# BIOLOGY AND IMMATURE STAGES OF CITHERONIA SPLENDENS SINALOENSIS AND EACLES OSLARI IN ARIZONA (SATURNIIDAE)

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**ABSTRACT.** Citheronia splendens sinaloensis and Eacles oslari occur in Cochise, Pima, and Santa Cruz counties in southern Arizona. Both species have one generation per year. The flight season of *E. oslari* extends from early June to mid-August, and the larval host plants include *Quercus* species. The flight season of *C. splendens* extends from July to mid-August, and the larval host plants include wild cotton, manzanita, and New Mexico evergreen sumac. The immature stages are described for the first time.

The citheroniine fauna of Arizona is unique in that all seven species are primarily of Mexican origin (Tuskes 1985). The biology of the two largest species, *Citheronia splendens sinaloensis* (Hoffmann) and *Eacles oslari* Rothschild, is poorly known. Ferguson (1971) illustrated the adults, summarized existing information, and indicated that their immature stages were undescribed. The purpose of this paper is to describe the immature stages of both species and to present additional biological and distributional information.

## Citheronia splendens sinaloensis (Figs. 1-4)

Citheronia splendens sinaloensis is the only member of the genus presently known to occur in Arizona. Citheronia mexicana G. & R. occurs just south of Arizona, in Sonora, Mexico. Although reported from Arizona before the turn of the century, there are no recent United States records. Citheronia regalis (F.) and C. sepulcralis (Druce) are common in the eastern or central United States but do not occur farther west than central Texas.

Until recently *splendens* was only known from a few locations in Arizona, and specimens were scarce (Ferguson 1971). Observations and collecting in southern Arizona during the past 15 years have improved our knowledge of this species. Recently, *splendens* was taken from the Baboquivari Mts. (Pima Co.) east through Santa Cruz and southern Cochise counties to Guadalupe Canyon in the Peloncillo Mts. along the Arizona-New Mexico border, a distance of approximately 250 km.

Adults were taken at lights from the first or second week of July to the second week of August, with peak emergence occurring in late July. Males appear at lights usually after 2300 h, and are collected sporadically until predawn. Females are seldom attracted to lights. Mating occurs between 0100 and 0330 h. Males exhibit little variation in forewing pattern, except in the extent of the cream colored markings through the antemedial area. The hindwings show more variation than the forewings. Some specimens exhibit diffused white patches through the dark gray submarginal area. The basal area of the hindwings can be cream or dark gray. Male forewing length varies from 48 to 56 mm, averaging 53 mm (N = 21). Females are larger than males, with forewing length ranging from 59 to 70 mm, averaging 64 mm (N = 12). Although forewing markings are similar to those of males, the wings of females are broader and less pointed, and the cream colored markings on the hindwings are reduced to small patches.

Adults and larvae are usually associated with high desert arroyos containing wild cotton (*Gossypium thurberi* L.) (Malvaceae), and transitional areas where manzanita (*Arctostaphylos pungens* H.B.K.) (Ericaceae), and New Mexico evergreen sumac (*Rhus choriophylla* Woot. & Standl.) (Anacardiaceae) grow. Arizona black walnut (*Juglans major* Torr.) (Juglandaceae) is associated with canyon washes above 670 m, and is a possible but unconfirmed natural host. Wild cotton and manzanita are the two most commonly utilized host plants. Some populations are highly host specific and utilize only one species even though others are present. Ova are deposited on the underside of the leaves, either singly or in groups up to four.

On cotton, the larva rests on the upper surface of the leaf curled in a J shape, and appears similar to a bird dropping (Fig. 2). During the early instars, most feeding occurs in the evening. As the larva matures, it rests on the petiole of the leaf or stem, and feeds sporadically through the day. Once larvae become established on the host plant, they are often reluctant to feed on other host plant species. Larvae transferred from cotton to manzanita, or from California pepper (*Shinus molle* L.) to cotton, often refuse to feed or fail to achieve the size of wild specimens. There are five instars, and development is rapid, with pupation occurring in September. Before pupation the larva leaves the plant and burrows into the ground where it constructs a pupation chamber of soil.

### Larval Description

The following larval description is based on material reared from ova deposited by a female collected at Pena Blanca Lake, Santa Cruz Co., Arizona. Larvae collected from Box Canyon (Pima Co.) were also examined. Twenty-two larvae were examined; preserved larvae are in the author's collection.

First instar. Head: Black, diameter 1.5 mm. Body: Ground color black with orange band (Fig. 3). Length 15 mm, width 2.2 mm. Dorsal and dorsolateral thoracic (T) scoli



FIGS. 1-6. 1-4. Immature stages of *Citheronia splendens sinaloensis*. 1, Mature fifth instar; 2, First instar in bird dropping pose; 3, First instar; 4, Third instar. 5,6. Immature stages of *Eacles oslari*. 5, Mature fifth instar; 6, First instar.

black with bulb at tip, and  $3-4 \times$  larger than dorsal abdominal scoli. Mid-dorsal caudal scolus on abdominal (A) segment 8 enlarged compared to dorsal abdominal scoli. All scoli black with short black spines on shafts. Segments A2, 6–8 with orange area on lateral surface surrounding each dorsolateral scolus. Segments A3–5 with orange extending from lateral surface dorsally over back; mid-dorsal black dot and smaller intersegmental black dot anterior to dorsal and dorsolateral scoli. True legs and prolegs black.

Second instar. Head: Black, diameter 2.1 mm. Body: Ground color black and orange. Length 24–26 mm, width 5 mm. Dorsal T2, 3 scoli  $5 \times$  or greater in length than dorsal abdominal scoli. Mid-dorsal scolus (A8)  $3 \times$  or greater in length than dorsal abdominal scoli. All scoli black with black spines on shaft. Segments A1–8: Lateral surface from just below lateral scoli to base of dorsal scoli orange. Orange coloration extending over mid-

dorsal area on A3-5, as in first instar, but more variable. Caudal segment, true legs, prolegs, and spiracles black.

Third instar. Head: Shiny black, diameter 2.5 mm. Clypeus black. Body: Ground color black or dark brown and orange (Fig. 4). Length 28-31 mm, width 6.7 mm. Dorsal thoracic and mid-dorsal scolus  $2 \times$  or greater in length than abdominal scoli. All scoli black with short black spines on shaft. Thoracic segments primarily black. Abdominal segments: Area from base on lateral to dorsolateral scoli orangish brown. A series of black lines occurs on the lateral surface. Segments A1-8 with black line extending from just ventral of spiracle dorsally at 45-degree angle, terminating in intersegmental area. Segments A3-5: Orangish brown coloration extends dorsally over back. Circular black patch occurs between dorsal and dorsolateral scoli. Segments A1, 2, and 6-9 with black to dark brownish orange dorsal area. Segments A1-8 with 1-2 black lines extending from middorsal area ventrally, terminating posteriorly to spiracle. Intersegmental area dark brown, with black triangular patch in line with dorsal scoli. Ventral surface orangish brown, with numerous parallel black lines in intersegmental folds. True legs and prolegs black and orange. Spiracles black.

Fourth instar. Head: Black except for light brown frontal, frons, and adfrontal areas, diameter 4.6 mm. Clypeus cream. Body: Ground color dark purple to purplish pink. Length 59–66 mm, width 9.5–11 mm. Scoli of T2, 3 recurved, dorsal and dorsolateral 10.5 and 5.5 mm long, respectively. Dorsal scoli T1 straight, 7.5 mm long, shaft white with black tip; short black spines on shaft. Mid-dorsal A8 scolus elongated, 10.5 mm long, with short black spines on shaft. Base of all abdominal scoli orangish brown. Abdominal segments: Dorsal, dorsolateral, and lateral surfaces dark purple to purplish pink. Posterior and anterior portion of abdominal segments with 1–2 thin black vertical line and 2 black dots occur between dorsal and dorsolateral scoli. Thoracic segments primarily black dorsally, lateral surface black to dark purple. Ventral surface purplish brown: Proleg lateral surfaces black to dark purple, anterior and posterior surfaces light brown. Spiracles black.

Fifth instar. Head: Shiny black, frontal suture brown, frons light brown, diameter 9.2 mm. Clypeus light brown. Body: Ground color pale purplish brown. Length 110–117 mm, width 15–17 mm. Dorsal and dorsolateral thoracic scoli T2, 3, and mid-dorsal scolus A8,  $2 \times$  or greater in length than dorsal abdominal scoli. All dorsal, dorsolateral and lateral scoli light orange to light brown with black tips and small black spines on shaft. Sublateral scoli on T2, 3, and A7–9 light brown. Abdominal segments pale purplish brown. Intersegmental area light brown with thin black vertical lines. Cream colored undulating subspiracular fold extending from T3 to A8. Numerous thin black lines or dots on dorsal and lateral surfaces. One small black dot occurs anterior to dorsolateral scoli, and two between dorsal and dorsolateral scoli. T3–A8 with V-shaped mid-dorsal marking on each segment. Anterior to spiracle, black dots form continuous line to middorsal area. Thin black line paralleling intersegmental fold. Ventral surface brownish black; intersegmental area with 1–2 thin parallel black lines. True legs light brown. Proleg lateral surface dark purple, anterior and posterior surfaces light brown. Spiracles black.

Mature larvae of U.S. *Citheronia* are readily distinguished from each other. Larvae of *splendens* (Fig. 1) have a purplish brown ground color. Dorsal and dorsolateral thoracic scoli are light brown at the base with black tips. There is a trace of a cream colored abdominal subspiracular line, and the ventral surface is brownish black. *Citheronia mexicana* occurs in Sonora, Mexico and has been reported from Arizona. Mature larvae of *mexicana* have a dark brown to black ground color and a prominent light yellow subspiracular line that extends the length of the abdomen. The dorsal and dorsolateral thoracic scoli are light pink with black tips. Larvae of *regalis* have a brownish green ground color and bright red and black dorsal thoracic scoli. Bold white spiracular patches form a line on the lateral abdominal surface, but no subspiracular line is present. The ventral surface is greenish. Larvae of *sepulcralis* have a brown ground color and light brown dorsal and dorsolateral thoracic scoli. No spiracular or subspiracular white or cream colored lines or patches are present on the lateral surface, and the ventral surface is brown. Neither *regalis* or *sepulcralis* occur west of central Texas and are thus allopatric relative to *splendens*.

> Eacles oslari (Figs. 5, 6)

*Eacles* from southern Arizona was assumed to represent a disjunct population of *Eacles imperialis* (Drury) until Ferguson (1971) elevated it to species status, based on differences in distribution, adult morphology, coloration, and pattern. At that time, *E. oslari* was rare in collections, and only 16 specimens were available for examination, all of which were from the Nogales–Pena Blanca Lake area of Santa Cruz Co., Arizona. Since then, *oslari* has been found in lower Madera Canyon and Box Canyon in southern Pima Co., and in Patagonia, and most of the major canyons in the Huachuca Mts. of western Cochise Co. It is also widespread in Sonora and Sinaloa, Mexico. Although previously unreported from Mexico, *oslari* appears to be primarily a Mexican species whose northern limits extend into southern Arizona.

The flight season of *oslari* in Arizona extends from the first week of July to mid-August, but the peak flight period is from 20 July to 5 August. Both sexes are attracted to lights, but males are more frequently captured than females. Forewing length of males ranges from 51 to 58 mm, averaging 56 mm (N = 27); females are larger, forewing lengths ranging from 64 to 68 mm, averaging 66 mm (N = 38). There are three distinct adult color phenotypes resulting from differences in ground color: (1) deep yellow, (2) orangish brown, or (3) pale lavender to lavender-tinged. Some specimens appear transitional; yellow is the most common phenotype.

In captivity, females deposit ova singly or in clusters of up to six. Confirmed larval food plants are *Quercus oblongifolia* Torr. Mexican blue oak, and *Q. emoryi* Torr., Emory oak, but other species of oak are probably utilized. Early instars are brown; after the third instar, larvae may be either brown or green. Before pupation, the larva leaves the tree and constructs a pupation chamber underground. In captivity, larvae have been successfully reared on various species of oak, California pepper tree, *Schinus molle* L. (Anacardiaceae), and *Liquidambar styraciflua* L. (Falatingiaceae). There is one generation per year. Pine, a common host for *E. imperialis nobilis* Neumoegen, *E. imperialis pini* Michener, and some southern populations of nominate *imperialis*, appears unsuitable as a host for *oslari*. An attempt was made by Gage (1976) to rear 40 *oslari* from ova on various conifers, but only one larva reached the last instar. Although the larva was illustrated in color, the immature stages were not described.

Hybridization studies conducted by the author support the species rank assigned to *oslari* based on morphological criteria (Ferguson 1971). A newly emerged *imperialis nobilis* female, reared from ova collected in Waller Co., Texas, was tied out in Box Canyon, Pima Co., Arizona. The female attracted and mated with a male *oslari* at 0130 h, and the pair remained together until the following evening. Only 21 ova were deposited by the female. Seventeen were infertile, four developed embryos, but only one hatched, and it perished in the first instar.

#### Larval Description

The larval description is based on material reared from ova deposited by a female collected at Pena Blanca Lake, Santa Cruz Co., Arizona. Larvae reared by the author from females captured at Patagonia, Cochise Co. (N = 14) and Lower Madera Canyon, Pima Co. (N = 22) were also examined and are in the author's collection.

First instar. Head: Yellow with short light brown setae present, diameter 1.8 mm. Body: Ground color brown (Fig. 6). Length 11–13 mm, width 2.7 mm. Dorsal abdominal scoli black with small spines on shaft and one on apex. Dorsolateral and lateral scoli black with 1–2 black spines on shaft. Sublateral scoli on T1–2 and A6–7 consisting of short, simple black spines. Thoracic segments with enlarged dorsal and dorsolateral scoli which have forked tips. Mid-dorsal caudal scolus on A8 black with forked tip, at least  $3 \times$  larger than dorsal abdominal scoli. Abdominal segments with 2 dark brown lines extending from lateral surface dorsally over back. Small crescent shaped line occurs anterior and ventral of spiracle. Ventral surface brown. True legs dark brown to black. Prolegs brown with black shields.

Second instar. Head: Diameter 2.7-3.0 mm. Black, frontal area near mandibles orange. Short black secondary setae present. Diameter 2.7-3.0 mm. Body: Ground color dark brown. Length 20 mm, width 4.5 mm. Dorsal, dorsolateral, and lateral abdominal scoli cream to brown with 1-4 black spines. Enlarged mid-dorsal caudal scolus with light brown shaft and numerous short black spines. Dorsal and dorsolateral thoracic scoli orangish brown to light brown with numerous short black spines on shaft; 2 black spines at tip of each scoli. Lateral abdominal surface dark brown with numerous light brown secondary setae. Thoracic segments dark brown. Ventral surface brown. True legs orangish brown. Prolegs brown with black shields. Spiracles black.

Third instar. Head: Brown, area adjacent to adfrontal region light brown. Short brown secondary setae present. Diameter 3.7–3.9 mm. Body: Ground color brown or green. Length 25–28 mm, width 6.2 mm. Enlarged dorsal and dorsolateral thoracic scoli red with short red spines. All abdominal scoli cream; short cream spines with black tips on shafts. Enlarged caudal scolus red with red spines on shaft. Anal shield light brown with bluish black center; numerous small raised circular blue or white spots present. Green form: Spiracles turquoise and ringed with black. Proleg green; shields brown. True legs light brown. Brown form: Spiracles black shields. True legs light brown. Both color forms with

elongate setae present on dorsal and dorsolateral areas, short secondary setae on lateral surface and prolegs.

Fourth instar. Head: Dark brown or green, depending on body ground color. Light brown line extending from antennae, tapering dorsally to vertex of each lobe. Diameter 5.5 mm. Body: Ground color brown or green. Length 41–51 mm, width 10 mm. Brown form: Enlarged dorsal and dorsolateral thoracic scoli brownish purple, with short yellow spines on shaft. Dorsal abdominal scoli yellow with short black spines. Dorsal, dorsolateral, lateral, and sublateral scoli light yellow and greatly reduced in size. Mid-dorsal caudal scolus brownish purple and enlarged. True legs light brown. Prolegs brown. Green form: Ground color green. Other coloration as above with following exceptions. Enlarged dorsal and dorsolateral thoracic scoli yellowish. True legs yellowish. Prolegs green. Both forms with elongated setae on dorsal and dorsolateral area, short secondary setae on lateral surface and prolegs.

Fifth instar. Head: Brown or green depending on body ground color. Light brown line extending from antennae, tapering dorsally to vertex of each lobe. Diameter 7.8 mm. Body: Ground color brown or green (Fig. 5). Length 90-110 mm, width 18 mm. Brown form: Dorsal and dorsolateral meso- and metathoracic scoli enlarged, 2.5 mm long, pinkish beige with small yellow tubercles on shaft. Dorsal, dorsolateral, lateral, and sublateral abdominal scoli reduced, 1 mm long, ivory in color with 2-4 short spines. Enlarged mid-dorsal caudal scolus pinkish beige with small yellow tubercles on shaft. Ventral and lateral surface brown, dorsolateral and dorsal areas light brown to brownish pink. Green form: As above but ground color green. Both color forms with elongate setae 9-11 mm long on dorsal surface. Lateral and ventral surfaces with light brown to short white secondary setae. Prothoracic shield yellowish green, ringed with light brown tubercles. Anal shield dark blue to black with small, raised light blue or white circular spots; shield ringed with light orange; caudal proleg shield similar. True legs yellowish brown. Spiracles turquoise.

Larvae of *oslari* are similar in appearance and size to those of *imperialis* from the eastern U.S. Larval variation among *imperialis* populations (Michigan, Virginia, Florida, Mississippi, and Texas) is so extensive that characters which appear to make *oslari* larvae unique are also found in *imperialis*. The larvae of *oslari* tend to have less contrasting differences in ground color on the dorsal and lateral surfaces, and the spiracles are consistently turquoise. Most populations of *imperialis* have cream colored spiracles—others black or turquoise—and contrasting light brown patches on the lateral surfaces.

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