

A SYNOPSIS OF NEARCTIC ADELID MOTHS, WITH  
DESCRIPTIONS OF NEW SPECIES (INCURVARIIDAE)

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Adelids are small, brightly colored, dayflying moths with exceptionally long antennae. They comprise a group of about 250 species of worldwide distribution, which usually has been assigned family status. However, these insects are closely allied to the Incurvariidae according to structures of the adults and probably will be considered a subfamily of the Incurvariidae by future writers in general. Forbes (1923) accorded the adelids subfamily rank along with the Prodoxinae (yucca moths) and the typical incurvariids, and Davis (1968) has used the same classification. The three groups share similarities in mouthpart structure, wing venation, and male genitalia, and are unique among primitive Lepidoptera in the possession of a well developed piercing ovipositor with which the eggs are inserted into plant tissue. From related moths, the adelids are most easily distinguished by the greatly elongated antennae, which are often two to three times the length of the forewing in the males. A few species, including one described here, have relatively short antennae, slightly longer than the forewing in the male, and slightly shorter than the forewing in the female.

TAXONOMY

Present classifications propose six or seven genera to accommodate the world fauna. These include three large genera: *Ceromitia*, which is primarily South African in distribution; *Nemophora* (including *Nemotois*), which is widespread over the Palearctic, Indo-Malayan, and Australian Regions; and *Adela*, which is mainly Holarctic, being well represented in both the Old and New Worlds.

The present synopsis treats 13 species, one in *Nemophora*, the remainder in *Adela*, three of which are previously undescribed.

For the most part Nearctic adelids have been described on the basis of external features, particularly color, which serves to distinguish species in most cases. In addition to color pattern differences, species of North American *Adela* also exhibit remarkable interspecific variation in eye size wing venation, and antennal structure (*e.g.*, Table 1). In most species the antennae of the male are about twice the length of the female's, while in other species the difference is less.

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TABLE 1. MORPHOLOGICAL VARIATION AMONG NORTH AMERICAN ADELA

	HW M <sub>1</sub> + M <sub>2</sub>	♂ Antenna w/spe- cialized scaling	♂ Eye	♂ Antenna: FW	♀ Antenna: ♂ <sup>1</sup>
<i>bella</i>	stalked	yes	small	3 +	.5
<i>aeruginosella</i>	?	?	small	3 +	.5
<i>ridingsella</i>	stalked	yes	large	3 +	.5
<i>purpurea</i>	stalked	yes	large	3 +	.5
<i>trigrapha</i>	separate	no	large	3 +	.5
<i>eldorada</i>	separate	no	large	3 +	.5
<i>flammeusella</i>	separate	no	large	3 +	.5
<i>thorpella</i>	separate	no	large	2.5	.6
<i>oplerella</i>	separate	no	small	1.2	.75
<i>septentrionella</i>	separate	no	intermed.	3	.67
<i>singulella</i>	separate	no	small	4.5	.75
<i>punctiferella</i>	separate	no	small	3 +	.75

<sup>1</sup> Approximate length of female antenna compared to male, corrected to eliminate size dimorphism in forewing.

On the other hand, structures of the genitalia, long the standard of species differentiation for most microlepidopterists, are exceedingly uniform both in males and in females, at least in the North American species. Although there are apparently consistent minor differences between species in the males, these are difficult to define and compare relative to the easily observed and measured distinguishing features of external morphology. In females I have found no differences in internal structures. The ovipositor "saws" may exhibit small differences, but so slight that very high magnification, phase contrast microscopy is required (*i.e.*, nothing comparable to the diversity found in Prodoxinae (Davis, 1968)). By contrast, the shape of the seventh sternite of the female varies conspicuously between some of the species. For these reasons I have relied almost exclusively on external characters for the present diagnosis. In fact, color features alone will readily separate nearly all the Nearctic species.

#### MATERIAL AND METHODS

Adelids are often encountered in large numbers visiting flowers on warm spring days and can easily be collected. Nonetheless until quite recently they had remained poorly known in most parts of North America. Although I have been able to examine some 4000 specimens during this study, probably 75% of these have been collected in California during the past decade by persons collecting in my interest. A request (Powell,

1961) for collecting received considerable response from hymenopterists and professionals of other interests, but the legion of western amateur lepidopterists have steadfastly refused to touch anything in this size range. In the eastern half of North America both the geographical distributions and biologies of these moths remain poorly known.

Difficulties inherent in study of dry adult specimens, owing to their small size, fragile condition, and dense vestiture were in part overcome during this investigation by preparation of whole mounts of representative specimens on slides. After removal of the wings, specimens were cleared and dehydrated by routine methods used in genitalic preparations. A saggital section was then made of the exoskeleton, employing surgical scissors, and mounted in Canada Balsam, a modification of the technique suggested by Hogue (1964). However, with the exception of the head appendages and abdominal sclerites of the female, no useful exoskeletal characters were discovered. Subsequently it has sufficed to clear only the head in order to make accurate measurements of the antennae and mouthparts.

For practical purposes identification of species can be done from dry material, but the antennal lengths have to be estimated since the antennae curl upon drying.

Forewing length is measured along a line from mid-base to apex, and unless otherwise indicated (as in length:width ratios) includes the fringe. Eye diameter is measured along the greatest distance across the eye as viewed from an external plane; the distance between the eyes, along the shortest distance, *i.e.*, across the crown in large eye males, across the front below the antennae in small eye individuals. Measurements of mouthpart lengths are exclusive of vestiture.

My study of adelids began in 1961 when I selected what I thought would be an "easy" group as a project in the Bulletin of the California Insect Survey. I knew the species and assumed that a couple of seasons' survey work to fill in the poorly known distributions would be sufficient to complete an adequate treatment. Although the five previously recognized California *Adela* were described between 1875 and 1890, three previously undescribed (and virtually uncollected) species turned up, two quite distinct from the known fauna and the third a sibling of the widespread *Adela trigrapha*. In addition, two color forms of *A. singulella* were discovered which posed an interesting problem.

The survey was essentially finished by 1965, but I delayed its completion, hoping that some information on the biologies of California *Adela* could be discovered. Through assistance provided by National Science Foundation grants GB-4014 and GB-6813x this has been partially success-

ful. The main purpose of the present paper is to make the new taxa available for use in the survey bulletin and in more comprehensive revisionary work by D. R. Davis at the U. S. National Museum.

Primary types of the newly described species are deposited at the California Academy of Sciences, on indefinite loan from the California Insect Survey.

#### BIOLOGY

All the North American adelid moths are believed to undergo a single annual generation, flying in spring or early summer. In Europe, *Nemophora swammerdamella* (L.) is said to live two years in the larval stage (Ford, 1949), and this longevity may obtain with *N. bellela*, a Boreal Nearctic species which ranges to 65° N. latitude. Members of both *Adela* and *Nemophora* feed as larger larvae within cases on lower leaves or fallen leaves during summer. Overwintering is accomplished by prepupal larvae or pupae in the larval cases. In a number of Palearctic species in both genera, females are known to deposit the eggs into young seed of particular plants, and this has proven to be the case with several California *Adela*. The larvae consume the contents of the developing seed capsules and then descend to the ground where they construct flat, usually pear- or figure eight-shaped cases, in which they feed on lower parts or fallen leaves of the same or other plants. A number of species for which no oviposition site is known have been reared from the case-bearing larvae in Europe (*e.g.*, Stainton, *et al.*, 1873). None of the Nearctic species has been reared, and I have had success neither with rearing the larvae from first instars nor in finding cases in the field, despite the fact that adults of every species are sometimes abundant.

In Europe the oviposition hosts of *Adela* include *Cardamine* and *Sisymbrium* (Cruciferae), *Hypericum* (Hypericaceae), and *Veronica* (Scrophulariaceae), and suspects include *Salix* (Salicaceae) and *Quercus* (Fagaceae); in California oviposition occurs in *Linanthus* and *Gilia* (Polemoniaceae), *Platystemon* and *Meconella* (Papaveraceae), and *Holodiscus* (Rosaceae); for *Nemophora* in Europe, *Scabiosa* (Dipsacaceae) (several species), *Anemone* (Ranunculaceae), and *Ballota* (Labiatae) have been recorded as foodplants. All species are specific to one or two closely related plant genera. (Stainton, 1873; Schutze, 1931; Ford, 1949; Jacobs, 1949).

Weiss and West (1925) reported an adelid as a petiole gall maker on Virginia creeper in New Jersey, but the moths were not reared. The identification was based on larvae and is suspect, in view of biological characteristics of other *Adela*.

## KEY TO SPECIES OF NEARCTIC ADELINAE

1. Males: Frenulum well developed; abdomen with 7 visible segments, the terminal one not laterally flattened or attenuate, fully scaled ..... 2  
 Females: Frenulum lacking; abdomen with 6 visible segments, the terminal one often partially unscaled, laterally flattened, sharply attenuate, for piercing ..... 14
2. Antenna thickened, width of flagellum near base more than .2 eye diameter, basal 5 segments each with one short peg-like seta; forewing broad, length less than 3× width, orange with a broad pale, transverse band at outer  $\frac{1}{3}$  ..... *Nemophora bellela* (Walker)  
 Antenna filamentous, width of flagellum near base less than .2 eye diameter; no stout setae on basal segments; forewing narrower, length more than 3× width ..... *Adela* 3
3. Eyes enlarged, extending on to crown behind antennae, eye diameter nearly 2× or greater than 2× the distance between eyes ..... 4  
 Eyes small, not extended back of antennae; eye diameter only slightly greater or smaller than distance between eyes ..... 9
4. Eyes greatly enlarged, nearly holoptic; diameter 3× or more the distance between eyes; antennae without specialized scaling ..... 5  
 Eyes moderately enlarged; diameter about 2× the distance between eyes; antennal flagellum with enlarged, specialized scaling between segments 8-13 ..... 8
5. Antennae greatly elongate, more than 3× forewing length; more than 150 segments; forewing if bronzy, with fringe dark ..... 6  
 Antennae moderately elongate, about 2.5× forewing length; about 120 segments; forewing brassy bronze with whitish fringe ..... *thorpella* Powell
6. Eye diameter usually about 4× the distance between eyes; forewing black usually with complete transverse whitish stripes ..... 7  
 Eye diameter usually about 3× the distance between eyes; forewing bronzy or coppery with at most isolated whitish spots ..... *flammeusella* Chambers
7. Vestiture of crown mostly or entirely orange; inner two forewing bands pale yellow, usually broad, width of median one .22-.50 the distance between them in cell (about .42-.70 eye diameter); labial palpus elongate, segments II + III usually 1.06-1.15 eye diameter ..... *eldorada* Powell  
 Vestiture of crown mostly or entirely black; inner two forewing bands usually white, narrower, width of median one .10-.20 the distance between them (.25-.42 eye diameter); labial palpus usually shorter, segments II + III .90-1.06 eye diameter ..... *trigrapha* Zeller
8. Antennal flagellum with specialized scaling on segments 8-10, segments relatively large, less than 100; forewing orange-brown with metallic lead colored spots above tornus ..... *ridingsella* Clemens  
 Antennal flagellum with specialized scaling on segments 11-13, segments small, more than 160; forewing purplish or bluish with a broad whitish transverse stripe at outer  $\frac{1}{3}$  ..... *purpurea* Walker
9. Antennae short, about 1.2× forewing length; forewing deep bronzy with at most a few whitish spots ..... *oplerella* Powell  
 Antennae long, more than 2× forewing length ..... 10
10. Eye diameter about .25 greater than distance between eyes; forewing black usually with white transverse bands ..... *septentrionella* Walsingham  
 Eye diameter about .5 to .75 the distance between eyes; forewing not black ..... 11
11. Antennae greatly elongate, more than 4× the forewing length; forewing bronzy with white transverse band or costa white at outer  $\frac{1}{3}$  .....  
 ..... *singulella* Walsingham

- Antenna less elongate, about  $3\times$  forewing length; forewing, if bronzy, costa without white ..... 12
12. Antennal flagellum with specialized scaling on segments 9–11; forewing purplish with indistinct metallic reddish striae in outer  $\frac{1}{3}$  ... *bella* Chambers  
Antenna with or without specialized scaling; forewing bronzy or greenish with no transverse striae in outer  $\frac{1}{3}$  ..... 13
13. Forewing metallic green basally, purplish apically, with ill-defined streaks ...  
..... *aeruginosella* Walsingham  
Forewing bronzy with or without a white dot or transverse line at end of cell ..... *punctiferella* Walsingham
14. Forewing broad, length about  $3\times$  width, orange with a broad, transverse pale band at outer  $\frac{1}{3}$ ; hindwing with veins  $R_s$  and  $M_1$  usually stalked ...  
..... *Nemophora bellela* (Walker)  
Forewing usually narrower, if orange, without transverse band; hindwing  $R_s$  and  $M_1$  separate ..... *Adela* 15
15. Antenna thickened on basal half by elongate, dense, purplish scaling, filamentous, white distally ..... 16  
Antenna not thickened on basal half, filamentous, evenly diminishing in diameter ..... 17
16. Forewing bluish or purplish with concolorous, metallic, transverse striae on outer  $\frac{1}{3}$  ..... *bella* Chambers  
Forewing metallic green basally, purplish apically, with ill-defined streaks but no transverse striae on outer  $\frac{1}{3}$  ..... *aeruginosella* Walsingham
17. Antenna shorter than forewing; forewing dark bronzy with or without indistinct pale spotting ..... *oplerella* Powell  
Antenna longer than forewing ..... 18
18. Antenna greatly elongate, more than  $2.5\times$  forewing length ..... 19  
Antenna moderately elongate, about  $1.2\text{--}2.1\times$  forewing length ..... 20
19. Antenna more than  $3\times$  forewing length; forewing narrow, length about  $3.4\times$  width, bronzy with complete white transverse band or white along costa at outer  $\frac{1}{3}$  ..... *singulella* Walsingham  
Antenna less than  $3\times$  forewing length; forewing broader, length about  $3.1\times$  width, bronzy with or without a dot on thin incomplete transverse line at outer  $\frac{1}{3}$  ..... *punctiferella* Walsingham
20. Antenna elongate, more than  $2\times$  forewing length; forewing black usually with thin, white transverse bands ..... *septentrionella* Walsingham  
Antenna less elongate, about  $1.2\text{--}1.6\times$  forewing length ..... 21
21. Antenna short, 1.3 or less times forewing length ..... 22  
Antenna longer, 1.5 or more times forewing length ..... 23
22. Abdomen with VII sternite strongly produced and attenuate, more than  $3.2\times$  VI sternite (pl. 6, fig. 1); forewing olivaceous bronze, reflecting brass metallic, fringe whitish ..... *thorpella* Powell  
Abdomen with VII sternite less attenuate; length less than  $3.1\times$  VI (pl. 5, fig. 2); forewing orange brown, with lead colored metallic scaling on black spots above tornus; fringe brownish ..... *ridingsella* Clemens
23. Forewing black, green or bluish with or without one or more white transverse bands ..... 24  
Forewing bronze colored reflecting metallic purplish to coppery with or without whitish spots, no transverse bands ..... *flammeusella* Chambers
24. Head bright orange; forewing greenish with 2 or 3 transverse white bands ...  
..... *trigrapha* Zeller and *eldorada* Powell  
Head ochreous; forewing bluish with one broad transverse white band at outer  $\frac{1}{3}$  ..... *purpurea* Walker

## NEMOPHORA Hoffmannsegg

- Nemophora* Hoffmannsegg, 1798, Illiger Verz. Käfer Preussens, :499; Hübner, 1826, Verz. bek. Schmett., :417; Meyrick, 1912, Gen. Insectorum, 133:2 (synonymy); Fletcher, 1929, Mem. Dept. Agric. India, Ent. Ser., 11: 146 (synonymy).  
*Nemotois* Hübner, 1826, Verz. bek. Schmett., :416.  
*Nematopogon* Zeller, 1839, Isis, :185.  
*Nemotois* (error) Chambers, 1876, Canad. Ent., 8:103.

*Type*.—*Tinea degeerella* Linnaeus, 1758 (Europe)

The above synonymy follows Fletcher (1929), although Meyrick and others have credited the name *Nemophora* to Hübner, 1826 (type: *swammerdammella* L., 1758). Janse (1945), Jacobs (1949), and Diakonoff (1951) recognized Hoffmannsegg as the valid author and considered *Nemotois* a synonym of *Nemophora*, but retained *Nematopogon* Zeller (type: *schwarziella* Z., 1839) as a separate genus.

NEMOPHORA BELLELA (Walker), **new combination**

(Pl. 1, fig. 1; pl. 5, fig. 1)

- Adela bella* Walker, 1863, Cat. Lep. Het. Brit. Mus., 28:501; Walsingham, 1880, Proc. Zool. Soc. Lond., :79.  
*Nemotois bella*; Barnes & McDunnough, 1917, Checklist Lepid. Bor. Amer., :196.  
*Adela bella* (error), Walsingham, 1890, Insect Life, 2:284.  
*Nemotois bella* (error), Meyrick, 1912, Lepid. Cat., 6:10; Forbes, 1923, Cornell Univ., Agr. Exp. Sta., Mem. 68:78 (distr.).  
*Nemotois bella* (error), Anderson, 1915, Proc. Ent. Soc. B. C., 6:129 (distr.).

*Type data*.—St. Martin's Falls, Albany River, Hudson's Bay, type female in British Museum.

*Taxonomic discussion*.—Walsingham (1890) suggested that this species may be synonymous with the widespread Palearctic *N. degeerella* (L.), a possibility enhanced by its presently known distribution. Specimens from Japan were said to be indistinguishable from North American examples.

*Geographical distribution*.—A boreal species ranging from Quebec across Canada north of the plains to the mountains of British Columbia; northward, widespread in the Northwest Territories, Yukon, and Alaska; at least to 65° N. Lat. at Great Bear Lake. Forbes (1923) reported it from Colorado.

*Flight period*.—Late June and July.

*Oviposition site*.—Unknown; *N. degeerella* is said to feed on leaves of *Anemone nemorosa* (Ranunculaceae) (Schutze, 1931).

## ADELA Latrielle

- Adela* Latrielle, 1796, Gen. Crust Ins., 4:224; 1796, Prec. caract. Ins., :147; 1802, Hist. Nat. Crust. Ins., 3: 417.

*Type*.—*Tinea reamurella* L. (= *viridella* Scopoli, 1763) (Europe).

## ADELA BELLA Chambers

(Pl. 1, fig. 2)

*Adela bella* Chambers, 1873, *Canad. Ent.*, 5:73; Chambers, 1878, *Bull. U. S. Geol. Survey*, 4:110 (biol.); Walsingham, 1880, *Proc. Zool. Soc. Lond.*, :79; Walsingham, 1890, *Insect Life*, 2:285 (synonymy); Engel, 1908, *Ann. Carnegie Mus.*, 5:135 (distr.); Meyrick, 1912, *Lepid. Cat.*, 6:12; Forbes, 1923, *Cornell Univ. Agr. Exp. Sta.*, 68:78 (distr.); Kimball, 1965, *Lepid. Fla.*, :303 (distr.).  
*Adela chalybeis* Zeller, 1873, *Verh. Zool.-bot. Ges. Wien*, 23:226; Chambers, 1878, *Bull. U. S. Geol. Survey*, 4:127; Walsingham, 1880, *Proc. Zool. Soc. Lond.*, :79.  
*Adela iochroa* Zeller, 1877, *Horae Ent. Soc. Rossicae*, 13:218; Walsingham, 1880, *Proc. Zool. Soc. Lond.*, :79.

*Type data.*—Kentucky, location of type unknown (*bella*); Texas, location of type unknown (*chalybeis*); Dallas, Texas, April 27, type in Staudinger collection (Walsingham, 1890) (*iochroa*).

*Geographical distribution.*—Widespread in eastern North America, from southern Quebec (Kazubazua) through the eastern coastal states to northwestern Florida and Alabama; Ohio, Kentucky, Tennessee and central Texas. Records are lacking for the Mississippi Valley.

*Flight period.*—March in Florida, April and May northward, August in Quebec.

*Oviposition site.*—Unknown; Chambers (1878) stated that the adults occur on flowers of *Celastrus scandens* (Celastraceae).

## ADELA AERUGINOSELLA Walsingham

*Adela aeruginosella* Walsingham, 1890, *Insect Life*, 2:285.

*Type data.*—Louisiana (Morrison), type in British Museum.

*Taxonomic discussion.*—According to the description, this species should be very similar to *A. bella*, differing primarily by the greenish color, although Walsingham did not mention the eye size. It apparently has not been recollected subsequent to the type series. In response to inquiries I have been able to locate only one specimen of *Adela* from the Gulf states; that a male from Baldwin County, Alabama, in the Mather collection, which is indistinguishable from more northern *A. bella*.

*Distribution.*—Louisiana.

*Flight period.*—Unknown.

*Oviposition site.*—Unknown.

## ADELA RIDINGSSELLA Clemens

(Pl. 1, figs. 3, 4; pl. 5, fig. 2)

*Adela ridingsella* Clemens, 1864, *Proc. Ent. Soc. Phila.*, 2:426; *Tineina N. A.*, :250; Chambers, 1878, *Bull. U. S. Geol. Survey*, 4:127; Walsingham, 1880, *Proc. Zool. Soc. Lond.*, :78, 79 (synonymy); Walsingham, 1890, *Insect Life*, 2:285; Meyrick, 1912, *Lepid. Cat.*, 6:10; Forbes, 1923, *Cornell Univ. Agr. Sta.*, *Mem.* 68:77 (distr.).



*Adela ?ridingsella*; Weiss and West, 1925, Ent. News, 36:116 (biol.); Felt, 1940, Plant Galls and Gall Makers, :287 (biol.).  
*Adela schlaegeri* Zeller, 1873, Verh. Zool.-bot. Ges. Wien, 23:227.  
*Dicte corruscifasciella* Chambers, 1873, Canad. Ent., 5:74.  
*Adela corruscifasciella*; Chambers, 1878, Bull. U. S. Geol. Survey, 4:127 (synonymy).  
*Adela coruscifasciella* (error), Walsingham, 1880, Proc. Zool. Soc. Lond., :79.

*Type data*.—"Virginia. Taken by Jas. Ridings of Philadelphia," type in Academy of Natural Sciences, Philadelphia (Busck, 1903) (*ridingsella*); Ohio, location of type unknown (*schlaegeri*); Kentucky, location of type unknown (*corruscifasciella*).

*Geographical distribution*.—Widespread in eastern North America, from Nova Scotia, Ontario, and Quebec, Maine to Pennsylvania and the mountains of North Carolina.

*Flight period*.—June and July.

*Oviposition site*.—Unknown; Weiss and West (1925) in New Jersey found larvae in petiole galls of *Parthenocissus quinquefolia* (Vitaceae). The larvae later formed external cases and were identified as adelid, possibly *Adela ridingsella* by Carl Heinrich. If correctly classified as *Adela*, the species involved might be *bella*, judging from the more southerly distribution of the plant and moth.

#### ADELA PURPUREA Walker

(Pl. 1, figs. 5, 6; pl. 5, fig. 3)

*Adela purpurea* Walker, 1863, Cat. Lepid. Het. Brit. Mus., 28:501; Walsingham, 1880, Proc. Zool. Soc. Lond., :78, 79 (synonymy); Walsingham, 1890, Insect Life, 2:285; Meyrick, 1912, Lepid. Cat., 6:10; Forbes, 1923, Cornell Univ. Agr. Exp. Sta., Mem. 68:78 (distr.).  
*Adela biviella* Zeller, 1873, Verh. Zool.-bot. Ges. Wien, 23:226; Chambers, 1878, U. S. Geol. Survey, 4:127.

*Type data*.—St. Martin's Falls, Albany River, Hudson's Bay, type in British Museum (*purpurea*); Massachusetts, location of type unknown (*biviella*).

*Taxonomic discussion*.—Meyrick (1912a, b) listed *A. caeruleella* Walker, supposedly described from Australia, in North America. This species was described on the page following *purpurea*, and Forbes (1923) has suggested that the two may be the same. However, no mention of a white, transverse band is made by Walker for *caeruleella*.

*Geographical distribution*.—Widespread in Boreal North America, from the Yukon Territory at 62° N. Lat., through the southern provinces of Canada to Quebec and southward to northern New Jersey.

*Flight period*.—May and June in northern Canada; April in New England.

*Oviposition site*.—Unknown. Forbes (1923) and labels on specimens from several areas indicate that the adults visit *Salix* blossoms.

## ADELA TRIGRAPHA Zeller

(Pl. 2, figs. 1, 2; pl. 5, fig. 4)

- Adela trigrapha* Zeller, 1875, Verh. Zool.-Bot. Ges. Wien, 25:342; Chambers, 1878, Bull. U. S. Geol. Survey, 4:128 (synonymy); Walsingham, 1880, Proc. Zool. Soc. Lond., :79 (synonymy); Meyrick, 1912, Lepid. Cat., 6:10; Powell, 1967, Pan-Pac. Ent., 43:83 (biol.).
- Adela* (*Nematais*?) *trifasciella* Chambers, 1876, Canad. Ent., 8:103; Meyrick, 1912, Lepid. Cat., 6:10. (new synonymy)
- Adela fasciella* Chambers, 1876, Canad. Ent., 8:103.
- Adela flammeusella* (not Chambers, 1876); Linsley and Usinger, 1936, Pan-Pac. Ent., 12:50 (biol.).
- Adela flammusella* (error) (not *flammeusella* Chambers); Linsley and Usinger, 1936, Pan-Pac. Ent., 12:53.

*Type data*.—California, location of type unknown (*trigrapha*); "from Mr. James Behrens, San Francisco," type apparently lost, neotype male, by present designation: California, 2 miles west of Fairfax, Marin County, April 17, 1961 (J. Powell), in U. S. National Museum (*trifasciella*); from "Mr. Behrens, San Francisco," type apparently lost, neotype female, by present designation: California, 2 miles west of Fairfax, Marin County, April 17, 1961 (J. Powell), in U. S. National Museum (*fasciella*).

*Taxonomic discussion*.—The synonymy of the two names *trifasciella* and *fasciella* as representing the sexes of one species was suggested by Chambers at the time of their proposal, but later (1878) he considered *fasciella* synonymous with *trigrapha*. I can see no difference between the descriptions of *trifasciella* and Zeller's male of *trigrapha* and concur with Walsingham (1880) that all three names refer to the one species. A search of the U. S. National Museum and Museum of Comparative Zoology collections, the most likely locations for Chambers' types, proved negative for any of Chambers' *Adela*. I have therefore made the above neotype designations from a locality in the San Francisco Bay area. I know of no colony of *A. trigrapha* in San Francisco now, although specimens were taken there in 1908. The neotype of *trifasciella* is of the variety mentioned by Zeller with the outer transverse band broken. About 40% of my sample from this locality have the band broken.

Colonies typical of the neotype locality occur throughout the San Francisco Bay area counties, mostly in the hills away from the immediate coast, up to at least 2300 feet on Mt. Hamilton (Pl. 2, figs. 1, 2). These populations are characterized by moderately large individuals (forewing length of males average 8.5–9 mm), having narrow, white forewing bands (median band width .12–.18 the distance between inner bands in cell, .3–.4 eye diameter), and a few to several orange scales at the back of the crown. The species shows considerable interpopulational variation, but geographical trends are difficult to define. Colonies of the inner

coast range (Yolo County, western Stanislaus County, eastern Alameda County, interior San Luis Obispo County), on Santa Cruz Island, and in the foothills of the Sierra Nevada (*e.g.*, nr. Soulsbyville, Tuolumne County; near Posey, Tulare County; near Woody, Kern County) consist of smaller individuals (forewing length of males average 7.5–8 mm) which tend to have reduced whitish markings, with the transverse bands of the forewing sometimes almost obsolete, but more variable than shown in typical colonies (width of median band .10–.20 the distance between the inner bands, .25–.42 eye diameter), and with even less pale scaling of the crown, usually only a few scales, which are sometimes whitish instead of orange. As discussed below, these colonies are at times sympatric with the newly described species *A. eldorada*, which is more similar to typical *trigrapha*, presuming that Zeller's material originated from the San Francisco area.

Northward in the coast ranges the moths average slightly larger than in the San Francisco Bay area, with somewhat larger, slightly yellowish forewing bands and generally more orange on the crown, mostly one-third to one-half of the scales comprising the occipital tufts, thus approaching *A. eldorada* in these regards. Further study of colonies from higher elevations (3–4000 feet) in Lake County northward will be needed to clarify relationships between the two species in this region.

*Geographical distribution.*—Southern British Columbia to southern California (records are lacking for most of Washington and all but southernmost Oregon). The species occurs over much of cismontane California, in the coast ranges up to about 4000 feet and the foothills of the Sierra Nevada to 2000 feet; and in parts of the central valley.

*Flight period.*—Late March to mid-May in the foothills, mid-April to mid-June in Lake County northward.

*Oviposition substrate.*—Buds of *Linanthus androsaceus* and *L. bicolor* (Polemoniaceae).

***Adela eldorada* Powell, new species**

(Pl. 2, figs. 3, 4; pl. 5, fig. 5)

*Adela trigrapha* (not Zeller, 1875); Usinger and Storer, 1963, *Sierra Nevada Nat. Hist.*, :191, pl. 14, fig. 45.

A large species of the Sierra Nevada which resembles *A. trigrapha* but has relatively broader bands on the forewing and predominantly orange head vestiture in the male.

*Male.*—Length of forewing 5.3 to 6.8 mm. *Head:* Eye large diameter 3.1 to 4.4× the distance between eyes on crown. Antenna elongate, about 3× forewing length, 166 to 172 segments; scape scaled, black above, whitish ventrally with elongate black and white bristles ventrally, flagellum scaled, basal 30 segments

banded black and white, remainder white. Maxillary palpus minute, 3 segments (distal 2 sometimes fused), length about .15 eye diameter; labial palpus elongate, 3 segments, length usually about 4.6:4.5, II + III 1.06 to 1.14 eye diameter, scaled, black, with a dense brush of elongate black bristles on ventral half. Scaling of tongue and front sparse, elongate, pale and dark, of crown elongate, dense, usually mostly to almost entirely orange, the remainder black. *Thorax*: Dorsal scaling black except immediately behind head, orange, appressed with intermixed elongate, erect hairs. Underside similar, dark gray; tarsi white ventrally; hind tibiae and tarsi with elongate, dense black scale brushes. *Forewing*: Length 3.2 to 3.3 times width (exclusive of fringe); costa flattened or slightly concave towards middle. Ground color black; three transverse yellow-white bands, the inner one from costa at  $\frac{1}{4}$ , angled slightly inward, median one from about mid-costa, angled outward slightly bowed, to dorsum before tornus, width of median one .22 to .28 (rarely to .5) the distance between the two bands along a line in cell; third band from outer  $\frac{1}{4}$  of costa, ending above tornus before terminal margin, narrower than inner two bands, usually broken (in about 70% of the sample), the lower part small, sometimes obsolete. Fringe black. Underside black, the pale bands of upperside showing through, the outer one reproduced by pale scaling. *Hindwing*: About as broad as forewing. Ground color brownish black, reflecting metallic purplish; usually two yellow-white spots near hind margin, inner one often reduced, sometimes lacking, just beyond anal angle, outer one at termination of 1st A fold. Fringe brownish black. Underside brownish black. *Abdomen*: Dorsal scaling black, faintly reflecting metallic purplish; underside somewhat paler, distal two segments and genital scaling often with some intermixed whitish. Genitalia essentially indistinguishable from *A. trigrapha* except larger (about 3:2 at the type locality); uncus strongly protruding; valvae round apically; reflexed part of aedeagus relatively short, about  $\frac{1}{3}$  the total length, its sclerotized portion arrowhead-shaped (2 preparations examined).

*Female*.—Length of forewing 5.6 to 6.9 mm. *Head*: Eye small, not extended onto crown; diameter .67 to .70 the distance between eyes. Antenna about .5 as long as in male, about 1.5 forewing length; 70 to 76 segments; scaled, banded dark gray and white or mostly gray on basal  $\frac{2}{3}$ , white beyond. Labial palpus shorter than in male (about 4:5), segment II usually slightly longer than III; scaled, black, and with elongate black bristles ventrally. Maxillary palpus small, but not smaller than in male, 3 or 4 segmented, the basal 2 segments larger. Tongue and lower front scaling black; upper part of front and crown densely clothed with elongate, bright orange scaling, no intermixed black. *Thorax*: Dorsal scaling metallic green anteriorly, becoming blackish posteriorly. Underside dark metallic gray, tibiae metallic greenish exteriorly. *Forewing*: Broad, length about 2.7 times width; costa gently convex. Ground color dark metallic green; three pale yellow bands, arranged as in male but narrower (width of median band .18 to .25 the distance between inner two), outer one not reaching costa, often broken (in 45% of the sample). Fringe blackish. Underside dark brown; pale bands of upperside showing through, not reproduced. *Hindwing*: Broader than forewing; frenulum lacking. Ground color dark brown, reflecting metallic purplish; the two marginal pale spots of male usually absent, when present, rarely also a third spot in cubital interspace. Underside dark gray-brown, without pale spots. *Abdomen*: Scaling entirely metallic blackish. VII sternite moderately elongate, length about 3.0 VI (Pl. 5, fig. 5).

*Holotype male* and allotype female: California, One mile east of Woody, Kern County, May 3, 1964 (J. Powell). Paratypes (125), all California: Fresno Co.: Trimmer, Kings Riv. Cyn., 1♂ IV-10-32 (E. L. Donohoe). Kern Co.: 1 mi. E Woody, 1♂, 1♀ IV-25-64 (C. A. Toschi), 10♂, 2♀ V-3-64 (J. Powell & P. A. Rude). Madera Co.: Bass Lake, 1♂ V-30-42 (C. Kennett). Mariposa Co.: Mariposa, 9♂, 1♀ V-20-61 (S. M.

Fullerton); 3 mi. N Bagby, 2♂ III-25-65 (R. L. Langston & J. Powell). Placer Co.: East end Bear Vy., nr. Emigrant Gap, 14♂, 4♀ VI-1-64 (P. H. Arnaud, Jr.). Tulare Co.: California Hot Springs, 3♂ V-14-63 (C. A. Toschi & J. Powell); 5 mi. NE Springville, 3♂, 1♀ V-14-63 (S. W. Earnshaw & Powell). Tuolumne Co.: N fork Tuol. Riv., 3 mi. NE Tuolumne, 16♂, 1♀ V-1-61 (C. D. MacNeill & Powell), 8♂, 4♀ V-13-61 (MacNeill); Tuol. Riv., 2 mi. NE Tuolumne, 4♂, 2♀ V-13-61 (MacNeill); Crocker Sta., 6 mi. S Mather, 7♂, 1♀ VI-12-61 (MacNeill & Powell); 4 mi. S Mather, 1♂ VI-12-61 (Powell); Twain Harte, 13♂, 7♀ VI-17-63 (M. R. Lundgren), 1♂ V-24-64, 7♂ V-30-64 (M. R. & S. H. Lundgren). Paratypes deposited in collections of California Academy of Sciences, California Insect Survey, and U. S. National Museum.

The following additional specimens have been examined, which probably represent *eldorada* but are not designated as paratypes owing to insufficient information on the populations involved. California: Butte Co.: S of Cohasset, 2♂, 1♀ IV-5-63 (L. D. Thurman). El Dorado Co.: Cool, 2♂ IV-5-63 (L. D. Thurman). Fresno Co.: 4 mi. W Tollhouse, 1♂ V-13-61 (D. J. Burdick). Kern Co.: Havilah, 3000', 1♂ IV-28-64 (J. Powell). Big Cr., nr. Huntington Lake, 2♂ VI-9-63 (C. P. Alexander). Madera Co.: 21 mi. NE Madera, 2♂ IV-14-61 (D. J. Burdick). Mariposa Co.: Mariposa, 4♂ V-7-39 (M. L. Walton); Mt. Bullion, 1♂ V-7-54 (Martin & Truxal). Tulare Co.: 4 mi. N Kaweah, 2♂ V-13-63 (S. W. Earnshaw).

This species is similar in superficial appearance and structure to *Adela trigrapha*, from which it differs by being larger and more brightly colored, in the male with relatively wider transverse bands which are yellowish rather than white and with orange vestiture on the head. The new species further differs by having in both sexes slightly larger labial and maxillary palpi, particularly the second segment of the labial palpi.

*Adela eldorada* essentially replaces *trigrapha* on the west slope of the Sierra, ranging from about 1500 to 6000 feet. In these areas it flies in canyon situations, in semi-shaded spots in the forest, or more or less open chaparral, and has not been observed visiting flowers. This habitat preference, which is similar to that of *A. septentrionella*, at once impressed us as distinct from that of *trigrapha* when we first encountered the species in 1961. *Adela trigrapha*, by contrast, almost invariably flies in more or less open meadow or grassy hillside situations where *Linanthus* grows and commonly visits flowers, especially Compositae. Owing to the nearly allopatric distribution, I would have been inclined to regard *eldorada* as a biological race or subspecific counterpart, except the two were found together near Woody, Kern County, in 1964. Here *eldorada* flew in small

openings in deep chaparral and scrub oak on a north facing slope, while *trigrapha* was common around *Baeria minor* (Compositae) on grassy flats subtending the slope, a few meters away.

As discussed above, populations of *A. trigrapha* from interior portions of the Coast Range and from foothills of the Sierra Nevada are characterized by individuals which are smaller and darker with less tendency for orange on the male head than typical *trigrapha* from the central coastal counties. Thus a character displacement type of situation obtains in which *trigrapha* and *eldorada* are much more distinct where their populations are sympatric or adjacent (along the Sierra Nevada foothills) than where samples from remote areas (coastal *trigrapha* and Sierran *eldorada*) are compared.

Each of the differences mentioned to distinguish *eldorada* from *trigrapha* breaks down in a few specimens from one locality or another. For example, specimens from 6000 feet in Tuolumne County, near Mather, show the extreme in orange head vestiture, characteristic of *eldorada*, but some have narrower forewing bands than at any other Sierran locality, well within the range shown by typical *trigrapha*. Specimens from east of Millville, Shasta County, are referred to *trigrapha* on the basis of wing markings, head color, and habitat, but they have a larger labial palpus than any other *trigrapha* measured, as in *eldorada*.

As mentioned in connection with *trigrapha*, its representatives from Lake County northward tend to have increased orange head scaling, yellowish bands, and more hindwing spots, and relationships between the two species should be investigated in mountains around the northern end of the Sacramento Valley and northward.

The only southern California mainland population sample I have studied, from Railroad Canyon near Elsinore, Riverside County (17♂, 1♀ IV-13/17-65, C. A. Toschi and J. Powell) is composed of small individuals as in interior northern sites. However, the Riverside specimens have relatively broad forewing bands (median band .21 to .28 the distance between inner bands, .45 eye diameter) and the head shows a moderate amount of pale, usually whitish, scaling.

#### ADELA FLAMMEUSELLA Chambers

(Pl. 3, figs. 3-5; pl. 5, fig. 6)

*Adela flammeusella* Chambers, 1876, Canad. Ent., 8:104.

*Adela flammensella* (error) Chambers, 1878, Bull. U. S. Geol. Survey, 4:127; Walsingham, 1890, Insect Life, 2:284 (synonymy).

*Adela flammensella* (error) Walsingham, 1880, Proc. Zool. Soc. Lond., :78, 79.

*Adela lactimaculella* Walsingham, 1880, Proc. Zool. Soc. Lond., :80, pl. 11.

*Adela flammeella* Meyrick, 1912, Lepid. Cat., 6:10.

*Type data*.—"from Mr. Behrens" [San Francisco], type apparently lost, neotype female, by present designation: California, 6 miles southeast of Yorkville, Mendocino Co., V-18-66 (J. Powell), in U. S. National Museum (*flammeusella*); "Mendocino County, California, June 10, 1871,"<sup>1</sup> type in British Museum (*lactimaculella*).

*Taxonomic discussion*.—This species was described on the basis of a single female specimen lacking antennae, which evidently has subsequently been destroyed. The description conceivably could apply either to *flammeusella* as it has been interpreted or to one of the two species described below, *A. thorpella* or *A. oplarella*. However, Chambers' use of "saffron" for the head color (the same term he used for *fasciella* = *trigrapha*) suggests that the species has been correctly interpreted by subsequent writers. Thus I have designated a neotype from a colony geographically and phenotypically near the type of *lactimaculella*, which was described on the basis of better material but later recognized by Walsingham (1890) to be a synonym of *flammeusella*. My concept of Walsingham's name is based on the good original description and figures and on my specimens from Lake and Mendocino Counties compared with the type at the British Museum by R. W. Hodges.

Walsingham supposed that the white markings were worn off Chambers' type, but unmarked individuals are normal in females, although rare in the north coastal counties. In this regard the species shows geographical variation but no well-defined trend. Males from Mendocino and Lake Counties tend to be strongly spotted, with at least the three spots described by Walsingham well-developed and white, strongly contrasting. Often a fourth spot appears above the tornus, and rarely there are two more at basal one-fourth, one each just above and just below the cell (Pl. 3, fig. 3). The females usually have three or four rather ill-defined spots. The neotype has none.

Southward, in populations of the San Francisco Bay area counties, specimens are generally less well marked, with most males having only the three spots illustrated by Walsingham, and these are not as large and contrastingly white, appearing yellowish or tan. Unmarked females are common, about 50% having at most a trace of the outer costal spot (Pl. 4, fig. 4). On Santa Cruz Island and in Placer County at 1300 feet in the Sierra Nevada foothills, about 50% of males have no markings on the forewing, the remainder having reduced spots, and females are immaculate. At Cool, El Dorado County, only seven airline miles from a Placer County sample site, all individuals in two samples (16♂, 13♀)

<sup>1</sup>Essig's (1941) account of the Walsingham itinerary places this date's collecting in the vicinity of Little Lake, near Willits.

have unicolorous forewings (Pl. 4, fig. 5). Southward in the Sierra Nevada the phenotype is more like the Placer County composition.

*Geographical distribution.*—Southern Washington (Columbia River), southward (although records are lacking for Oregon) through foothills and interior valleys of most of cismontane California, mostly below 2000 feet.

*Flight period.*—Late March (rare), April and May, to early June at higher elevations.

*Oviposition site.*—Unknown; probably various species of *Orthocarpus* (Scrophulariaceae) are involved.

***Adela thorpella* Powell, new species**

(Pl. 2, figs. 5, 6; pl. 6, fig. 1)

A densely hairy moth with large eyes in the male and olivaceous-bronzy colored forewings with brassy metallic reflections and a whitish fringe.

*Male.*—Length of forewing 5.9 to 7.0 mm. *Head:* Eyes enlarged, extending onto crown behind antennal sockets; eye diameter 3.3–3.7 times the distance between eyes; maxillary palpus small, length about .2 eye diameter, 3 segments of equal lengths; labial palpus elongate, about 1.5 eye diameter, segment lengths about 1:2:2. Antenna about 2.5 times forewing length, flagellum about 120 segments, scape with scale tuft dorsally and enlarged hair tuft ventrally. Mouthparts and crown above and below antennal sockets densely clothed with long hairs, whitish below front, with intermixed blackish bristles, slightly ochreous behind eyes in fresh specimens. *Thorax:* Scaled, black, and sparsely hairy, pale ochreous dorsally; densely hairy, gray to blackish ventrally; femora and hind tibiae with elongate brushes. *Forewing:* Length 3.7–4.0 times width (exclusive of fringes). Ground color olivaceous-bronze, reflecting metallic brass, at times overlaid with pale yellowish scales; without markings or more usually at least a trace of a white spot pattern which when well developed is composed of a faint spot in middle near base, a distinct, small spot angling in from costa beyond end of cell, and an opposing, distinct, larger spot angling upward from dorsum before tornus. Fringe distinctly white from apex nearly to tornus, becoming brown at tornus. Underside dark brown, costa and terminal fringe white. *Hindwing:* About as broad as forewing;  $M_1$  and  $M_2$  separate. Ground color brown, faintly reflecting purplish; fringe whitish around outer margin, becoming brownish at inner margin. Underside similar. *Abdomen:* Scaling black dorsally and ventrally; genital scaling whitish. *Genitalia:* Uncus bilobed, rather strongly protruding; valvae round apically; folded portion of aedeagus comparatively short (only about one-half the unfolded portion), its sclerotization spear- rather than arrowhead-shaped (4 preparations examined).

*Female.*—Length of forewing 5.7 to 6.1 mm. Generally similar to male, differing as follows. *Head:* Eye small, lateral to and almost entirely below antennal socket; eye diameter slightly over .5 the distance between eyes. Labial palpus shorter, about .67 as long as in male. Antenna shorter, 1.3 to 1.4 times forewing length; about 67 segments. Frenulum lacking. Abdomen fully scaled, brownish, mixed with paler ventrally and apically. Sternite VII elongate-attenuate (Pl. 6, fig. 1), about 3.25 times the length of VI.

*Holotype male* and allotype female: California, Russelmann Park, north slope of Mt. Diablo, 1100 feet elev., Contra Costa County, April 9,



1958 (J. Powell). Paratypes (184), all California: Colusa Co.: 4 mi. NW Lodoga, 13♂, 18♀ IV-12-62 (J. A. Chemsak and J. Powell). Contra Costa Co.: Mt. Diablo, 1♂ IV-4-36 (E. S. Ross); same data as holotype, 17♂, 3♀. El Dorado Co.: Tallac, Lake Tahoe, 1♂ no date (B. P. Clark donor). Lake Co.: 1 mi. SW Lakeport, 11♂, 9♀ IV-24-63 (R. W. Thorp). Madera Co.: 3.7 mi. W Oakhurst, 8♀ V-15-63, on *Platystemon* (R. W. Thorp). Mariposa Co.: 3 mi. N Bagby, 6♂, 3♀ III-25-65 *Platystemon californicus* (R. L. Langston and J. Powell). Monterey Co.: Hastings Reservation near Jamesburg, 12♂, 4♀ IV-27-63, on *Platystemon* and *Meconella* (R. W. Thorp); 6 mi. N Jolon, 1♂ IV-15-64 on *Layia* (R. W. Thorp). San Benito Co.: Limekiln Cyn., SW of Paicines, 4♂ III-30-63 (K. A. Hale and D. C. Rentz), 1♂, 1♀ IV-29-65 on *Platystemon* (P. A. Opler), 4♂ IV-24-65 (D. C. and K. A. Rentz), 3♀ IV-24-68 (J. T. Doyen and J. Powell). Santa Clara Co.: 1 mi. N New Almaden, 18♂, 12♀ III-29-65, "mainly on *Platystemon*" (P. A. Opler); 3.5 mi. NE New Almaden, 8♂, 2♀ IV-3-65 on *Plagiobothrys* (P. A. Opler); 0.5 mi. N New Almaden, 4♂, 16♀ IV-4-65 "mainly on *Platystemon*" (P. A. Opler). Sonoma Co.: 1 mi. S El Verano, 2♂ III-25-64, *Platystemon californicus* (R. W. Thorp), 2♂ IV-9-64, *Platystemon californicus* (J. Powell). Paratypes deposited in British Museum, California Academy of Sciences, California Insect Survey, and U. S. National Museum.

A nearly equal number of additional specimens, from the following localities in the southern half of the State, have been examined but not designated as paratypes. Kern Co.: Miracle Springs, IV-29-64 (J. Powell). Riverside Co.: Railroad Cyn., 4 mi. E Elsinore, IV-14/17-65, *Platystemon californicus* (J. Powell). San Luis Obispo Co.: 3 mi. N Nacimiento Dam, IV-14-67, *Platystemon* (J. A. Chemsak and J. Powell); 4 mi. S Creston, IV-13-67, *Meconella linearis* (Chemsak, Powell and Rude). San Diego Co.: San Diego, III-23-21 (W. S. Wright). Santa Barbara Co.: Prisoner's Harbor, Santa Cruz Island, IV-29-66 (J. Powell).

Southern California specimens tend to be slightly smaller and darker, with increased white spotting.

The few specimens of *Adela thorpella* which had been collected prior to 1958 evidently had been mixed in collections with *A. flammeusella*. The two are easily distinguished, however, by the brassy, rather than bronzy or coppery color, and the white fringe of the forewing of *A. thorpella*, its reduction of purplish on the hindwing, its heavier vestiture on body and legs, and appreciably shorter antennae. The present species is more similar in superficial appearance to *A. oplerella*, described below. From the latter, *A. thorpella* differs by its larger size, relatively longer antennae in both sexes and larger eyes in the male.

The species is named for Robbin W. Thorp, who, in connection with his bee studies, made most of the collections of this moth during the early years of my *Adela* survey.

***Adela oplerella* Powell, new species**

(Pl. 3, figs. 1, 2; pl. 6, fig. 2)

A small, dark bronzy colored moth with short antennae only slightly longer than the forewing in the male, and shorter than the forewing in the female.

*Male*.—Length of forewing 4.4 to 5.5 mm. *Head*: Eye lateral, almost entirely below antennal socket, diameter about .3 the distance between eyes. Labial palpus elongate, porrect, segments variable in length, II + III about 1.9 times eye diameter; scaled brown dorsally and whitish ventrally, ventral half with many spreading, elongate (to 2× eye diameter), black bristles. Maxillary palpus small, length about .3 eye diameter, three segments, the basal two subequal, larger than third. Antenna 1.0 to 1.2 forewing length; flagellum of 48 to 50 segments; scaled dark brown. Head clothed with elongate, irregularly spreading black and pale ochreous hairs. *Thorax*: Dorsal scaling blackish brown, reflecting bronzy, interspersed with long semi-erect black and ochreous hairs. Underside similar, coxae and femora densely hairy. Hind tibia and tarsi with pale elongate hairs and scale brushes. *Forewing*: Length 3.4 to 3.6 times width (exclusive of fringes). Ground color dark olivaceous bronzy, strongly metallic when fresh; without markings or with two faint whitish spots, one on costa beyond cell and one at lower corner of cell. Fringe dull whitish above tornus. Underside dark brown with scattered pale scales, costa and terminal fringe pale ochreous. *Hindwing*: Slightly narrower than forewing; M<sub>1</sub> and M<sub>2</sub> separate. Ground color dark brown, reflecting metallic bronzy and purplish. Fringe dull whitish below apex. Underside similar, with scattered pale scales in outer half. *Abdomen*: Dorsal scaling black, reflecting metallic bronze. Underside slightly paler. Genitalia with uncus reduced, lateral lobes scarcely protruding; valva strongly tapered apically; sclerotized part of reflexed portion of aedeagus spear-shaped, about .8 as long as basal portion (two preparations examined).

*Female*.—Length of forewing 5.0 to 6.1 mm. Essentially as described for male, differing as follows: Labial palpus slightly shorter, segments II + III about 1.8 eye diameter; antenna shorter, about .8 to .9 forewing length, 40 to 46 segments; elongate hairs of head and thorax mostly ochreous to pale ochreous. Wing fringes generally paler; frenulum lacking. Abdomen with VII sternite elongate, 3.35 to 3.5 times VI (Pl. 6, fig. 2); VIII moderately heavily sclerotized; internal genitalia without sclerotization.

*Holotype male* and allotype female: California, 5 miles southeast of Nicasio, Marin County, April 30, 1967, on *Platystemon californicus* (P. A. Opler and W. J. Turner). Paratypes (108), all California; Marin Co.: 21♂, 18♀ same data as holotype, 1♂ IV-13-68 (P. A. Opler); 5.5 mi. E Nicasio, 2♂, 6♀ IV-30-67 (G. A. Gorelick); 1 mi. SE Corte Madera, 8♂, 5♀ IV-13-68, on *Platystemon californicus* (P. A. Opler). San Francisco Co.: Lake Merced, 1♂, 1♀ III-21-08, 1♀ IV-19-08, 1♀ IV-11-09 (F. X. Williams). Santa Clara Co.: Silver Creek hills, 2♂ IV-12-62 (W. E. Ferguson); 6♀ IV-20-62 on *Platystemon californicus* (J. A. Chemsak and J. Powell); 1 mi. N New Almaden, 9♂, 5♀ III-29-65 on *Platystemon*

(P. A. Opler); 3.5 mi. NE New Almaden, 6♂, 10♀ IV-3-65 on *Platystemon* (P. A. Opler); 0.5 mi. N New Almaden, 5♀ IV-4-65 (P. A. Opler). Paratypes deposited in collections of British Museum, California Academy of Sciences, California Insect Survey, G. A. Gorelick, and U. S. National Museum.

As mentioned above, this species is most similar to *A. thorpella* among described species, and the two occur together on *Platystemon californicus* in central coastal California. *Adela oplerella* is smaller, darker and has small eyes in the male; the short antennae will distinguish the present species from all other described Nearctic *Adela*.

The species is named for Paul A. Opler, who has collected nearly all the specimens of this moth in addition to many other *Adela* during the course of this study.

#### ADELA SEPTENTRIONELLA Walsingham

(Pl. 3, fig. 6; pl. 4, figs. 1, 2; pl. 6, fig. 3)

*Adela septentrionella* Walsingham, 1880, Proc. Zool. Soc. Lond., :79, pl. 11; Walsingham, 1890, Insect Life, 2:285; Meyrick, 1912, Lepid. Cat., 6:10; Powell, 1967, Pan-Pac. Ent., 43:84 (biol.).

*Type data*.—Mendocino County, California, May and June, 1871, types in British Museum.

*Taxonomic discussion*.—Collections from northern Washington and British Columbia show a high proportion of specimens with reduced white markings, often the forewings are essentially immaculate black. Occasional examples in typical California populations exhibit a broadening of the white bands, as in Pl. 4, fig. 6.

*Geographical distribution*.—Widespread in the Pacific Coast states, from southern British Columbia and northwestern Idaho to the Transverse Range in southern California. The species is more Boreal than other West Coast *Adela*, following *Holodiscus* from canyon transition zone situations near the coast to near timberline above 6000 feet in the Trinity Alps and the mid Sierra Nevada, and 8000 feet in the southern Sierra Nevada.

*Flight period*.—Mid-April (rare), May and June, to mid-July at high elevations.

*Oviposition site*.—Buds of *Holodiscus discolor* (Rosaceae).

#### ADELA SINGULELLA Walsingham

(Pl. 4, figs. 3-5; pl. 6, figs. 4, 5)

*Adela singulella* Walsingham, 1880, Proc. Zool. Soc. Lond., :80, pl. 11; 1890, Insect Life, 2:285; Powell, 1961, Pan-Pac. Ent., 37:63.

*Type data.*—Mendocino County, California, May 25, 1871,<sup>1</sup> types in British Museum.

*Taxonomic discussion.*—Although typical populations of this species were not rediscovered for nearly 90 years after Walsingham found it, we now have adequate samples from four localities in the counties north of San Francisco Bay. Almost no variation in size or color is shown (Pl. 4, figs. 3, 4). Southward in the central Coast Range and along the west slope of the Sierra Nevada, are populations which are morphologically indistinguishable and occur in close association with the same plant. However, all these samples (some 150 specimens from a dozen localities) consist of specimens which average slightly smaller and lack all trace of the white forewing band, having only the white scaling along the costa which in the typical form gives rise to the transverse line (Pl. 4, fig. 5). In addition, the unbanded moths exhibit a duller appearance, lacking the purplish metallic reflections of the forewing, and thus superficially resemble *A. punctiferella*, with which some of the more austral colonies are nearly sympatric. I would consider the unbanded populations as a subspecies except for two small collections from the Transverse Range in southern California, which contain both phenotypes: 1) 9♂, 3♀ “Mt. Baldy, San Bernardino Mts.,” and “San Bernardino, Calif., Sept.” (USNM) which includes one male with the white band, the rest without it; at least the date on the latter is in error and probably the locality (Possibly the specimens came from Camp Baldy in the San Gabriel Mountains, west of San Bernardino.); 2) 3♂, 1♀ Tanbark Flat [2800' above Glendora], Los Angeles County, VI-18/19-56 (G. I. Stage and A. Menke, CIS, LACM), in which the males are banded, the female unbanded. The latter is worn and possibly also bore white scaling when fresh.

Thus some kind of polytopic interpretation may obtain when more colonies are discovered, particularly around the southern end of the Central Valley, and it seems best to withhold nomenclatural designation of the unbanded race for the present.

*Geographical distribution.*—California, southern Mendocino, Napa and northern Marin Counties (typical form); west slope of the Sierra Nevada (600–6000') from El Dorado to Kern County, in the Coast Ranges of Santa Clara County southward, to San Luis Obispo County (unbanded form), thence into the San Gabriel Mountains.

*Flight period.*—Mid-May to mid-June north of San Francisco Bay, the

<sup>1</sup> The Essig (1941) account of Walsingham's itinerary places this date's collection in the vicinity of Yorkville in the southern part of the county.

central Sierra Nevada and the San Gabriel Mountains; April in south Coast Range and southern Sierra Nevada.

*Oviposition site*.—Buds of *Gilia capitata* and *G. achillaeifolia* (Polemoniaceae).

ADELA PUNCTIFERELLA Walsingham

(Pl. 4, fig. 6; pl. 6, fig. 6)

*Adela punctiferella* Walsingham, 1890, *Insect Life*, 2:284.

*Type data*.—Los Angeles, California, type female in British Museum.

*Taxonomic discussion*.—The tiny white spot at the end of the cell of the forewing, which gave the species its name, is present on less than 30% of the individuals in all populations sampled (some 400 specimens from about 20 sites). Rarely a thin, transverse line is developed instead, usually not completely crossing wing. The moth is very similar to the unbanded form of *A. singulella*, differing by the shorter antennae, slightly broader, more rounded appearing forewing, and by lack of white on the costa.

*Geographical distribution*.—Semi-arid parts of California and southern Nevada; east side of the Coast Ranges from Colusa County southward, southern end of the Sierra Nevada, the desert ranges east of the Sierra Nevada into Nye County, both cis- and transmontane sides of the Transverse and northern Peninsular Ranges to Riverside County.

*Flight period*.—Beginning of March to April at lower elevations to mid-May in the interior mountains.

*Oviposition site*.—Unknown; the moths have been observed in close association with *Gilia tricolor* and *G. scopulorum* (Polemoniaceae) at several widely scattered stations.

INCURVARIINAE

CHALCEOPLA Braun

*Chalceopla* Braun, 1921, *Proc. Acad. Nat. Sci., Phila.*, 73:20.

*Cyanauges* Braun, 1919, *Ohio J. Sci.*, 20:24 (Preocc.).

*Type*.—*Incurvaria cyanella* Busck, 1915 (eastern U. S.).

CHALCEOPLA SIMPLICIELLA (Walsingham), **new combination**

*Adela simplicIELLA* Walsingham, 1880, *Proc. Zool. Soc. Lond.*, :81, pl. 11; Walsingham, 1890, *Insect Life*, 2:284; Meyrick, 1912, *Lepid. Cat.*, 6:12.

*Type data*.—Southern Oregon, May, 1872, types in British Museum.

*Taxonomic discussion*.—My recognition of this species is based on one specimen in the U. S. National Museum, from Rouge River, Oregon, collected by Walsingham and identified by him as *simplicIELLA*. It was compared, along with specimens of *Adela oplerella*, with the type at the

British Museum for me by R. W. Hodges, in 1963. I had considered the possibility that the latter species might be *simpliciella*, owing to the similar antennal lengths, but *simpliciella* is quite distinct, not *Adela*, and is congeneric with *Chalceopola cyanella*, according to D. R. Davis. I have recently collected *C. simpliciella* in Del Norte County, California, and it is similar to two other Californian species, but distinct, based on characters of the male genitalia. By contrast with *Adela*, members of *Chalceopola* possess elaborate interspecific genitalic features.

*Geographical distribution*.—Southern Oregon and extreme northern California.

*Flight period*.—May (Oregon); July at 4500 feet elevation in northern California.

*Oviposition site*.—Unknown; two related, apparently undescribed, species in California oviposit in young pods of *Arabis glabra* (Cruciferae) and *Erysimum capitatum* (Cruciferae), and each is host specific, according to observations at several localities.

#### CHECKLIST OF NEARCTIC ADELINAE

##### NEMOPHORA Hoffmannsegg, 1798

##### **bellela** (Walker, 1863)

*bellella* Walsingham, 1890

*belleta* Anderson, 1915

##### ADELA Latrielle, 1796

##### **bella** Chambers, 1873

*chalybeis* Zeller, 1873

*iochroa* Zeller, 1877

##### **aeruginosella** Walsingham, 1890

##### **ridingsella** Clemens, 1864

*corruscifasciella* (Chambers, 1873)

*schlaegeri* Zeller, 1873

##### **purpurea** Walker, 1863

*biviella* Zeller, 1873

##### **trigrapha** Zeller, 1875

*trifasciella* Chambers, 1876

*fasciella* Chambers, 1876

##### **eldorada** Powell, 1969

##### **flammeusella** Chambers, 1876

*flammensella* Chambers, 1878

*flamensella* Walsingham, 1880

*lactimaculella* Walsingham, 1880

*flammeella* Meyrick, 1912

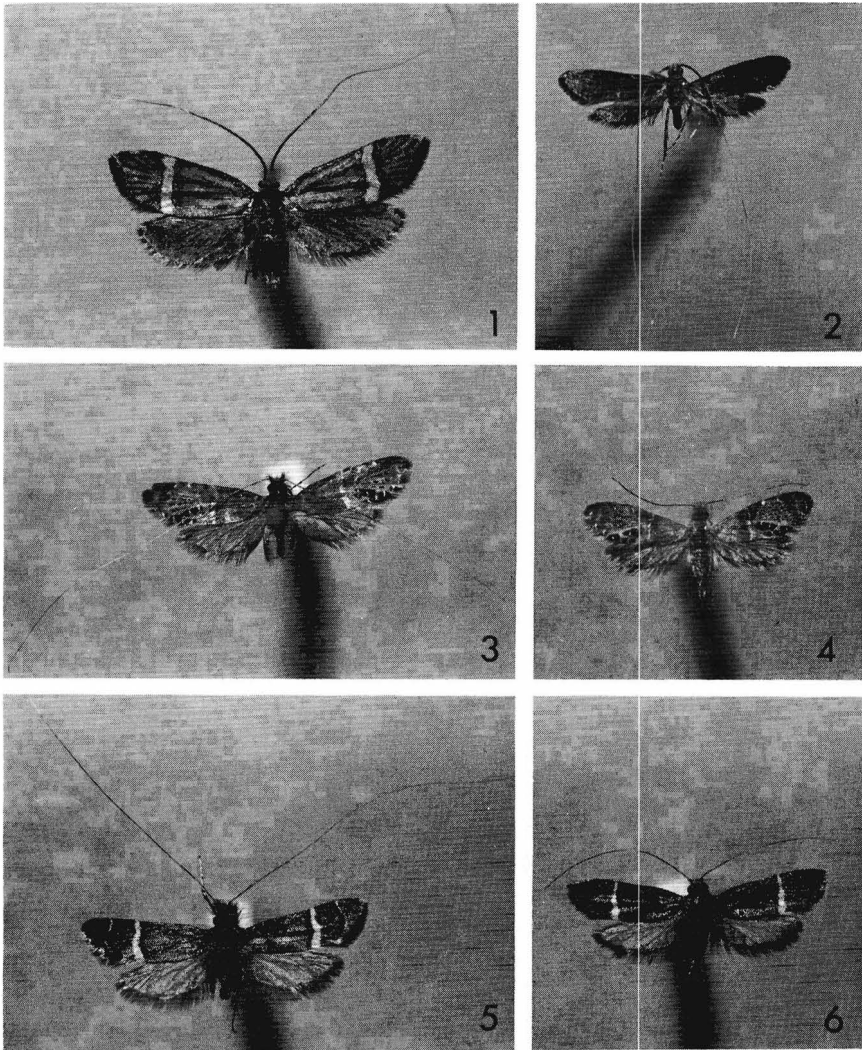
##### **thorpella** Powell, 1969

##### **oplerella** Powell, 1969

##### **septentrionella** Walsingham, 1880

##### **singulella** Walsingham, 1880

##### **punctiferella** Walsingham, 1890

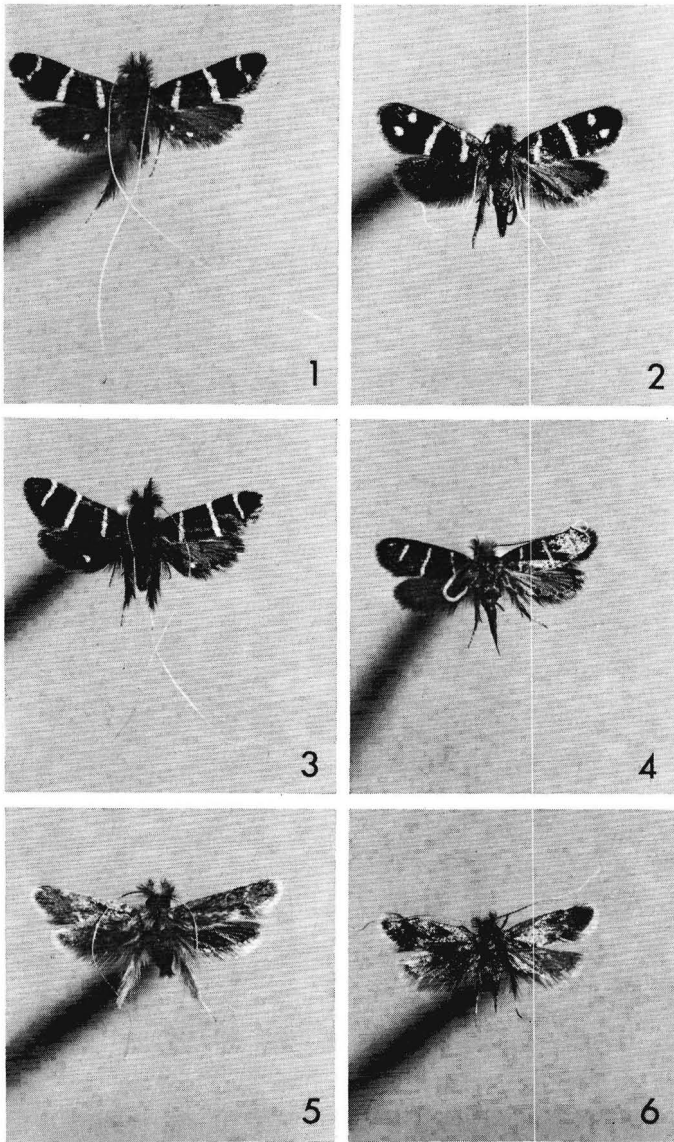


## EXPLANATION OF PLATE 1

Figs. 1-6, adults of adelid moths.<sup>1</sup>

- 1, *Nemophora bellela* (Walker), ♂, Dawson, Yukon, VI-30-49 (W. W. Judd).
- 2, *Adela bella* Chambers, ♂, Anglesea, N. J., V-30 (W. D. Kearfott).
- 3, *A. ridingsella* Clemens, ♂, Lac Mondor, Ste. Flor, Que., VI-22-51 (E. Munroe).
- 4, *A. ridingsella*, ♀, Merivale, Ont., VI-21-43 (G. S. Walley).
- 5, *A. purpurea* Walker, ♂, Constance Bay, Ont., IV-30-33 (G. S. Walley).
- 6, *A. purpurea*, ♀, Merivale, Ont., V-3-38 (T. N. Freeman).

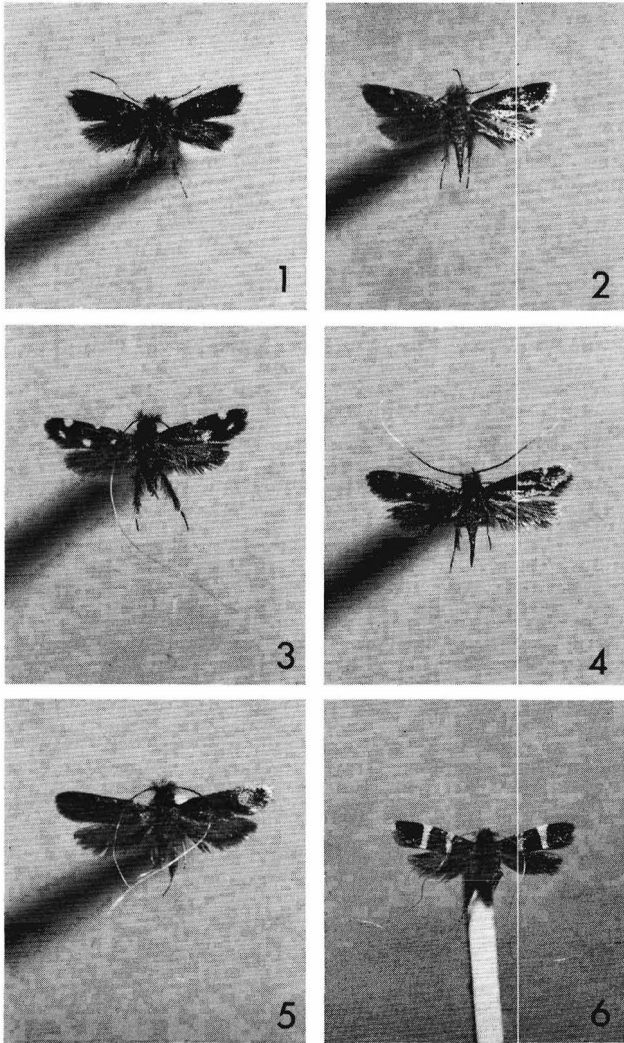
<sup>1</sup> Photographs of the moths are reproduced at approximately 2.3 × natural size.



## EXPLANATION OF PLATE 2

- 1, *A. eldorada* Powell, ♂ holotype, 1 mi. E Woody, Kern Co., Calif., V-3-64.
- 2, *A. eldorada*, ♀ allotype, same data.
- 3, *Adela trigrapha* Zeller, ♂, 9 mi. N Upper Lake, Lake Co., Calif., IV-4-62.
- 4, *A. trigrapha*, ♀, Russelman Park, Contra Costa Co., Calif., V-5-57 (J. Powell).
- 5, *A. thorpella* Powell, ♂, 1 mi. S El Verano, Sonoma Co., Calif., III-25-64 (Thorp).
- 6, *A. thorpella*, ♀, Russelmann Park, Contra Costa Co., Calif., IV-9-58 (J. Powell).

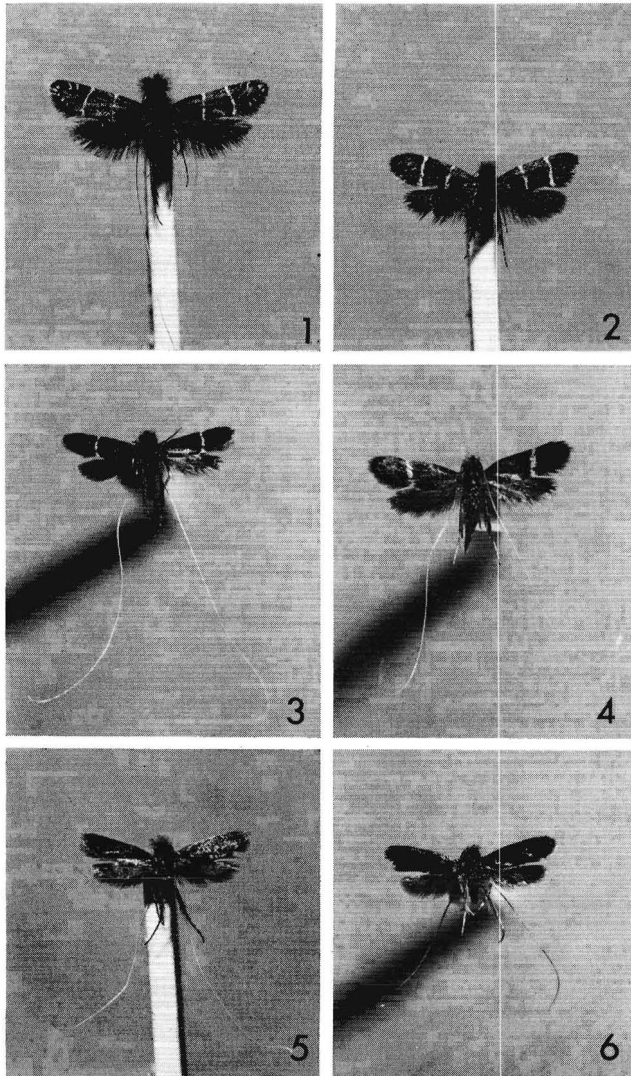




EXPLANATION OF PLATE 3

Figs. 1-6, adults of adelid moths.

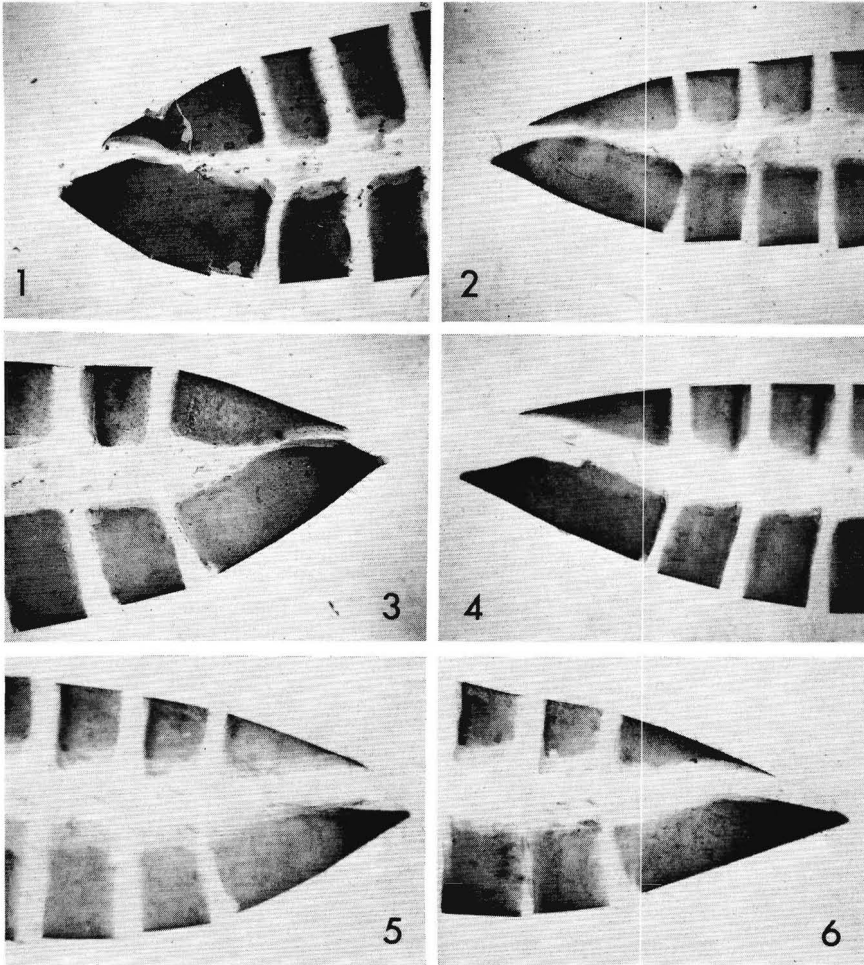
- 1, *Adela oplerella* Powell, ♂, 1 mi. N New Almaden, Santa Clara Co., Calif., IV-4-65 (P. A. Opler).
- 2, *A. oplerella*, ♀, same data, III-29-65.
- 3, *A. flammeusella* Chambers, ♂, 2 mi. SE Upper Lake, Lake Co., Calif., V-11-61.
- 4, *A. flammeusella*, ♀, Silver Cr. hills, Santa Clara Co., Calif., IV-20-62 (J. Powell).
- 5, *A. flammeusella*, ♂, Cool, El Dorado Co., Calif., IV-24-61 (J. Powell).
- 6, *A. septentrionella* Walsingham, ♂ aberrant, 2 mi. W. Fairfax, Marin Co., Calif., IV-17-61 (J. Powell).



EXPLANATION OF PLATE 4

Figs. 1-6, adults of adelid moths.

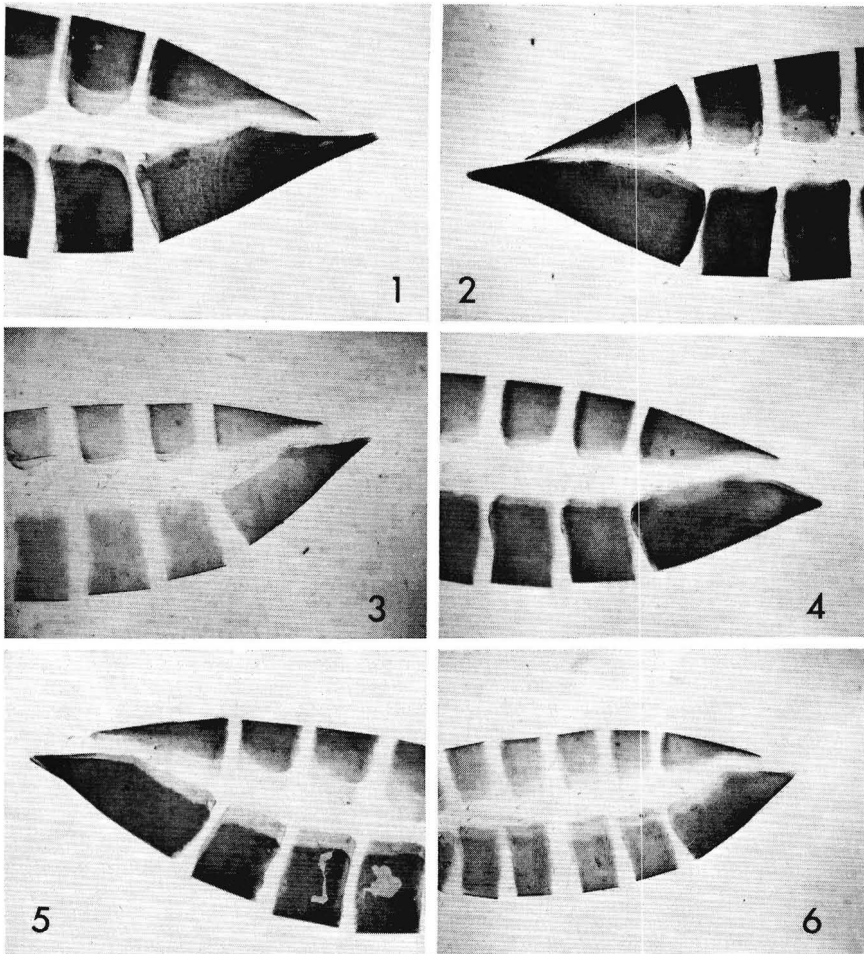
- 1, *Adela septentrionella* Walsingham, ♂, 2 mi W Fairfax, Marin Co., Calif., IV-17-61.
- 2, *A. septentrionella*, ♀, same data.
- 3, *A. singulella* Walsingham, ♂, 5 mi. SW Ukiah, Mendocino Co., Calif., V-22-60 (S. F. Cook, Jr.).
- 4, *A. singulella*, ♀, 7 mi. E Conn Dam, Napa Co., Calif., VI-5-64 (J. Powell).
- 5, *A. singulella*, ♂, La Panza Campgr., S. L. O. Co., Calif., IV-29-62 (R. W. Thorp).
- 6, *A. punctiferella* Walsingham, ♂, 5 mi. S Sage, Riverside Co., Calif., IV-16-65.



## EXPLANATION OF PLATE 5

Figs. 1-6, terminal abdominal segments of female adelid moths.

- 1, *Nemophora bellela* (Walker), Swim Lakes, Yukon, 3200', VI-13-60 (E. W. Rockburne) (JAP prep. 2641).
- 2, *Adela ridingsella* Clemens, Merivale, Ont., VI-21-43 (Walley) (JAP prep. 2642).
- 3, *A. purpurea* Walker, Lac Mondor, Ste. Flore, Que., V-11-51 (E. Munroe) (JAP prep. 2638).
- 4, *A. trigrapha* Zeller, Alpine Lake, Marin Co., Calif., IV-25-58 (J. Powell) (JAP prep. 1806).
- 5, *A. eldorada* Powell, 1 mi. E Woody, Kern Co., Calif., V-3-64 (J. Powell) (JAP prep. 1795).
- 6, *A. flammeusella* Chambers, 3 mi. NW Middletown, Lake Co., Calif. IV-15-64 (L. D. Thurman) (JAP prep. 1791).



## EXPLANATION OF PLATE 6

Figs. 1-6, terminal abdominal segments of female adelid moths.

- 1, *Adela thorpella* Powell, 1 mi. SW Lakeport, Lake Co., Calif., IV-24-63 (R. W. Thorp) (JAP prep. 1802).
- 2, *A. oplerella* Powell, 5 mi. SE Nicasio, Marin Co., Calif., IV-30-67 (P. A. Opler & W. J. Turner) (JAP prep. 2634).
- 3, *A. septentrionella* Walsingham, 2 mi. W Fairfax, Marin Co., Calif., V-13-66 (J. Powell) (JAP prep. 2632).
- 4, *A. singulella* Walsingham (typical), 7 mi. E Conn Dam, Napa Co., Calif. VI-12-64 (J. A. Chemsak) (JAP prep. 1816).
- 5, *A. singulella* (unbanded), 1 mi. S Mather, Tuolumne Co., Calif., VI-12-61 (G. I. Stage) (JAP prep. 1818).
- 6, *A. punctiferella* Walsingham, 4 mi. NW Lodoga, Colusa Co., Calif., IV-12-62 (J. Powell) (JAP prep. 2643).

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## LITERATURE CITED

- BUSCK, A., 1902. Notes on Brackenridge Clemens' types of Tineina. Proc. Ent. Soc. Wash., 5:181-220.
- CHAMBERS, V. T., 1878. Tineina and their food plants. Bull. U. S. Geol. & Geog. Surv., 4(1):107-124.
- DAVIS, D. R., 1967. A revision of the moths of the subfamily Prodoxinae (Lepidoptera: Incurvariidae). U. S. Natl. Mus., Bull. 255:1-170.
- DIKONOFF, A., 1951. Records and descriptions of Microlepidoptera (4). Treubia, 21:133-182.
- ESSIG, E. O., 1941. Itinerary of Lord Walsingham in California and Oregon, 1871-1872. Pan-Pac. Ent., 17(3):97-113.
- FLETCHER, T. B., 1929. A list of the generic names used for Microlepidoptera. India Dept. Agric., Memoirs, Ent. series, XI:1-244.
- FORBES, W. T. M., 1923. The Lepidoptera of New York and neighboring states. Primitive forms, Microlepidoptera, Pyraloids, Bombyces. Cornell U. Agr. Exp. Sta., Mem., 68, 729 pp.
- FORD, L. T., 1949. A guide to the smaller British Lepidoptera. So. Lond. Ent. & Nat. Hist. Soc., London, 230 pp.
- HOGUE, C. L., 1963. A standard method for mounting whole adult Lepidoptera on slides utilizing polystyrene plastic. J. Res. Lepid., 1(3):223-235 ["1962"].
- JACOBS, S. N. A., 1949. The British Lamproliidae and Adelidae. Proc. & Trans. So. Lond. Ent. & Nat. Hist. Soc., 1947-48:209-219.
- JANSE, A. J. T., 1945. Family Adelidae. in: The Moths of South Africa, 4(2): 79-148. E. P. & Commercial, Durban.
- MEYRICK, E., 1912a. Adelidae, Micropterygidae, Gracilariidae. in: Lepidoptorum Catalogus, ed. H. Wagner, pars. 6, 68 pp.
- 1912b. Family Adelidae. in: Genera Insectorum, fasc. 133, 12 pp. 1 pl.
- POWELL, J. A., 1961. Note on *Adela singulella*. in: Proc. Pacif. Coast Ent. Soc., 271st meeting. Pan-Pacif. Ent., 37:63-64.
- SCHÜTZE, K. T., 1931. Die Biologie der Kleinschmetterlinge unter besonderer Berücksichtigung ihrer Nahrungspflanzen und Erscheinungszeiten. Frankfurt-am-Main, Int. ent. ver., 235 pp.
- STANTON, H. T., P. C. ZELLER, J. W. DOUGLAS, AND H. FREY, 1873. The Natural History of the Tineina. Vol. 13, J. Van Voorst, London. 377 pp. + 8 col. pl.
- WALSINGHAM, LORD THOS. DE GREY, 1880. On some new and little known species of Tineidae. Proc. Zool. Soc. Lond., :77-93, 2 pls.
1890. Steps toward a revision of Chambers' Index, with notes and descriptions of new species [cont.]. Insect Life, 2:284-286.
- WEISS, H. B. AND E. WEST, 1925. An adelid gall on Virginia creeper (Lep.). Ent. News, 36:116-118.