



A new *Calliprora* species mining lead trees in Florida (Lepidoptera: Gelechiidae)

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Abstract

Calliprora leucaenae sp. nov. is described infesting foliage of *Leucaena leucocephala* (Lam.) de Wit. in Florida, USA. The larvae are blotch-miners and leaf-tiers and are capable of heavy damage to host plants. Photographs of the adult, wing venation, male and female genitalia and illustrations of the larval and pupal chaetotaxy are provided. *Calliprora* Meyrick is transferred to Thiotrichinae, as the species in the genus exhibit typical characters of the subfamily such as the presence of anellus lobes, a large sternum VIII, and a reduced male tergum VIII. Comparative diagnoses of the morphology and ecology are presented for the newly described species and other thiotrichine species.

Key words: *Calliprora sexstrigella*, *Palumbina*, *Polyhymno*, *Macrenches*, *Thiotricha*, leaf-miner, chaetotaxy, immature, larva

Introduction

Almost simultaneously in August and September 2015, plant inspectors with the Florida Department of Agriculture and Consumer Services caught specimens of a conspicuous micro-moth by sweep-netting and light-trapping in Fort Lauderdale and Tampa (FL, USA). We determined the moth was an undescribed species of *Calliprora* Meyrick, 1914. Related species tie leaves of *Chamaecrista* Moench (Fabaceae) and bore buds of *Prosopis* L. (Fabaceae) (Smith 1910; Rogers 1976), so the larvae were predicted to cause similar damage on some leguminous tree (Hayden 2016a). We found lead trees (*Leucaena leucocephala* (Lam.) de Wit. (Fabaceae)) heavily infested by caterpillars through subsequent inspections at the sites where adults were collected. We reared moths from caterpillars, so we were able to determine they were the same undescribed species. Infested plants were subsequently found farther south in Homestead (Miami-Dade Co.) and north in Gainesville (Alachua Co.).

Calliprora comprises eleven previously described species (Gaede 1937; Becker 1984). Meyrick (1914, 1922, 1926) described ten species with distributions within South America, and one species, *C. sexstrigella* (Chambers, 1874), is known from Texas, USA (Busck 1903; Gaede 1937; Lee *et al.* 2009). Rogers (1976) transferred *Polyhymno sexstrigella* to *Calliprora*, and Hodges (1983) synonymized *C. thermogramma* Meyrick. The type specimens of all of Meyrick's species are illustrated in Gates Clarke (1969), so we could confirm their identities with an acceptable level of confidence. *Calliprora* species typically have dark fuscous or whitish stripes on the head and thorax. The wings are strikingly colored, with pale whitish markings on dark ground. The proximal half of the forewing has several longitudinal streaks in most species, or else uniformly grey in some species. The distal half is marked with whitish, brownish or bronzy streaks. The proximal and distal sections are separated by a broad dark band and/or a pale patch across the middle of the wing.

The genus has received little attention since the original descriptions of the species. Immature stages and their ecology are also poorly known, and only the larvae of *C. sexstrigella* have been recorded as bud borers on *Prosopis glandulosa* Torr. (Fabaceae) (Rogers 1976). *Calliprora* has been placed in Gelechiinae (Hodges 1983; Lee *et al.* 2009; Pohl *et al.* 2016), but based on our morphological examination, species in the genus possess putative synapomorphies of Thiotrichinae (Gelechiidae). This subfamily was proposed by Karsholt *et al.* (2013) and includes four genera, *Palumbina* Rondani, *Polyhymno* Chambers, *Thiotricha* Meyrick, and *Macrenches* Meyrick.

Compared to their diagnosis of the subfamily, *Calliprora* species do not have very elongate antennal cilia, but males have an enlarged, posteriorly bifid sternum VIII and a reduced tergum VIII. *Calliprora* males also bear well-developed anellus lobes as in *Palumbina*, *Polyhymno* and *Thiotricha* (Gates Clarke 1969; Karsholt *et al.* 2013); therefore we transfer the genus to Thiotrichinae.

Meyrick (1925) briefly mentioned that *Calliprora* is probably related to *Polyhymno*. Most of the species share apically attenuate forewings, and the type species of both genera have long-stalked R_4 and R_5 (Gates Clarke 1969; Hodges 1998). They can be differentiated by forewing markings insofar as many *Calliprora* species have a transverse band or a patch at the middle of the wing and several short streaks usually in the distal half, while *Polyhymno* usually has long streaks running uninterrupted from the base to near the apex. Species of *Calliprora* have forewings with a larger tornal area, while species of *Polyhymno* have more slender and elongate forewings with a less produced tornus (Chambers 1874; Meyrick 1925). The anellus lobes are more strongly developed in *Calliprora*. We consider these characters to be apomorphies of *Calliprora*.

Leucaena leucocephala (lead tree) is a fast-growing legume native to Mexico and Central America. It was first introduced to the Philippines and South-East Asia by Spanish conquistadores, and from there it has spread to most of the subtropics and tropics including Australia, southern India and Africa (Brewbaker *et al.* 1985; Barros-Rodriguez *et al.* 2014; Ishihara *et al.* 2016). It is widely used for both industrial and non-industrial purposes such as animal feed, wood, and human consumption (Walton 2003; Pandey & Kumar 2013). However, it is aggressively invasive; IUCN's Invasive Species Specialist Group listed it as one of the world's worst invasive alien species (Lowe *et al.* 2000). In Florida, lead trees are a Category 2 noxious weed regulated by FDACS-DPI (Florida Department of State 2016; FLEPPC 2017). It has few insect enemies, the most common being the psyllid *Heteropsylla cubana* Crawford. We describe the new moth species because it could have a significant impact on the viability of its hosts.

Material and methods

The first samples of adult moths were collected on sticky traps placed near host plants or by sweeping. Most specimens were reared from late-instar larvae and pupae collected on host material. Larvae and pupae were separated into individual vials and left to develop at room temperature. The host plant wilts very quickly, so sprigs were kept in airtight plastic bags and kept clean of mold. Younger instars were not reared through because of the difficulty of keeping host plant fresh and transferring larvae to new leaves. Larvae collected in early January emerged as adults in 3 weeks, and pupae reared from larvae in June emerged approximately in 12 days.

Dissections of genitalia and wings were made according to Li (2002), and Eosin Y and Chlorazol Black were used as stains. Larvae were dissected by maceration in 10% KOH, cleaned, and stained in chlorazol black. The larval body was cut along the right side and temporarily mounted in glycerin for drawing chaetotaxy. Genital nomenclature mainly follows Klots (1970) and partially follows Karsholt *et al.* (2013) (for tergum/sternum) and Bradley (1961) (for anellus lobe). Larval nomenclature follows Stehr (1987), and pupal terms follow Mosher (1916). Terms for wing morphology follow Kristensen (2003), except that radial vein terms follow Hodges (1998) (R_2 – R_5 instead of Rs_1 – Rs_4). Images of adults, genitalia, wings and pupae were photographed with Leica M205A and Leica DM750 microscopes, coupled with Leica Application Suite 4.2 software. The line drawings of larval chaetotaxy were made using an Olympus CH30 microscope with a calibrated micrometer and refined in Photoshop® CS6. The distribution was mapped with DIVA-GIS 7.5 (Hijmans 2012) with a Florida counties shapefile.

Specimens and dissections of the new species are deposited in the FSCA and NKU. Related species, *Calliprora sexstrigella*, *Polyhymno luteostrigella* Chambers and *P. acaciella* Busck from North America and *Polyhymno* sp. from China were additionally examined.

Abbreviations of institutions

ASUHIC Arizona State University Hasbrouck Insect Collection, Tempe, AZ, USA

FSCA Florida State Collection of Arthropods, Gainesville, FL, USA [Lepidoptera housed at MGCL]

MGCL McGuire Center for Lepidoptera and Biodiversity, Florida Museum of Natural History, Gainesville, FL, USA

NKU College of Life Sciences, Nankai University, Tianjin, P.R. China

Systematics

Calliprora leucaenae Lee & Hayden, sp. nov.

urn:lsid:zoobank.org:act:AC92303A-46A2-4A82-8CF6-A0E15E826AE1

Type material. Holotype ♂: USA, Florida, Hillsborough Co., Tampa, E. Columbus & 62 St., 27.9670, -82.3853, ex *L. leucocephala* leaves, 8.i.2017, eclosed 27.i.2017, J. Hayden, E17-66 (FSCA) (reared, not dissected).

Paratypes: USA, Florida: 2 ♂♂, 1 ♀: Alachua Co., Gainesville, Museum Road, 29.6446, -82.3635, ex *L. leucocephala* leaves, 18.vi.2017, J. Hayden, female genitalia and wings slide MGCL-NKU04; 1 ♀: same data except 10.vii.2017, MGCL slide 4605; 2 ♂♂: same data except 28.ix.2017, [one specimen] MGCL slide 4606; 1 ♀: same data except 11.xi.2017; 2 ♂♂: Alachua Co., Gainesville, Museum x Radio Roads, 29.64268, -82.36420, ex *L. leucocephala* leaves, 26.xi.2017, J. Hayden; 1 ♂: same data except 11.xii.2017; 2 ♂♂: Broward Co. Dania Beach, 775 NE 10th St. empty lot, 26.06301, -80.13411, CAPS IMS UVL [trap], 3.ix.2015, J. Garcia & E. Dougherty, E15-5313; 1 ♂, 2 ♀♀: same data except: mining and silking *L. leucocephala* leaves, 13.ix.2016, J. Hayden, E16-4325, MGCL slides 3670F, 4268M; 1 ♂, 1 ♀: Hillsborough Co., Tampa, US41, 27.90577, -82.40157, ex *L. leucocephala* leaves, 8.i.2017, J. Hayden, genitalia and wings slide MGCL-NKU01, MGCL-NKU03 (NKU); 4 ♂♂, 1 ♀: same data as holotype; 2 ♂♂: Hillsborough Co. Temple Terrace, 3295 Riverhill Dr., [sweeping] on trees & shrubs, 5.viii.2015, T. Streeter, E15-4601, MGCL slides 3013 [male gen.], 3275 [wings]; 1 ♀: Hillsborough Co. Tampa, 6202 Eugene Ave. across street, sweep, 29.iv.2016, T. Streeter, E16-1965, MGCL slide 3441; 3 ♂♂, 11 ♀♀: Tampa, U.S. 41, 27.90577, -82.40157, ex *L. leucocephala* leaves, 8.i.2017, J. Hayden, E17-67; 2 ♂♂, 4 ♀♀: Manatee Co., Palmetto, 13604 Reeder Rd., 27.63936, -82.55574, CAPS *Chilo partellus* trap CP-D-2a, 26.ii.2018, D. Restom-Gaskill, E18-1298; 3 ♂♂, 1 ♀: same data except: 12.iii.2018, E18-1119, [one specimen] MGCL slide 4644F; 3 ♂♂, 1 ♀: Miami-Dade Co., Homestead, 248 St. E. of 177 Ave., 25.53582, -80.47632, ex *L. leucocephala* leaves, 11.vi.2017, J. Hayden & J. Awad. (Paratypes two males and two females are deposited in the NKU, and all other paratypes are in the FSCA).

Other material examined: Whole-body slides: 1 ♂, USA, FL, [Hillsborough Co.] Tampa, US 41 & S. Montg[omery] St. 27.90584 -82.40168 CAPS *L.[ymantria] xyliana* trap LX-D-0004a, 28-VI-2016 D. R.[estom]-Gaskill, E16-3426, slide MGCL 3554; 1 ♂, Hillsborough Co., Tampa, E. Columbus & 62 St., 27.9670, -82.3853, ex *L. leucocephala* leaves, 8.i.2017, J. Hayden, slide MGCL-NKU02. **Four larval cuticle slides:** USA, FL, Broward Co. Dania Beach, 775 NE 10th St. empty lot, 26.06301, -80.13411, mining *L. leucocephala* leaves, 13.ix.2016, J. Hayden, E16-4325, slide MGCL 3635; Alachua Co. Gainesville, Museum Rd. UF Bathhouse gardens, 29.6446, -82.3635 ex *L. leucocephala* leaves, 11-xi-2017, J. Hayden, slide MGCL 4588; Alachua Co. Gainesville, Museum Rd. UF Ethnoecology garden, 29.6446, -82.3635 ex *L. leucocephala* leaves, 15-vii-2017, J. Hayden, slides MGCL-NKU32, MGCL-NKU33.

All specimens were reared unless indicated by “trap” or “sweeping.” The dates on reared specimens refer to when the larva was collected. Numbers starting with “E” are DPI Entomology sample numbers.

Diagnosis. *Calliprora leucaenae* is easily distinguished from congeners by the uniformly colored head and thorax, the uniformly grey proximal half of the forewing, and the presence of two pink stripes obliquely extended from the middle of the forewing costa toward the medial veins (Figs. 1, 2). In the male genitalia, the distal half of the phallus is evenly tapered and equal in length to the bulbous base of the phallus. In the female genitalia, the signum is reduced to capitulum-like processes that extend internally like horns: a long, tail-like anterior process and a pair of shorter posterior processes (Figs. 10, 10a). Most of the congeneric species have a head and a thorax with black and white stripes. Some congeners share the uniformly grey forewing base (such as *C. sexstrigella*, *C. erethstis* Meyrick, and *C. peritura* Meyrick), but in those species, the pale tornal area is absent or smaller and well-separated from the termen by black, and pink stripes are absent. In *C. sexstrigella*, the most similar congener, the medial costal streak is a rectangular whitish patch on the costa, there is another white patch on the cell, and an orange-brown (not pink) streak extends distad between the white patches longitudinally instead of obliquely (Fig. 29). In the genitalia of other species, where known, the narrow distal part of the phallus is at least twice the length of the bulbous base, and the anellus lobes are more strongly developed. The signum is a broad, serrate plate with a medial groove and without processes (*C. clistogramma*, *C. peritura*) or is an oval plate with a small cylindrical process (*C. sexstrigella*) (Fig. 33; Gates Clarke 1969).

Description. Adult. *Head* (Figs. 3–4). Vertex dark grey, with ochreous reflections; frons yellowish. Labial

palpus 0.35–0.50 mm long, whitish on dorsal surface, with narrow black line on ventral surface, segment I very short, segment II 2 to 2.5 times the length of III. Antenna with dorsal surface dark grey, ventral surface white or yellow; male flagellum with short cilia ventrally; female cilia in distal 2/3, shorter than that of male.

Thorax. Dorsum of thorax and tegula dark grey with ocher reflections. Legs whitish yellow. Prothoracic legs with coxa sometimes suffused with dark grey basally, tibia black on outer surface, tarsomeres black and ringed with yellow apically. Mesothoracic legs with femur dark grey proximally, tibia black at base and apex with an oblique black streak at middle, tarsomeres black and ringed with white apically. Metathoracic legs with tibia black on outer surface except middle and apex white, tarsus with first tarsomere white proximally, each tarsomere white-ringed apically.

Wings (Figs. 1–2). Spread forewings span 5.0–7.0 mm. Forewing proximal half grey, distal half black with three pink streaks joined near end of cell: two streaks extended toward distal 1/2 and 1/4 of costa, both whitish at costa, and one pink streak extended longitudinally at anterior 1/2, lying between distal 1/2 and 1/5, its distal end sometimes confluent with postmedial costal streak; broadly yellow-white in tornal area, separated by an oblique black streak extending from posterior margin of discal cell to tornus along CuA_2 ; some fresh specimens suffused with pink in yellow-white area; distal 1/4 of costa brown, marked with black-tipped whitish scales at subapex and apex; apex elongated, sometimes slightly downward; termen brown, cilia black with pink reflections; dorsum with dark grey cilia; venation (Figs. 5–7): forewing with 11 or 12 veins, all separately arising from discal cell except R_4 and R_5 , long-stalked, separated at distal 1/7; CuA_2 , sometimes absent (Fig. 6, see arrow). Hindwing and cilia dark grey; with 7 or 8 veins, M_1 stalked with R_s , usually faint or sometimes absent (Fig. 7, see arrow); CuA_1 and CuA_2 parallel.

Pregenital abdomen (Fig. 8). Male sternum VIII with lateral margins slightly concave, leading to deeply bifid posterior apex. Female abdomen not modified.

Male genitalia (Fig. 9). Uncus subquadrate, width 0.6X length. Gnathos hook slender, sharply bent, apically pointed. Tegumen about 2.5 times longer than uncus, anterior margin broadly concave. Valva moderately digitate, not exceeding apex of uncus, distal 1/3 of costa slightly concave before apex, ventral margin nearly straight, a row of short longitudinal setae in distal 2/3; apex rounded, slightly curved inward. Anellus lobe digitate, 2/5 length of valva, apically bearing a long seta. Juxta with sparse setae, basal 1/3 of inner margin protruded. Vinculum simple and slender. Saccus broad, sub-triangular, lateral margins slightly convex and narrowing toward blunt apex. Phallus with base distinctly bulbous, distal part slender, evenly tapered, equal in length to base, apex pointed.

Female genitalia (Figs. 10, 10a). Papillae anales moderately melanized, sub-triangular in lateral view, covered with short setae. Apophyses anteriores 1/2 length of apophyses posteriores. Sternum VIII deeply concave posteriorly about 3/5 of the length and slightly projecting anteriorly; medially with a well-sclerotized sub-rectangular plate, its posterior margin emarginate at middle. Tergum VIII divided into two sclerites, medially membranous. Ostium bursae at anterior 1/3 of sternum VIII. Ductus bursae posteriorly narrowed, gradually widening toward corpus bursae, slightly twisted at anterior 1/3; ductus seminalis arising from near posterior end of ductus bursae. Corpus bursae oval, 2/5 length of ductus bursae, posterior margin with a signum bearing horn-like processes: anterior process long, projecting inward at angle of 30 degrees, meeting posterior process at membrane of corpus bursae; anterior process bifid, shorter than posterior process, transversely projecting inward.

Larva (Figs. 11–18). Length of mature larva 4.5–5.5 mm ($n=10$). Body light green, head capsule brown; pinacula unpigmented; thoracic legs, prothoracic shield and anal shield light brown.

Head (Figs. 11, 12). Epicranium with deep epicranial notch in frontal view, dorso-ventrally slightly flattened. P1 slightly below AF1, P2 slightly below AF2, with very short seta, Pb between P1 and P2, distance between Pa and stemma 1 less than diameter of stemma; distance between L1 and stemma 1 less than diameter of stemma; A3 and S2 longest setae, S1 below stemma 2, S3 seta long, close to MG1. Mandible with five teeth.

Thorax (Fig. 13). T1 with six pairs of setae on prothoracic shield: XD1 on anterior margin, SD1 and SD2 along ventral margin, D1 and D2 in shield, D2 longer than D1; XD2 on anterior corner of shield; MXD1 bordering posterior margin of shield; L-group trisetose, L1 below L2 and L3; SV-group bisetose, SV1 slightly longer than SV2; MV3 below V1, MV2 absent. T2–T3 with D1 very short; SD1 much longer than SD2; L-group trisetose, L1 longest seta, L3 slightly longer than L2; MD1 below D-group; MSD1 slightly below MSD2 on T2, above MSD2 on T3; MV1 below SV1, MV3 above V1, MV2 absent.

Abdomen (Figs. 13, 15–18). D1 below D2 on A1–A7 and A9, above D2 on A8, A1–A6 with D2 slightly shorter than those on thorax; SD1 above SD2 except on A1; SD1 on A9 curved. L-group trisetose on A1–A8 and

A10, bisetose on A9, abdominal L2 and L3 shorter than those on thorax, L3 remote from L1 and L2 on A1–A8. SV-group unisetose on A1 and A7–9, bisetose on A2–A6; MD1 below D1 and D2, absent on A9. MV3 above V1; V1s on A9 minute, closer together than on preceding segments. A10 with SD1 the longest seta, L2 close to SV2. Prolegs with 10–13 crochets: uniordinal, base rounded, apical hook short and round-tipped (Fig. 16). Anal prolegs with a single row of 7–8 crochets (Fig. 17). Anal comb present, consisting of two tines curved inwardly and sharply pointed apically (Fig. 18).

Pupa (Figs. 19, 19a, 20, 20a). Mean length 3.5 mm, mean width 1.0 mm, mean dorsoventral thickness 0.7 mm (n=5). Color light brown. Cuticle with minute spines from vertex to anterior margin of mesothorax dorsally. Vertex rounded, labrum U-shaped, labial palpus not exposed. Prothorax with a pair of small bumps on post-lateral corner of tergite. Prothoracic leg slightly shorter than maxilla/haustellum, mesothoracic leg reaching posterior half of body, tip of metathoracic leg visible, extending beyond posterior margin of A4. Posterior margin of forewing reaching posterior margin of A4. A7 with a transverse row of spines near anterior margin, medially absent on sternite. A8 with a pair of ventrolateral projections covered with dense spines. Cremaster absent.

Etymology. The species name is derived from the genitive singular of the genus of its known host plant, *Leucaena leucocephala*.

Behavior (Figs. 21–28). Neonate larvae mine inside a leaflet. Larger stages tie together two leaflets, either adjacent or opposite ones. Pupation happens between two leaflets. Larvae can exit leaf shelters to create new ones.

Distribution (Fig. 34). Specimens have been collected in Florida, USA, including Alachua, Broward, Hillsborough, Manatee, and Miami-Dade counties.

Remarks. Some specimens have normally long palpi, but some have distinctly short palpi as shown in Figs 3 and 4. The short palpi belong to reared specimens killed after eclosion, and we assume that the palpi did not expand to their full length.

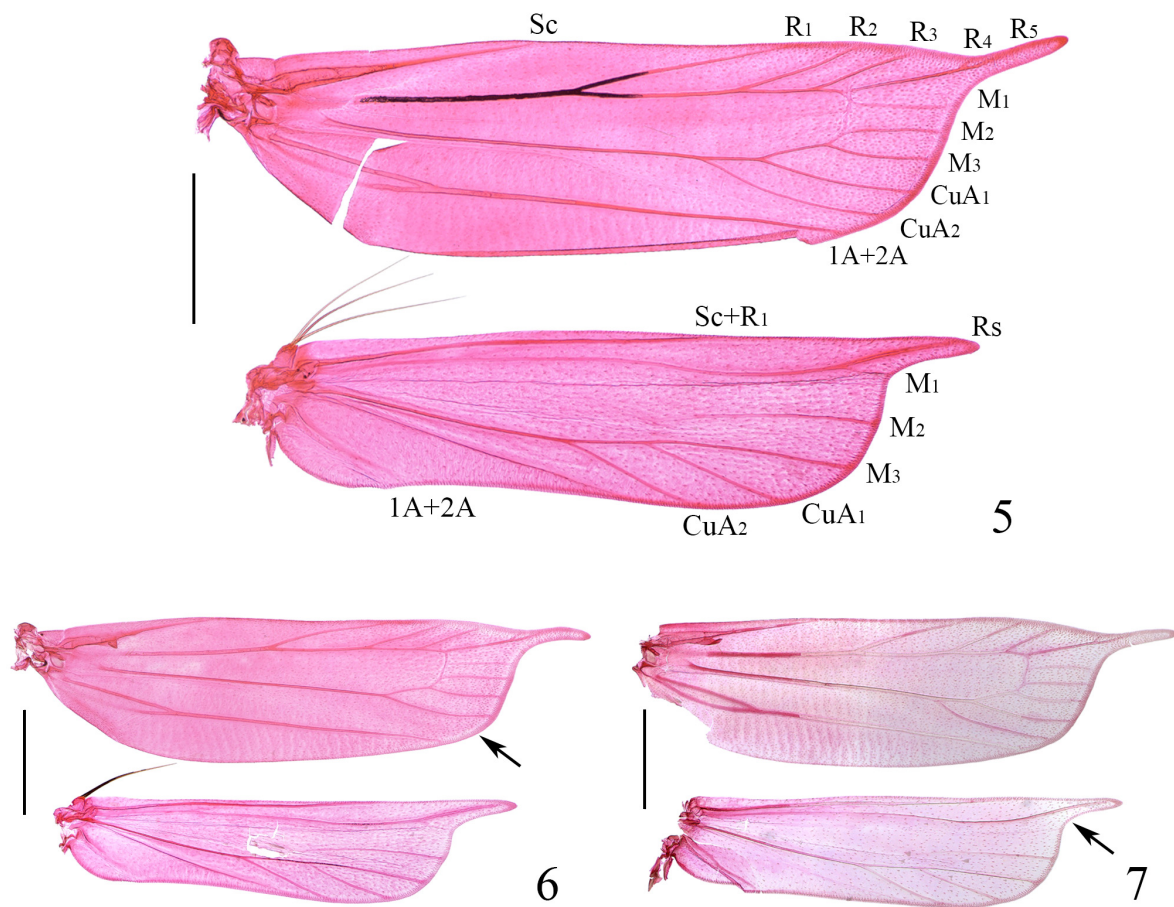
Additional species examined. *Calliprora sexstrigella*: 1 ♀, USA, Texas, Bexar Co. Ebony Hill Res. Station, 29.vii.1989, E. Knudson, slide MGCL 3442; 1 ♂, Texas, Bexar Co., San Antonio, 29.vii.1984, E. Knudson, slide MGCL 4306; 1 ♀, Texas, Culberson Co., Guadalupe Mts. Nat. Park, 8–9.v.2000, E. Knudson and C. Bordelon, slide MGCL 4308; 1 ♂, Arizona, Tempe, 17.v.1923, E.V. Walter and M. Martinez, slide ASUHIC-NKU03; 1 ♂, Texas, San Patricio Co., Welder Wildlife Refuge near Sinton, 14–16.vi.1985, E.C. Knudson, genitalia and wing slides MGCL-NKU05; 1 ♀, Arizona, Pima Co., Tuscon, 8.vi.1991, R.S. Wielgus, genitalia and wings slide ASUHIC-NKU04.

Polyhymno luteostrigella: 3 ♂♂, 3 ♀♀, USA, Florida, Alachua Co. Gainesville, Hull Road, FLMNH McGuire Ctr., 2.viii.2014, 30–31.viii.2015, and 27.iii.2016, J. Hayden, wings slide LGE16164, LGE16165, LGE16166, MGCL-NKU07, MGCL 3289, MGCL 3305; 1 ♂, Florida, Gainesville, 28.viii.1972, J.B. Heppner, slide MGCL 3030; 1 ♀, Gainesville, 11.iii.1975, J.B. Heppner, wings slide MGCL 3274; 1 ♂, Florida, Monroe Co., Dry Tortugas, Garden Key, 8.v.1961, H.V. Weems Jr., slide MGCL 3947; 1 ♂, Florida, Monroe Co., Big Pine Key, 24.7096, -81.3826, UVL, 12–13.iv.2018, J. Hayden & CAPS team, E18-1830, slide MGCL 4817; 1 ♂, Florida, Santa Rosa Co., FAMU Biol. Station near Holt, 25–28.viii.1986, J.B. Heppner, slide MGCL 3965; 1 ♂, USA, Louisiana, St. John Parish, Edgard, 2.viii.1981, V.A. Brou, gen. and wings slide MGCL 3937; 1 ♀, same data except 5.viii.1981, gen. and wings slide MGCL 3946; 1 ♀, Missouri, Randolph Co., Rudolf Bennit Wildlife Area, 24.vii.1971, J.R. Heitzman, wing slide MGCL 3963; 1 ♂, Oklahoma, Tulsa Co., Bixby, 19.viii.2007, J.M. Nelson, slide MGCL 3966; 1 ♀, USA, Puerto Rico, Maricao, Rte. 4409 km. 1.6, 30.i.2016, J. Hayden and C. Penca, slide MGCL 3964.

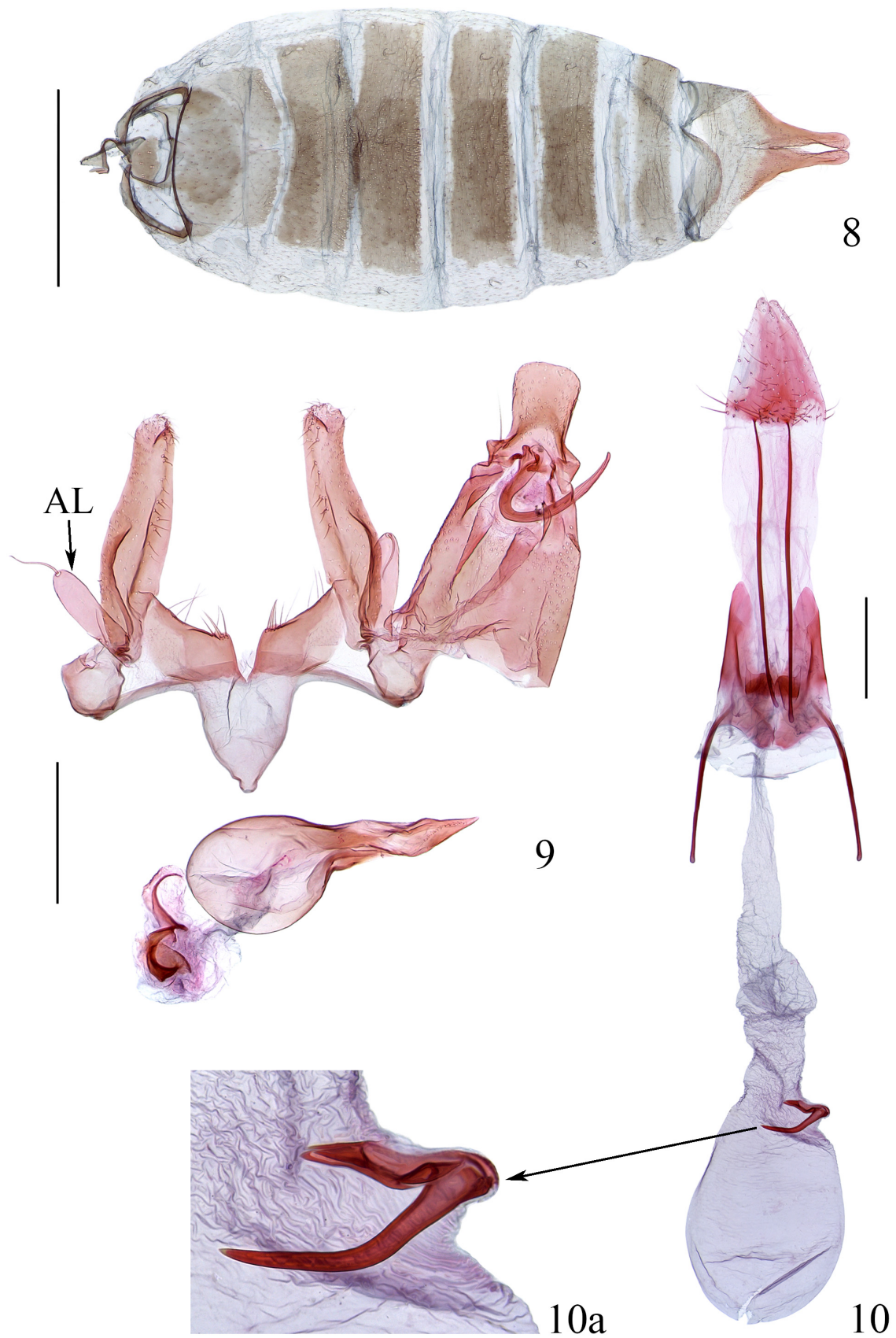
Polyhymno sp. cf. *luteostrigella*: 1 ♂, USA, Florida, Highlands Co. Archbold Biol. Station, 4.v.1975, J.B. Heppner, slide MGCL 3960; 1 ♂, USA, Georgia, Camden Co., Crooked River St. Park, 27.iv.1976, J.B. Heppner, slide MGCL 3962; 1 ♂, 1 ♀, USA, Missouri, Benton Co. 4 mi. NW of Warsaw, 10.vii.1971, J.R. Heitzman, gen. and wing slides MGCL 3958, 3959.

Polyhymno acaciella: 1 ♂, USA, Arizona, Cochise Co., Huachuca Mts., Pueblo Del Sol, 5131 Bannock St. 8.vi.1985, R.S. Wielgus, genitalia and wings slide ASUHIC-NKU01; 1 ♀, Arizona, Cochise Co., Huachuca Mts., Hunter Canyon, 6.vi.1985, R.S. Wielgus, genitalia slide ASUHIC-NKU02; 1 ♂, Arizona, Cochise Co., Chiricahua Mts., Coronado Nat. Forest, Rte 42B, 1.viii.2005, J.E. Hayden, slide MGCL 3285.

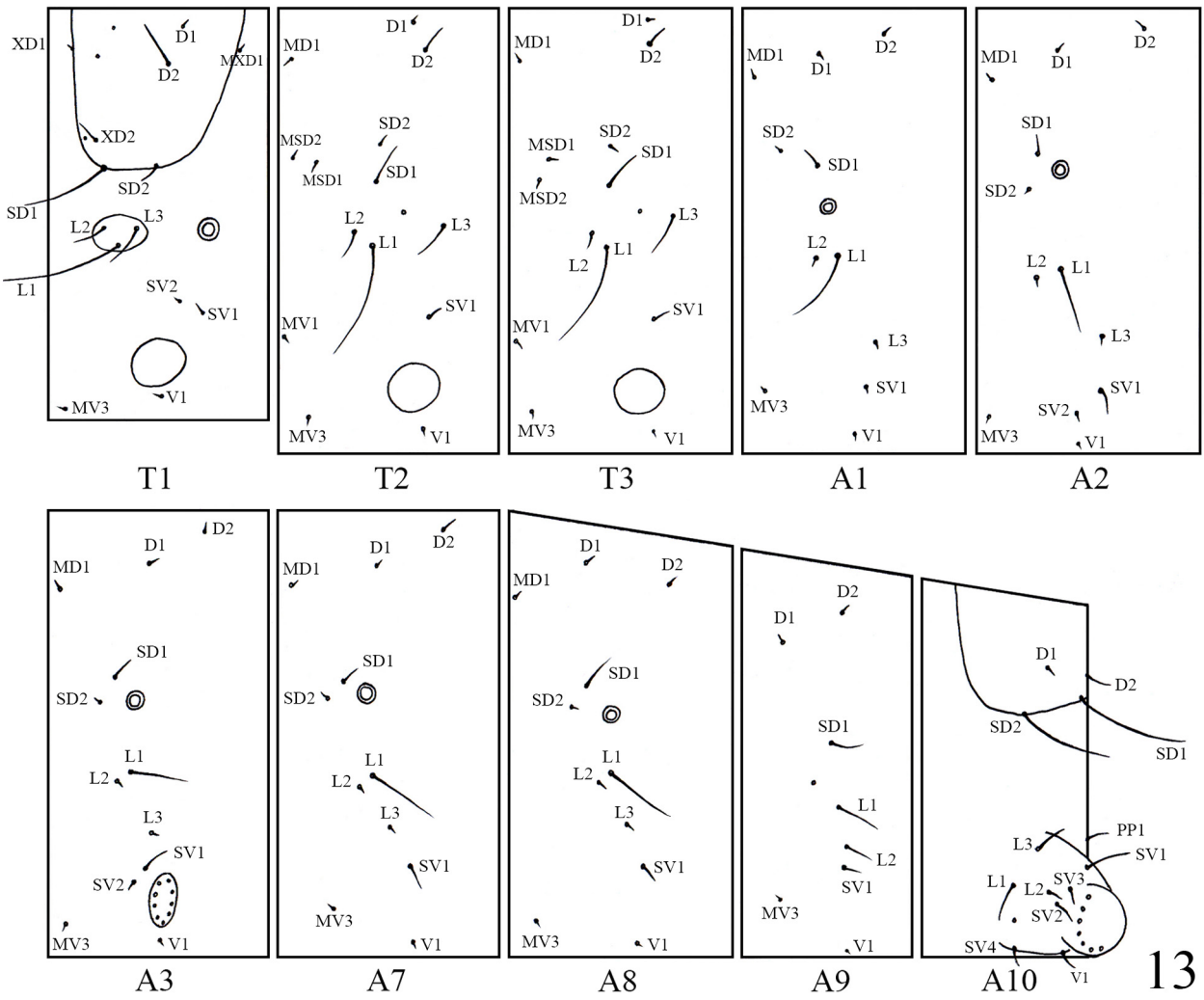
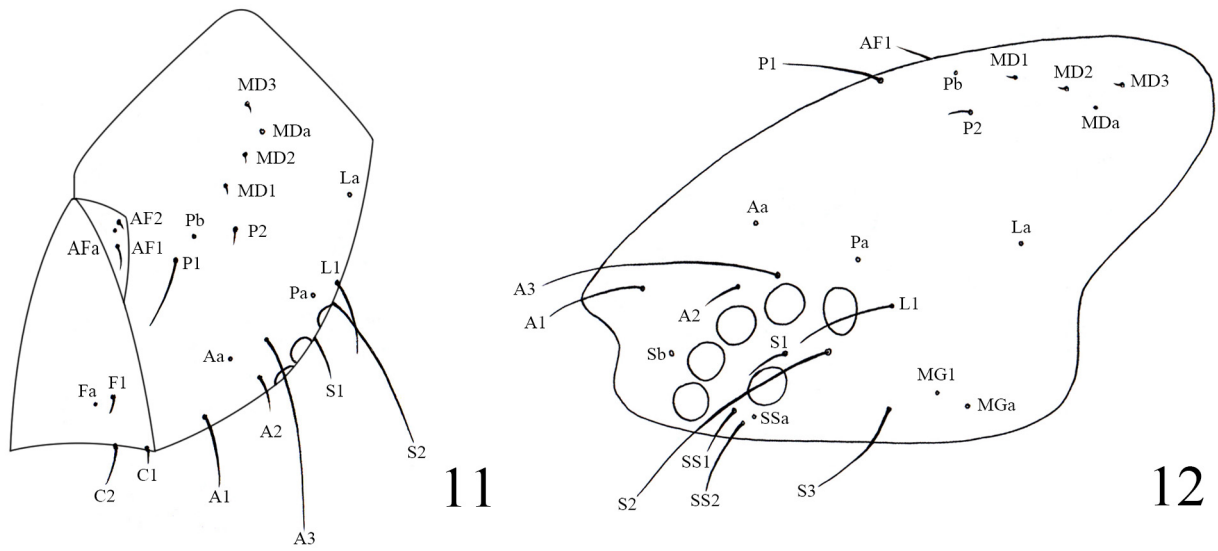
Polyhymno sp.: 1 ♂, 1 ♀, China, Yunnan Province, Pu'er City, Taiyanghe National Forest Park, 1450 m, 3–18.iv.2015, Kaijian Teng, genitalia and wings slide LGE16020, LGE16021.



FIGURES 1–7. Adults and wing venation of *Calliprora leucaenae* sp. nov. 1, male, dorsum; 2, female, dorsum; 3, lateral view of male head; 4, lateral view of female head; 5, wing venation of female, slide no. MGCL-NKU03; 6, wing venation of male, slide no. MGCL-NKU02; 7, wing venation of male, slide no. MGCL-NKU01. (Scale bars = 0.5 mm except 1, 2 = 2.0 mm)



FIGURES 8–10. Abdomen and genitalia of *C. leucaenae*. 8, male abdomen, slide no. MGCL-NKU01; 9, male genitalia, slide no. MGCL-NKU01 (AL, anellus lobe); 10, female genitalia, 10a, enlarged view of signum, slide no. MGCL-NKU03. (Scale bars = 0.2 mm except 8 = 0.5 mm)



FIGURES 11–13. Chaetotaxy of *C. leucaenae*. 11, head, frontal view; 12, head, lateral view; 13, T1–A10, lateral view.

Discussion

Knowledge of thiotrichine morphology is incomplete, especially of immature stages, but some comparison is possible. The wing venation of *C. leucaenae* (Figs. 5–7) is like that of *C. pentagramma* Meyrick (Gates Clarke 1969) except that forewing CuA_2 and hindwing M_1 can be obsolete. If two veins are present, CuA_2 is remote from CuA_1 as in *C. pentagramma* (connate in *C. sexstrigella*), and M_1 is stalked with R_s as in *C. sexstrigella* (connate in *C. pentagramma*) (Fig. 30). Meyrick (1914, 1925) noted that vein 7 (R_s) of the forewings is absent in *Calliprora*, but the type *C. pentagramma* has R_s long-stalked with R_4 (Gates Clarke 1969) as in *C. leucaenae*. The presence, fusion, or absence of R_s vein seems to be variable within the genus, since we examined two specimens of *C. sexstrigella* without R_s . Species of *Polyhymno* also have R_s stalked or coincident with R_4 (Meyrick 1925). Intraspecific variation of wing venation in Gelechiidae is inadequately documented, but it has been reported in some groups of Lepidoptera such as Arctiinae (Sotavalta 1964), Elachistidae (Albrecht & Kaila 1997), and Agathiphagidae (Schachat & Gibbs 2016).

The larvae of *C. leucaenae* are distinguished from the only other known thiotrichine larvae, *Thiotricha prunifolivora* Ueda & Fujiwara, by having a head that is dorso-ventrally slightly flattened and an epicranium with a deep epicranial notch (Figs. 11, 12). The larvae of the latter species have a more rounded head, and the epicranial notch is shallow (Ueda & Fujiwara 2005). In the larval chaetotaxy of the new species, D1 is above D2 on T1–T3 and A8, and it is below D2 on A1–7 and A9; the SV-group is unisetose on A1 and A7–9, and bisetose on A2–A6; MV1 is only present on T1 and T2, and MV2 is always absent (Fig. 13). In *T. prunifolivora*, however, D1 is always above D2; the SV-group is bisetose on A1 and A7, trisetose on A2–A6, and unisetose on A8 and A9; and MV2 is present on T1 and T2. The D-group of the new species is rather similar to those of *Chrysoesthia heringi* Kuroko (Gelechiidae: Apatetrinae) in position (Kuroko 1961). The unisetose SV group on A1 is unusual, since most Gelechiidae have A1 with 2 SV setae (Hodges 1998). The A1 with a unisetose SV group has been reported in *Exoteleia pinifoliella* (Chambers) (Gelechiinae) (Lindquist 1963), although other congeneric species such as *E. burkei* Keifer, *E. dodecella* (L.) and *E. nepheos* Freeman have a bisetose SV group on A1 (Adamski *et al.* 2010). The flat head and reduced number of SV setae may be adaptations for leaf-mining.

The pupae are characterized by having a transverse row of spines on A7 and a pair of ventro-lateral projections on A8 (Figs. 19, 19a, 20, 20a). *Thiotricha subocellea* has similar structures, although those are situated on A8 and A9, respectively (Bland *et al.* 2002). *Thiotricha prunifolivora* has a row of tergal spines on both A6 and A7, and a pair of pads on A7 (Ueda & Fujiwara 2005).

Considering that *C. leucaenae* and *C. sexstrigella* both feed on leguminous trees with small leaflets, other congeners might also feed on related Fabaceae. The hosts of *Polyhymno* species are all Fabaceae: two North American species *P. luteostrigella* and *P. acaciella* feed on *Chamaecrista fasciculata* (Michx.) Greene and *Vachellia farnesiana* (L.) Wright & Arn., respectively (Busck 1900, 1903; Smith 1910), an unidentified *Polyhymno* species feeds on *Vachellia cornigera* (L.) Seidler & Ebinger in Mexico (Eubanks *et al.* 1997), and seven African species have been reared on *Acacia* spp. (Agassiz & Bidzilya 2016). Although other host usage is still unknown for the remaining species of *Calliprora* and *Polyhymno*, the fact that many species of both genera utilize the same host family Fabaceae (especially Mimosoideae) indicates that the host-specificity may be correlated with the presence of secondary compounds of the plants (Kergoat *et al.* 2004). Related insect taxa tend to feed on taxonomically related host plants (Lopez-Vaamonde *et al.* 2003; Doorenweerd *et al.* 2015). Another thiotrichine, *Macrenches clerica* (Rosenstock), also known to feed on *Acacia brownii* (Poir.) Steud. (Common 1990), but the genus is morphologically different from *Calliprora* because the anellus lobes characteristic of *Palumbina*, *Polyhymno* and *Thiotricha* are missing in *Macrenches* (Karsholt *et al.* 2013). The species-rich genus *Thiotricha* feeds on a wide range of plant families including Fagaceae, Lamiaceae, Oleaceae, Proteaceae, Symplocaceae, and others (Meyrick 1925; Ueda & Fujiwara 2005; Sakamaki 2013), and *Palumbina* species are known to feed on Anacardiaceae (*P. guerinii* and *P. glaucitis*) and Fagaceae (*P. pylartis*) (Meyrick 1925; Kuroko 1957; Sattler 1982; Sakamaki 2013). Feeding on Fabaceae could be a synapomorphy of *Calliprora* and *Polyhymno* in addition to the morphological similarities. *Leucaena leucocephala* is well-known for its production of mimosine, an herbivory-detering toxin, so *C. leucaenae* should be tested on *Mimosa* species and related legumes that also have mimosine (Xuan *et al.* 2016).

In the field, the young larvae of *C. leucaenae* mine in the mesophyll of the leaves and make irregular blotches. A single larva occupies each mine. Later instars tie two adjacent or opposite leaflets and continue to feed. Pupation takes place in the same shelter between the leaflets. The new species is the third record of a leaf-miner in

Thiotrichinae after *Palumbina guerinii* (Stainton) and *P. pylartis* (Meyrick) (Sattler 1982). In Gelechiidae, the leaf-mining larval habit is known to be widespread but scattered among unrelated genera (Powell 1980; Adamski *et al.* 2014).



FIGURES 14–18. Larva of *C. leucaenae*. 14, preserved larva, lateral view; 15, thoracic leg; 16, crochets; 17, A10, ventral view; 18, A10 and anal comb (arrow), dorsal view. (Scale bars = 0.1 mm except 14 = 2.0 mm)

Busck (1900) reported the larvae of *Polyhymno luteostrigella* and *P. acaciella* to be leaf-spinners and leaf-webbers, respectively. Eubanks *et al.* (1997) also observed the larvae of a *Polyhymno* species constructing sealed shelters by webbing together leaves. The shelters served as a refuge from ant attacks, and it promoted the exploitation of the ant-defended host plant. On the other hand, the larvae of *C. sexstrigella* burrow in buds (Rogers 1976), which is more similar to the behavior of *Thiotricha* species. The larvae of *Macrenches clerica* shelter in a

gallery of silk on the host plant, but interaction with ants has not been reported (Common 1990). Most known species of *Thiotricha* are case-makers feeding on flowers, seeds or leaves as reported in *T. coleella* (Constant), *T. subocellea* (Stephens), *T. pontifera* Meyrick and *T. prunifolivora* (Meyrick 1925; Huemer 1993; Robinson *et al.* 1994; Bland *et al.* 2002; Ueda & Fujiwara 2005; Sakamaki 2013), but at least one species is a shoot-borer (Robinson *et al.* 1994). In *Palumbina*, the larvae are associated with aphid galls (*P. guerinii*) or mine leaves (*P. guerinii* and *P. pylartis*) (Sattler 1982).

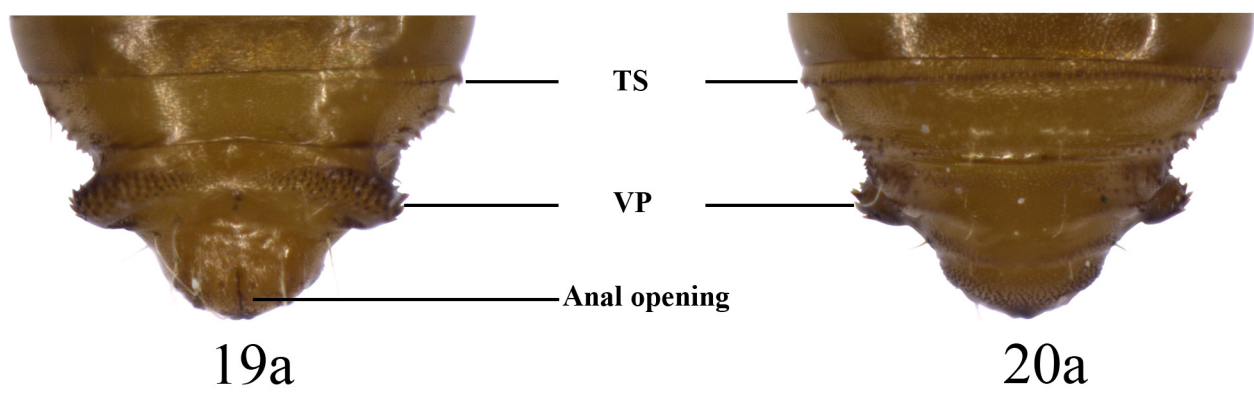
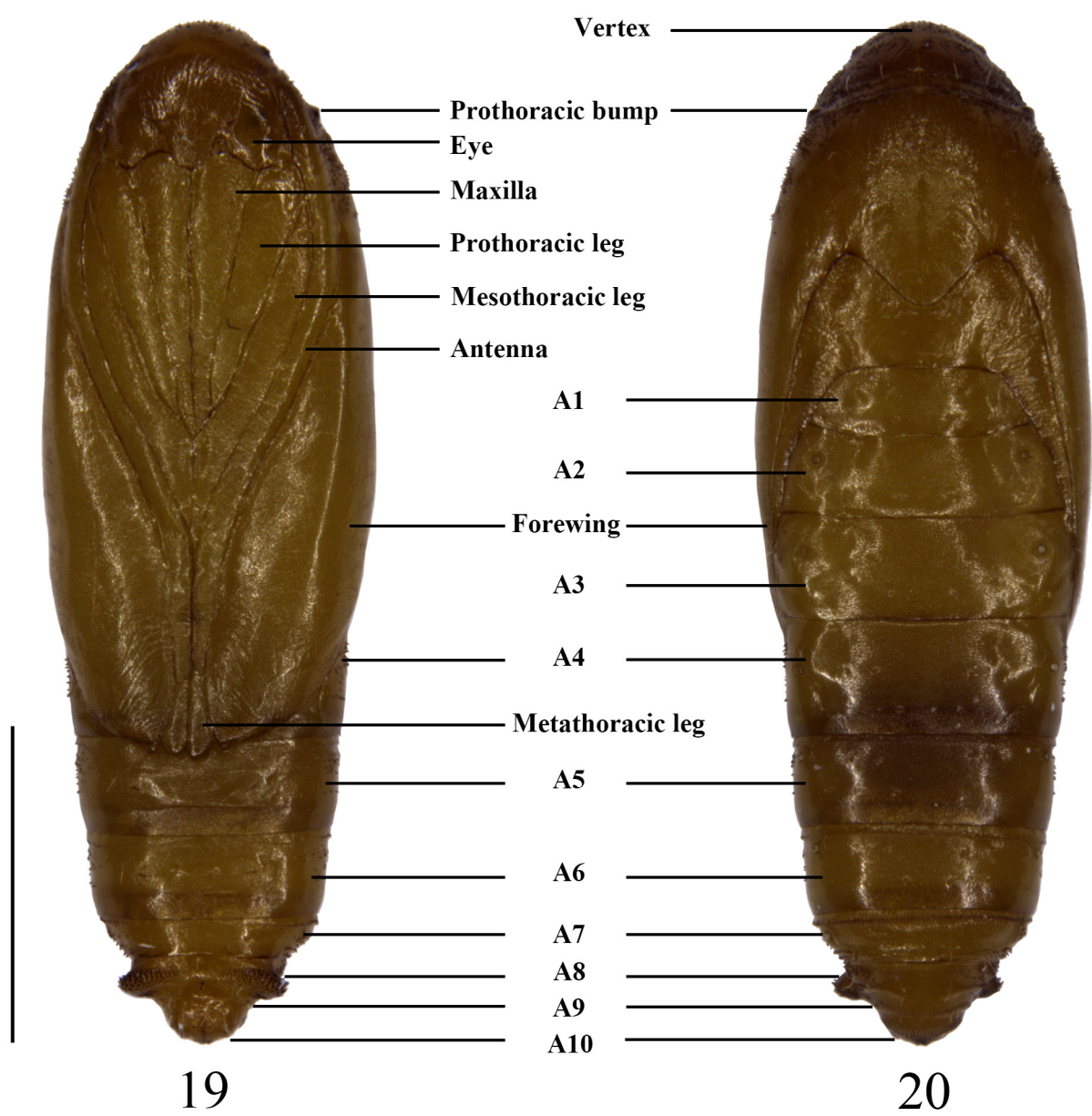
The sudden appearance of *C. leucaenae* in Florida suggests an exotic origin. Specimens were not found in the FSCA prior to 2015. The species probably originated in Mexico and Central America, where *L. leucocephala* is native. A Central American origin would fill a biogeographic gap between the species of *Calliprora* in South America and *C. sexstrigella* in the southern United States. We admittedly have scruples about making a type locality someplace other than its predicted native range. However, we have not been able to find specimens in microlepidoptera collections from Central America, and we think the species' potential economic importance and invasiveness justify an expedited description. Although we have not examined specimens collected before 2015, *C. leucaenae* may have been present in Florida much earlier. In November 2007, adults and immature stages were collected from lead tree with "severe" damage in a waste field in Miami (DPI #E2007-8789, leg. H. Escobar). The sample was identified preliminarily as "*Calliprora* or *Polyhymno* sp." by D. Matthews-Lott (FLMNH), but we cannot find the specimens in the FSCA/MGCL. If the moth really was present earlier, it should be no surprise that damage was overlooked because the host has no economic value in Florida.

Few known insect pests damage lead trees. The bruchid beetle *Acanthoscelides macrophthalmus* (Schaeffer) is a seed predator that reduces seed production, the psyllid *Heteropsylla cubana* prevents flowering and seedpod formation by sucking sap, the cosmopterigid caterpillar *Ithome lassula* Hodges reduces pod production by feeding on flower buds, and the long soft scale *Coccus longulus* (Douglas) reduces the growth of *Leucaena* by sucking activity (Walton 2003). One other moth in Florida makes similar mining damage. We reared a possibly undescribed species of *Siskiwitia* Hodges (Cosmopterigidae) from lead tree in Pinellas Co., and more have been collected on traps underneath lead trees in Manatee Co. together with *C. leucaenae*.

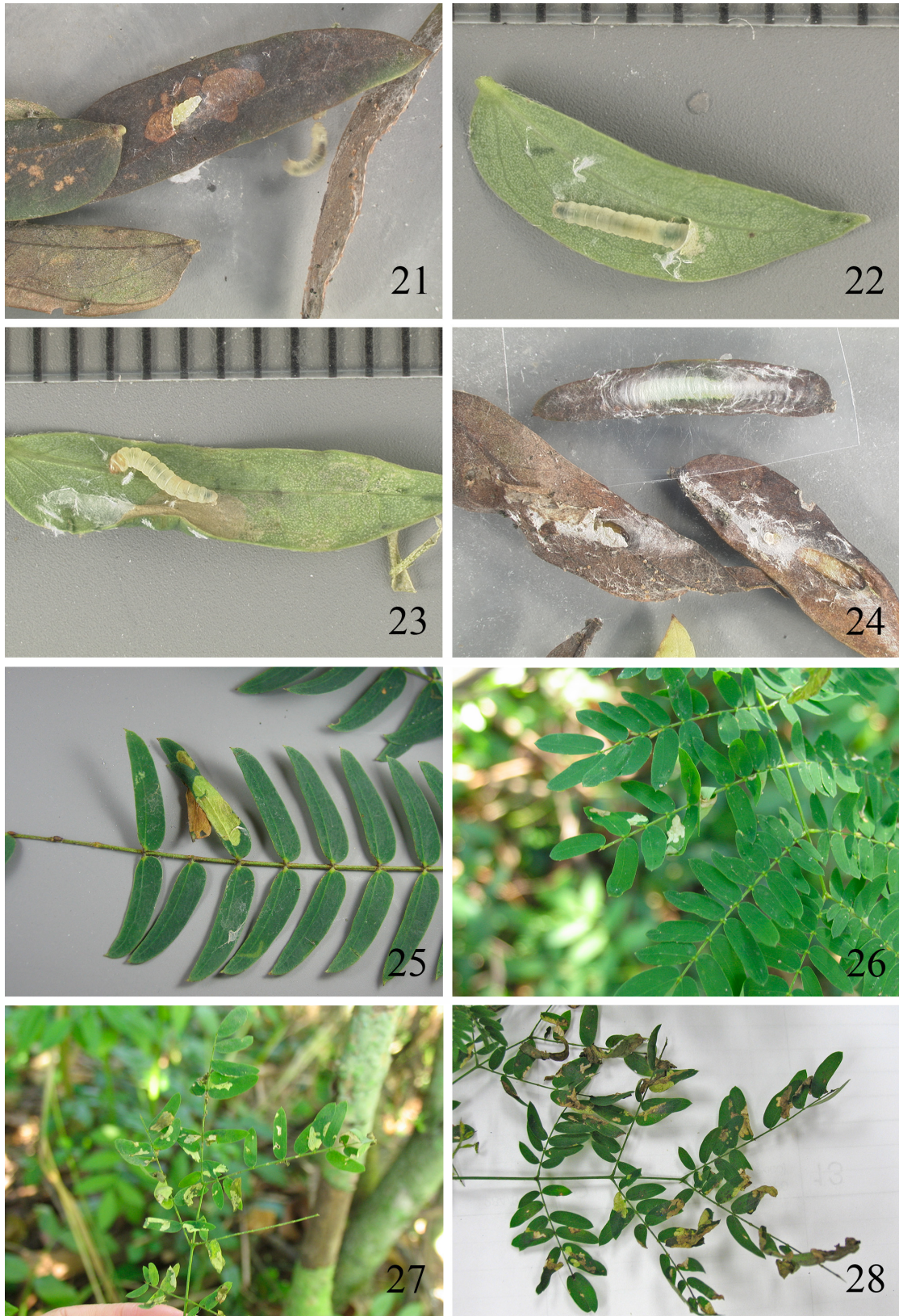
Leucaena leucocephala was likely introduced to Florida in 1898 (Morton 1976; MacDonald *et al.* 2014). Besides America, *L. leucocephala* is widespread in over 80 countries globally (Walton 2003). In Asia the earliest record was in 1645 in Taiwan (Wu *et al.* 2003), and it was recorded in Japan in 1867 and continental China in 1920 (Tuda *et al.* 2009). It spread across the Pacific during the 1800s and was introduced into Australia and South Africa approximately in the late 19th century (Walton 2003; Oelkers 2011). Lead tree was considered a multipurpose beneficial plant, but now it has become an aggressive invader in more than 20 countries (Walton 2003; Tuda *et al.* 2009). Some non-native insect pests have been introduced to the countries where *L. leucocephala* is established: *A. macrophthalmus* was deliberately released in South Africa as a biocontrol agent, and *H. cubana* and *I. lassula* were accidentally imported into Australia. Now most of them are globally distributed along with the host plant (Walton 2003; Tuda *et al.* 2009; Ahmed *et al.* 2014). To date, no *Calliprora* species have been recorded from the Palearctic and Oriental regions, and we could not find any related species in the NKU, a collection that preserves a large number of moth specimens collected all throughout China and from some neighboring countries.

The larvae of *Calliprora leucaenae* do not kill lead trees, but they could affect the photosynthetic efficiency and cause an early drop of leaves, as do many leaf miner species (Maier 1983; Schaffer *et al.* 1997; Liu *et al.* 2015). Further studies on seasonal occurrence of larvae and annual impacts on plants should be performed to determine its suitability as a possible biological control agent. The distribution of the moth needs to be traced if it should spread to other regions where the lead trees are established. If *C. leucaenae* is stenophagous, it should be restricted to subtropical regions where lead tree survives. Long periods of freezing temperature kill the foliage of lead trees. In January 2018, a freeze killed foliage in Gainesville, and the moths have not yet been observed on the new growth as of August 2018.

The thiotrichine fauna of Florida includes at least four species besides *C. leucaenae*. The other species are white with brown or golden lines and cannot be confused with *Calliprora*. Specimens identified as *Polyhymno luteostrigella* comprise two species, one of which is widespread in Florida and the eastern U.S., and the other is possibly restricted to xeric habitats. A species tentatively identified as *Thiotricha laterestriata* Walsingham has been collected in Miami and Key West (Hayden 2016b). The fifth is an undescribed species of uncertain generic placement, resembling small *P. luteostrigella*, known from Archbold Biological Station, points on the Atlantic and Gulf Coasts, and pine rockland in Miami-Dade Co.



FIGURES 19, 20. Pupa of *C. leucaenae*. 19, ventral view, 19a, enlarged view of A7–A10; 20, dorsal view, 20a, enlarged view of A7–A10. TS, transversal spines; VP, ventrolateral projection. (Scale bar = 1.0 mm)



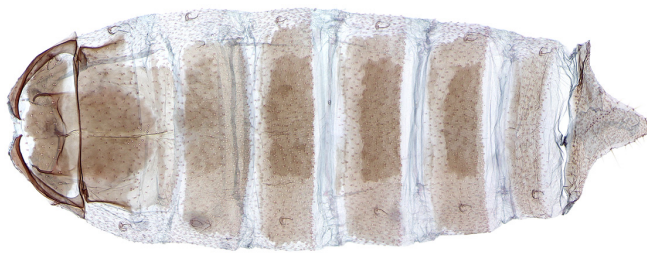
FIGURES 21–28. Damage and live immature stages of *C. leucaenae* on *Leucaena leucocephala* foliage. 21, middle-instar larvae, one initiating mine in senescent leaf (Tampa, FL, January 2017); 22, older instar with head in partial mine (Homestead, FL, June 2017); 23, larva on leaf surface (same origin as Fig. 22); 24, pupal chambers on leaves (Tampa, Jan. 2017); 25, two mined leaflets tied together (Dania Beach, FL, September 2016); 26, leaf with minor damage (Gainesville, FL, September 2017); 27, heavily infested leaf in the field (same origin as Fig. 26); 28, heavily infested leaf (Gainesville, November 2017). (Scales in mm.)



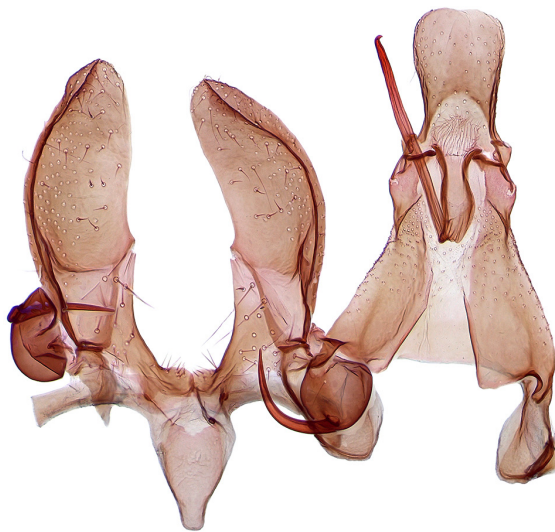
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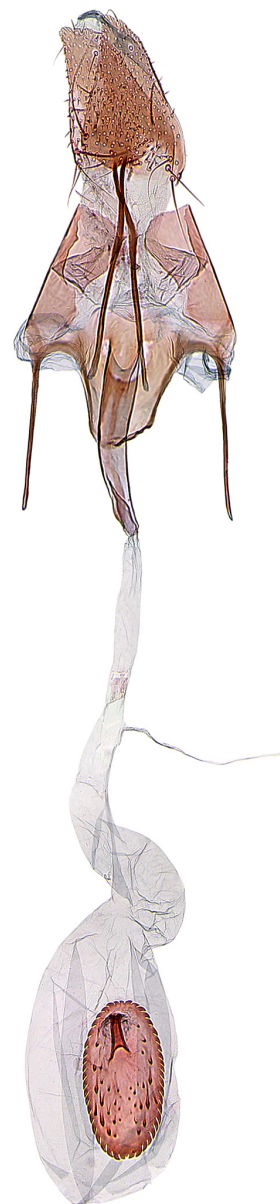
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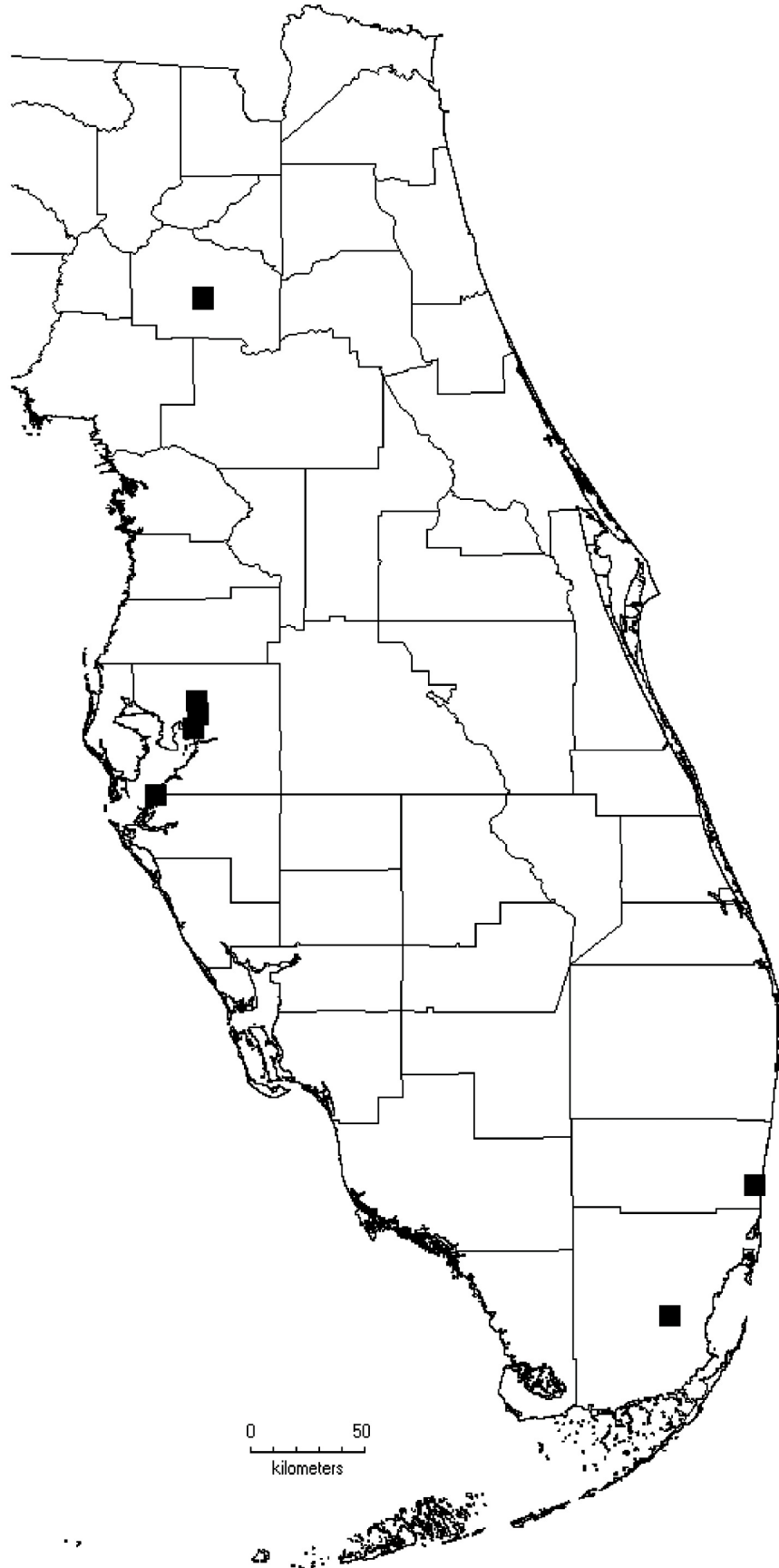


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FIGURES 29–33. *Calliprora sexstrigella* (Chambers). 29, male (Texas), dorsum; 30, wing venation of male, slide no. MGCL-NKU05; 31, male abdomen, slide no. MGCL-NKU05; 32, male genitalia, slide no. MGCL-NKU05; 33, female genitalia, slide no. MGCL-NKU06. (Scale bars: 29 = 2.0 mm; 30, 31, 33 = 0.5 mm; 32 = 0.2 mm)



34

FIGURE 34. Distribution of *C. leucaenae* in Peninsular Florida, USA. Squares = collection sites.

The maculation of *C. leucaenae* resembles that of some other Nearctic microlepidoptera, such as *Anacampsis levipedella* (Clemens) (Gelechiidae), *Cydia fahlbergiana* (Thunberg) (Tortricidae), and species of *Coptodisca* Walsingham (Heliozelidae). The proximal half of the forewing is plain grey, and the distal half is dark with pale streaks. We have not yet observed display behaviors that could explain the shared pattern.

Acknowledgements

We thank Travis J. Streeter (FDACS-DPI), Eric M. Dougherty (FDACS-DPI), and Julio C. Garcia (USDA APHIS) for collecting the first specimens, and especially Mr. Streeter for giving advice and follow-up inspections around the Tampa Bay area. Doug Restom-Gaskill (USDA APHIS) also placed traps in judicious places in the same region. Sangmi Lee (ASUHC) kindly lent specimens of *Calliprora sexstrigella* and *Polyhymno acaciella*. Dr. E.C. Knudson donated the Texas Lepidoptera Survey Collection to the MGCL during the course of this study, which provided many useful specimens for comparison. Patti J. Anderson (FDACS-DPI) identified our plant samples, advised about botanical nomenclature, and encouraged us to find enemies of lead tree. Mark Metz (USDA ARS SEL) kindly searched the National Museum of Natural History for specimens. We thank J.N. Awad and Drs P.J. Anderson, P.E. Skelley, J.D. Stanley, and G.S. Hodges (all FDACS-DPI) and two anonymous reviewers for extensive, constructive comments. We thank the Florida Department of Agriculture and Consumer Services – Division of Plant Industry for their support on this contribution. This study was supported by the National Natural Science Foundation of China (No. 31672372).

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