



## New records of leaf-mining Tortricidae (Lepidoptera) in North America, with the description of a new species of *Grapholita*

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### Abstract

We discuss seven species of tortricid moths that are leafminers at least in early instars. These include *Grapholita thermopsidis* Eiseman & Austin, **new species**, which feeds on *Thermopsis rhombifolia* (Pursh) Richardson (Fabaceae), along with two others for which larval hosts were previously unknown: *Catastega triangulana* Brown (Ericaceae: *Arctostaphylos pungens* Kunth) and *Sparganothis xanthoides* (Walker) (Polemoniaceae: *Phlox divaricata* L.). Parasitoids of *G. thermopsidis* include *Dolichogenidea* sp. (Hymenoptera: Braconidae) and *Zagrammosoma mirum* Girault (Hymenoptera: Eulophidae). The female genitalia of *Epinotia nigralbana* (Walsingham), a species that mines leaves of *Arctostaphylos* throughout larval development, are illustrated for the first time. *Rhopobota finitimana* (Heinrich), which feeds on *Ilex* spp. (Aquifoliaceae), is confirmed to mine leaves as has been documented previously in *R. dietziana* (Kearfott). *Talponia plummeriana* (Busck), which is known to feed in the developing ovaries of pawpaw (Annonaceae: *Asimina* spp.), also feeds in leaves before boring in the twigs and stems. *Cenopis lamberti* (Franclemont), previously reported from *Persea* sp. (Lauraceae), was reared from *Symplocos tinctoria* (L.) L'Hér. (Symplocaceae). Apart from the two exceptions noted above, all of these species exit their mines in later instars to feed in leaf shelters.

**Key words:** plant-insect interactions, rearing, *Catastega*, *Cenopis*, *Epinotia*, *Rhopobota*, *Sparganothis*, *Talponia plummeriana*

### Introduction

Tortricidae are commonly referred to as “leafroller moths” because the larvae of many species use silk to roll leaves into shelters in which they feed. However, some tortricid larvae form other types of leaf shelters (using silk to fold or crumple individual leaves, or to tie together multiple leaves), and many feed in other concealed situations: they may bore in stems, roots, or fruits; feed within galls they induce, or in galls induced by other insects; or they may feed in flowers or seed heads, as predators of scale insects, or as detritivores in leaf litter (Brown *et al.* 2008). Some feed as leafminers in early instars (Eiseman 2014b; Eiseman & Jensen 2015), or in a few cases throughout their development (Eiseman 2014a).

Eiseman (2019) summarized the known examples of leaf- (and needle-) mining in North American Tortricidae, including representatives of both Olethreutinae (six genera of Eucosmini, three of Grapholitini, and two of Olethreutini) and Tortricinae (three genera of Archipini, one of Cnephasiini, two of Cochylini, and one of Sparganothini). Some of these represented previously unpublished records involving tentatively identified moths. The identities of the reared adults have now all been confirmed via dissection, and we present the details below, including the description of one new species, along with discussion of an additional grapholitine that was missed by Eiseman (2019).

## Material and methods

Leaf mines were photographed at the time of collection. They were then placed in sealed, 9- or 15-dram plastic vials, which were stored away from direct sunlight and checked daily (when possible) for emerging insects. Larger leaves were instead placed in resealable plastic bags. If deemed necessary, a crumpled piece of toilet paper was added to the container—either a dry one to absorb excess moisture, or moistened with several drops of water to prevent desiccation. If the leaves deteriorated and larvae were seen wandering in search of food, fresh leaves of the same or a congeneric hostplant were added. The overwintering *Grapholita* pupae were stored in a refrigerator at 1–3 °C from 1 November 2015 to 1 March 2016. Adult moths were photographed alive as described by Eiseman & Lonsdale (2018), then placed in a killing jar with ammonium carbonate, after which they were spread and double mounted.

Dissection methods follow Landry (2007). When necessary, structures were stained using Eosin Y and Chlorazol Black. Moth identifications were made by KAA by comparison to figures in Heinrich (1926), Brown (1992), Gilligan *et al.* (2008), Powell & Brown (2012), and Gilligan *et al.* (2018). Genitalia are stored in glycerol-containing microvials pinned beneath the specimens; larvae are stored in a vial of 70% ethanol. All moth specimens examined were deposited in the Cornell University Insect Collection (CUIC), except one paratype of the new species which will be deposited in the National Museum of Natural History (USNM). Adults, larvae, and pupae were measured by superimposing a scalebar onto images using Adobe® Photoshop® CC 19.1.8 (2018) to the nearest tenth-millimeter; forewing length was measured similarly from the base of wing to the apex including fringe. Terminology follows Komai (1999) and Gilligan *et al.* (2008), except for “phallus,” which we use instead of “aedeagus”.

In the “Material examined” sections, the first date listed for each collection event indicates when the larvae were collected, and “em.” precedes the date(s) of adult emergence; “ex” before a plant name indicates that the specimens were reared from larvae feeding on this plant. The following abbreviations are used for depositories of moth specimens not examined by us: EME = Essig Museum of Entomology, University of California, Berkeley; MSC = private collection of M. Sabourin, Marshfield, Vermont; WIRC = Wisconsin Insect Research Collection, University of Wisconsin, Madison. Braconid wasps were identified by J. Fernández-Triana and are deposited in the Canadian National Collection of Insects, Arachnids & Nematodes, Ottawa (CNC). Eulophid wasps were identified by R. Perry and are deposited at the University of California, Riverside (UCR). Plant taxonomy in the “Host” sections follows POWO (2019).

## Olethreutinae

### Eucosmini

#### *Catastega triangulana* Brown

(Figs. 1–6)

**Material examined.** ARIZONA: Cochise Co., Miller Canyon, 3.iii.2017, em. 10.vi.2017, C.S. Eiseman & J.A. Blyth, ex *Arctostaphylos pungens*, #CSE3812 (1♀, CUIC).

**Host.** Ericaceae: *Arctostaphylos pungens* Kunth.

**Biology.** The larva forms a full-depth, elongate, branching leaf mine, with some fecal pellets inside and some expelled through a hole adjacent to the midrib, where it may accumulate in a mass on the leaf surface (Figs. 1–4). In captivity, the larva exited the mine and switched to window-feeding between veins, ultimately pupating between two tied leaves. Our single specimen was collected on 3 March and emerged as an adult on 10 June (Figs. 5–6). The type series included adults collected in Arizona from 27 July to 5 August, as well as on 1 September and 10 and 17 October (Brown 1992). These dates suggest there may be more than one generation.

**Comments.** This is the first definite host association for *C. triangulana*, although Brown (1992) tentatively identified as this species a specimen beaten from *Arctostaphylos* in Durango, Mexico. It is also the first confirmed record of leafmining in *Catastega*. Chambers (1878) stated that *C. aceriella* Clemens and *C. timidella* Clemens (both of which were known only from larvae at that time) initially feed as leafminers before constructing their characteristic tubes of frass, but this has not been repeated by later authors. At least in later instars, both species feed beneath sheets of silk that could conceivably be mistaken for the loosened lower epidermis of a leaf mine.



**FIGURES 1–6.** *Catastega triangulana*. 1: Leaf mine on *Arctostaphylos pungens*, upper surface; 2: Lower surface of same leaf, showing frass accumulation; 3–4: Backlit views of two other mines, showing frass inside; 5: Pupal exuviae; 6: Reared adult female.

### *Epinotia nigralbana* (Walsingham)

(Figs. 7–13)

**Material examined.** CALIFORNIA: San Diego Co., Pacific Crest Trail (Barrel Spring: 33.210401, -116.580605), 12.iii.2017, em. 15.iv.2017, C.S. Eiseman & J.A. Blyth, ex *Arctostaphylos*, #CSE3494 (1♀, CUIC); em. 24.iv.2017, #CSE3556 (1♂, CUIC).

**Hosts.** Ericaceae: *Arbutus menziesii* Pursh, *Arctostaphylos hooveri* P.V.Wells, *A. manzanita* Parry, *A. montana* Eastw., *A. patula* Greene, *A. virgata* Eastw. (Powell 2006).

**Biology.** According to Powell & Opler (2009), *E. nigralbana* “mines the leaves of madrone and manzanita during winter, maturing in March to May, and adults fly April to August. . . [Young larvae] mine a thin loop from the leaf margin, defining a circular area, into which they mine digitate extensions after overwintering. Pupation occurs in the mine.” We have found active mines in Oregon on 21 October, by which time the larvae had already begun mining digitate extensions into the semicircular area delineated by the initial arc (Fig. 7). All frass is expelled from a hole at one end of the arc. Our two reared California specimens (Figs. 12–13) were collected as larvae on 12 March; in both cases the leaf was completely mined out at this time (the initial arc still discernable), with oblong fecal pellets scattered throughout (Fig. 8). One larva (CSE3556) pupated within the original leaf, and the pupal exuviae were left protruding from the mine when the adult emerged. The other larva (CSE3494) had tied the edge of a second leaf to the upper surface of the original leaf, without any obvious silk on the surface of either leaf, and had formed a frass-free blotch in the adjacent portion of the fresh leaf (Fig. 9). In captivity the latter larva continued to feed in the new leaf, apparently with a silk tunnel running through the middle of the mine, with frass deposited along either side. When finished feeding it chewed a conspicuous circular exit hole and pupated in a cocoon spun in the bottom of the rearing vial. At the same collection site we found another mine in which the larva had formed an elongate blotch along the leaf margin (proceeding from the initial arc), with a similar pattern of frass flanking a central silk gallery (Fig. 10). There was a similar round hole at the end of this mine, suggesting pupation at least sometimes takes place outside the mine under natural conditions.

**Comments.** To our knowledge, no illustration or description of the female genitalia of *Epinotia nigralbana* has ever been published. Heinrich (1926) figured the male genitalia but omitted the female. To that end, we figure the female genitalia here (Fig. 13).

### *Rhopobota finitimana* (Heinrich)

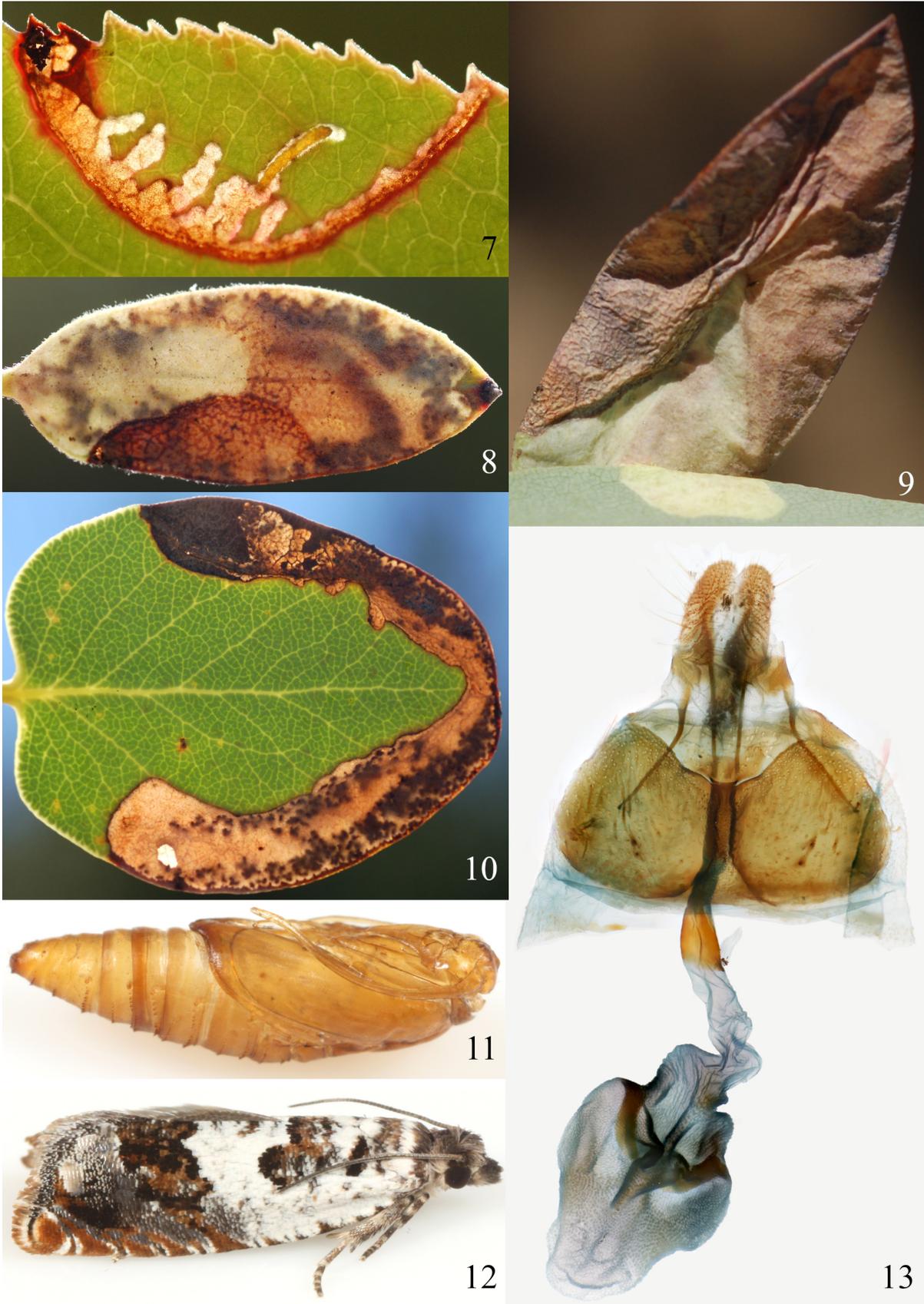
(Figs. 14–17)

**Material examined.** NORTH CAROLINA: Durham Co., Durham, Leigh Farm Park, 14.vi.2017, em. 16.vii.2017, T.S. Feldman, ex *Ilex decidua*, #CSE3965 (2♀♀, CUIC); Scotland Co., Laurinburg, St. Andrews University, 27.ii.2019, em. 13.v.2019, T.S. Feldman, ex *Ilex opaca*, #CSE5261 (1♂, CUIC).

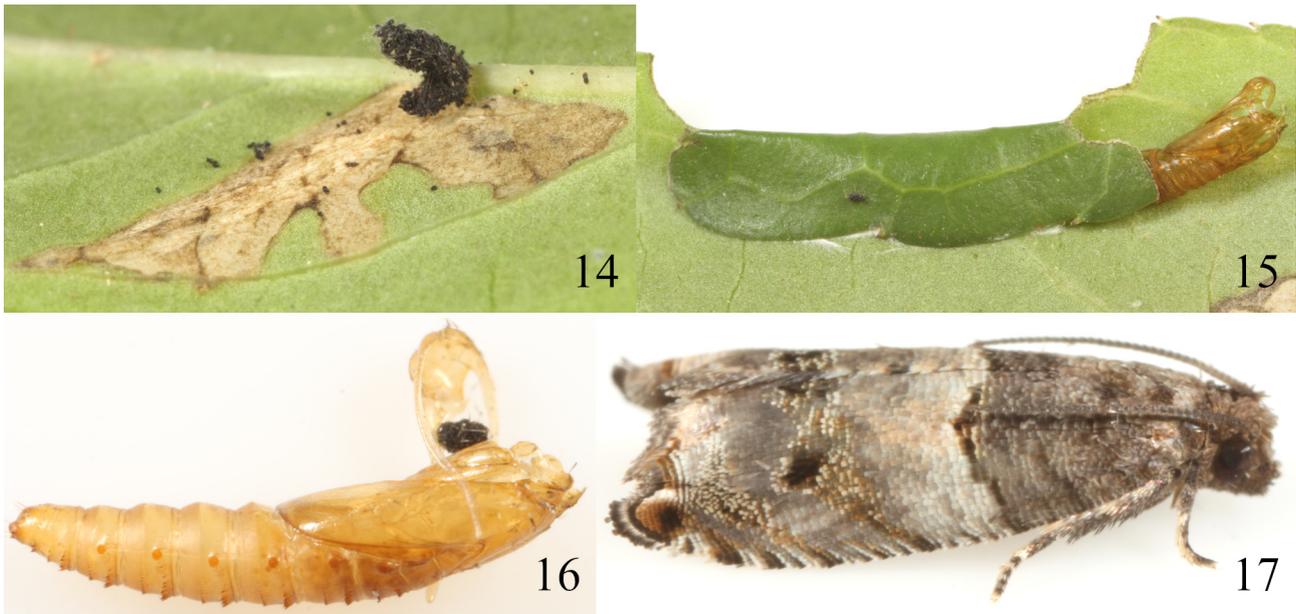
**Hosts.** Aquifoliaceae: *Ilex decidua* Walter, *I. mucronata* (L.) M.Powell, Savol. & S.Andrews (Ferguson 1975), *I. opaca* Aiton, *I. verticillata* (L.) A.Gray (Heinrich 1923). Prentice (1966) listed a single record of this species as a solitary leafroller of *Populus balsamifera* L. (Salicaceae). We regard this as likely representing either a misidentified moth or a pupation site rather than a larval feeding site.

**Biology.** Young larvae form full-depth leaf mines, which on *I. opaca* tend to be long and narrow and on deciduous hosts tend to be more compact. In either case frass is extruded from a hole in the lower epidermis, usually at the leaf midrib, and is bound together with silk. On deciduous hosts the frass bundle becomes a narrow, curved tube (Fig. 14). The mines are frequently digitate or branching due to the larva’s pauses in feeding to dispose of frass. Older larvae abandon their mines to feed in a leaf shelter, either crumpling one leaf or tying two together. A pupal case is sometimes made by cutting one or two small arcs in a leaf to form a flap in which the larva spins its cocoon (Fig. 15). Our rearing records suggest this species is at least bivoltine in North Carolina.

**Comments.** Eiseman (2014b) documented identical larval habits in *Rhopobota dietziana* (Kearfott) on *Ilex glabra* (L.) A.Gray and *I. verticillata*, noting that further rearing efforts would be desirable to determine whether *R. finitimana* is also a leafminer initially. We have found *Rhopobota* mines on *I. vomitoria* Aiton in North Carolina, but no adults have been reared from these. The other Nearctic species in this genus, *R. naevana* (Hübner), also occurs on *Ilex* but larvae reportedly feed as leaftiers (i.e., not as leafminers but as external feeders within shelters formed by tying leaves together with silk) throughout their development (Eiseman 2014b).



**FIGURES 7–13.** *Epinotia nigralbana*. 7: Backlit view of larva mining in *Arbutus menziesii* leaf in October; 8: Backlit view of completely mined-out *Arctostaphylos* leaf in March; 9: Another mined-out *Arctostaphylos* leaf, tied to a second leaf (below) into which the larva has begun to mine; 10: A third, vacated mine found near the previous two; 11: Pupal exuviae; 12: Reared adult female; 13: Female genitalia.



**FIGURES 14–17.** *Rhopobota finitimana*. 14: Lower surface of leaf mine on *Ilex decidua*, with tube of expelled frass adjacent to midrib; 15: Pupal shelter with pupal exuviae protruding at right; 16: Pupal exuviae; 17: Reared adult female.

## Grapholitini

### *Grapholita thermopsidis* Eiseman & Austin, spec. nov.

(Figs. 18–41)

**Holotype.** ♂, USA: Colorado: Chaffee Co.: Nathrop, Mesa Antero (38.673161, -106.127711), 5.vii.2015, em. 29.iii.2016, C.S. Eiseman & J.A. Blyth, ex *Thermopsis*, #CSE2293 (CUIC). Affixed with the following red handwritten label: “HOLOTYPE *Grapholita thermopsidis* Eiseman & Austin”.

**Paratypes.** 4♀♀, same data as holotype except 1♀ em. 7.iv.2016 (#CSE2337, CUIC) and 1♀ with larva collected 7.vii.2015, em. 5.iv.2016 (#CSE2322, USNM). All paratypes affixed with the following yellow handwritten label: “PARATYPE *Grapholita thermopsidis* Eiseman & Austin”.

**Additional material examined.** 2 larvae (one cut and cleaned to make pelt), same collection data as holotype, preserved 22.vii.2015 (#CSE1754, CUIC).

**Diagnosis.** *Grapholita thermopsidis* can be separated from all other Nearctic Grapholitini by the following combination of forewing characters: dorsal strigula white and undivided; ocellus bordered laterally by iridescent pale purple scales and containing four faint longitudinal black lines; and costal strigulae becoming iridescent blue-purple along longitudinal axis. The genitalia are consistent with members of the Nearctic *jungiella*-group (see Harrison *et al.* 2014). The shape of the sterigma separates it from all Nearctic *Grapholita* except *G. eclipsana* (Zeller). From *G. eclipsana* it differs in having a broader band-like lamella antevaginalis. Distinguishing male genitalia of this group relies heavily on the size, shape, number, and placement of cornuti, which we were unfortunately unable to carefully examine in this new species as the phallus was lost prior to examination by KAA and the initial photograph of it from 2017 is very blurry. *Grapholita thermopsidis* is the only described species of *Grapholita* known to feed on *Thermopsis* (but see Comments below).

**Adult description** (Figs. 18–21, 40–41). Forewing length 4.0–4.6 mm (mean = 4.3; n = 5).

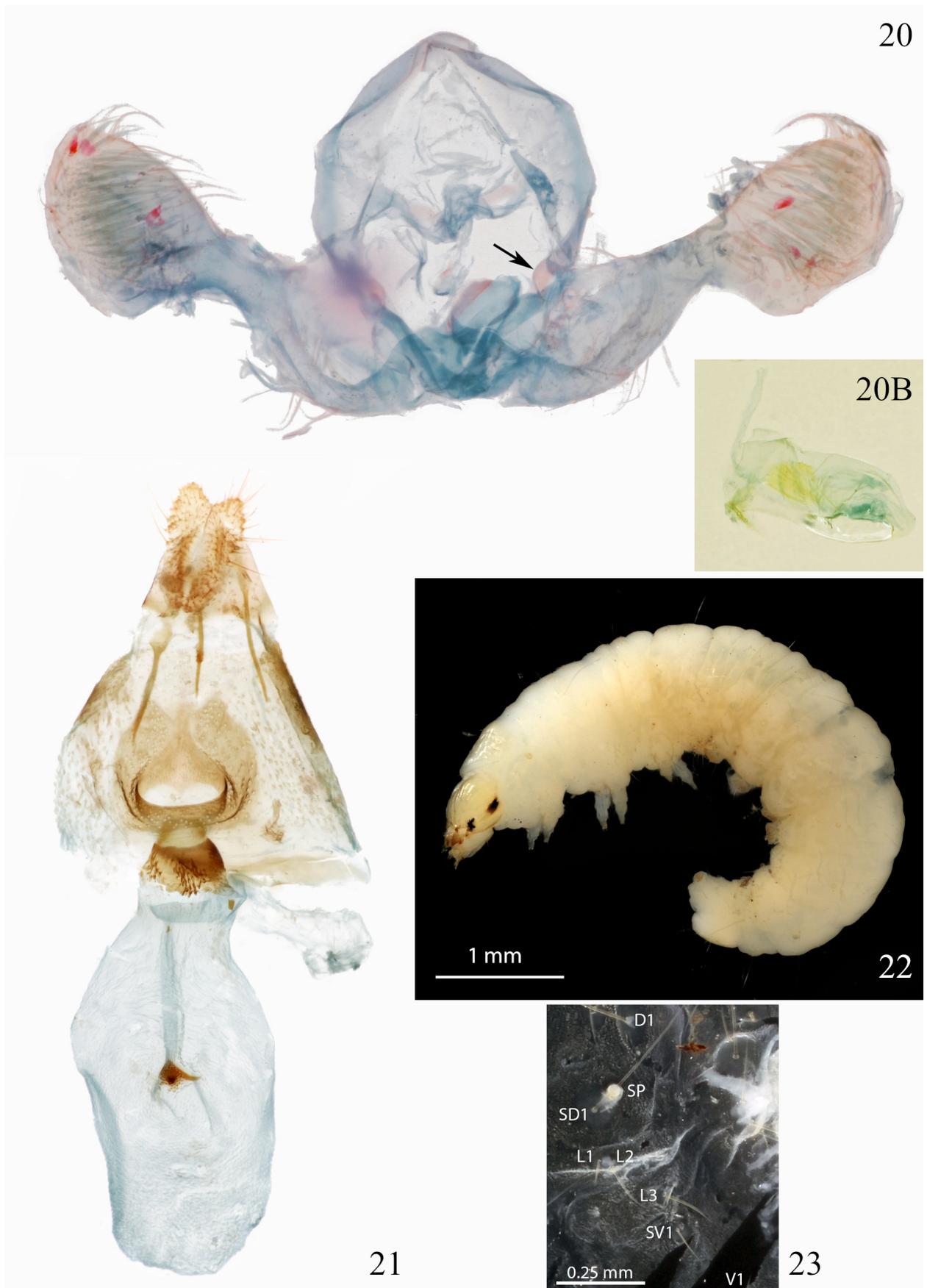
**Head:** Scales on vertex ashy silver; scales on frons white. Labial palpus white, second segment with scales expanding loosely on ventral face, third segment with a few ashy silver scales. Scape and antenna with dorsal half ashy silver, ventral half white. Chaetosemata 0.5–0.75× length of scales on vertex; ocellus moderate in size, only narrowly separated from compound eye.

**Thorax:** Tegulae and dorsum of metathorax concolorous with vertex; dorsum of prothorax and mesothorax dark brown. Lateral and ventral portions of thorax white with intermixed glossy dark gray scales. Forelegs with lateral

face glossy dark gray, median face white to pale gray; tarsomeres dark gray with apices ringed in white. Midlegs similar to forelegs but with lateral face of femur and tibia pale silver. Hindlegs also similar to forelegs but with lateral face of femur and tibia pale gray to dirty white. Forewing ground color ashy silver to or nearly to costal strigula 4, iridescent dark brown to black beyond; dorsal strigulae united to form a solid white patch; strigulae white, well developed except for strigulae 6 and 7, which are short and often united; iridescent blue-purple striae emanating from strigula 4 towards dorsal strigulae, from strigula 5 towards basal transverse band of ocellus, from strigula 8 towards distal transverse band of ocellus, and from strigula 9 towards subapical whitish stria; ocellus bordered laterally by iridescent pale purple scales and containing four faint black longitudinal lines on a faint orange central field; basal line black; fringe glossy silver. Depending on angle of lighting, the iridescent blue-purple forewing scales may not be visible (compare Fig. 18 to Fig. 19). Dorsal surface of hindwing dark brown; costa white to 0.67×; fringe dark brown. Ventral surface of wings with brilliant multicolored iridescent scaling; strigulae present along forewing costa. No sexual dimorphism observed.



**FIGURES 18–19.** *Grapholita thermopsidis*. 18: Holotype male; 19: Paratype female.



**FIGURES 20–23.** *Grapholita thermopsidis*. 20: Male genitalia (arrow indicates curved base of tegumen; 20B = phallus, not to scale); 21: Female genitalia; 22: Larva; 23: Detail of larval pelt (A8).

**Abdomen:** Vestiture of abdomen with dorsum glossy lead gray, ventral surface concolorous but with wide row of white scales on apical portion of segments. Remnants of hair pencil (“coremata” sensu Komai) between A8 and A9 appear to be present, but abdominal pelt of sole male specimen badly mangled making confirmation difficult.

**Male genitalia** (Fig. 20) with uncus, socii, and gnathos absent; tegumen broad, weakly-sclerotized, curved at base (demarcated with arrow in Fig. 20), 0.5× length of valva; valva composed of three sections: (1) a basal third with straight dorsal margin, evenly curved on ventral margin, composed of basal cavity and sacculus, (2) a constricted and ventrally-curved neck, and (3) broadly-rounded cucullus covered in fine setae on ventromedial surface. Basal cavity 0.3× length of valva; sacculus 0.3× width of basal third of valva; at widest point basal third 0.3× length of valva; at narrowest point neck width 0.1× length of valva; length of cucullus 0.45× length of valva; at widest point cucullus 0.3× length of valva; juxta with T-shaped sclerotization, shallowly notched dorsally; phallus lost prior to examination by KAA, but present (albeit blurry and badly mangled) in initial photograph of genitalia from 2017: phallus (Fig. 20B) cylindrical, length approximately 4× width, no fixed spines or cornuti observed.

**Female genitalia** (Fig. 21) with papillae anales unusually broad for the genus, densely roughened and covered with setae on ventral surface; apophyses posteriores and anteriores straight, approximately equal in length; apophyses anteriores with a small triangular projection at approximately 0.25× length; sterigma large, well sclerotized, broadest at midpoint, with V-shaped notch posteriorly; lamella postvaginalis with short extension into ostium and longer extension posteriorly, covered in fine, short setae throughout; lamella antevaginalis well sclerotized, band-like; ostium wide; colliculum well sclerotized; base of ductus bursae heavily sclerotized, with dense patches of short spines; base of corpus bursae of similar width to anterior portion of ductus bursae, making the distinction between them ambiguous; ductus seminalis and bulla seminalis short, broad, pouch-like; width of unmated corpus bursae 0.5× length; two short, thorn-like signa present at 0.5× length of corpus bursae: one on dorsal face and one on ventral face, each with a small disc of fine inward-pointing thorns at base.

**Larva** (Figs. 22–24). Length of one preserved larva approximately 5.6 mm. Length of one photographed, non-preserved larva approximately 7.0 mm. Body uniformly pale yellow; pinacula concolorous; prothoracic shield glossy yellow. Head capsule pale orange-yellow with black pigmentation surrounding stemmata and lateral head apodeme; chaetotaxy typical for subgenus *Grapholita* as described by Komai (1999), including SV group unisetose on A8 (Fig. 23); anal fork present.

**Pupa** (Figs. 25–29). Length 4.2–4.8 mm (mean = 4.5; n = 5); structure typical for subgenus *Grapholita* as described by Komai (1999).

**Etymology.** The specific epithet refers to the genus of the larval host plant, *Thermopsis* R.Br. The name of this new species is formed taking the genus name of the larval host plant as a noun in the nominative case. This combination of species-group name agrees with Art. 31.2.1. of the ICZN.

**Host.** Fabaceae: *Thermopsis rhombifolia* (Pursh) Richardson (Fig. 30).

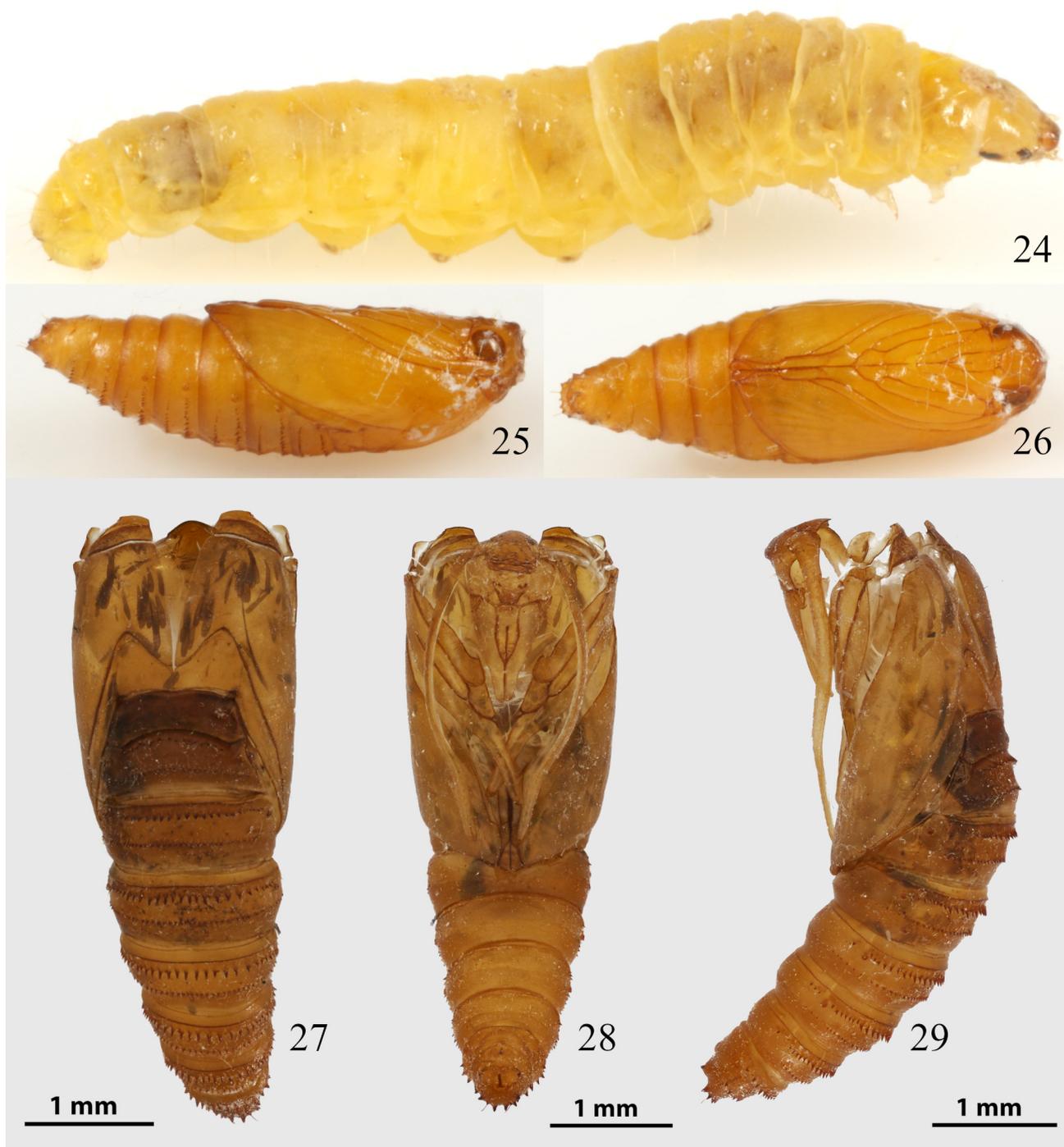
**Biology.** Leaf-mining larvae were collected on 5 and 7 July. Typical mines resemble the “underside tentiform” mines of lithocolletine gracillariids, formed along one side of the leaflet midrib and causing the leaflet to buckle (Figs. 31–35). The loosened lower epidermis is pale brown and finely wrinkled, with a hole at one end from which the frass is expelled. The upper epidermis is green in younger mines, becoming mottled with whitish or brown as the parenchyma is consumed. Some mines are formed on the upper surface (CSE2322), and these cross the midrib in both photographed examples (Figs. 36–37). By 15 July, captive larvae were beginning to exit their mines and spin extensive webbing on one leaf surface, causing the leaflet to curl or fold (Figs. 38–39). Feeding continued within the resulting shelter. Fresh leaves were added to the rearing vials as the original ones deteriorated, and the larvae formed new shelters by tying these leaves together. Pupation took place between the tied leaves in early August. Adults emerged the following spring, 4–5 weeks after being removed from refrigeration (Figs. 40–41). Given that this would have occurred much later under natural conditions, it is likely that this species is univoltine.

**Parasitoids.** Four adults of *Zagrammosoma mirum* Girault (Hymenoptera: Eulophidae) emerged on 21 and 22 July 2015 from both upper and lower surface mines collected on 7 July (CSE1769, UCR). Two adults of an undetermined species of *Dolichogenidea* Viereck (Hymenoptera: Braconidae) emerged on 21 and 25 July from lower surface mines, and a third was found dead on 5 August (CSE1778, CNC).

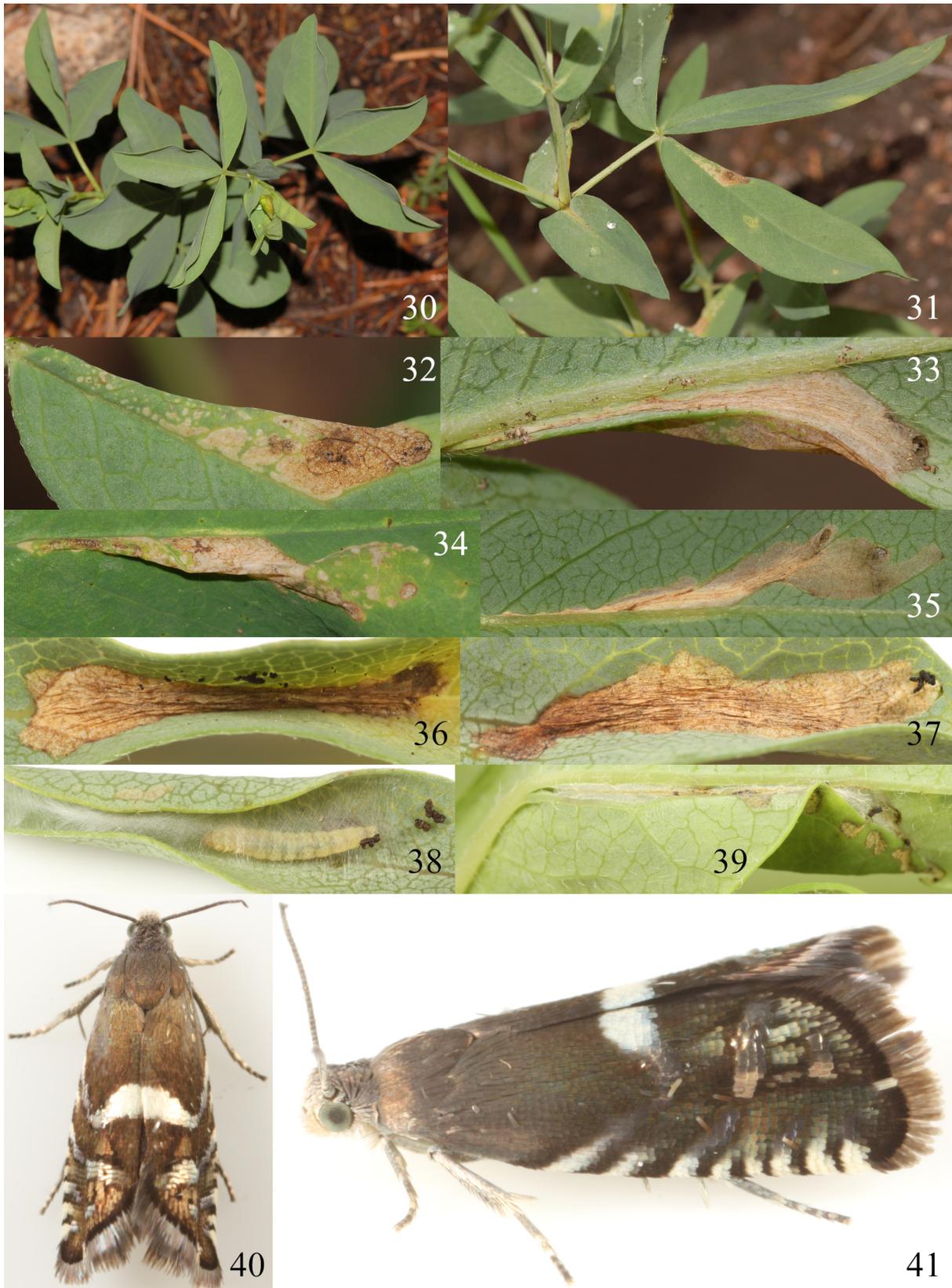
**Comments.** Following Komai (1999), *Grapholita thermopsisidis* belongs to the *jungiella*-group of subgenus *Grapholita* based on larval host preference (Fabaceae), forewing pattern and coloration, and the female colliculum possessing a “sclerotized ring bearing minute thorns”. However, we did not observe the small “darkly pigmented sclerite situated anterodorsal to ventral prolegs on A2–A6” apparently present in larvae of Palearctic members of the

*jungiella*-group. The dissection of the only known male of *G. thermopsidis* was performed prior to KAA examining the specimen and unfortunately the phallus was lost shortly after. Harrison *et al.* (2014) listed Nearctic members of the *jungiella*-group. In addition to *G. thermopsidis*, we also propose including *G. boulderana* McDunnough in this group based on identical forewing pattern to that of *G. orbexilana* Harrison, its possible sister species in the east.

To our knowledge this is the first record of leafmining in *Grapholita*. Two other North American grapholitines are known to mine leaves, in addition to *Talponia plummeriana* (discussed below): *Dichrorampha incanana* (Clemens) feeds on *Arnoglossum* Raf. and *Packera* Á.Löve & D.Löve (Asteraceae: Senecioneae) and is a leafminer throughout its development (Priest 2008; Eiseman 2014a); *Ricula maculana* (Fernald) feeds on *Schoepfia schreberi* J.F.Gmel. (Schoepfiaceae) and has similar habits to *G. thermopsidis*—first forming leaf mines from which the frass is expelled, later feeding within tied or folded leaves (Dyar 1901).



**FIGURES 24–29.** *Grapholita thermopsidis*. 24: Live larva; 25: Live pupa, lateral view; 26: Same, ventral view; 27: Pupal exuvia, dorsal view; 28: Same, ventral view; 29: Same, lateral view.



**FIGURES 30–41.** *Grapholita thermopsisidis*. 30: The host plant, *Thermopsis rhombifolia*; 31: Leaf with mine (right of center); 32: Detail of same mine; 33: Lower-surface view of same mine; 34: Upper surface of a different mine; 35: Same, lower surface; 36: An upper-surface mine, centered on the leaflet midrib; 37: Another upper-surface mine, crossing midrib at lower left; 38: Older larva spinning silk to form leaf shelter; 39: A completed folded-leaf shelter; 40: Reared adult, dorsal view; 41: Same, lateral view.

Brown *et al.* (2008) list *Grapholita "thermopsae"* as feeding on *Thermopsis macrophylla* Hook. & Arn. in California, citing Powell (2006). BSCIT (2019) lists a specimen of "*Grapholita thermopsae* Powell & Sm. ms" at EME collected by J. Powell on 28 February 1967 at Carson Ridge, Marin Co., California. J. Powell (*in litt.* to CSE, 31 March 2016) informed us that this manuscript name for an undescribed species was from an aborted collaboration with Norm Smith, then an M.S. student at UC Davis. He did not provide details of the larval biology but doubted that the California species was conspecific with our new species from Colorado. We were unable to examine the EME specimens for this study, as J. Powell (*in litt.* to KAA, 9 November 2019) was unable to locate any.

### ***Talponia plummeriana* (Busck)**

(Figs. 42–47)

**Material examined.** NORTH CAROLINA: Wake Co., Morrisville, Lake Crabtree County Park, 6.vi.2019, em. by 19.vii.2019, T.S. Feldman, ex *Asimina parviflora*, #CSE5675 (2♀, CUIC).

**Hosts.** Annonaceae: *Asimina parviflora* (Michx.) Dunal, *A. triloba* (L.) Dunal (Heinrich 1926).

**Biology.** Sedlacek *et al.* (2012) reported larvae boring in unripe and ripe pawpaw (*Asimina triloba*) fruit, and stated that previously this species had been documented to feed only by boring into pawpaw flowers and peduncles. More recently, larvae have been found feeding in roots and stems. According to Powell & Peterson (2015), this species overwinters in cocoons spun inside the twigs and stems, and in Ohio adults emerge in April or May when pawpaws are in bloom, leaving the pupal exuviae protruding from the stem (apparently always next to a bud). Eggs of the first brood are laid in flowers and the larvae feed on the anthers, then bore into the peduncles and from there into the twigs, feeding on the pith. Oviposition has not been observed in the next generation, but investigations during winter pruning revealed that the frass-filled gallery always leads upward to a leaf scar, beginning as a tiny white hole where a vascular bundle should be. Based on this observation, Powell & Peterson presumed that the egg is laid on the underside of the leaf midrib and the larva bores from here into the twig.

Our specimens were collected on 6 June 2019 as larvae feeding in the leaf midribs of *Asimina parviflora*, forming galleries that were externally visible as straight or winding brown lines (Figs. 45–47). In some cases the larval entrance hole was not in the midrib but in the adjacent leaf lamina. While we cannot rule out the possibility that some eggs are deposited directly on the midrib as suggested by Powell & Peterson (2015), we believe that the small leaf mines found on *A. parviflora* at the same locality were made by first-instar larvae of *Talponia plummeriana*, which then abandoned them to enter the midribs. These mines are full-depth and linear, 2–8 mm long, with granular frass scattered irregularly inside (Figs. 42–44). They are usually initiated adjacent to a major vein and frequently in a vein axil. We first observed vacated mines on 26 June 2018; similar mines were collected in a plastic bag on 5 July, and when the latter leaves were checked in 17 July, a 4 mm, apparently tortricid larva was found in association with window-feeding between the leaves. It was presumed that this larva had emerged from one of the mines, but this is not certain and we were unable to rear it. Fresh mines were found on 2 June 2019, including two that still contained larvae three days later, but these likewise could not be reared to adults. As noted above, we then collected leaves with midrib mines on 6 June. After these leaves turned brown in mid-June it was assumed that this rearing attempt had likewise failed, and they were ignored until mid-July when two dead, moldy adults were discovered. The larvae had fed externally between the deteriorating leaves, window-feeding, skeletonizing, and eating holes. Each constructed a pupal case, reminiscent of those made by Heliozelidae and Incurvariidae, consisting of oval sections excised from two leaves and tied together with silk.

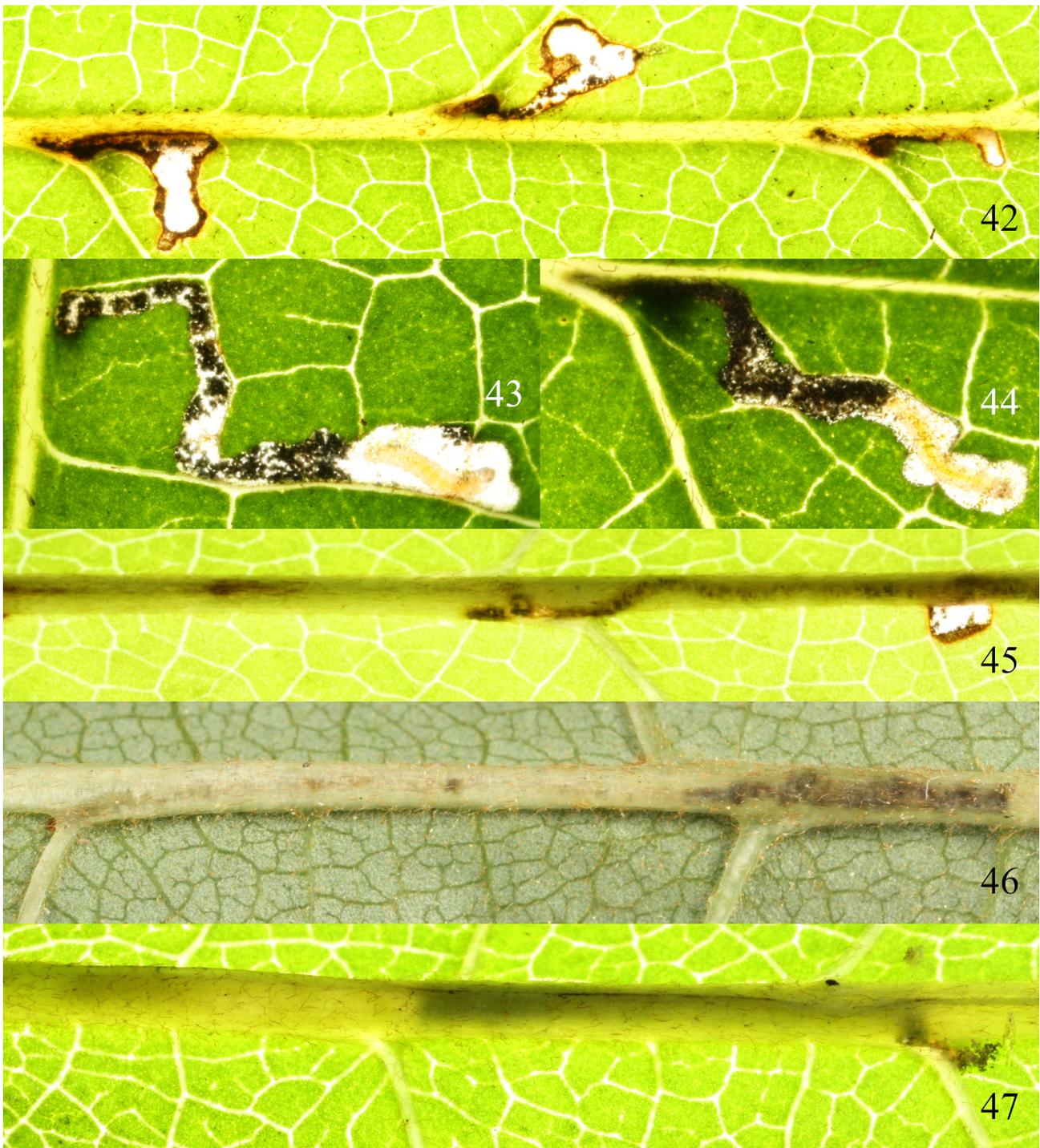
## **Tortricinae**

### **Sparganothini**

#### ***Cenopsis lamberti* (Franclemont)**

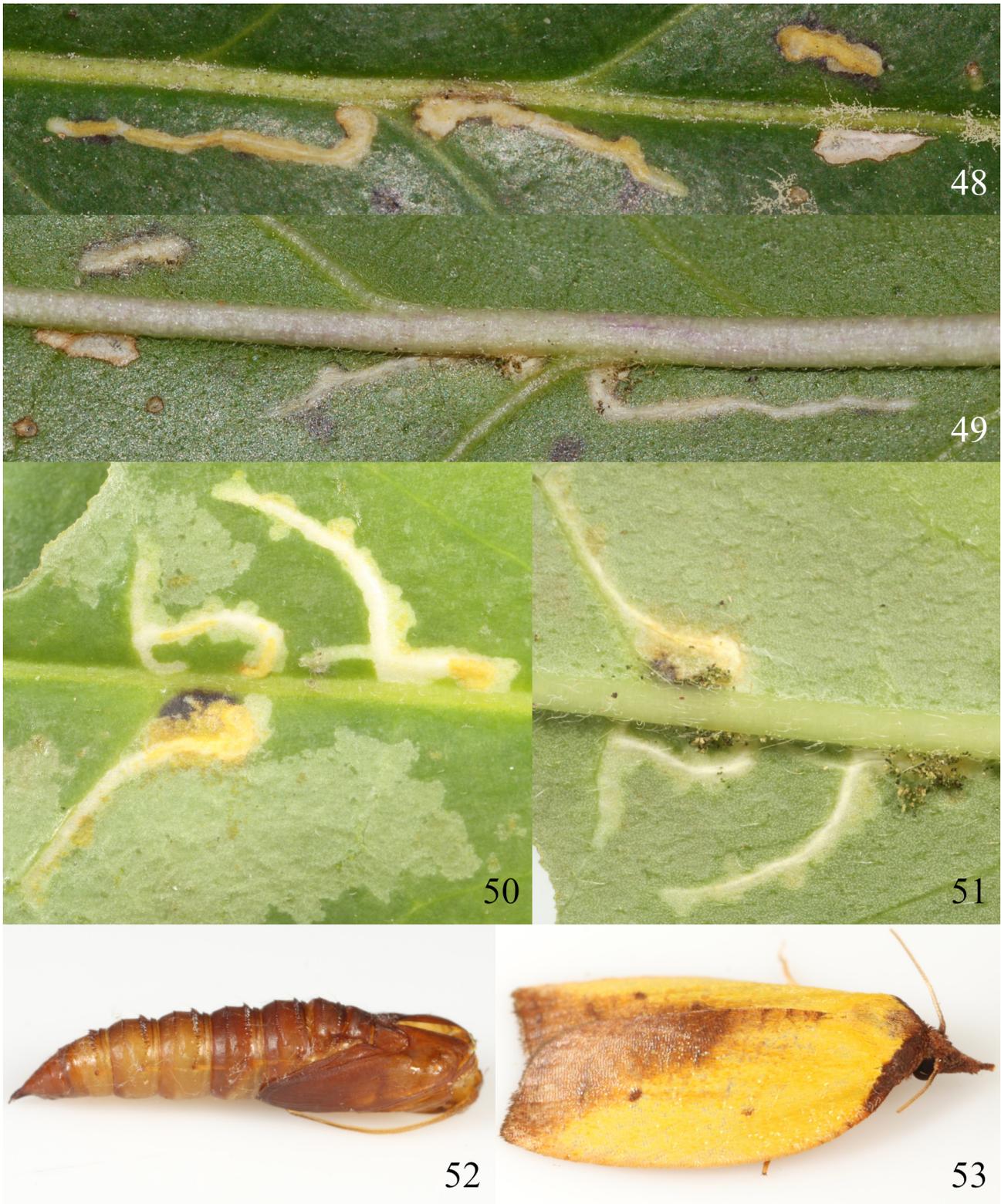
(Figs. 48–53)

**Material examined.** NORTH CAROLINA: Scotland Co., Laurinburg, St. Andrews University, 23.viii.2016, em. 27.ix.2016, T.S. Feldman, ex *Symplocos tinctoria*, #CSE3014 (1♀, CUIC).



**FIGURES 42–47.** Mines of *Talponia plummeriana* in *Asimina parviflora* leaves. 42: Three vacated mines, each beginning in a vein axil; 43: Mine with larva inside; 44: Another example of same; 45: Midrib mine visible as winding frass line in transmitted light; 46: Midrib mine originating in vein axil at far left, with frass conspicuous at far right; 47: Midrib mine originating at far right, where the larva entered from adjacent leaf lamina and deposited frass on the lower surface; larva partially visible as dark spot at far left.

**Host.** Symplocaceae: *Symplocos tinctoria* (L.) L'Hér. Powell & Brown (2012) noted one record of this species being reared from a larva collected on *Persea* Mill. (Lauraceae) in Mississippi. Confirmation of this host would be desirable, since *Symplocos* could easily be mistaken for *Persea*. Our record is supported by two additional specimens from North Carolina in the USNM, reared by Bo Sullivan from *S. tinctoria* (J. Brown, *in litt.*).



**FIGURES 48–53.** *Cenopsis lamberti*. 48: Four old mines on a leaf of *Symplocos tinctoria*; 49: Same mines viewed from lower surface; 50: Three fresh mines; 51: Same mines viewed from lower surface, with frass deposits along midrib; 52: Pupal exuviae; 53: Reared adult female.

**Biology.** Nothing has been published previously about the larval habits of this species beyond the rearing record from *Persea* cited above. Our specimen was collected as a leaf-tying larva on 23 August and the adult emerged on 27 September. We believe that empty mines found on nearby *Symplocos* leaves were made by early instars of *C.*

*lamberti*. We have found these mines several times in North and South Carolina, but the only occupied examples were found at St. Andrews University on 29 June 2016. These larvae exited their mines by 3 July and proceeded to feed between tied leaves until at least 2 August, but we were unable to rear them to adults. The presumed *C. lamberti* mines are white and full-depth, mostly 10–15 mm long (rarely up to ~4 cm), sometimes branching, and may be ~1 mm wide throughout or may widen to ~3 mm. Each begins with a round hole in the lower epidermis, through which most frass is expelled and through which the larva ultimately exits. Some of the minute fecal pellets are caught in webbing on the lower leaf surface.

Powell & Brown (2012) stated that capture records of *C. lamberti* suggest two broods. Adults have been collected from late May through early September, with most records from June through August, and with a single record from October.

**Comments.** Although there are apparently no previous records of leafmining in Sparganothini, we have confirmed it in *Sparganothis xanthoides* (discussed below), which forms similar mines to those found on *Symplocos*. Larvae of this tribe are typically external feeders within silk-lined shelters on foliage or inflorescences (Powell & Brown 2012), as was the case with older larvae of both species discussed here.

### *Sparganothis xanthoides* (Walker)

(Figs. 54–58)

**Material examined.** MISSOURI: Franklin Co., Gray Summit, Shaw Nature Reserve, 1.vii.2015, found dead 10.viii.2015, C.S. Eiseman & J.A. Blyth, ex *Phlox divaricata*, #CSE1959 (1 larva, CUIC); em. 4–7.ix.2015, #CSE2026 (1♂ CUIC, 1♂ MSC); em. 30.ix.2015, #CSE2096 (1♂, CUIC).

**Host.** Polemoniaceae: *Phlox divaricata* L.

**Biology.** Larvae were found on 1 July forming irregular, more or less elongate leaf mines (Fig. 54). These were full-depth and transparent, with a hole in the upper epidermis at one end from which all frass was expelled. By 20 July, the captive larvae had exited their mines and were continuing to feed among tied leaves. At least one larva pupated between 17 and 22 August and emerged as an adult between 4 and 7 September, and the last adult emerged on 30 September, but another larva remained active as late as 22 October. Under natural conditions, adults apparently do not emerge until spring. Powell & Brown (2012) reported capture dates ranging from late June through early August. Our observation of a prolonged larval feeding period supports their suggestion that this species is univoltine.

**Comments.** Powell & Brown's (2012) range map for *S. xanthoides* shows no records from Missouri or any of the surrounding states. They stated that although this is one of the most abundant species in collections, nothing is known of the early stages. Powell's (2006) California record of this species from *Holodiscus discolor* (Pursh) Maxim. (Rosaceae) is therefore puzzling; there is no mention of *Holodiscus* in connection with any sparganothine in Powell & Brown (2012), so the record may have only referred to a pupation site or adult collection. M. Sabourin (*in litt.*) reports having seen a female specimen at WIRC with the label data "Gypsy Moth Proj., #751103A, em. 11-vii-1975; Iowa Co., WI, T6N, R5E, S1, 23-vi-1975; *Quercus alba*." Given that we observed a pupal period of two weeks or more, it is likely that this collection from white oak involved a pupation site rather than a feeding site. Larva (Figs. 56–57) chaetotaxy agrees with MacKay (1952) and Powell & Brown (2012) except minute SD2 not observed on A1–A8.

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**FIGURES 54–58.** *Sparganothis xanthoides*. 54: Mines of two larvae in a leaf of *Phlox divaricata*; 55: Reared adult male; 56: Live larva; 57: Preserved larva; 58: Pupal exuviae.

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