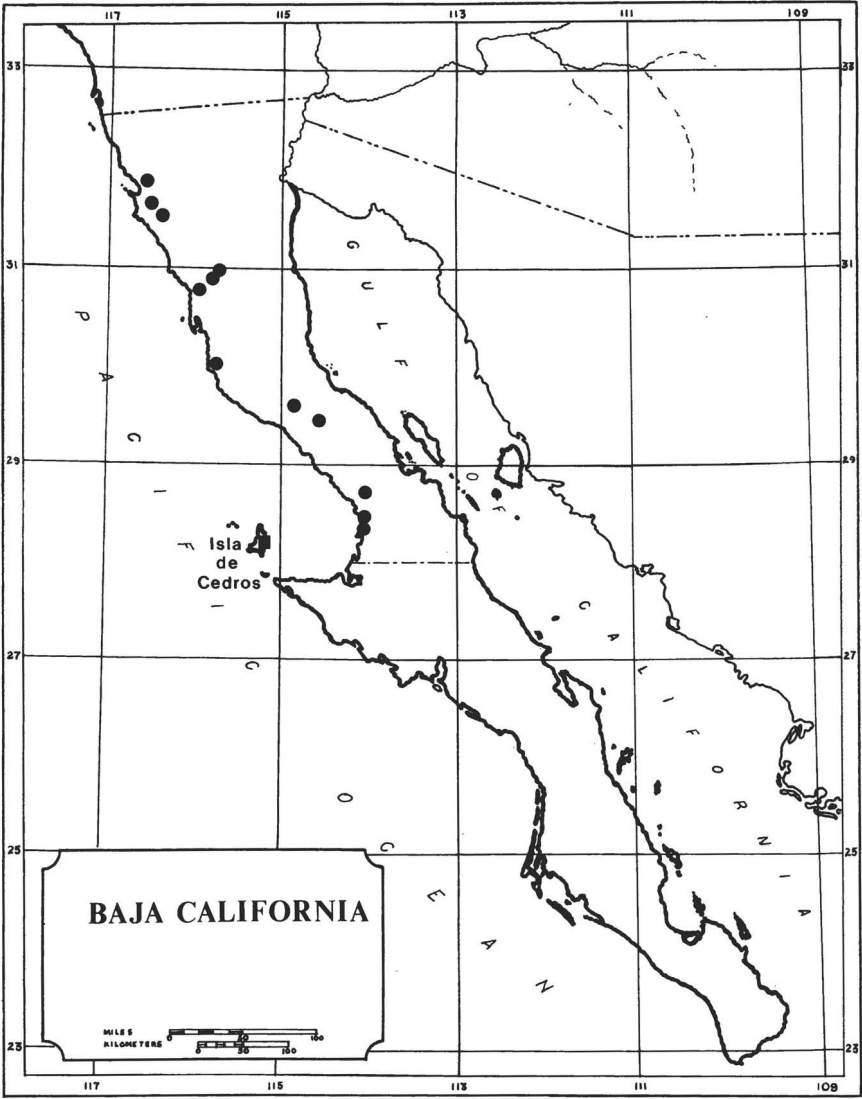


FIG. 3. Distribution of *H. euryalus* in Baja California, Mexico: closed squares = *H. e. cedrosensis*; closed circles = *H. e. euryalus*.

FIG. 2. Adult *Hyalophora euryalus*: a. *H. e. cedrosensis* male; b. *H. e. cedrosensis* female; c. *H. e. euryalus* male from mainland Baja California peninsula; d. *H. e. euryalus* female from mainland Baja California peninsula.

Female (Fig. 2b). Forewing length 60.9 mm, $n = 1$ (the other wild caught female too damaged to measure). Wing surface characters essentially the same as in male.

Topotypical pairs are deposited in the collections of the Universidad Autónoma de Ensenada, Ensenada, Baja California Norte, Mexico, and San Diego Natural History Museum, San Diego, California.

Distribution. The distribution of *Hyalophora euryalus euryalus* in Baja California is shown in Fig. 3. All wild caught specimens of *Hyalophora euryalus cedrosensis* are from Gran Canyon, Isla de Cedros, Baja California, Mexico.

Larvae. Description based on 20 larvae obtained from eggs deposited by two female specimens collected on 3 January 1987 and 6 January 1987, Gran Canyon, Isla de Cedros, about 40–60 meters from the water's edge. All larvae were reared by REW on California peppertree (*Schinus molle* Linnaeus, Anacardiaceae).

First instar. Emerged between 31 January 1987 and 8 February 1987. Length at emergence 4–5 mm; length prior to molt 10–11 mm, width 2.0–2.5 mm. Larval color predominantly black, some individuals (about 20%) with yellow-orange at the base of the thoracic tubercles. Some anterior spines tinted orange. Instar lasted 7–10 days.

Second instar. After molt, length 11–13 mm, width 2.0–2.5 mm. Head and all legs black. Ground color variable from nearly solid black (most) to dull yellow-green. Darkest larvae with orange spots at base of each dorsal tubercle; some orange spots enlarged, contiguous with adjoining spots, creating an orange-green longitudinal stripe on the back. Orange-green stripe widening to create yellow-green ground color in some individuals. Dull yellow-green larvae variable from dark to bright. Brightest larvae yellow-green with only the tubercles and legs black. Tubercles enlarged in 2nd and 3rd thoracic segment and 1st abdominal segment; tubercles slightly enlarged on 2nd abdominal segment. Tubercle singular and prominent on 8th abdominal segment. Spines and tubercles most prominent in this instar with greatest tubercle to larval body size ratio. Instar lasted 7 days.

Third instar. After molt, length 13–25 mm, width to 4 mm. Head black with inverted dull green "Y" in center. True legs black, prolegs dull green blotched with black. Tubercles and spines black. Thorax and abdomen dull green with dull yellow-orange patches. Some larvae with yellow-orange patches on lateral surfaces. Tubercles enlarged on 2nd and 3rd thoracic, and 1st and 8th abdominal segments. Spines prominent after molt, decreasing in prominence as larvae expand during growth. (Consistent for all instars.) Spiracles black. Instar lasted 9 days.

Fourth instar. After molt, length 24–53 mm, width 7–10 mm (11–12 mm at dorsal segments). Head 2.5–3.0 mm, dull green and black. Ground color dull green with no segmental markings; many individuals diffuse to dull black from mid-lateral to ventral surface (this is a 4th instar characteristic disappearing in the 5th instar). Tubercles enlarged on 2nd and 3rd thoracic and 1st abdominal segments; these have base color orange, ringed and spotted irregularly with black (some examples are totally black). Tubercles bulbous in the middle, spines reduced and more bristlelike, some light orange basally. Tubercles smaller on 2nd through 7th abdominal segments; orange with small black bristles; end spike of these most prominent. Tubercle on 8th abdominal segment singular, centrally located, orange and unmarked (except in a few specimens that are lightly spotted with black). Lateral tubercles black, usually with black spines. Some specimens with median row of tubercles dull green centrally, with black spines and black base. Two specimens with central green area white. Spiracles white. Instar lasted 9 days.

Fifth instar (Fig. 4a). After molt, length 53–90 mm, width 10–15 mm. Head and legs light green; prolegs light green with dark gray pads. Body color uniformly dull green transitioning to a darker green (dull black tone) ventrally, without the relatively sharp delineation between green and blackish of the fourth instar. No conspicuous black or orange markings. All lateral tubercles short, rounded, white, including those anterior to large dorsal tubercle on 8th abdominal segment. Row of tubercles nearest prolegs shorter, broader, and rounder; upper medial tubercle row longer, thinner, and more pointed. Dorsal tubercles on 2nd and 3rd thoracic and 1st abdominal segments enlarged (3.0–3.5 mm), light yellow, ringed by typical equatorial band in the middle. Dorsal tubercles on 2nd through 7th abdominal segments smaller, lighter yellow (occasionally flecked with

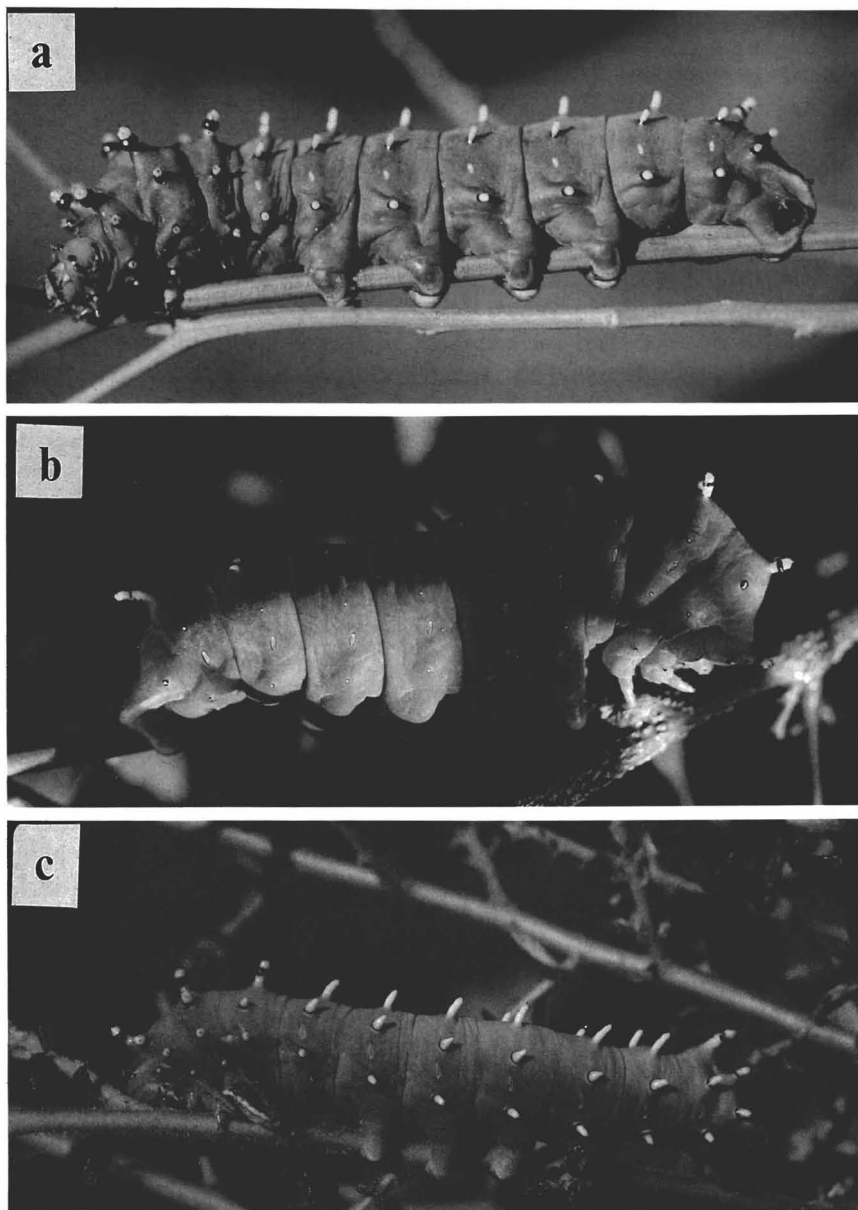


FIG. 4. Final instar larvae of *H. euryalus*: a. *H. e. cedrosensis* from Isla de Cedros, Baja California Norte, Mexico (photo by R. Wells); b. *H. e. euryalus* from El Socorro, Baja California Norte (mainland), Mexico (photo by M. J. Smith); c. *H. e. euryalus* from Orinda, San Mateo Co., California (photo by F. McLaren).

black), with no change in basal color. Tubercle on 8th abdominal segment singular, 3 mm long, lacking bulbous black ring, but flecked with black. All tubercles with minute black bristles on the tips; most tubercles black basally. Spiracles white.

DIAGNOSIS AND DISCUSSION

Hyalophora euryalus cedrosensis can be distinguished from *H. e. euryalus* by its darker color and the more prominent appearance of the hindwing discal spots (see Fig. 2). The deep maroon-red of the dorsal wing surface is darker than the variable pink-red (lavender) to red-brown of *H. e. euryalus*. The darkest specimens of the nominotypical subspecies tend toward dark brown rather than to maroon-red as in *H. e. cedrosensis*. The second most notable difference, and most diagnostic, is the sooty black suffusion of the postmedian line in *H. e. cedrosensis*, especially on the forewing. This is the character described by Cockerell (in Packard 1914), and it is consistent in all specimens examined. Sweadner (1937) incorrectly suggested that this black suffusion was caused by soot from the oil lamps that attracted the suspected (unlabelled) specimen of *H. e. cedrosensis* he studied. The dark ventral surface described by Cockerell is variable from black-brown to dark brown, but tends to be darker than in nominotypical *H. euryalus*. The outer third of the dorsal surface of *H. e. cedrosensis* is darker than the basal two-thirds owing to the black scaling, thus differing from the lighter pinkish-red to red-brown of the outer third of *H. e. euryalus* (see Collins 1984). The abdominal color of *H. e. cedrosensis* is a dark maroon-red compared to the brighter reddish lavender of *H. e. euryalus*. On the mainland of Baja California, *H. euryalus* is found from the California border, south to about 69 km north of Guerrero Negro (see Fig. 3). Mainland populations fall within the range of variation of California *H. e. euryalus*. Although the Baja California specimens tend to be redder (female specimens browner) than those of California, we consider them to be nominotypical *H. euryalus*.

In general, larvae of *H. e. cedrosensis* are darker or possess more black markings (or both) than larvae of *H. e. euryalus* in all instars (see Fig. 4). Only the first instar in the nominotypical subspecies is all black, whereas many individuals in the second instar of *H. e. cedrosensis* are totally black. In the middle instars, this black color is displaced by shades of yellow and dark green; however, the green of even the final instar always retains the dusky, charcoal pigment in *H. e. cedrosensis*. Larvae of *H. e. cedrosensis* never have the bright, almost pearly-green appearance of the mainland subspecies.

Larvae of *H. e. cedrosensis* feed on *Malosma laurina* and *Rhus integrifolia*, and on the Baja California endemic *Pachycormus discolor* (all Anacardiaceae); the latter is a new foodplant record for the species.

Rhus lenti Kell. (Anacardiaceae) also occurs on Isla de Cedros and hybridizes with *R. integrifolia* where the two species are sympatric (Young 1978). The preferred foodplant on Isla de Cedros appears to be *Malosma laurina* since the greatest percentage of cocoons were found on this species. The use of *Pachycormus discolor*, originally discovered on Cedros, has been confirmed for the mainland subspecies (Wells pers. obs., Tuskes pers. comm.). We observed no significant differences between the cocoons of the two subspecies.

The consistency of adult and larval differences between *H. euryalus euryalus* and *H. euryalus cedrosensis* indicate that *H. e. cedrosensis* is sufficiently distinct from *H. e. euryalus* to be considered a valid subspecies endemic to Isla de Cedros. The lack of variation in *H. e. cedrosensis* follows Mayr's (1976) founder principle wherein it is postulated that original colonists to the island would have contained less genetic variability than mainland populations. Evolution would occur more rapidly in the island population because of its genetic isolation (see Peigler 1989:115). *Hyalophora euryalus cedrosensis* was isolated on Isla de Cedros along with other remnants of the Californian Biotic Province; this pattern is illustrated by the butterfly fauna (Brown & Faulkner 1989). Based on Moore (1969) and Minch et al. (1976), the formation of the modern basins along the continental borderland west of the peninsula of Baja California dates from mid-Pliocene times and was followed by a marine regression from the close of the Pliocene, the Pleistocene, and Holocene times. Thus *H. e. cedrosensis* may have been isolated from the mainland since the early Pliocene. Owing to the considerable distance, gene flow between the mainland and insular populations is probably low.

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