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Cover Illustration: Nearctic *Phaneta* Stephens (Tortricidae), clockwise from upper left: *P. corculana* (Zeller), *P. mormonensis* (Heinrich), *P. arenana* Wright, *P. misturana* (Heinrich), *P. goblinana* Wright, *P. labiata* Wright, *P. indagatricana* (Heinrich), *P. browni* Wright. Images by Donald Wright. See article on page 117.

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NINE NEW SPECIES OF *PHANETA* STEPHENS (TORTRICIDAE) FROM WESTERN NORTH AMERICA, WITH REVIEWS OF TEN RELATED SPECIES

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ABSTRACT. Nine previously unrecognized species of *Phaneta* Stephens (Tortricidae) are described from western North America: *P. browni*, *P. arenana*, *P. labiata*, *P. goblinana*, *P. cibolana*, *P. parvula*, *P. clementeana*, *P. baloghi*, and *P. vogelana*. Reviewed are: *Phaneta corculana* (Zeller) and *Phaneta mormonensis* (Heinrich), which have male genitalia similar to those of *P. browni* and *P. arenana*; *Phaneta indagatricana* (Heinrich) and *Phaneta misturana* (Heinrich), due to similarity in forewing pattern with *P. labiata* and *P. goblinana*; *Phaneta stramineana* (Walsingham), *Phaneta parvana* (Walsingham), and *Phaneta grindeliana* (Busck), close relatives of *P. clementeana*; *P. minimana* (Walsingham), a species misidentified in North American collections for more than eighty years; and *Phaneta latens* (Heinrich), which is similar in male genitalia to *P. labiata*. *Phaneta verecundana* Blanchard is recognized as a synonym of *P. indagatricana*. Adults and genitalia are illustrated for each species.

Additional key words: Olethreutinae, Eucosmini, *verecundana*, *minimana*, *parvana*, *grindeliana*, *stramineana*

Over the past several decades, specimens representing numerous unnamed species of *Phaneta* Stephens, *Eucosma* Hübner, and *Pelochrista* Lederer have been accumulating in North American institutional and private collections. For the most part these insects are from western United States and have received little or no attention, probably due to similarities with currently recognized taxa and uncertainty in the application of available names. This paper proposes names for nine such species and reviews the current taxa with which they are most likely to be confused. Following prevailing practice, the new species are placed in *Phaneta* based on the absence of a costal fold on the dorsal surface of the male forewing.

Two of the new species, *Phaneta browni* and *Phaneta arenana*, appear to be closely related to *Phaneta corculana* (Zeller) and *Phaneta mormonensis* (Heinrich), based on male genitalia.

Phaneta goblinana, new species, is superficially similar to *Phaneta indagatricana* (Heinrich). Review of *P. indagatricana* led to consideration of *Phaneta misturana* (Heinrich) and *Phaneta verecundana* Blanchard and, in turn, to the discovery that the type series for the latter taxon includes two distinct species. The holotype of *P. verecundana* is treated here as a whitish phenotype of *P. indagatricana*; six of the paratypes are recognized as *Phaneta labiata*, new species. Also reviewed are *Phaneta latens* (Heinrich), which has male genitalia that can be confused with those of *P. labiata*, and *Phaneta minimana* (Walsingham), because the genitalia illustrated under that name by Heinrich (1923) are not those of *P. minimana* but do resemble those of *P. labiata*.

Phaneta clementeana and *Phaneta baloghi*, new species, are superficially similar to *Phaneta stramineana* (Walsingham), a taxon that has been misidentified in North American collections since Heinrich (1923) confused it with *Phaneta grindeliana* (Busck). Reviews are included of *P. stramineana*, *P. grindeliana*, and *Phaneta parvana* (Walsingham), the last species being very closely related to *P. stramineana*.

Finally, descriptions are provided for *Phaneta cibolana*, *Phaneta parvula*, and *Phaneta vogelana*, new species with similarities to one or more of the aforementioned taxa.

MATERIALS AND METHODS

I examined 788 specimens and 224 associated genitalia preparations from the following institutional and private collections: Canadian National Collection, Ottawa (CNC); George J. Balogh, Portage, Michigan (GJB); Colorado State University, Fort Collins, Colorado (CSU); Essig Museum of Entomology, UC Berkeley (EME); Todd M. Gilligan, Loveland, Colorado (TMG); Mississippi Entomological Museum, Mississippi State, Mississippi (MEM); John S. Nordin, Laramie, Wyoming (JSN); The Natural History Museum, London (BMNH); United States Museum of Natural History, Washington D.C. (USNM); and Donald J. Wright (DJW).

Forewing length (FWL) is defined as the distance from base to apex including fringe, aspect ratio (AR) as FWL divided by medial forewing width. Saccular angle (SA) refers to the angle-like projection on the ventral margin of the valva formed where the ventral margin of the sacculus meets that of the adjacent part of the neck. Its size was estimated by drawing lines approximating the two margins on a projected image of the valva and measuring the resulting angle with a protractor. The number of cornuti in the male vesica was determined by counting sockets. That count is subject to considerable intraspecific variation in the species treated here. The symbol "≈" stands for "approximately equal to," and the letter n signifies the number of observations supporting a particular statement. Images of adults were edited in Adobe Photoshop CS and sized to fit a standard cell in the plates, so the illustrations do not show the relative sizes of the taxa. The latter information is contained in the forewing data in the species accounts. Morphological nomenclature follows Gilligan *et al*. (2008).

With the exception of *P. corculana* (Zeller), I examined the holotype/lectotype of each species treated below as well as any paratypes residing in the USNM. Reports of paratypes in other institutions are based on literature records. In particular, references to specimens at the American Museum of Natural History (AMNH) are based on Heinrich (1923) and Klots (1942); I did not examine those specimens. For stability of nomenclature, I am designating lectotypes for *P. grindeliana* (Busck), *P. minimana* (Walsingham), *P. parvana* (Walsingham), and *P. stramineana* (Walsingham), the selections for the Walsingham species being those previously made by Obraztsov but never published.

Species Accounts

Phaneta corculana (Zeller)

(Figs. 1–4, 49, 67–69, 101)

Semasia corculana Zeller 1874:433; Walsingham 1884:141.
Thiodia corculana: Fernald [1903]:461; Heinrich 1923:41; McDunnough 1939:44.
Eucosma corculana: Barnes and McDunnough 1917:171.
Phaneta corculana: Powell 1983:33; Brown 2005:493.

Discussion. Zeller (1874) described *Semasia corculana* from a single female captured on Vancouver Island, British Columbia. There are several references in the literature to possible confusion regarding this species and the European *Eucosma aspidiscana* (Hübner): Walsingham (1879:77), Walsingham (1884:141), Kearfott (1907:38), and Heinrich (1923:41). Walsingham (1879:77) reported collecting *E. aspidiscana* in April, 1872 at Fort Dalles, Oregon, and subsequent authors seem to have viewed this record as a misidentification of *P. corculana*. I examined one *Phaneta* specimen with this data from the BMNH. It is a female, and dissection revealed that it is neither *P. corculana* nor *E. aspidiscana*, but I am unable to assign it to any of the available names. The genitalia of *P. corculana* are distinct from *E. aspidiscana* (Figs. 49, 67; Razowski 2003, species 272). To my knowledge there are no valid records of *E. aspidiscana* from North America.

To confirm the identity of *P. corculana*, I relied on photographs made by Obraztsov of the holotype and its genitalia. The holotype resembles the specimen in Fig. 1. The male-female association presented here is based on a pair of specimens I collected on 12 July 1993 near Mishawaka in Larimer Co., Colorado, the female agreeing with the holotype, the male with the female in forewing color and maculation. Specimens of like genitalia exhibited the variation in forewing appearance illustrated in Figs. 1–4.

Type. Holotype: ♀, [British Columbia], Vancouver, Mathis, 74, genitalia slide 11547, BMNH.

Descriptive notes. In typical *P. corculana* (Figs. 1–3) the forewing is yellowish-brown basally, shading to reddish-brown or brown distally, with darker but weakly defined subbasal and median fasciae. Frequently there is a patch of whitish scales at mid-dorsum (Figs. 1, 3), but occasionally the region posterior to CuA2 is suffused with black (Fig. 2). In some instances (Fig. 4) the basal two-thirds of the forewing is blackish brown. Most specimens have at least a few red-brown to orange-brown scales in the apical portion of the wing. The costal strigulae are white and conspicuous from mid-costa to apex but muted and weakly expressed from base to mid-costa. The pale yellowish-brown central field of the ocellus is crossed by up to three thin black dashes and is bordered basally and distally by narrow transverse silvery-gray bars. Forewing statistics: ♂ FWL: 5.5–8.1 mm (mean = 7.3, n = 39), AR = 3.14; ♀ FWL: 6.8–9.0 mm (mean = 7.6, n = 19), AR = 3.11.

Male genitalia (Fig. 49) (n = 21): Valva with costal margin concave, distal margin convex, of nearly uniform curvature, but occasionally (Fig. 49a) with shallow concave inflection near anal angle, SA ≈ 110°; cucullus roughly symmetrical about horizontal center-line, tapering dorsally to rounded apex, ventrally to acute anal angle, with basoventral margin overlapping ventral margin of neck; vesica with 17–35 deciduous cornuti (n = 19). *Female genitalia* (Figs. 67–69) (n = 7): Lamella postvaginalis a shallow trough; sternum 7 with posterior margin invaginated to length of sterigma and fused with lateral margins of lamella postvaginalis and with outer rim of ringlike lamella antevaginalis; portions of sternum 7 flanking ostium sometimes mildly raised; ductus bursae with sclerotized ring posterior to juncture with ductus seminalis; corpus bursae with two signa of nearly equal size.

Distribution and biology. I examined 99 specimens

(71 ♂, 28 ♀) from Alberta, British Columbia, Saskatchewan, California, Colorado, Montana, Nevada, Oregon, Washington and Wyoming (Fig. 101) as well as a male in poor condition from Nain, Newfoundland which I take to be *P. corculana* based on similarity of genitalia. Collection sites range in elevation from near sea level at Comox, British Columbia to 14,000 ft. on Mt. Evans, Colorado. Collection dates range from April to late August, but most records are from July and August. There appears to be some geographical influence on the distribution of color forms: most specimens from Colorado and Wyoming are red brown (Figs. 1, 2); those from California, Nevada, Oregon and Washington are dark brown (Fig. 3); and the Canadian material comes in both forms. The darkest phenotype (Fig. 4) was collected on Mt. Evans at elevations above 11,700 feet.

Phaneta mormonensis (Heinrich)

(Figs. 5–8, 51, 72, 73, 101)

Thiodia mormonensis Heinrich 1923:44; McDunnough 1939:44.

Phaneta mormonensis: Powell 1983:33; Brown 2005:494.

Types. Holotype: ♂, Utah, Salt Lake City, C. N. Ainslie, genitalia slide 72772, USNM. Paratypes. COLORADO: Denver, Oslar (3 ♂, genitalia slides 69983, 69984), USNM. Klots (1942) reported two paratypes in the AMNH.

Descriptive notes. Head, thorax, and forewing (Figs. 5–8) are yellow brown to yellow gray; forewing markings are brown, similar in pattern to those of *corculana*. The yellowish central field of the ocellus is crossed by three dark dashes and bordered basally and distally by lustrous gray bars. Forewing statistics: ♂ FWL: 6.3–8.7 mm (mean = 7.4, n = 23), AR = 3.16; ♀ FWL: 7.0–8.3 mm (mean = 7.6, n = 8), AR = 3.12.

Male genitalia (Fig. 51) (n = 17): Valva with costal margin strongly concave near apex, neck tapering evenly, SA ≈ 140°; cucullus asymmetrical with respect to horizontal center-line, with anal angle broadly rounded, distal margin convex except for occasional weakly concave inflection near apex, and basoventral margin weakly sinuate and broadly overlapping neck; vesica with 15–38 deciduous cornuti (n = 15). *Female genitalia* (Figs. 72, 73) (n = 3): Lamella postvaginalis elongate, narrowing posteriorly but weakly flared at posterolateral corners, length ca. 3 × medial width; posterior margin of sternum 7 invaginated nearly to length of sterigma and fused with lateral margins of lamella postvaginalis and with inner rim of ringlike lamella antevaginalis; ductus bursae with sclerotized ring posterior to juncture with the ductus seminalis; corpus bursae with two signa of nearly equal size.

Distribution and biology. I examined 28 specimens (23 ♂, 5 ♀) from California, Idaho, Montana, New Mexico, North Dakota, and Utah (Fig. 101). Most collections are from July and August, but records in California range from May to early September. Two specimens collected diurnally in Contra Costa Co., California were flushed from *Grindelia camporum* Greene (Asteraceae) (J. A. Powell, personal communication).

***Phaneta browni*, new species**

(Figs. 9–11, 52, 74, 75, 101)

Diagnosis. This species differs from *P. corculana* and *P. mormonensis*, its closest congeners, in maculation and genitalia. The forewing is noticeably narrower (AR ≈ 3.43 vs. 3.13 and 3.15 in *P. corculana* and *P. mormonensis*, respectively). It is pale brown with dark brown surrounding the ocellus, the latter color extending basally in thin streaks through the median area (Figs. 9–11). It lacks well defined transverse markings and red-brown/orange-brown apical scaling. In genitalia, *P. browni* is most similar to *P. mormonensis* (Figs. 51, 52 & 72–75). Males differ in the shape and armature of the anal angle: triangular with two or three spiniform setae in *P. browni* vs. semicircular and lacking spiniform setae in *P. mormonensis*. Females of *P. browni* have the posterolateral corners of the lamella postvaginalis more strongly flared and the lamella antevaginalis separated from sternum 7 by a narrow strip of membrane.

Description. *Head*: Frons white; vertex beige medially, a shade darker laterally; labial palpus with first segment white, second segment white medially, brownish-gray laterally, with long brownish-gray scales concealing brownish-gray third segment; antenna with dorsal scaling concolorous with vertex, ventral scaling paler. *Thorax*: Dorsal surface pale brown, ventral surface white; legs white to pale brown with brown annular markings on tarsi. *Forewing* (Figs. 9–11): ♂ FWL 6.1–8.2 mm (mean = 7.3, n = 36), AR = 3.46; ♀ FWL 6.5–8.0 (mean = 7.2, n = 9), AR = 3.36; costal margin nearly straight, apex acute, termen straight to weakly concave; dorsal surface pale brown, lacking well defined fascial markings, with dark brown scaling along anterior and proximal margins of ocellus and with thin dark brown longitudinal streaking from base to ocellus; costal strigulae obscure from base to mid-costa, more strongly expressed from mid-costa to apex; central field of ocellus white to beige, crossed by two or three thin black dashes, and bordered basally and distally by lustrous gray transverse bars; fringe scales brown with white apices, becoming paler toward tornus. *Hindwing*: Uniformly grayish brown, fringe a shade lighter. *Male genitalia* (Fig. 52) (n = 10): Uncus a dorsally setose lobe with rounded apex; dorsolateral shoulders of tegumen well developed; socii short and fingerlike; vesica with 17–26 deciduous cornuti (n = 8); valva with costal margin concave, apex rounded, distal margin convex medially but often with shallow concave inflection near apex and/or anal angle, anal angle acute, neck evenly tapered, SA ≈ 125°; cucullus with weakly sinuate basoventral margin broadly overlapping ventral margin of neck, with moderately stout setae evenly distributed along ventral two-thirds of distal margin, and with two or three larger setae at anal angle. *Female genitalia* (Figs. 74, 75) (n = 4): Papillae anales laterally facing and sparsely setose; lamella postvaginalis elongate, length ca. 3 × width, narrowing medially but flaring posteriorly, width of posterior margin nearly equal to ostium diameter; posterior margin of sternum 7 invaginated nearly to length of sterigma, fused with lateral margins of lamella postvaginalis, but separated from ringlike lamella antevaginalis by narrow strip of membrane; ductus bursae with sclerotized ring posterior to juncture with ductus seminalis; corpus bursae with two signa of similar size.

Holotype. ♂, Colorado, Chaffee Co., 4 mi N. Buena Vista, Co. Rd. 375, 8800 ft., 38° 54' N, 106° 7.8' W, D. J. Wright, 15 August 1999, USNM.

Paratypes. ARIZONA: Coconino Co., Walnut Canyon, 6-1/3 mi EESE Flagstaff, 6500 ft., J. G. Franclemont, 16 August 1964 (1 ♀); Fort Valley, 7-1/2 mi NW Flagstaff, 7350 ft., R. W. Hodges, 19 August

1961 (1 ♂, genitalia slide USNM 69990). COLORADO: same data as holotype (7 ♂, genitalia slide DJW 537); Fremont Co., 4.6 mi. SE of Salida on W side of US 50, 7100 ft., D. J. Wright, 22 August 1997 (2 ♀, genitalia slide DJW 400); Mesa Co., 10.3 mi. E of US 50 along Land's End Rd., D. J. Wright, 2 September 2000 (1 ♂, genitalia slide DJW 1999; 1 ♀, genitalia slide DJW 2000); Denver, Oslar (1 ♂, genitalia slide USNM 69985; 1 ♀). NEW MEXICO: Sandoval Co., Valles Caldera, VC03 @ gate to Redondo Meadow, 7900 ft., 35° 52.38' N, 106° 37.30' W, J. Brown, 16 August 2007 (3 ♂, genitalia slide USNM 126416); Socorro Co., Hwy 60 mile 91–93, vic. VLA site, G. J. Balogh, 25 September 2003 (1 ♂, genitalia slide DJW 1126); Taos Co., S side US 64, 10 mi. SE Tres Piedras, 7550 ft., D. J. Wright, 11 August 1999 (1 ♂, genitalia slide DJW 1998; 1 ♀, genitalia slide DJW 852). UTAH: Uintah Co., 3 mi N of Vernal on 2500 W, 6184 ft., D. J. Wright, 4 September 2000 (2 ♂); WYOMING: Albany Co., T15N R73W Sec 1, 2217 Sky View Lane, 7480 ft., J. S. Nordin, 30 July 2001 (1 ♂, genitalia slide DJW 848), 30 July 2006 (1 ♂), 31 July 2003 (1 ♀), 12 August 2003 (1 ♂), 13 August 2001 (1 ♂, genitalia slide DJW 826), 15 August 2002 (1 ♂), 19 August 2001 (1 ♀); Albany Co., T15N R73W Sec 1, C. D. Ferris, 8 August 2002 (1 ♂), 13 August 2002 (1 ♂), 15 August 2002 (1 ♀, genitalia slide DJW 2001). Paratype depositories: BMNH, CNC, CSU, EME, JSN, MEM, USNM, DJW.

Etymology. This species is named in honor of Richard L. Brown in appreciation of the guidance and encouragement generously provided to the author over the past dozen years.

Distribution and biology. I examined 50 adults (40 ♂, 10 ♀) from Arizona, Colorado, New Mexico, Utah, and Wyoming (Fig. 101) collected between 4 June and 25 September at elevations of 6000 to 9000 feet. In my experience, *P. browni* is associated with sagebrush habitat.

***Phaneta arenana*, new species**

(Figs. 12, 50, 70, 71, 101)

Diagnosis. Though similar in male genitalia to *P. corculana*, *P. mormonensis* and *P. browni*, *P. arenana* is separated from those taxa by forewing color (Fig. 12 vs. Figs. 1–11). It is also the largest species in this group, with mean FWL exceeding that of *P. corculana* (next in size) by 1.8 mm. The male genitalia are distinguished by the weakly falcate condition of the anal angle of the cucullus. The female genitalia are nearly identical to those of *P. corculana*, but sternum 7 is more strongly sculptured near the lateral margins of the ostium.

Description. *Head*: Frons and vertex creamy white, with black dot anterior to eye; labial palpus white, second segment with dark gray patch on lateral surface and pale brownish scales concealing brownish-gray third segment; antenna concolorous with vertex, base of scape with ring of black scales. *Thorax*: Dorsal surface creamy white to pale brownish yellow, ventral surface creamy white; legs whitish, sometimes with pale brown shading; tarsi with brown annular markings; foreleg tibiae with two brown transverse marks. *Forewing* (Fig. 12): ♂ FWL 7.9–10.0 mm (mean = 9.2, n = 14), AR = 3.44; ♀ FWL 8.3–9.6 (mean = 9.1, n = 7), AR = 3.15; costal margin straight, apex acute, termen straight to weakly concave; dorsal surface brownish yellow, lacking fascial markings; costa with short, thin, closely spaced, blackish-brown dashes from base to apex; ocellus inconspicuous but well expressed, defined basally and distally by lustrous beige transverse bars, with white central field crossed by up to three blackish-brown dashes; proximal margin of ocellus often edged with white scales, the latter preceded basally by thin blackish-brown line; a thin brownish line sometimes present on CuA2 from cubitus to tornus. *Hindwing*: Uniformly grayish brown, fringe lighter. *Male genitalia* (Fig. 50) (n = 3): Uncus a dorsally setose lobe with rounded apex; dorsolateral shoulders of tegumen well developed; socii fingerlike; vesica with 12–33 deciduous cornuti (n = 3); valva with costal margin concave, apex rounded, distal margin convex except near anal angle, anal angle weakly falcate, SA ≈ 90°. *Female genitalia* (Figs. 70, 71) (n = 3): Papillae anales laterally facing and sparsely setose; lamella postvaginalis a shallow trough; posterior margin of sternum 7 invaginated to length of sterigma and fused with lateral margins of lamella postvaginalis and with outer rim of ringlike lamella antevaginalis; sternum 7 with raised ridge on either side of ostium; ductus bursae with sclerotized ring posterior to juncture with ductus seminalis; corpus bursae with two signa of nearly equal size.

Holotype (Fig. 12). ♂, Utah, Emery Co., Goblin Valley Rd., 5010 ft., J. S. Nordin, 9 May 2007, genitalia slide DJW 1961, USNM.

Paratypes. UTAH: same data as holotype (8 ♂, genitalia slide DJW 1960; 2 ♀, genitalia slide DJW 1963); Emery Co., Hwy 24 & Goblin Valley Rd., T25S R21E Sec 22, 5010 ft., J. S. Nordin, 17 May 1998 (1 ♂, genitalia slide DJW 692; 1 ♀), 17 May 2002 (2 ♀, genitalia slides DJW 930, 951). Paratype depositories: BMNH, CNC, CSU, EME, JSN, MEM, USNM, DJW.

Etymology. The specific epithet derives from the Latin noun arena, meaning sand, and refers to the desert-like habitat at the type locality.

Distribution and biology. This species is known only from the vicinity of Goblin Valley Road in Emery Co., Utah (Fig. 101). The 21 specimens examined (14 ♂, 7 ♀) were collected on 9 May and 17 May.

Phaneta indagatricana (Heinrich)

(Figs. 13–17, 53, 76–78, 102)

Thiodia indagatricana Heinrich 1923:56; McDunnough 1939:44.

Phaneta indagatricana: Powell 1983:33; Brown 2005:493.

Phaneta verecundana Blanchard 1979:210; Brown 2005:496, **new synonymy**.

Discussion. *Phaneta indagatricana* is widespread in western North America. I examined 230 specimens (171 ♂, 59 ♀) with varying forewing coloration as depicted in Figs. 13–17. The holotype resembles the specimen in Fig. 15. Thirty-one associated genitalia preparations (21 ♂, 10 ♀) provided no support for interpreting these specimens as more than one taxon. Blanchard (1979) proposed the name *P. verecundana* for what he considered to be a distinct species represented by specimens at the white end (Fig. 13) of the color range. In examining the types of *P. verecundana* (7 ♂, 4 ♀) I found that Blanchard's conclusions were based on a mixed series. The holotype and four of the male paratypes agree with the specimen in Fig. 13. One of these five had been dissected by Blanchard, and the genitalia are typical of *P. indagatricana*. The remaining six paratypes (2 ♂, 4 ♀) are distinguishable from the holotype in forewing appearance and genitalia and represent a new species described below as *Phaneta labiata*. Blanchard had dissected one of the females but neither of these two males. John F. G. Clarke examined the two dissected paratypes (1 ♂, 1 ♀) and suggested (see Blanchard 1979) the following characters as possibly diagnostic for *P. verecundana*: basal one-half of costa lacking thin dark dashes, ventral margin of valva more deeply excavated than in *P. indagatricana*, and lamella postvaginalis not sclerotized. The first comment is descriptive of *P. labiata* (Figs. 21–23) but not entirely accurate for the white phenotype of *P. indagatricana*. The dark dashes on the basal one-half of the costa are reduced in *P. indagatricana*, particularly in specimens at the light end of the color range. Nevertheless, faint indications of these marks can usually be detected, even in the whitest specimens. I tested Clarke's second comment by calculating the ratio of neck width to valval width, the latter measurement taken at the saccular angle, and obtained values varying from 0.41 to 0.48 in both white and brownish-gray specimens (n = 12). Clarke's third comment, being based on a specimen of *P. labiata*, has no bearing on the taxonomic status of *P. verecundana*. These observations are the grounds for the synonymy proposed here.

Types. *Thiodia indagatricana*. Holotype: ♂, Utah, [Utah Co.], Provo, Tom Spalding, 26 August 1908, genitalia slide 72766, USNM. Paratypes. COLORADO: [Garfield Co.], Glenwood Springs, W. Barnes, August 1892 (1 ♀), USNM; Denver, Collection Wm. Schaus (2 ♂, genitalia slide 70059; 2 ♀), USNM. SOUTH DAKOTA: [Union Co.], Elk Point, C. N. Ainslie, August 1913 (1 ♀), USNM. UTAH: [Utah Co.], Provo, Tom Spalding, 26 August 1908 (2 ♂; 2 ♀, genitalia slide 70060), USNM; [Juab Co.], Eureka, Tom Spalding, 6 August 1910 (1 ♂), USNM, 9 August 1911 (3 ♂), USNM. Klots (1942) reported 8 paratypes in the AMNH. This accounts for 23 of the 25 specimens mentioned by Heinrich (1923). *Phaneta verecundana*. Holotype: ♂, Texas, Hemphill Co., Canadian, A. & M. E. Blanchard, 15 August 1971, USNM. Paratypes: same location and collectors as holotype, 13 August 1971 (4 ♂, genitalia slide 90504), USNM.

Descriptive notes. The forewing of *P. indagatricana* (Figs. 13–17) features a white streak on the cubitus flanked by conspicuous brown bars extending from base to mid-wing. The costa is white, with brown striae from mid-wing to apex. Except for the ocellus, the rest of the wing varies from white to brownish gray. Forewing statistics: ♂ FWL 5.8–8.3 mm (mean = 7.2, n = 106), AR = 3.37; ♀ FWL 5.4–8.0 mm (mean = 7.1, n = 40), AR = 3.33.

Male genitalia (Fig. 53) (n = 21): Uncus triangular and dorsally setose; dorsolateral shoulders of tegumen well developed; socii fingerlike, with distal one-third tapering abruptly to narrowly rounded apex; vesica with 18–37 deciduous cornuti (n = 19); valva with costal margin concave, apex rounded, distal margin weakly convex, anal angle broadly rounded, ventral margin strongly emarginated, SA ≈ 90°; cucullus of nearly uniform width; medial surface of valva with patch of moderately stout setae on raised area at base of neck. *Female genitalia* (Figs. 76–78) (n = 10): Lamella postvaginalis rectangular, width nearly equal to length, with medial trough microspinulate and weakly depressed; sternum 7 with posterior margin invaginated to length of sterigma and fused with lateral margins of lamella postvaginalis; ductus bursae with sclerotized ring posterior to juncture with ductus seminalis; corpus bursae with two signa of similar size.

Distribution and biology. Figure 102 shows the geographic range based on 230 specimens examined. Adults fly from July through early October, but the vast majority of capture dates are in July and August. This species is commonly encountered in sagebrush habitat.

Phaneta misturana (Heinrich)

(Figs. 18, 19, 54, 79, 80, 102)

Thiodia misturana Heinrich 1923:54; McDunnough 1939:44.

Phaneta misturana: Powell 1983:33; Brown 2005:494.

Types. Holotype: ♂, Saskatchewan, Oxbow, Fred K. Knab, 9 June 1907, genitalia slide 72773, USNM. Paratypes: same location and collector as holotype, 5 June 1907, (1 ♀, genitalia slide DJW 2151), USNM. Klots (1942) reported one paratype in the AMNH.

Descriptive notes. The forewing (Figs. 18, 19) is brownish-gray to blackish-gray, with white highlights. It is similar in pattern to that of *P. indagatricana*, but the overall appearance is darker, the proximal one-half of the costa is brownish gray instead of white, and the distal end of the white cubital streak is well separated from the ocellus by a patch of blackish-gray scales. The posterior margin of the cubital streak is marked with a thin black line that expands at mid-wing into a dark mark that nearly interrupts the streak. Usually the two species can be separated by head color: brownish gray in *P. misturana*; white in *P. indagatricana*, with gray to pale brown suffusion in darker phenotypes. Forewing statistics: ♂ FWL 6.3–8.3 mm (mean = 7.2, n = 18), AR = 3.30; ♀ FWL 5.7–7.5 mm (mean = 6.7, n = 6), AR = 3.17.

The genitalia of *P. misturana* are virtually indistinguishable from those of *P. indagatricana*. The uncus tends to be a little less strongly developed, the socii a little more rounded distally, and the cucullus a little more abruptly tapered at the anal angle, but these differences are subtle and do not appear to be diagnostic.

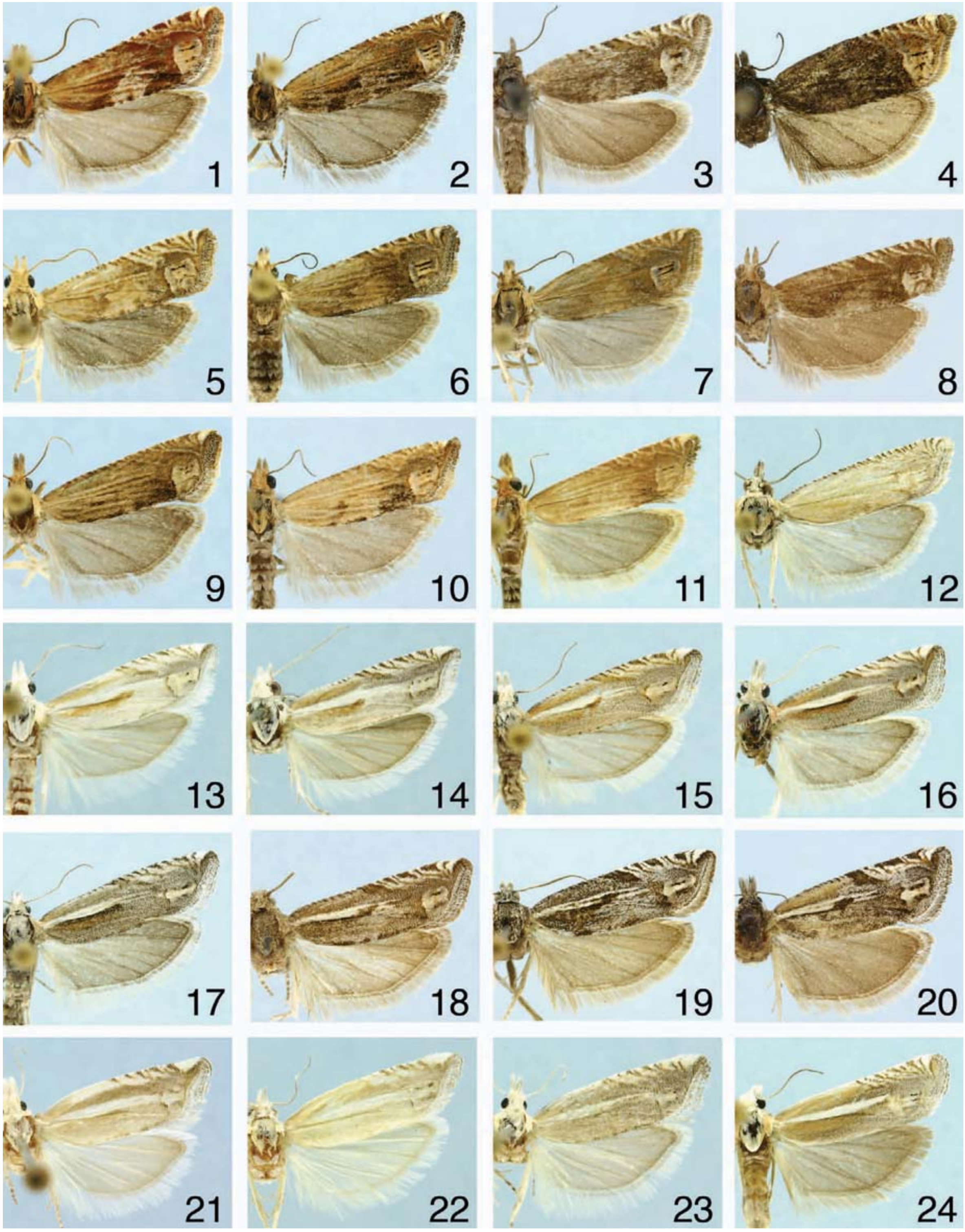
Distribution and biology. Figure 102 shows the geographic range of *P. misturana* based on 29 specimens (22 ♂, 7 ♀). Powell & Opler (2009:133) reported *Artemisia californica* Less. (Asteraceae) as a larval host in coastal California, and there is one reported rearing from southern Idaho on *Artemisia tridentata* Nutt. (Asteraceae) (Brown *et al*., 1983). The flight period of *P. misturana* (mid-March to late June) is disjunct from that of *P. indagatricana* (July through early October).

Remarks. Figure 20 is representative of four specimens collected on 21 June and 18 July at Ebbetts Pass, Alpine Co., California (8350 ft.) which are similar in genitalia, forewing pattern, and coloration to *P. misturana* and *P. indagatricana*. One female exhibited sculpturing of the sterigma that is slightly different than typical *P. indagatricana* and *P. misturana*. These specimens may represent a distinct species, but I think that decision is best deferred until more material is available.

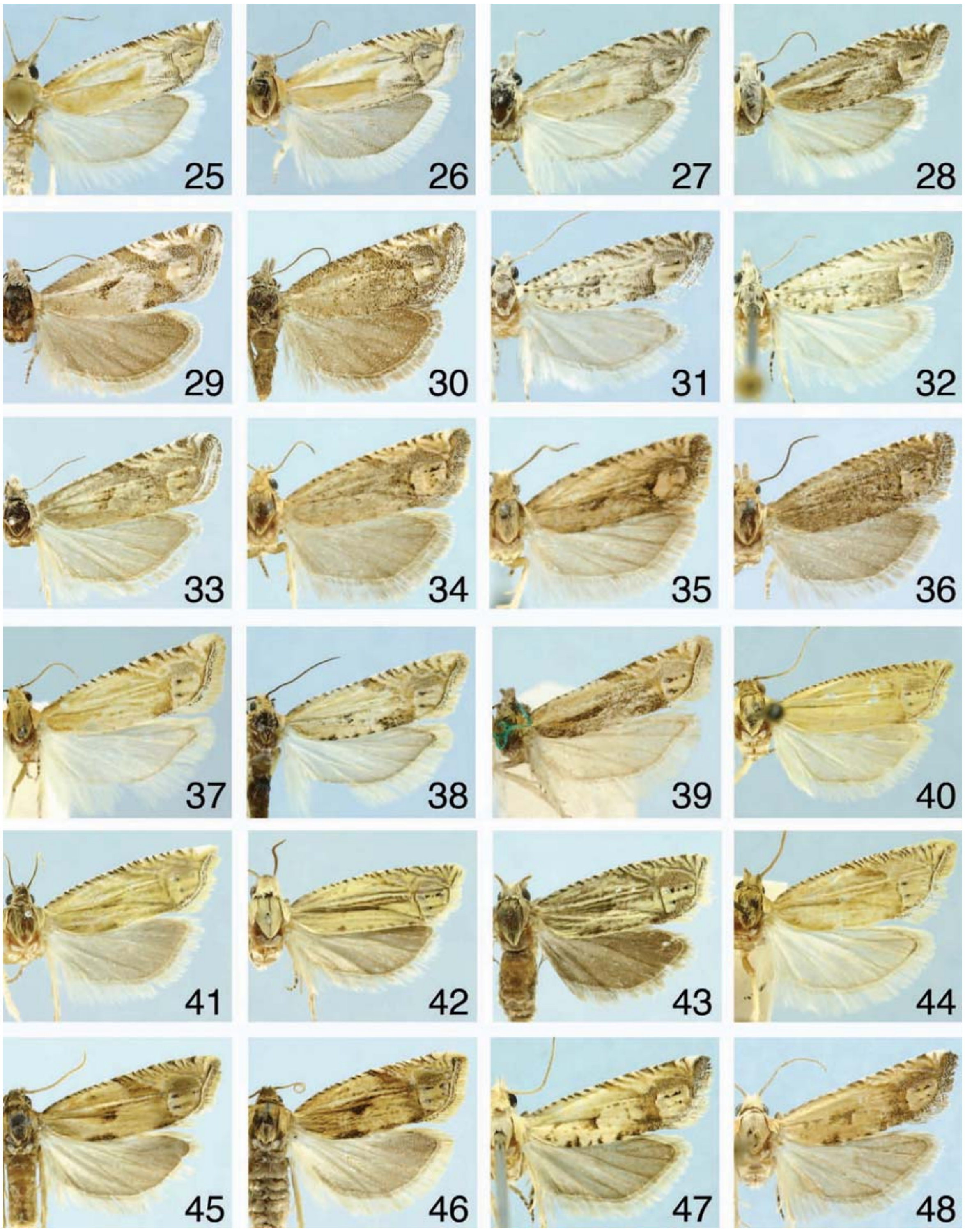
***Phaneta labiata*, new species**

(Figs. 21–23, 55, 81, 82, 102)

Diagnosis. This species is superficially similar to many Nearctic *Phaneta* but is readily diagnosed by genitalic characters: males (Fig. 55) have a prominent liplike flange on the ventral margin of the basal excavation of the valva; females (Figs. 81, 82) have a membranous lamella antevaginalis and a patch of microspinules on the inner surface of the sclerotized ring in the ductus bursae. *Phaneta labiata* resembles *Phaneta latens* (Fig. 57) in valval profile but is easily



Figs. 1–24. **1–4,** *P. corculana*. **1,** ♂ Larimer Co., Colorado. **2,** ♀ Chaffee Co., Colorado. **3,** ♀ Whitman Co., Washington. **4,** ♀ Clear Creek Co., Colorado. **5–8,** *P. mormonensis*. **5,** ♂ Sanpete Co., Utah. **6,** ♀ Grant Co., New Mexico. **7,** ♀ Lincoln Co., New Mexico. **8,** ♂ Contra Costa Co., California. **9–11,** *P. browni*. 9, ♀ Taos Co., New Mexico. **10,** ♂ Chaffee Co., Colorado. **11,** ♂ Albany Co., Wyoming. **12,** *P. arenana*, ♂ holotype, Emery Co., Utah. **13–17,** *P. indagatricana*. **13,** ♂ Baca Co., Colorado. **14,** ♂ Weld Co., Colorado. **15,** ♂ Taos Co., New Mexico. **16,** ♂ Carter Co., Montana. **17,** ♂ Sanpete Co., Utah. **18–19,** *P. misturana*. **18,** ♂ Los Angeles Co., California. **19,** ♂ Twin Falls Co., Idaho. **20,** *Phaneta* sp., ♀ Alpine Co., California. **21–23,** *P. labiata*. **21,** ♀ Hemphill Co., Texas. **22,** ♂ Albany Co., Wyoming. **23,** ♂ Oneida Co., Idaho. **24,** *P. goblinana*, Emery Co., Utah.



Figs. 25–48. **25–26,** *P. cibolana*, ♂, ♀ holotype, Cibola Co., New Mexico. **27–28,** *P. parvula*. **27,** ♂ holotype, Oneida Co., Idaho. **28,** ♂ Uintah Co., Utah. **29–30,** *P. latens*, ♂, ♂ Kern Co., California. **31–32,** *P. minimana*, ♂, ♀ Washington Co., Utah. **33,** *Phaneta* sp., ♂ San Bernardino Co., California. **34–36,** *P. vogelana*, ♀, holotype, ♀, Otero Co., Colorado. **37–38,** *P. stramineana*. **37,** ♂ Fremont Co., Wyoming. **38,** ♂, Albany Co., Wyoming. **39,** ♂, *P. parvana* lectotype. **40–44**, *P. grindeliana*. **40,** ♂ paratype, Donley Co., Texas. **41,** ♀, Morton Co., Kansas. **42,** ♂, Marion Co., Florida. **43,** ♂, Suwannee Co., Florida. **44,** ♂, San Diego Co., California. **45–46,** *P. clementeana*, ♂ holotype, ♀, Los Angeles Co., California. **47–48,** *P. baloghi*. **47,** ♂ holotype, Otero Co., New Mexico. **48,** ♂ Gove Co., Kansas.

separated from the latter species by forewing appearance (Figs. 21–23 vs. 29, 30).

Description. *Head*: Frons and vertex white; labial palpus white with long yellowish-white scales on second segment concealing third segment; antenna white with yellowish tints. *Thorax*: Dorsal and ventral surfaces white to pale yellowish white; legs yellowish white with darker tarsal annulations. *Forewing* (Figs. 21–23): ♂ FWL 5.4–8.0 mm (mean = 6.9, n = 8), AR = 3.26; ♀ FWL 5.8–7.5 mm (mean = 6.8, n = 6), AR = 3.02; costal margin weakly convex, apex acute, termen weakly concave; dorsal surface grayish brown to yellowish brown with prominent white cubital streak from base to ocellus; costa white with thin dark dashes from mid-wing to apex; ocellus with white central field crossed by one or two weakly defined brown dashes and bordered basally and distally by lustrous pearly white transverse bars; fringe scales white with brown cross-bars, the latter forming several thin lines parallel to termen. *Hindwing*: Pale grayish brown, fringe white. *Male genitalia* (Fig. 55) (n = 7): Uncus and dorsolateral shoulders of tegumen moderately developed; socii fingerlike; vesica with 21–29 deciduous cornuti (n = 7); valva with costal margin concave, apex rounded, distal margin nearly straight, anal angle acute, neck long and narrowing distally, saccular corner broadly rounded, SA ≈ 145°; cucullus with basoventral margin overlapping ventral margin of neck; basal excavation with ventral margin thickened and developed into liplike projection. *Female genitalia* (Figs. 81, 82) (n = 5): Papillae anales laterally facing and sparsely setose; lamella postvaginalis rectangular, width ca. 2 × length, microspinulate throughout, with anterolateral corners joined to sternum 7, and with two fingerlike projections forming posterior margin of ostium; lamella antevaginalis membranous; posterior margin of sternum 7 invaginated to length of sterigma; ductus bursae short, with sclerotized ring posterior to juncture with ductus seminalis; inner surface of ring microspinulate near ductus seminalis; corpus bursae with two signa of nearly equal size; anterior one-third of inner surface of corpus bursae strongly microspinulate.

Holotype. ♂, Texas, Cottle Co., Paducah, A. & M. E. Blanchard, 4 June 1970, genitalia slide DJW 2149, USNM.

Paratypes. CALIFORNIA: Inyo Co., Westguard [misspelling of Westgard] Pass, White Mts., P. Opler, J. Powell, & J. A. Scott, 19 July 1968 (1 ♂, genitalia slide DJW 2113; 1 ♀, genitalia slide DJW 2114). COLORADO: Grand Co., Beaver Creek at US 40, 7800 ft., D. J. Wright, 25 August 1997 (1 ♀, genitalia slide DJW 409); Summit Co., Co. Rd. 950, 5.3 mi S. of Frisco off St. Rt. 9, 9100 ft., D. J. Wright, 30 July 2008 (2 ♂, genitalia slides DJW 2066, 2068). IDAHO: Oneida Co., Curlew NG, 5 mi ENE of Holbrook, D. J. Wright, 15 July 2006 (1 ♂, genitalia slide DJW 2144). NEW MEXICO: Taos Co., S. side US 64, 10 mi. SE Tres Piedras, 7550 ft., D. J. Wright, 11 August 1999 (1 ♂, genitalia slide DJW 547). TEXAS: Hemphill Co., Canadian, A. & M. E. Blanchard, 28 May 1970 (1 ♂; 4 ♀, genitalia slides USNM 90503, DJW 2150, 2153). WYOMING, Albany Co., T15N R73W Sec. 1, 2217 Sky View Lane, 7480 ft., J. S. Nordin, 21 June 2002, (1 ♂, genitalia slide DJW 931). Paratype depositories: CSU, EME, USNM, DJW.

Etymology. The specific epithet comes from the Latin adjective labiatus, meaning lipped, and refers to the flangelike projection on the margin of the basal excavation of the valva.

Distribution and biology. Figure 102 shows the distribution of the 14 specimens (8 ♂, 6 ♀) in the type series. Capture dates range from 28 May to 25 August. The specimens from Inyo Co., California are smaller than the rest (mean FWL = 5.6 mm) and more yellowish in forewing appearance; those from Colorado and Idaho have grayish forewings.

Remarks. The holotype and the five paratypes from Texas were designated by Blanchard (1979) as paratypes of *P. verecundana*. Clarke's comment (Blanchard 1979) regarding the lack of sclerotization of the lamella postvaginalis in *P. verecundana* was based on a specimen of *P. labiata*. The lamella postvaginalis is not very strongly developed, but it is sclerotized.

***Phaneta goblinana*, new species**

(Figs. 24, 56, 83, 84, 102)

Diagnosis. *Phaneta goblinana* is similar in forewing appearance to some phenotypes of *indagatricana* (Figs. 24, 14, 15), but the white cubital streak is flanked by larger yellow-brown patches, the basal one-half of the costa is unmarked, and the dorsum is suffused with white. Mean FWL in *P. goblinana* exceeds that in *P. indagatricana* by 1.5 mm. Differences in male genitalia include: ventral emargination of neck broad and shallow, SA ≈ 130°, and anal angle narrowly rounded in *P. goblinana*, vs. U-shaped, 90°, and broadly rounded, respectively, in *P. indagatricana*. The lamella postvaginalis is separated from sternum 7 in *P. goblinana* but fused with sternum 7 in *P. indagatricana*.

Description. *Head*: Frons and vertex white; labial palpus white with grayish-brown shading on lateral surface of second segment; antenna white with grayish-brown streak along dorsal surface. *Thorax*: Dorsal surface white, with yellow-brown tegulae; ventral surface white; legs white with varying shades of grayish brown, tarsal segments gray brown with white annulations. *Forewing* (Fig. 24): ♂ FWL 7.6–9.9 mm (mean = 8.8, n = 20), AR = 3.53; ♀ FWL 7.4–8.7 mm (mean = 8.0, n = 9), AR = 3.34; costa straight, apex acute, termen straight to weakly convex; dorsal surface with three longitudinal white streaks: one on costa from base to apex, interrupted beyond mid-wing by brown striae; a second anterior to cubitus, extending from base to distal end of cell; and a third along dorsum from base to mid-wing; cubital streak flanked by yellowish-brown coloration, the later shading to gray from mid-wing to termen; central field of ocellus white, bordered basally and distally by lustrous, transverse, pearly white to pale gray bars, crossed longitudinally by three variably expressed black dashes; fringe scales white with blackish subapical cross-bars. *Hindwing*: Grayish brown with concolorous fringe. *Male genitalia* (Fig. 56) (n = 3): Uncus a prominent lobe with rounded apex and setose dorsal surface; dorsolateral shoulders of tegumen well developed; socii fingerlike, broad basally, with distal one-third tapering to narrowly rounded apex; vesica with 13–22 deciduous cornuti (n = 3); valva with costal margin concave, apex blunt to rounded, ventral one-half of distal margin nearly straight, anal angle weakly developed and narrowly rounded, ventral emargination broad and shallow, neck long, SA ≈ 130°. *Female genitalia* (Figs. 83, 84) (n = 2): Papillae anales laterally facing and moderately setose; lamella postvaginalis rectangular, flaring slightly posteriorly, length nearly equal to width, lateral margins not fused with sternum 7; sternum 7 with posterior margin invaginated nearly to length of sterigma and with lateral extremities triangular and broadly developed; ductus bursae with sclerotized ring posterior to juncture with ductus seminalis; corpus bursae with two signa, one noticeably larger than the other.

Holotype. ♂, Utah, Emery Co., Rt. 24 & Goblin Valley Rd., 5010 ft., J. S. Nordin, 11 May 2001, genitalia slide DJW 1939, USNM.

Paratypes. UTAH: Emery Co., Goblin Valley Rd., J. S. Nordin, 9 May 2007 (1 ♂, 1 ♀); same data as holotype (5 ♂, genitalia slides DJW 858, 1938); Emery Co., T24S R13E Sec 2, HWY 24, mi. 146.8, 4880 ft., J. S. Nordin, 19 May 2003 (10 ♂, 2 ♀), 21 May 2003 (4 ♂; 4 ♀, genitalia slides DJW 1940, 1941); Emery Co., T24S R13E Sec 4, HWY 24, mi. 154.8, 4880 ft., J. S. Nordin, 21 May 2003 (1 ♂). Paratype depositories: CNC, CSU, EME, JSN, USNM, DJW.

Etymology. This species is named after the type locality.

Distribution and biology. The type series consists of 29 specimens (20 ♂, 9 ♀) collected between 9 May and 21 May in sandy habitat at or near the type locality. Capture sites range in elevation from 4250 to 5010 feet.

Phaneta latens Heinrich

(Figs. 29, 30, 57, 89, 90, 103)

Thiodia latens Heinrich 1929:2; McDunnough 1939:44.
Phaneta latens: Powell 1983:33; Brown 2005:494.

Types. *Holotype*: ♂, California, Tulare County, Monachee Meadows, 8,000 ft., 8–14 July, genitalia slide 72769, USNM. Paratypes: same locality as holotype, 1–7 July (2 ♂), USNM, 8–14 July (2 ♂), USNM. [Heinrich (1929) mentioned 7 ♂ paratypes dated 8–14 July, but pin labels on two USNM specimens read 1–7 July.] Klots (1942) reported 2 paratypes in the AMNH.

Descriptive notes. *Phaneta latens* is a brownish-gray moth with two somewhat different looking phenotypes (Figs. 29, 30). The holotype resembles the specimen in Fig. 30, with fascial markings obscured by extensive brownish-gray suffusion from base to median fascia. The second form (Fig. 29) has an outwardly oblique brown mark on the cubitus representing the subbasal fascia, a prominent chevron-shaped median fascia extending from mid-costa to dorsum, and a white streak through the cell from base to mid-wing. Both forms have bright white strigulae on the distal one-half of the costa. Forewing statistics: ♂ FWL 6.4–7.6 mm (mean = 7.2 n = 16), AR = 2.99; ♀ FWL 6.8–7.5 mm (mean = 7.1, n = 3), AR = 2.99.

Male genitalia (Fig. 57) (n = 5): Uncus a dorsally setose bulge, basal width ca. 4 × height, weakly differentiated from rounded dorsolateral shoulders of tegumen; socii short; vesica with 26–37 deciduous cornuti (n = 3); valva with costal margin weakly concave, apex rounded, distal margin straight to convex, neck elongate and narrowing distally, SA ≈ 140°; cucullus with length (apex to anal angle) ca. 3 × medial width and with basoventral margin overlapping ventral margin of neck. *Female genitalia* (Fig. 89, 90) (n = 2): Lamella postvaginalis rectangular, narrowing slightly posteriorly, with shallow microspinulate medial trough; posterior margin of sternum 7 invaginated to length of sterigma and fused with lateral margins of lamella postvaginalis; ductus bursae with sclerotized ring posterior to juncture with ductus seminalis; corpus bursae with two signa of equal size.

Distribution and biology. I examined the holotype, four paratypes at the USNM, one male from Lander Co., Nevada, and 18 specimens (15 ♂, 3 ♀) from two localities in the Los Padres National Forest in Kern Co., California. This material was collected between 8 June and 21 July at elevations ranging from about 7500 to 8300 feet. Specimens from Cerro Noroeste, Kern Co., California have pin labels with the notation *Artemisia* (Asteraceae).

Remarks. Figure 33 illustrates an unnamed species that appears to be very closely related to *P. latens*. I have seen three specimens of this taxon, all males, two from San Bernardino Co., and one from Inyo Co., California. The Inyo Co. specimen was incorrectly determined and illustrated by Heinrich (1923, Fig. 131) as *Phaneta minimana* (Walsingham). Its genitalia are similar to those of *latens*, but the basoventral margin of the cucullus does not overlap the ventral margin of the neck. Description of this species is deferred for lack of material.

Phaneta minimana (Walsingham)

(Figs. 31, 32, 58, 91, 92, 103)

Semasia minimana Walsingham 1879:60.
Eucosma minimana: Barnes & McDunnough 1917:172.
Thiodia minimana: Fernald [1903]:462; Heinrich 1923:61; McDunnough 1939:45.
Phaneta minimana: Powell 1983:34; Brown 2005:494.

Discussion. Lacking an opportunity to examine the syntypes, Heinrich (1923, Fig. 131) illustrated as *P. minimana* a specimen from Inyo Co., California that resembles in forewing appearance and genitalia the specimen in Fig. 33 but does not resemble in either respect the lectotype of *P. minimana* (designated below). The species illustrated by Heinrich does not appear to have a valid name (see Remarks under *P. latens*).

Types. Lectotype here designated: ♂, California, Siskiyou Co., Sheep Rock, 3 September 1871, Walsingham, genitalia slide 5740, BMNH. Paralectotype: 1 ♀, same data as lectotype, genitalia slide 5751, BMNH.

Descriptive notes. *Phaneta minimana* is a small whitish insect with black markings as follows: a dot on lateral surface of labial palpus, a mark on dorsal surface of scape, a spot at base of tegula, a dash at mid-costa of forewing, and irrorations on basal one-half of forewing. The white central field of the ocellus is crossed by two blackish-gray dashes and is edged basally and distally by lustrous gray bars. Patches of white-tipped grayish scales are located along the proximal and anterior margins of the ocellus, the latter patch often infiltrating the central field of the ocellus. Fringe scales are white with blackish cross-bars. Forewing statistics: ♂ FWL 5.0–5.4 mm (mean = 5.2 n = 4), AR = 3.29; ♀ FWL 5.4–7.2 mm (mean = 6.5, n = 4), AR = 3.05.

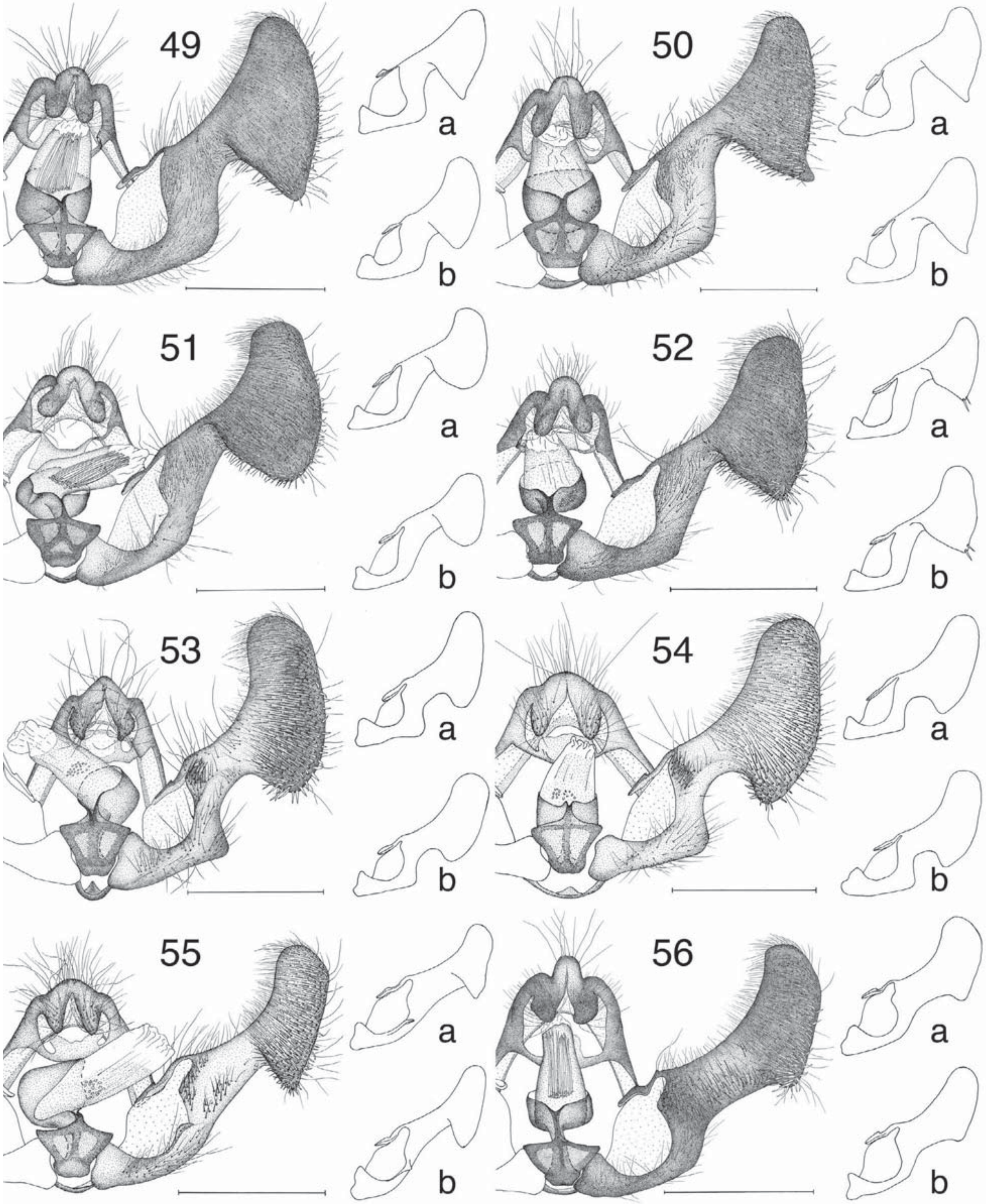
Male genitalia (Fig. 58) (n = 4): Uncus a weakly developed convex bulge; dorsolateral shoulders of tegumen well defined; socii fingerlike; vesica with 29–38 deciduous cornuti (n = 4); valva with costal margin concave, apex rounded, distal margin convex and of uniform curvature, anal angle a weakly developed, narrowly rounded lobe, ventral emargination broad and shallow, neck widening distally, saccular angle obtuse; medial surface of valva with broad band of moderately stout setae on ventral one-half of neck and with prominent line of similar setae parallel to costal margin and arising on weakly developed ridge at margin of basal excavation. *Female genitalia* (Figs. 91, 92) (n = 3): Papillae anales weakly sclerotized and laterally facing; sterigma ringlike; lamella postvaginalis weakly developed, width ca. 4 × length; lamella antevaginalis with sclerotized inner edge and membranous outer rim; sternum 7 weakly sclerotized, with posterior margin invaginated beyond length of sterigma and fused with lamella antevaginalis; ductus bursae long, with sclerotized ring near ostium; corpus bursae with two signa of nearly equal size.

Distribution and biology. The syntypes were collected in early September in northern California. I examined the lectotype, 3 ♀ from San Diego County, California dated 4 September, and 4 specimens (3 ♂, 1 ♀) from Washington County, Utah dated 25 September.

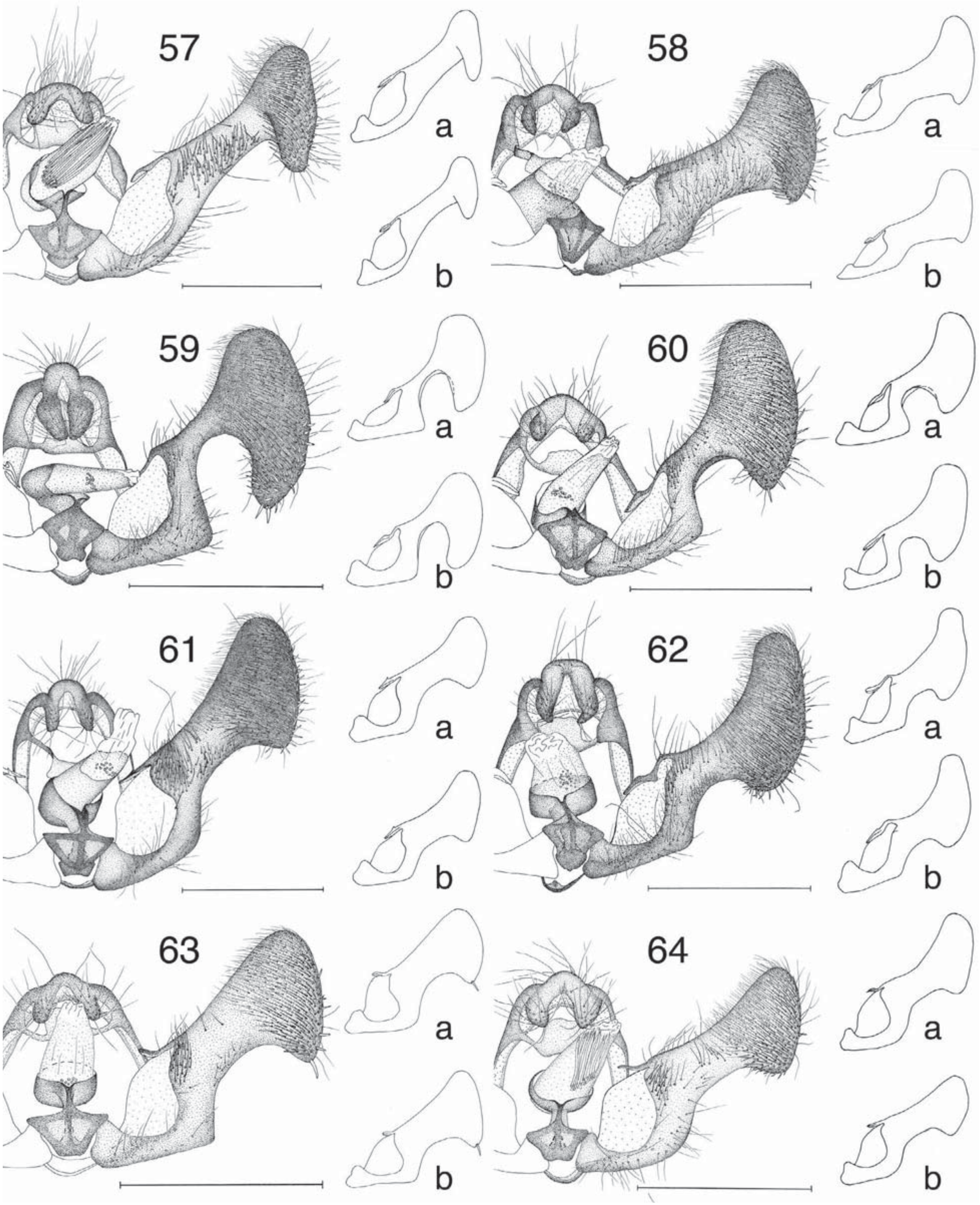
***Phaneta cibolana*, new species**

(Figs. 25, 26, 61, 85, 86, 103)

Diagnosis. In forewing appearance, *Phaneta cibolana* (Figs. 25, 26) resembles certain phenotypes of *P. indagatricana* (Fig. 14) and *P. parvula* (Fig. 27) (described below), but the three species differ in



Figs. 49–56. Male genitalia. **49,** *P. corculana*, slides DJW853, USNM69953, DJW2127. **50,** *P. arenana*, slides DJW1961, 692, 1960. **51**, *P. mormonensis*, slides DJW1977, 934, 2137. **52,** *P. browni*, slides DJW1999, 826, 1998. **53,** *P. indagatricana*, slides DJW1953, 395, 746. **54,** *P. misturana*, USNM70050, 70053, DJW2155. **55,** *P. labiata*, slides DJW2149, 2113, 931. **56,** *P. goblinana*, slides DJW858, 1938, 1939. Scale bar = 0.5 mm.



Figs. 57–64. Male genitalia. **57,** *P. latens*, slides DJW2089, 2134, 2133. **58,** *P. minimana*, slides DJW2023, 2170, 936. **59,** *P. vogelana*, slides DJW1935, 554, 376. **60,** *P. parvula*, slides DJW932, 745, TOR1046. **61,** *P. cibolana*, slides DJW1395, 2159, 1942. **62,** *P. baloghi*, slides DJW651, 702, 2141. **63,** *P. stramineana*, slides BMNH11601, DJW2016, 929. **64,** *P. clementeana*, slides DJW2091, 2178, 2177. Scale bar = 0.5 mm.

genitalia (Figs. 61, 53, 60 & 85, 76, 87) and size (mean FWL ≈ 6.7, 7.2, and 5.2 mm in *P. cibolana*, *P. indagatricana*, and *P. parvula*, respectively). The male genitalia are somewhat similar to those of *Phaneta clementeana* (described below) and *Phaneta grindeliana* (Figs. 61, 64, 66), but *P. cibolana* is separated from the latter two taxa by forewing color and maculation (Figs. 25–26 vs. 40–46).

Description. *Head*: Frons white; vertex pale grayish brown; labial palpus with first segment white, second segment white with brownish-gray mark on lateral surface and long brownish-gray scales at distal extremity, third segment brownish-gray; antenna brownish gray. *Thorax*: Dorsal surface straw yellow, ventral surface white; legs white, tinted with brown, with blackish-brown tarsal annulations. *Forewing* (Figs. 25, 26): ♂ FWL 6.0–7.9 mm (mean = 6.6, n = 8), AR = 3.25; ♀ FWL 6.1–8.0 mm (mean = 6.9, n = 4), AR = 3.17; costal margin weakly convex, apex weakly falcate, termen concave from apex to M3; dorsal surface straw yellow from base to mid-wing, with longitudinal white streak on cubitus; costa white, marked with thin black dashes, those from base to mid-costa greatly reduced; dorsum suffused with white; median fascia represented by blackish mark at mid-costa; proximal and anterior margins of ocellus bordered by patches of white scales with blackish cross-bars; central field of ocellus pale yellow, crossed by two dark dashes, and edged basally and distally by lustrous gray transverse bars; termen with thin blackish line from apex to tornus; fringe scales white with blackish cross-bars. *Hindwing*: Grayish brown, fringe white. *Male genitalia* (Fig. 61) (n = 3): Uncus semicircular and dorsally setose; dorsolateral shoulders of tegumen well developed; socii fingerlike; vesica with 21–24 deciduous cornuti (n = 3); valva with costal margin weakly concave, apex rounded, distal margin convex of nearly uniform curvature, anal angle moderately developed, ventral emargination broad; medial surface of valva with patch of stout setae at base of neck. *Female genitalia* (Figs. 85, 86) (n = 3): Papillae anales weakly sclerotized and laterally facing; lamella postvaginalis with length ca. 2 × ostium diameter, width of posterior margin ca. 0.5 × ostium diameter; sternum 7 with strongly produced and sharply pointed lateral extremities; posterior margin of sternum 7 invaginated to length of sterigma, fused with lateral margins of lamella postvaginalis, but separated from lamella antevaginalis by narrow strip of membrane; ductus bursae with sclerotized ring posterior to juncture with ductus seminalis; corpus bursae with two signa of similar size.

Holotype (Fig. 26). ♀, New Mexico, Cibola Co., Cibola NF, Lobo Canyon Picnic Area, 7300 ft., 35° 12.77' N, 107° 43.21' W, D. J. Wright, 9 August 2005, genitalia slide DJW 1943, USNM.

Paratypes. COLORADO: Zapata Ranch, 7900 ft., R. W. Hodges, 26 June 1982 (1 ♂, genitalia slide DJW 2159); Alamosa Co., Great Sand Dunes, Mosca Creek, 8200 ft., R. W. Hodges, 28 June 1982 (1 ♀, genitalia slide DJW 2160). IDAHO: Oneida Co., Curlew National Grassland, 5 mi. ENE of Holbrook, D. J. Wright, 15 July 2006 (1 ♀, genitalia slide DJW 1959); Oneida Co., Curlew National Grassland, 5 mi. SSE of Holbrook, 4800 ft., D. J. Wright, 18 July 2001 (1 ♂, genitalia slide DJW 1942). NEW MEXICO: Cibola Co., Cibola NF, 11 mi. NE of Grants, 8300 ft., D. J. Wright, 8 August 2005 (1 ♂); same data as holotype (2 ♂); Cibola Co., Cibola NF, Coal Mine Canyon Campground, 7200 ft., D. J. Wright, 9 August 2005 (3 ♂, genitalia slide DJW 1395; 1 ♀). Paratype depositories: CSU, EME, USNM, DJW.

Etymology. The specific epithet refers to the type locality in Cibola National Forest, Cibola Co., New Mexico.

Distribution and biology. The type material (8 ♂, 4 ♀) was collected in southern Idaho, south central Colorado, and northwestern New Mexico between 26 June and 9 August (Fig. 103). The Idaho localities are dominated by sagebrush; those in New Mexico are forested.

Phaneta parvula, new species

(Figs. 27, 28, 60, 87, 88, 103)

Diagnosis. Some *Phaneta parvula* specimens (Fig. 27) are superficially similar to *P. cibolana* (Fig. 26), but the latter species is larger (see *P. cibolana* diagnosis) and more yellowish. The two taxa are easily separated by genitalia: males have different valval shapes (Figs. 60, 61); females differ in the shape of sternum 7 (Figs. 85, 87) and the structure of the sterigma (Figs. 86, 88).

Description. *Head*: Frons and vertex white; labial palpus white, second segment with black spot on lateral surface and long yellowish-gray scales concealing dark gray third segment; antenna white. *Thorax*: Dorsal surface white; tegulae with pale yellow suffusion; ventral surface white; legs white with blackish-brown tarsal annulations. *Forewing* (Figs. 27, 28): ♂ FWL 4.9–5.6 mm (mean = 5.2, n = 11), AR = 3.15; ♀ FWL 5.3–5.5 mm (mean = 5.4, n = 2), AR = 3.14; costal margin weakly convex, apex acute, termen weakly concave; dorsal surface whitish gray, with pale white cubital streak and brownish-yellow to brownish-gray suffusion from base to subbasal fascia; subbasal fascia represented by dark mark on cubitus, median fascia by dark outwardly oblique bar at mid-costa; costa white with thin black dashes from base to apex; proximal and anterior margins of ocellus with adjacent patches of white-tipped grayish-brown scales; central field of ocellus white, crossed by two brownish dashes, and bordered basally and distally by lustrous grayish-white bars; termen with thin white line from tornus to apex; fringe scales white with blackish-gray cross bars. *Hindwing*: Brownish gray on margins, shading to grayish white at base. *Male genitalia* (Fig. 60) (n = 5): Uncus a rounded bulge, basal width ca. 2 × height, weakly differentiated from dorsolateral shoulders of tegumen; socii short; vesica with 10–15 deciduous cornuti (n = 5); valva with costal margin concave, apex rounded, distal margin convex of nearly uniform curvature, anal angle acute, ventral emargination U-shaped, neck narrow, SA ≈ 90°; *Female genitalia* (Figs. 87, 88) (n = 2): Papillae anales laterally facing, weakly sclerotized, and sparsely setose; lamella postvaginalis rectangular, length ca. 2 × width, medial trough shallow and microspinulate, anterior margin with two fingerlike projections forming posterior margin of ostium; posterior margin of sternum 7 invaginated to length of sterigma, fused with lateral margins of lamella postvaginalis, but well separated from ringlike lamella antevaginalis; ductus bursae long, with sclerotized ring near ostium; corpus bursae with two large signa of similar size.

Holotype (Fig. 27). ♂, Idaho, Oneida Co., Curlew National Grassland, T14S R32E Sec 30, D. J. Wright, 28 July 2003, genitalia slide DJW 1958, USNM.

Paratypes. COLORADO: Mesa Co., 10.3 mi. E. of US 50 along Land's End Road, D. J. Wright, 2 September 2000 (1 ♂, genitalia slide DJW 932). MONTANA: [Phillips Co.,], Malta, J. McDunnough, 8 August 1928 (1 ♂; 1 ♀, genitalia slide DJW 2096), 12 August 1928 (2 ♂, genitalia slide TOR-1046). UTAH: Uintah Co., 3 mi. N. of Vernal on 2500 W, 6184 ft., D. J. Wright, 4 September 2000 (2 ♂, genitalia slides DJW 745, 2025); Green River Cpgd., Dinosaur Nat. Mon., J. Powell, 12 August 1973 (1 ♂; 1 ♀, genitalia slide DJW 2095); Spanish River, 4–8 September (1 ♂, genitalia slide TOR-1047). Paratype depositories: CNC, EME, USNM, DJW.

Etymology. The specific name derives from the Latin parvulus, meaning very small.

Distribution and biology. The type series consists of 13 specimens (11 ♂, 2 ♀) from Colorado, Idaho, Montana, and Utah (Fig. 103) captured between 28 July and 4 September.

Phaneta stramineana (Walsingham)
(Figs. 37, 38, 63, 104)

Semasia stramineana Walsingham 1879:60.

Thiodia stramineana: Fernald [1903]:462; Heinrich 1923:69; McDunnough 1939:45.

Eucosma stramineana: Barnes and McDunnough 1917:172.

Phaneta stramineana: Powell 1983:34; Brown 2005:496.

Discussion. Walsingham (1879) described *stramineana* from two specimens (1 ♂, 1 ♀) collected at Denver, Colorado in July, 1872. I examined both specimens. The male, which resembles the specimen in Fig. 37, was chosen as lectotype by Obraztsov and is so designated below. The female does not seem to be conspecific with the male. The abdomen is missing, but forewing color and maculation suggest that it is *Phaneta pallidarcis* (Heinrich).

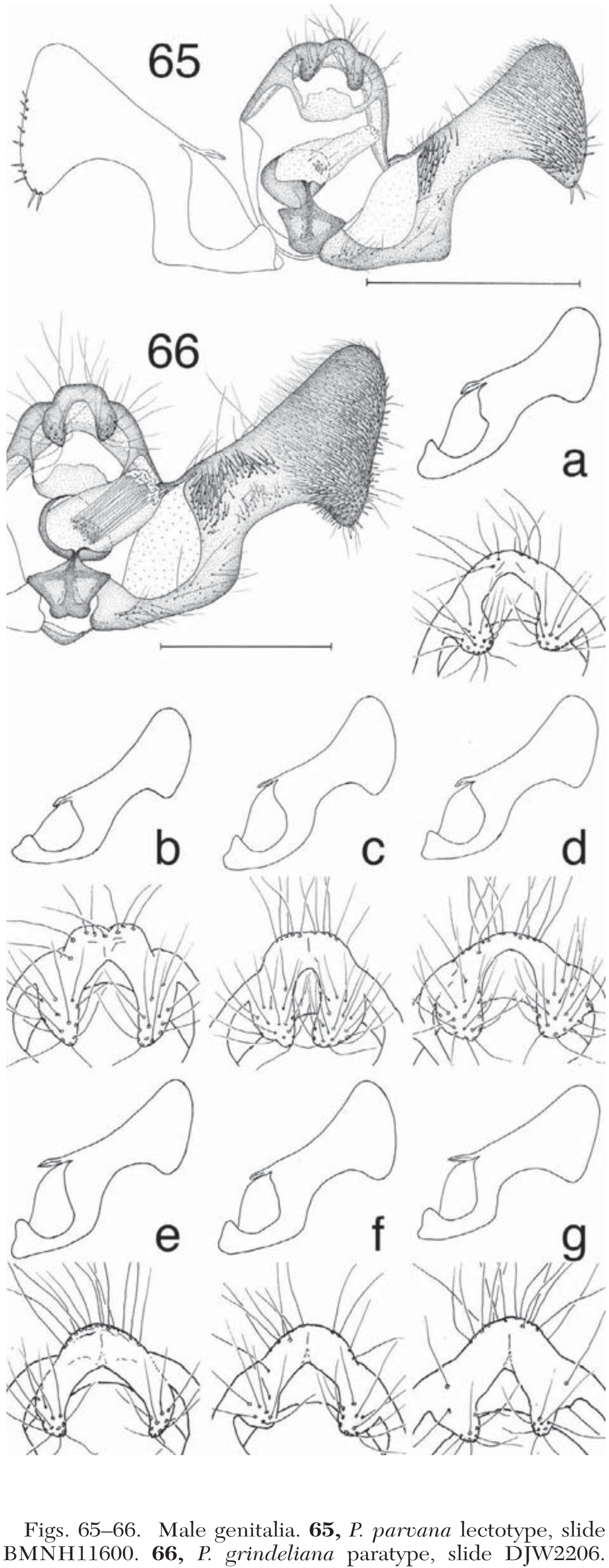
Heinrich (1923) mistakenly interpreted as *P. stramineana* several specimens treated here as members of a species complex associated with *Phaneta grindeliana* (Busck). He illustrated the genitalia (Fig. 118) of one of the latter specimens under the former name. Since then, most *grindeliana*-like specimens in North American collections have been referred to *P. stramineana*. The two taxa are readily separated by male genitalia (Figs. 63, 66): in *P. stramineana* the saccular angle has a well defined vertex, and there are one or two spines at the anal angle of the cucullus; *P. grindeliana* has a broadly rounded saccular corner and lacks spines at the anal angle.

Types. *Semasia stramineana*. Lectotype here designated: ♂, Colorado, Denver, Walsingham, July 1872, genitalia side 11601, BMNH.

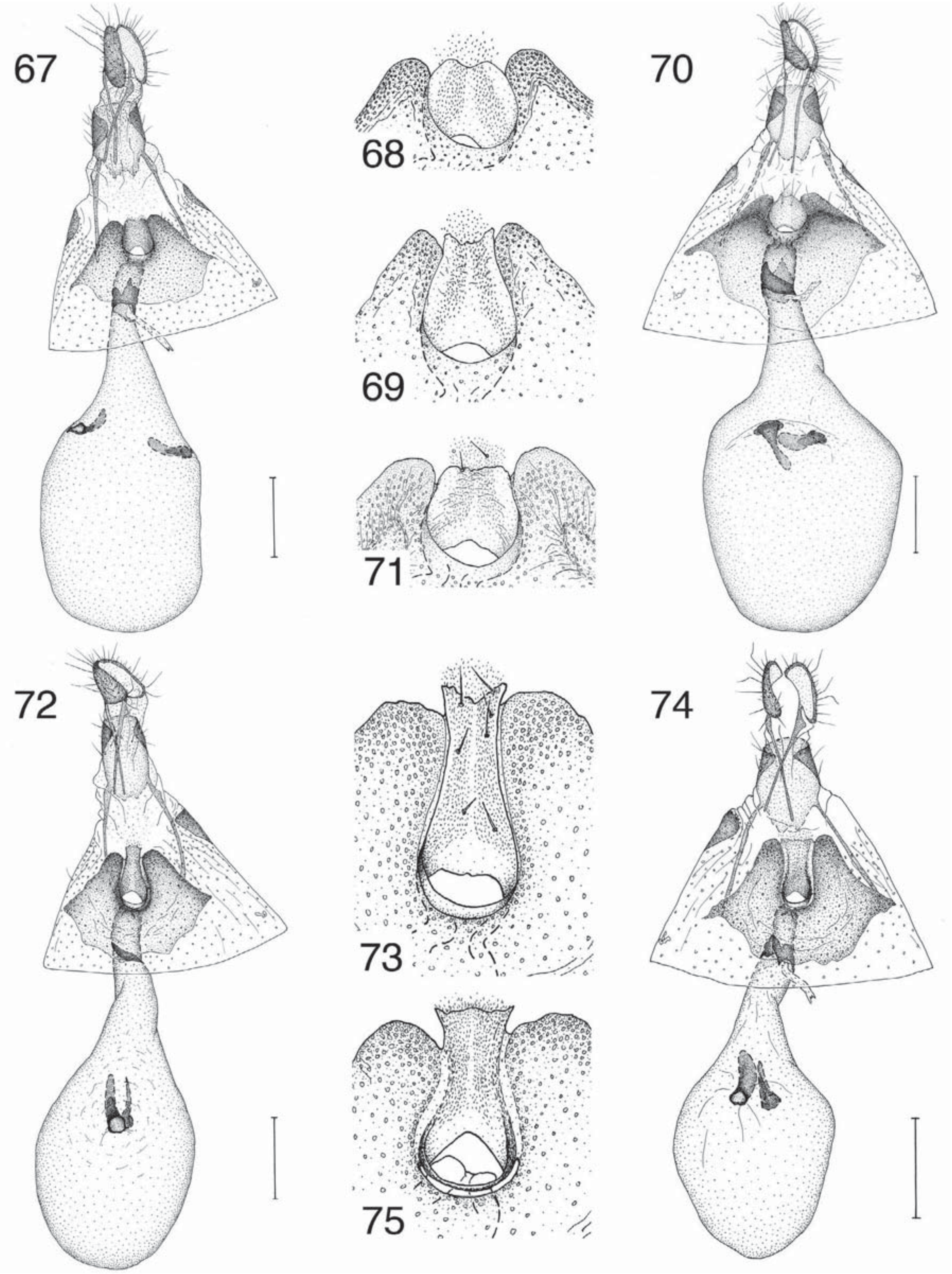
Descriptive notes. This small yellowish moth (Figs. 37, 38) has little in the way of fascial markings. Fragments of a subbasal fascia are sometimes present in the form of blackish-brown marks on the cubitus and/or dorsum. The median fascia is reduced to a blackish-brown mark at mid-costa, which infrequently is joined to the dorsum by a brown band along the proximal margin of the ocellus. The yellowish-white central field of the ocellus is crossed by two blackish-brown dashes and defined basally and distally by inconspicuous pearly white bars. There is a thin dark line along the termen, followed distally by a thin yellow line. Fringe scales are yellowish-white with black cross-bars that align parallel to the termen. Forewing statistics: ♂ FWL: 5.6–6.6 mm (mean = 6.1, n = 26), AR = 3.43; ♀ unknown.

Male genitalia (Fig. 63) (n = 5): Uncus a convex bulge, weakly differentiated from rounded dorsolateral shoulders of tegumen; socii short; vesica with 9–14 deciduous cornuti (n = 5); valva with costal margin nearly straight, apex rounded, distal margin weakly convex, anal angle with one or two spiniform setae, ventral emargination broad, neck widening distally. *Female genitalia:* unknown.

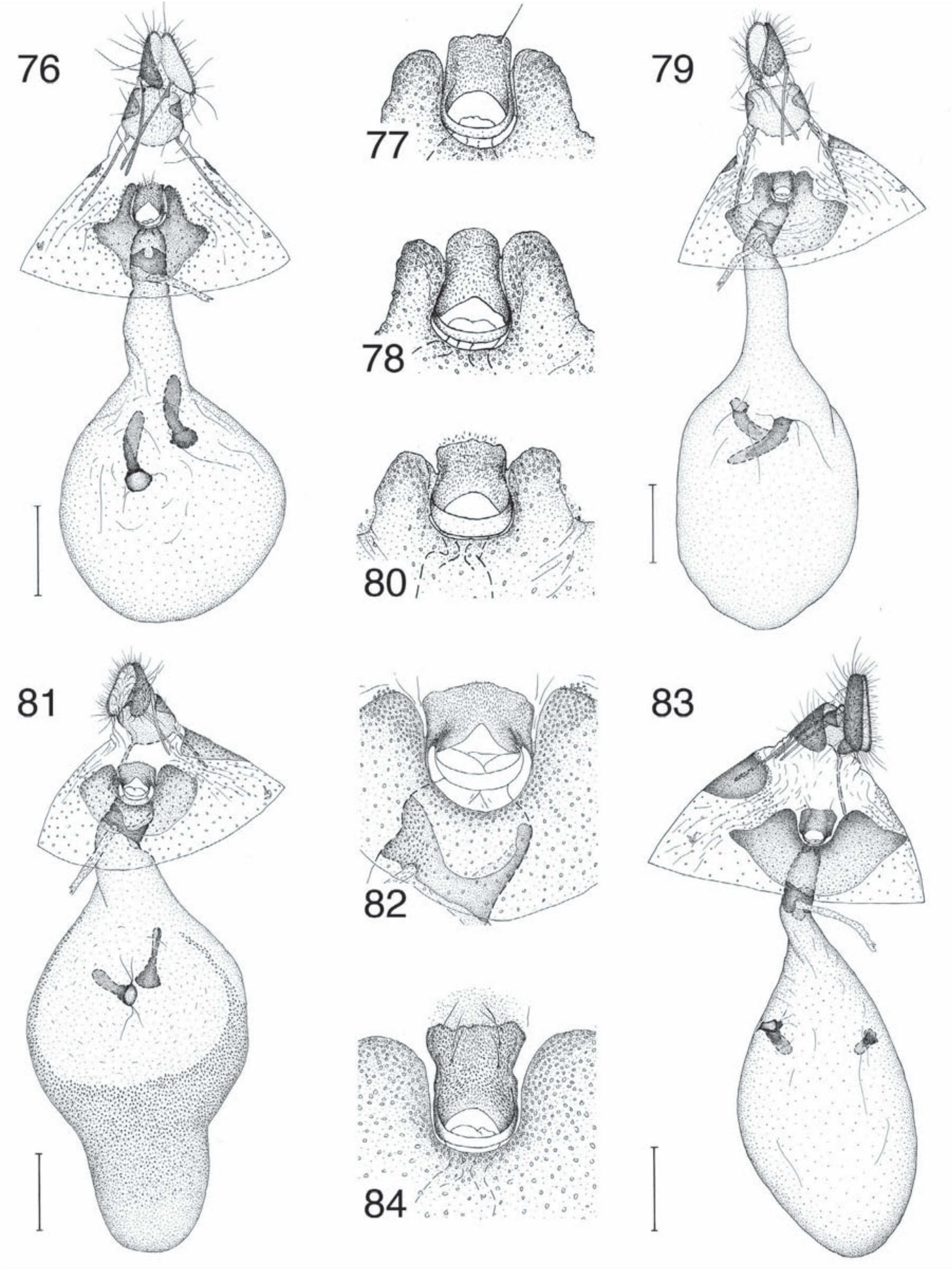
Distribution and biology. I examined 27 males from Colorado, Oregon, Nevada, and Wyoming (Fig. 104). Capture dates range from 16 June to 22 July.



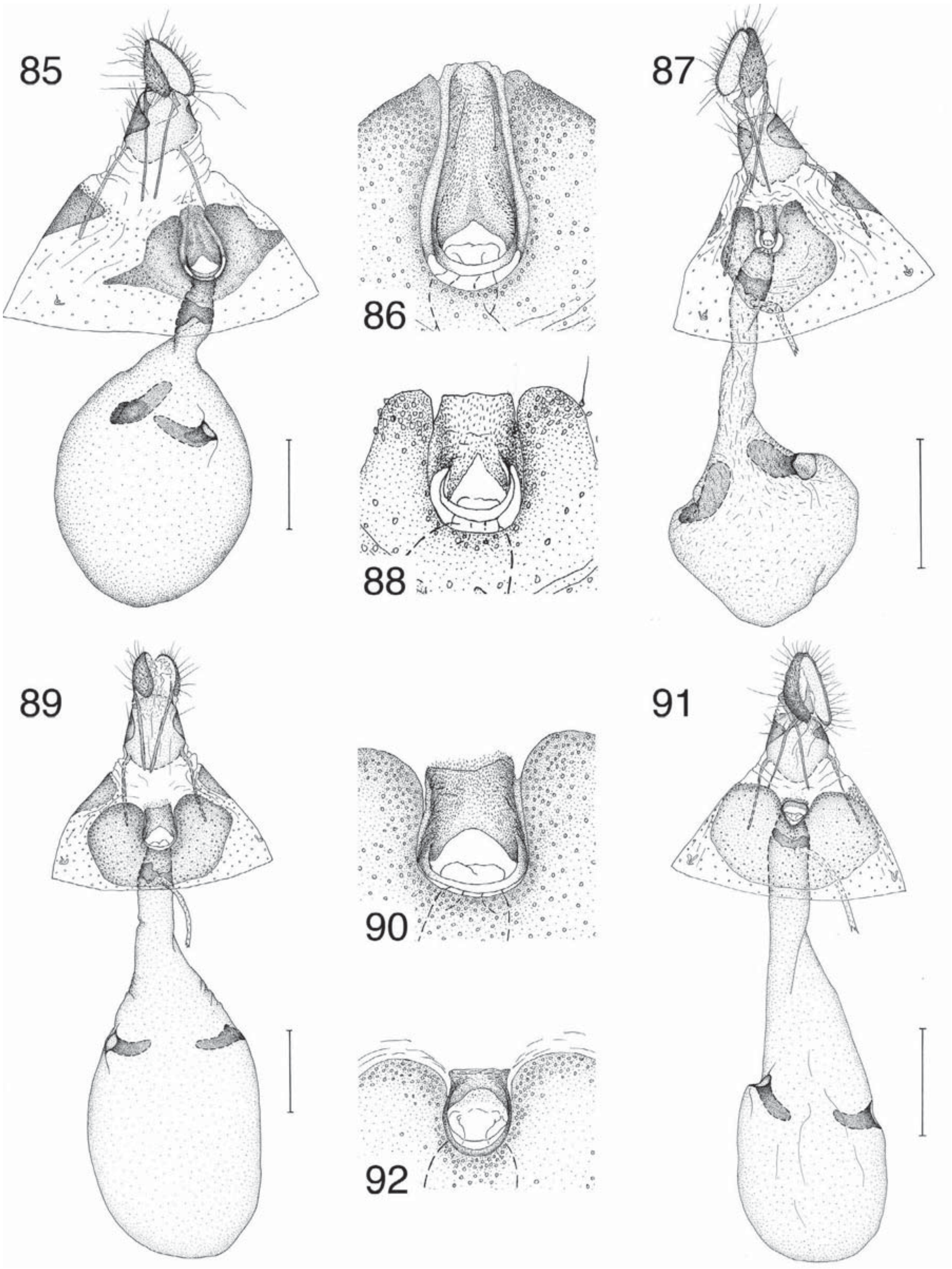
Figs. 65–66. Male genitalia. **65,** *P. parvana* lectotype, slide BMNH11600. **66,** *P. grindeliana* paratype, slide DJW2206. **66a-g,** *P. grindeliana* complex, slides DJW2027, 536, 2209, 2208, 2220, 2219, 2198. Scale bar = 0.5 mm.



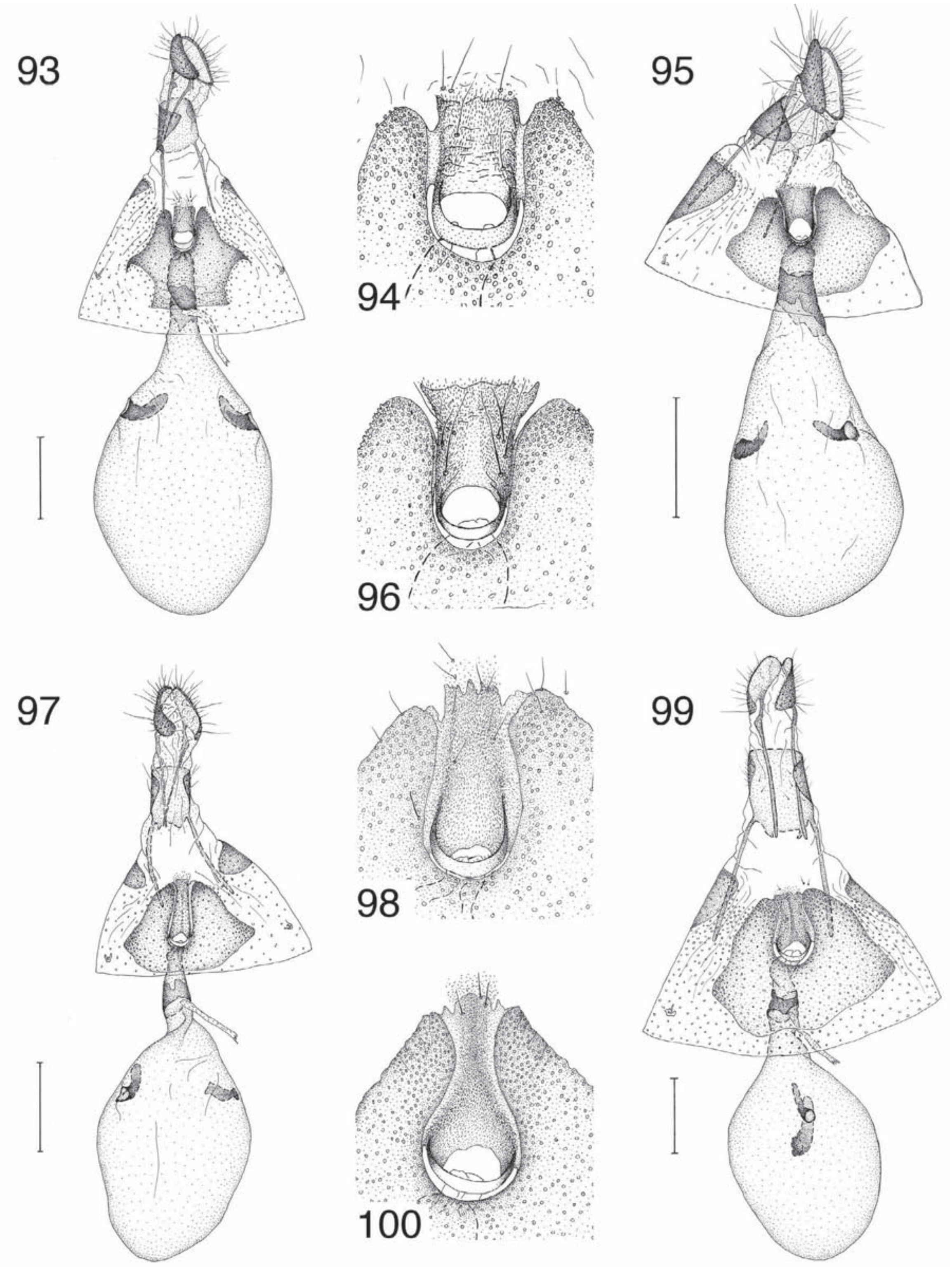
Figs. 67–75. Female genitalia. **67–69,** *P. corculana*, slides DJW1965, 851, 2128. **70–71,** *P. arenana*, slides DJW1963, 951. **72–73,** *P. mormonensis*, slide DJW1966. **74–75,** *P. browni*, slides DJW2001, 852. Scale bar = 0.5 mm.



Figs. 76–84. Female genitalia. **76–78,** *P. indagatricana*, slides DJW1945, 1944, 2022. **79–80,** *P. misturana*, slides DJW2158, 2151. **81–82,** *P. labiata*, slide DJW2153. **83–84,** *P. goblinana*, slides DJW1940, 1941. Scale bar = 0.5 mm.



Figs. 85–92. Female genitalia. **85–86,** *P. cibolana*, slides DJW1943, 2160. **87–88,** *P. parvula*, slides DJW2095, 2096. **89–90,** *P. latens*, slide DJW2090. **91–92,** *P. minimana*, slides DJW2024, 2107. Scale bar = 0.5 mm.



Figs. 93–100. Female genitalia. **93–94,** *P. baloghi*, slides DJW1948, 1403. **95–96,** *P. vogelana*, slides DJW1936, 427. **97–98,** *P. clementeana*, slides DJW2094, 2179. **99–100,** *P. grindeliana* paratypes, slides DJW2207, 2221. Scale bar = 0.5 mm.

Phaneta parvana (Walsingham)

(Figs. 39, 65)

Semasia parvana Walsingham 1879:60.
Thiodia parvana: Fernald [1903]:462; Heinrich 1923:55; Heinrich 1929:6; McDunnough 1939:44.
Eucosma parvana: Barnes and McDunnough 1917:172.
Phaneta parvana: Powell 1983:33; Brown 2005:495.

Discussion. The description of *P. parvana* mentions two male syntypes collected by Walsingham in April, 1872 in Grant County, Oregon. The BMNH has a third male, also collected by Walsingham, with data identical to that of the two syntypes except for the date of capture, which reads March–April 1872. I examined these three specimens but was unable to locate any additional representatives of this species. Figure 39 shows the syntype that was selected as lectotype by Obraztsov and which is designated below as such. It is representative of all three specimens. Heinrich (1923) was unable to review *P. parvana* for lack of authoritatively determined material but later (1929) illustrated the genitalia of a male from Yellowstone National Park that he misidentified as this species. I examined the specimen he illustrated and cannot associate it with any of the available names.

Phaneta parvana is very similar to *P. stramineana*. It is darker (Fig. 39 vs. Figs. 37, 38) and a little smaller (mean FWL = 5.3 mm vs. 6.1 mm), but there are only three *P. paravana* specimens supporting these comparisons. The lectotypes of the two species are essentially indistinguishable in genitalia (Figs. 65, 63): the former has two spines at the anal angle of each valva; the latter has one on the right valva and two on the left (not illustrated). I think it is likely that the types of *P. parvana*, being collected in April, represent a dark spring form of *P. stramineana*. I have collected typical *P. stramineana* in July near Hines, Oregon, which is located some 60 to 70 miles south of the *P. parvana* type locality. Further resolution of this situation will probably have to await the availability of additional *parvana*-like material and females of both taxa.

Types. Lectotype here designated: ♂, Oregon, Grant Co., Camp Watson, Walsingham, April 1872, genitalia slide 11600, BMNH. Paralectotype: same data as lectotype (1 ♂), BMNH.

Phaneta grindeliana (Busck)

(Figs. 40–44, 66, 99, 100)

Cydia grindeliana Busck 1906:211.
Thiodia grindeliana: Heinrich 1923:69; McDunnough 1939:45.
Thiodia stramineana: (not Walsingham 1879) Heinrich 1923:69.
Phaneta grindeliana: Powell 1983:34; Brown 2005:493.
Phaneta stramineana: (not Walsingham 1879) Gilligan *et al*. 2008:100.

Discussion. Heinrich (1923) noted that the syntypes of *P. grindeliana* (FWL ≈ 8.2 mm) are similar in forewing appearance and male genitalia to a few smaller specimens (FWL ≈ 6.5 mm) from Arizona, California, and New Mexico that he misidentified as *P. stramineana* (see discussion under *stramineana*). Since then the *grindeliana*-like specimens that have accumulated in North American collections have for most part been determined as *P. stramineana*. This material comes from southern United States (North Carolina to California) and is variable in forewing appearance (Figs. 40–44) as well as size. The male genitalia exhibit considerable variation in the shape of the uncus and socii but only subtle differences in valval shape (Fig. 66); the female genitalia are essentially uniform. Recorded larval hosts include *Grindelia* (Asteraceae) in Texas (Busck, 1906) and *Haplopappus* (Asteraceae) in Texas, Arizona, and California (Brown *et al*. 1983, under *P. stramineana*; J. A. Powell, personal communication). These specimens likely represent a complex of sibling species, but I am treating them all as *P. grindeliana* for lack of reliably diagnostic morphological characters. Under these circumstances, the species presented in Gilligan *et al*. (2008) as *P. stramineana* is *P. grindeliana*.

Types. Lectotype here designated: ♂, Texas, [Donley Co.], Clarendon, W. D. Pierce, 19 September 1905 [immature collected], 28 September 1905 [adult emergence], genitalia slide DJW 2206, USNM. Paralectotypes: same data as lectotype, with emergence dates varying from 22 September to 10 October, 1905 (3 ♂, genitalia slide 70119; 5 ♀, genitalia slides DJW 2207, 2221), USNM. Busck (1906) did not specify the number of syntypes but named the USNM and the AMNH as depositories. Klots (1942) reported one syntype in the AMNH.

Descriptive notes. Busck (1906) observed that in the syntypes of *P. grindeliana* the antennae and tips of the labial palpi are darker than the forewing. This contrast is conspicuous in *grindeliana*-like specimens from Kansas and Texas, in which there is blackish-gray to olive-gray scaling on the vertex, the third segment of the labial palpus, the scape, and the dorsal surface of the antenna. In specimens from California, Arizona, and Baja California the head and forewing are concolorous; those from Florida are mixed in this respect. The forewing is yellow and often longitudinally streaked with olive-gray (Fig. 41) or blackish-brown (Figs. 42, 43). Both streaked and uniformly yellow specimens are found in the *P. grindeliana* type series. Thin, closely-spaced blackish-brown dashes are present on the costa from base to apex. Some specimens show faint traces of a subbasal and/or median fascia (Figs. 41, 43, 44), but many lack transverse markings entirely. The proximal margin of the ocellus is marked by a thin, sometimes obscure, dark line. The termen is marked by a dark line from tornus to apex, followed distally by a thin white line. Dark cross-bars on the fringe scales produce a second diffuse dark line parallel to the termen. Size is variable, but forewing geometry, as measured by AR, is nearly constant. Forewing statistics: ♂ FWL 4.4–8.9 mm (mean = 6.1, n = 103), AR = 2.98; ♀ FWL 5.4–9.0 mm (mean = 6.5, n = 26), AR = 3.02. The largest specimens are the *P. grindeliana* syntypes (from north central Texas), with mean FWL = 8.2 mm (n = 7). In *grindeliana*-like specimens from California, Baja California and Arizona, mean FWL = 7.2 (n = 25); in those from Kansas, the Gulf Coast of Texas, Alabama, and Florida, mean FWL = 5.8 (n = 97).

Male genitalia (Fig. 66) (n = 28): Uncus and socii variable, as illustrated in Fig. 66; aedeagus with 17–48 deciduous cornuti (n = 24);

valva with costal margin weakly concave, apex rounded, distal margin convex to nearly straight, anal angle acute, saccular corner well rounded. *Female genitalia* (Figs. 99, 100) (n = 14): Lamella postvaginalis elongate, length ca. 1.5 × ostium diameter, narrowing posteriorly; posterior margin of sternum 7 invaginated to length of sterigma, fused with lateral margins of lamella postvaginalis, but separated by narrow strip of membrane from ringlike lamella antevaginalis; ductus bursae with sclerotized ring posterior to juncture with ductus seminalis; corpus bursae with two signa of nearly equal size. In some specimens the surface of the corpus bursae is weakly distorted by a band of densely spaced microspinulae near the ductus bursae (not illustrated).

Distribution and biology. I examined 156 specimens (123 ♂, 33 ♀) from Alabama, Arizona, California, Florida, Kansas, New Mexico, North Carolina, Oklahoma, Texas, and Baja California, Mexico. Florida adults have been captured in March, May, July, September, and November; Kansas records are from August in Morton County; collections along the Gulf Coast of Texas range from February to November; and southern California records are from March to June and again in October. The type series for *P. grindeliana* was reared from *Grindelia squarrosa* (Pursh) Dunal (Asteraceae) by W. D. Pierce, an employee of the U.S. Department of Agriculture (Busck 1906). The larvae feed in flower heads, and pupation occurs in a loose cocoon at the feeding site.

***Phaneta clementeana*, new species**

(Figs. 45, 46, 64, 97, 98, 104)

Phaneta stramineana: (in part, not Walsingham 1879) Powell & Opler, 2009.

Diagnosis. This species is similar to *P. stramineana*, *P. grindeliana*, and *P. parvana*. It is separated from the first two by its brownish forewing color and strongly expressed median fascia. The male genitalia differ from those of *P. stramineana* and *P. parvana* in the lack of spiniform setae at the anal angle of the cucullus but are virtually indistinguishable from those of *P. grindeliana* (Figs. 63–66). The lamella postvaginalis is slightly more elongate in *P. clementeana* than *P. grindeliana* (Figs. 97, 99).

Description. *Head*: Frons yellowish white; vertex brownish yellow to dark brown; labial palpus with medial surface yellowish white, lateral surface brown, sometimes shading to black at apex; antenna brownish yellow with brown dorsal streak. *Thorax*: Dorsal surface concolorous with head, ventral surface a shade lighter; legs brownish yellow to brown, with yellow tarsal annulations. *Forewing* (Figs. 45, 46): ♂ FWL 5.1–8.0 mm (mean = 6.3, n = 27), AR = 3.05; ♀ FWL 5.4–7.5 mm (mean = 6.2, n = 13), AR = 3.01; costal margin weakly convex, apex acute, termen straight to weakly concave; dorsal surface yellowish brown with brown markings, often with some longitudinal streaking from base to median fascia; subbasal fascia represented by dark marks on cubitus and dorsum; median fascia an outwardly oblique bar at mid-costa, usually joined to dorsum by dark band along proximal margin of ocellus; ocellus bordered basally and distally by lustrous gray transverse bars, anteriorly by patch of dark brown scales; yellowish central field of ocellus crossed by two dark longitudinal dashes which are often reduced to one or two black dots; costa marked from base to apex with thin dark dashes; termen with thin black line from apex to tornus, followed distally by yellowish-white line; fringe scales pale brownish yellow, with black cross-bars aligned parallel to termen. *Hindwing*: Pale grayish brown, fringe a shade lighter. *Male genitalia* (Fig. 64) (n = 4): Uncus a convex dorsally setose lobe; dorsolateral shoulders of tegumen rounded; socii short; vesica with 23–37 deciduous cornuti (n = 4); valva with costal margin weakly concave, apex rounded, distal margin convex of nearly uniform curvature, ventral emargination broad and shallow, saccular corner rounded, SA ≈ 115°. *Female genitalia* (Figs. 97, 98) (n = 3): Papillae anales laterally facing and sparsely setose; lamella postvaginalis rectangular, length ca. 2.5 × width; sternum 7 with posterior margin invaginated to length of sterigma and fused with lateral margins of lamella postvaginalis; ductus bursae with sclerotized ring posterior to juncture with ductus seminalis; corpus bursae with two signa of similar size.

Holotype (Fig. 45). ♂, California, Los Angeles Co., San Clemente Island, Wilson Cove, Powell & De Benedictis, 1 October 2002, EME.

Paratypes. CALIFORNIA: same data as holotype (17 ♂, genitalia slides DJW 2091, 2178; 10 ♀, genitalia slides DJW 2092, 2179); San Diego Co., Cardiff, J. A. Powell, 2 October 1964 (1 ♂, genitalia slide DJW 2177; 1 ♀, genitalia slide DJW 2094); San Luis Obispo Co., San Simeon Beach State Park, J. A. Powell, 28 August 1961 (1 ♂); Santa Barbara Co., Jalama Beach, J. A. Powell, 23 April 1966 (4 ♂). Paratype depositories: EME, USNM, DJW.

Etymology. The specific epithet refers to the type locality, San Clemente Island.

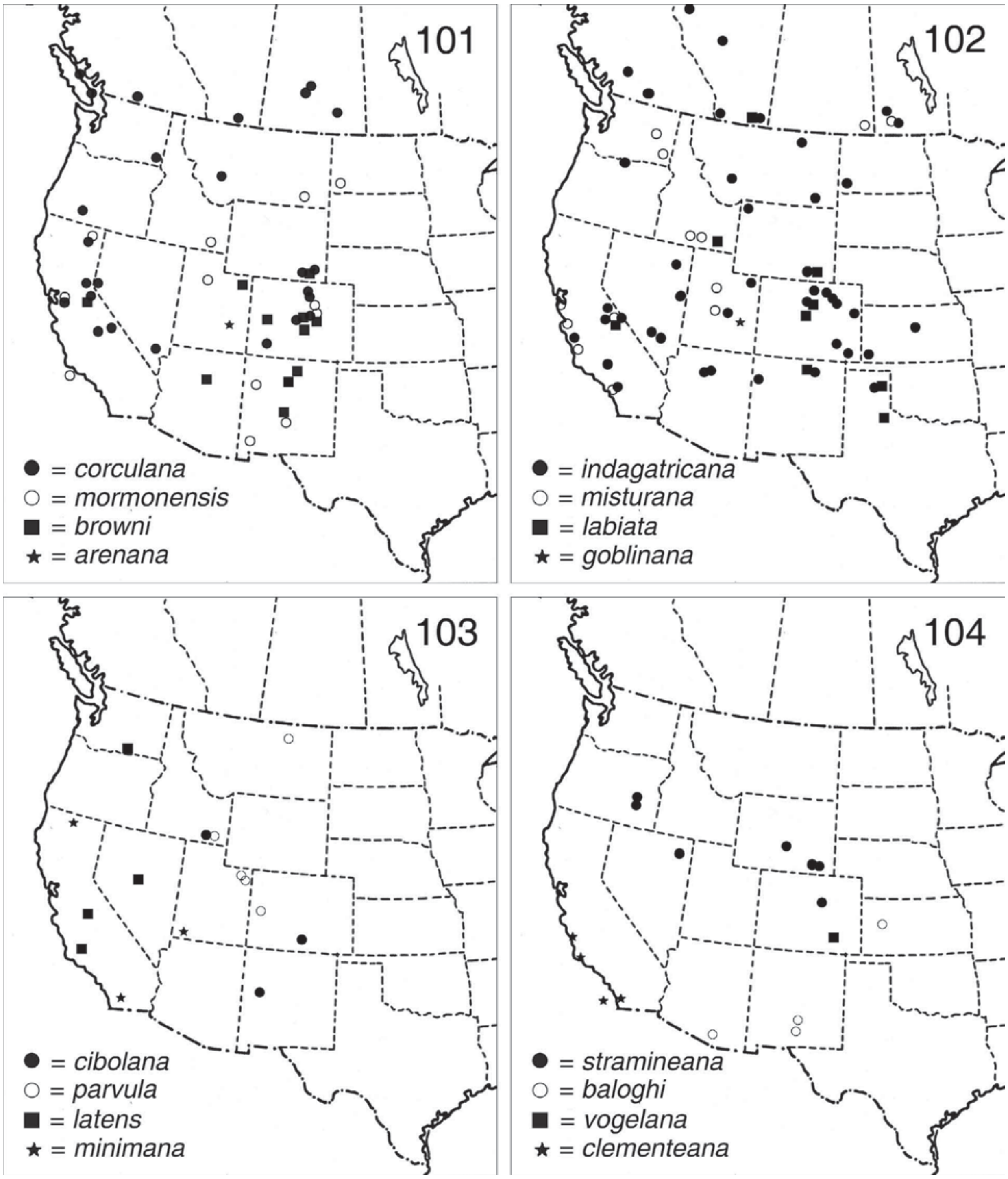
Distribution and biology. The type series consists of 35 adults (24 ♂; 11 ♀) from Los Angeles, San Diego, San Luis Obispo, and Santa Barbara counties in southern California (Fig. 104). Spring, summer and autumn capture dates suggest the likelihood of two or three generations per year. The specimens from San Clemente Island were collected as immatures on *Isocoma menziesii* (Hook. & Arn.) (Asteraceae). The larva creates a gall-like shelter causing the twig to curl just below the flower, and pupation occurs in the "gall" (J. A. Powell, personal communication). Adults emerged in the laboratory between 9 October and 9 November 2002.

***Phaneta baloghi*, new species**

(Figs. 47, 48, 62, 93, 94, 104)

Diagnosis. The yellowish phenotype of *P. baloghi* (Fig. 47) is similar in size, forewing color, and maculation to *P. stramineana* (Fig. 38) but lacks the thin black line on the termen of the forewing; the browner phenotype (Fig. 48) resembles some specimens of *Phaneta vogelana* (Fig. 34) (described below), which is a considerably smaller insect. The three species have distinctly different male genitalia (Figs. 59, 62, 63).

Description. *Head*: Frons creamy white; vertex creamy white with yellowish-brown tints; labial palpus creamy white, second segment with yellowish-brown patch on lateral surface and long yellowish-brown scales concealing brownish third segment; antenna concolorous with vertex. *Thorax*: Dorsal and ventral surfaces concolorous with head; legs creamy white to pale brown, with brown tarsal annulations and brown marks on the fore and mid tibiae. *Forewing* (Figs. 47, 48): ♂ FWL 5.8–6.5 mm (mean = 6.2, n = 7), AR = 3.33; ♀ FWL 5.3–6.3 mm (mean = 5.9, n = 4), AR = 3.18; costal margin straight, apex acute, termen straight to weakly concave; dorsal surface yellow to pale brown; subbasal fascia represented by brown marks on cubitus and dorsum, median fascia by narrow brown dash at mid-costa; ocellus



Figs. 101–104. Geographic distribution of species.

defined basally and distally by pale, lustrous gray bars and bordered on proximal and anterior margins by bands of brown scales; central field of ocellus creamy white to pale yellowish brown, with up to three dark longitudinal dashes; costa marked from base to apex with thin dark dashes, those from base to median fascia sometimes greatly reduced; fringe scales white with blackish-brown cross-bars. *Hindwing*: Grayish brown, fringe a shade lighter. *Male genitalia* (Fig. 62) (n = 6): Uncus a broad, convex, dorsally setose lobe, basal width ca. 2 × height; dorsolateral shoulders of tegumen well developed; socii fingerlike, with distal one-third tapering to narrowly rounded apex; vesica with 22–35 deciduous cornuti (n = 5); valva with costal margin concave, apex rounded, dorsal one-half of distal margin nearly straight, anal angle broadly rounded, ventral emargination moderate, SA ≈ 120°. *Female genitalia* (Figs. 93, 94) (n = 3): Papillae anales laterally facing and sparsely setose; lamella postvaginalis rectangular, length ca. 1.5 × width; posterior margin of sternum 7 invaginated to length of sterigma and fused with lateral margins of lamella postvaginalis; lateral extremities of sternum 7 triangular with acute vertices; ductus bursae with sclerotized ring posterior to juncture with ductus seminalis; corpus bursae with two signa of similar size.

Holotype (Fig. 47). ♂, New Mexico, Otero Co., vic. [vicinity] Holloman Lakes, G. J. Balogh, 14 September 2004, genitalia slide DJW 1667, USNM.

Paratypes. ARIZONA: Pima Co., Baboquivari Mts., O. C. Poling, 1–15 September 1924 (1 ♂, genitalia slide DJW 2171). KANSAS: Gove Co., Monument Rocks, G. J. Balogh, 24 September 1999 (3 ♂, genitalia slides DJW 651, 702, 2140). NEW MEXICO: same data as holotype (2 ♂, genitalia slide DJW 2141; 3 ♀, genitalia slide DJW 1948); Lincoln Co., Valley of Fires RA [Recreation Area], 4 mi. NW Carrizozo, 5350 ft., D. J. Wright, 19 August 2005 (1 ♀, genitalia side DJW 1403). Paratype depositories: EME, GJB, USNM, DJW.

Etymology. This species is named after George J. Balogh, who collected most of the specimens in the type series.

Distribution and biology. The type series consists of 11 specimens (7 ♂, 4 ♀) from western Kansas, southwestern Arizona, and south central New Mexico (Fig. 104). Collection dates range from mid-August to late September.

***Phaneta vogelana*, new species**

(Figs. 34–36, 59, 95, 96, 104)

Diagnosis. This small brown insect is similar in forewing appearance to many western Eucosmini but is distinguished by genitalia: males (Fig. 59) with ventral margin of valva deeply emarginated, neck short and narrow, cucullus elongate with anal angle inclined slightly toward saccular corner; females (Figs. 95, 96) with posterior one-third of the lamella postvaginalis flared and not fused with sternum 7.

Description. *Head*: Frons white, scales of vertex white to tan basally, yellowish brown to brownish gray distally; labial palpus with medial surface white, lateral surface white to tan, shading to brownish gray ventrally, with bushy scaling of second segment nearly concealing dark third segment; antenna brown. *Thorax*: Dorsal surface concolorous with head, ventral surface paler, legs tan with brownish annular markings on tarsi. *Forewing* (Figs. 34–36): ♂ FWL 4.8–5.8 mm (mean = 5.2, n = 14), AR = 3.16; ♀ FWL 5.0–6.0 (mean = 5.3, n = 10), AR = 3.21; costal margin weakly convex, apex acute, termen straight to weakly concave; dorsal surface pale brown; median fascia reduced to mark at mid-costa; ocellus edged with dark brown scaling and bounded basally and distally by lustrous white transverse bars, with yellowish-brown central field crossed by one to three black dashes; fringe from apex to M3 brown, paler toward tornus. Infrequently the entire wing is suffused with brown (Fig. 36). *Hindwing*: Uniformly pale grayish brown, fringe lighter. *Male genitalia* (Fig. 59) (n = 3): Uncus rounded and dorsally setose; dorsolateral shoulders of tegumen well developed; socii broad medially, narrowing toward base and apex; vesica with 16–21 deciduous cornuti (n = 2); valva with costal margin concave, apex rounded, distal margin convex of uniform curvature, ventral margin deeply emarginated, neck short and narrow (width ca. 0.25 × valval width at saccular corner), SA ≈ 90°. *Female genitalia* (Fig. 95, 96) (n = 2): Papillae anales laterally facing and sparsely setose; lamella postvaginalis with posterolateral corners flared, medial trough shallow and microspinulate, length ca. 1.5 × ostium diameter; posterior margin of sternum 7 invaginated nearly to length of sterigma and fused with anterior one-half of lamella postvaginalis; lamella antevaginalis ringlike and separated from sternum 7 by narrow strip of membrane; ductus bursae widening anteriorly, with sclerotized ring posterior to junction with ductus seminalis; corpus bursae with two signa of similar size.

Holotype (Fig. 35). ♂, Colorado, Otero Co., Vogel Canyon Picnic Area, 15 mi. S. of La Junta, 4340 ft., 37°46'13" N, 103°30'46" W, 18 August 1997, D. J. Wright, genitalia slide DJW 554, USNM.

Paratypes. COLORADO: same data as holotype (13 ♂, genitalia slides DJW 376, 1935; 10 ♀, genitalia slides DJW 427, 1936). Paratype depositories: BMNH, CNC, CSU, EME, USNM, DJW.

Etymology. This species is named after the type locality, Vogel Canyon Picnic Area, Comanche National Grassland, west of state route 109, 15 miles south of La Junta, Colorado.

Distribution and biology. All 24 specimens in the type series were all collected on the same night in mid-August. The type locality is predominantly short grass prairie.

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DESCRIPTION OF A NEW *LUCILLELLA* SPECIES (RIODINIDAE: SYMMACHIINI) DISCOVERED IN THE EASTERN ANDES OF ECUADOR USING THE SINGLE ROPE CANOPY ACCESS TECHNIQUE

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ABSTRACT. A new riodinid species in the tribe Symmachiini, *Lucillella arcoirisa* Hall & Willmott n. sp., is described from the eastern Andes of Ecuador. All five true members of the genus *Lucillella* Strand, 1932, are figured, and their known geographic ranges are mapped. *Lucillella* is hypothesized to be monophyletic with the exclusion of *suberra* Hewitson, 1877, and the sister genus is hypothesized to be *Esthemopsis* C. & R. Felder, 1865. The new *Lucillella* species was discovered in the forest canopy using the single rope technique. The equipment and procedures used in this canopy access method are described and illustrated.

Additional key words: canopy diversity, canopy sampling methods, montane forest, South America

Vertical stratification within tropical forest butterfly communities is now a well-known phenomenon (e.g., Papageorgis 1975; Burd 1994; Beccaloni 1997; DeVries *et al*. 1997). However, studying butterflies that fly in the upper-most levels of the forest, beyond the reach of even the most long-handled nets, is physically problematic. Fogging techniques, involving the use of portable machines to spray insecticide into the canopy of targeted trees, have been a boon to the study of some of the more sessile insect taxa, such as Coleoptera, Hemiptera, and Hymenoptera (e.g., Adis *et al*. 1998), but adult butterflies are far too mobile to be sampled in this way. The most commonly used method to sample midstory and canopy butterfly species is bait trapping. Such trapping methods have made a significant contribution to our knowledge of subtropical and tropical butterfly faunas, including the discovery of new species (e.g., Hall & Willmott 1998) and the improvement of species distribution data. Without the use of traps, a large proportion of any given butterfly community is likely to remain completely unseen, even after hundreds of man-hours of sampling (Hardy & Dennis 2005). Nevertheless, bait traps have two major disadvantages. Firstly, no bait attracts all species of interest. For example, although rotting carrion is the most effective known bait for Riodinidae, there are still many genera and species that have never been found on any bait, or indeed observed feeding at all during the adult stage (Hall & Willmott 2000). Secondly, the relative abundance of species in bait traps may be strongly dependent on differences in bait preference and mobility, thus providing a poor estimate of true abundance.

By making direct observations from within the midstory and canopy, species may be recorded that are unlikely to be sampled by any other method, and the true abundance and behavior of species that are otherwise never seen in their natural habitat may be studied. Canopy rafts (e.g., Lowman *et al*. 1993), canopy towers (e.g., Burd 1994), and canopy cranes (e.g., Parker *et al*. 1992; Basset *et al*. 2003) all provide a means of directly observing midstory and canopy species, but the usual goals of such canopy sampling projects are to study herbivory or total arthropod diversity, and we do not know of any Neotropical butterfly inventories that have widely employed canopy access techniques. For the majority of tropical Lepidoptera researchers, mobility, flexibility, and/or cost are the major factors that limit the practical use of all these methods. An alternative that is cost effective and applicable to any forest site is the use of rope techniques to access the midstory and canopy. There are a bewildering variety of such techniques available, developed mainly by cave explorers, professional arborists, and recreational tree climbers (e.g., Dial & Tobin 1994; Smith & Padgett 1996; Jepson 2000). Perry (1978) provided one of the first descriptions of a method suitable for tropical ecologists, which is now generally known as the single rope technique. This method enables the researcher to quickly place ropes and then make relatively easy ascents and descents, with a minimum of equipment that can be carried along rough trails by a single person. During the last few years, we have increasingly used this method to aid our long-term study of the butterflies of Ecuador (see www.butterfliesofecuador.com). We have successfully

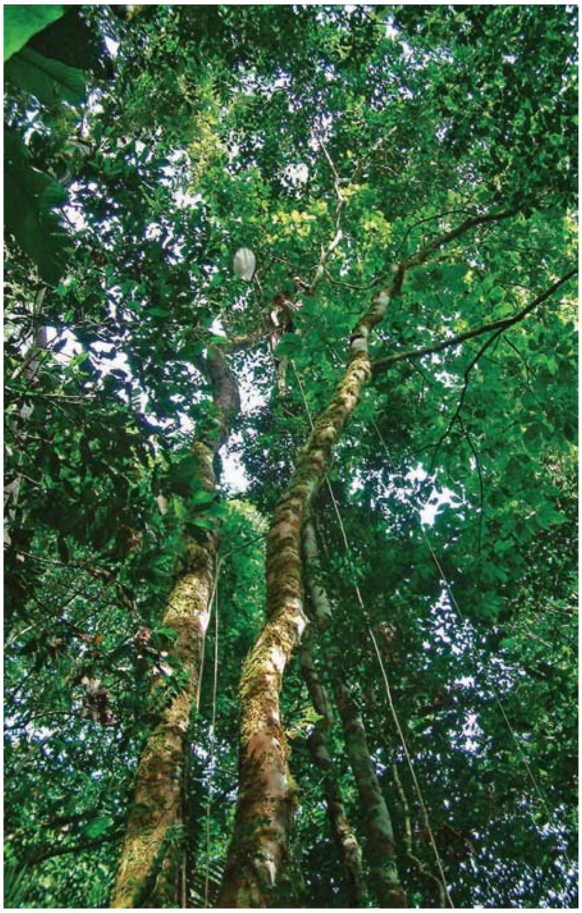

FIG. 1. One of the authors (KRW) using the single rope climbing equipment in Ecuador.

used the single rope technique in both lowland and montane forest in Ecuador to collect specimens and make observations at heights varying from 5 to 30 meters above the ground (see Fig. 1).

During recent fieldwork at the Fundación Arcoiris montane forest reserve in the upper Zamora valley of southeastern Ecuador, the single rope technique was used to survey butterflies in several different microhabitats at elevations between 1900 and 2200 meters. During a rope survey conducted approximately 20 meters above a stream gulley, to investigate a diverse array of butterflies seen flying above a dense midcanopy layer of *Cecropia* Loefl. trees, one of the species captured was a new species of *Lucillella* Strand, 1932, which to our knowledge has never previously been seen or collected. *Lucillella* is a small genus of rare, aposematically brightly colored riodinid butterflies in the tribe Symmachiini that is confined to elevations between about 900 and 2200 meters in the northern and central Andes of South America. The members of this sizeable tribe are among the rarest in the family, and they are only very infrequently attracted to baited traps (Hall & Willmott 2000), meaning that they have to be sampled by traditional hand-netting techniques. The Symmachiini is exactly the kind of butterfly group in which innovative canopy sampling methods would be expected to uncover new taxa. In this paper, we first describe and illustrate the equipment and specific procedures that we have used to conduct canopy surveys of butterflies in Ecuador, and then we describe

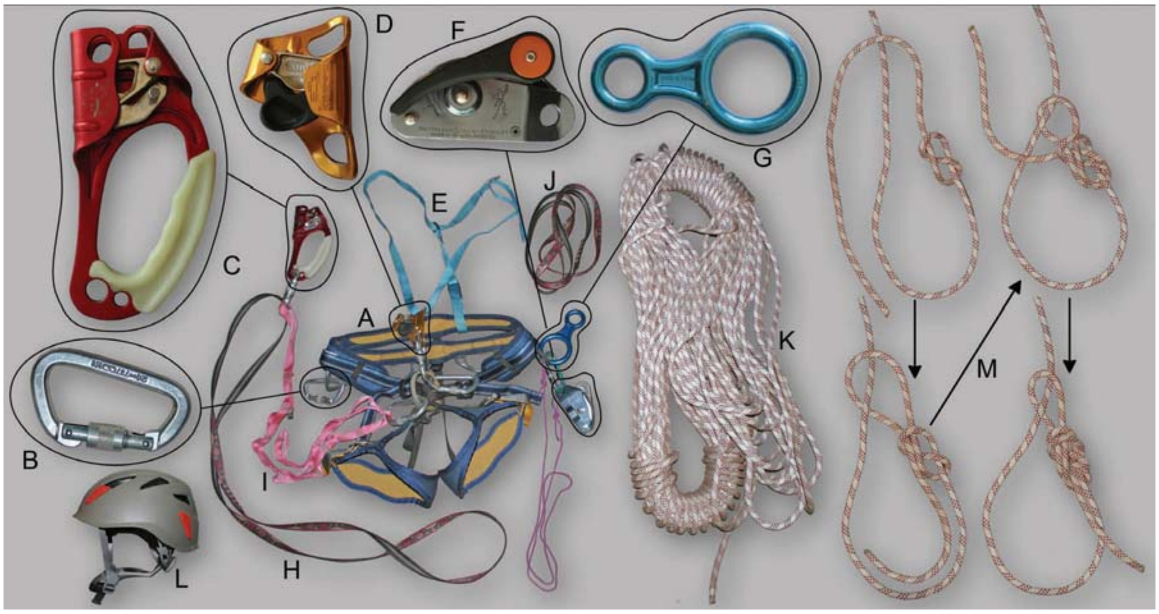

FIG. 2. Single rope climbing equipment. **A.** Petzl Calidris climbing harness. **B**. Screw-lock carabiner, 24 kN (x 5). C. Ascender (jumar). **D.** Croll. **E.** Croll harness (torse). **F.** Petzl Grigri descending device. **G.** Figure-8 descender. **H.** Sling (120 cm). **I.** "Daisy-chain" sling. **J.** Spare sling (120 cm) for attaching harness to tree limb. **K.** Static climbing rope (11 mm) x 80 m. **L.** Petzl Altios climbing helmet. **M.** Steps in tying a figure-8 knot.

the new species of *Lucillella* in the context of a taxonomic overview of the genus.

METHODS

Single Rope Canopy Access Technique

Basic equipment: Most of the equipment we use is illustrated in Fig. 2. It weighs approximately 8 kg. Other essential items include a lead fishing weight, a thin throwing line, and a 5 mm line for raising the rope. Close-focusing binoculars (< 2 meters) are valuable for recording species that are out of reach of the net. We use "static" rope (Fig. 2K) rather than the more elastic rock-climbing rope, but since "static" rope will break after a much shorter fall, it is important to maintain tension on the rope attaching the climber to the tree at all times. We carry 80 meters of rope, giving access up to 40 meters, but in practice 50 meters will suffice for most sites. Rope is most easily stored in a canvas sack or old rucksack, into which it is placed as it is hauled in from a tree.

Choosing a rope site: Rope sites can be random or designed to sample areas where butterflies congregate, such as perching or feeding sites. In our experience, the most productive sites are hilltop and streamside lightgaps, and flowering trees. Leaning, dead, or dying trees should obviously be avoided, and Hymenoptera nests are a further concern, so a thorough preliminary inspection of a targeted supporting tree is necessary (e.g., see Jepson 2000). The rope should pass over a crotch between branches rather than over a single branch, and ideally should pass over at least one other branch or crotch to provide a back up. The rope should ideally be placed to provide access to an additional limb, as it is considerably easier to net butterflies, as well as use binoculars, while sitting or standing on a limb.

Placing the rope: We use a 5 oz (c. 150 g) lead fishing weight attached to light polyethylene builder's line to initially pass a line over the rope site. The underarm throwing method is physically the easiest, although considerable practice may be necessary to achieve accuracy. The string is held approximately 50 cm above the weight (a slip knot may be useful to help grip the string), and the weight is swung slowly back and forth in a pendular motion through an arc of approximately 90 degrees, with the arm remaining parallel to the string. The momentum of the weight is used to launch it upwards, and remarkably little effort is required to reach the canopy of even the tallest trees. An alternative method is to use an overarm throw. It is more precise at shorter distances, but is physically more demanding and cannot attain the same heights as the underarm method. Devices such as modified crossbows and shotguns are also in use, but they suffer from the disadvantages of being expensive, bulky to carry, potentially difficult to transport across international borders, and vulnerable to mechanical failure in the field. One possible low-tech alternative is a robust slingshot. Once the initial line is in place, a thicker 5 mm line, which is readily available in any hardware store throughout the tropics, is attached and pulled over the tree limb, then used to pull the climbing rope into place. This thicker line can be left in place after climbing to permit the site to be easily revisited. With the climbing rope in place over the tree limb, one end needs to be firmly attached at ground level. We tie the rope around the base of the climbing tree using a figure-8 knot as a slip knot (see Fig. 2L). Although rather cumbersome, the figure-8 knot has the advantages of being secure, easy to learn and remember, and easy to check.

Ascending: The method of ascent relies on two mechanical devices, the croll (Fig. 2D) and the ascender (Fig. 2C), one of which is moved up the rope and then locked in place, providing the leverage to advance the other device. Hanging from the croll, which is anchored to the harness (Fig. 2A), the climber moves the ascender up the rope, places a foot in the sling (Fig. 2H) attached to the ascender, and "stands up". This movement advances the croll up the rope. The climb continues with alternating sitting and standing movements until the desired height is reached. If a branch is available on which to stand or sit, a sling (Fig. 2J) may be used to provide extra security by looping it around the trunk or another branch and fastening to a carabiner attached to the harness. The rope attachments (croll and ascender) should not be removed until the grigri descending device is attached and checked. If a mid-air position is unavoidable, we have found that surveys of up to 2 hours are possible, but a simple wooden swing attached to an additional ascender can greatly reduce any discomfort.

Descending: The transition from ascending to descending is one of the most difficult and potentially dangerous stages of any climb. We use a grigri descending device (Fig. 2F), which locks automatically when the handle is released, but we also suggest carrying a figure-8 descender as a back up (Fig. 2G). The grigri is first attached to the rope immediately below the croll, paying close attention to the rope direction, and then clipped into a third harness carabiner. Once the grigri is attached to both rope and carabiner, the climber stands up on the sling attached to the ascender to release the tension on the croll, and detaches the croll from the rope. At this point, the climber will be supported entirely by the grigri, and can reach up and detach the ascender. Cranking the handle of the grigri allows a controlled descent.

FIGS. 3–8. *Lucillella* and *Hades* adult males (dorsal surface on left, ventral surface on right). **3.** *Lucillella camissa* (Hewitson, 1870), Río Pindo Grande, Shell, E. Ecuador (JHKW). **4.** *Lucillella asterra* (Grose-Smith, 1898), Valdevia, C.W. Colombia (MNHN). **5.** *Lucillella pomposa* (Stichel, 1910), holotype, Marcapata, S.E. Peru (ZMHU). **6.** *Lucillella splendida* Hall & Harvey, 2007, holotype, Arcabuco, C. Colombia (USNM). **7.** *Lucillella arcoirisa* Hall & Willmott n. sp., holotype, Río San Francisco, Loja-Zamora rd., E. Ecuador (FLMNH). **8.** *Hades hecamede* Hewitson, 1870, Río San Francisco, Loja-Zamora rd., E. Ecuador (JHKW), a hypothesized co-mimic of *Lucillella arcoirisa*.

Safety issues: It must be remembered that rope climbing is a potentially dangerous activity, and it is highly advisable not to climb alone. Before attempting to climb, we highly recommend reading widely on the subject of canopy access in general and the single rope technique in particular. It is absolutely necessary to receive prior training from a local climbing club and/or an experienced rope-climbing colleague.

Taxonomy

The terminology for male genital and abdominal structures largely follows Klots (1956), Eliot (1973), and Harvey (1987a), and nomenclature for venation follows Comstock & Needham (1918), with cells named for the vein above. The dissection methods used followed those outlined in Hall (2005). The following collection acronyms are used throughout the text: BMNH - The Natural History Museum, London, England; FLMNH - Florida Museum of Natural History, Gainesville, FL; JHKW - Collection of Jason P. W. Hall and Keith R. Willmott, Washington, DC, USA; MNHN - Muséum National d'Histoire Naturelle, Paris, France; USNM - National Museum of Natural History, Smithsonian Institution, Washington, DC, USA; ZMHU - Zoologisches Museum, Humboldt Universität, Berlin, Germany.

Description of New *Lucillella* Species

Lucillella arcoirisa Hall & Willmott, **new species**

(Figs. 7; 9; 10)

Description: MALE: Forewing length 24 mm. *Wing shape*: Both wings slightly elongate; base of forewing costa very slightly convex, anal margin very slightly convex basally, and distal margin convex; hindwing rounded, with a rounded tornus and apex. *Dorsal surface*: Forewing pale black, with a subtle dark blue iridescence across distal half of wing; a large, somewhat oval, dark orange patch extends from near wing base two-thirds distance towards distal margin, is bounded by upper margin of discal cell and vein 2A, and has an uneven, streaky distal margin; forewing fringe pale black; hindwing predominantly chalky pale blue overlaid with a subtle dark blue iridescence, except for some whitish-blue scales through middle of cells Cu$_2$ to M$_2$, grayish-black costal and anal margins, a proximally black discal cell, a narrow black area along distal margin of apex, a very narrow line of black scaling along remainder of distal margin, and black scaling outlining all veins, a wing crease through middle of cell Cu$_2$, and a short diagonal line just inside lower half of discal cell end; hindwing fringe black. *Ventral surface*: Forewing brown with some orange scaling along anal margin below vein 2A, orange in approximately basal half of wing, with orange patch occupying nearly all of discal cell, very base of cell M$_3$, basal half of cell Cu$_1$, and all but very base of cell Cu$_2$, and metallic bluish gray overlaid with a subtle dark blue iridescence in distal half of wing, with black scaling outlining distal veins and along entire distal margin; hindwing predominantly metallic bluish gray overlaid with a subtle dark blue iridescence, except for an uneven area of black scaling along costal margin, a very narrow line of black scaling along distal margin, and black scaling outlining all veins, a wing crease through middle of cell Cu$_2$, and a short diagonal line just inside lower half of discal cell end.

FIG. 9. Male genitalia of *Lucillella arcoirisa* in lateral view. Scale bar = 0.5 mm.

Head: Eyes brown and bare, with black marginal scaling; frons black; labial palpi black; antennal length approximately 60% of forewing length, segments black with a small section of whitish scaling at base, nudum along inner ventral margin discontinuous, clubs black.

Body: Dorsal and ventral surfaces of thorax and abdomen black; a narrow, medially divided band of concealed androconial scales along anterodorsal margin of tergites four, five, and six; all legs black.

Genitalia (Fig. 9): Uncus approximately rectangular in lateral view, with a long, downwardly curved posterior projection from middle of dorsal posterior margin; tegumen with a broad ventral lobe; falces large, with a slightly broader base, a rounded "elbow", and a slightly upturned tip; vinculum an evenly narrow and moderately sinuous ribbon that is fused to dorsal portion of anterior margin of tegumen, saccus in lateral view broadly triangular and of medium length, with a slightly downwardly directed anterior tip; valvae in lateral view somewhat dorsally elongate and positioned at a 45^{o} angle, with a small, narrow, and slightly posteriorly curved anterodorsal portion, a broadly rectangular posteroventral portion, and a narrowly elongate medial portion that slightly broadens and angles dorsally at middle, valves fused at base; aedeagus somewhat short, evenly very broad, and weakly convex, with an upturned and angular posterior tip that is slightly posteriorly projecting along dorsal margin, anterior end opens anteroventrally and posterior tip opens posteriorly, everted vesica very bulbous at base before abruptly narrowing to become an evenly narrow tube, with three evenly spaced, approximately parallel cornutal bands, consisting of two bulbous dorsolateral to lateral bands of small, densely packed, anteriorly flattened spines, and a single ventrolateral line of slightly larger and more erect anteriorly directed spines, and numerous very tiny spines sparsely distributed between these cornutal bands (too small to be illustrated); pedicel short, broad, and strap-like, ventrally joining aedeagus at its middle; eighth abdominal tergite and sternite approximately square.

FEMALE: Unknown.

Types: *Holotype male*, ECUADOR: *Zamora-Chinchipe*, Río San Francisco, km 24 Loja-Zamora rd., Reserva Arcoiris, 3°59.30'S 79°50.58'W, 2050 meters, 3 Dec 2006 (K. R. Willmott) (FLMNH).

No additional specimens have been located in the major museums of Europe, North America, and South America (as listed in Hall 1999, 2005; Willmott 2003).

Etymology: This species is named after the Fundación Arcoiris, which promotes conservation in southern Ecuador and owns the reserve where the species was discovered. The Spanish word "arcoiris", meaning rainbow, is also an appropriate descriptor for such a beautifully patterned species.

Systematic placement and diagnosis: The genus *Lucillella* Strand, 1932, first proposed by Hewitson (1870) under the preoccupied name *Lucilla*, was treated by Stichel (1910-11, 1930-31) in what is now the tribe Riodinini, but was correctly moved to the tribe Symmachiini by Harvey (1987a) on the basis of its males possessing concealed androconial scales along the anterodorsal margin of certain abdominal tergites. Throughout the twentieth century, *Lucillella* was treated by most authors as containing three species, *L. camissa* (Hewitson, 1870), *L. asterra* (Grose-Smith, 1898), and *L. suberra* (Hewitson, 1877) (e.g., Stichel 1910-11; Seitz 1916-20; d'Abrera 1994). With the elevation of *L. pomposa* (Stichel, 1910) to species status from a subspecies of *L. asterra* (Hall & Harvey 2002), and the recent description of the new species *L. splendida* Hall & Harvey, 2007 (Hall & Harvey 2007), *Lucillella* is currently recognized as containing five species. However, the wing pattern and morphology of *suberra* are highly divergent, and the species does not appear to form a monophyletic group with the remaining four described members of *Lucillella* (Hall & Harvey 2002 [see Table 3], 2007). These four species, *L. camissa*, *L. asterra*, *L. pomposa*, and *L. splendida*, along with the new species *L. arcoirisa* described here, do however form a rather homogeneous group that seems to be monophyletic.

All five of these *Lucillella* species, illustrated in Figs. 3–7, are medium to large sized riodinids, with a relatively compact wing shape. The dorsal forewing is black with a broad orange to red band across its middle to base, the dorsal hindwing is predominantly pale to medium blue with variably broad black margins and all veins outlined with black scaling, and both dorsal wings have a variably prominent dark blue iridescence when viewed at an angle. The ventral surface is rather similar to the dorsal surface, but the hindwing and distal half of the forewing are a dully-iridescent blue or green with the veins outlined in black. Also outlined in black on the ventral (and sometimes dorsal) hindwing is a wing crease through the middle of cell Cu_2 and a short diagonal line just inside the lower half of the discal cell end, which forms one side of a small black triangle. Although the former character occurs in certain other genera, the latter character appears to be unique to *Lucillella*. In a few species of *Xenandra* C. & R. Felder, 1865, a similar black triangle occurs in the discal cell of the forewing. In contrast, *suberra* is a slightly smaller species, with narrow and elongate wings, no blue on the dorsal hindwing, no dark blue iridescence on both dorsal wings, a pale brown instead of dully-iridescent blue or green ventral surface, and no black scaling along a line through cell Cu_2 or inside the discal cell end on the ventral hindwing.

The male genitalia of the five true *Lucillella* species are characterized by a long, rectangular uncus bearing a prominent, downwardly curved projection from the middle of the dorsal posterior margin, and relatively large falces. The typically tripartite valvae are positioned at a roughly 45° angle in lateral view, and consist of a small, variably narrow, and slightly posteriorly curved anterodorsal portion, a generally rectangular posteroventral portion, and a dorsally elongate medial portion that is often posteriorly pointed at its tip. The aedeagus is somewhat short, very broad, and slightly medially convex, and the everted vesica is variably bulbous basally and bears three evenly spaced, approximately parallel, basal bands of small, anteriorly directed spine-like cornuti, two of which are large, oval, and dorsolaterally to laterally positioned, and one of which consists of a single row of slightly larger, ventrolaterally positioned spines. As *L. camissa* is the only true *Lucillella* species whose female appears to be known, no generalizations can yet be made about the female genitalia of the genus. In contrast, *suberra* has a short, square uncus bearing a tiny dorsal posterior projection, relatively small falces, a prominently convex aedeagus, and, most critically, a very different valve complex and everted vesica. The valvae consist of a long, dorsally, and slightly outwardly directed, narrowly rectangular, and very slightly medially convex main section, with a small, inwardly directed oval process attached anterodorsally by membranous tissue. The everted vesica is a uniformly narrow tube, with a pair of rather small, anteriorly directed, "hand"-like cornutal patches situated laterally at its very base, and a cluster of approximately eight very long and narrow, anterolaterally directed spines originating from the middle of its right side. As the wing pattern and morphology of *suberra* do not match those of any species in *Lucillella*, as defined here, or any other genus, it seems likely that *suberra* will eventually need to be placed in its own monotypic genus. Until such time as a more exhaustive generic-level study of the tribe can be completed (Hall in prep.), we prefer to retain *suberra* in *Lucillella* as a misplaced species rather than transfer it temporarily to another probably more distantly related genus (see below).

The sister genus to *Lucillella* is probably *Esthemopsis* C. & R. Felder, 1865 (Hall & Harvey 2002 [see Table 3]), based on similarities in the male genitalia, particularly the arrangement of cornuti on the everted vesica and the basic underlying structure of the valvae, and to a lesser extent certain ventral wing pattern elements, as well as the fact that both genera share the same distribution pattern of concealed male abdominal androconia. The males of all true *Lucillella* and *Esthemopsis* species have a narrow, medially divided band of androconial scales along the anterodorsal margin of tergites four, five, and six (Harvey 1987a; Hall & Willmott 1996; Hall & Harvey 2002). The only other symmachiine species with this androconial arrangement is *suberra*, suggesting that this species probably does have a close phylogenetic relationship with *Lucillella* and *Esthemopsis*, perhaps as their sister taxon.

Based on similarities in size, wing shape, wing pattern, and male genitalia, *L. arcoirisa* seems to be most closely related to the Colombian species *L. splendida*. Externally, *L. arcoirisa* differs from *L. splendida* by having a slightly more elongate wing shape, with a slightly less prominently convex forewing distal margin, and a forewing band that is twice as broad, dark orange instead of red, basally instead of discally positioned, and more elongate on the ventral surface, reaching the tornus, and by lacking a yellow bar along the costal margin of both hindwing surfaces. The male genitalia of the two species are similar, but differ slightly in the shape of the valvae, the male genital structure that exhibits the most interspecific variation in *Lucillella*. In the valvae of *L. arcoirisa*, the posterior margin of the rectangular posteroventral section curves anteriorly towards the medial section of the valvae instead of continuing in a straight line, and the posterior margin of the medial section of the valvae is approximately straight in its dorsal half instead of medially indented, leaving the posterior valve tip rounded instead of slightly posteriorly projecting.

Biology: This very rare species was found in wet montane forest at 2050 meters. Based on the type locality of the close relative *L. splendida*, which lies near the upper elevational limit for the family Riodinidae, the upper elevational limit for *L. arcoirisa* is likely to be close to 2200 meters. Based on the elevational ranges of other riodinids that occur with *L. arcoirisa* at 2050 meters, the lower elevational limit for *L. arcoirisa* is likely to be around 1500–1600 meters. Males of *L. arcoirisa* were discovered perching high above a small, vegetation-choked stream from about 1245 to 1315 hrs. From ground level, in the relatively gloomy understory, the butterfly activity above was barely discernible. However, by using the single rope technique to ascend above the dense midstory layer of streamside *Cecropia* trees, it became apparent that several riodinid species, among others, were perching in the sunny subcanopy, about 12 to 15 meters above the ground. The *Lucillella* males flew with a slow fluttering flight and landed beneath the tips of *Cecropia* leaves with their wings outspread. Although several *Lucillella* males were seen, given the difficult collecting conditions, only a single individual could be captured.

Another riodinid species found flying in this same

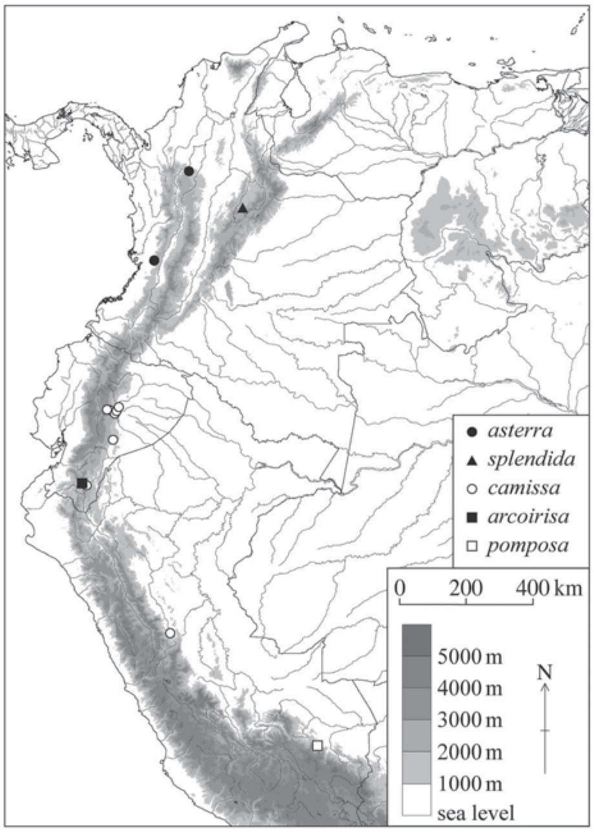

FIG. 10. Map of the northern and central Andes showing the known geographic ranges of the five true *Lucillella* species. The data points are based on the following locality data gleaned from the BMNH, ZMHU, MNHN, USNM, FLMNH, and JHKW: *L. camissa* (ECUADOR: Tunguruhua: Mapoto; Pastaza: Cashurco, Shell, Puyo, Río Llandia [Puyo-Tena rd.]; Morona-Santiago: Macas; Zamora-Chinchipe: Quebrada de Chorrillos [above Zamora]. PERU: Huánuco: Tingo Maria); *L. asterra* (COLOMBIA: Antioquia: Valdivia; Valle del Cauca: upper Calima valley); *L. pomposa* (PERU: Cuzco: Marcapata); *L. splendida* (COLOMBIA: Boyacá: Arcabuco); *L. arcoirisa* (ECUADOR: Zamora-Chinchipe: Río San Francisco [above Zamora]).

subcanopy lightgap was *Hades hecamede* Hewitson, 1870, a large member of the subfamily Euselasiinae (see Fig. 8). The males of *L. arcoirisa* and *H. hecamede* have such similar wing patterns and flight behaviors, it was not until a *Lucillella* male was actually netted that its true identity was realized. At a distance, the two species could only be readily separated when they landed, with *L. arcoirisa* resting with its wings open and *H. hecamede* resting with its wings closed. The remarkable similarity in the wing patterns of these two unrelated species, which fly in the same montane streamside habitats, suggests that there may be a mimetic relationship. It is certainly notable that the only other member of *Hades*, the white-rayed *H. noctula* Westwood, 1851, from the Transandean region, and most, if not all, of the other, aposematically brightly colored, *Lucillella* species appear to be involved in their own mimetic relationships. Given that the caterpillars of *H. noctula* are known to feed on plants in the Anacardiaceae, the caterpillars and pupae are gregarious (Harvey 1987b; Janzen & Hallwachs 2009), and fresh adults will exude drops of an oily brown fluid from the thorax when handled, in a manner similar to many arctiid moths (DeVries 1997), *H. hecamede* would seem to be a possible model in this mimicry system. With no good evidence to suggest that any members of the Symmachiini are unpalatable to predators, *L. arcoirisa* is probably a Batesian mimic. Other members of this mimicry ring might include the similarly patterned, although larger, members of the pierid genus *Pereute* Herrich-Schäffer, 1867, which fly with a slow gliding flight in the same streamside habitats.

Distribution: *Lucillella arcoirisa* is currently known only from the type locality in the southeastern Andes of Ecuador. However, given that no two *Lucillella* species are known to be sympatric (see Fig. 10 for the known distributions of all five true *Lucillella* species), with the most closely related species apparently geographically allo- or parapatrically distributed (e.g., *L. asterra* and *L. camissa*) and the more distantly related species elevationally allo- or parapatrically distributed (e.g., *L. arcoirisa* and *L. camissa*), the true distribution of *L. arcoirisa* can be estimated. We suggest that *L. arcoirisa* probably ranges from eastern Colombia to at least central eastern Peru, whereas the close relative *L. splendida* is probably confined to central Colombia and perhaps the Chocó.

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A NEW GEOMETRID GENUS AND SPECIES FROM SOUTHEASTERN ARIZONA (ENNOMINAE: NACOPHORINI)

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ABSTRACT. The new genus *Chiricahua* is described from moths collected in the Chiricahua Mtns., Cochise Co., Arizona. Two species are recognized: the new species *C. lichenaria*, the type species for the genus, and *C. multidentata*, previously placed in *Biston*. Adults and genitalia are illustrated.

Additional key words: Arizona, *Biston*, Bistonini, *Chiricahua multidentata, Chiricahua lichenaria*, Ennominae, Geometridae, Nacophorini

In mid-2008, I received from Ronald Leuschner, Manhattan Beach, CA, a male specimen of *Biston multidentata* Guedet, and two pairs of an undescribed moth also presumed to be a *Biston*, all collected in the Chiricahua Mtns. of southeastern Arizona. The abdomens were missing from one pair of the unknown species and the pin labels indicated that genitalic slides had been made. No slides accompanied the specimens and they are presumed lost following a thorough search for them. Guedet (1941) described *B. multidentata* from three females. When Rindge revised the New World Bistonini (1975), he had for examination only the three Guedet female specimens (from the California Academy of Sciences) and a fourth female collected by R. F. Sternitzky, also from the type locality (Flys Peak, Chiricahua Mtns., Cochise Co., AZ). The male was unknown at that time. Superficially the five specimens that I received certainly resemble a *Biston* species, excepting that the male antennae are not bipectinate. Rindge, however, did note a wing venation character in *B. multidentata* that differed from typical Bistonini and stated that a male would have to be examined to insure proper generic placement of the taxon. For reference, an adult male *Biston betularia cognataria* (Gn.) and genitalia are illustrated in Figs. 1–3.

When I dissected the male *multidentata* and the intact male of the undescribed species, I found the genitalia to be very similar, but totally different from anything in the Bistonini. Based on the male genitalia and a close examination of the external morphology, it is clear to me that both species belong in the Nacophorini, despite their superficial resemblance to *Biston*. The members of the tribe Nacophorini appear to be united by a character of the male genitalia: the frequently articulated or partially fused processes of the anellus (Figs. 9, 11, 14, 16). In her extensive treatment of the Australian Nacophorini, Young (2008) considered the tribe on a world basis, and briefly reviewed the New World species groups defined by Rindge (1983). The reader is referred to Young's treatise for discussion of the problems associated with defining this tribe.

In his comprehensive generic revision of the New World Nacophorini, Rindge (1983) recognized forty genera (in four species groups), ten of which occur north of Mexico. Pitkin (2002) followed Rindge's arrangement in her treatment of the Neotropical Nacophorini genera. Rindge defined the tribe by thirteen external morphological characters (Table 1, nos. 1–13, p. 151), eleven male genitalic characters (Table 3, nos. 14–24, p. 154), and 8 female genitalic characters (Table 5, nos. 25–32, p. 157). Each character is represented by a plesiomorphic (–) and an apomorphic state (+). When I coded the two species according to Rindge's characters 1–32, and then compared the results against his genus characters in Tables 1, 3, and 5, I did not find an exact match with any of the 40 recognized genera. The two species at hand have vestigial tongues in addition to lacking bipectinate antennae in the males. This combination does not match any of the forty genera in Rindge's Table 1. There are many genera without male bipectinate antennae or with vestigial tongues, but not in that combination. The male genitalic characters are closest to *Papago* Rindge, but fail to match on the antennae, uncus tip shape, and vesica sclerotization. No close genus affinities were found relative to the female genitalic characters. Based upon these results, I now propose a new genus.

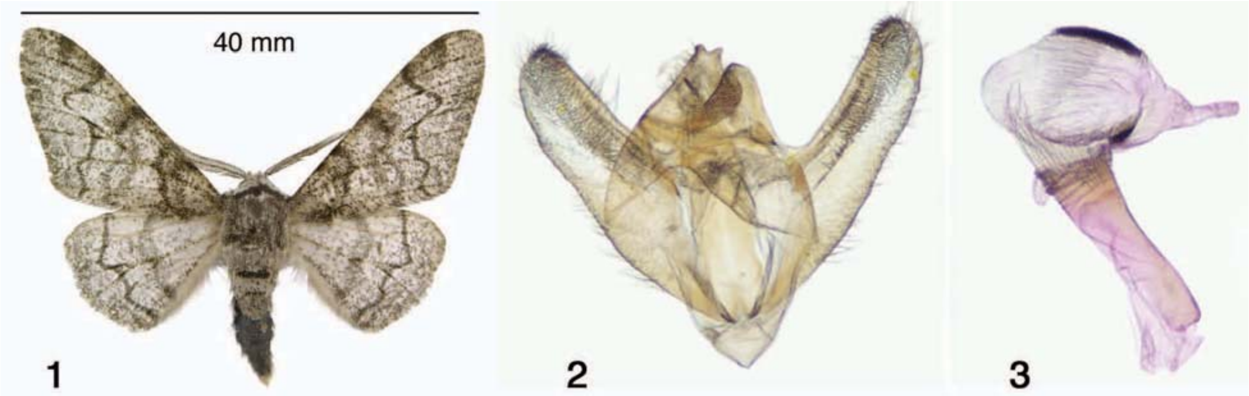
***CHIRICAHUA* Ferris, new genus**

(Fig. 4)

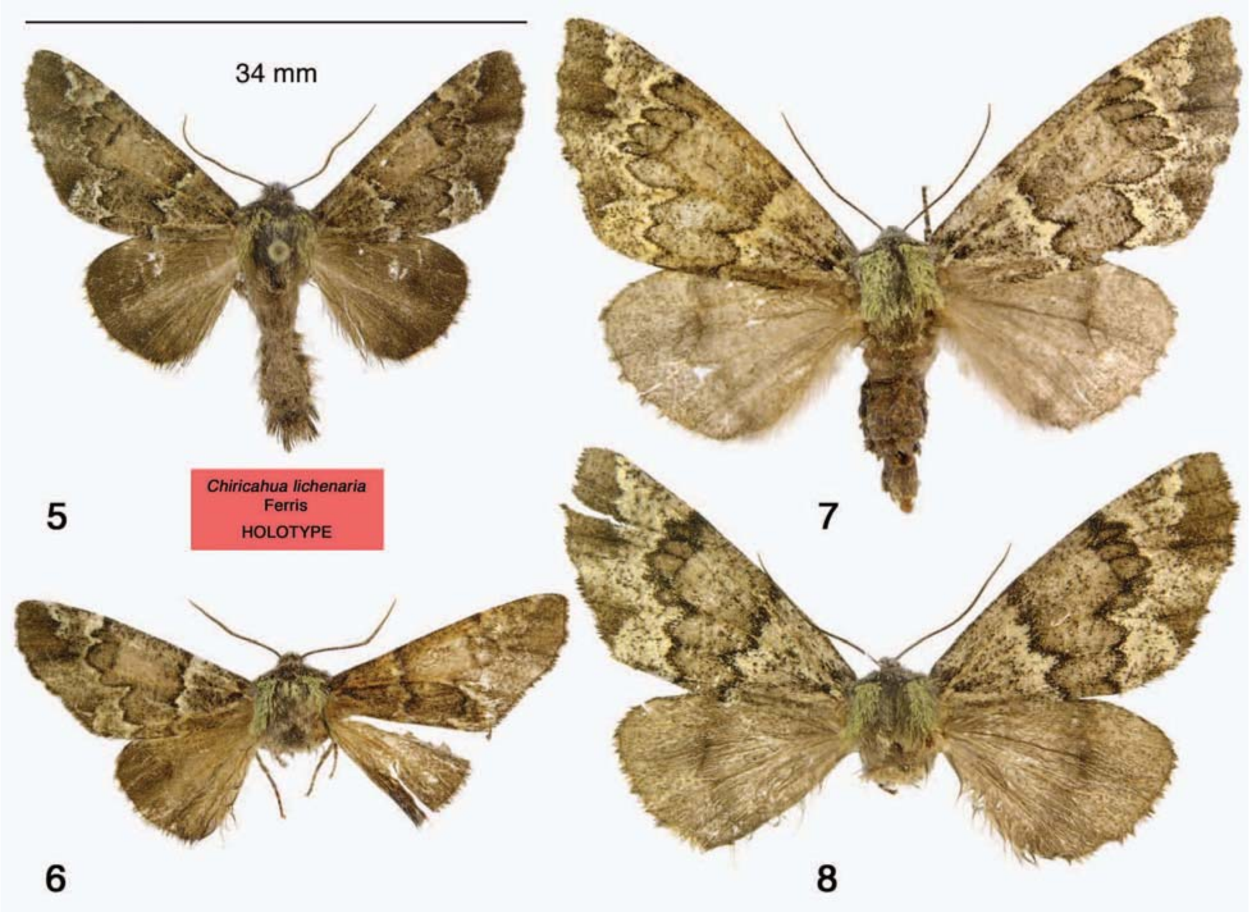
Biston, in part: Rindge, 1975, pp. 78–88, figs. 11, 17

Type species: *Chiricahua lichenaria*, Ferris, 2010.

Diagnosis. The two included species are medium-sized (length of forewing: 13–18 males, 17–26 mm



FIGS. 1–3. *Biston betularia cognataria*, Grant Co., NM. **1,** adult male; **2,** male genitalia less aedeagus; **3,** aedeagus with vesica everted.



FIGS. 5–8. *Chiricahua lichenaria* adults. **5**, holotype male (before dissection); **6,** male paratype; **7–8,** female paratypes (7 before dissection).

females), heavy-bodied, robust moths with cryptically mottled gray or brown wings, with the females larger than the males. The forewing apex is acute, but not falcate; the outer margin is sightly curved at the apex, then straight. The wing venation (Fig. 4) of the mle paratype of *C. lichenaria* was visualized by supporting a specimen on back-lit glass sides, wetting the wings with isopropanol, photographing the veins, then tracing the photo to obtain the line drawing. The venation in *C. multidentata* is similar. The male antennae are dentate, the female antennae filiform. Eyes are of normal size. The tongue is vestigial. There is one pair of spurs on the hind tibia and no hair pencil in the males. In the male genitalia, the uncus is simple and straight, the gnathos V-shaped, upcurved, and medially pointed, anellus with two prominent sclerotized processes, the vesica of the aedeagus is simple without armature. In the female genitalia, the corpus bursae is elongate, without striations, and with or without an inconspicuous small signum just above the fundus; the accessory glands are extremely large. Using Rindge's character set, the genus is represented as follows (characters 5–7 are omitted as they apply to bipectinate antennae; – = plesiomorphic state; + = apomorphic state): *External morphology*. (1 +) vestigial tongue; (2 –) 3rd segment of palpi one-half or less length of middle segment; (3 –) female palpi as large as those of males; (4 +) male antennae fasciculate; (8 –) front flat; (9 –) metathoracic tufts present; (10 +) dorsal abdominal tufts absent; (11 –) row of setae ventrally on 3rd abdominal segment of male abdomen absent; (12 +) one hind-tibial pair of spurs; (13 –) male hind-tibial hair pencil absent. *Male genitalia*. (14 –) uncus simple, straight; (15 +) uncus length greater than 1.0 mm; (16 –) socius present; (17 –) socius low, padlike; (18 –) gnathos present; (19 +) gnathos V-shaped, medially pointed; (20 –) valves simple without projections; (21 –) processes of anellus prominent, sclerotized; (22 +) length of processes of anellus shorter than length of uncus; (23 –) anellus without posteromedian extension; (24 +) spines or sclerotized rod absent in vesica. *Female genitalia*. (25 +) median point of attachment of apophyses posteriores to papillae anales; (26 +) length of ductus bursae shorter than wide; (27 –) length of corpus bursae less than twice as long as apophyses posteriores; (28 –) striations on posterior of corpus bursae absent; (29 –) shape of corpus bursae elongate/elliptical; (30 +/–) signum present/absent; (31 –) signum (when present) irregularly shaped, partially dentate; (32 –) shape of signum inside corpus bursae, flat, on surface only.

Biology. Unknown. Adults in June–August.

Distribution. Above 8000' (2440 m), Chiricahua Mtns., Cochise Co., Arizona; Durango, Mexico.

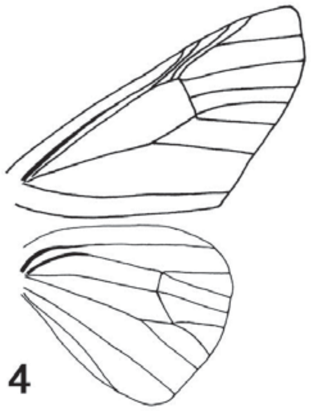


FIG. 4. Wing venation in *Chiricahua* from male paratype of *C. lichenaria*.

Etymology. The generic name is that of a mountain (Chiricahua means "Great Mountain") and an Indian tribe in Arizona; the gender is masculine.

Discussion. Consideration of its overall characters places *Chiricahua* in Rindge's Group I. Descriptions of the two species assigned to this genus follow.

Chiricahua lichenaria Ferris, **new species**

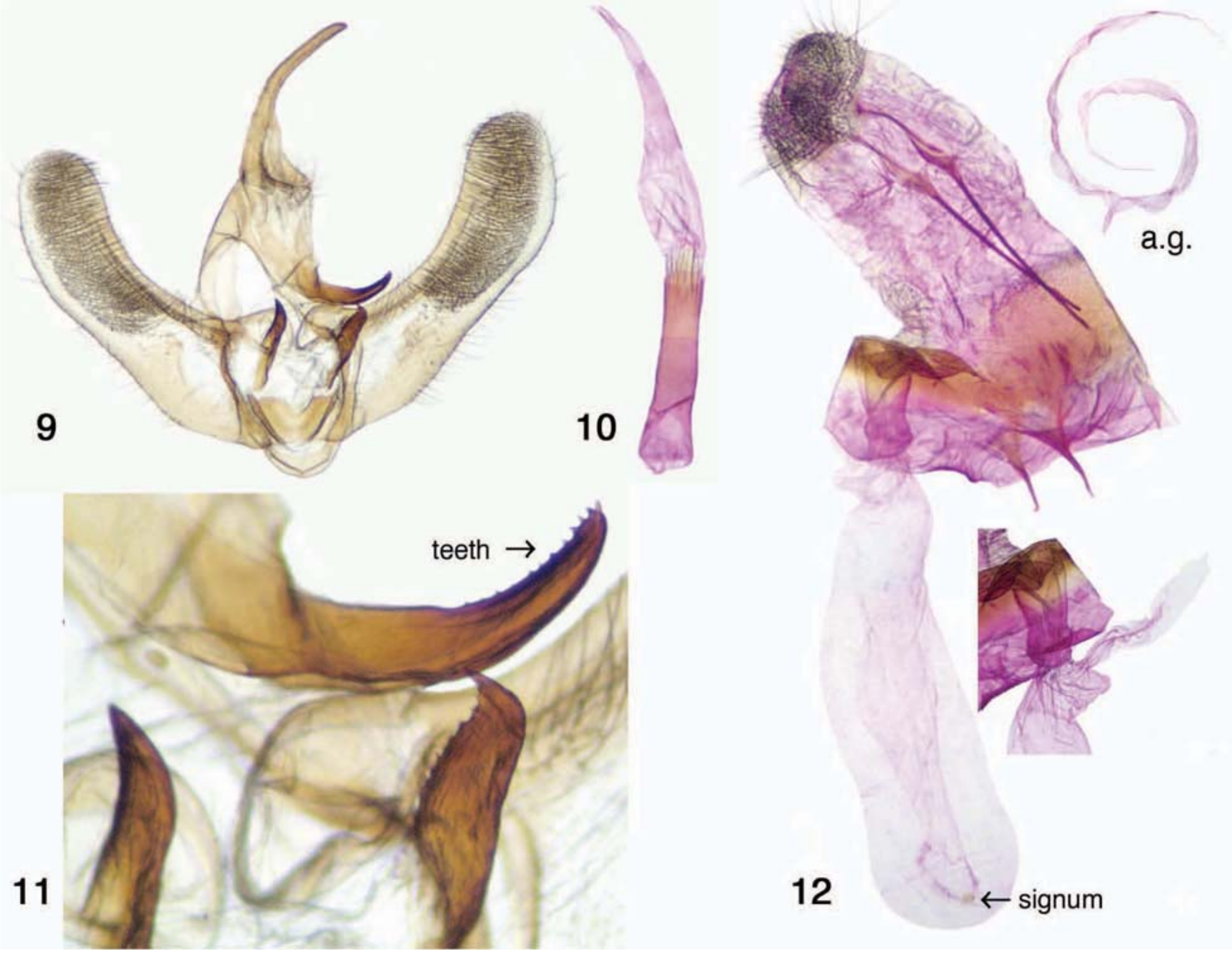
(Figs. 5–12)

Diagnosis. Its overall brown color, mottled appearance, and dorsal thorax mossy green scaling separate *Chiricahua lichenaria* from the sharply contrasting dark gray-brown and white pattern of its congener *C. multidentata*. In the male genitalia, the teeth on the dorsal surface of the gnathos are small and extend from about mid-length to the tip in *C. lichenaria*(Fig. 11); in *C. multidentata* the teeth are large and restricted to the area of the tip (Fig. 16). In the female genitalia of *C. lichenaria* there is a small signum in the corpus bursae that is absent in *C. multidentata*.

Description. As for the genus in general. *Head*. Antennae brown, dentate in males, filiform in females; front flat; eyes of normal size, elliptical (long axis vertical); labial palpi porrect and relatively short (length about that of eye vertical axis) with mixed dark brown and paler scales, ventral circle of whitish scales immediately behind head. *Thorax*. Anterior brown collar, then mixed mossy-green, brown, and paler scales dorsally, ventrally mostly brown scales with many hair-like long scales. Legs with alternating brown and whitish rings; one pair of hind-tibial spurs. *Abdomen.* Clothed with brown scales dorsally and ventrally. *Wings.* Male (FWL = 17–18 mm, n = 2). Ground color brown; dorsal forewing irregular dark brown AM line with pale shading basad; median area slightly paler brown than basal region; irregular dark brown PM line with distal narrow pale shading mid-wing, expanding into prominent mottled pale patches at costa and inner margin; fringe checkered brown and whitish; dark brown linear discal spot; overall scattered peppering of single or two conjoined dark brown scales. Dorsal hindwing uniformly brown, slightly paler basad; fringe checkered brown and white. Ventrally both wings uniformly brown; PM line and discal spot repeated on forewing; hindwing with narrow irregular dark brown median band. Female (FWL = 23–26 mm, n = 2). Dorsal forewing similar to males, but ground color sightly paler with expanded pale areas; discal spot obscured by smeary patch of brown scales. Ventral hindwing with "print though" of dorsal maculation. Dorsal and ventral hindwing uniformly brown with broad irregular darker brown median band. Fringes as in males. *Male genitalia.* As for the genus in general. Uncus long, slender, tapers to a point; pad-like socius with long slender hairs; medially-pointed and recurved gnathos v-shaped, with small teeth on dorsal surface near tip; valves simple, broad with sclerotized costa; two robust sclerotized anellus processes, with teeth dorsally near tips; aedeagus tubular, membranous vesica without sclerotization, slightly swollen about mid-length. *Female genitalia.* As for genus in general. Posterior apophyses ca. 4.7× length of anterior apophyses; ductus seminalis originates from small diverticulum at top of corpus bursae; corpus bursae long, of nearly uniform diameter expanding slightly toward fundus; small weakly sclerotized roughly circular signum with five scattered insignificant surface projections and irregular margin just above fundus.

Types. Holotype male (Figs. 5, 9–11): Arizona, Cochise Co., Rustler Park [Chiricahua Mtns.], 6 August, 1991, R. & J. K. Robertson. Deposited in American Museum of Natural History [AMNH], New York, NY. Paratypes (Figs. 6–8): 1♂ , same locality as holotype, 21.vii.1985, R. Robertson; 2♀ , same data as holotype. The paratypes are in the author's collection.

Additional Material. Following the initial submission of this paper, I received a photograph of an unspread female specimen in the Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Canada. It was collected by J. E. H. Martin at 9000' (2745m) 10 mi. west of El Salto, Durango, Mexico on 11 August, 1964. I have not included this specimen in the type series since I examined it by color photograph only.



FIGS. 9–12. *Chiricahua lichenaria* genitalia. **9–11,** male genitalia: **9,** genitalia, aedeagus removed; **10,** aedeagus with vesica everted; 11, lower part of gnathos and anellus processes. **12,** lateral images female genitalia (accessory glands removed); insets show: diverticulum and ductus seminalis viewed from opposing side; accessory glands (a.g.) at much reduced magnification.

Biology. Unknown.

Distribution. Known from the type locality and vic. El Salto, Durango, Mexico.

Etymology. The name *lichenaria* (adjective) reflects the lichenous pattern of the forewings.

Chiricahua multidentata Guedet. **new status**

(Figs. 13–18)

Amphidasis multidentata Guedet, 1941, Pan–Pacific Entomol. 17(4), pp. 191–192.
Biston multidentata Rindge, 1975.

Diagnosis. Males of *Chiricahua multidentata* are recognized by their dentate antennae, thus separating them from similar-looking *Biston* species. The sharply contrasting dark gray-brown and white wing pattern and brown and white banded dorsal thorax separates *multidentata* from its sombre mottled brown congener *lichenaria*. In the male genitalia, the teeth on the dorsal surface of the gnathos are large and restricted to the tip in *C. multidentata*; in *C. lichenaria* the teeth are small and extend from about mid-length to the tip. In the female genitalia, the small signum seen in *C. lichenaria* is absent in *C. multidentata*.

Comment. Both Guedet (1941) and Rindge (1975) provided descriptions of the external morphology of the female of this species. Rindge illustrated the female adult and genitalia, and provided a detailed description of the latter. The male was unknown, and is now described along with a brief description of the female.

Description. Male, as for genus in general. *Head*. Antennae dentate, checkered brown and pale gray; eyes of normal size, elliptical (long axis vertical); labial palpi porrect and relatively short (length about that of eye vertical axis) with mixed dark brown and paler scales; tuft of white scales between eyes; collar dark brown. *Thorax*. Ventral with mixture of long mixed brown hair-like scales; dorsal with three broad white axial bands separated by two narrow dark brown bands, outer bands edged in dark brown, midthoracic brown and white scale tuft. Legs with alternating brown and whitish rings; one pair of hind-tibial spurs. *Abdomen*. Clothed with pale gray-brown scales dorsally and ventrally, except last two terminal segments dark brown. *Wings* (FWL = 13–15 mm, n = 3). Dorsal forewing ground color white, sprinkled lightly with brown scales; irregular bold dark brown AM band; median area more heavily brown irrorated than basal area; discal spot a narrow dark brown vertical line; PM line irregular, very dark brown, inwardly brown shaded from costa to below discal spot; marginal area white with sight brown irroration; broad brown marginal band interrupted at middle by broad white intrusion. Dorsal hindwing white, heavily irrorated by brown scales; narrow broken irregular median band; checkered brown and white fringes, both wings. Dorsal wing pattern repeated ventrad. Female (FWL = 17–19 mm, n = 5). Wings and body virtually identical in color and maculation to males; dorsal forewing median band slightly paler than in males. *Male genitalia*. As for the genus in general. Uncus long, slender, tapers to a point; pad-like socius with long slender hairs; medially-pointed and recurved gnathos V-shaped, with well-developed teeth on dorsal surface at tip; valves simple, broad with sclerotized costa; two sclerotized anellus processes, pointed at tips; aedeagus tubular with rod-like process originating at mid-length and extending beyond apex; membranous conical vesica without sclerotization. *Female genitalia*. As for genus in general. Posterior apophyses ca. 2.6× length of anterior apophyses; ductus seminalis originates from small diverticulum at top of corpus bursae; corpus bursae long, of nearly uniform diameter expanding into a bulb toward fundus; signum absent.

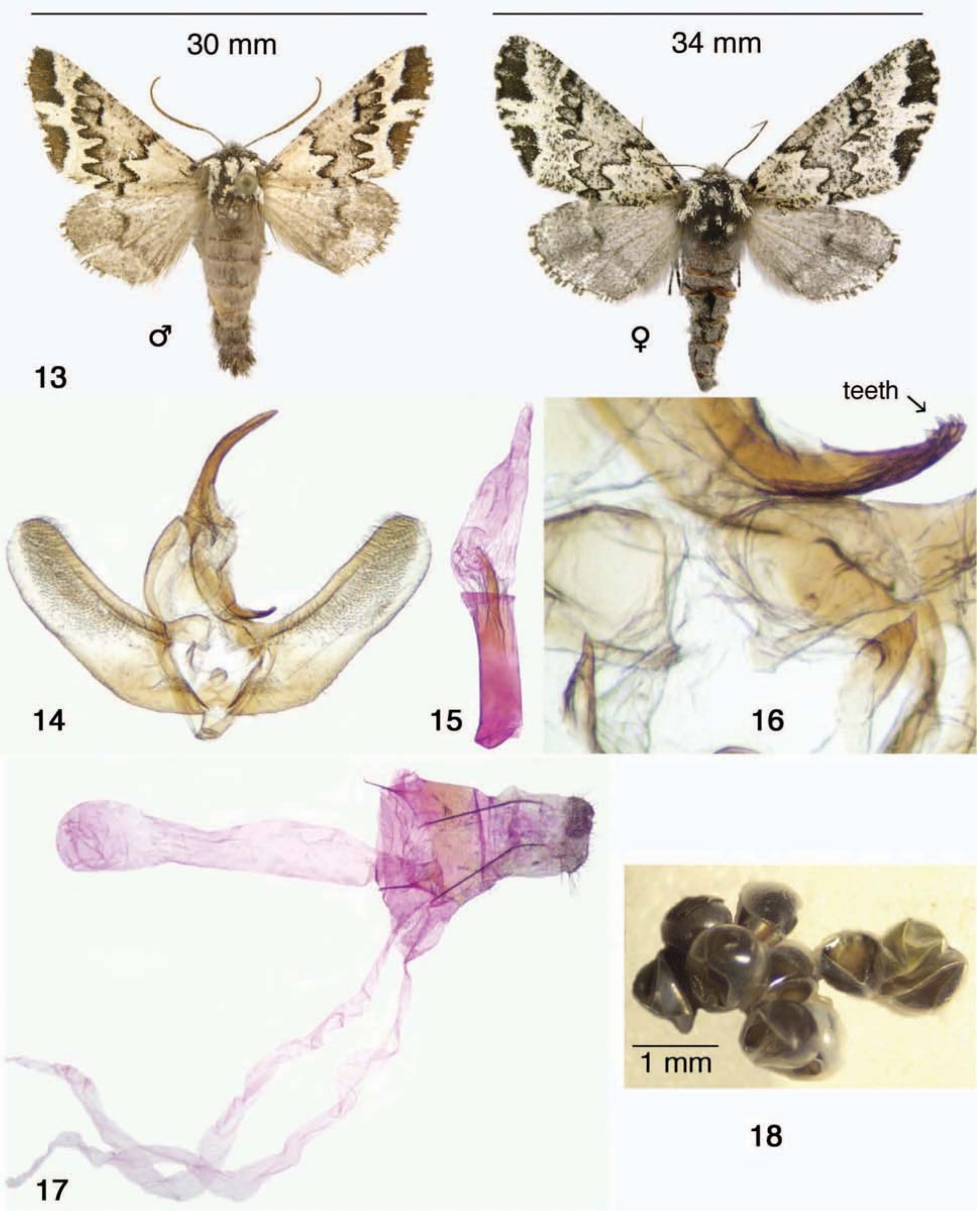
Types. Holotype and two paratypes deposited in California Academy of Sciences, San Francisco, CA. Holotype female, type No. 5206. Type locality: Fly [*sic*] Peak, Chiricahua Mountains, Cochise County, Arizona, 9000–9300 feet [2745–2837m], July 30, 1927, collected by J. A. Kusche. Two female paratypes, same locality on 28 July, 1927.

Additional Material Studied. In addition to the three females in the type series, a fourth female from the type locality was collected by R. F. Sternitzky on 17 June, 1974 and is in the American Museum of Natural History, New York. A fifth female (abdomen missing) collected by W. C. McGuffin 10 miles west of El Salto, Durango Mexico, 9000' (2745m), 10 August, 1964 is in the Canadian National Collection of Insects, Arachnids, and Nematodes (CNC). The male specimen described herein is one of two collected in Rustler Park, 8500’ (2590m) on 27 July, 1998 by Ron Leuschner and K. Richers. Until June, 2009, *C. multidentata* was known only from 2 males and 5 females with collection dates spanning from 1927 to 1974. On the night of 13 June, 2009, John Palting (Tucson, AZ) collected eleven fresh males in Long Park, 9160’ (2794m), Chiricahua Mtns., Cochise Co., AZ at mercury vapor light, and on the night of 17 July, 2009 three additional males and five females. J. B. Walsh (Tucson, AZ) collected a fresh male at mercury vapor light in Long Park on the night of 16 June, 2009. Thus in 2009, fifteen males and five females of *C. multidentata* were collected with now seventeen males and ten females known for this species. Long Park is the trailhead for the Flys Peak trail. I visited Long Park on the night of 29 July, 2009, and although the weather conditions were very favorable for moth collecting, no *C. multidentata* were found, nor was *C. lichenaria*.

Biology. Unknown. One of the females collected by John Palting deposited black eggs on a pine stem after being offered a suite of plants that included alder, aspen, *Spirea*, maple, spruce and pine. The eggs (Fig. 18) failed to hatch.

Distribution. Known from the Chiricahua Mtns., Cochise Co., Arizona, and Durango, Mexico.

Discussion. Based upon current evidence, both species of *Chiricahua* are uncommon (with collection dates spanning from 1927 to 2009). To my knowledge, the only specimens existing in collections are the thirty-two mentioned herein. Flys Peak lies in the Chiricahua Wilderness Area with the only access by foot or possibly horseback, which accounts for few visits by collectors.



FIGS. 13–18. *Chiricahua multidentata*. **13,** adults (before dissection; male slightly faded, Rustler Park, 27.vii.1998; female, Long Park, 17.vii.2009). **14–16,** male genitalia: **14,** genitalia, aedeagus removed; **15,** aedeagus with vesica everted; **16,** lower part of gnathos and anellus processes. **17,** female genitalia (ventro-lateral view) showing the two large accessory glands, ductus seminalis obscured by overlying tissue. **18,** eggs.

Long Park is accessible by a high-clearance 4×4 vehicle over a primitive trail. On the other hand, Rustler Park is a popular camping and collecting area with good road access and regular visits by collectors. The lack of viable mouth parts suggests that the adult moths have short lives. The collection dates are during the monsoonal rain period, the start of which can vary by several weeks annually. One might infer that adult emergence is triggered by rain and that individual moths then fly during a few nights only. June 2009 was unusually wet in SE Arizona. The cryptic pattern of *Chiricahua multidentata* suggests that adults may roost on the bark of Aspens. The somber and mottled pattern of *C. lichenaria* suggests the roosting substrate to be lichen-covered dark tree trunks or perhaps lichen-covered boulders. It's possible that the Chiricahua Mtns. represent the northern range limit of these two species, and that they are more abundant in montane areas yet to be explored in Mexico . It is interesting to note that one specimen each of both species was taken a night apart at the same locality in Durango, Mexico.

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NOTES ON THE STATUS AND ECOLOGY OF *STRYMON ACIS BARTRAMI* (LYCAENIDAE) IN EVERGLADES NATIONAL PARK

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ABSTRACT. A 10-year survey was conducted within the pine rocklands of Everglades National Park to study the status, phenology and natural history of *Strymon acis bartrami* (W. Huntington and Comstock). The response of populations of this species to prescribed fires and hurricane activity within the Everglades was also noted. *Strymon a. bartrami* (n = 77 adults) was encountered throughout the survey, most often in the spring, but was generally uncommon. The species was slow to re-colonize recently burned pine rocklands. However, prescribed fires conducted in a cyclic pattern as well as near appropriate hostplant-bearing refugia may have aided *S. a. bartrami* in post-burn re-establishment. In addition, the species appeared to recover quickly after hurricane events in the Everglades.

Additional key words: prescribed fire, phenology, conservation, hurricanes

Strymon acis bartrami (W. Huntington & Comstock) (Lycaenidae) (Fig. 1) has historically occurred throughout the pine rocklands of southern Florida and the lower Florida Keys (Baggett 1982; Minno & Emmel 1993; Smith *et al*. 1994; Salvato & Hennessey 2004), where it is endemic. However, due to extensive habitat loss across much of its former range, this species is now restricted to the pine rocklands within and adjacent to Everglades National Park (Fig. 2) as well as to Big Pine Key, which is part of the National Key Deer Refuge (NKDR) in the lower Florida Keys.

In addition to habitat loss, use of chemical adulticides for mosquito control and suppression of natural fire regimes have been suggested as primary factors that have influenced the decline of *S. a. bartrami* (Hennessey & Habeck 1991; Hennessey *et al*. 1992; Emmel *et al*. 1995; Schwarz *et al*. 1996; Salvato 1999, 2001).

In the Everglades, where the threat of further habitat loss or use of chemical pesticides is reduced, the role and frequency of fire remains a critical factor influencing populations of *S. a. bartrami* (Salvato 1999; Salvato & Hennessey 2004). Historically, periodic lightning-induced fires were a vital component in maintaining native vegetation within the pine rockland ecosystem (Loope & Dunevitz 1981; Slocum *et al*. 2003), including *Croton linearis* Jacq. (Euphorbiaceae), the only known hostplant for *S. a. bartrami*. While prescribed fire had been employed as a management tool in the Everglades for several decades, it was only towards the end of the twentieth century that these protocols were adapted to best mimic the timing of lightning-ignited fires and their role in natural histories of various pine rockland species.

Strymon a. bartrami is rarely found farther than 5 m from the hostplant (Schwartz 1987; Worth *et al*. 1996; Salvato & Salvato 2008) and is generally thought to have limited dispersal abilities preventing the species from escaping fire events (Salvato & Hennessey 2004). Kwilosz & Knutson (1999) found that, while fire

FIG. 1. *S. a. bartrami* at gate 4 in Long Pine Key on 22 November 2003 (Photo: H. L. Salvato).

improves habitat, it also temporarily suppresses resident butterfly populations. Swengel (1996) and Swengel & Swengel (2001, 2007) indicated that many specialist insects have a negative short-term response to fires because they must rebuild their populations from unburned areas. Therefore, when large or entire tracts of *C. linearis*-bearing pine rocklands are burned the *S. a. bartrami* populations that occurred within them may be either extirpated or only slowly re-colonized from adjacent areas (Lenczewski 1980; Salvato & Hennessey 2004).

Salvato & Salvato (2007) discussed the influence of hurricane and tropical storm activity on several butterfly species within coastal portions of southern Florida. These studies indicated that species richness and abundance returned to pre-storm levels within one year after the disturbances. However, the potential influence of tropical storms on pine rockland species such as *S. a. bartrami* has never been evaluated.

This paper describes our ongoing population monitoring of *S. a. bartrami* within Everglades National Park and examines phenology, natural history, and response to hurricane activity, as well as the possible influence of prescribed fires on the abundance of this species.

METHODS

A survey transect was established at the gate 4 nature trail in the Long Pine Key (LPK) portion of Everglades National Park and monitored on one sampling date a month from January 1999 to December 2008 following the parameters outlined in Hennessey & Habeck (1991) and Salvato (1999). The transect was 400 m long and 5 m wide (0.2 ha) and occurred within pine rockland habitat with evenly distributed amounts of hostplant. To determine *S. a. bartrami* distribution in LPK additional, similarly proportioned transects (n = 3) were established during 2004 in areas where the species had been historically reported (gates 2, 8 and 10) (Fig. 3). These additional transects were monitored on one sampling date a month from 2004 to 2008. The status and natural history of another imperiled pine rockland

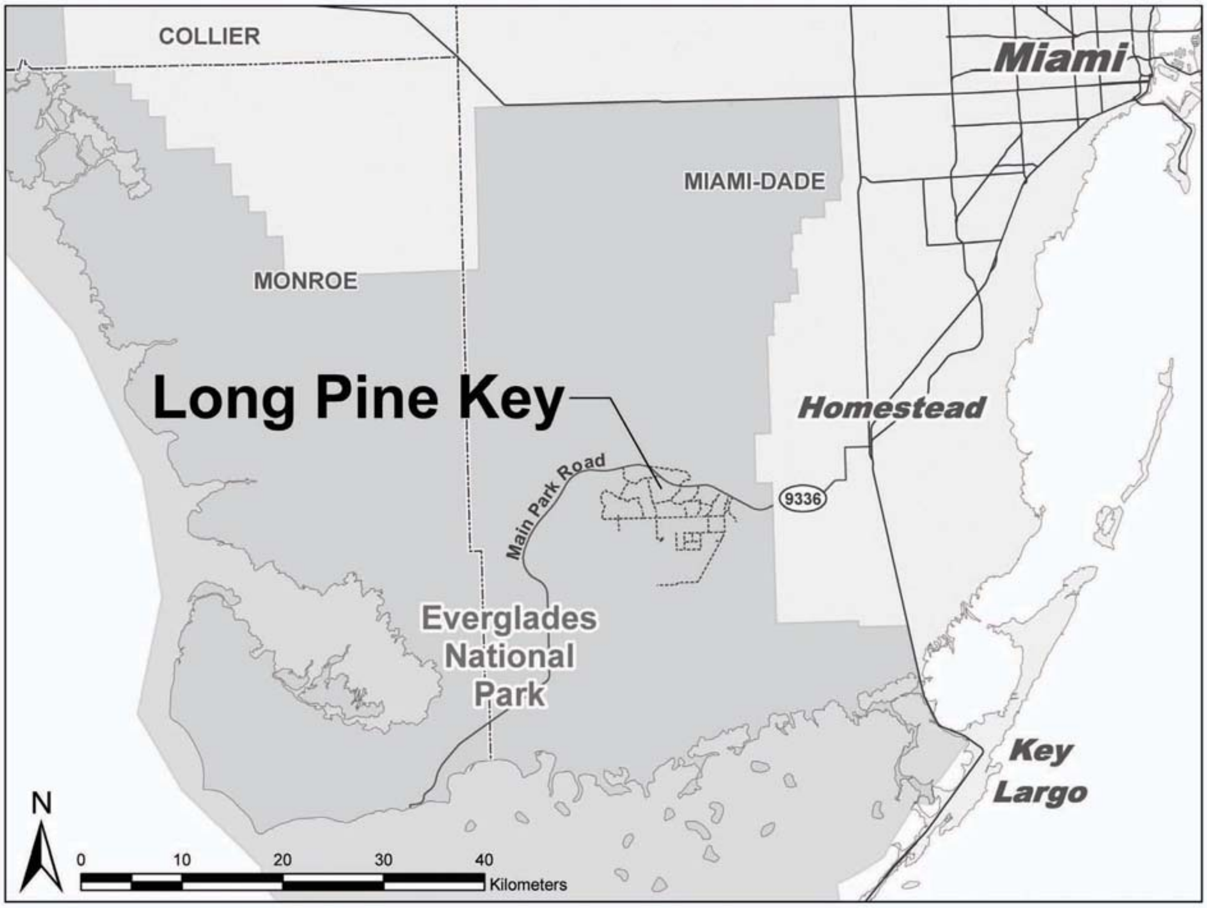

FIG. 2. Location of Long Pine Key within Everglades National Park (Park area and boundaries are indicated by shaded coloring) and southern Florida.

butterfly, *Anaea troglodyta floridalis* F. Johnson & Comstock, was also studied during this survey and these data are discussed elsewhere (Salvato & Salvato 2010).

Sampling dates occurred on warm, clear days when temperatures were considered sufficient for butterflies to be active. Adult butterfly abundance was determined on each monthly sampling date by recording the number of butterflies observed. Monthly visits to transects occurred at approximately four-week intervals which reduced the likelihood of encountering the same individuals on consecutive sampling dates. During 1999 to 2003 each monthly sampling date included approximately three to four hours of field time (between 08:00–12:00 h) at gate 4. From 2004 onward field time increased to approximately 9 hours (between 08:00– 17:00 h) on each monthly sampling date to accommodate the additional study sites at gates 2, 8 and 10.

Surveying transects on a monthly basis provided a standardized method for monitoring *S. a. bartrami* over the study period. Throughout the 10-year duration of this survey we attempted to choose sampling dates under appropriate weather conditions for *S. a. bartrami* to be active. However, these studies only provided a general estimate of *S. a. bartrami* abundance during this time frame. Additional sampling dates may have reflected a different level of abundance at the various survey sites.

On the same dates *C. linearis* (n = 100) was inspected at the gate 4 transect to monitor for larval activity. Fresh growth and flowers of *C. linearis* were examined for early instar *S. a. bartrami* larvae, while mature parts of the hostplant were searched for older larvae. Approximately one hour was spent inspecting *C. linearis* for *S. a. bartrami* larvae at gate 4 during every sampling date. *Croton linearis* was not monitored as extensively for larvae on the remaining transects, but larval activity, when observed at these locations, was noted. We attempted to determine the fate of larval development on subsequent sampling dates by examining the plants on or near where larvae had been observed during prior visits.

On several occasions throughout the study, prescribed burns were administered on all or part of select study sites. In such instances *C. linearis* was monitored to note general recovery time post-burn as well as duration until *S. a. bartrami* returned to the study site. In addition, adult *S. a. bartrami* abundance within the gate 4 study area was evaluated during the six months preceding and following burn events. A paired t-test (one-tailed) was used to compare overall *S. a. bartrami* abundance pre- and post-burn following prescribed fires at gate 4. This analysis allowed for small sample sizes of *S. a. bartrami* abundance, with unequal variances, to be examined before and after fire events at the same site on different years.

Following hurricanes Irene (1999), Katrina (2005) and Wilma (2005) we monitored the response of *S. a. bartrami* to storm influence.

RESULTS

Table 1 indicates the number of adult *S. a. bartrami* observed during 1999 to 2008 at Long Pine Key at gate 4, based on monthly surveys. Only one adult was observed during 1999 (9 March) (Salvato 2003). In subsequent years between one (2008) and 15 (2006) adults were observed annually.

A total of 55 adult *S. a. bartrami* was recorded at gate 4 over the 10-year survey period. Table 1 summarizes our observations of the species (n = 22) at gates 2, 8 and 10 during 2004 to 2008. Adults were observed during every month of the year, but the majority of observations occurred from March to June (Table 2), suggesting the species reaches peak abundance in LPK during spring.

TABLE 1. Total number of adult S. a. bartrami observed annually during 1999 to 2008 in Long Pine Key at gates 2, 4, 8 and 10, based on 12 months of sampling each year. NA indicates that data was not collected at this location during this period.

Area	1999	2000	2001	2002	2003	2004	2005	2006	2007	2008
Gate 2	NA	NA	NA	NA	NA	2	5	6	4	0
Gate 4	1	6	6	5	3	9	6	15	3	1
Gate 8	NA	NA	NA	NA	NA	0	0	0	1	4
Gate 10	NA	NA	NA	NA	NA	0	0	0	0	0

TABLE 2. The mean number (± standard deviation) of adult S. a. bartrami observed monthly during 1999 to 2008 in Long Pine Key at gate 4 only, based on 12 months of sampling each year.

Month	Mean	Std. Deviation
January	0.3	0.483
February	0.4	0.516
March	0.7	0.675
April	1.0	1.491
May	1.4	1.647
June	0.9	1.101
July	0.2	0.422
August	0.2	0.422
September	0.3	0.483
October	0.2	0.422
November	0.5	0.707
December	0.3	0.483

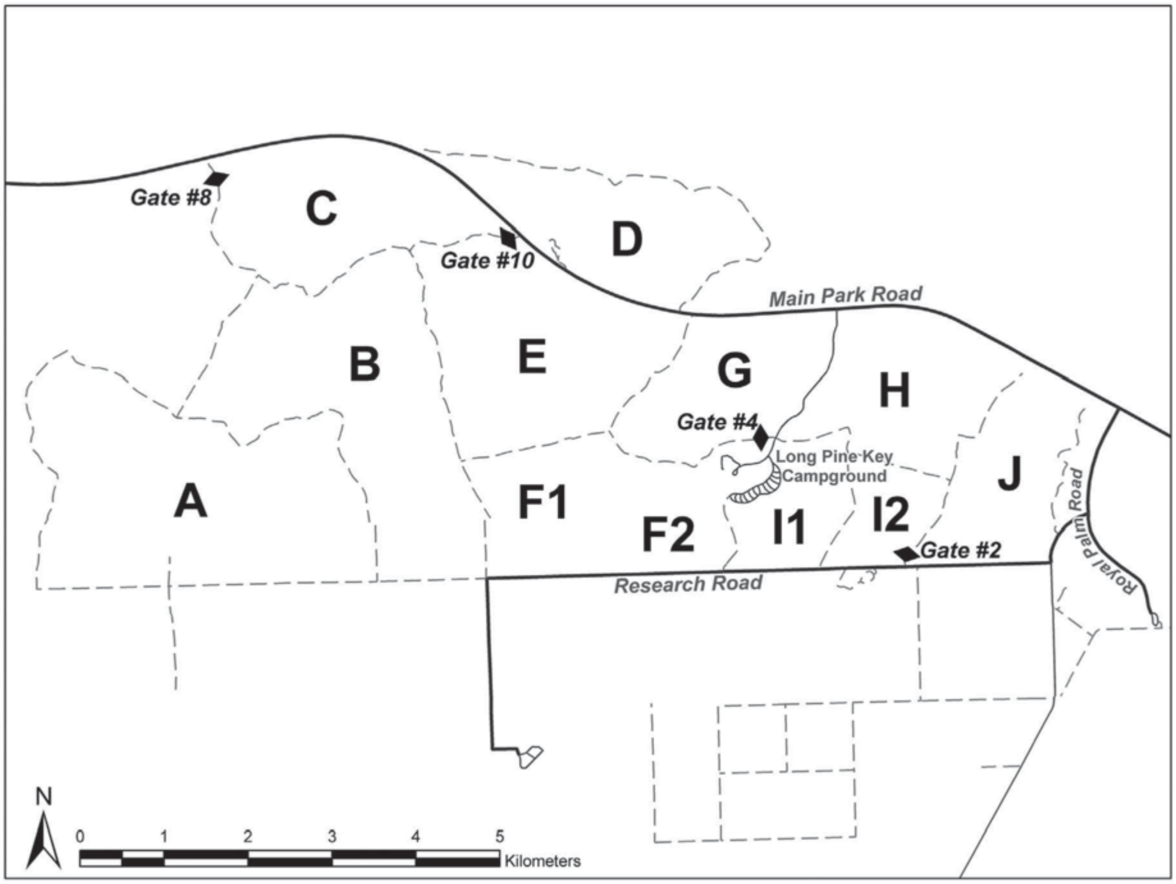

FIG. 3. Locations of the study areas at gates 2, 4, 8 and 10 and the burn units within Long Pine Key.

Figure 4 shows adult *S. a. bartrami* abundance at gate 4 during the six-month periods preceding and following the six prescribed fire events administered during the study period. Similar *S. a. bartrami* abundance was observed at gate 4 before and after four of the six burn events. As a result, although more adults were observed prior to prescribed burns (n = 29, mean = 4.833) than after the fires (n = 4, mean = 0.667), this difference was not significant (t-test; t = 1.7885, p = 0.0669).

Several adult *S. a. bartrami* observations at gate 4 in early 2000 (n = 6) (following Hurricane Irene in October 1999) and early 2006 (n = 15) (after Hurricane Katrina in August 2005 and Hurricane Wilma in October 2005) suggested that this species can recover quickly from the influence of storm activity.

Only four *S. a. bartrami* larvae were encountered during this study, three at gate 4 (May 1999, March 2003 and April 2006) and one at gate 8 (December 2007). The cryptic nature of the larvae made them difficult to locate and it is likely that a considerable number of individuals were overlooked during our surveys.

DISCUSSION

The population status of *S. a. bartrami* within the Everglades has varied in the literature for several decades. Lenczewski (1980) indicated that while the species was encountered consistently within the pine rocklands of Long Pine Key during the early 1970s, it appeared to have been extirpated in the Everglades later that decade. However, subsequent surveys by Hennessey & Habeck (1991) and Emmel *et al*. (1995) found the species in low numbers. Salvato (2001) was unable to find *S. a. bartrami* within LPK during an intensive survey in 1997–98, but did ultimately encounter the species in 1999 at gate 4 at the onset of this study (Salvato 2003). During the present survey, the species was observed throughout the year, most frequently during the winter and spring across LPK, but never abundantly.

Salvato & Hennessey (2004) suggested that *S. a. bartrami* may have historically been more common within the Everglades due to the influence of a natural fire regime that maintained a widespread distribution of *C. linearis*. Natural fires in the pine rocklands are

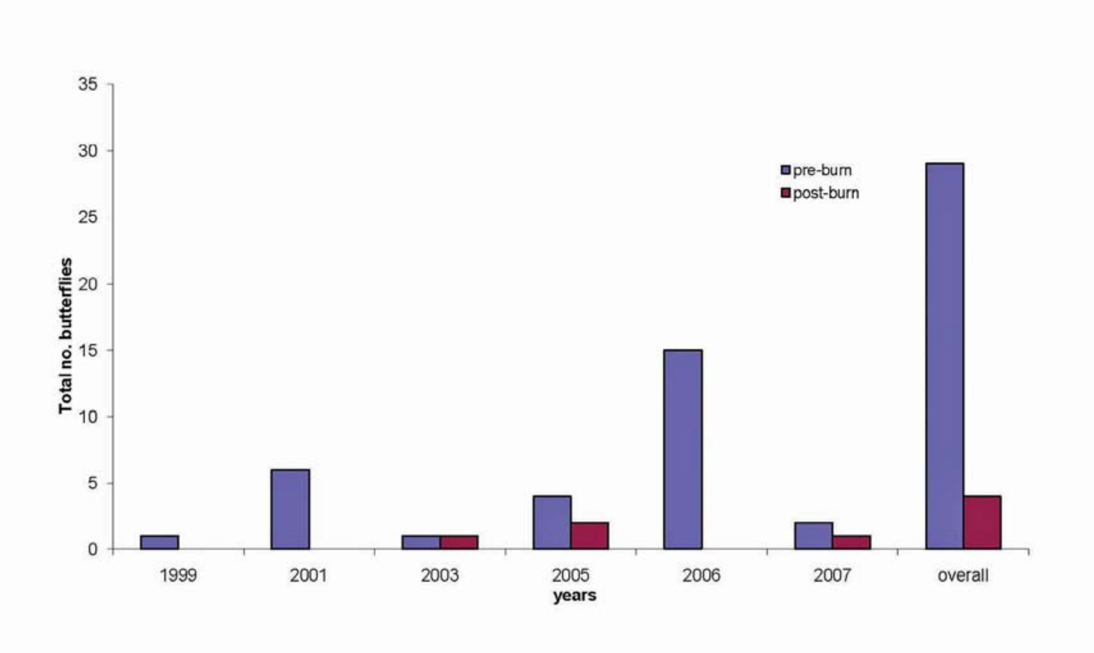

FIG. 4. Indicates the total number of adult *S. a. bartrami* observed at gate 4 of Long Pine Key within the six months preceding and following prescribed burn events.

important in regulating and maintaining the herbaceous layer, including *C. linearis* (Loope & Dunevitz 1981; Carlson *et al*. 1993; Bergh & Wisby 1996; Slocum *et al*. 2003). Since 1989, LPK fire management staff have ignited prescribed fires on a cyclic basis to best mimic those historically initiated by lightning strikes (Slocum *et al*. 2003). While this policy has resulted in pine rockland restoration throughout much of LPK, including a resurgence in *C. linearis*, many populations of this hostplant remain fragmented throughout the Everglades. This has isolated *S. a. bartrami* populations (Salvato 1999), possibly presenting an obstacle towards re-colonization. Salvato & Hennessey (2004) indicated that *S. a. bartrami* appears to require continuous stands of *C. linearis*, based on its close association with this hostplant. In the lower Florida Keys, Salvato (1999, 2003) and MHS & HLS (unpublished data) reported finding *S. a. bartrami* reliably in areas of Big Pine Key within NKDR that maintained widespread *C. linearis*, but found the species to be less frequent where hostplant populations were small or fragmented.

At the onset of this survey we encountered *S. a. bartrami* consistently in low numbers at gate 4, an area in Long Pine Key where *C. linearis* is common and largely contiguous. During June 2001 much of our gate 4 study area in burn units F2 and G (see Fig. 3) was subjected to a prescribed burn (approximately 540 ha) and *S. a. bartrami* was not observed again at this location more than six months (Fig. 4).

Lenczewski (1980) and Salvato & Hennessey (2004) indicated that *S. a. bartrami* requires at least five months to re-colonize an area following a burn. However, in 2007 MHS & HLS (unpublished data) found that this species had successfully re-colonized prescribed burn areas of Navy Wells Pineland Preserve, an approximately 100-ha area consisting largely of relict pine rocklands adjacent to the Everglades, within only three to four months of the fires. The small sizes of these prescribed fires (5 and 11 ha, respectively) and availability of *C. linearis* adjacent to the burn sites may have aided *S. a. bartrami* in re-establishing more quickly. By comparison burns in LPK during this study were often larger and not always near or containing appropriate hostplant-bearing refugia. Knight & Holt (2005) found insect abundance to be higher at the edges of burned areas bordered by refugia as compared to the interior of the treatment area. Swengel & Swengel (1996) reported that *Lycaeides melissa samuelis* Nabokov (Lycaenidae) responded favorably to fire management practices in central and northwestern Wisconsin when provided with unburned refugia for recolonization. Kwilosz & Knutson (1999) determined that while *L. m. samuelis* numbers dropped substantially within burned areas, overall population numbers remained unchanged due to recolonization of the area by individuals surviving within the refugia or returning from adjacent unburned units. Similarly, Panzer (2003) and Johnson *et al*. (2008) reported that many insects will successfully rebound in a burned location provided that enough individuals can re-colonize from adjacent areas. If *S. a. bartrami* is unable to disperse adequately during fire events then only adults at the periphery of burned areas are likely to escape to adjacent pine rocklands (Salvato & Hennessey 2004). Given the low numbers of *S. a. bartrami* found in this and other surveys, it is likely that only a small number of butterflies reach refugia during LPK burn events, thereby reducing the ability of the species to return and re-colonize in substantial numbers after a fire.

Although the prescribed burns conducted within the gate 4 study area during 2001 were extensive, those conducted throughout the remainder of the survey period were done in an alternating pattern from year-to-year. This provided such species as *S. a. bartrami* with refugia of similar habitat adjacent to the burn locations. Following each of these subsequent burns, at least one side of our gate 4 study site (unit F2 or G) continued to maintain *C. linearis* for butterfly use until the entire area recovered. Possibly as a result of this cyclic burn pattern and continual access to *C. linearis* adult *S. a. bartrami* observations increased within gate 4 during 2004 and into early 2006. In the winter and spring of 2006, we recorded 15 adults within the northern half of gate 4, the greatest abundance noted for the species during this survey.

However, this increased abundance was short-lived. A prescribed burn (approximately 353 ha) was conducted during June 2005 within unit F2 on the southern side of the gate 4 study area. Post-burn recovery of *C. linearis* was slow and hampered by hurricane activity. At one-year post-burn, the hostplant was sparse within the southern portion of gate 4, but it remained abundant in unit G to the north, where the majority of the *S. a. bartrami* were observed. A prescribed burn (approximately 318 ha) was administered to unit G during July 2006. Following this burn *S. a. bartrami* abundance declined again at gate 4 for the remainder of the study (Table 1).

Strymon a. bartrami was encountered sporadically on a number of our other transects (gates 2 and 8) and elsewhere (gate 11) in LPK during the remaining years of this study. These are areas where the species was previously reported (Hennessey & Habeck 1991; Emmel *et al*. 1995) (Table 1). This suggests that while *S. a. bartrami* is largely uncommon in LPK, the species continues to be widespread. Although our studies focused largely on the relationship of *S. a. bartrami* and fire at gate 4, we also noted that the species responded favorably to a burn at gate 8 (around Pine Glades Lake) in 2005 and less so to a fire at gate 2 during 2007. The role and influence of prescribed fire on other *S. a. bartrami* population segments within the Park will require further evaluation.

Cyclic and alternating treatment of burn units may have benefited *S. a. bartrami* during much of the present study, both at gate 4 and perhaps elsewhere in LPK, yet this alone may not be sufficient to increase the species' numbers. Providing refugia directly within (as well as adjacent to) the treatment area during prescribed burn activities may substantially increase the potential for *S. a. bartrami* to re-colonize recently burned areas and allow the species to remain within or near the fire-treated pineland. Use of refugia, particularly within the most abundant segment of a specialist butterfly population, has proven successful in retaining or increasing the densities of several imperiled butterflies (Panzer 2002, 2003; Kwilosz & Knutson 1999; Swengel & Swengel 1996, 2007). In addition, Swengel & Swengel (2007) indicated that establishment of permanent, non-fire refugia, managed through the use of less intensive alternatives had numerous benefits for a variety of specialist arthropod groups. Emmel *et al*. (2005) and Schwarz *et al*. (1996) promoted the use of prescribed fire to maintain the pine rocklands for *S. a. bartrami* conservation, but suggested that in addition to the burns, select areas with large stands of *C. linearis* be maintained by hand clearing of dense understory growth.

Strymon a. bartrami was listed as a candidate species for Federal protection on 12 September 2006 based on the continued range-wide decline of the species within the United States. Given the imperiled status of *S. a. bartrami* in southern Florida, the conservation and protection of this species requires urgent attention from land managers.

In summary, to help reduce fragmentation of *S. a. bartrami* populations and limit obstacles toward the species re-colonization in LPK following burns, prescribed fire treatments in the pine rocklands should continue on a cyclic basis, and whenever possible be on a smaller scale than those done historically. Maintaining unburned patches of hostplant-bearing refugia within or adjacent to the treatment areas will likely also aid *S. a. bartrami* in reestablishment. Where feasible, over growth should be reduced through hand clearing or other less intensive means. In the absence of continued cyclic burn patterns, reductions in overall treatment scale, adequate refugia within burn-treated areas, or the application of other forms of adaptive management within the LPK fire regime, it is likely *S. a. bartrami* will continue to occur only in the low densities observed during the majority of this study.

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A NEW SUBSPECIES OF *OENEIS CHRYXUS* (NYMPHALIDAE: SATYRINAE) FROM SOUTH CENTRAL NEW MEXICO

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ABSTRACT. The widely reported isolate population of *Oeneis chrysus* from Mt. Withington, Socorro County, New Mexico, is formally described as *Oeneis chryxus socorro*.

Additional key words: endemic, Arctic, insular biology, refugia antiquity

One of the great events in collecting where no one has gone before is the discovery of populations that initially seem to have no explanation for being there. Finding an isolated colony of *Oeneis chryxus* on a single ridge in Socorro County, New Mexico, is an intriguing example, and I describe this colony here.

The ridge mentioned above is about 9500' at its crest, is definitely in the aspen zone, and runs about 6.5 air miles from Mt. Withington (10,097', 33.881°, -107.486°) to Grassy Knoll (9662', 33.781°, -107.376°) in the SW. A forest Service road (USFS Rd. 330) runs along the ridge. In good years, the butterflies will fly down Monica Canyon on the north slope of Mt. Withington and out on the Plains of San Augustin around 7500'. This is the site of the rail-mounted radio-telescopes composing the Very Large Array (VLA). These hundred meter high mobile telescopes were used as a backdrop to shoot one of the movie sequels to *2001*, and in real life are a unique asset to the astrophysics world.

Although most *Oeneis* are biennial, *O. chryxus* flies equally every year at all New Mexican sites known to me. The present ridge comprises the northern half of the San Mateo Mountains—a granite formation of locally spectacular beauty. These mountains are dissected by East Red Canyon and West Red Canyon. *Oeneis chryxus* has never been observed in the southern half of the San Mateo Mts., or in any of the other six or eight ranges that ring the Plains of San Augustin and have been searched for Lepidoptera.

Small mountain top isolates are of considerable evolutionary and conservation interest for several reasons. First, they are relatively infrequent. Second, they may be very vulnerable to extermination by a small degree of global warming. Third, they are invaluable biological indicators that exist on unique geographical sites. Fourth, they may merit the special protection of a unique ecological habitat. (With an altitudinal spread of 2500', global warming may be less of an issue at this site.)

The nearest other population of *Oeneis chryxus* is *Oeneis chryxus chryxus* in the Jemez Mountains about 125 miles directly to the north. This population in the Jemez joins the Taos County populations and the Rocky Mountain branch of *O. chryxus*' nearctic distribution without major interruption. However, the Jemez Mts. and the San Mateo Mts. are today separated by some Chihuahuan Desert which is very inhospitable to *Oeneis*.

Oeneis chryxus is apparently the least boreal member of its genus, and seems to be restricted to North America. There are other population isolates elsewhere. I have seen *O. c. strigulosis* McDonough on Pre-Cambrian outcroppings on the Gaspe Peninsula of Quebec and *O. c. calais* Scudder in the Upper Peninsula of Michigan (Klots 1951). Until very recently, I had assumed all Colorado *Oeneis chryxus* were typical *chryxus*. However, in 2006, Scott described *Oeneis chryxus* (*calais*) *altacordillera* from some Front Range peaks in Colorado and New Mexico (Scott 2006). I would not be surprised if my high-altitude Taos Co. material keys out as *O. c. altacordillera*. Because *O. c. socorro* and *O. c. altacordillera* occur at opposite extremes of the *O. chryxus* altitudinal domain, I would expect to see and read little of their taxonomic and ecological interaction.

An astute reviewer has also pointed out that there are problems with the designation of a holotype in the original description of *Oeneis chryxus* (Doubleday 1847), and in the Shephard (1984) choice of the sex of his lectotype. I lack access to the resources to deal with these issues.

Oeneis chryxus is a plastic taxon, and a rather widespread one at that. The significant attribute of the Socorro Co. isolate is not its distinctiveness, but merely the fact that it exists at all. Describing such populations is probably not in keeping with the original intent of the ICZN—but then neither was documenting the impact of global warming on mountaintop ecology. In days of crisis, survival mandates use of all available tools, not blind obedience to their original function.

FIGS. 1–3. **1.** Prototype of Grade 3 dark scaling along forewing medial and cubital veins, essentially causing the limbal region to appear to be banded by a row of rounded spots. The hindwing eyespot in this individual is developed to Grade 3 also, with a white pupil present, as is that in cell M$_1$. The DFW spots in cells M$_3$ and Cu$_1$ are developed to Grade 2, or subjectively to Grade 2 1/2. **2.** Prototype of Grade 2 dark scaling along forewing medial and cubital veins, with only the scaling along M$_3$ extensive enough to cause the light spot in cells M$_2$ and M$_3$ to appear to have rounded corners. The forewing M$_1$ eyespot is typical of Grade 2, with size not reduced, but pupil unexpressed. The Cu$_1$ spot is Grade 1 or 1/2. **3.** Prototype of Grade 1 dark scaling along the forewing medial and cubital veins, with scaling limited to the veins themselves and not spreading into the adjacent cells. The forewing Cu$_1$ spot of this and the middle specimen are typical of grade 1 development, with size reduced and white pupil absent. This specimen also has a Grade 1 hindwing eyespot. The occasional eyespot which is reduced in size, but still clearly pupiled is classified as grade 3. The bottom specimen is typical of the Socorro County isolate; dark limbal scaling is reduced as is the DHW eyespot.

Thus, my intent here is not to break new ground in evolution, taxonomy or ecology, but to leave a written record of what I saw after it can no longer be seen. To do this, I merely need find a trait which is unique to the Socorro Co. isolate. In this paper, I shall do no less and no more than this. As I have done before, I shall buttress my arguments for the distinctiveness of this new subspecies by statistical factors, so that observation of a single insect may be inadequate to skewer it with a subspecific identity (Holland 1988, 1995).

MATERIAL STUDIED

All specimens examined, excluding the Socorro County material, fall into the *Oeneis chryxus chryxus* classification. The Socorro Co. material is *Oeneis chryxus socorro*. Where not noted, specimens were taken by the author.

San Mateo Mts., Socorro County, New Mexico: 3-vi-72, Beartrap Campground, ca. 2 mi. W of Mt. Withington, 8000', 6 ♂♂ (including holotype); 25-vi-71, same loc., 2 ♀♀; 19-vi-71, same loc., ♀; 4-vii-71, same loc., ♂ & ♀; 8-vii-72, same loc., ♂; 10-vi-72, same loc, 2 ♂♂, 4-vii-71, 1 mi. W of Mt. Withington, 8800', ♂ & ♀; 10-vi-72, Big Pigeon Can., NE slope, 8600', 2 ♂♂; 4-vii-71, 2 mi. down Big Pigeon Can. from Crest F.S. Road, NE slope, 8500', ♀; 19-vi-71, Big Pigeon Can., 9000', 3 ♂♂; 19-vi-71, bottom of Monica Can., N slope, 7500', ♂; 21-vi-97, Monica Can, at Switch Springs, N slope, 7500', 3 ♂♂.

Jemez Mts., Sandoval County, New Mexico: 4-vii-83, Beaver Dam near Seven Springs, 8200', ♂; 4-vi-77, Smokey Bear Hill, 8400', 7 ♂♂ & ♀; 4-vii-77, Sec. 29, T19N R1E, Rito La Cueva, 8300', ♂; 23-vi-97, Sec. 33, T 19N R1E, Rito La Cueva, 8400', ♂ & ♀; 28-vi-68, UNM Biology Cabin, near Seven Springs, ca. 8200', leg. W. Morrison, 2 ♀♀; 17-vi-84, Cerro Pelado, S slope, 10,000', 15-vii-84, 2 ♂♂ & 2 ♀♀, U.S. F.S. Road 144 at Road Can., 8500', ♂.

Jemez Mts., Rio Arriba County, New Mexico: 23-vii-84, Sec.27, Rito Café, 9000', ♀.

Jemez Mts., Los Alamos County, New Mexico: 7-vii-85, Pajarito Ski Area, 10,000', ♀.

Sangre de Cristo Mts., Taos County, New Mexico: 19-vi-66, near Twining & Wheeler Peak at treeline, 11,600, 9 ♂♂; 19-vi-66, near Twining, 10,400', 4 ♂♂ & 7 ♀♀; 28-vi-93, Cerro Vista, near Chacon, ca. 10,000, 3 ♂♂ & ♀; 3-vii-66, Bull of the Woods, 11,000', ♂.

Sangre de Cristo Mts., Costilla County, Colorado: 5-vii-66, Whiskey Creek Pass, 12,000', ♀.

Sangre de Cristo Mts., San Miguel County, New Mexico: 21-vi-87, Hamilton Mesa, 10,200', leg S.J. Cary, ♂.

The question now arises, can the Socorro County material be separated from the Jemez material without looking at the collection data; i.e., are the two populations phenotypically distinct? It quickly becomes apparent that this question does not have a resounding affirmative response. Consequently, I selected 11 wing features for the males, and assigned each feature on each insect a value of 0 to 3, depending on its development in each insect. Features selected included ocellus expression, (0 for absent, 1 for small and unoscellated, 2 for small but oscillated, and 3 for large and fully oscillated), suffusion with dark scales, (0 for no dark scales, 1 for dark scales on vein only, 2 for enough suffusion to reduce the apparent area of the bounded

Figs.4–7. *Oeneis chryxus socorro*. Type pair: **4 & 5.** Holotype male, 3-vi-72, Beartrap Campground, ca. 2 mi. W of Mt. Withington, San Mateo Mts., Socorro County, New Mexico, 8000', leg. R. Holland. **6 & 7.** Paratype female, 4-vii-71, 1 mi. W of Mt. Withington, San Mateo Mts., Socorro County, New Mexico, 8800', leg. R. Holland. Left. Dorsal surfaces. Right. Ventral surfaces. Both types have a weakly developed (Grade 1) VHW band but strongly developed (Grade 3) VHW striations. The female paratype has all three DFW ocelli fully developed (Grade 3). The holotype has two Grade 2 1/2 ocelli and a Grade 1 ocellus on the DFW.

light cells, and 3 for enough suffusion to alter the apparent shape of the bounded light cells), degree of light/dark contrast between the VHW transverse light band and the dark inner and outer thirds of the VHW (0 for the band not present to 3 for the white band lighter in the extreme), size, and degree of VHW transverse striation (0 for none to 3 for extreme).

Refer to Figures 1–3 for illustrations of these states, but bear in mind their taxonomic definition rests entirely with the above verbiage, not at all with the guideline pictures. Assigned values were not necessarily integers.

Specifically, the 11 features of state mentioned above were:

1. Wingspread
2. Intensity of striation on the ventral surface (see Figs. 5 & 7)
3. Contrast of the hind wing medial band ventrally (see Figs 5 & 7)
4. DFW suffusion of veins with dark scales in medial region (see Figs. 1–3)
5. Development of the ocellus in DFW cell M_1
6. Development of the ocellus in DFW cell M_2
7. Development of the ocellus in DFW cell M_3
8. Development of the ocellus in DFW cell Cu_1
9. Presence and intensity of additional dorsal ocelli
10. Development of the ocellus in DHW cell Cu_1
11. Total ocelli score dorsally

I had 23 Socorro County males and 13 Jemez Mountains males to work with. Additionally, I had 19 males from the Sangre de Cristo Mountains of Taos County. Many of the latter were extreme high-altitude specimens taken up to 13,000'. Even before the *altacordillera* issue was raised, I did not place any taxonomic importance on differences in specimens taken 5500' above the Socorro County isolates. Statistically positive results for separation of Taos Co, from Socorro or Sandoval counties were never used to infer a Socorro/Sandoval separation.

Oeneis chryxus socorro R. Holland **new subspecies**

Diagnosis and description. Two of the 11 features tested distinct between Socorro County and the Jemez Mountains using Fisher's *t*-test at the 99% level (Hodgeman et al. 1957; Turner & Thayer 2001) (see Table 1 for summary of all my statistical data, raw and manipulated). Two more tested positive at the 95% level—I am not persuaded to take these latter two as decisive. If I run 11 tests and get back two 95% positives (where I would have expected one anyway), I have not proved anything.

The most positive test considered the amount of dark scaling along the male DFW veins—this gave a *t* of 5.72 (df = 34), which is far into the realm of statistical significance (see Figs. 1–3). The significantly different result is that the dark scaling is REDUCED in the Socorro County specimens. The other apparently decisive test considered the development of the DHW ocellus—this yielded a *t* of 2.96, which corresponds to a *p* of about one in 300 that my observations were purely chance related. Socorro County specimens have the DHW ocellus LESS developed. These two features each separate *O. c. socorro* at least statistically from all populations with which it could be confused, geographic factors considered.

The Taos County specimens also differed significantly from the Socorro County isolates in the dorsal scaling along the veins (*t* = 4.00, df = 40). They also differed ventrally in having a bolder transverse medial band on the hindwing (*t* = 3.23) and in having more intense transverse striations lateral to the band (*t* = 3.10).

The Taos County specimen eyespots did not differ from the Socorro ones in any way, at any level of significance. This result led me to be skeptical of the apparent significance in the ocellus difference observed between Socorro Co. and the Jemez Mts. There are seven ocellus-based tests between each population, or a total of 21 in the study. The fact that one test out of 21 showed a chance factor of 1 in 300 does not do it for me.

I am thus left with a single feature that differs enough to set aside the Socorro Co. population: reduced DFW suffusion along the veins of the central area of the wing of males.

All factors involved here are so subtle and all available female counts are so low that I elect to disregard all female factors in describing this taxon.

DISCUSSION

In general, as one progresses to higher altitude the dark markings on all butterflies tend to become more pronounced and individuals become smaller. These are well-known thermoregulatory or resource adaptations. Thus, some of the statistically significant differences in Table 1, especially wingspread, indicate statistically different environments, not genomes. Separation of these differences is, and likely will remain, largely a judgment call far into the future of taxonomy.

However, the Socorro Co. isolates do come from a warmer environment than typical *O. chryxus*. Thus, the air inside these veins at the hottest point (wing center) needs less and will receive less solar heating. If the veins are hollow, basking insects will be injected with less warmed, convected air than typical specimens. This argument is just different enough that I like it.

Discussion of Types: Illustrations, Data, and Disposition

The above-mentioned difference and the clear reproductive isolation from other populations suggest a distinct subspecific status. I therefore name this taxon *Oeneis chryxus socorro* R. Holland. Type specimens include the 23 males and six females. The holotype will be placed in the CNC and paratypes will be placed in stable repositories, including the McGuire Center in Florida, the Colorado State University collection, the CNC collection in Ottawa, and the Smithsonian. All illustrated and typical individuals will be so labeled.

Figures 4–7 illustrate the holotype and a female paratype of *Oeneis chryxus socorro*. The reduced limbal DFW venal scaling on the male is the feature which separates this entity from Sangre de Cristo and Jemez populations. I have only six female paratypes to work with, plus 10 specimens each from the Jemez and the Sangre de Cristo Mountains. Socorro County females are distinguished from Jemez females with over 99% certainty (*t* = 4.1) by the reduced intensity of the VHW transverse band. It is the small female sample size which makes the female-associated separation criterion seem shaky and potentially accidental to me. Consequently, I do not add any female-based criteria to the taxon definition or analysis.

Flight period is at least the end of May to late July. Male wingspread is 49.3 mm (*n* = 23, std = 2.0 mm), female is 53.7 mm (*n* = 6, std = 1.6 mm). The corresponding statistics for the Jemez Mountains sample are 47.9 mm (*n* = 13, std = 2.2 mm) and 51.0 mm (*n* = 10, std = 1.8 mm). For Taos County, the are 45.1 mm (*n* = 19, std = 2.3 mm) and 48.5 mm (*n* = 10, std = 1.8 mm).

The correlation between the Jemez Mts. butterfly fauna and the San Mateo Mts. fauna is 0.45 (Holland

Table 1. Statistical data & analysis for 11 parameters of *Oeneis chryxus socorro* males ($t_{95\%} = 2.04$ (italicized); $t_{99\%} = 2.70$ (**boldface**)).

Feature		1	2	3	4	5	6	7	8	9	10	11
	Parameter	Wingspan	V Striation	V Band	DFW	O1	O2	O3	O4	OX	HO	ΣO
Jemez	Ave.	47.92	1.692	2.538	2.154	2.923	0.08	1.385	1.846	0.0	2.385	8.62
n = 13	St.D.	2.234	0.630	0.519	0.554	0.280	0.280	1.325	1.140	0.0	1.12	2.28
Taos	Ave.	45.16	2.00	2.00	1.842	2.684	0.0	0.263	1.474	0/0	1.158	5.579
n = 19	St. D.	2.302	0.745	0.7339	0.688	0.477	0.0	0.205	1.041	0.0	0.834	1.924
df = 30	ttaos, jem	**-5.198**	2.057	1.613	*2.365*	**-3.61**	-1.17	**3.573**	-1.37	0.0	**-4.62**	**-4.46**
Socorro	Ave.	49.20	1.391	2.043	1.087	2.652	0.04	0.565	1.565	0.04	1.087	5.956
n = 23	St. D.	2.02	0.488	0.624	0.503	0.699	0.205	0.867	1.279	0.205	1.283	3.277
df = 34	tsoc, jem	1.811	-1.531	*-2.358*	**5.721**	-1.30	-0.41	*2.166*	-0.64	0.735	**-2.96**	*-2.37*
df = 40	tsoc, taos	**6.019**	**-3.102**	**-3.234**	**4.000**	-0.17	0.893	1.328	0.245	0.893	-0.29	0.433

2009). Use of my recently published Antiquity Formula ($a = 100,000(1 - \rho)^{2.5}/(1 + \rho)^{1/2}$) (Holland 2009) yields 18,600 years for the age of this new taxon. The antiquity via direct colonization from the Sangre de Cristo Mts. is not much greater: ρ from Raton Mesa to the San Mateo Mts. is 0.42, implying a = 21,500 years.

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A NEW SUBSPECIES OF *SATYRIUM TITUS* (LYCAENIDAE: THECLINAE) FROM SOUTH CENTRAL NEW MEXICO

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ABSTRACT. I here describe *Satyrium titus carrizozo*, the third of three endemic hairstreaks, and of five endemic Lycaenids occurring in the Sacramento Mts. of southern New Mexico. This is the only mountain range in New Mexico isolated long enough to have evolved endemic subspecies of Lepidoptera—my Antiquity Formula places its time of separation from the nearest area of potential gene-exchange as about 8000 years ago. The new taxon differs from other known Coral hairstreak populations by having both the VHW namesake coral and the inner coral whitecapping in the "*thecla*-spot" greatly reduced.

Additional key words: endemic, insular biology, refugia, antiquity, Coral Hairstreak, global warming, Sacramento Mts.

There appear to be about 10 subspecies of butterflies endemic to the Sacramento Mts. of Lincoln and Otero Counties in southern New Mexico. These mountains are isolated by the usual factors, with elevation being primary, and precipitation, flora, life zones, human activity, afternoon rainfall, fire and exotic introductions being secondary. The Sacrmento Mts. are primarily limestone over granite, with occasional volcanic intrusions, and an occasional real oddity, such as a lava flow or snow white gypsum dry lake bed, epitomized by Lake Lucero at White Sands. Many basins in southern New Mexico are closed including the Tularosa Basin to the west of the Sacramento Mountains and the Orogrande-Dell City Basins to the south. Endemic butterflies include:

Poanes hobomok nr. *wetona* Scott
Satyrium titus carrizozo R. Holland
Callophrys affinis albipalpis Gorelick
Callophrys sheridanii sacramento Scott
Glaucopsyche lygdamus ruidoso R. Holland
Plebejus icarioides sacre R. Holland
Speyeria hesperis capitanensis R. Holland
Speyeria nokomis tularosa (R. Holland) (extinct?)
Euphydryas anicia cloudcrofti (Ferris & R. Holland)
Phyciodes cocyta nr. *incognitus* Gatrelle
plus whatever Megathymidae, *Euphilotes*, *Celastrina*, and *Apodemia* there be

This paper shall describe the second, and probably the rarest of the above surviving endemics. Basically, Gatrelle (2004) claims only one subspecies of *Satyrium titus* (F.) for New Mexico, *S. t. immaculosus* (W. Comstock). As one passes south across New Mexico, the *S. titus* phenotype becomes dingy in two ways—the coral-colored areas shrink and what there is becomes duller red. South of Albuquerque, *S. titus* is very rarely encountered. There is one colony in the Manzano Mts, about 40 miles to the southeast, at about 8200 feet in New Canyon. This is population is difficult to place, as most specimens are females, while most specimens from other sites are males. I feel most comfortable postponing the issue of the Manzano Mts. affinity. Further south, I have found two mountain-top colonies, both near Carrizozo in the Sacramento Mts. complex. One is at the very summit of Nogal Peak, at exactly 10,000'. The other is at the Carrizo Peak microwave relay site, on a summit in its own right, but at 8800', about 800' below the true crest. These colonies, like all of *Satyrium titus* in New Mexico, are intimately associated with choke cherry (*Prunus melanocarpa* (Nelson)). A very tiny increase in global temperature shall push this taxon into thin air, and give it no place to live.

The Manzano and Sacramento colonies were serendipitously discovered during my lifelong project to explore everywhere in or near New Mexico. They were not found while specifically seeking *S. titus*.

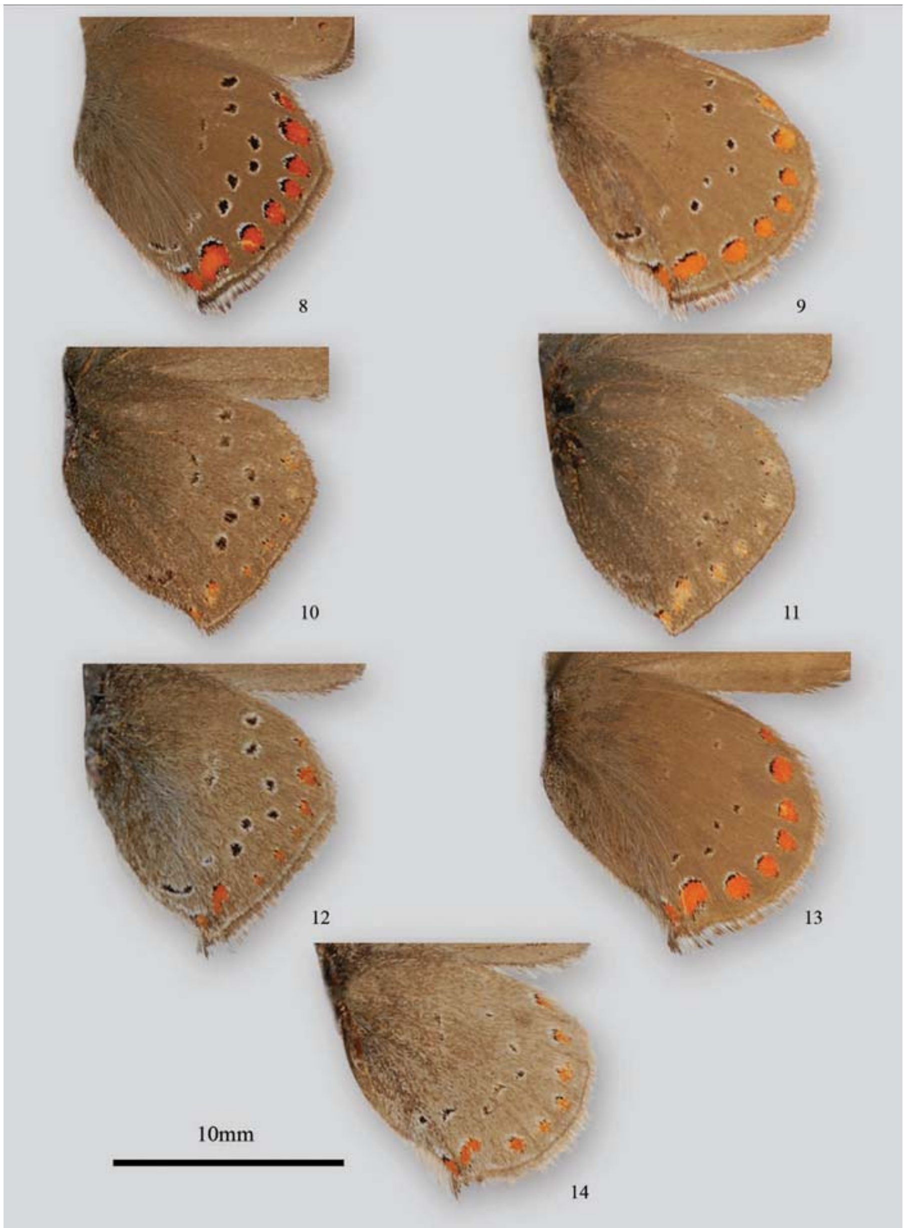
MATERIAL STUDIED

I have found useful illustrations of the *S. titus* subspecies in Ferris & Brown (1980), Scott (1986), Howe (1975), Holland (1982), and especially Gatrelle (2004). Figures referred to here by number only are from the plate in Gatrelle. At this time, I have the following material before me from New Mexico or just across the state line in Colorado:

***Satyrium titus immaculosus*: Males.** Las Animas Co., Colorado, 8800', N. slope of San Francisco Pass, Raton Mesa Complex, 17-vii-97, leg. R. Holland & E. Caprisecca: *S. t. immaculosus* specimen which is a fair match for Fig. 21, no reduction in the VHW "*thecla*-spot" coral marking or elimination of their whitecaps.

Colfax Co., New Mexico, 8400', Red Hill, Johnson Mesa, leg. R. Holland & S. J. Cary, 10 total, 5 on 4-vii-96, 4 on 27-vii-96, 1 on 19-vii-97: two specimens which are acceptable matches for Fig. 21, except the VHW coral is more brilliant than in the figure, six specimens

Figures 1–7. *Satyrium titus* from New Mexico.**1.** *Satyrium titus immaculosus* ♂. Red Hill, Johnson Mesa, Colfax Co., NM, 8400', 18-vii-97, leg. R. Holland & S. J. Cary. CNC LEP 00032025. Note the coral does not coalesce into a band of eight circular spots for this ssp. (Type 1). **2.** *Satyrium titus immaculosus* ♀. New Canyon CG, Manzano Mts., Torrance Co., NM, 8200', 29-vii-67, leg. R. Holland. CNC LEP 0032026. Note the coalescing of the coral into a band of eight circular spots (Type 1). **3.** Paratype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032027 **4.** Paratype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032029 **5.** Holotype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 19-vii-98, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032028 **6.** Paratype ♀ of *Satyrium titus carrizozo*. Summit of Nogal Peak, near Carrizozo, Lincoln Co., NM, Sacramento Mts. Complex, 10,000', 9-viii-75, leg. R. Holland. Note that, while the area of the coral and its intensity is not reduced in this specimen, it is coalesced into a band of seven round dots. CNC LEP 00032030 **7.** Paratype ♀ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral. CNC LEP 0032031



Figures 8–14.. *Satyrium titus* VHW maculation. **8.** *Satyrium titus immaculosus* ♂. Red Hill, Johnson Mesa, Colfax Co., NM, 8400', 18-vii-97, leg. R. Holland & S. J. Cary. CNC LEP 00032025. Note the coral does not coalesce into a band of eight circular spots for this ssp. (Type 1). **9.** *Satyrium titus immaculosus* ♀. New Canyon CG, Manzano Mts., Torrance Co., NM, 8200', 29-vii-67, leg. R. Holland. CNC LEP 0032026. Note the coalescing of the coral into a band of eight circular spots (Type 1). **10.** Paratype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032027 **11.** Paratype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032029 **12.** Holotype ♂ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 19-vii-98, leg. R. Holland. Note the dulling and reduced area of the coral and its coalescing into a band of seven faded dots. CNC LEP 00032028 **13.** Paratype ♀ of *Satyrium titus carrizozo*. Summit of Nogal Peak, near Carrizozo, Lincoln Co., NM, Sacramento Mts. Complex, 10,000', 9-viii-75, leg. R. Holland. Note that, while the area of the coral and its intensity is not reduced in this specimen, it is coalesced into a band of seven round dots. CNC LEP 00032030 **14.** Paratype ♀ of *Satyrium titus carrizozo*. Microwave relay site, Carrizo Peak, near Carrizozo, Lincoln Co., NM, 8800', 11-vii-97, leg. R. Holland. Note the dulling and reduced area of the coral. CNC LEP 0032031

are acceptable matches for Fig. 21, one specimen is unique in having the HW coral markings enhanced both dorsally and ventrally, and one specimen has noticeably enhanced coral markings ventrally only. All of these individuals have just a vestige of whitecaps. A specimen shown in our Fig. 1 is one of the matches.

Union Co., New Mexico, 7500', parking area, NE approach to Sierra Grande, 20-vii-97, leg. S. J. Cary: *S. t. immaculosus* specimen matching Fig. 21, but with whitecaps and the coral more brilliant on the VHW, and with just a trace of coral on the DHW, no coral anywhere on the FW.

Taos Co., New Mexico, 7500', Arroyo Hondo, 24-viii-85, leg. R. Holland: *S. t. immaculosus* specimen which is a good, whitecapped match for Fig. 21; same data, but at 8000', 30-vii-64, leg. R. Holland: another good match for Fig. 21, but with the whitecaps missing from the coral markings.

Females. Sandoval Co., New Mexico, 8000', Paliza Canyon, Jemez Mts, 21-vii-84, leg. R. Holland: *S. t. immaculosus* female, matching Figs. 22 and 28 well ventrally and Fig. 22 fairly well dorsally (evidence of type 3(C) bird attack (Sargent 1976)).

Satyrium titus of uncertain affinity: **Males.** Torrance Co., New Mexico, 8000', New Canyon CG, Manzano Mts, 29-vii-67, leg. R. Holland: atypical *S. t. immaculosus* specimen with the coral area 40% reduced, and with the normally coral areas straw-colored instead, reminiscent of *Strymon melinus* ab. *meinersi* Gunder (Holland 1980, 1982), otherwise a fair match for Fig. 21.

Females. Torrance Co., New Mexico, 8000', New Canyon CG, Manzano Mts, 9-vii-67, leg. R. Holland: a typical *S. t. immaculosus* specimen with the coral area normal dorsally and on the hindwing ventrally with whitecapping, but missing on the VFW, otherwise an acceptable match for Figs. 22 and 28; 8400', New Canyon CG, Manzano Mts, 29-vii-67, leg. R. Holland: two quasi-typical *S. t. immaculosus* with the coral area reduced 50% dorsally and 70% ventrally, and almost no whitecaps, but otherwise acceptable matches for Figs. 22 and 28; 8000', New Canyon CG, Manzano Mts, 9-vii-67, leg. R. Holland: a typical *S. t. immaculosus* specimen with the coral area normal dorsally and on the hindwing ventrally, but missing on the VFW, VHW coral reduced 30%, vestigial whitecaps, otherwise an acceptable match for Figs. 22 and 28.

***Satyrium titus carrizozo*: Males.** Lincoln Co., New Mexico, 8800', microwave relay, mostly July, Carrizo Peak, leg. R. Holland [& E. Caprisecca]; 10,000', summit of Nogal Peak, Sacramento Mts. Complex, 9-viii-75, leg. R. Holland: six types and paratypes, one aberration (see Table 1).

Females. Lincoln Co., New Mexico, 8800', microwave relay, Carrizo Peak, leg. R. Holland [& E. Caprisecca]; 10,000', summit of Nogal Peak, Sacramento Mts. complex, 9-viii-75, leg. R. Holland: two types and paratypes (see my Table 1 and Figs. 6, 7, 13, & 14).

OBSERVATIONS AND CONCLUSIONS

Combining specimens from both *S. titus* colonies, I, thus, have a type series of 6 males and 2 females to work with; any thought of using statistics would necessarily seem to be of modest intent. Nevertheless, I did do some ANOVA (Table 1), and came to some unexpected conclusions.

The trait I considered was the coral reduction factor in the sixth column. First, I examined the reduction in the two Lincoln County populations. To my surprise, upon ignoring the possibility of sexual dimorphism, this

Table 1. Extant specimens of *Satyrium titus carrizozo* from Lincoln County, New Mexico

Location	CNC Number	sex & mm wingspan	date	white caps	DHW coral	VHW coral	status	Resembles Gatrelle Fig.	Illustrated in Holland Fig.
Carrizo Pk.	32029	♂ 28.5	11-vii-97	none	none	95% reduced	holotype	none	5 & 12
Manzano Mts.	32026	♂ 27.5	9-vii-97	none	enhanced	70% reduced	paratype	27 pale	
Carrizo Pk.	32027	♂ 27.5	11-vii-97	none	enhanced	70% reduced	paratype	none	3 & 10
Carrizo Pk.	32028	♂ 30	25-vii-97	none	enhanced	70% reduced	paratype	none	4 & 11
Nogal Pk.		♂ 25.5	9-viii-75	yes	enhanced	30% reduced	paratype	27 pale	
Nogal Pk.		♂ 28.5	9-viii-75	yes	enhanced	50% reduced	paratype	none	1982
Nogal Pk.		♂ 27.5	9-viii-75	none	normal	70% reduced	aberant	none	1982
Carrizo Pk.	32031	♀ 31	19-vii-98	none	none	90% reduced	allotype	18	7 & 14
Nogal Pk.	32030	♀ 31	9-viii-75	yes	normal	normal	paratype	28	6 & 13

reduction was statistically distinguishable between just the two colonies with a significance on the order of $p < 10^{-4}$. While this is not an ideal situation to use ANOVA, it should give perfectly correct evaluations. If both sexes are considered in a single test, I obtained F(1,7) = 147. A value of 12.3 would have yielded $p < 10^{-2}$, and 29.2 would mean $p < 10^{-3}$. In this probability region, every time F doubles, p is reduced by a factor of 10. Thus, the odds against the reductions in coral being due to chance alone in the Carrizo Peak colony compared to the Nogal Peak colony are about 10^{-5}.

If one only considers the Lincoln County males, the relevant ANOVA statistic is F(1,5), (Turner & Thayer 2001) and my data lead to a Lincoln County only value of 65 (Zelen & Severo 1965). The required F(1,5) value for 99.9% confidence is 47, so there is quite eloquent statistical evidence that today even the two Lincoln County colonies are totally isolated even from each other. (Yes, you can easily see Nogal Peak from Carrizo Peak, and back again.)

It would be possible to do a similar statistical analysis of the Lincoln Co. *S. t. carrizo* things with the Colfax Co. specimens taken on Red Hill, but the difference here is so strikingly evident, I do not think it is necessary.

One may ask, "How long have the two *S. t. carrizozo* colonies been isolated?" Quite by chance, I have a value available for the butterfly distribution correlation between the main part of the Sacramento Mts. and Carrizo Peak: it is .69, implying a separation antiquity of 4100 years (Holland 2009). Alternatively, the maximum correlation between the Sacramento Complex and any other range where *Satyrium titus* is known to occur is .60 with the Manzano Mts. This implies the Divine Engineer had 8000 years to tweak *S. t. immaculatus* into *S. t. carrizozo*, assuming He started in the Manzanos.

Satyrium titus carrizozo, **new subspecies**

Diagnosis and Description. Let me define *Satyrium titus carrizozo* to be an isolate offshoot of *Satyrium titus immaculatus*, the only subspecies which it resembles or could interact with because of its range. The coral markings of *S. t. carrizozo* midway between the veins may actually be enhanced post-medially on the DHW of males, but are eliminated on the VFW. Species signature "*thecla*-spot" coral markings suffer over 70% reduction on the VHW of *S. t. carrizozo*, and the whitecaps are totally suppressed over all the coral "*thecla*-markings". What coral markings are retained on the VHW are of a subdued hue in *S. t. carrizozo*, and it may require electronic enhancement to detect the relevant scales. This is especially true of all midcell coral markings on the VHW caudal of Vein Cu_2. If >1/2 the individuals in a population bear these last three traits, the population is *S. t. carrizozo.* Note that this is at least somewhat a statistically defined subspecies. Occasionally a specimen will occur which is not distinguishable from *S. t. immaculatus*; the female paratype in Figs.6 & 13 is such a case. The male holotype and allotype appear in my Figs. 5 & 12, 7 & 14, respectively. The other female paratype appears in my Figs. 6 & 13. Two additional males, including another male paratype, already appear in the open literature (Holland 1982). In my Figs. 3, 4, 10, & 11, for comparison, I show two additional males of *S. t. carrizozo*. The dorsal surfaces of the type material shown in Fig. 5 and Fig. 7, the type pair, are an almost featureless deep, uniform brown. One of the confusing Manzano Mts. females appears in Figs. 2 & 9, and a male *immaculatus* appears in Figs. 1 & 8. The coral coloring in the VHW of *S. t. carrizozo* is either reduced to an arc of circles (Figs. 12 & 14, Type 1), or still further reduced to tiny broken marginal patches (Figs. 10 & 11, Type 2). Type 1 and 2 coral markings are not usually seen except on *S. t. carrizozo* and the Manzano Mts. specimens.

Etymology. The etymology here may be somewhat confusing. The nearby town is Carrizozo, New Mexico, but the butterfly is found on Carrizo and Nogal Peaks. Carrizo is Spanish for grassy, Carrizozo is an emphatic "grass all over the place," and Nogal means walnut. The name *carrizozo* is selected to include the Nogal Peak population as well as the Carrizo Peak population. Carrizozo is masculine.

Primary types will be placed in the Canadian National Collection and paratypes will be donated to Colorado State University.

Discussion

This paper is the sixth of about 14 in which I shall describe Sacramento Mts. endemics (Holland 1988, 2003, 2009; Scott 2006; Ferris & Holland 1982; Gorelick 2005). Except for its association with '*Prunus*' almost nothing is known about the ecology of the new subspecies. The only credible habitat threats are spraying and fire. As with all mountain top denizens, the prognosis for survival until 2100 is poor. The flight of *Satyrium titus* in New Mexico is univoltine, from mid-July to mid-August.

Acknowledgements

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A NEW SUBSPECIES OF *EUEIDES LAMPETO* BATES, 1862 (NYMPHALIDAE: HELICONIINAE) FROM SURINAME

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ABSTRACT. A new subspecies of *Eueides lampeto* Bates, 1862 (Nymphalidae: Heliconiinae), *E. l. brownsbergensis*, is described from Suriname; its sexual dimorphism and involvement in mimicry complexes in Suriname is discussed.

Additional key words: butterflies, neotropics, mimicry, Surinam.

As currently known, the butterfly *Eueides lampeto* Bates, 1862 (Nymphalidae: Heliconiinae), is distributed from Ecuador and Peru through Venezuela and Guiana to western and northwestern Brazil (Holzinger 1994, pp. 27-28). Six subspecies have been described (Lamas 2004, p. 266):

- *E. l. lampeto* Bates, 1862; type location Brazil (Amazonas); distribution: western Brazil to eastern Peru.
- *E. l. acacetes* Hewitson, 1869; type location Ecuador; distribution: Ecuador, Peru.
- *E. l. apicalis* Röber, 1927; type location Ecuador; distribution: Ecuador.
- *E. l. carbo* Seitz, 1913; type location Ecuador; distribution: Ecuador.
- *E. l. concisa* Lamas, 1985; type location Peru; distribution: southern Peru.
- *E. l. nigrofulva* Kaye, 1906; type location Guiana; distribution: Venezuela, Guiana and adjacent Brazil.

In addition, it has been known for 30 years that an unnamed subspecies occurs in French Guiana (Brown 1979, p. 59, Brévignon 1995), also mentioned by Lamas (2004, p. 266) as 'n. ssp. KS Brown, MS'.

We describe a hitherto undescribed, sexually dimorphic subspecies from Suriname, first identified from the collection of D. Schilder, donated in 2007 to the National Centre for Biodiversity Naturalis, Leiden, the Netherlands (NCB Naturalis). Forewing length was measured from base to apex.

Eueides lampeto brownsbergensis Gernaat & Beckles, **new subspecies**
(Fig. 1)

Description. MALE: forewing length (FWL) 31-36 mm. Antennae: black-brown, ventral side of clubs yellow-orange. *Dorsal forewing (FW)*: ground colour bright orange tawny without yellow; apex black with a faint trace of three white spots; subapical orange band broader; postmedial black markings barely continuous; orange-brown, at times faintly black, spots in spaces M3 and Cu1; outer margin continuously black with two triangular black spots near tornus, the posterior one faintly connected to the black horizontal bar. *Dorsal hindwing (HW)*: transverse medial band consists of considerably shorter black spots, which are ill defined proximally and clearly separated from marginal border; black marginal border with white paired dots faintly visible. *Ventral FW*: subapical band and medial area subdued yellow ground colour; ill-defined grey-black spots in spaces M3 and Cu1; outer margin with two triangular black spots near tornus, the posterior one faintly connected to the black horizontal bar. *Ventral HW*: submedial area subdued yellow ground colour; black spots of transverse medial band larger, better defined than on dorsal side and clearly separated from marginal border.

FEMALE: FWL 35-39 mm. Differs from the male as follows: Antennae: yellow-orange colored. *Dorsal FW*: wing shape more rounded; one faint yellow spot in apex; yellow ground colour medial and subapical areas; postmedial black markings clearly continuous; ill-defined black spot in space Cu1; outer margin continuously black with two triangular black spots near tornus, the posterior one connected to the black horizontal bar. *Dorsal HW*: subcostal black band; discal area yellow-orange coloured; black spots of transverse medial band larger; black marginal border with white paired dots. *Ventral FW*: subapical band and medial area light yellow ground colour; ill-defined grey-black spots in space Cu1; black horizontal bar clearly connected to posterior triangular marginal spot. *Ventral HW*: subcostal band yellowish-orange; black markings somewhat more extensive.

Diagnosis. The male differs from *E. l. lampeto* and *E. l. nigrofulva* mainly by two triangular black spots near the tornus, a more extensive postmedial black patch at the cell end and orange-brown spots in spaces M3 and Cu1 on the dorsal FW, and on the dorsal HW a less prominent black transverse medial band. The female differs from *E. l. lampeto* and *E. l. nigrofulva* mainly by a yellow ground color of the medial and subapical areas, continuous postmedial black markings and two triangular black spots near the tornus on the dorsal FW, and on the dorsal HW a less prominent black transverse medial band.

Holotype: male. Label: "3423. Brownsberg, Suriname, 22 January 1973, leg. D. Schilder 2007". FWL 36 mm. Collection NCB Naturalis (Fig. 1).

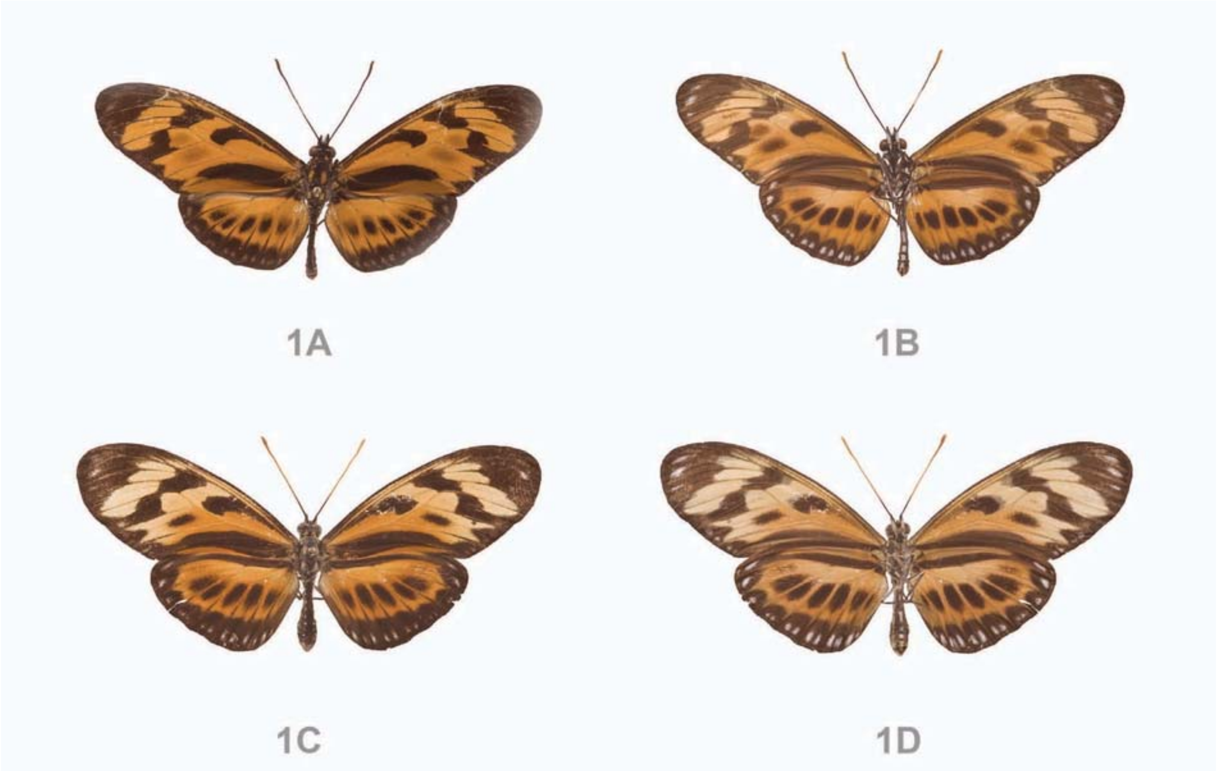

FIG.1. *Eueides lampeto brownsbergensis*. **A and B**. Holotype (data in text). **A:** dorsal surface, **B:** ventral surface. **C and D**. Allotype (data in text). **C:** dorsal surface, **D:** ventral surface.

Paratypes:

1. allotype: female. Label: "3425. Brownsberg, Suriname, 22 January 1973, leg. D. Schilder 2007". FWL 38 mm. Collection NCB Naturalis (Fig. 1).
2. male. Label: " 3424. Brownsberg, Suriname, 22 January 1973, leg. D. Schilder 2007". FWL 33 mm. Collection NCB Naturalis.
3. male. Label: "3426. Brownsberg, bosgebied [forest area], Suriname, 2 September 1972, leg. E.H. Jonkers". FWL 36 mm. Collection NCB Naturalis.
4. male. Label: "RMNH.INS 382035, nr. 3427. Brownsberg, bosgebied [forest area], Suriname, 2 September 1972, 450 m, leg. E.H. Jonkers". FWL 31 mm. Collection NCB Naturalis.
5. female. Label: "RMNH.INS 382040, nr. 3428. Brownsberg, bosgebied top [forest area, summit], Suriname, 17 July 1969, 550 m, leg. E.H. Jonkers". FWL 35 mm. Collection NCB Naturalis.
6. female. Label: "RMNH.INS 382039, nr. 3429. Brownsberg, bosgebied [forest area], Suriname, 12 October 1972, 450 m, leg. E.H. Jonkers". FWL 37 mm. Collection NCB Naturalis.
7. female. Label: "RMNH.INS 382038, nr. 3430. Brownsberg, bosgebied [forest area], Suriname, 2 September 1972, leg. E.H. Jonkers". FWL 39 mm. Collection NCB Naturalis.
8. female. Label: "RMNH.INS 382037, nr. 3431. Brownsberg, bosgebied aan Brokopondomeer [forest area on lake Brokopondo], Suriname, 28 January 1973, 250m, leg. E.H. Jonkers". FWL 36 mm. Collection NCB Naturalis.
9. female. Label: "3432. Albina, Marowijne, Suriname, don 1879, leg. A. Kappler, Museum Natura Artis Magistra." FWL 35 mm. Collection Zoological Museum Amsterdam.

Etymology: *brownsbergensis* refers to the Brownsberg Nature Park in Suriname (type location).

DISCUSSION

Species of Heliconiinae, including members of the genus *Eueides*, are well known for the extent of involvement in mimicry complexes as well as intraspecific variation. Therefore, it might seem preliminary to describe a new subspecies, in this case of *E.lampeto*, without further data on its biology. However, one of the striking features of *brownsbergensis* is its phenetic stability: label data of specimens range from 1879 to 1973 and there is very little variation, both among males and among females. Therefore, we consider *brownsbergensis* a valid subspecies.

As currently known, *E. l. brownsbergensis* is restricted to Suriname, although it is quite possible that the French Guianese specimens, reported as *E. l. copiosus* (a junior homonym of *E. l. nigrofulva*) (Lacomme 2003; Lamas 2004), also belong to ssp. *brownsbergensis*. Also, there are two possible records from the Guianan-Suriname-border (Dr. K.S. Brown Jr. pers. com.).

Eueides lampeto is considered a local and rarely encountered species, possibly because it is mainly restricted to the canopy. For ssp. *brownsbergensis* we only found ten specimens, of which nine came from the same locality (Brownsberg Nature Park, 250–550m altitude), taken in the months January, July, September and October. In French Guiana, the species has been recorded from January, October and November (Lacomme 2003). In Brazil, larvae have been reported to feed on various species of the *Granadilla* subgroup of *Passiflora* (Passifloraceae), notably *P. quadrangulares* L. and *P. laurifolia* L. (Brown 1981, p. 446). Its hostplant(s) and early stages in Suriname are not known. *P. laurifolia* ('paramarkoesa' in Suriname) is known to occur at the Brownsberg plateau (ter Steege 2007, p. 206).

A conspicuous feature of subspecies *brownsbergensis* is its sexual dimorphism, which does not occur in other subspecies of *E.lampeto*, although it is known in other Heliconiinae (e.g. *Eueides vibilia* (Godart, 1819)). Generally, sexual dimorphism is thought to be the result of selective forces working separately on males and females. Males spend most of their lives searching for and chasing females interspersed with feeding on flowers, whereas females mainly search for suitable locations to oviposit and occasionally feed on flowers. As such, males and females often occupy different microhabitats, may be part of different prey-predator regimes and therefore have evolved to be participants of different mimicry complexes (Mallet 1995; Willmott 2004). Judging from phenetic similarity, female *E.lampeto brownsbergensis* seem to be part of an extensive mimicry complex in Suriname comprising, among others, Danainae (*Lycorea halia halia* (Hübner, 1816), *Lycorea pasinuntia* (Stoll, 1780)), Ithomiinae (*Tithorea harmonia harmonia* (Cramer, 1777), *Melinaea mneme mneme* (Linnaeus, 1763), *Forbestra equicola equicola* (Cramer, 1780), *Mechanitis polymnia polymnia* (Fabricius, 1793), *Mechanitis mazaeus pannifera* Butler, 1877, *Hypothyris euclea forbesi* R.M. Fox, 1941, *Hypothyris ninonia latefasciata* (Haensch, 1909)), Nymphalinae (*Eresia eunice eunice* (Hübner, 1807)) and Heliconiinae (*Eueides isabella isabella* (Stoll, 1781), *Heliconius ethilla thielei* Riffarth, 1900, *Heliconius numata numata* (Cramer, 1780)). Male *E.lampeto brownsbergensis* appear to belong to another, less extensive group of mimetic species (Riodinidae: *Stalachtis calliope calliope* (Linnaeus, 1780)); Heliconiinae: *Eueides aliphera aliphera* (Godart, 1819), *Eueides vibilia vibilia* (Godart, 1819), *Eueides lybia lybia* (Fabricius, 1775), and possibly the larger species *Dione juno juno* (Cramer, 1779), *Dryadula phaetusa* (Linnaeus, 1758) and *Dryas iulia alcionea* (Cramer, 1779)). Why sexual dimorphism has evolved in ssp. *brownsbergensis* in Suriname as opposed to other subspecies of *E.lampeto* in other regions, merits further study.

Note: National Museum of National History, Naturalis, Leiden, the Netherlands (RMNH) is currently named the National Centre for Biodiversity Naturalis, Leiden, the Netherlands (NCB Naturalis).

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SATURNIIDAE OF THE WORLD... PFAUENSPINNER DER WELT: THEIR LIFE STAGES FROM THE EGGS TO THE ADULTS... IHRE ENTWICKLUNGSSTADIEN VOM EI ZUM FALTER, by Rudolf E. J. Lampe. 368 pages, including 336 color plates; bilingual text in English and German; 8.5 × 12 inches, hardbound; ISBN 13: 978-3-89937-084-3; 68 euros (about US$91.00); Verlag Dr. Friedrich Pfeil, München; Publication date: March 2010.

Rudolf Lampe has produced an excellent contribution that will be scientifically useful and aesthetically enjoyable for those who rear and study Saturniidae. For more than 30 years, Lampe has reared and photographed saturniids, and this book is a wonderful culmination of his efforts. More than 300 species of Saturniidae are depicted on 336 plates of 2948 illustrations. Each species is documented in an appendix giving the locality data, dates of the rearing, and the hostplant. Additional notes are given for some species. The quality of the photographs ranges from good to excellent, and includes close-up views of eggs, all larval stages, pupae, cocoons (for those species that make cocoons), pinned adults (usually of both sexes), and sometimes live adults in natural repose. One hybrid is included: *Gonimbrasia tyrrhea* ♂ × *G. hoehnelii* ♀, and since the parental species are also shown, direct comparisons are easy to make. It is a joy to turn the pages and see plate after plate of the Saturniidae, and much praise must go to the person who designed the book at the publishing house in Munich.

No books in or out of print offer so many illustrations of the rich saturniid fauna of Africa. All of the saturniids that fly in Japan and Europe are included, as are many from India, China, Indonesia, Australia, and the Philippines. About 90 species from sub-Saharan Africa are covered, and dozens more from Mexico and countries of Central and South America. Most of the large Saturniinae in North America are treated as well. Lampe obviously became skilled at rearing saturniids at his home in Nuremberg, even ones from deserts and rainforests. His text is brief, but he gives rearing tips regarding care of eggs, larvae, and pupae. Lampe must also have become an accomplished botanist and horticulturist to successfully rear so many moth species in Germany.

Lampe published a large number of short papers on the species he reared in *Entomologische Zeitschrift* (from Essen, formerly from Stuttgart) in the 1980s and 1990s, with black & white photos. He published a faunal survey of Saturniidae of West Malaysia in 1984 in German, expanded and in English in 1985. He co-authored the volumes on Saturniidae of *Moths of Thailand* in 1990 and *Heterocera Sumatrana* in 1996, but he had been off the radar screen, so to speak, for many recent years, and now we see why. I have had only occasional correspondence with him over the years, but he always responded generously to my requests for information and photographs. I was delighted to see that two of the rearings in his book resulted from eggs I sent him, namely *Citheronia sepulcralis* from a female I collected on a road trip through Florida in 1997, and *Hemileuca oliviae* of which I collected the egg rings on a plateau in New Mexico above 8000 feet on a day in 1988 that was brutally cold and windy. Lampe developed a successful network of contacts all over the world to send him eggs over the last 30 years, and now all of those people can be proud that they contributed to this marvelous book.

Shortcomings and errors in the book are few. Usage of the subfamily-group name Ludiinae is not correct, because that name is preoccupied by a group of click beetles (Elateridae). The so-called Ludiinae of the saturniids is now combined with *Micragone* in the tribe Micragoniini within the Saturniinae. Therefore the name Ludiinae should not be used for nomenclatural and phylogenetic reasons in Saturniidae, but most users of this book will not care about such taxonomic matters. The insect he calls *Caligula boisduvalii* from Vietnam is not the same as the one he shows from eastern Russia, and although the larvae and adults look much alike, the tropical one is actually *Caligula naumanni*. The *Samia* reared from Japan is *S. cynthia* (introduced there in 1870 from China) not *Samia pryeri*, which is indigenous to Japan. The taxon he calls *Antheraea castanea youngi* is actually the muga silkmoth, *Antheraea assamensis*, and the names *castanea* and *youngi* refer to different species. Some species listed under *Gonimbrasia* and *Imbrasia* belong in other genera, but most African saturniids and the genus *Antheraea* are in need of modern revisions, so Lampe cannot be assigned much blame here. *Attacus lorquinii* is consistently misspelled as *Attacus lorguinii* and does not occur on Palawan, so Lampe's supplier of eggs mislabeled that batch. Amusingly, the "locality" on Sulawesi cited for two species as Telur Kupu Malam actually means "eggs of moth" in Bahasa Indonesia. Lampe places the species that are traditionally called *Neoris* into *Perisomena*. The two groups are closely allied, and *Perisomena* is the older name, so that arrangement has both phylogenetic and nomenclatural support. I disagree with his treatment of the Mexican *Actias truncatipennis* as a subspecies of *A. luna*, but was glad to learn that *Actias luna azteca* from Nicaragua really does exist, rather than being based on a mislabeled specimen, as many of us had supposed.

It is nice to see larval photos of so many species that have never been published, or published in works that are not easily accessible. Some users will be pleased to see the life cycles of charismatic species like *Archaeoattacus staudingeri*, *Actias rhodopneuma*, *Actias isis*, *Copiopteryx semiramis banghaasi*, *Eochroa trimenii*, and *Attacus caesar*, all depicted in colorful detail. I did not expect to see the immature stages of rare species like *Epiphora lugardi*, *Ubaena fuelleborniana*, *Rothschildia schreiteriana*, and two species of *Salassa*. The mature larva of *Automeris janus* from Venezuela is extraordinarily beautiful. It is ironic that Lampe himself has exposed the synonymy of *Automeris naranja* Schaus 1898 and *Automeris umbrosa lampei* Lemaire 2002 by showing on facing pages that the larvae and adults of these two names are identical! For workers who want to check or tabulate certain morphological characters of larvae or pupae to use in phylogenetic analyses, the clear and detailed photographs provide a huge database.

I highly recommend that museum curators and university faculty persuade their librarians to add this important book to their holdings. This is a book that once you see a copy, you will have to have it. Books like this go a long way to encourage young naturalists to become entomologists. As a professor, I know that many young people do not collect books, thinking that they can get everything they need on the internet. This book is not expensive considering its attributes, so I hope that every admirer of Saturniidae will acquire it. When your computer crashes or the power goes out, you can immerse yourself in Lampe's beautiful book using natural daylight or candlelight until those things get fixed. I thank Stefan Naumann in Berlin for pointing out some of the book's errors to me.

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