The Moths of America North of Mexico

FASCICLE 5.1

SESIOIDEA

Sesiidae

THOMAS D. EICHLIN
and
W. DONALD DUCKWORTH

1988

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Fascicle 20.2A **Bombycoidea,** Saturniidae (part)
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Fascicle 20.2B **Bombycoidea,** Saturniidae (conclusion)
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22 October 1987

Check List of The Lepidoptera of America North of Mexico
30 May 1983

The Moths of America North of Mexico

INCLUDING GREENLAND

FASCICLE 5.1

SESIOIDEA

SESIIDAE

THOMAS D. EICHLIN
INSECT TAXONOMY LABORATORY
CALIFORNIA DEPARTMENT OF FOOD AND AGRICULTURE
SACRAMENTO, CALIFORNIA

W. DONALD DUCKWORTH
BERNICE P. BISHOP MUSEUM
HONOLULU, HAWAII

COLOR PHOTOGRAPHS BY
KJELL B. SANDVED
SMITHSONIAN INSTITUTION

MONOCHROME PHOTOGRAPHS BY
THOMAS D. EICHLIN

DRAWINGS BY
ELAINE R. S. HODGES

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RONALD W. HODGES, EDITOR-IN-CHIEF

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To my boyhood companion
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who long ago inspired and introduced me to my future profession

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SUPERFAMILY
SESIOIDEA

FAMILY
Sesiidae Boisduval

Type genus: *Sesia* Fabricius, 1775.

Sesiariae Boisduval, 1828, *Europaeorum Lepidopterorum Index Methodicus,* 29.

Aegeriidae Stephens, 1829, *A Systematic Catalogue of British Insects,* **2**: 34.

The Sesiidae are a well-defined family of over 1,000 described species that are distributed worldwide except in the coldest zones. Adults are primarily diurnal and strongly mimetic in both appearance and behavior. The degree to which species in this family have become modified structurally and behaviorally to resemble their models, primarily bees and wasps, is truly striking. The development of wasp mimicry by sesiids parallels or surpasses that of the ctenuchine arctiids. The wings are narrow and in most instances partially devoid of scales; the abdomen is commonly banded with orange, yellow, or white and narrowed basally, either by actual constriction or color patterned so as to create an illusion of constriction. In addition, the legs usually are modified to resemble those of the model, even to the extent in some groups of scale tufts tipped with yellow to simulate the pollen gathering devices of bees.

The generally inconspicuous nature of adult sesiids, enhanced by diurnal flight periods and mimicry, results in very poor representation of the family in most collections. Thus, our knowledge of the distribution and abundance of the group at all taxonomic levels is very poor. While the family is better known in the more temperate regions of the world, it is likely that as the fauna of the tropical and subtropical areas is elucidated it will show these regions to be centers of diversity for the family. In North America north of Mexico, 123 species in 20 genera are recognized in the present study. Although the family in North America has been the subject of two extensive monographs during this century (Beutenmüller, 1901; Engelhardt, 1946), there are undoubtably new species yet to be discovered and certainly innumerable life-history investigations remaining to be pursued. Despite the striking mimetic nature of Sesiidae, virtually no studies have been conducted on this aspect of their biology, and most general works on mimicry omit reference to the family.

In preparation for this review of the family north of Mexico and ongoing revisionary studies of the Western Hemisphere Sesiidae (Eichlin, 1986), a classification of the sesiids (Duckworth and Eichlin, 1977c) and of the Sesioidea (Heppner and Duckworth, 1981) were published. New species were described, a genus (*Osminia* Le Cerf) was revised (Duckworth and Eichlin, 1983), and the California clearwing moths were reviewed (Duckworth and Eichlin, 1978).

Since these studies began, chemical sex attractants (pheromones) produced by the female to lure males for mating have been discovered, isolated, analysed, and synthesized in the laboratory. These chemical attractants in various combinations and concentrations or when used singly as baits have been shown to be attractive to males of many clearwing moth species. From several surveys using these chemicals, much new information has been gathered recently and new species discovered. The first substance to be isolated was the major component of the pheromone system of the peachtree borer, *Synanthedon exitiosa,* by Tumlinson et al. (1974), which is Z,Z

3,13-octadecadien-1-ol acetate (hereafter referred to as Z,Z-ODDA or the alcohol as -ODDOH).

NOTE—When the sex attractant is listed in the text as the single compound Z,Z-ODDA or mostly Z,Z-ODDA, the attractant is about 96% Z,Z-ODDA, 3% E,Z-ODDA, and 1% assorted isomers ("impurities").

Next, the major component of the pheromones of the lesser peachtree borer, *S. pictipes,* (E,Z 3,13-ODDA) (usually referred to here as E,Z-ODDA) was synthesized by Yonce et al. (1974). More recently, another effective isomer was isolated from the grape root borer, *Vitacea polistiformis,* (E,Z 2,13-ODDA, which is referred to here in this form to distinguish it from the 3,13 compounds) by Schwartz et al. (1983). Use of these synthetic attractants as baits has led to the discovery of several new species in North America (Duckworth and Eichlin, 1977a, 1977b; Purrington and Nielsen, 1977; Greenfield and Karandinos, 1979; Brown et al., 1985b; and Eichlin, 1986, 1987). A number of undescribed species from the Neotropical Region have been collected using synthetic sex attractants. Regional surveys have been conducted and the results published (Nielsen et al., 1975; Karandinos et al., 1977; Sharp et al., 1978; Nielsen et al., 1979; Sharp and Eichlin, 1979; Solomon, 1979; Reed et al., 1981; Solomon et al., 1982; Neal and Eichlin, 1983; Snow et al., 1985; and Brown and Snow, 1986).

LIFE HISTORY. The larvae are primarily borers in the trunks, bark, stems or roots of trees, shrubs, or vines or in the stems and roots of herbaceous plants. Some species are inquiline borers in galls on woody and herbaceous plants. Although much biological information is known for species that occur in temperate regions, particularly the Nearctic and Palearctic Regions, the life histories of species in tropical and subtropical areas are still very poorly known.

Adults nearly always are diurnal and look and behave like wasps and bees. The season of the year and the time of day for adult emergence and activity depends upon the species. Daily activity periods apparently preferred by most species are the morning hours or late afternoon, usually not the hottest midday hours. About an hour following emergence, the female commences "calling" behavior, which is the act of emitting a sex pheromone to lure males for mating. She usually remains in the vicinity of her host plant, while the active males fly rapidly toward the pheromone source. Oviposition begins soon after mating. The adults are shortlived, surviving a little over one week. Many species visit flowers to obtain nectar, but certain genera have a reduced and nonfunctional haustellum, and, consequently, the adults cannot feed.

The eggs are placed singly on bark crevices or wounds of the host or are dropped near the base of the plant. If the hatchling larvae cannot quickly locate a suitable entry point on the host, they will soon desiccate. Most species seem to have relatively narrow host preferences, with some genera being restricted to one host plant genus or one plant family.

Generally, the larvae feed and construct galleries as they grow within the host from summer through winter to spring. Most species are univoltine, but some require more than one year for development. Our observations indicate that certain species may be able to protract their developmental time during periods of adverse conditions. About a month prior to pupation, the larva constructs an exit tunnel to the surface, leaving a thin layer of plant tissue to conceal the eventual exit hole.

Pupation occurs just prior to the adult flight period, most often in a specially prepared, silk-lined pupal chamber in the larval gallery (sometimes in a silken cocoon incorporating larval frass and wood particles) or in a cell in the adjacent soil (Duckworth and Eichlin, 1978). At emergence, using encircling spines on the abdomen, the mobile pupa moves through the emergence tunnel and breaks through the emergence hole. The pupa protrudes partially through the opening on the surface of the plant, and from this position, the adult emerges, leaving the cast exuvium as evidence that the plant had been host to the borer.

SURVEY OF LARVAL HOST PLANTS OF NORTH AMERICAN SESIIDAE

ACERACEAE

Acer spp.	*Synanthedon acerrubri*
Acer rubrum	*Synanthedon acerni*
Acer saccharinum	*Synanthedon acerni*

AQUIFOLIACEAE

Ilex spp.	*Synanthedon kathyae*

ASTERACEAE

Artemisia sp.	*Carmenta texana*
Aster umbellatus	*Carmenta corni*
Brickellia rusbyi	*Carmenta engelhardti*
Eupatorium album	*Carmenta pyralidiformis*
Eupatorium perfoliatum	*Carmenta pyralidiformis*
Eupatorium serotinum	*Carmenta texana*
Eupatorium sessilifolium	*Carmenta pyralidiformis*
Grindelia sp.	*Carmenta texana*
Helenium autumnale	*Carmenta ithacae*
Heliopsis helianthoides	*Carmenta ithacae*
Hymenoclea monogyra	*Hymenoclea palmii*

Liatris punctata	*Carmenta anthracipennis*
Liatris scariosa	*Carmenta anthracipennis*
Melanthera deltoidea	*Carmenta texana*
Parthenium hysterophorus	*Carmenta ithacae*
Vernonia crinita	*Carmenta bassiformis*
Vernonia noveboracensis	*Carmenta bassiformis*

BETULACEAE

Alnus spp.	*Synanthedon culiciformis*
Alnus rhombifolia	*Synanthedon culiciformis*
Betula spp.	*Paranthrene robiniae*
	Synanthedon culiciformis
	Synanthedon fulvipes
	Synanthedon scitula
Corylus sp.	*Synanthedon scitula*

BORAGINACEAE

Amsinckia sp.	*Carmenta mariona*
Lithospermum incisum	*Carmenta mariona*
Lithospermum ruderale	*Carmenta verecunda*

CAPRIFOLIACEAE

Viburnum spp.	*Synanthedon fatifera*
	Synanthedon viburni
Viburnum dentatum	*Synanthedon viburni*
Viburnum lantana	*Synanthedon viburni*
Viburnum opulus nanum	*Synanthedon fatifera*

CASUARINACEAE

Casuarina equisetifolia	*Synanthedon geliformis*

CORNACEAE

Cornus spp.	*Synanthedon geliformis*
	Synanthedon scitula

CUCURBITACEAE

Cucurbita spp. (and cultivars)	*Melittia calabaza*
	Melittia cucurbitae
Cucurbita digitata	*Melittia gloriosa*
Cucurbita foetidissima	*Melittia grandis*
	Melittia gloriosa
Cucurbita mixta	*Melittia magnifica*
Cucurbita palmata	*Melittia gloriosa*
Marah fabaceus	*Melittia gloriosa*
Marah oreganus	*Melittia gloriosa*

EBENACEAE

Diospyros virginiana	*Sannina uroceriformis*

ERICACEAE

Kalmia latifolia	*Synanthedon rhododendri*
Rhododendron spp.	*Synanthedon rhododendri*

FABACEAE

Mimosa biuncifera	*Carmenta prosopis*
Prosopis spp.	*Carmenta prosopis*
Wisteria sp.	*Synanthedon scitula*

FAGACEAE

Castanea sp.	*Synanthedon scitula*
Castanea dentata	*Synanthedon castaneae*
Fagus sp.	*Synanthedon scitula*
Quercus spp.	*Paranthrene asilipennis*
	Paranthrene simulans
	Synanthedon decipiens
	Synanthedon geliformis
	Synanthedon sapygaeformis
	Synanthedon scitula
Quercus agrifolia	*Synanthedon resplendens*
Quercus arizonica	*Carmenta querci*
Quercus oblongifolia	*Carmenta querci*

JUGLANDACEAE

Carya spp.	*Synanthedon geliformis*
	Synanthedon scitula

LAURACEAE

Persea americana	*Synanthedon resplendens*

LORANTHACEAE

Phoradendron flavescens	*Carmenta phoradendri*
Phoradendron orbiculatum	*Carmenta tecta*

MALVACEAE

Pseudabutilon lozanii	*Zenodoxus palmii*
Sida leprosa var. *hederacea*	*Zenodoxus canescens*
Sidalcea oregana	*Zenodoxus sidalceae*
Sphaeralcea ambigua	*Zenodoxus palmii*
Sphaeralcea incana	*Zenodoxus palmii*
Sphaeralcea munroana	*Zenodoxus palmii*

MYRICACEAE

Myrica cerifera	*Synanthedon scitula*
Myrica pensylvanica	*Synanthedon scitula*

NYSSACEAE

Nyssa sp.	*Synanthedon rubrofascia*

OLEACEAE

Chionanthus virginicus	*Podosesia syringae*
Fraxinus spp.	*Podosesia aureocincta*
	Podosesia syringae
Fraxinus americana	*Podosesia syringae*
Fraxinus caroliniana	*Podosesia syringae*
Fraxinus nigra	*Podosesia syringae*
Fraxinus pennsylvanica	*Podosesia syringae*
Ligustrum sp.	*Podosesia syringae*
Olea europaea	*Podosesia syringae*
Syringa vulgaris	*Podosesia syringae*

ONAGRACEAE

Epilobium angustifolium	*Albuna pyramidalis*
Epilobium latifolium	*Albuna pyramidalis*
Gaura michauxii	*Euhagena emphytiformis*
Oenothera avita	*Euhagena nebraskae*
Oenothera biennis	*Albuna pyramidalis*

PINACEAE

Picea abies	*Synanthedon pini*
Picea engelmannii	*Synanthedon novaroensis*
Picea glauca	*Synanthedon pini*
Picea sitchensis	*Synanthedon novaroensis*
Pinus sp.	*Synanthedon scitula*
Pinus banksiana	*Synanthedon pini*
Pinus contorta	*Synanthedon novaroensis*
	Synanthedon sequoiae
Pinus lambertiana	*Synanthedon sequoiae*

Pinus monticola	*Synanthedon novaroensis*
Pinus muricata	*Synanthedon sequoiae*
Pinus ponderosa	*Synanthedon sequoiae*
Pinus radiata	*Synanthedon sequoiae*
Pinus strobus	*Synanthedon pini*
Pinus sylvestris	*Synanthedon pini*
Pseudotsuga menziesii	*Synanthedon novaroensis*
PLATANACEAE	
Platanus racemosa	*Synanthedon resplendens*
POLEMONIACEAE	
Leptodactylon pungens hallii	*Synanthedon polygoni*
POLYGONACEAE	
Eriogonum compositum	*Synanthedon polygoni*
Eriogonum fasciculatum	*Synanthedon polygoni*
Eriogonum gracile	*Synanthedon polygoni*
Eriogonum inflatum	*Synanthedon polygoni*
Eriogonum latifolium sulphureum	*Synanthedon polygoni*
Eriongonum parvifolium	*Synanthedon polygoni*
Eriogonum wrightii	*Synanthedon polygoni*
Polygonum sp.	*Synanthedon chrysidipennis*
Polygonum davisiae	*Synanthedon chrysidipennis*
Polygonum paronychia	*Synanthedon polygoni*
RANUNCULACEAE	
Clematis ligusticifolia	*Alcathoe autumnalis*
	Alcathoe pepsioides
	Alcathoe verrugo
Clematis virginiana	*Alcathoe caudata*
RHAMNACEAE	
Berchemia scandens	*Synanthedon scitula*
Ceanothus thyrsiflorus	*Synanthedon mellinipennis*
ROSACEAE	
Crataegus sp.	*Synanthedon scitula*
Cydonia oblonga	*Synanthedon scitula*
Fragaria sp.	*Synanthedon bibionipennis*
Malus spp.	*Synanthedon pictipes*
	Synanthedon pyri
	Synanthedon scitula
Physocarpus opulifolius	*Synanthedon scitula*
Potentilla sp.	*Synanthedon bibionipennis*
Prunus spp.	*Synanthedon exitiosa*
	Synanthedon pictipes
	Synanthedon pyri
	Synanthedon scitula
Prunus serotina	*Synanthedon pictipes*
	Synanthedon scitula
Prunus virginiana var. *demissa*	*Synanthedon exitiosa*
Pyrus sp.	*Synanthedon pyri*
Rosa sp.	*Synanthedon bibionipennis*
Rubus spp.	*Pennisetia marginata*
	Synanthedon bibionipennis
	Synanthedon tipuliformis
Sorbus sp.	*Synanthedon scitula*
SALICACEAE	
Populus spp.	*Paranthrene dollii*
	Paranthrene robiniae
	Paranthrene tabaniformis
	Sesia apiformis
	Sesia tibialis
Populus alba	*Sesia tibialis*
Populus candicans	*Sesia tibialis*
Populus deltoides	*Sesia tibialis*
Populus fremontii	*Sesia tibialis*
Populus nigra	*Sesia apiformis*
Populus tremuloides	*Sesia tibialis*
Populus trichocarpa	*Sesia tibialis*
Salix spp.	*Paranthrene dollii*
	Paranthrene robiniae
	Paranthrene tabaniformis
	Sesia apiformis
	Sesia tibialis
	Synanthedon albicornis
	Synanthedon bolteri
	Synanthedon proxima
	Synanthedon scitula
Salix tristis	*Synanthedon sigmoidea*
SAXIFRAGACEAE	
Ribes spp.	*Synanthedon tipuliformis*
SCROPHULARIACEAE	
Linaria genistifolia dalmatica	*Penstemonia clarkei*
Penstemon breviflorus	*Penstemonia dammersi*
Penstemon centranthifolius	*Penstemonia edwardsii*
Penstemon cordifolius	*Penstemonia dammersi*
Penstemon palmeri	*Penstemonia pappi*
Penstemon parishii	*Penstemonia hennei*
Penstemon parryi	*Penstemonia edwardsii*
Penstemon richardsonii	*Penstemonia clarkei*
Penstemon spectabilis	*Penstemonia dammersi*
	Penstemonia hennei
Penstemon ternatus	*Penstemonia dammersi*
SOLANACEAE	
Chamaesaracha coronopus	*Carmenta mimuli*
Solanum carolinense	*Synanthedon rileyana*
VITACEAE	
Cissus incisa	*Cissuvora ampelopsis*
Parthenocissus quinquefolia	*Albuna fraxini*
	Vitacea scepsiformis
Parthenocissus tricuspidata var. *veitchii*	*Vitacea scepsiformis*
Vitis spp.	*Vitacea polistiformis*
Vitis labrusca	*Vitacea polistiformis*

DESCRIPTION AND CHARACTERS. The sesiids are small to relatively large moths with a forewing length ranging from 5–30 mm. The general body form and patterns are highly modified, apparently the evolutionary results of positive selective advantages to resemble closely various aculeate Hymenoptera.

Structural features of adult Sesiidae are as follows: Head (text figure 1) with compound eyes relatively

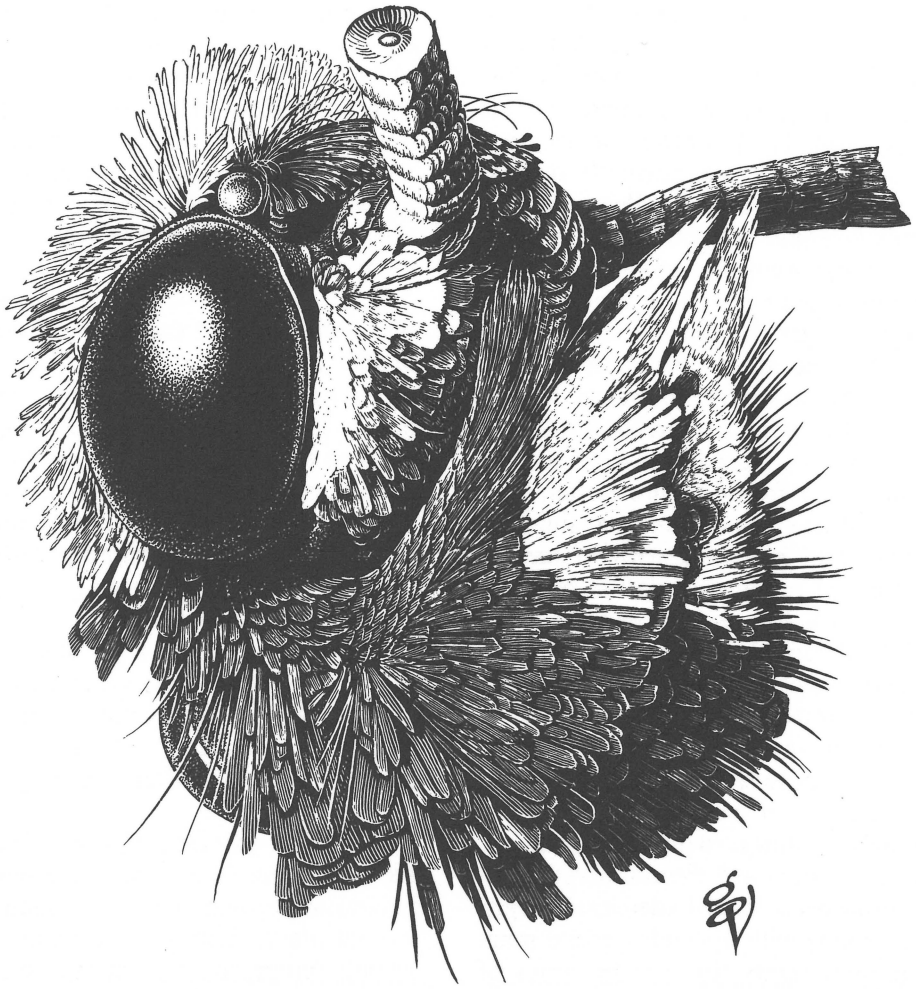

FIGURE 1: FRONTOLATERAL VIEW OF HEAD OF *PARANTHRENE TABANIFORMIS*

large compared to vertical height of front, range about 0.6–2.2 ("eye index," Powell, 1973: 8), naked and outlined with short broad white or yellow scales; ocelli present and prominent; haustellum naked, most often three to four times length of labial palpus, functional, but rudimentary and nonfunctional in some genera; labial palpus upcurved, long, usually approaching or exceeding top of front, either thickened and roughened in appearance by slender projecting scales or slender and smooth in appearance with short broad appressed scales, first segment slightly more than ½ length of second, which is generally the longest segment, third segment varying from ⅓ to subequal the length of second segment, depending on the species; maxillary palpus minute, one to three segmented, most species with variations involving two segments; pilifers with strong spinelike setae of varying lengths; mandibles small, flattened and somewhat hatchet shaped; antenna of most species variously clavate, tapered to point apically, terminated by small unique scale tuft, males ciliate ventrally, pectinate ciliate in certain groups, females lacking ciliation ventrally; front smooth, often white laterally; vertex generally smooth, scales often overlapping front, chaetosemata apparently present posteriorly at least in certain groups; margin of head with occipital fringe of erect thin contrastingly colored scales. Thorax on dorsoanterior region of preepimeron with unique baglike protuberance on all species except those of the Tinthiinae; many species with pale-yellow or white, narrow, subdorsal, longitudinal stripe above wing bases and brightly colored patch beneath wings. Abdomen generally elongate, slender, tapering posteriorly, often variously narrowed at base, most often variously transversely banded with white, yellow, orange, or red, these patterns often varying interspecifically, intraspecifically, and between sexes of the same species; males

with an anal scale tuft, capable of spreading out like a fan, but on females reduced and brushlike, tuft originating from dorsolateral sclerites on posterior abdominal tergite (illustrated in Naumann, 1971; Duckworth and Eichlin, 1983). Legs elongate, slender, though often variously tufted, normally at tibial spurs and first tarsal segment of hindleg, which is elongate, generally ½ length of tibia. Forewing elongate, narrow, varying according to species from mostly hyaline with prominent discal spot to completely opaque (see Fibiger and Kristensen, 1974 for nomenclature of hyaline areas); venation of forewing generally with R having five branches, R_4 and R_5 usually stalked; M with three branches; CuA with two branches; anal veins reduced or lost. Hindwing shorter and broader than forewing, most often hyaline but opaque in some species; frenulum single in both sexes; venation of hindwing with M having three widely separated branches; relative position of bases of M_3 and CuA_1 to crossvein dependent on group; anal veins with CuP degenerate (superficially indicated by line of scales in wing fold), present to varying degrees in primitive groups, 1A present, 2A either short, fused to near base of 1A, or absent, 3A present except in primitive groups. Fore- and hindwings held together to facilitate moth's characteristic rapid flight by unique wing-locking mechanism (in addition to standard frenulum/retinaculum system), resulting from down-folded hindmargin of forewing interlocking with up-folded costal margin of hindwing, held firmly together by series of interlocking recurved spinelike setae on both folds, this wing coupling device being similar to that of aculeate Hymenoptera. Male genitalia with uncus simple in primitive groups or more often modified and/or fused with tegumen, with lateral setaceous pads or apically with socii composed of paired, elongate, tapered dorsoanteriorly projecting, membranous sacs (scopula androconialis) clothed with specialized bifurcate setae; gnathos absent or present in various forms; tegumen simple, or reduced, or modified and fused with uncus; vinculum somewhat ring shaped, extended anteriorly as saccus variable in length and width; valva varying from small and quadrangular to elongate and slender, with either simple setae or combination of simple setae of varying shapes and sizes and arrangements of bifurcate or multifurcate setae; specialized saccular ridge (crista sacculi) present or absent; aedoeagus generally elongate, very slender, slightly bulbous at base. Female genitalia with papillae anales generally small and narrow; ostium bursae situated ventrally between sclerites of abdominal segment eight, in intersegmental membrane between segments seven and eight, or on posterior margin of abdominal segment seven; ductus bursae most often elongate, narrow, with sclerotization for the most part confined to posterior portion; ductus seminalis originates from various points along ductus bursae, most often toward posterior end; corpus bursae generally small, obovate and membranous, with convolutions or signa in some species.

Kristensen (1974), in his detailed investigation of sesiid scales, found that for the family in general the opaque areas of the wings are typically a multilayered covering of scales, with the upper layer colored but the lower layer of scales only slightly pigmented, without trabeculated lumen, with more or less reduced perforation and fairly even apical margin. The transparent areas result from the following types of modifications: pigmented covering scales may be lost, while the lower layer remains as transparent scales; covering scales and lower transparent scales both lost; or the lower layer of scales is missing and the pigmented covering scales are mostly deciduous, resulting from modification of the base of the deciduous scale. In the latter case, the deciduous scales are shed very soon after or during adult emergence.

IMMATURE STAGES. Eggs of various sesiid groups have differing forms but are generally pale brown to chestnut brown, ovate, disc shaped, flat, or slightly concave dorsally and ventrally, with the surface usually sculptured with minute shagreening in hexagonal designs. Scanning electron micrographs of the eggs of at least one species of all but four (*Sophona, Palmia, Podosesia,* and *Alcathoe*) of the 20 genera treated here are shown on plates A and B. No comparative studies have been made or taxonomic conclusions attempted, based on sesiid egg morphology, because the eggs of too few species have been examined.

Sesiid larvae, being true borers, lack body color or pattern and generally share characters common to boring larvae of other superfamilies or even other orders. MacKay (1968a) defined clearwing moth larvae in the following manner: "larva a borer; body pale and without pattern except on prothoracic shield, and thoracic segments often enlarged; head with ocelli I–IV arranged in a trapezoid and remote from ocelli V and VI, and vertical angle usually deep and acute; three setae in the lateral group on the prothorax; L1 on meso- and metathorax on its own pinaculum about equidistant from SD1 and L2, with L3 closer than SD1 or L2 to L1 and posterior and usually somewhat dorsal to it; L1 and L2 always

adjacent on abdominal segments 1–8; crochets uniserial and arranged in two transverse bands (except in some specimens of *Bembecia* [=*Pennisetia*])."

The pupa is highly modified to aid in extricating itself from the larval chamber within the host plant or from beneath the soil. Abdominal segments 3–10 are freely movable, with double rows of posteriorly projecting spines on segments 2–6, also on 7 of the male, and a single row on the remaining segments, and with large broad spines posteroventrally on segment 10 (no cremaster). Maxillary palpi are present, and there are special sharp prominences on the head, such as a chisellike process on the clypeus (see Mosher, 1916).

CLASSIFICATION. Heppner and Duckworth (1981) discussed in depth the classification of the superfamily Sesioidea, which includes three families: Brachodidae, Choreutidae, and Sesiidae. Previously, we had presented our classification scheme for the Sesiidae of America north of Mexico (Duckworth and Eichlin, 1977c). Both of the above references reviewed the literature and presented changes, and, except for subsequently discovering species of the genus *Sophona* occurring in the fauna covered here, no changes have been made to the higher classification.

The 123 species of Sesiidae treated here are placed in three subfamilies, eight tribes (tribe Synanthedonini, with 86 species, accounts for 70 percent of the fauna), and 20 genera. Genital structure forms a major basis for the classification, with wing venation and specific structures of the head and thorax important, especially in defining the highest categories.

The 41 species of *Synanthedon* are grouped in the text on the basis of similarities in the genitalia and are not listed alphabetically as are the species in other genera. The subgroupings of *Synanthedon* basically correspond to several genera that were used by previous workers, more recently Engelhardt (1946) and Naumann (1971). Because our studies convinced us that the categories had no concordance with other sesiid genera, were defined only on a few genitalia features, and these character states often overlapped from one taxon to another, we placed those "genera" under *Synanthedon* (Duckworth and Eichlin, 1977c: 31).

Engelhardt (1946) presented many trinomials and referred to most of them as "races." Several other trinomials were called "forms," and a few were called "varieties." We are unable to discern why he made these distinctions. Further, because there are so many gaps in our knowledge of the distributions, geographic patterns, and range of variation among the species, we feel it is inappropriate to apply trinomials (subspecies) at this time to any North American sesiid. Therefore, we uniformly treat most of Engelhardt's trinomials (if they are distinctive enough to note) as color forms, placing the name in italics and in quotes, e.g. *Synanthedon polygoni* color form "*animosa,*" so the names will not be mistaken for subspecies.

The higher classification of the Sesiidae of America north of Mexico is as follows:

FAMILY **SESIIDAE**

SUBFAMILY **Tinthiinae**

TRIBE **Pennisetiini**
Pennisetia

TRIBE **Tinthiini**
Sophona *Zenodoxus*

SUBFAMILY **Paranthreninae**

TRIBE **Cissuvorini**
Cissuvora

TRIBE **Paranthrenini**
Paranthrene *Albuna*
Vitacea *Euhagena*

SUBFAMILY **Sesiinae**

TRIBE **Melittiini**
Melittia

TRIBE **Osminiini**
Calasesia *Osminia*

TRIBE **Sesiini**
Sesia

TRIBE **Synanthedonini**
Synanthedon *Carmenta*
Palmia *Penstemonia*
Podosesia *Alcathoe*
Sannina *Hymenoclea*

KEY TO THE SUBFAMILIES OF SESIIDAE

1. Scale tuft at tip of antenna absent; forewing with veins R_4 and R_5 separate, or if stalked then M_3 absent; hindwing with CuP partially or fully developed, 2A and 3A absent; posterior margin of head without chaetosemata . . . . . Tinthiinae p. 16

— Scale tuft at tip of antenna present; forewing with veins R_4 and R_5 stalked, M_3 present; hindwing with CuP degenerate, 2A present and

free or partially joined to 1A, 3A present; posterior margin of head with chaetosemata 2

2. Hindwing with vein 2A free; CuA_1 arising distad of crossvein, or if arising at or basad of crossvein, then forewing with stalk of R_4 plus R_5 not more than ½ length of R_4 or R_5, or R_4 and R_5 coincident ..... Sesiinae p. 49

— Hindwing with veins 1A and 2A coincident except near base; CuA_1 arising basad of crossvein, or if arising at or distad of crossvein, then forewing with stalk of R_{4+5} greater than ½ length of R_4 or R_5, or R_{4+5} stalked with R_3 ..... Paranthreninae p. 26

SUBFAMILY

Tinthiinae Le Cerf

Tinthiinae Le Cerf, 1917, *in* Oberthür, *Études de Lépidoptérologie Comparée,* **14**: 148.
Type genus: *Tinthia* Walker, 1864.

Bembeciinae: of Niculescu, 1964, *Linneana Belgica,* **3**: 42.
Type genus: *Bembecia,* of authors (not Hübner, 1819), considered to be a synonym of *Pennisetia* Dehne, 1850.

Zenodoxinae MacKay, 1968, *Mem. Ent. Soc. Canada,* **58**: 5.
Type genus: *Zenodoxus* Grote and Robinson, 1868.

The Tinthiinae are the smallest group in the family and exhibit the least specialized condition in most characters. The subfamily occurs throughout the world but appears to be most abundant in the eastern Oriental Region. In America north of Mexico, the group is represented by 10 species in three genera.

The Tinthiinae are distinguished by the following combination of characters: Hindwing with CuP present, 1A, 2A, 3A coincident (text figure 2); eyes smallest in the family (index range: 0.7–0.8); antenna filiform or bipectinate, never clavate, without terminal scale tuft; maxillary palpus one segmented; thorax without baglike protuberance on preepimeron; male genitalia with valva lacking saccular ridge and specialized setae, gnathos absent, uncus simple, slightly bifurcate apically, sparsely clothed with variable-lengthed setae; scales forming anal tuft in males arising from weakly differentiated, narrow band on abdominal segment eight, usually not from well-defined sclerites. The larvae have the following characters in common; head with seta P2 unmodified, at least as long as A2; segment eight with L1 and L2 pinacula as far below the spiracle as on preceding segments; L2 on segment nine often on a common pinaculum with L1.

The larvae are borers in the roots and basal stalks of the host plants, which, in our area, consist of various species of *Rubus* (Rosaceae) by species of *Pennisetia* and mallows (Malvaceae) by species of *Zenodoxus.* Larval foods of *Sophona* are unknown.

KEY TO THE TRIBES OF TINTHIINAE

1. Forewing with veins R_4 and R_5 long stalked .. .. Pennisetiini p. 16

— Forewing with veins R_4 and R_5 separate .. Tinthiini p. 19

TRIBE

Pennisetiini Naumann

Pennisetiini Naumann, 1971, *Bonner Zoologische Monographien,* **1**: 55.
Type genus: *Pennisetia* Dehne, 1850.

This tribe is represented in North America by a single genus, *Pennisetia.*

Distinctive characters of the tribe are as follows: forewing with veins R_4 and R_5 long stalked, M_3 coincident with M_2; hindwing with M_3 and CuA_1 long stalked (text figure 3 *a*); male antenna ciliate, often strongly bipectinate (text figure 3 *b*); maxillary palpus one segmented, well sclerotized, without setae; eye relatively small (index 0.77–0.80).

GENUS

Pennisetia Dehne

Pennisetia Dehne, 1850, *Stettiner Ent. Zeit.,* **11**: 28.
Type species: *Pennisetia anomala* Dehne, 1850, now considered to be a junior synonym of *Sesia hylaeiformis* Laspeyres, 1801.

NOTE—Engelhardt's (1946: 191) usage of *Bembecia* Hübner, 1819, with *Sesia hylaeiformis* Laspeyres as the type species, has been documented as incorrect by Naumann (1971: 56, 92). *Bembecia scopigera* Scopoli was fixed as the type species of *Bembecia* by Newman *in* Westwood, 1840, *Synopsis of the Genera of British Insects,* **2**: 89. *Bembecia* is thus a sesiine genus, and *S. hylaeiformis* is the type species of *Pennisetia.* Naumann (1971) showed that *P. anomala* is a junior synonym of *S. hylaeiformis.*

Pennisetia is represented by a single species in America north of Mexico. Another species is known

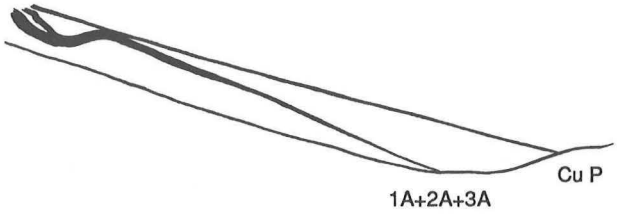

FIGURE 2: ANAL VEINS OF HINDWING OF TINTHIINI (*XENODOXUS PALMII*) (USNM 75842)

from Mexico and Central America. Structural characters of the genus are as follows: haustellum relatively short, approximately 1½ the length of the labial palpus; male antennae bipectinate in North American species. Wings mostly hyaline; hindwing with M_3 and CuA_1 characteristically long stalked. Scales of anal tuft of male arise from weakly sclerotized, narrow band on abdominal segment eight obliquely positioned on the tergite. Male genitalia with valva short and wide, approximately as wide as long, broadly rounded apically, clothed evenly with soft, pale, setaceous scales; anellus a wide, elongate, sclerotized cylinder covered with small setae ventrally, membranous dorsally with two scobinate concavities dorsobasally and two dorsoapically; saccus short, wide basally, tapering to bluntly pointed apex; uncus wide, slightly curved with two lobes at apex sparsely clothed with setae of various lengths; aedoeagus relatively straight, thick, sclerotized, often with a well-sclerotized spine on the apical third, surface of the vesica covered with minute spines. Female genitalia with ductus bursae sclerotized, somewhat flattened from ostium bursae, becoming wide and membranous, looping 180° (text figure 3 *c*) before reaching corpus bursae; corpus bursae obovate, without signum.

Pennisetia marginata (Harris) (Raspberry Crown Borer*; Rhizophage du Framboisier, m., Fr.)

PL. 1, FIGS. 1–3; PL. A, FIG. 1. TEXT FIG. 3 *a–c* (RWH 2513).

Trochilium marginatum Harris, 1839, *Amer. Jour. Arts and Sci.* **36**: 309.
Type locality: New Hampshire. [MCZ]

Aegeria pleciaeformis Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 40.
Type locality: Nova Scotia. [BMNH]

Aegeria odyneripennis Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 42.
Type locality: Nova Scotia. [BMNH]

Aegeria rubi Riley, 1874, *Annual Report of the State Board of Agriculture [Missouri] (1873),* **9**: 111.
Type locality: Missouri. [USNM]

Sesia flavipes Hulst, 1881, *Bull. Brooklyn Ent. Soc.,* **3**: 76.
Type locality: Brooklyn, New York. [AMNH]

Bembecia marginata variety *albicoma* Hulst, 1883, *Bull. Brooklyn Ent. Soc.,* **6**: 9.
Type locality: Brooklyn, New York. [AMNH]

This species is closely related to *hylaeiformis* Laspeyres, a European species, both in superficial resemblance and habits. However, due to several minor but consistent differences in the male genitalia, it has been maintained as a distinct North American species (Eichlin, 1986).

Male: Head with vertex dark brown; front dark brown with pale yellow laterally and ventrally; occipital fringe yellow dorsally and white laterally; labial palpus roughened and pale yellow; antenna dark brown, sometimes shaded with yellow dorsoapically. Thorax dark brown with two narrow subdorsal streaks of yellow anteriorly, narrow yellow bands laterally from anterior margin of wings, curving dorsally over base of wings, long tufts of yellow hairlike scales laterally posteriad of wings, and yellow spot subventrally. Abdomen dark brown with each segment ringed with yellow on posterior margin except for segments one and two on which yellow is on anterior half or absent. Anal tuft dark brown mixed with yellow. Legs usually yellow, occasionally femora dorsally and basal half of tibiae dark brown. Tibia and first tarsal segment of hindlegs strongly roughened dorsally, less so ventrally, because of erect hairlike scales. Wings mostly hyaline, with forewing marked with brown scales only on costal and anterior margins, discal spot, veins, and fringe. Yellow powdering may be on anterior margin basally. Females marked essentially the same as males except

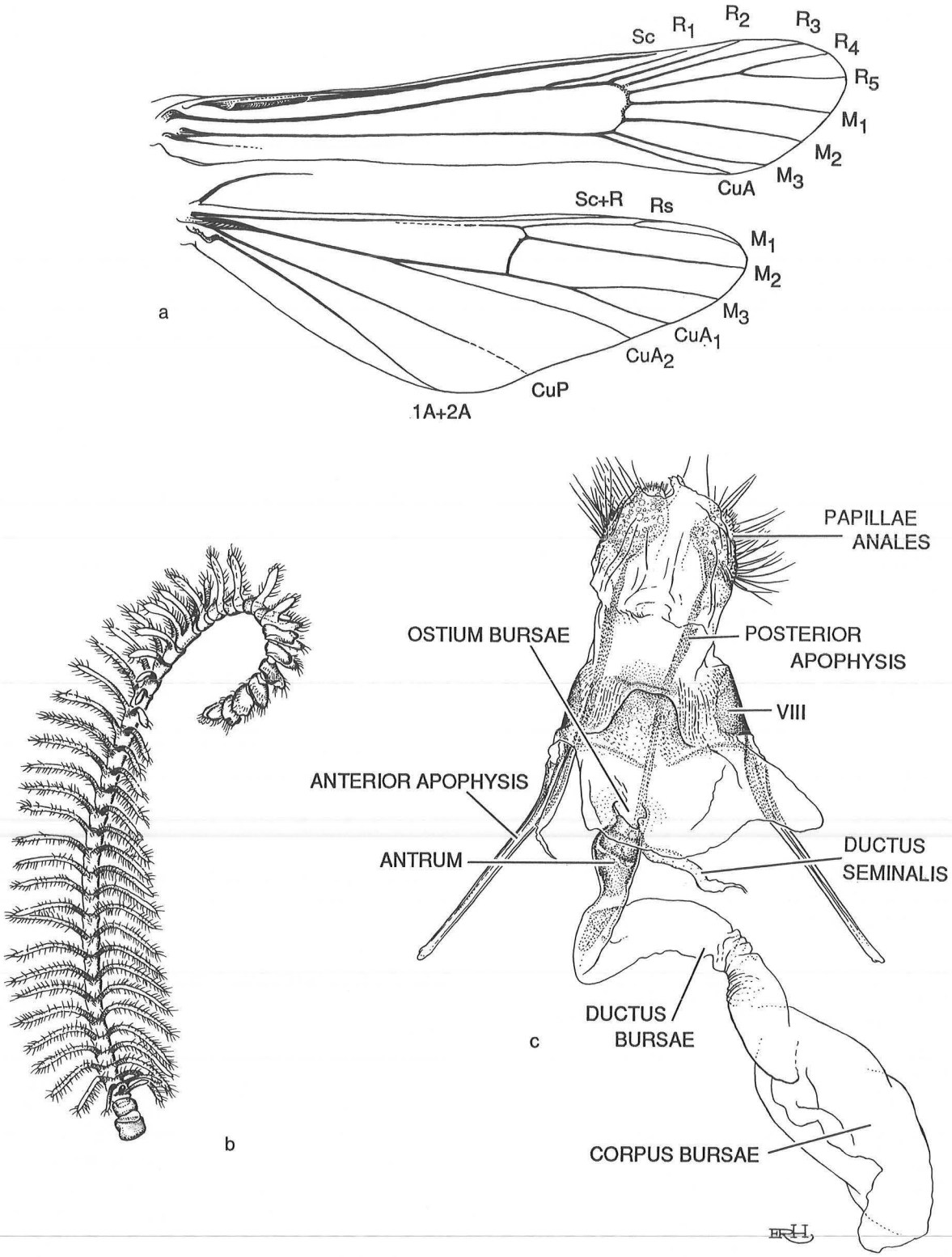

FIGURE 3: STRUCTURES OF PENNISETIINI

a–c. Pennisetia marginata, a. Venation (USNM 75829); *b.* Ventral view of male antenna (USNM 75895); *c.* Female genitalia (USNM 75830).

wings sometimes with more scaling that often is orange brown. Terminal segment of abdomen is yellow, lacking definite anal tuft.

The form "*albicoma*" fits the description above except the brighter yellow is replaced with pale yellow or white, and the legs are primarily brown black on the outer surfaces. Wing length 8–16 mm, with the males generally smaller than the females.

Adults have been reared from *Rubus* species (Rosaceae), including blackberry and raspberry. After mating, the adult female oviposits on the host plant in late summer. The hatchling larvae form small hibernacula on the sides of canes at or just below soil level in which they overwinter. In the spring the small larvae feed on buds and shoots of fruiting canes arising from the crown. That summer, the late instar larvae often girdle the plant stems above ground level, frequently causing the plant to wilt or break off. Though some may complete development at this time, most overwinter a second year in the base of young canes. Fully developed larvae in the crown prepare exit and pupal chambers a short distance into the fruiting canes. The pupal stage may last up to one month. Upon emergence in July through October, the adults fly actively around patches of brambles on sunny days (see Breakey, 1963). According to Engelhardt (1946: 193), the adults in flight are very similar in behavior and appearance to common "yellow-jacket" wasps. Solomon et al. (1982) captured males in traps baited with sex attractant (E,Z-ODDOH).

This species is widespread in North America with numerous records from throughout the United States in the region east of the Mississippi River as far south as Florida (Brown and Snow, 1985) and the Pacific Coast states. There are only a few scattered records from the Rocky Mountain area and Great Plains region. In Canada, *marginata* is known from Newfoundland, Nova Scotia, Quebec, Ontario, and British Columbia.

TRIBE

Tinthiini Le Cerf

Tinthiinae Le Cerf, 1917, *in* Oberthür, *Études de Lépidoptérologie Comparée,* **14**: 148.
Type genus: *Tinthia* Walker, 1864.

Zenodoxini MacKay, 1968, *Mem. Ent. Soc. Canada,* **58**: 5.
Type genus: *Zenodoxus* Grote and Robinson, 1868.

This tribe is represented in North America north of Mexico by two genera, *Sophona* and *Zenodoxus.*

Distinctive characters of the tribe are as follows: forewing with veins R_4 and R_5 separate; hindwing with vein CuA_1 arising well basad of the crossvein; antenna filiform, ciliated ventrally on males; maxillary palpus one segmented; eye small, index 0.67–0.90.

KEY TO THE GENERA OF TINTHIINI

1. Haustellum reduced, shorter than labial palpus ..... *Zenodoxus* p. 21
— Haustellum normal, longer than labial palpus ..... *Sophona* p. 19

GENUS

Sophona Walker

Sophona Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 60.
Type species: *Sophona halictipennis* Walker, 1856. Monotypy.

Myrmecosphecia Le Cerf, 1917, *Études de Lépidoptérologie Comparée,* **14**: 374.
Type species: *Myrmecosphecia lemoulti* Le Cerf, 1917. Original designation.

Bombosceles Meyrick, 1930, *Ann. Naturhistorischen Museums in Wien,* **44**: 260.
Type species: *Bombosceles cyanomyia* Meyrick, 1930. Monotypy.

Ficivora Clarke, 1962, *Proc. U. S. Natl. Mus.,* **113**: 383.
Type species: *Ficivora leucoteles* Clarke, 1962. Original designation.

This New World, mostly tropical, genus contains small species about which little or nothing is known regarding their habits. Only two species of *Sophona* (from southeastern Arizona and adjacent New Mexico) are known from America north of Mexico. Twenty-two other species of *Sophona* are found from Mexico through South America (Eichlin, 1986: 329).

The species of *Sophona* have a developed haustellum, whereas the haustellum is much reduced in the following genus *Zenodoxus.* Head and eyes relatively small (eye index 0.67–0.90), most species falling near median of this range. Labial palpus short and rough scaled. Unlike *Zenodoxus,* several species of *Sophona* have fore- and hindwings mostly hyaline, at least in the male, while others, as with *Zeno-*

doxus species, are mostly or entirely opaque on one or both pairs of wings; females of a given species often are more nearly opaque. Venation of the wings is like that of *Zenodoxus.* As with the latter genus, the male genitalia are proportionately small overall; valves short, rounded apically and clothed with simple setae; saccus broad and tapering to a rounded apex; uncus varying in length from a short, reduced setose knob to a long, slender, curving setose rod, lacking a terminal hook or other such structure; and aedoeagus proportionately long, curved, sharply pointed apically, and usually without much of a basal extension such as is typical for *Zenodoxus.* Female genitalia vary more among species than do the male genitalia, with ductus bursae short, as for *Zenodoxus,* or long and with a signum of various forms, depending on the species.

Essentially nothing is known of the early stages or habits of the species, and, apparently, more species remain to be discovered, especially in the Neotropical Region.

KEY TO THE SPECIES OF *SOPHONA*

1. Abdomen banded with yellow and orange red ..... *snellingi* p. 20
— Abdomen unbanded, orange with dorsal horizontal brown stripe ..... *greenfieldi* p. 20

Sophona greenfieldi Eichlin

PL. 3, FIG. 1.

Sophona greenfieldi Eichlin, 1986, *Entomography,* **4**: 347.
Type locality: Kitt Peak, Baboquivari Mts., 5,800′, Pima Co., Arizona. [USNM]

The dark-brown opaque wings and orange body with broad brown dorsal stripe of this small unique tinthiine superficially appear like a dwarf of the sesiine *Melittia snowii.* Because the specimens were collected in traps baited with sex attractants, only the male is known.

Head structures unicolorous, brown; labial palpus relatively short, ventrally flattened, orange with brown ventrally and apically. Thorax brown with broad orange subdorsal stripe, extending from, but not including, collar and over wing bases to abdomen. Abdomen orange but with broad brown dorsal stripe, extending from base to near tip of abdomen. Legs brown outside, darker at joints, mostly pale orange inside. Forewing opaque, brown. Hindwing opaque, brown, except some diffuse hyaline areas near base. Some orange over bases of both wings. Male genitalia as described generally for the genus. Wing length 6–8 mm.

The early stages and the host plant are unknown. Sex attractants were used as bait to trap the moths (Z,Z-ODDOH alone or mixed with E,Z-ODDA). Aside from the type locality in Pima Co., other specimens were collected in Madera Canyon, 5,800′, Santa Rita Mts., Santa Cruz Co., Arizona.

Sophona snellingi Eichlin

PL. 1, FIG. 4.

Sophona snellingi Eichlin, 1986, *Entomography,* **4**: 349.
Type locality: La Burrera, Baja California Sur, Mexico. [LACM]

Male: Head with vertex pale brown and pale orange; front pale orange; occipital fringe pale orange dorsally, white laterally; antenna mostly powdered orange and mixed red orange; labial palpus roughened, white on basal half, pale orange on apical half; haustellum present, normal. Thorax brown but with much orange, pale yellow, and mixed orange red in front and behind wing bases, yellow beneath; collar mostly yellow on margin; metathorax brown black. Abdomen dorsally with segments one, four, six, and seven yellow; two, three, and five orange red, segment five with yellow on posterior margin; ventrally color pattern similar, perhaps somewhat paler; anal tuft short, pale orange and orange red mixed. Legs mostly pale yellow to pale orange with orange red on forecoxa, on tufts near tibial spurs, and at tarsal joints. Forewing opaque, brown with orange brown in center through cell and on hind margin; ventrally strongly powdered orange. Hindwing mostly opaque but with hyaline areas basally in half of cell, below cell, and small portion in anal area, concolorous with forewing dorsally and ventrally. Female: Similar to male but with hindwing more nearly opaque basally, powdered more heavily with yellow; antenna with contrasting dark patch of longer scales dorsally about ⅓ from tip, which is absent on male. Corpus bursae with elongate, narrow, straight signum about ¼ length of corpus bursae. Wing length 11–12 mm.

Host plant is unknown.

On 30 July 1987, Eichlin and F. G. Andrews collected two males responding to sex attractant bait (Z,Z-ODDA) near Rodeo, New Mexico. Until then, *snellingi* was known only from Sonora and Baja

California Sur, Mexico. *Sophona snellingi* was captured from mid-July to mid-September.

GENUS
Zenodoxus Grote and Robinson

Zenodoxus Grote and Robinson, 1868, *Trans. Amer. Ent. Soc.,* **2**: 184.
Type species: *Zenodoxus maculipes* Grote and Robinson, 1868. Original designation.

Zenodoxus consists of seven species in America north of Mexico, all of which occur in the western United States. Some of them undoubtedly also extend into Mexico. The genus is defined as follows: Wings entirely opaque or with only small hyaline region on hindwings of few species. Wing length relatively small for family, ranging from 5–11 mm with some specimens of *palmii* Neumoegen reaching 14 mm. In forewing, vein CuA_2 is very short, CuA_1 arising well basad of crossvein. Hindwing with rudimentary accessory cell formed at bases of veins M_1 and M_2 (text figure 4 *a*). Eye small, index 0.72–0.83. Haustellum reduced, approximately ½ length of labial palpus. Labial palpus relatively short, barely reaching top of front and roughened by long, erect, thin scales. Antenna of male with long cilia ventrally, female sometimes with short cilia. Abdomen, scales of anal tuft of male arise from weakly sclerotized, narrow band on posterior margin of segment eight. Male genitalia very similar throughout genus and provide little assistance in distinguishing species. Valvae sometimes modified, generally short and broad, about ¾ as wide as long, quadrate or slightly rounded apically. Saccus thick basally, tapering gradually to broadly rounded apex (text figure 4 *c*). Uncus narrow, simple, and with simple setae dorsoapically. Aedoeagus long, slightly curved, pointed apically and produced basally as a sclerotized rod. Ductus bursae short, straight and variably sclerotized. Ductus seminalis arising in membranous region approximately ⅓ length of ductus bursae from ostium bursae. Signum usually present on corpus bursae (text figure 4 *b*).

The seven species comprising this genus in our area are similar in wing venation, and the genitalia are very similar. Even more troublesome from an identification standpoint, the range of variation of color within species is considerable and undoubtedly accounts for the number of names applied to the species by previous workers.

The larvae of all species, where known, bore in the roots and lower stems of Malvaceae. Adults of *Z. heucherae* have been associated with *Heuchera* (Saxifragaceae), but the larval host is unknown.

KEY TO THE SPECIES OF *ZENODOXUS*

1. Hindwing at least partially scaled with pink, orange, or red dorsally, or hyaline at least on basal ⅓ 2
— Hindwing gray, gray black, or brown black dorsally; entirely opaque 5

2. Abdomen with two or more yellow bands, some of which may be very pale 3
— Abdomen with one yellow band or none 4

3. Foreleg with coxa yellow orange, sometimes with pink tint ..... *palmii* p. 24
— Foreleg with coxa gray black, occasionally with some red ..... *sidalceae* p. 26

4. Foreleg with coxa mostly white or gray white; anal tuft gray white; male without pink or red on hindwing ..... *canescens* p. 21
— Foreleg with coxa mostly gray black, occasionally with some reddish scales laterally; anal tuft orange or pink; male and female with pink or red on hindwing ..... *rubens* p. 25

5. Forewing with apical area primarily white .. .. *mexicanus* p. 24
— Forewing with apical area colors other than white 6

6. Abdomen with segments 2, 3, and 5 dusted with orange-red scales ..... *maculipes* p. 23
— Abdomen with segmental bands yellow *heucherae* p. 23

Zenodoxus canescens Henry Edwards

PL. 3, FIGS. 2, 3 (RWH 2514).

Zenodoxus canescens Henry Edwards, 1881, *Papilio,* **1**: 205.
Type locality: Colorado. [AMNH]

Zenodoxus canescens race *sidae* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 199.
Type locality: Blythe, Riverside County, California. [USNM]

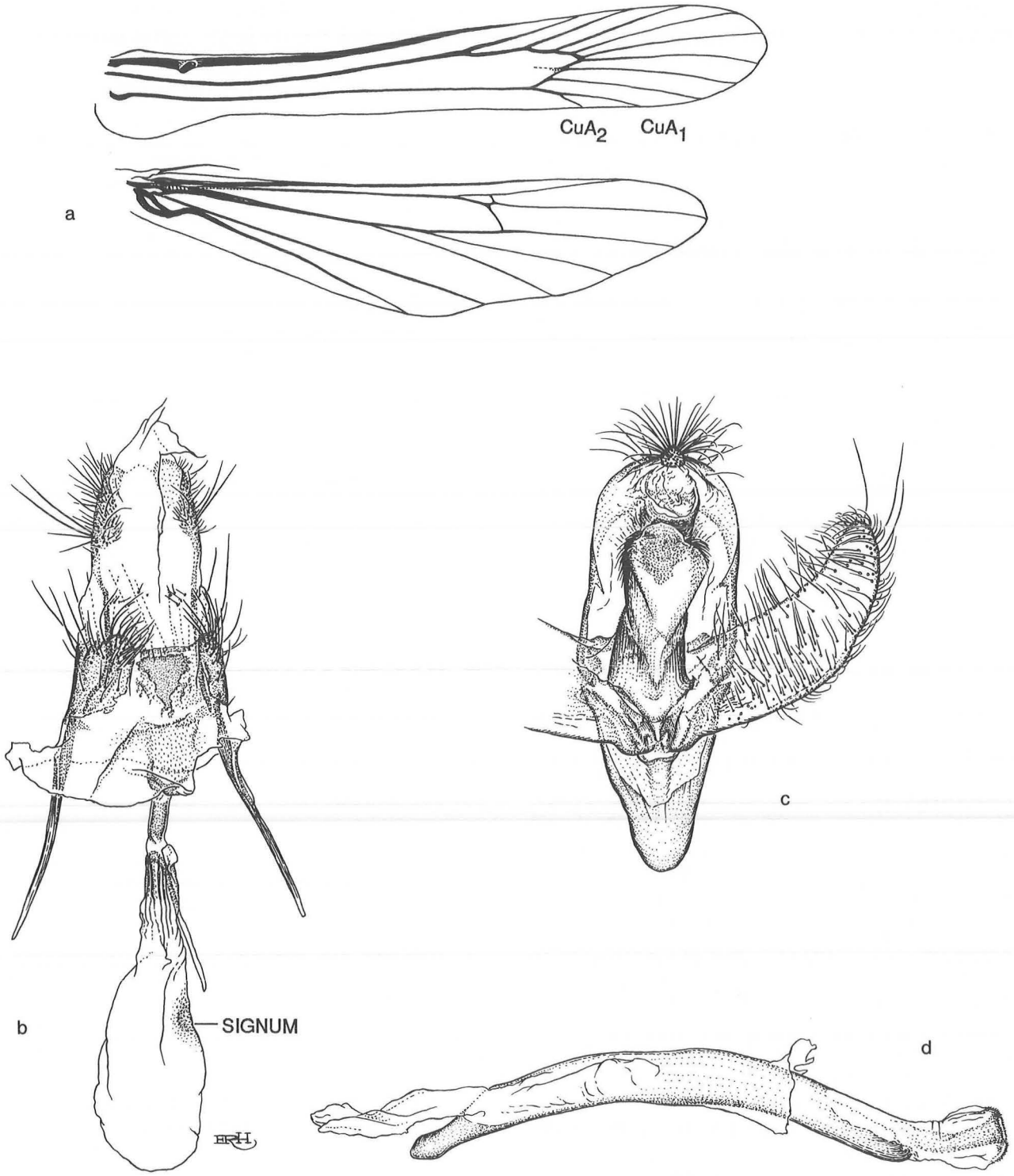

FIGURE 4: STRUCTURES OF XENODOXINI

a, c, d. Xenodoxus palmii, a. Venation of male (USNM 75842); *c.* Male genitalia (left valve and aedoeagus omitted) (USNM 75844); *d.* Aedoeagus (USNM 75842). *b.* Female genitalia, *Zenodoxus maculipes* (USNM 75834).

Male: Head with labial palpus light gray tinted with pale yellow, very roughly and unevenly scaled; vertex rough with mixture of light-gray, pale-yellow and a few black scales, scales overhanging front, which is similarly scaled, or front and vertex more smooth and clothed mostly with brown black mixed with some gray and yellow; antennae covered with light-gray scales dorsally. Thorax generally mixed brown black, light gray and light yellow, overlaid with long hairlike light-gray to white scales. Abdomen mixed light gray, light yellow, and some brown black, with anal tuft pale yellow or occasionally tending toward light brown. Legs scaled as on abdomen and with variable amounts of brown black, especially on coxa of foreleg; scale tufts on hindtibia near spurs light yellow with several long spinelike scales. Forewings entirely opaque, mostly light gray but with some light yellow and much dark brown, especially along wing margins and apex; fringe brown tipped with light gray. Hindwings hyaline medially in basal ⅔, with other areas of wings concolorous with forewings, and fringe with considerable light-gray or white shading, particularly on anal margins. Females marked essentially the same as males on the head, thorax, abdomen, and legs. Sometimes, females are more extensively shaded in these areas with brown black, especially on abdominal segments one and two, as well as having a few pale-pink scales scattered on the abdomen and forewings. Females are easily recognized by the red hindwings and the red on the venter of both fore- and hindwings. The forewings also have more dark brown dorsally than found on the males. Forewing length 6–11 mm. Engelhardt (1946: 199, 200) described two new races of *canescens.* The first, "*sidae,*" from Blythe, Riverside County, California, is not considered in our study to be a subspecies, because it is not geographically or morphologically separable from the nominate form. Also, Engelhardt described the female rather than the male, as he had indicated. The second race, "*bexari,*" from Bexar County, Texas, was found to be a form of *rubens* Engelhardt and is treated in the discussion of that species (p. 25).

The adult has been reared from larvae feeding in the roots of *Sida leprosa* variety *hederacea* (Douglas) K. Schum (Malvaceae) (Engelhardt, 1946: 199). Details of the life history are not known.

Z. canescens is widespread in the western United States, with records from Washington, northwestern Montana, west-central South Dakota, Wyoming, Colorado, western Texas, southwestern Arizona, and southeastern California. The dates of capture were in September, October, and November for most specimens examined, a few from California and Texas were taken in February and March.

Zenodoxus heucherae Henry Edwards
PL. 3, FIG. 4 (RWH 2515).

Zenodoxus heucherae Henry Edwards, 1881, *Papilio,* **1**: 205.
Type locality: Lake Tahoe, California. [AMNH]

Zenodoxus potentillae Henry Edwards, 1881, *Papilio,* **1**: 205.
Type locality: Lake Tahoe, California. [AMNH]

Male: Head with labial palpi roughened, white with brown black mixed primarily on apical ½, often with pale yellow basally; vertex brown black with yellow scales at bases of antennae; front gray black or brown black; occipital fringe yellow or yellow orange dorsally. Thorax mostly brown black, dorsally with a few hairlike pale-yellow scales projecting posteriorly, laterally with pale yellow anterior to wing bases and beneath wings. Abdomen brown black, broadly banded dorsally with yellow on segments one, four, six, and seven; other segments may be variously powdered with yellow, often heavily on segment five; ventral surface with only scattered yellow scales; anal tuft brown black, occasionally with a few scattered yellow scales. Legs with coxae and femora brown black with some pale yellow ventrally; tibiae with scale tufts very pronounced consisting of a mixture of brown-black and yellow-orange, spinelike scales; between tibial spurs hindleg pale yellow or white on outer surface and bright yellow on inner surface; tarsi yellow ringed with brown-black tufts at joints. Wings opaque, brown black, powdered with much yellow ventrally. Forewings lightly powdered with pale yellow and dull orange dorsally. Females differ from males only in occasionally having a little more orange powdering on forewings, some orange on hindwings, and yellow on outer surface of tibia of hindleg between spurs. Wing length 5–10 mm.

Engelhardt (1946: 197) mentioned that this species frequently visits the flowers of alumroot, *Heuchera rubescens* Torrey, a member of the Saxifragaceae. However, as there is no indication that specimens were reared from this plant, it should not be considered a hostplant record. Flight period is from June to August.

Records are from the Sierra Nevada of California from Modoc County south to Tuolumne County.

Zenodoxus maculipes Grote and Robinson
PL. 1, FIGS. 5, 6. TEXT FIG. 4 *b* (RWH 2516).

Zenodoxus maculipes Grote and Robinson, 1868, *Trans. Amer. Ent. Soc.*, **2**: 184.
Type locality: Texas [AMNH]

Although similar to the preceding species, *maculipes* is readily distinguished from *heucherae* by having abdominal segments two, three, and five dusted with orange-red scales; and *maculipes* occurs in the Great Plains, *heucherae* in the Pacific mountain region.

Male: Head with labial palpus roughened, pale yellow to white, light brown apically; vertex and front brown black with wide, flat, pale-yellow and light-brown scales variously overlaid; occipital fringe pale yellow dorsally, gradually becoming paler lateroventrally; antenna dorsally pale yellow. Thorax brown black mixed with pale yellow, light brown, and some dull orange. Abdomen dorsally with segments one, four, six, and seven mostly pale yellow, remaining segments and anal tuft a mixture of brown black, pale yellow, light brown, and dull orange red. Legs various shades of brown; coxae of forelegs heavily shaded with pale yellow and with wide band of pale yellow around hindtibiae between spurs. Tarsi light brown with darker rings at joints. Wings opaque, dark brown, often powdered light brown on forewing dorsally, with forewing pale yellow and gray white ventrally. Females similar to males, occasionally with more dull orange red on thorax and abdomen and more pale yellow on head. In addition, female specimens lack lighter scaling on ventral surface of wings found on males. Wing length 7–10 mm.

Host plant information and other biological data are not known for this species.

Capture records indicate the adults are active in June and July. This species is known from the Great Plains, from Kansas south to Texas.

Zenodoxus mexicanus Beutenmüller
PL. 3, FIG. 5 (RWH 2517).

Zenodoxus mexicanus Beutenmüller, 1897, *Bull. Amer. Mus. Nat. Hist.*, **9**: 216.
Type locality: New Mexico [AMNH]

This species is most similar to *maculipes* and *heucherae* in appearance; however, it is readily distinguished from them by the presence in the forewing of white patches between the veins in the apical area beyond the cell.

Males: Head with labial palpus roughened, white with brown black at apex; vertex brown black; front gray black, white laterally; occipital fringe white, occasionally somewhat pale yellow; antenna light brown dorsally. Thorax brown black with a patch of pale yellow before and beneath the wings, with tufts of pale-yellow, hairlike scales dorsally at the base of the wings, and occasionally a few pink scales posteriorly. Abdomen dorsally with wide yellow bands on segments one, four, five, six, and seven with some pale pink mixed on segment five and considerably more pale pink on segments two and three; ventrally abdomen brown black, lightly powdered with pale pink or yellow; anal tuft a mixture of brown black and pale yellow, occasionally with a few pale-pink scales. Legs with forecoxa brown black and white with some pale pink; middle and hindlegs with tibiae and first tarsal segments brushlike with dark-brown and pink scale tufts; tibiae white shaded with some pink on outer surface and primarily pink on inner surface between spurs; tarsi ringed with dark brown at joints; and femora edged with pale pink dorsally. Wings opaque except white or pale pink sparsely on hindwings basally. Forewings dark brown dorsally with pale pink and white in cell and white between veins in apical area beyond cell; ventrally, white with some pale pink mixed with dark brown on veins and discal spot; fringe dark brown tipped with white. Single female specimen studied agrees in most respects with description for males except: head with vertex pale yellow, front all white, hindwing lacks hyaline area basally, and forewing more heavily powdered with pale yellow dorsally. Wing length, male 5–8 mm, female 8 mm.

Larval host plant and other biological data are unknown for *mexicanus.*

Label data suggest the adults are active from the end of May through July. *Z. mexicanus* is recorded from the eastern Rocky Mountain Region from Billings, Montana south to Big Bend, Texas. The specimen from Montana differs superficially from other specimens in the absence of pale pink throughout and in having the abdominal markings white rather than yellow.

Zenodoxus palmii (Neumoegen)
PL. 1, FIGS. 7–11; PL. A, FIG. 3. TEXT FIGS. 2; 4 *a, c, d* (RWH 2518).

Larunda palmii Neumoegen, 1891, *Ent. News*, **2**: 108.
Type locality: South Arizona. [AMNH]

Paranthrene palmiana Dalla Torre, 1925, *Lepidopterorum Catologus, Aergeriidae,* **31**: 160.
NOTE—*Paranthrene palmiana* is an unjustified new name for *Larunda palmii* Neumoegen, 1891.

Zenodoxus wissadulae Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 195.
Type locality: Brownsville, Texas. [USNM]

NOTE—Engelhardt described *wissadulae* on the basis of material reared from *Wissadula lozanii* in Brownsville, Texas. Examination of the type material showed the color pattern to be similar to darker specimens of *palmii* and the genitalia to agree with those of *palmii.* Thus, *wissadulae* is considered a synonym of *palmii* (Duckworth and Eichlin, 1977c).

Zenodoxus palmii race *sphaeralceae* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 198.
Type locality: Snake River, Whitman County, Washington, opposite Clarkston. [USNM]

Zenodoxus palmii race *incanae* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 198.
Type locality: Yuma, Arizona. [USNM]

Engelhardt (1946) described two races of *palmii,* applying to them the names "*sphaeralceae*" and "*incanae.*" We found no differences to warrant subspecific ranking for these entities, thus, we treat them as color forms of *palmii.*

Typical males: Head brown black on vertex, yellow orange at base of antenna; front dark gray with yellow ventrally and sometimes laterally; antenna dorsally powdered yellow orange; labial palpus thickened but only slightly roughened, yellow with yellow orange apically. Thorax brown black with yellow on collar and laterally before forewings, orange posteriorly and in narrow, subdorsal, longitudinal band at base of wings. Abdomen primarily yellow with segments two and three chestnut brown dorsally, all segments ventrally dull orange or yellow with some dull orange dorsally on segments four, five, six, seven, and anal tuft. Legs mostly orange with femora brown black and coxae of forelegs yellow and brown black with orange. Genitalia with valva slightly narrowed and upturned apically. Wings dark brown with orange on forewings medially and apically and on hindwings medially and on basal ⅓; ventrally, hindwings primarily orange, becoming yellow apically; both pairs of wings opaque generally, hindwings may have hyaline regions. Females as for males except none of the forms with hyaline regions on hindwings. The typical form has the head with front completely yellow and a pink tint ventrally on the legs. In the form "*incanae*" the hindwing has much more red pink than the male. Wing length 7–15 mm.

In the form "*sphaeralceae*" the orange is very pale or replaced with yellow, the wings are mostly brown black with yellow, the hindwings hyaline in cell to wing base and abdominal segments two and three are brown black with orange dorsally. In the form "*incanae*" the orange is replaced with yellow, all abdominal segments are primarily yellow dorsally and red pink on basal segments ventrally; scale tufts of the legs are orange red; the bases of the hindwing and of the forewing ventrally have red-pink powdering; the hyaline area of the hindwings is more extensive than in "*sphaeralceae*;" on the head the vertex is mixed with pale yellow and brown; the front is pale yellow to white; and the occipital fringe is pale yellow dorsally becoming white laterally.

Zenodoxus palmii has been reared from a number of species of Malvaceae: *Pseudabutilon lozanii* (Rose), *Sphaeralcea ambigua* Gray, *S. incana* Torrey, and *S. munroana* (Douglas) Spach (Engelhardt, 1946: 197).

Flight period is from July through early October, based on capture records. Reared adults from Brownsville, Texas emerged in April and May. *Z. palmii* occurs throughout the western plateaus from eastern Washington and Oregon south into Arizona and southeastern California and southeast into Texas to the Gulf Coast.

Zenodoxus rubens Engelhardt
PL. 1, FIGS. 12, 13; PL. 3, FIG. 6; PL. A, FIG. 2 (RWH 2519).

Zenodoxus rubens Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 200.
Type locality: Davis Mountains, Texas. [USNM]

Zenodoxus canescens race *bexari* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 200.
Type locality: Bexar County, Texas. [USNM]

Z. rubens resembles the females of *canescens* but can be separated easily by the pale-yellow and red anal tuft and the red on the legs. Males of *rubens* are readily distinguished by the red hindwings. Although *bexari* resembles *canescens* in that both have a large medial hyaline region on the hindwings, it is conspecific with *rubens,* differing only by having the hyaline area in the hindwings of the males. Females of *bexari* match those of *rubens* completely.

Male: Head with vertex and front brown black, red at base of antenna; labial palpus roughened, white or pale yellow basally and light brown to black brown apically; occipital fringe pale yellow, occasionally with some red dorsally; antenna dorsally pale yellow. Thorax brown black variously powdered with pale yellow and red. Abdomen brown black, var-

iously powdered with pale yellow and red, occasionally heavily pale yellow on segment one; anal tuft a mixture of pale red and pale yellow. Legs with coxae and femora brown black with some pale yellow and red; mid- and hindlegs primarily brown black on outer surface, with light-brown scale tufts around tibial spurs and joints of tarsi, white between the two pairs of spurs on hind tibiae; inner surface of legs mostly red, especially on tibiae. Forewings brown black powdered variously with pale yellow and orange red, especially concentrated in apical area. Hindwings entirely red except for dark-brown fringe, or at least red on basal ⅔. Both pairs of wings opaque except for males of "*bexari.*" Genitalia with apex of valva broadly rounded, not quadrate as in most species of the genus. Females may differ from males only in the presence of more red powdering throughout. Wing length 6–10 mm.

Host plant and other biological data are unknown for this species. Sex attractant lures (Z,Z-ODDA) have been used to collect males of *rubens* in Texas and Mexico. The flight period is from September through November.

Z. rubens occurs in Texas, New Mexico, and Arizona; *rubens* form "*bexari*" also occurs in Mexico in areas adjacent to the eastern side of the central cordillera.

Zenodoxus sidalceae Engelhardt
PL. 3, FIG. 7; PL. 4, FIG. 1 (RWH 2520).

Zenodoxus sidalceae Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 196.
Type locality: Pullman, Washington. [USNM]

Z. sidalceae is very similar superficially to *heucherae* but is readily separated by the pink basal and medial shading on the hindwing, which is not present in *heucherae.* Male: Head with vertex brown black; front brown black with pale-yellow or white scales randomly distributed; occipital fringe pale yellow; labial palpus roughened, white with dark brown and some pale yellow; antenna powdered with pale yellow dorsally. Thorax brown black with some pale-yellow scales and long, hairlike pale-yellow and red scales posteriorly, extending over base of abdomen. Legs with forecoxa brown black with some hairlike pink scales; femora brown black with white on ventral margins; tibiae and tarsi white often powdered lightly with pink, with dark and light brown at tarsal joints, strongly red pink on inner surfaces of tibiae and first tarsal segments. Abdomen with wide yellow bands on segments one, four, six, and seven, other segments and anal tuft brown black shaded with mixed pale yellow and red. Wings opaque; forewings brown black, powdered medially with red pink and heavily red pink in apical region; hindwings brown on margins and pink basally and medially; ventrally, forewings powdered white on costal margin, mixed white and pink apically and hindwings pink, shaded slightly with white. Genitalia with apex of valva broadly rounded. Maculation of females similar to males except: generally more heavily marked with red throughout. On well-marked specimens, occipital fringe and vertex of head, coxae of forelegs, and other parts of legs heavily shaded with red. Abdominal segments two, three, and five and anal tuft mostly red on black. Wing length 6–9 mm.

The adult of *sidalceae* has been reared from larvae feeding in *Sidalcea oregana* Gray (Malvaceae) (Engelhardt, 1946: 196). Other details of the life history are unknown. Capture records suggest an adult flight period from late March to early September.

Z. sidalceae has been recorded from Alberta south through western Washington, Idaho, and Oregon to Los Angeles, California.

SUBFAMILY
Paranthreninae Niculescu

Paranthreninae Niculescu, 1964, *Linneana Belgica,* **3**: 38.
Type genus: *Paranthrene* Hübner, 1819.

Sesiinae Boisduval, Naumann, 1971, *Bonner Zoologische Monographien,* **1**: 58. (part).

Although more diverse than the Tinthiinae, the subfamily Paranthreninae is a moderately small group in our area. The subfamily occurs worldwide but appears to achieve its greatest development in the Eastern Hemisphere. In America north of Mexico the group is represented by 14 species in four genera.

The Paranthreninae are distinguished by the following combination of characters: Head with maxillary palpus two or three segmented; antenna clavate with terminal tuft of scales, bipectinate and/or ciliate in male, simple and nonciliate in female; eye proportionately larger than for species of Tinthiinae (eye index range: 1.0–1.4); forewing with veins R_4 and R_5 long stalked, stalk generally longer than ½ total length of R_4 or R_5, CuA_2 present, at least as long as CuA; hindwing with vein CuP degenerate (to observe, scales must be removed), 1A and 2A coincident except at base, 3A present (text figure 5); thorax with baglike protuberance on preepimeron; male genitalia with valva having scales multifurcate

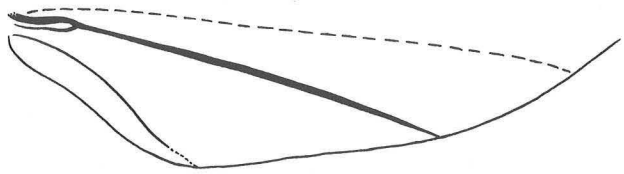

FIGURE 5: ANAL VEINS OF HINDWING OF PARANTHRENINAE (*PARANTHRENE ASILIPENNIS*) (USNM 75795)

dorsally and hairlike ventrally and apically, median area unscaled or with thick dark scales in saccular region; tegumen reduced; gnathos, when present, much shorter, simpler structure than in most Sesiinae; uncus wide, elongate, about three to five times longer than tegumen, clothed lateroapically with long hairlike scales, mostly bilobed apically; vinculum narrow, saccus relatively short; most species with subapical spine on aedoeagus; female genitalia with ductus bursae membranous with a sclerotized ring near ostium bursae; ductus seminalis arises from ductus bursae immediately distad of sclerotized area; corpus bursae elongate ovate, often thickened with many transverse folds and various longitudinal sclerotized bands.

The larvae of species of Paranthreninae are borers in a broad range of host plants. Although some species feed in other parts of the plant, many in the subfamily are root borers.

KEY TO THE GENERA OF PARANTHRENINAE

1. Haustellum rudimentary ..... *Euhagena* p. 45
— Haustellum coiled, longer than labial palpus 2

2. Forewing with stalk of veins R_4 and R_5 stalked with R_3 ..... *Cissuvora* p. 27
— Forewing with stalk of veins R_4 and R_5 not stalked with R_3 3

3. Hindwing with opaque area of wing fold (CuP) at least 3 times wider than vein 1A apically; male with 2 subdorsal and 2 shorter lateral hair pencils at tip of abdomen ..... *Vitacea* p. 38
— Hindwing with wing fold (CuP) not more than 2 times as wide as vein 1A apically; male without hair pencils at tip of abdomen 4

4. Forewing with stalk of veins R_4 and R_5 joined to base of vein R_3 ..... *Paranthrene* p. 31
— R_4 and R_5 separated from base of vein R_3 joined by crossvein ..... *Albuna* p. 42

TRIBE

Cissuvorini Duckworth and Eichlin

Cissuvorini Duckworth and Eichlin, 1977, *California Dept. Food and Agric., Occasional Papers Ent.*, **26**: 13.
Type genus: *Cissuvora* Engelhardt, 1946.

This tribe consists of a single, monobasic genus, *Cissuvora*. Engelhardt (1946) recognized the unique nature of the species that comprises this tribe and its deceptive resemblance to species in the genus *Paranthrene*. Our studies further confirm his original observations and are reflected in its elevation to tribal rank in the Paranthreninae.

Distinctive characters of the Cissuvorini are as follows: Antennae clavate with an apical scale tuft, males with antennae unipectinate and ventrally ciliate; maxillary palpus three segmented; male genitalia with palmate-furcate scales on valva and well-developed gnathos; female genitalia similar to *Paranthrene* type. MacKay (1968b) provided a description of the larva of *C. ampelopsis*; however, the specimen upon which it is based is assumed to be properly identified only by circumstantial evidence. Associated larvae of *C. ampelopsis* are yet to be collected. MacKay found the presumed larva of *Cissuvora* to be very distinctive in the shape of the mandibles and by the presence of an unusual and prominent elevation on each side of the meso- and metathorax.

GENUS

Cissuvora Engelhardt

Cissuvora Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 134.
Type species: *Cissuvora ampelopsis* Engelhardt. Original designation.

The genus *Cissuvora* consists of a single species that is known only from the vicinity of San Antonio, Texas.

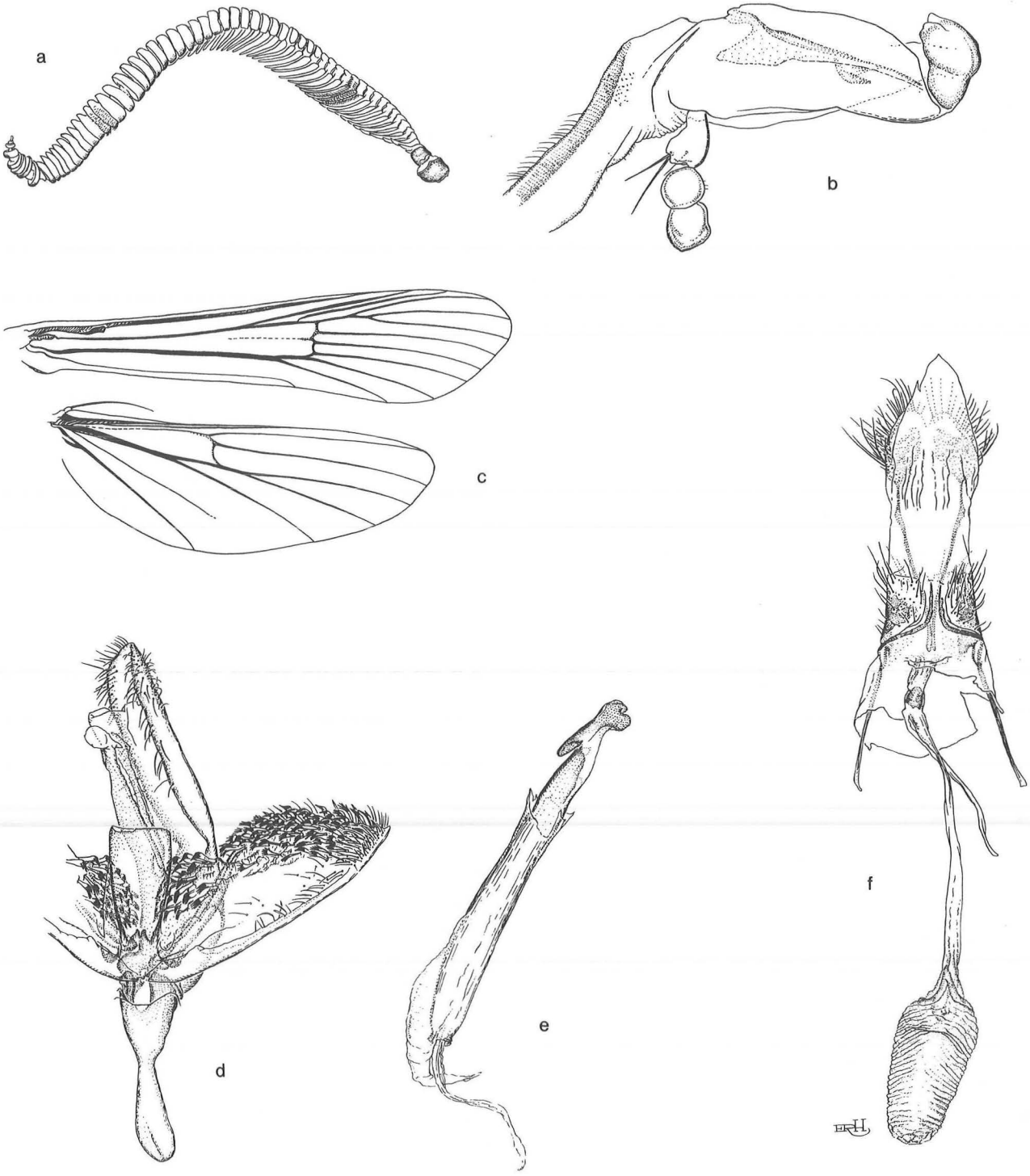

FIGURE 6: STRUCTURES OF CISSUVORINI

a–f. Cissuvora ampelopsis, a. Male antenna (USNM 75869); *b.* Maxillary palpus (USNM 75869); *c.* Venation (USNM 75768); *d.* Male genitalia (left valve and aedoeagus omitted) (USNM 75768); *e.* Aedoeagus (USNM 75768); *f.* Female genitalia (USNM 75769).

The genus may be distinguished by the following characteristics: Forewing with stalk of veins R_4 and R_5 short and stalked with R_3, vein M_3 basally approaching CuA_1; hindwing with vein M_3 arising from CuA_1 at junction of crossvein, M_2 basally nearer M_1 than M_3; maxillary palpus three segmented; antenna of male clavate, unipectinate, ventrally ciliate; labial palpus with third segment approximately ⅓ length of second segment; haustellum approximately 1½ length of labial palpus, numerous small papillae ventrally near apex. Male genitalia with gnathos well developed; valva nearly as wide as long, sharply pointed apically, with palmate-multifurcate scales on dorsal half, ventral half with only scattered setae along ventral margin and apex; uncus sparsely clothed with short, hairlike scales lateroapically; vinculum laterally compressed; saccus about ½ length of ventral margin of valva, constricted medially, broadly rounded apically; aedoeagus with subapical recurved spine, vesica without cornuti. Female genitalia with initial portion of ductus bursae from ostium bursae short, membranous, slightly shagreened, then becoming sclerotized for a short distance with inception of ductus seminalis just beyond sclerotized area, rest of ductus bursae long, slender, membranous; corpus bursae with many transverse folds throughout, evenly shagreened, signum consisting of a circular, lightly sclerotized area near entrance of ductus bursae.

Cissuvora ampelopsis Engelhardt
PL. 1, FIG. 16; PL. A, FIG. 4. TEXT FIG. 6 *a–f* (RWH 2521).

Cissuvora ampelopsis Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 134.
Type locality: Victoria, Texas. [USNM]

Male: Head with vertex, front, and occipital fringe yellow with some rust; labial palpus roughened, yellow with rust laterally; antenna yellow dorsally, sometimes slightly powdered with rust. Thorax rust with collar yellow, two narrow, longitudinal yellow stripes subdorsally, a narrow yellow stripe before wing, large yellow patch beneath wing, and transversely yellow on posterior margin. Abdomen rust with segments one and four primarily yellow, anterior margins of segments five, six, and seven yellow; anal tuft is mostly rust dorsally and yellow laterally. Legs yellow shaded with rust red. Forewing dorsally opaque with rust scales on the anterior half, hyaline on posterior half; ventrally costal margin powdered yellow. Hindwing hyaline with scaling only on veins and fringe. Female essentially as for male, except forewing mostly opaque with small hyaline areas basally and near anal angle; and abdominal segments five, six, and seven with more yellow scaling. Wing length: male 10–12 mm; female 13–17 mm.

The host plant for this species is a climbing vine with thick, succulent foliage, *Cissus incisa* (Nuttall) Desmoulin (Vitaceae) (Engelhardt, 1946: 135). The larvae of *ampelopsis* bore in the vines causing gall-like swellings, frequently moving from weakened plants to initiate new burrows in other plants or healthier areas of the same plant. Fully grown larvae leave the host plant and pupate in the soil in tough, oval cocoons. The flight period is uncertain, because this species is known mainly from reared specimens that emerged at various times throughout the year.

According to Engelhardt (1946: 136), the principal adult season is May and June. He also noted that the adult moths are perfect mimics of a species of *Polistes* wasp that is common in southern Texas. Although *ampelopsis* is known only from the vicinity of San Antonio, Texas, it probably occurs throughout the range of its host plant, which is common in Mexico.

TRIBE
Paranthrenini Niculescu

Paranthrenini Niculescu, 1964, *Linneana Belgica,* **3**: 38.
Type genus: *Paranthrene* Hübner, 1819.

Paranthrenini are represented in most of the regions of the world and are the larger of the two tribes of the Paranthreninae that occur in our area. In America north of Mexico the tribe consists of four genera, *Paranthrene, Vitacea, Albuna,* and *Euhagena.* The tribe is distinguished by the following characteristics: Antenna clavate with apical scale tufts, male with antenna bipectinate and ventrally ciliate except in *Albuna* where no pectination occurs, females lack pectination and cilia; maxillary palpus two segmented, second segment large, positioned on apex of first segment, often indented medially, first segment with a few apical setae; haustellum coiled, approximately two to three times the length of labial palpus except in *Euhagena* where haustellum is rudimentary; labial palpus with third segment approximately ½ length of second, in all genera except *Albuna* labial palpus greatly expanded ventrally with thick, hairlike scales; hindwing with M_3 arising from CuA_1 basad of crossvein; genitalia very uniform among species; valva elongate, somewhat ovoid, with

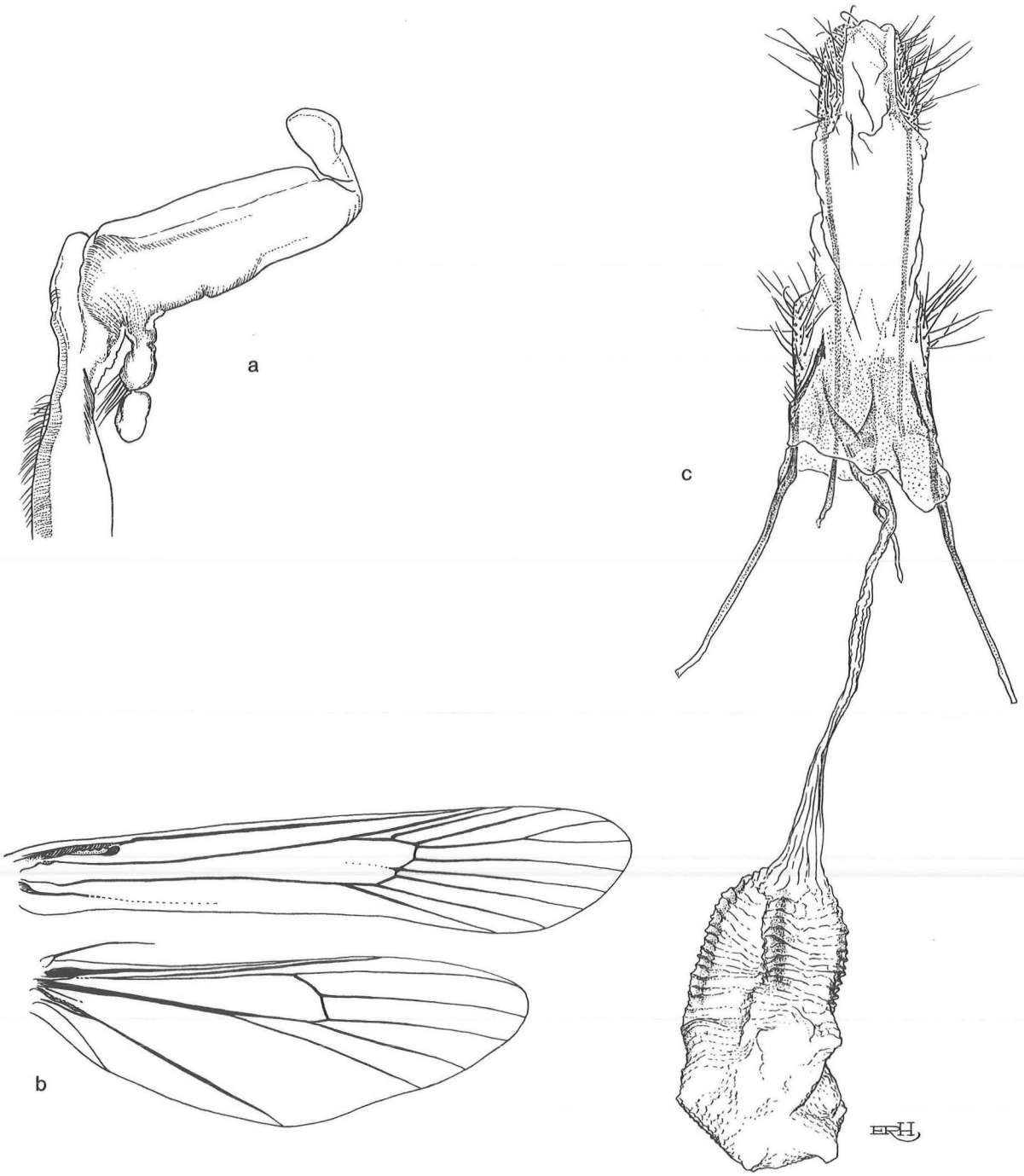

FIGURE 7: STRUCTURES OF PARANTHRENINI

a, b. Paranthrene tabaniformis, a. Maxillary palpus (USNM 75870); *b.* Venation (USNM 75771). *c.* Female genitalia (USNM 75790).

wide marginal band of hairlike scales, often with patch of dark, spinelike scales basally in saccular area, median area unscaled or sparsely scaled; saccus short, usually ⅓ the length of ventral margin of valva, narrow; gnathos short; tegumen reduced; subscaphium a narrow, elongate, sclerotized band; uncus clothed with ventrally curved hairlike scales on most species; aedoeagus with one or more apical or subapical spines, vesica shagreened, usually without cornuti. Female genitalia with ductus bursae long, narrow, membranous except for narrow band of sclerotization near ostium bursae; inception of duc-

tus seminalis just beyond sclerotized band; corpus bursae elongate ovate with transverse folds.

GENUS

Paranthrene Hübner

Paranthrene Hübner, [1819], *Verzeichniss bekannter Schmettlinge* [sic], 128.
Type species: *Sphinx asiliformis* Denis and Schiffermüller, 1775, not *Sphinx asiliformis* Fabricius, 1775. *Sphinx asiliformis* Denis and Schiffermüller, 1775, is a junior synonym of *Sphinx tabaniformis* Rottemburg, 1775. Designated by Newman *in* Westwood, 1840, *An Introduction to the Modern Classification of Insects,* **2** (*Synopsis of the Genera of British Insects*): 89.

NOTE—According to Fletcher and Nye (1982: 119) "Newman cited as type-species *Sphinx vespiformis* Linnaeus, 1761, a nominal species not originally included in *Paranthrene.* At the same time however, on the same page, Newman placed *S. vespiformis* as a senior synonym of *Sphinx asiliformis* [Denis & Schiffermüller] (but cited as *asiliformis* Haworth, an incorrect authorship), a nominal species originally included in *Paranthrene.* Under the *Code,* Article 69(a)(iv), this designation constitutes the fixation of the originally included nominal species as the type-species."

Memythrus Newman, 1832, *Sphinx vespiformis: an Essay,* 53.
Type species: *Sphinx vespiformis* Newman, 1832, not *Sphinx vespiformis* Linnaeus, 1761. *Sphinx vespiformis* Newman, 1832, is a junior synonym of *Sphinx tabaniformis* Rottemburg, 1775. Designated by Beutenmüller, 1901, *Memoirs Amer. Mus. Nat. Hist.,* **1**: 246.

NOTE—Beutenmüller designated the type species as "*Sphinx tabaniformis* Rott. (=*vespiformis* Linn. [sensu Newman])."

Sciapteron Staudinger, 1854, *De Sesiis agri Berolinensis, Dissertatio Entomologica,* 43.
Type species: *Sphinx asiliformis* Denis and Schiffermüller, 1775. Monotypy.

NOTE—*Sciapteron* is a junior objective synonym of *Paranthrene* Hübner, 1819.

Tarsa Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 61.
Type species: *Tarsa bombyciformis* Walker, 1856, a junior synonym of *Sesia asilipennis* Guérin-Méneville, 1832.

Pseudosesia Felder, 1861, *Sitzungsberichte der Kaiserlichen Akademie der Wissenschaften, Mathematisch-naturwissenschaftliche Klasse (Vienna),* **43**: 28.
Type species: *Pseudosesia insularis* Felder, 1861. Monotypy.

Pramila Moore, 1879, *in* Hewitson and Moore, *Descriptions of New Indian Lepidopterous Insects from the Collection of the Late Mr. W. S. Atkinson: Heterocera* (1): 9.
Type species: *Pramila atkinsoni* Moore, 1879. Monotypy.

Fatua Henry Edwards, 1882, *Papilio,* **2**: 97.
Type species: *Trochilium denudatum* Harris, 1839. Original designation.

NOTE—*Fatua* Henry Edwards, 1882, is a junior homonym of *Fatua* Dejean, 1835, in the Coleoptera.

Phlogothauma Butler, 1882, *Ann. and Mag. Nat. Hist.* (series 5), **10**: 237.
Type species: *Phlogothauma scintillans* Butler, 1882. Monotypy.

Sciopterum Bartel, 1912, *in* Seitz, *Die Gross-Schmetterlinge der Erde,* **2**: 376.

NOTE—*Sciopterum* is an unjustified emendation of *Sciapteron* Staudinger, 1854.

Nokona Matsumura, 1931, *Insecta Matsumurana,* **6**: 7.
Type species: *Paranthrene yezonica* Matsumura, 1931, now considered to be a junior synonym of *Sciapteron regale* Butler, 1878. Original designation.

Leptocimbicina Bryk, 1947, *Opuscula Ent.,* **12**: 100.
Type species: *Leptocimbicina aurivena* Bryk, 1947. Original designation.

Paranthrene is a moderately large, worldwide genus that appears to achieve its greatest diversity in the Oriental Region. In America north of Mexico the genus is represented by seven species, most of which have rather broad geographic ranges. The differentiating features provided in the key to genera of Paranthreninae should allow ready recognition of the group.

The genitalia are very homogeneous among the species of *Paranthrene* and are typical of the tribe. All species in the genus have an apical spine on the aedoeagus in the males, and the corpus bursae in the females has numerous transverse folds and one or more longitudinal, sclerotized bands.

MacKay (1968a) characterizes the larvae of *Paranthrene* as follows: ocellus I nearer II than IV, ocellus III nearer IV than II is to III; seta O^2 ventral or posteroventral to ocellus I; dorsal pinacula on abdomen moderately small; shape of anal shield frequently modified; crotchets slender, well developed.

Depending on the species, the larvae of *Paranthrene* are borers in the horizontal roots and under the bark into the wood of the trunks and branches of various willows, poplars, and aspens (Salicaceae) and oaks (Fagaceae). The life cycle requires two years for completion. In the late fall of the second year the larva constructs a pupal chamber in the burrow near the surface, capping the circular exit hole with silk and bark. Overwintering the second year is accomplished in the larval or prepupal stage, pupation occurring in the spring, emergence of the adults in the summer.

KEY TO SPECIES OF *PARANTHRENE*

1. Forewings and approximately ½ of hindwings mostly orange; labial palpus, head, thorax, abdomen and legs black ..... *fenestrata* p. 37
— Pattern of wings not as above 2

2. Head with front white laterally, occasionally mixed with some orange and gray 3
— Head with front yellow or pale yellow laterally, occasionally mixed with some orange or front and vertex mostly yellow or orange 4

3. Occipital fringe dull orange ..... *dollii* p. 35
— Occipital fringe bright yellow ..... *tabaniformis* p. 36

4. Occipital fringe black dorsally 5
— Occipital fringe dull orange or yellow orange 6

5. Forewing hyaline ..... *pellucida* p. 34
— Forewing with much opaque scaling on anterior half ..... *simulans* p. 33

6. Forewing with hyaline region posteroapically, extending from near the posterior edge of discal spot to wing margin; abdominal segments reddish brown to brown black with narrow yellow bands on posterior edges of all but the first segment ..... *asilipennis* p. 32
— Forewing with a small hyaline region, when present, next to apical edge of discal spot and not extending to the wing margin in any direction; abdominal segments not marked as above, but variously banded with yellow and black or yellow and dull red ..... *robiniae* p. 34

Paranthrene asilipennis (Guérin-Méneville)
PL. 1. FIGS. 14, 15. TEXT FIG. 5 (RWH 2522).

Sesia asilipennis Guérin-Méneville, 1829, *Iconographie du Règne Animal de G. Cuvier,* **3**(6) (Insects), 496.
Type locality: l'Amerique septentrionale. [USNM]

Trochilium denudatum Harris, 1839, *Amer. Jour. Arts and Science,* **36**: 310.
Type locality: Massachusetts. [MCZ]

Trochilium vespipenne Herrich-Schäffer, 1854, *Systematisches Verzeichniss der im diesem Werke gelieferten Arten, Sammlung neuer order wenig bekannter aussereuropaischer Schmetterlinge,* 57, fig. 217.
Type locality: China. [Unknown]

Tarsa bombyciformis Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 61.
Type locality: Not given. [BMNH]

Sphecia championi Druce, 1883, *in* Godman and Salvin, *Biologia Centrali-Americana. Insecta. Lepidoptera-Heterocera,* **1**: 29.
Type locality: Guatemala City, Guatemala. [BMNH]

Male: Head with vertex brown black, front brown black with yellow laterally; occipital fringe yellow or yellow orange; labial palpus roughened, orange dorsally, yellow and white ventrally, brown black laterally; antenna strongly bipectinate, yellow with some brown black dorsally, orange ventrally and apically. Thorax brown black with yellow band on collar and posterior margin of mesothorax dorsally and laterally, and large yellow patch at base of wings partially overlaid with rust scales. Abdomen brown black with narrow yellow bands posteriorly on all but first segment, some segments variously powdered with rust, especially terminal segments; anal tuft mixed brown and yellow. Coxa of foreleg brown black basally, then rust orange, broadly yellow on margins; all legs with femora brown black, mixed

rust orange and yellow dorsally, yellow ventrally with long, white hairlike scales; tibiae brown black dorsolaterally, rust orange ventrally, dorsally roughened with orange scales on the hind tibia, tarsi, inner surface of tibiae yellow. Forewings largely hyaline, anteriorly opaque with brown black anterior of cell to wing apex, on veins, and variously posterad of cell and not extending to wing base or above vein CuA_1, rust red basally on costal edge, in anal area and in center of discal spot, discal spot bordered variously with brown black; ventrally, forewing pale yellow powdered with orange, especially on discal spot. Hindwing hyaline except for brown black on veins and orange on discal spot; fringes dark brown. Female essentially as male except: forewing mostly opaque, having only a small hyaline area basally and a somewhat triangular hyaline area apically above vein CuA_1 and below M_1. Wing length 12–20 mm.

According to Engelhardt (1946: 150), the larvae of *asilipennis* are borers in the solid wood of oaks (*Quercus* spp.). There is, apparently, no discrimination as to the species of oak used; however, young trees and especially the stumps of cut or broken trees are preferred. Normally, the larvae bore at the base of the host plant or in the surface roots, and during the two-year life cycle, tunnel deep into the wood. When stumps are available, the eggs are laid on the bark and outer edge of the wood, and the young larvae bore downward to a depth of approximately six inches. In spring of the second year pupation occurs in a chamber capped below and above, the exit concealed with minute particles of wood. Engelhardt reports counting as many as 50 pupal cases on a single stump. The stumps continue to serve as larval food sources long after the upper part of the tree is dead, succeeding generations of larvae bore deeper and deeper into the still living tissue.

Adults emerge from May or June, leaving the pupal case protruding from the surface of the stump; the flight period extends into July. Some males have been captured in traps containing sex attractant (Z,Z-ODDA) (Sharp et al., 1978; Sharp and Eichlin, 1979; Snow et al., 1985).

In America north of Mexico *asilipennis* ranges from Massachusetts to Wisconsin to Florida and to eastern Texas. Engelhardt (1946: 149,150 [*Sphecia championi* Druce, 1883]) indicated the species also occurs in temperate and tropical zones of Mexico and Central America. Because we did not examine the type of *vespipenne* Herrich-Schäffer (type locality China), we are not certain of the synonymy with *asilipennis* (Engelhardt, 1946: 148) and, thus, are not sure if *asilipennis* also occurs in the Oriental Region.

Paranthrene simulans (Grote)
PL. 1. FIGS. 28–33 (RWH 2527).

Trochilium simulans Grote, 1881, *Bull. Brooklyn Ent. Soc.*, **3**: 78.
Type locality: Algonquin, Illinois. [AMNH]

Fatua palmii Hy. Edwards, 1887, *Can. Ent.*, **19**: 145.
Type locality: Enterprise, Florida. [AMNH]

Trochilium luggeri Hy. Edwards, 1891, *in* Lugger, *Psyche,* **6**: 108.
Type locality: St. Anthony Park, Minnesota. [AMNH]

Male: Head with vertex brown black, perhaps with a few yellow scales mixed; front brown black with yellow laterally; occipital fringe brown black becoming yellow lateroventrally; labial palpus brown black basally and laterally, yellow dorsally, apically and on ventral ⅔, strongly roughened; antenna brown black with orange apically. Thorax brown black with yellow on collar, base of forewing surrounded by a yellow spot, an oblique short yellow spot near base of hindwing and a short yellow band dorsad on posterior margin. Abdomen with segment one brown black, segment two mostly brown black dorsally with yellow posterolaterally and ventrally, segment four brown black dorsally with thin yellow band on posterior margin medially gradually widening laterad with yellow covering width of segment laterally, segments five, six, seven, and anal tuft yellow except for small area anteriorly, dorsomesad on each segment. Legs mostly yellow often becoming orange distally, forecoxa brown black with wide band of yellow on outer margins, mid- and hindlegs with femora brown black, tibiae brown black dorsally at base and apex. Forewing with dark brown on wing margins, veins, and discal spot extending basad somewhat into cell and opaque apically from discal spot to distal wing margin and from vein M_2 anteriorly to costal margin, variously opaque in anal region posterior to anal fold, rest of wings hyaline. Hindwing hyaline. Female: Essentially same as male, although, there tends to be a more opaque area in cell and apically beyond vein CuA_2 on forewing of female. Wing length 12–18 mm.

Two color pattern variants of *simulans* have been described by previous workers as separate species. The color form "*luggeri*" of Henry Edwards differs from the typical form by having abdominal seg-

ments two, three, and four dorsally mostly yellow or at least the posterior half, and no brown black on the tibiae of the hindlegs. The form "*palmii*" is very similar to "*luggeri*" except the yellow patterns of the latter form are replaced with yellow orange and orange, abdominal segment one may be slightly powdered orange, and the subdorsal thoracic band on the posterior half of "*luggeri*" extends longitudinally nearly to the anterior margin of the thorax.

The larvae of *simulans* are borers in the wood of oaks (*Quercus* spp.) (Fagaceae). Various species of black oaks, white oaks and red oaks are used, with young shoots and saplings preferred, when available. According to Engelhardt (1946: 146) the early instar larva begins a shallow excavation under bulging bark, which is enlarged in the spring, before boring into the solid wood to a depth of about two inches. As in other species of *Paranthrene,* a pupal chamber is prepared near the surface in the fall of the second year and pupation occurs in the following spring.

Engelhardt (1946: 148) in his discussion of *palmii,* comments on the close similarity with *simulans* even to the extent of intermediates between the two occurring, although he maintains the two as separate species. Hosts are shared by both forms, though, in general, "*palmii*" has, to our knowledge, not been reared from species of white oaks, nor has the typical *simulans* been reared from black oaks, but this information is based on relatively few rearing lots from scattered localities. The morphology and biology of the two forms are essentially the same and differ only in color from yellow to orange ("*simulans*" to "*palmii*") and in the relative length of the subdorsal, longitudinal band on the thorax; both characters can be shown to intergrade in some specimens. On the basis of trapping studies in Mississippi, Arkansas, and Texas, Solomon (1979) speculated that "*palmii*" may be a distinct species. He captured over 2,600 males in Mississippi (mostly to a 96:4 blend of Z,Z-ODDA/E,Z-ODDA) during the period from mid-June through July. In Florida (Sharp and Eichlin, 1979), it was reported that captures of males indicated two flight periods: March–May (*simulans* ?); and June–July (*palmii* ?). In Georgia (Snow et al., 1985), apparently only *simulans* was captured (best attractant was nearly pure [99%] Z,Z-ODDA), and the flight period started in early May, peaked in late May, and ended in early July. With these facts in mind, further studies in the Southeast may prove the two populations to be distinct species, as Solomon had surmised.

Paranthrene simulans occurs from Nova Scotia and Eastern Canada to Minnesota, from Florida, Mississippi, Missouri to Texas. Engelhardt (1946: 148) mentioned that characteristic burrows of "*palmii*" were found on white scrub oak near Salt Lake City, Utah, Jemez Springs, New Mexico, and Yosemite Park, California, but he lacked specimens to verify these records. In general, the form "*palmii*" occurs in the more southern portions of the range and the form "*luggeri*" in the western.

Paranthrene pellucida Greenfield and Karandinos
PL. 1. FIG. 34.

Paranthrene pellucida Greenfield and Karandinos, 1979, *Proc. Ent. Soc. Washington,* **81**: 499.
Type locality: Arena, Iowa County, Wisconsin. [UW]

This apparent sibling species of *simulans* is most like the form "*luggeri*" in appearance; the abdomen is banded yellow on all but the first segment. The recognizable difference is that *pellucida* has hyaline forewings, lacking the suffusion of opaque scales from discal spot into cell and from M_2 to costal margin. The male and female genitalia are indistinguishable from *simulans.* The two species have overlapping host preferences; they utilize some of the same species of *Quercus* (oaks). Both have a two-year life cycle. However, they are effectively separated by having different flight seasons that may only overlap slightly at most. Adults of *simulans* are active in May and June (except form "*palmii*"; see discussion above), whereas *pellucida* adults are active in late June and July.

Paranthrene pellucida has been identified from locations from New York to Wisconsin, and several were collected in Missouri.

Paranthrene robiniae (Hy. Edwards)
PL. 1. FIGS. 24–27; PL. A, FIG. 5. TEXT FIG. 7 *c* (RWH 2526).

Sciapteron robiniae Hy. Edwards, 1880, *Bull. Brooklyn Ent. Soc.,* **3**: 72.
Type locality: Virginia City, Nevada. [AMNH]

Memythrus perlucida Busck, 1915, *Proc. Ent. Soc. Washington,* **17**: 80.
Type locality: Missoula, Montana. [USNM]

Paranthrene robiniae form *palescens* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 144.
Type locality: Palm Springs, California. [USNM]

Paranthrene robiniae is closely related to *dollii* structurally, and both species occur on the same kinds of host plants and have similar biologies. *P. tabaniformis, dollii,* and *robiniae* form a closely related group that has generally exploited the same resources in much the same manner. Distributionally, *tabaniformis* is the most widespread, extending throughout the more northern portions of the ranges of the other two species as well as in the Palearctic Region, whereas *dollii* occurs primarily in the eastern half of the United States and Canada, *robiniae* in the western half.

Male: Head with vertex mostly orange or rust; front and occipital fringe yellow or orange; labial palpus roughened, yellow with orange and brown black laterally, occasionally some orange ventrally; antenna orange, occasionally with some black apically. Thorax brown black with collar yellow, U-shaped yellow band posteriorly, yellow spot anterior of wing bases extending down posterior margin of mesothorax beneath wings, and lightly powdered with rust scales subdorsally before wings. Abdomen mostly yellow in the typical form, with segment one brown black, segment two yellow on posterior half and segment three with narrow yellow band on posterior margin, segments two and three often with rust posteriorly, occasionally replacing yellow on segment three. Legs mostly orange or red orange with some yellow especially on tarsi, coxa of forewing brown black medially, hindleg with femur brown black, and tibia dorsally and occasionally laterally shaded with brown black, tibia of hindleg with ridge of raised yellow scales on dorsum. Forewing mostly opaque, rust or dull orange, purple black on veins, except for small hyaline area mediobasally and occasionally just beyond discal spot; ventrally, forewing lighter, pale orange with some yellow. Hindwing hyaline except where orange on discal spot and in very narrow band on wing margin. Female similar to male. Genitalia with corpus bursae short and ovoid, and with two or four weakly sclerotized, longitudinal, narrow signa equally spaced on the posterior half. Wing length 11–18 mm.

Initially described as a separate species by Busck, the color form "*perlucida*" differs from the description provided above by having the abdomen and thorax mostly deep red and with yellow on the abdomen confined to a wide band on segment four and a narrow band posteriorly on segment two; however, other segments may have varying amounts of yellow intermixed. This color variant occurs in the northern Rocky Mountains of the United States and Canada. Engelhardt (1946: 144) described another color form of *robiniae* from the extreme desert regions of southern California, which he designated "*palescens.*" In this form the entire moth is pale yellow except for some slight orange powdering on the thorax, wing bases, and anteriorly on abdominal segments two and three, and occasionally four. The forewings are mixed light brown and pale yellow with some scattered pale orange.

The larvae of *robiniae* bore in poplars (*Populus* spp.). and willows (*Salix* spp.) (Salicaceae) and are attracted to weakened or damaged trees of young poplars and low-growing willows, attacking the stems and branches. We have observed that the larvae can be destructive to ornamental plantings of birches (*Betula* spp.) (Betulaceae). The life history of *robiniae* is similar to *dollii* (refer to account given for the latter species).

Some specimens of *robiniae,* especially of the color form "*perlucida,*" are very similar to specimens of *dollii,* but may be readily separated by the degree of opacity of the hindwings. The hindwings of *robiniae* are hyaline, whereas in *dollii* the hindwings are approximately ½ opaque.

Except for one record from western Kansas, present data for *robiniae* indicate a geographical range from the Rocky Mountains to the California coast, to Alaska and to the desert Southwest. Elevational records indicate *robiniae* occurs from sea level to near the timberline.

The flight period appears to be May through July throughout most of the range; however, in southern California specimens have been taken in November and in February through May.

Paranthrene dollii (Neumoegen)
PL. 1, FIGS. 17, 21–23 (RWH 2523).

Sciapteron dollii Neumoegen, 1894, *Ent. News,* **5**: 330.
Type locality: New York, New York. [USNM]

Sciapteron dollii variety *castaneum* Beutenmüller, 1897, *Bull. Am. Mus. Nat. Hist.,* **9**: 213.
Type locality: Texas. [USNM]

Paranthrene dollii form *fasciventris* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 142.
Type locality: Chicago, Illinois. [USNM]

Paranthrene dollii is similar to *tabaniformis* in many respects, especially in larval host plant preferences and habits. However, adult moths of *dollii* may be distinguished by the following characteristics. Head with vertex brown black mixed with orange; front gray black with white laterally, occasionally with some

pale orange; occipital fringe dark orange; labial palpus very rough, brown black laterally and basally, dark orange dorsally and ventrally on apical half; antenna orange with some blue black dorsally. Thorax brown black finely covered with hairlike, gray scales, a narrow yellow band on collar, yellow orange beneath the wings, a broad patch of orange brown above and before the forewing becoming orange posteriorly. Abdomen brown black with narrow yellow bands posteriorly on segments two and four; orange brown posteriorly on segment three, most of segment four, and covering all of segments five, six, and seven; anal tuft brown mixed with orange brown. Legs mostly dark orange except for some brown black on coxa of foreleg, femora, and basally and laterally on outer portion of mid- and hindtibiae; dorsal surface of hindtibia and first tarsal segments roughened. Forewing opaque, except occasionally for small hyaline spot at base, brown black with some dark orange basally between veins and along costal edge, occasionally very lightly powdered with dark orange apically; ventrally forewing orange, lighter on costal margin. Hindwing somewhat hyaline but with broad borders of brown black and brown-black discal spot; ventrally opaque areas, veins and discal spot powdered dark orange. Female genitalia with corpus bursae elongate and without signum. Wing length 12–18 mm.

In certain parts of the range, specimens of *dollii* vary in pattern sufficiently from the description above to have received nomenclatural designation by previous workers. In the northwestern portion of its range (Michigan, Indiana, Illinois, Wisconsin), there is a color form described by Engelhardt (1946) as "*fasciventris,*" in which there is a yellow band on the posterior margin of the thorax, more yellow on the labial palpus, yellow bands posteriorly on all abdominal segments, except the first, and widest on segment four, and both pairs of wings are heavily powdered with dark orange, frequently shading to yellow orange on the hindwings. The form "*castaneum*" described by Beutenmüller occurs in the southern and western parts of the range. In this variant, the orange brown of the typical *dollii* is replaced with deep red brown, the labial palpus is dark orange, and the legs are mostly deep orange with very little brown black.

The following biological information is summarized from Engelhardt (1946: 141). The larvae of *dollii* are wood borers in poplars (*Populus* spp.) and willows (*Salix* spp.). In undisturbed areas along streams and swamp borders, the species occurs sporadically; however, in disturbed areas where the host plants have been weakened and damaged, the numbers increase sharply. On willows the larvae prefer low-growing, shrubby species, as do the larvae of *tabaniformis.* The larvae of *dollii* feed only in the main trunks and branches, whereas, those of *tabaniformis* feed also in the roots. On willows, the larvae of *dollii* often are found in association with woodboring Coleoptera of the genera *Saperda* (Cerambycidae) and *Cryptorhynchus* (Curculionidae) (as are the larvae of *tabaniformis* and *robinae*). The larvae become fully grown in the fall of the second year of the two-year life cycle. At that time pupal chambers are prepared at the upper part of the burrow, capped with silk but without cocoons. The larvae overwinter and pupate in late May and June; the adults emerge two to three weeks later. In the southern part of the range the adults may be in flight as early as March. If parasitized, the larvae linger through the winter and spring, dying as the braconid wasp larvae complete their development and fill the burrow with small white cocoons. The most effective attractant baits were blends containing Z,Z-ODDOH/E,Z-ODDOH (Sharp et al., 1978; Sharp and Eichlin, 1979; Solomon et al., 1982; Snow et al., 1985).

Records indicate *dollii* (typical specimens) occurs in the northeastern United States from Massachusetts to Virginia; "*castaneum*" specimens from Virginia to Florida, to Texas and Arizona and in the Mississippi Valley to Missouri; and "*fasciventris*" specimens in the northern Midwest from Michigan and Wisconsin.

Paranthrene tabaniformis (Rottemburg)
(Dusky Clearwing)
PL. 1, FIGS. 35–38. TEXT FIGS. 1; 7 *a, b* (RWH 2524).

Sphinx tabaniformis Rottemburg, 1775, *Der Naturforscher,* **6**: 110.
Type locality: Landsberg an der Warthe, Germany. [lost]

Sphinx asiliformis [Denis and Schiffermüller], 1775, *Verzeichniss der Schmetterlinge der Wiener Gegend,* 305.
Type locality: Vienna, Austria. [destroyed]

Sphinx rhingiaeformis Hübner, 1790, *Beiträge zur Geschichte der Schmetterlinge,* 89.
Type locality: [Augsburg, Germany]. [lost]

Aegeria tricincta Harris, 1839, *Amer. Jour. Arts and Sci.,* **36**: 310.
Type locality: Massachusetts. [MCZ]

Sphinx serratiformis Freyer, 1842, *Neuer Beiträge zur Schmetterlingskunde,* **4**: 130.
Type locality: Hanover, Germany. [lost]

Albuna denotata Hy. Edwards, 1882, *Papilio,* **2**: 55.
Type locality: Montana Territory. [AMNH]

Paranthrene tricincta form *oslari* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 140.
Type locality: Bear Creek, Morrison County, Colorado. [USNM]

NOTE—Engelhardt (1946: 139) commented on the close similarity between *tricincta* Harris and *tabaniformis,* which he considered to occur only in Europe. However, he maintained *tricincta* as the North American element of a closely related species pair on the basis of slight differences in the male genitalia. Our studies suggest that these differences are well within the normal range of variation in the species and do not justify maintaining *tricincta* as a separate species.

Paranthrene tabaniformis is very similar to *dollii* in many respects; however, males of *tabaniformis* may be distinguished by the following characters. Head with vertex blue black; front gray black with white laterally; occipital fringe yellow; labial palpus strongly roughened, blue black with yellow ventrally on apical half and some yellow dorsally; antennae blue black, dull orange ventrally, at apex, and dorsally on basal half. Thorax blue black with yellow laterally near anterior margin and beneath wings, yellow around base of forewing and a small spot of yellow subdorsally on posterior margin. Abdomen blue black with yellow bands posteriorly on segments two, four, six, and seven; anal tuft blue black. Legs with coxae blue black laterally shaded with yellow; femora blue black with white hairlike scaling ventrally on the mid- and hindlegs; tibiae blue black basally, also apically on midleg, orange on apical half and somewhat roughened dorsally; tarsi with first segment yellow or yellow orange, remaining segments blue black mixed with yellow. Forewing primarily opaque but with some hyaline area mediobasally, brown black powdered with rust basally, along anal margin, and narrow streak between veins Sc and R; ventrally costal margin powdered yellow or yellow orange, with scattered orange in cell and strongly powdered dull orange between veins in apical region. Hindwing mostly hyaline, dorsally with brown-black scaling on veins and discal spot and in narrow band at wing margins; ventrally wing margin and discal spot strongly powdered orange. Females are patterned as for males except abdominal segment seven sometimes with two weak, longitudinal yellow streaks. Corpus bursae ovate with one longitudinal pigmented signum. Wing length 8–14 mm.

Within the range of superficial color and pattern variation in North America, two types have been singled out by previous workers. From the description provided above, the form "*denotata*" differs by having abdominal segments three and five narrowly edged posteriorly with yellow in both sexes and the anal tuft of the males mixed with some yellow. The form "*oslari*" has all abdominal segments except segment one with yellow bands, widest on segments two and six, narrower on three and five; the female has more yellow than the male on all the segments mentioned.

The larvae feed primarily on willows (*Salix* spp.), preferring low-growing shrubby types but also have been reported by several researchers on poplar (*Populus* spp.) (more recent reports include: Anonymous, 1961; MacKay, 1968a; Abrahamson and McCracken, 1972; Baker, 1972; Nielsen, 1974; Solomon and Abrahamson, 1972; Morris et al, 1975; Cook and Solomon, 1976). The larvae bore in exposed roots, stems and branches as well as the galls and swellings produced by the larvae of *Saperda* (Cerambycidae). Mature larvae spend the final winter of their two-year life cycle in pupal chambers constructed in the upper portion of their tunnels, which are capped above and below and provide access to circular exits concealed under a cover of silk and bark. Pupation occurs in the following spring, adults emerge in late spring and summer. The flight period is from late May through August.

This species is holarctic in distribution; in North America *tabaniformis* occurs from the eastern half of the United States through the Midwest (recorded from Oklahoma) and Rocky Mountains, across southern Canada and north into Alaska. Large numbers of males were captured in traps baited with sex attractants (mostly E,Z-ODDOH) in Mississippi (Solomon, 1979; Solomon et al., 1982) and Georgia (Snow et al., 1985).

Paranthrene fenestrata Barnes and Lindsey
PL. 1, FIGS. 18–20 (RWH 2525).

Paranthrene fenestratus Barnes and Lindsey, 1922, *Bull. Brooklyn Ent. Soc.,* **18**: 122.
Type locality: Chiricahua Mts., Cochise Co., Arizona. [USNM]

This species was known from three females collected in southeastern Arizona in June 1916 until males, which are described here for the first time, were

recently collected at high elevations in northern and western Colorado, western New Mexico, Utah, and in the state of Hidalgo, Mexico.

Adults: Head, except for apex of antenna, which is orange on specimens found north of Mexico, thorax, abdomen, and legs uniformly brown black. Forewing opaque, orange with brown-black shading basally, on costal and anal margins, very narrowly along outer margin and powdered on veins R and CuA basad of cross veins; fringe brown tipped with pale orange. Hindwing orange, but with hyaline areas between M_3 and CuA_1, CuA_1 and CuA_2, CuA_2 and anal fold (CuP), anal fold and 1A, and 1A and wing margin. Specimens from Mexico sometimes have a hyaline area only between 1A and the wing margin and somewhat between CuA_2 and the anal fold.

A very distinctive color form was initially collected along with the typical form at Emory Pass, 8,200–8,400 feet elevation, Sierra County, New Mexico, 11 July 1977. Males of both forms have been found in most locations. They were attracted to a bait (mostly Z,Z-ODDA). The scale arrangements on the wings are similar, but the color patterns overall are different. This new form is superficially different from the typical orange and black form: Head with vertex, occipital fringe, front, labial palpus, and antenna pale yellow and pale orange, some white laterally on front and ventrally on labial palpus. Thorax with pale yellow and pale orange on collar and forming a spot laterally before wing base, powdered with some deep orange dorsally. Abdomen dorsally with narrow pale-yellow bands with orange powdering on posterior margin of segments two, three, and four; segment five with yellow expanding laterally, six, seven, and anal tuft mostly or entirely pale-yellow; ventrally with broader pale-yellow bands on segments two, three, and four, and five to tip of abdomen solid pale yellow. Legs with forecoxa mostly pale yellow, orange and black medially; tibiae with much orange; tarsi pale orange and yellow. Wings as for typical form, including same hyaline areas, but with much brown black on veins, narrowly on margins and powdered on apical region. The yellow and black form looks much like *robiniae* but differs most noticeably by the extensive opaque areas of the hindwings, the hindwings of *robiniae* being hyaline. A slightly different color form than the one just described was collected with the same sex attractants in Larimer and Mesa counties, Colorado.

Superficially, typical *fenestrata* resembles the females of *Alcathoe autumnalis* Engelhardt (Sesiinae), which also occur in the southwestern United States. Characters of both the genitalia and wing venation indicate *fenestrata* is correctly placed in *Paranthrene* and that the resemblance to *autumnalis* is superficial.

Nothing is known concerning the life history of *fenestrata.* The New Mexico collections were made in an area which is predominantly an oak-pine association. The area contains several species of both red and white oaks, some of which may prove to be hosts for *fenestrata.*

Knowledge of its distribution is limited to: Chiricahua Mountains, 9,000–9,800 feet, Cochise County, Arizona; Black Mountains, Emory Pass, 8,200–8,400 feet, Sierra County, New Mexico; Ft. Collins, Larimer County, and Mesa Creek along Highway 65, Mesa County, Colorado; Pleasant Grove, Utah Co., Utah; 13 km northeast of Jacala, 1,570 m, and 26 km south of Jacala, 1,980 m, Hidalgo, Mexico.

GENUS

Vitacea Engelhardt

> *Vitacea* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 151.
> Type species: *Aegeria polistiformis* Harris, 1854. Original designation.

Vitacea consists of four species in our area and is closely related to *Paranthrene* both structurally and biologically. As the generic name implies, the larvae in this group feed on vines in the Vitaceae, feeding in the horizontal roots. *Vitacea* may be distinguished from *Paranthrene* biologically in that the larvae of *Vitacea* before pupation construct a cocoon, which is either attached to the tunnel or separate in the adjacent soil; whereas, in *Paranthrene* pupation takes place within the tunnel without a cocoon. Structurally, species of *Vitacea* may be separated from other Paranthreninae by the more heavily scaled anal fold (CuP) in the hindwing and the presence on the tip of the abdomen in the males of two pairs of slender scale tufts (hair pencils), the longer pair subdorsad and the shorter pair laterad (text figure 8). The major differentiating character in the male genitalia in species of *Vitacea* is the absence of an apical spine on the aedoeagus in most instances, otherwise, the genitalia of the two genera are very similar.

The life cycle of one species, *polistiformis,* requires two years for completion (Engelhardt, 1946: 153). Eggs are deposited on foliage, stems, or on the ground and hatch in two to three weeks. Newly hatched larvae burrow down to the horizontal roots

beneath the soil where they feed until maturity in the early summer months of the second year. Pupation occurs in a cocoon constructed either in the larval gallery or in the soil near the surface. Adults emerge in three to four weeks.

MacKay (1968a: 16) described the larvae of *Vitacea* as follows: ocelli I to IV extremely close together; seta O^2 adjacent to ocellus I, ventral and somewhat anterior to it, seta O^1 very near ocelli III and IV and nearly between them, seta O^1 and O^2 exceptionally close to each other; seta SD1 on segment 8 distinctly anterior to the spiracle; seta D1 on segment 9 is always somewhat anterodorsal to SD1; the shape of the anal shield without modification; crochets in early instars as well developed as in *Paranthrene,* becoming poorly developed (short and broad) in later instars, and noticeably reduced in number on segment 6 and anal prolegs.

KEY TO SPECIES OF *VITACEA*

1. Hindwings with area between veins CuA_1 and CuA_2 mostly or entirely opaque 2
— Hindwings with area between veins CuA_1 and CuA_2 hyaline 3

2. Hindleg with tibia mostly orange or red orange dorsally; collar yellow dorsally ..... *admiranda* p. 41
— Hindleg with tibia brown black dorsally with yellow orange or red orange basally; collar deep orange to rust red dorsally ..... *scepsiformis* p. 40

3. Abdominal segments four, five, six, and seven mostly or entirely yellow dorsally ..... *cupressi* p. 41
— Abdominal segments with different color pattern ..... *polistiformis* p. 39

Vitacea polistiformis (Harris) (Grape Root Borer*)

PL. 1, FIGS. 41–44; PL. A, FIG. 6 (RWH 2530).

Aegeria polistiformis Harris, 1854, *Proc. Amer. Pomological Soc. Cong.,* 216.
Type locality: Southeastern United States. [MCZ]

Sciapteron seminole Neumoegen, 1894, *Ent. News,* **2**: 330.
Type locality: Florida. [USNM]

Vitacea polistiformis form *huron* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 154.
Type locality: Pentwater, Michigan. [USNM]

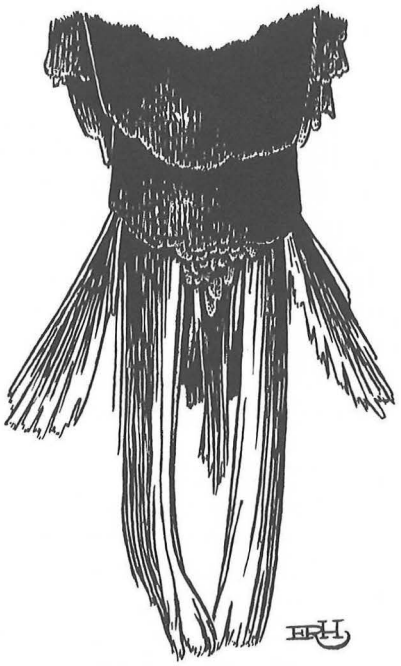

FIGURE 8: ANAL TUFTS OF MALE *VITACEA SCEPSIFORMIS*

This species is of considerable economic importance as a root borer of cultivated grapes (Jubb, 1982: 20) and has received a great deal of attention in the economic literature. The adults, according to Engelhardt (1946: 153), mimic wasps of the genus *Polistes* in both behavior and appearance. Male: Head with vertex orange; front gray, occasionally with some pale yellow laterally; occipital fringe deep orange; labial palpus roughened, orange mixed with brown basally and laterally; antenna orange with varying amounts of brown black dorsally. Thorax brown, yellow laterally near anterior margin, in front and beneath wing bases, and yellow with orange transversely on posterior edge of mesothorax and subdorsally on metathorax, frequently with a subdorsal, narrow, longitudinal orange stripe. Abdomen brown or brown black, often lighter brown on segments, five, six, and seven, a very narrow yellow band on posterior margin of segments two, four, and often slightly visible on six, latter two segments with bands dull orange instead of yellow, most segments variously powdered dull orange laterally and ventrally; anal tuft orange mixed with some brown. Legs orange with brown black on femora, laterally on tibiae, basally and medially on coxa of foreleg; hindtibia strongly roughened with orange scales dorsally. Dorsally, forewing opaque, brown black except for a small hyaline area mesobasad and with rust-red

scaling basally on anal margin; ventrally liberally dusted with orange, paler basally and along costal margin. Hindwing hyaline except for brown black narrowly along wing margin, widest at anal angle, moderately wide strip on anal fold (at least twice as wide as in species of *Paranthrene*), and brown-black scaling on veins and discal spot dorsally; ventrally powdered with orange along anal margin. Female: similar to male except for more rust red on forewing, particularly in cell, and usually more rust-red powdering on abdomen. Corpus bursae with two longitudinal, weakly sclerotized signa, unlike other species of genus where signum absent. Wing length 12–19 mm.

Two extreme color variants of *polistiformis* have been named by previous workers. Males of the form "*huron,*" which occur in the more northern portion of the range, differ from the description above by having mixed yellow, orange, and rust red between veins dorsally and ventrally on forewings, on the veins, margins and discal spot dorsally and ventrally on hindwings, and variously powdered on abdomen, especially on terminal segments. In addition, occipital fringe laterally, distal margin of coxae and lateral surface of tibiae with yellow scales; relatively wide yellow band posteriorly on abdominal segment four dorsally and ventrally; and yellow on the margins of most abdominal segments ventrally. The form "*seminole,*" described originally as a distinct species, occurs in the southern portion of the range and is known only from female specimens. In the extreme variation of this form the labial palpus, thorax, abdomen, and legs are mostly rust red. Both forms mentioned intergrade fully with the more widely distributed nominate form.

Larvae of *polistiformis* bore in the horizontal roots of cultivated grapes as well as other species of *Vitis* (Vitaceae). Engelhardt (1946: 153) reported rearing this species from fox grape, *Vitis labrusca* Linnaeus, the first known case of its occurrence on a wild species (refer to the following for comprehensive summaries on the life history: Brooks, 1907; Clark and Enns, 1964). The female lays 300 to 400 eggs on the ground, foliage, or stems either singly or in small clusters. The larvae hatch in two or three weeks, burrow down to the roots and begin a gallery beneath the bark that is gradually enlarged as the larvae develop to maturity in the early summer of the second year. Fully developed larvae leave the galleries and pupate in a tough cocoon constructed in the soil near the surface. Adults emerge three to four weeks after pupation, in late May and June in warmer areas, late July and August in cooler parts of the range. Flight period is from May until September depending on the area.

Vitacea polistiformis occurs in the Atlantic and Gulf Coastal Plains from New York south to Florida and west to Texas; the Appalachian Plateaus, ridges and valleys in Pennsylvania (Jubb, 1982), West Virginia, and North Carolina; and the central lowlands of the Midwest in Illinois, Indiana, and Michigan.

Vitacea scepsiformis (Hy. Edwards)
PL. 1, FIGS. 48, 49. TEXT FIG. 8 (RWH 2531).

Sciapteron scepsiformis Hy. Edwards, 1881, *Papilio,* **1**: 183.
Type locality: Texas. [USNM]

Vitacea scepsiformis is very similar to *polistiformis* and has a similar life history. It can be separated from *polistiformis* by a number of characters including the greater degree of opacity on the hindwings, especially between veins CuA_1 and CuA_2 and by the brown-black area dorsad on the hindtibia. Both *scepsiformis* and *polistiformis* resemble common species of the wasp genus *Polistes* (Vespidae), and, according to Engelhardt (1946: 157), *scepsiformis* is almost impossible to distinguish in flight from *P. fuscatus* (Fabricius). Male: Head with vertex dark brown often mixed with rust red; front gray; occipital fringe deep orange to rust red becoming yellow ventrally; labial palpus roughened, pale yellow dorsobasally, orange ventrally and apically, mixed with brown black laterally and ventrally on basal half; antenna orange, dorsally brown black, orange apically. Thorax dark brown, yellow laterally at anterior margin and posterior margin of mesothorax beneath the wings, with wide subdorsal patches of orange brown and rust brown dorsally on posterior half and along the posterior margin of mesothorax. Abdomen brown black variously powdered orange brown especially dorsad on segments three and four, with narrow, yellow band on posterior margin of segment two dorsally, sometimes four, and to some degree on six and anal tuft; anal tuft with shorter lateral pair of hair pencils brown black and subdorsal pair brown black basally becoming yellow toward apex. Foreleg with coxa brown black powdered with rust red, femora of all legs brown black with varying amounts of orange; tibia of hindleg brown black with oblique patch of yellow from middle pair of spurs basad to dorsum, becoming mixed with orange and roughened, tarsi yellow with orange at base of first tarsal segment, which is somewhat roughened on hindleg. Forewing opaque; dorsally

brown black on costal margin, veins, and fringe, powdered variously with red brown along anal margin, in cell and between veins, and a few yellow scales at wing base; ventrally both wings powdered dark orange on veins and opaque areas. Hindwing hyaline with brown black on veins, discal spot, in a relatively wide marginal band, strongly on anal fold (CuP) and between veins CuA_1 and CuA_2, expanding distally to opaque margin, and spreading below CuA_2; yellow basad on anal margins. Females tend to have more rust red throughout and broader opaque areas on the hindwings. Wing length 12–16 mm.

A Floridian specimen has the hindwings mostly opaque with the hyaline area restricted to the basal third. One from Atlanta, Georgia has the abdomen mostly red brown with narrow yellow bands on segments four and six as well as the normal band on segment two, and the typical brown-black area of the hindtibiae is replaced with rust red.

The larvae of *scepsiformis* are borers in the upper main and branching horizontal roots of species of *Vitaceae.* Engelhardt (1946: 157) reported the only food plant and rearing records available were *Parthenocissus quinquefolia* (Linnaeus) Planch (Virginia creeper) and *P. tricuspidata* Planch var. *veitchii* Rehder. Larvae feed under the bark on the soft fibers, avoiding the hard central core. During late June and July of the second year, elongated cocoons of silk, chips, and earth usually are constructed under the bark at the upper ends of the galleries but occasionally in the adjoining soil. Pupation takes from three to four weeks. The flight period extends from July to October. Males are attracted to synthetic baits (Z,Z-ODDA, usually blended with lesser quantities of E,Z-ODDA or E,Z-ODDOH) (Sharp et al., 1978; Sharp and Eichlin, 1979; Solomon et al., 1982; Snow et al., 1985).

Collection records indicate a distribution extending from New York to southern Florida and west to Texas, Arkansas, and Missouri.

Vitacea admiranda (Hy. Edwards)
PL. 1, FIG. 39 (RWH 2528).

Sciapteron admirandus Hy. Edwards, 1882, *Papilio,* **2**: 54.
Type locality: Texas. [AMNH]

Vitacea admiranda is most similar to *scepsiformis* in wing maculation; however, it is easily separated on the basis of color differences of the head, abdomen, and legs. Male: Head with vertex yellow, brown posteriorly; front white or pale yellow; occipital fringe yellow; labial palpus roughened, yellow or yellow orange, rust red basally; antenna orange, somewhat brown black dorsally, especially near apex. Thorax brown black, yellow orange laterally near anterior margin of mesothorax, beneath and around base of wings, along posterior margin of mesothorax and metathorax, and with rust red subdorsally on anterior half and mixed with yellow, hairlike, scale tufts laterally on metathorax. Abdomen with segment one brown black, segment two anteriorly with narrow band of brown black and rust red followed by larger band of orange yellow and terminated by a narrow band of brown black on posterior margin, segment three mostly rust red bordered with brown black, segment four orange yellow bordered with brown black, segments five, six, and seven, orange red bordered with yellow or brown black; anal tuft with hair pencils brown black. Legs with coxae brown black basally, orange red and yellow apically, femora brown black with orange apically, hindtibia with brown black basally and somewhat apically, mostly rust red with a yellow diagonal stripe medially, dorsally roughened as on hind-tarsi, which are mostly orange red or rust red, other tibiae mostly orange with brown black laterally. Forewing opaque, brown black with light powdering of yellow and orange in cell, anal region, and slightly between veins apically. Hindwing hyaline with typical areas of scaling, brown black on the veins, discal spots, anal folds, and variously between veins CuA_1 and CuA_2, and orange red basally. Aedoeagus with apical spine as found in the genus *Paranthrene* and unlike other species of *Vitacea* where this structure is absent. Female similar to male, except occasionally opaque areas of hindwing somewhat more extensive. Wing length 12–15 mm.

Nothing is known about the life history of *admiranda.* Engelhardt (1946: 158) indicated that the two specimens captured in San Antonio, Texas were taken along open roadside hedges composed principally of wild grape (*Vitis* sp.) and *Ampelopsis* sp. and that these are the probable host plants for *admiranda.* However, efforts to discover larvae and their workings in such hedges proved unsuccessful.

This species is known from Texas, the holotype presumably from near Dallas (Engelhardt, 1946: 158), and two additional specimens collected by H. B. Parks in San Antonio.

Vitacea cupressi (Hy. Edwards)
PL. 1, FIG. 40 (RWH 2529).

Sciapteron cupressi Hy. Edwards, 1881, *Papilio,* **1**: 183.
Type locality: Colorado. [USNM]

Superficially, *cupressi* bears a remarkable resemblance to *Paranthrene robiniae*; however, *cupressi* is readily distinguished by having four anal hair pencils and a more broadly scaled anal fold on the hindwing. Engelhardt (1946: 156) indicated that he suspected that when more material of *cupressi* became available, the species would prove to be a western race of *polistiformis*. We are unable to shed further light on this situation, because no additional material has been found. Male: Head with vertex orange, perhaps with some brown black posteriorly; front orange, occasionally with brown black medially and some white laterally; occipital fringe mixed yellow and orange, often paler laterally; labial palpus roughened, yellow with orange basally; antenna orange with brown black dorsally near apex. Thorax brown black with yellow and orange on collar, yellow at base of wings and in a narrow band on posterior margin of mesothorax, with hairlike yellow and orange scales mixed laterally on metathorax. Abdomen dorsally yellow except for segment one, which is brown black, and segment two, which is brown black anteriorly, brown posteriorly with a narrow posterior margin of brown black; ventrally yellow restricted to posterior margins of abdominal segments; hair pencils of anal tuft yellow and brown. Legs yellow and orange with brown black on femora, hindtibia dorsally roughened, orange. Forewing dorsally opaque, dark brown with a strong powdering of orange and yellow near anal margin, in cell and between veins beyond cell; ventrally, both fore- and hindwings strongly powdered with yellow and orange. Hindwings hyaline except for dark brown on margins, veins, discal spot, and prominently on anal fold (CuP), and with yellow and orange basally and along anal margins; fringes dark brown. Female occasionally somewhat paler. Wing length 13–16 mm.

Host plant information and other biological data are lacking for this species although Engelhardt (1946: 156) assumed it to be a root borer in grape as are the other species in the genus. The four specimens known of *cupressi* are in poor condition and incompletely labelled.

This species is currently known only from Utah, Colorado, and Arizona.

GENUS

Albuna Hy. Edwards

Albuna Hy. Edwards, 1881, *Papilio,* **1**: 186. Type species: *Aegeria hylotomiformis* Walker, 1856, now considered to be a junior synonym of *Aegeria pyramidalis* Walker, 1856. Original designation.

Harmonia Hy. Edwards, 1882, *Papilio,* **2**: 54. Type species: *Harmonia morrisoni* Hy. Edwards, 1882, now considered to be a synonym of *Carmenta fraxini* Hy. Edwards, 1881. Original designation.

NOTE—*Harmonia* Hy. Edwards, 1882, is a junior homonym of *Harmonia* Mulsant, 1846 in the Coleoptera, *Harmonia* Haswell, 1879 in the Crustacea, and *Harmonia* Hartman, 1881 in the Mollusca.

Parharmonia Beutenmüller, 1894, *Bull. Amer. Mus. Nat. Hist.,* **6**: 89.

NOTE—*Parharmonia* is a replacement name for *Harmonia* Hy. Edwards, 1882.

Albuna is a small genus of only two species in North America and, like *Vitacea,* is closely allied to *Paranthrene. Albuna* is readily distinguished by the following characters. Forewing with stalk of veins R_4 + R_5 not joined to base of R_3 as is the case in *Paranthrene*; antenna of males clavate, ventrally ciliate and with terminal scale tuft but not pectinate as in *Paranthrene*; maxillary palpus two segmented, third segment of labial palpus approximately ½ as long as second; and haustellum approximately three times length of labial palpus. Genitalia very similar to those found in *Paranthrene*; however, uncus in *Albuna* species with coarse, mostly erect scales dorsally; species of *Paranthrene* with soft, hairlike scales on dorsum of uncus that project ventrally; gnathos of *Albuna* with toothlike spines apically that are lacking in *Paranthrene.*

MacKay (1968a: 18) characterized the larvae of *Albuna* as follows: ocelli I, II, and VI usually faint, VI often absent; seta O^2 some distance from ocellus I and anterior to it, seta O^1 usually near ocellus III, setae O^1 and O^2 unusually close to each other as in *Vitacea* but for a different reason; seta SD1 on segment 8 is anterior to the spiracle; seta D1 on segment 9 is dorsal to SD1; anal shield not modified; crochets as in *Vitacea*; mandibles with outer surfaces distinctly shagreened or at least dull in appearance and reticulated.

Larvae of *Albuna* are borers in the horizontal roots of species of Onagraceae and Vitaceae (Engelhardt, 1946: 163, 168), and evidence from rearings indicates that the life-cycle requires one year for completion. Pupal exuviae can be found protruding from the bases of host plants following emergence of the adults in summer. The cocoon is constructed in the vertical tunnels just below the surface of the ground. The larval tunnels lead down to the roots one or two feet below the surface.

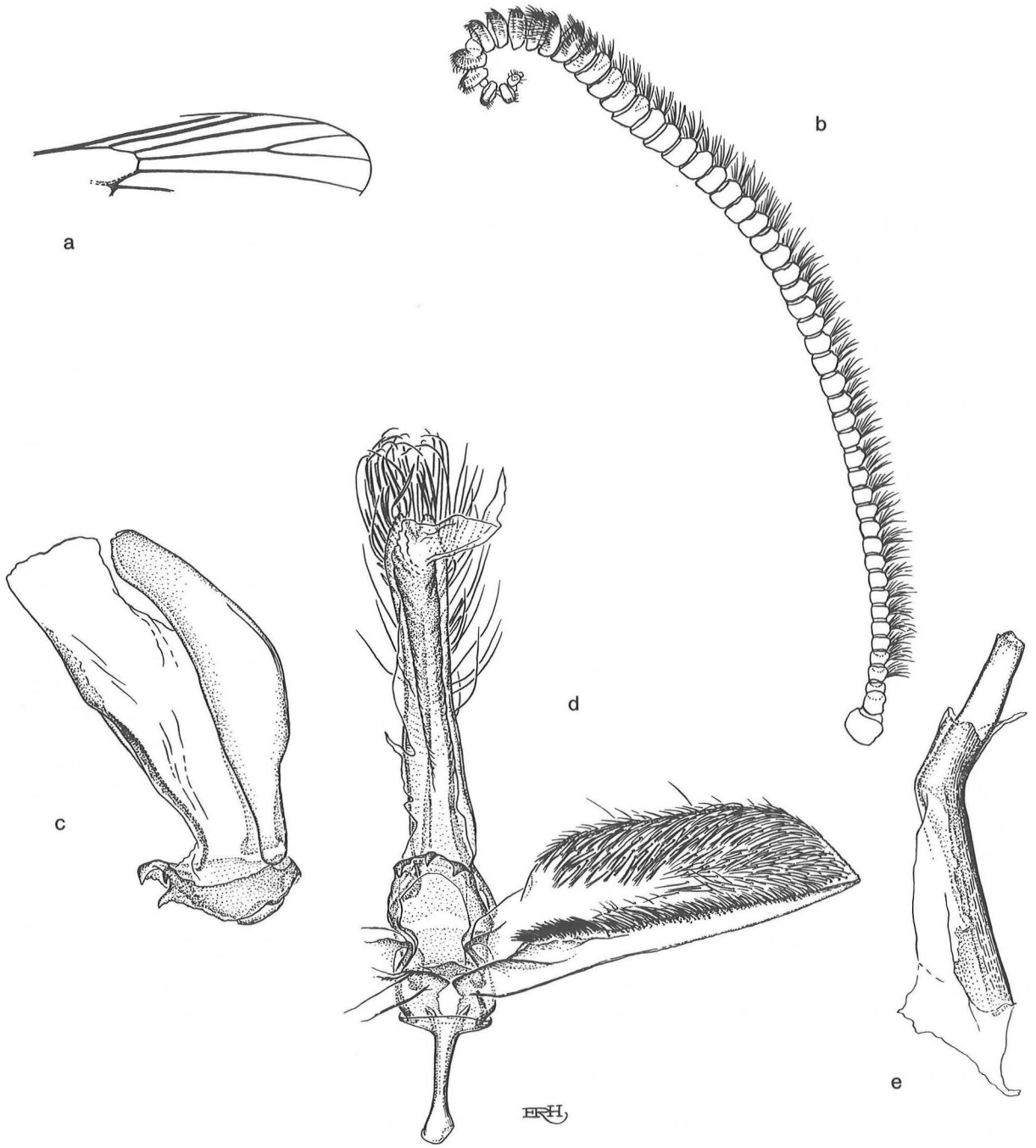

FIGURE 9: STRUCTURES OF *ALBUNA PYRAMIDALIS*

a. Partial forewing venation of male (AB[usck] 1907). *b.* Antenna (USNM 75874). *c.* Lateral view of tegumen and uncus (USNM 75804). *d.* Male genitalia (left valve and aedoeagus omitted) (USNM 75804). *e.* Aedoeagus (USNM 75804).

KEY TO THE SPECIES OF *ALBUNA*

1. Antennae with pale yellow toward apices .. *fraxini* p. 45

— Antennae without pale yellow ..... *pyramidalis* p. 43

Albuna pyramidalis (Walker)

PL. 1, FIGS. 50–54. TEXT FIG. 9 *a–e* (RWH 2533).

Aegeria pyramidalis Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 40.

Type locality: St. Martin's Falls, Albany River, Hudson's Bay [Canada]. [BMNH]

Aegeria hylotomiformis Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 43.
Type locality: Nova Scotia. [BMNH]

Sesia nomadaepennis Boisduval, 1869, *Ann. Soc. Ent. Belgique,* **12**: 63.
Type locality: California. [USNM]

Sesia rubescens Hulst, 1881, *Bull. Brooklyn Ent. Soc.,* **3**: 76.
Type locality: Colorado. [AMNH]

Albuna montana Hy. Edwards, 1881, *Papilio,* **1**: 188.
Type locality: Colorado. [AMNH]

Albuna tanaceti Hy. Edwards, 1881, *Papilio,* **1**: 188.
Type locality: Sierra Nevada, California. [AMNH]

Albuna vancouverensis Hy. Edwards, 1881, *Papilio,* **1**: 188.
Type locality: Vancouver Island. [AMNH]

Albuna coloradensis Hy. Edwards, 1881, *Papilio,* **1**: 189.
Type locality: Colorado. [AMNH]

Albuna torva Hy. Edwards, 1881, *Papilio,* **1**: 189.
Type locality: Vancouver Island. [AMNH]

Albuna beutenmulleri Skinner, 1903, *Ent. News,* **14**: 126.
Type locality: Stockton, Utah. [ANSP]

Albuna pyramidalis is well represented in most collections, an indication of its common occurrence wherever its host plants are established. It can be recognized readily by the wide, oblique discal mark on the forewings even though there is a wide range of variation in other superficial patterns as evidenced by the number of names that have been applied by previous workers. Male: Head with vertex blue black; front yellow white; occipital fringe pale yellow; labial palpus roughened, pale yellow with black laterally; antenna blue black dorsally, pale orange ventrally. Thorax blue black with pale yellow at the base of the tegulae and a pale-yellow area before and beneath base of forewings. Abdomen blue black dorsally with posterior margin of each segment narrowly marked with pale yellow except for segment one, which is unmarked, and segment three, which is only faintly marked with pale yellow; each segment ventrally with pale yellow on posterior margins; anal tuft black with pale yellow laterally and often slightly divided medially. Legs primarily blue black marked laterally with yellow on the coxa of foreleg, base and spurs on tibia of midleg, at both pairs of spurs on tibia of hindleg, and mixed with black on tarsi. Forewing hyaline in cell and variously hyaline beyond discal spot, discal spot broad, oblique, brown black outlined variously with orange red, apex of wing and costal margin broadly brown black; veins and fringe brown black with orange-red shading between veins above and especially below cell; considerably more orange-red shading on ventral surface. Hindwing mostly hyaline with brown black narrowly along wing margins, veins, fringe, and discal spot. The wings of *pyramidalis* vary from entirely black to strongly orange red. Color patterns of females have essentially the same range of variation as found in the males. Pale-yellow bands on abdomen, when present, usually broader, and anal tuft very short. Wing length 8–14 mm.

Engelhardt (1946: 164–167) recognized four color forms in addition to the typical pattern. Form "*coloradensis*" refers to specimens that are almost entirely black and occur throughout the range of the typical form. Form "*montana*" was proposed for specimens that have somewhat more red on the forewings and are a nebulous entity. The form "*rubescens*" refers to specimens from Colorado and Utah, with the discal spot of the forewing broadly outlined with orange red, the dark apical area broadly orange red basally, mixed with some pale yellow on the costal margin, more orange red on the anal margin between the veins, and heavily shaded with orange red ventrally. The hindwings of this form have orange red on the anal fold (CuP), below 1A, and in a narrow band around the wing margins. The most distinctive form, "*beutenmulleri*" from Utah, is characterized by having both pairs of wings strongly opaque with orange red, often with no black on the discal spots, the wing margins marked with varying widths of black, and the labial palpus, occipital fringe, and legs entirely black or yellow and black. After studying large numbers of specimens from throughout the range of *pyramidalis,* it becomes obvious that the distinctions implied by the application of form names do not occur but rather that the species is highly variable in color pattern. Genital structures are quite constant throughout the geographic range of *pyramidalis.*

The larvae of *pyramidalis* are borers in the main

roots of *Epilobium latifolium* (Linnaeus) Sweet, *E. angustifolium* (Linnaeus) Scopoli and *Oenothera biennis* Linnaeus (Engelhardt, 1946: 163, 166). The larvae bore into the main roots as much as one to two feet below the surface of the ground, and overwinter in specially constructed, oblong cocoons in which pupation occurs in the spring. The cocoons are located just below the soil surface at the upper ends of vertical silk tunnels, which are external to the plant, leading down to the main roots. The adult flight period is from late May to mid-August with most capture records in June and July. The adults are attracted to flowers, especially of umbelliferous plants, and, according to Engelhardt (1946: 164), the rapidly flying males hover over the blossoms while the heavier and more sluggish females rest on the foliage or on the flowers.

Present records indicate a range for *pyramidalis* which extends probably throughout most provinces of Canada, Alaska, the northeastern United States, northern Michigan and Wisconsin, throughout the Rocky Mountains, the Cascades and Sierra Nevada to the Pacific coast.

Albuna fraxini (Hy. Edwards)
PL. 1, FIGS. 45–47; PL. A, FIG. 7 (RWH 2532).

Carmenta fraxini Hy. Edwards, 1881, *Papilio,* **1**: 185.
Type locality: Washington, D. C. [lost]

Harmonia morrisoni Hy. Edwards, 1882, *Papilio,* **2**: 55.
Type locality: Montana Territory. [AMNH]

Albuna fraxini form *vitriosa* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 169.
Type locality: Chicago, Illinois. [USNM]

Albuna fraxini shows close affinities with *pyramidalis,* especially in structures of the genitalia. Male: Head with vertex brown black; occipital fringe brown black, occasionally mixed with some yellow; front brown black, often lighter brown; labial palpus only slightly roughened, pale yellow with brown black dorsally and laterally; antenna dorsally pale yellow marked with brown black on basal half and at apices, orange ventrally. Thorax brown black, occasionally mixed with some brown and yellow on tegula, yellow orange laterally before wings, yellow on anterior margin of collar and long tufts of silky-white scales laterally behind the wings. Abdomen brown black, powdered variously with pale yellow and white ventrally; anal tuft fan shaped. Legs brown black, except for pale yellow basally on coxa of foreleg and on all tarsi, though often heavily powdered with brown black, often with white on inner surface of tibiae of hindleg. Forewing mostly opaque except for hyaline streaks above and below cubitus near wing base, opaque area brown black with orange or rust red on apical margin of discal spot. Hindwing mostly hyaline with brown black in a narrow band along wing margins, on discal spot, veins, and fringe. Ventrally, wings variously powdered with pale yellow, especially on costal margins and on veins on basal half; and forewing with more orange or rust red on discal spot and apically between veins than on dorsal surface. Female: similar to male but with wings deeper black, other parts of body somewhat blue black, legs entirely black, and forewing often entirely opaque or with a narrow hyaline streak basally. Wing length 8–15 mm.

Engelhardt (1946: 169) proposed "*vitriosa*" for males that have extensive hyaline areas on the forewings, a state that is well within the range of variation for this character and which does not require formal designation.

The larvae of *fraxini* are root borers in Virginia creeper, *Parthenocissus quinquefolia* (Linnaeus) Planch (Vitaceae) (Engelhardt, 1946: 168). Additional details of the larval life history are unknown. Capture records indicate the flight period is from June through mid-August.

Records indicate that *fraxini* occurs from New England west to the Rocky Mountains in Colorado, no farther south than Illinois and Kansas and not farther north than North Dakota and Michigan. It has not been recorded from Canada.

GENUS
Euhagena Hy. Edwards

Euhagena Hy. Edwards, 1881, *Papilio,* **1**: 180.
Type species: *Euhagena nebraskae* Hy. Edwards, 1881. Original designation.

Larunda Hy. Edwards, 1881, *Papilio,* **1**: 182.
Type species: *Larunda solituda* Hy. Edwards, 1881, now considered to be a synonym of *Aegeria emphytiformis* Walker, 1856.

NOTE—*Larunda* Hy. Edwards, 1881, is a homonym of *Larunda* Hübner, 1816 in the Geometridae.

Gaea Beutenmüller, 1896, *Bull. Amer. Mus. Nat. Hist.,* **8**: 115.

NOTE—*Gaea* is a replacement name for *Larunda* Hy. Edwards, 1881.

Euhagena is a small genus of only two species. Careful examination of the species involved indicated that the few differentiating structures used to distinguish *Gaea* were inadequate, in view of the numerous characteristics the species have in common, to warrant their continued separation.

A number of characteristics serve to distinguish *Euhagena* from the other genera in the Paranthrenini; however, possibly the most interesting of these is the rudimentary haustellum, which is unique in the subfamily. Reduction of the haustellum occurs in genera of both the other subfamilies and indicates probable parallel evolution within the family. Eyes (eye index: 1.08–1.18) proportionally larger than those found in the genus *Zenodoxus*. Antennae clavate, bipectinate, and ciliate only in males, with rami long and somewhat appressed on pinned specimens. Wing venation typical for tribe. Genitalia very similar among species of *Euhagena* and generally of *Paranthrene* type. Valva elongate with apex broadly rounded or only slightly tapered; inner surface clothed with long, simple, hairlike setae on apical ¼ and in wide marginal bands dorsally and ventrally; center and basal area of valva devoid of setae; ventrad of meson and basally is a patch of thick, dark, often spinelike setae. Juxta narrow and straplike; saccus short, narrow, and projecting anteriorly at approximately a right angle to vinculum; basal ⅔ of aedoeagus wide, gently curved then narrowed sharply with apical third less than half basal width and with or without apical spines, vesica uniformly shagreened. Ostium bursae located in membranous area anterior to sclerites of eighth abdominal segment; ductus bursae long, slender, first narrowing then gradually expanding in width to corpus bursae, membranous except for a thin sclerotized band near ostium bursae in some species; corpus bursae ovate and without signa.

Very little is known of the biology of *Euhagena* species. The larvae of both species have been associated with plants in the Onagraceae. Adults fly in the late summer and fall, an uncommon pattern in the family.

KEY TO THE SPECIES OF *EUHAGENA*

1. Antennae dorsally mostly orange, perhaps powdered with black ..... *emphytiformis* p. 46

— Antennae dorsally black, without orange .... *nebraskae* p. 48

Euhagena emphytiformis (Walker)
PL. 1, FIGS. 55–57. TEXT FIG. 10 *a, c, d* (RWH 2534).

Aegeria emphytiformis Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 43.
Type locality: United States. [BMNH]

Larunda solituda Hy. Edwards, 1881, *Papilio,* **1**: 182.
Type locality: Texas. [USNM]

Euhagena emphytiformis, though attractive in color and pattern, is rather poorly represented in most collections. Placed in *Gaea* by Engelhardt (1946) along with the type species *solituda, emphytiformis* is considered to be more correctly placed in *Euhagena,* and *solituda* has been determined to be a junior synonym, as suggested by Engelhardt. Males: Head with vertex brown black, mixed with orange and occasionally pale yellow; occipital fringe yellow; front pale yellow; labial palpus strongly roughened, pale yellow dorsally, pale orange on third segment, ventrally mixed black with some orange; antenna deep orange, powdered with black mostly on apex. Thorax brown black with some orange and yellow scattered dorsally, collar brown black, sometimes orange dorsomedially and yellow lateroventrally; tegulae mixed brown black, orange red, and yellow with the latter extending posteriorly over and under the wing bases; posterior margin of mesothorax yellow and margins of metathorax orange red. Abdomen with each segment yellow, more narrowly banded on segments one, three, and five, all but first two segments black on posterior margins, most segments mixed with varying amounts of orange red; anal tuft short, bluntly pointed apically, laterally folded downward, brown black mixed with yellow and orange red. Foreleg with coxa brown black basally, orange red and yellow apically, all femora brown black ventrally, pale yellow with some orange red dorsally, tarsi pale orange; tibia of hindleg orange red with yellow medially, occasionally with some brown black at apex. Forewing opaque dorsally, primarily brown black mixed with yellow and with some orange red in cell and between veins just beyond discal spot, anal margin orange red toward base; ventrally forewing primarily yellow and orange. Hindwing often with basal ⅓ hyaline between veins and occasionally just beyond discal spot, rest of wings brown black with some orange powdering and red orange on anal margins basally; ventrally,

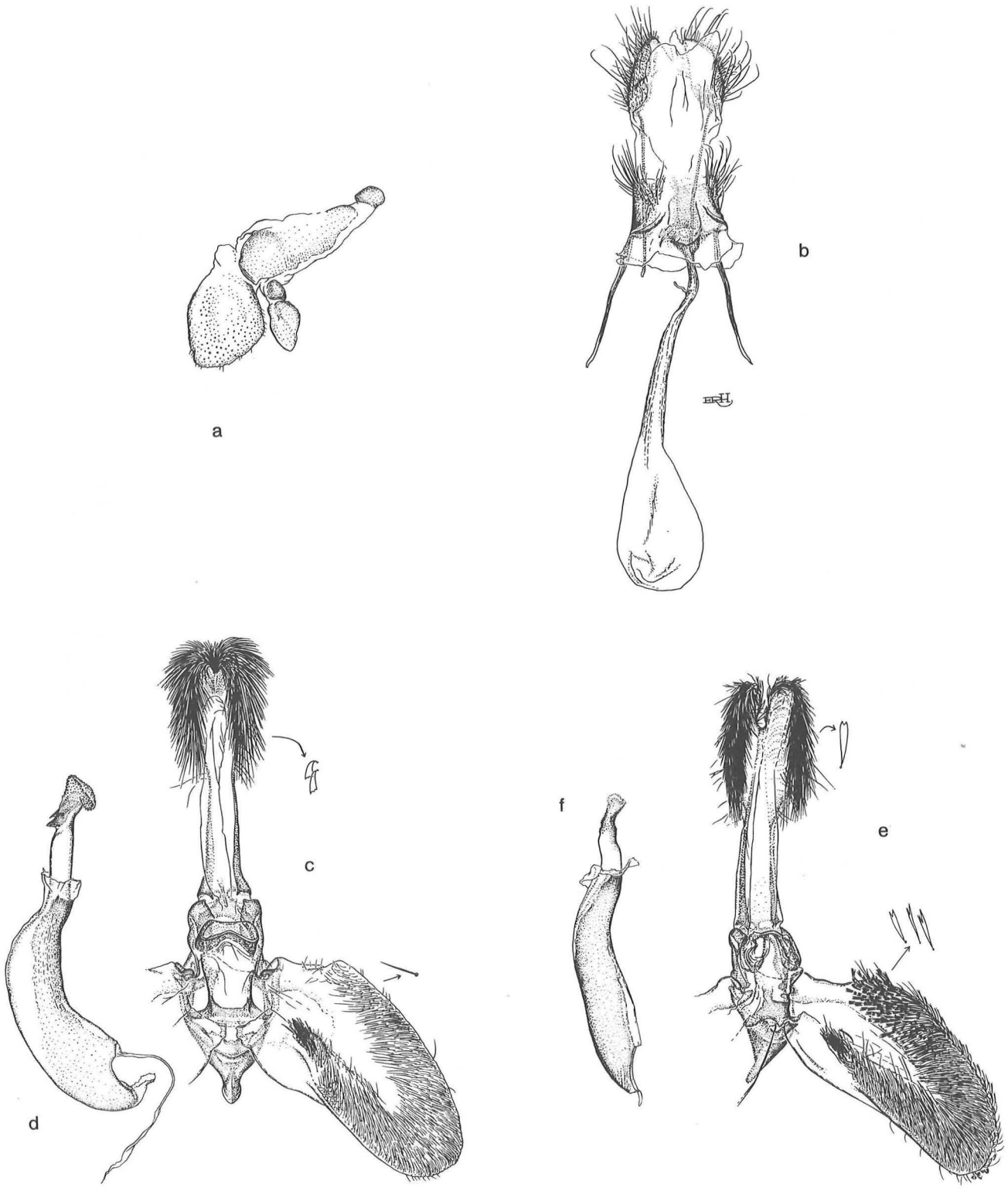

FIGURE 10: STRUCTURES OF *EUHAGENA*

a, c, d. Euhagena emphytiformis, a. Maxillary palpus (USNM 75878); *c.* Male genitalia (left valve and aedoeagus omitted) (USNM 75810); *d.* Aedoeagus (USNM 75810). *b, e, f. Euhagena nebraskae, b.* Female genitalia (USNM 75813); *e.* Male genitalia (left valve and aedoeagus omitted) (USNM 75812); *f.* Aedoeagus (USNM 75812).

orange except for brown black veins. Female: similar to male but generally more heavily shaded with orange red throughout; labial palpus not as roughened as in males and without black ventrally; vertex strongly orange; anal tuft truncate apically and orange with black laterally. Ductus bursae with narrow sclerotized ring near ostium bursae. Wing length 8–14 mm.

In the western part of the range, specimens of *emphytiformis* tend to have more yellow on the wings and abdomen, which resulted in their being described as *solituda.* The genitalia show no differences.

The larvae of *emphytiformis* are reported by Engelhardt (1946: 161) to be borers in the perennial main roots of *Gaura michauxii* Spach (=*G. filipes* Spach) (Onagraceae). The flight period is apparently in July through September; however, T. C. MacRae captured two males in Missouri (pers. comm.) in early May, and a series of males was taken in Arizona by R. Wielgus (pers. comm.) between late June and early July. Engelhardt reported that in the area of Mobile, Alabama a favorite habitat for adults was a sand ridge among pines and oaks, where specimens were easily captured either in flight or resting on foliage.

Euhagena emphytiformis occurs along the Atlantic and Gulf coastal plains from South Carolina to Florida, Alabama, and Texas (two males were captured in Missouri), the Rocky Mountain region of Wyoming and Colorado, and into the western plateau region of southern Arizona to the State of Coahuila, Mexico.

Euhagena nebraskae Hy. Edwards
PL. 1, FIGS. 58–61; PL. A, FIG. 8. TEXT FIG. 10 *b, e, f* (RWH 2535).

Euhagena nebraskae Hy. Edwards, 1881, *Papilio,* **1**: 181.
Type locality: Nebraska. [MCZ]

Pyrrhotaenia coloradensis Beutenmüller, 1893, *Bull. Amer. Mus. Nat. Hist.,* **5**: 25.
Type locality: Custer County, Colorado. [AMNH]

Euhagena nebraskae form *mormoni* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 171.
Type locality: Logan, Utah. [USNM]

Euhagena nebraskae form *intensa* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 172.
Type locality: Barnwell, San Bernardino County, California. [USNM]

Euhagena nebraskae is fairly widespread in the western half of the United States and adjacent Canada. Adults fly very late in the season and appear to prefer montane or high desert habitats. Male: Head with vertex brown black with long, white, silklike sclaes mesad on the posterior margin; front roughened, white with brown dorsolaterally; occipital fringe hairlike, brown black; labial palpus white ventrally with long, hairlike scales on segments one and two brown black with some white mesially; antenna strongly bipectinate, brown black, rami appressed, powdered with white. Thorax brown black overlaid dorsally with long, hairlike white and blue-white scales that project posteriorly as far as third abdominal segment, collar brown black. Abdomen brown black with segments two, four, six, and seven narrowly edged with white on posterior margins dorsally and somewhat edged with white ventrally on segment four, segments one, two, and three overlaid with hairlike, white to blue-white scales dorsally; anal tuft brown black, somewhat expanded apically and broadly rounded. Legs mostly brown black except for gray on femur of foreleg, mixed with some white dorsally on tibia of hindleg, and all tarsi white. Fore- and hindwings opaque, deep orange with brown black broadly on discal spot, around wing margins, and to a varying extent on veins. Forewing may have orange areas powdered with white. Hindwing generally more broadly margined with brown black than forewing and may have orange areas variously powdered with brown black. Aedoeagus lacks an apical spine. Female: Similar to male except labial palpus, thorax, and abdominal segments lack white, silklike scales; legs entirely brown black; and abdomen with narrow, white bands on segments two, four, and six; and with a short, weakly defined anal tuft. Ductus bursae lacks sclerotization near ostium bursae. Wing length 6–11 mm.

Variation in color and pattern of the adults throughout the range has resulted in a number of color form designations. The color form "*intensa,*" described by Engelhardt (1946) from the Mojave Desert in California, has the wings more completely deep orange with brown black confined to a very narrow band around the wing margin, on the fringe, and forming a narrow discal spot only on the forewing of the females. Also, the abdominal banding of "*intensa*" is pale yellow instead of white. Engelhardt (1946) also described the form "*mormoni*" based on two large male specimens from Logan, Utah. This form has the orange-red areas of the wings replaced with white, especially ventrad, and somewhat powdered with orange especially on the

hindwings, in the anal region, on the veins, and around the wing margins; the wing fringes are mostly white along the anal margins. In "*mormoni*" the abdominal bands are broadly yellow on segments four, six, and seven and only faintly indicated on segment two. In the male genitalia of "*mormoni*" a character was observed that is absent in the other specimens of *nebraskae* examined and suggests the possibility that when additional specimens are obtained this form may prove to be a distinct species. On the valva the base of the sacculus is produced dorsad into a distinct fingerlike projection.

Until recently very little was known of the biology of *nebraskae,* and many details are to be discovered. Engelhardt (1946: 170) suggested that search in a known habitat among deep-rooted herbaceous, perennial plants should prove rewarding. The California population of the form "*intensa*" from the Mojave Desert is associated with *Oenothera avita* (W. Klein), a low-growing plant on open sand. Larvae feed in the perennial tap root and prior to pupation, construct exit tubes made of silk and covered with sand extending vertically from the root to the soil surface around the crown. Pupation takes place in a cocoon formed at the base of the tube on or just in the root. At emergence the pupa comes to the surface through the sand tube, leaving the exuvium partially wedged in the opening at ground level (Duckworth and Eichlin, 1978: 19). Capture records indicate an adult flight period from September through October.

The distribution of *nebraskae* is quite sketchy with many obvious gaps yet to be filled. Most existing records are from the Rocky Mountain region of northern New Mexico and Colorado, with scattered records from Utah, Nebraska, South Dakota, and western Mojave Desert region of California; in Canada from Alberta and Saskatchewan near their common border with Montana; and a single specimen from near Mexico City, Mexico.

SUBFAMILY
Sesiinae Boisduval

Sesiinae Boisduval, 1828, *Europaeorum Lepidopterorum, Index Methodicus,* 29.
Type genus: *Sesia* Fabricius, 1775.

Aegeriinae *sensu* Le Cerf, 1917, *in* Oberthür, *Études de Lépidoptérologie Comparée,* **14**: 148.
Type genus: *Aegeria* Fabricius, 1807.

NOTE—*Aegeria* Fabricius, 1807, is a junior synonym of *Sesia* Fabricius, 1775.

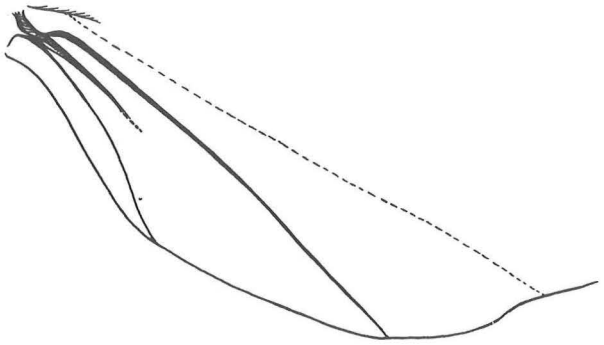

FIGURE 11: ANAL VEINS OF HINDWING OF SESIINAE (*HYMENOCLEA PALMII*) (USNM 75711)

The Sesiinae contain by far the largest number of species on a world basis and for the North American fauna. The various tribes of Sesiinae are quite diverse; however, within each tribe the species are structurally homogeneous. In America north of Mexico the subfamily is represented by 97 species in 12 genera.

The Sesiinae are easily recognized by the pattern of anal veins on the hindwing. Vein CuP has been lost, though its prior position is indicated by a line of scales on the wing fold. Veins 1A, 3A and a portion of 2A are present (text figure 11). Generally, on the forewing veins R_4 and R_5 are stalked for less than half their length, and on the hindwing vein CuA_1 arises distad of the crossvein, rarely at the juncture of the crossvein, or in *Melittia,* well basad of the crossvein. The head with maxillary palpus two segmented, second segment much reduced in most species and positioned laterally on the larger first segment; antenna clavate with terminal scale tuft, with short cilia ventrally on male, pectinate only on some species of Melittiini and Sesiini. As in the Paranthreninae, a protuberance is on the preepimeron of the metathorax, and the average size of the eyes is larger than the other two subfamilies (eye index range: about 1.5–2.5).

With the exceptions of the Melittiini, Sesiini and Osminiini, which are structurally unique tribes, morphological features of species of the Sesiinae are similar, particularly the genitalia.

The species of Sesiinae are highly diversified in their selection of hosts and habitats. Though the larvae of some species are root borers, the trend is toward a less concealed habitat in stems, branches, injured areas, under bark, or as inquilines in galls.

KEY TO THE TRIBES OF SESIINAE

1. Hindleg with tibia and tarsus strongly tufted throughout; scale plate present beneath scape

of antenna extending somewhat over eye; hindwing with vein M_3 arising from CuA_1 well basad of crossvein ..... Melittiini p. 50

— Without above listed combination of characters 2

2. Haustellum reduced, shorter than labial palpus; forewing with veins R_1 and R_2 separate; hindwing with M_3 arising from CuA_1 at juncture of crossvein ..... Sesiini p. 63

— Haustellum coiled, longer than labial palpus, or if reduced then veins R_1 and R_2 of forewing coincident apically and veins M_3 and CuA_1 of hindwing short stalked distad of crossvein 3

3. Forewing with veins R_4 and R_5 coincident, or if R_4 and R_5 stalked, then R_1 shortened, not extending to costal margin; male antenna without cilia ventrally ..... Osminiini p. 58

— Forewing with veins R_4 and R_5 stalked; R_1 not shortened, extending to costal margin; male antenna with short cilia ventrally ... Synanthedonini p. 68

TRIBE
Melittiini Le Cerf

Melittiini Le Cerf, 1917, *in* Oberthur, *Études de Lépidoptérologie Comparée,* **14**: 148.
Type genus: *Melittia* Hübner, 1819.

In America north of Mexico the Melittiini consist of a single genus, *Melittia,* with six species. The tribe is distributed worldwide, its range undoubtedly influenced by the evolution and distribution of its principal host plants, species of Cucurbitaceae.

The tribe is distinguished by the following characteristics: Antenna of the male varies from having rudiments of pectinations to unipectinate; maxillary palpus two segmented with second segment nearly as large as first and joined at apex of first; haustellum functional, at least twice length of labial palpus; hindwing with CuA_1 arising well basad of crossvein; abdomen dorsally with broad spinelike scales on posterior margin of each segment. Male gentialia with valva thick, well sclerotized, mostly naked at least on basal ½, simple spinelike scales concentrated into dense dark patches apically; saccus thick, often long, as long as valva in some species; uncus most often bifurcate apically with dense, dark pads of short spinelike scales on mesial surface.

Relative similarities in structural morphology suggest that the Melittiini are more closely related to the Sesiini than to any other group; however, both tribes have developed distinctive characteristics, particularly of the genitalia, that separate them from other tribes in the subfamily.

GENUS
Melittia Hübner

Melittia Hübner, 1819, *Verzeichniss bekannter Schmettlinge* [sic], 128.
Type species: *Sphinx bombyliformis* Stoll, 1782.
Monotypy.

NOTE—*Sphinx bombyliformis* Stoll, 1782, is a junior homonym of *Sphinx bombyliformis* Linnaeus, 1758. The objective replacement name is *Melittia anthedoniformis* Hübner, 1816.

Eumallopoda Wallengren, 1858, *Öfversigt af Konglica Vetenskaps Akademiens Förhandlingar,* 84.
Type species: *Eumallopoda laniremis* Wallengren, 1858. Monotypy.

Parasa Wallengren, 1863, *Wiener Entomologische Monatschrift,* **7**: 137.
Type species: *Parasa aureosquamata* Wallengren, 1863. Monotypy.

NOTE—*Parasa* Wallengren, 1863, is a junior homonym of *Parasa* Moore, 1858 (Limacodidae).

Pansa Wallengren, 1865, *Konglica Svenska Vetenskaps-Akademiens Handlingar,* **5**: 9.

NOTE—*Pansa* Wallengren, 1865, is a replacement name for *Parasa* Wallengren, 1863.

Poderis Boisduval, 1874, *Spécies général des Lépidoptères Hétérocères,* **1**: 433 (published as a junior synonym of *Melittia* Hübner, 1819, and not subsequently treated as an available name under the *Code,* Article 11(d)).

Premelittia Le Cerf, 1916, *in* Oberthür, *Études de Lépidoptérologie Comparée,* **12**: 9.
Type species: *Premelittia rufescens* Le Cerf, 1916. Monotypy.

Neosphecia Le Cerf, 1916, *in* Oberthür, *Études de Lépidoptérologie Comparée,* **12**: 9.
Type species: *Neosphecia combusta* Le Cerf, 1916. Monotypy.

Melittina Le Cerf, 1917, *in* Oberthür, *Études de Lépidoptérologie Comparée,* **14**: 239.
Type species: *Melittina nigra* Le Cerf, 1917. Monotypy.

Melittia is a well-defined genus, distributed worldwide. In America north of Mexico the genus is rep-

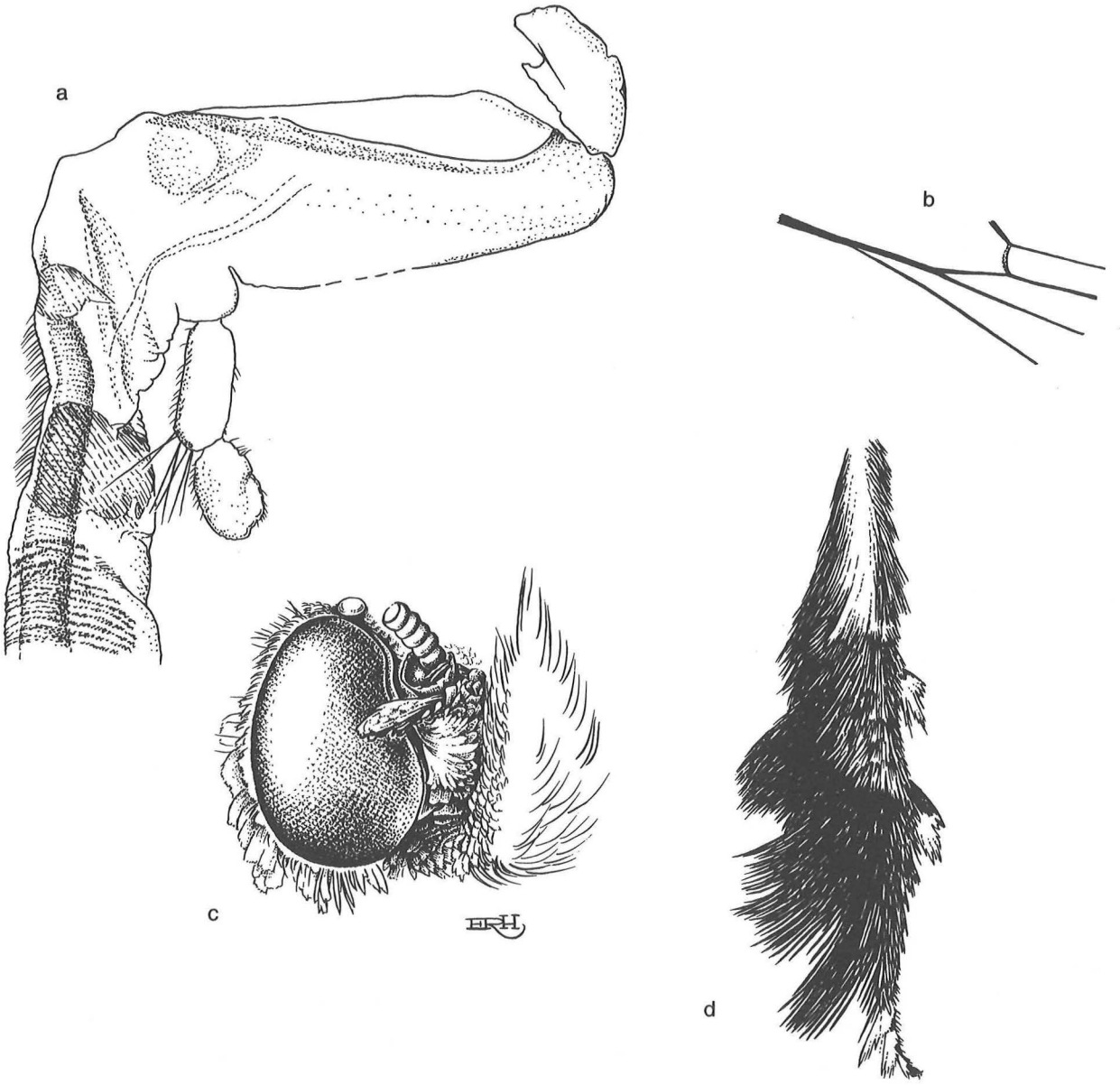

FIGURE 12: STRUCTURES OF *MELITTIA CUCURBITAE*

a. Maxillary palpus (USNM 75881). *b.* Partial hindwing venation (USNM 75819). *c.* Frontolateral view of head. *d.* Dorsal view of hindleg.

resented by six species, all of which appear to have distribution patterns extending into Mexico. The squash vine borer, *M. cucurbitae,* ranges throughout the United States into Canada east of the Rocky Mountains and south along the east coast of Mexico. The other species have varying ranges in the southwestern United States and into Mexico.

Some of the largest and most colorful species in the Sesiidae are in this genus. Size ranges from a wing length of 8 mm for males of *snowii* to 28 mm for large females of *gloriosa.* The hindlegs are unique in that they possess long, projecting, often brightly colored, hairlike tufts, particularly on the mesial surface and dorsally on the tibiae and first tarsal segments, a character which readily identifies members of the genus. Also present and most developed in this genus are the broad, flat scales which project from beneath the antennae and extend over the middle of the large eyes (eye index: 1.7–2.2).

In males antenna strongly ciliate ventrally and rudimentarily pectinate to strongly unipectinate in *gloriosa.* Venation typical for Sesiinae except hind-

wing vein CuA_1 arises well basad of crossvein. Wide valva with thick patches of elongate, pointed, black scales and without furcate scales; saccular region with one to three raised ridges devoid of scales; vinculum narrower than saccus, which is elongate and rounded on apex; juxta with two long, weakly sclerotized, lateral projections; uncus composed of a bifurcate, sclerotized apex and two wide lateral extensions with patches of short, black, pointed scales distally on mesial surface; gnathos absent; subscaphium a narrow, sclerotized band ventrad of tuba analis; aedoeagus elongate, narrow, and expanded basally. In female ductus bursae very long, thin, and membranous, except for a short section near ostium bursae that is variously sclerotized; ductus seminalis generally arising midway along ductus bursae or slightly closer to ostium bursae than to corpus bursae; a semilunate, sclerotized area lateral and posterior to ostium bursae; corpus bursae ovate to obovate and with or without a signum.

MacKay (1968a: 23) characterized the larvae of *Melittia* as follows: L2 on abdominal segment 8 posterior or posterior and somewhat dorsal to L1; ocelli reduced to size of a setal base; spiracle on segment 8 in its most extreme position near posterior margin and dorsal rather than lateral on segment; D2's on segment 9 unusually small, far apart, and each close to and posteromedial to its corresponding D1; anal shield in some species modified by presence of a medial hump, stout spine or transverse ridge; ventral prolegs are scarcely apparent; most setae usually short; D2's on anal shield as short as D1's; papilla, if present, posterolateral to anal crochets, dorsal to large seta.

Larvae of species of *Melittia* are borers in species of Cucurbitaceae. In America north of Mexico larvae of two species feed nearly exclusively on cultivated species of *Cucurbita* and their cultivars (Eichlin, 1975: 5; Engelhardt, 1946: 183). The other species, insofar as known, have adapted to life in the stems or perennial tubers of wild gourds of the arid and semiarid regions of the southwestern United States and northern Mexico. The life cycle requires one or two years. Females oviposit on leaf blades or petioles on new shoots of the vines, on or near the base of the plant. Newly hatched larvae burrow into the main portions of the vine, sometimes forming galls, or burrow into the tubers, maturing late in the summer or early fall. At this time mature larvae leave the host and spin cocoons just beneath the soil in which they will pupate in the spring. Special structures on the pupal head aid the pupa to escape from the cocoon. It then wriggles, by means of rows of abdominal spines, to the surface where the adult moth emerges. Females tend to remain at or near the emergence site and begin to broadcast sex pheromones almost immediately. Males, upon emergence, actively seek females and mating occurs as soon as a suitable female is located. Emergence normally occurs in June and July, but later and earlier emergence dates have been noted. The adults are active fliers on sunny days over the host plants; they tend to rest on the plants on cloudy days and at night. Males visit flowers of various composites and are rarely found on their host plants after mating. Females tend to stay in the host plant patches; under caged conditions, females live longer than males (Friedlander, pers. comm.).

KEY TO SPECIES OF *MELITTIA*

1. Abdomen mesodorsally uniformly gray, laterally orange ..... *snowii* p. 54
— Abdomen mesodorsally not uniformly gray, or if so then laterally banded with black and orange 2

2. Abdomen primarily deep orange dorsally or mixed with some gray and with a middorsal black spot on most segments; an elongate narrow, hyaline area basad on forewing 3
— Abdomen not marked as above dorsally; forewing entirely opaque 4

3. Abdomen dorsally with second segment mostly orange ..... *calabaza* p. 54
— Abdomen dorsally with second segment dark olive green ..... *cucurbitae* p. 52

4. Abdomen entirely blue black ..... *magnifica* p. 58
— Abdomen with yellow or orange dorsally 5

5. Abdomen with each segment deep orange dorsally banded on posterior margin with gray black, or gray mesodorsally ..... *grandis* p. 56
— Abdomen with segments three and five solid yellow dorsally; one, two, and four gray mesad; seven, eight, and anal tuft pale blue ..... *gloriosa* p. 57

Melittia cucurbitae (Harris) (Squash Vine Borer* Perceur de la courge, m., Fr.)
PL. 2, FIG. 4. TEXT FIGS. 12 *a–d*; 13 *b* (RWH 2536).

Aegeria cucurbitae Harris, 1828, *New England Farmer,* 7: 33.
Type locality: Massachusetts. [MCZ]

Melittia satyriniformis Hübner [1831], *Zuträge zur Sammlung Exotischer Schmettlinge* [sic], 3: 17, figs. 453, 454.
Type locality: Georgia. [unknown]

NOTE—Subsequent to the publication of our classification of the Sesiidae (Duckworth and Eichlin, 1977c), J. B. Heppner, after consultation with entomologists at the Smithsonian Institution and British Museum of Natural History, pointed out that Hübner's *satyriniformis* should be synonymized because there was too much uncertainty regarding the year of publication of the name. Heppner and Duckworth (1981: 26) treated *satyriniformis* Hübner [1831] as a junior synonym of *cucurbitae* Harris (1828).

Trochilium ceto Westwood, 1848, *The Cabinet of Oriental Entomology,* 62.
Type locality: North America. [unknown]

Melittia amoena Hy. Edwards, 1882, *Papilio,* 2: 54.
Type locality: Douglas County, Kansas, 900 feet. [unknown]

Melittia cucurbitae and *calabaza* are of considerable economic importance as stem borers in cultivated cucurbits. While *cucurbitae* has received much attention in the economic literature through the years, *calabaza* has only recently been recognized as a distinct species; and its biology is yet to be thoroughly investigated.

Male: Head with vertex olive green, with specialized, hairlike scales (chaetosemata) posteriorly and medially; flat, olive-green scales projecting shelflike from beneath antenna over middle of eye; occipital fringe brown black mixed with white; eyes margined with white; front white often with gray dorsomesiad; labial palpus orange, white on basal segment and ventrally on second segment, with ventrally projecting tuft of black scales at apex of second segment, and perhaps a line of black scales subventrally; antenna not pectinate but strongly ciliate ventrally, olive green dorsally slightly powdered white or pale yellow on apical third. Thorax olive green, with lateral tufts of long, hairlike, pale-yellow or white scales posteriorly, often projecting ventrally. Abdomen orange or orange red, except for olive green on segments one and two and often on six and seven; laterally olive green on all segments and most of anal tuft except apex that is orange, usually with a black spot dorsomedially on segments four, five, six, and often on seven. Legs with prothoracic coxa orange with some white basally; femur orange at least dorsoapically and often brown black ventrobasally; mesothoracic tibia orange with white on basal half; metathoracic tibia very strongly tufted with brown black dorsomesially, orange or orange red dorsally and dorsolaterally with some white medially, spurs brown black but with white tufting on posterior margin of both lateral spurs; first tarsal segment of metathoracic leg tufted as tibiae but with less orange; remaining tarsal segments alternately ringed with brown black and white. Dorsally, forewings olive green, opaque except for a narrow, hyaline streak basally below vein CuA; costal edge pale orange with fringe brown black tipped with white. Hindwing hyaline except for a very narrow band of brown black on margins, brown black on veins, and often some white on anal margin basally. Inner margins of apical uncal processes gently angled; saccus only slightly bulbous at apex; valva with saccular ridge abruptly narrowed toward apex and slightly widened and depressed ventrad on the basal half; an additional expanded process in center of valva dorsad of saccular ridge, which is smoothly rounded apically. Female specimens like male except most of olive green somewhat darker; small, black scale tuft on labial palpus of male lacking; abdomen mostly orange except for dark olive green on segment one and variously olive green on segments three and four, black spot dorsomedially on all segments except first. Wing length 12–15 mm.

Larvae of *cucurbitae* feed in the main portions of the vines of most cultivated species of the genus *Cucurbita* (squashes, gourds and pumpkins); however, cultivars of *C. moschata* Duchesne ex Poir are unsuitable for larval development and generally avoided for oviposition by females (Friedlander, pers. comm.). As the white grublike larvae grow, the stem is hollowed out, often splitting in several places. The leaves of the plant appear wilted and turn yellow from the base of the plant outwardly. After becoming fully developed fourth instars, the larvae leave their burrows and enter the soil beneath the vine where they form tough cocoons about 2.5 to 15 cm beneath the surface. They remain in the cocoons, overwinter as prepupae, and pupate in the spring. A chisellike structure on the head of the pupa facilitates exit from the pupal chamber, and the mobile pupa works its way to the surface with the aid of posteriorly directed rows of stout spines on most abdominal segments (life history information summarized from Friend, 1933; Howe, 1950; Miller, 1955). The sex attractant developed from the grape

root borer (*Vitacea polistiformis*) (E,Z 2,13-ODDA/Z,Z 3,13-ODDA 99:1) has been useful as bait to trap males of *cucurbitae* (K. Scarborough, pers. comm.).

Records indicate a range for *cucurbitae* extending throughout the eastern half of North America, including extreme southern Canada, east of the Rocky Mountains, south into eastern Texas and disjunctly southward along the Mexican Gulf Coast to Veracruz. Throughout its range *cucurbitae* may be found as early as April and as late as November in the southern portions of its range where it is at least double brooded.

Melittia calabaza Duckworth and Eichlin
PL. 2, FIG. 2. TEXT FIG. 13 *a, c, g* (RWH 2537).

Melittia calabaza Duckworth and Eichlin, 1973, *Proc. Ent. Soc. Washington,* **75**: 151.
Type locality: Teotihuacan, Mexico. [USNM]

Melittia calabaza is very closely related to *cucurbitae* and to *pulchripes* Walker, which occurs from southern Mexico south through Central America and most of South America (Becker and Eichlin, 1984: 14). Superficially, both sexes of *calabaza* are readily separated from the other two species in the complex by having the second abdominal segment mostly orange rather than olive green as in *cucurbitae* and *pulchripes.* Additionally, the inner margin of apical uncal processes is sharply angled relative to those of *cucurbitae* and *pulchripes*; the saccus is narrow for most of its length, bulbous at apex, but thicker than in other species and only slightly expanded apically; the valva lacks additional expanded process near center dorsad of saccular ridge; the saccular ridge abruptly narrows toward its apex in the other two species; and the saccular ridge is widened and variously concave ventrad on its basal half in *calabaza,* though only slightly widened and depressed on *cucurbitae* and essentially unwidened on *pulchripes.* Wing length 12–15 mm.

Larval food plant preferences for *calabaza* were unknown until the authors collected and reared specimens from cultivated species of *Cucurbita* in Tucson, Arizona. Observations in Austin, Texas by T. Friedlander (pers. comm.) showed that *calabaza* has similar food plant preferences as *cucurbitae* with two notable exceptions: *calabaza* larvae were not found in *C. mixta* Pangalo; larvae did extensive damage to cultivars of *C. moschata* Duchesne ex Poir. and were able to complete development in them. There are no data on the relative winter-hardiness of these two species. Aside from the above host choice differences and while detailed study of the life history of *calabaza* has yet to be completed, the observations to date indicate little or no differences in larval habits from those of *cucurbitae.*

Present records indicate that *calabaza* occurs from southern Arizona to central Texas, and southward through Mexico, including the Sierra Madre Occidental, to Veracruz.

Melittia snowii Hy. Edwards
PL. 2, FIG. 7. TEXT FIG. 13 *f* (RWH 2538).

Melittia snowii Hy. Edwards, 1882, *Papilio,* **2**: 53.
Type locality: Kansas. [AMNH]

This species, *grandis*, and *gloriosa* are adapted to live in the stems or tubers of wild gourds of the arid and semiarid regions of the southwestern United States and northern Mexico. Male: Head with vertex gray, chaetosema posterior; flat gray scales projecting from beneath antenna over middle of eye; occipital fringe white, occasionally mixed with some gray; front white; labial palpus roughened, white with some pale yellow apically and longer, hairlike, brown-black scales sublaterally; antenna green black, often with white apically, strongly ciliate ventrally but not pectinate. Thorax gray with individual scales lighter apically as on wings and abdomen (similar to *grandis*); some white tufting laterally on metathorax. Abdomen dorsally with first segment gray, remaining segments medially with continuous, wide, gray band, orange laterally, most segments often with narrow band of chocolate brown, spinose scales on posterior margin; abdomen ventrally with gray medially and white laterally. Legs with coxae white, often mixed with gray; femora gray brown, orange dorsally with white apically; foreleg with tibia brown black, pale orange ventrally, tarsus brown black, white ventrally; midleg with tibia pale yellow or white laterally, brown black ventrally and orange dorsally, tarsus brown black, white ventrally; hindleg with tibia pale yellow and white laterally, orange dorsally, brown black ventrally and mesially, spurs brown black with white tufts on posterior edge, first tarsal segment tufted as on tibia, brown black, narrowly orange laterally outside, white ventrally, remaining tarsal segments white, tufted dorsally with some brown black on segment two. Forewing opaque, dorsally speckled gray, narrowly margined with palc yellow, fringe brown black, ventrally powdered with pale yellow and orange. Hindwing hyaline, dorsally veins gray, wing margins narrowly pale yellow, fringe

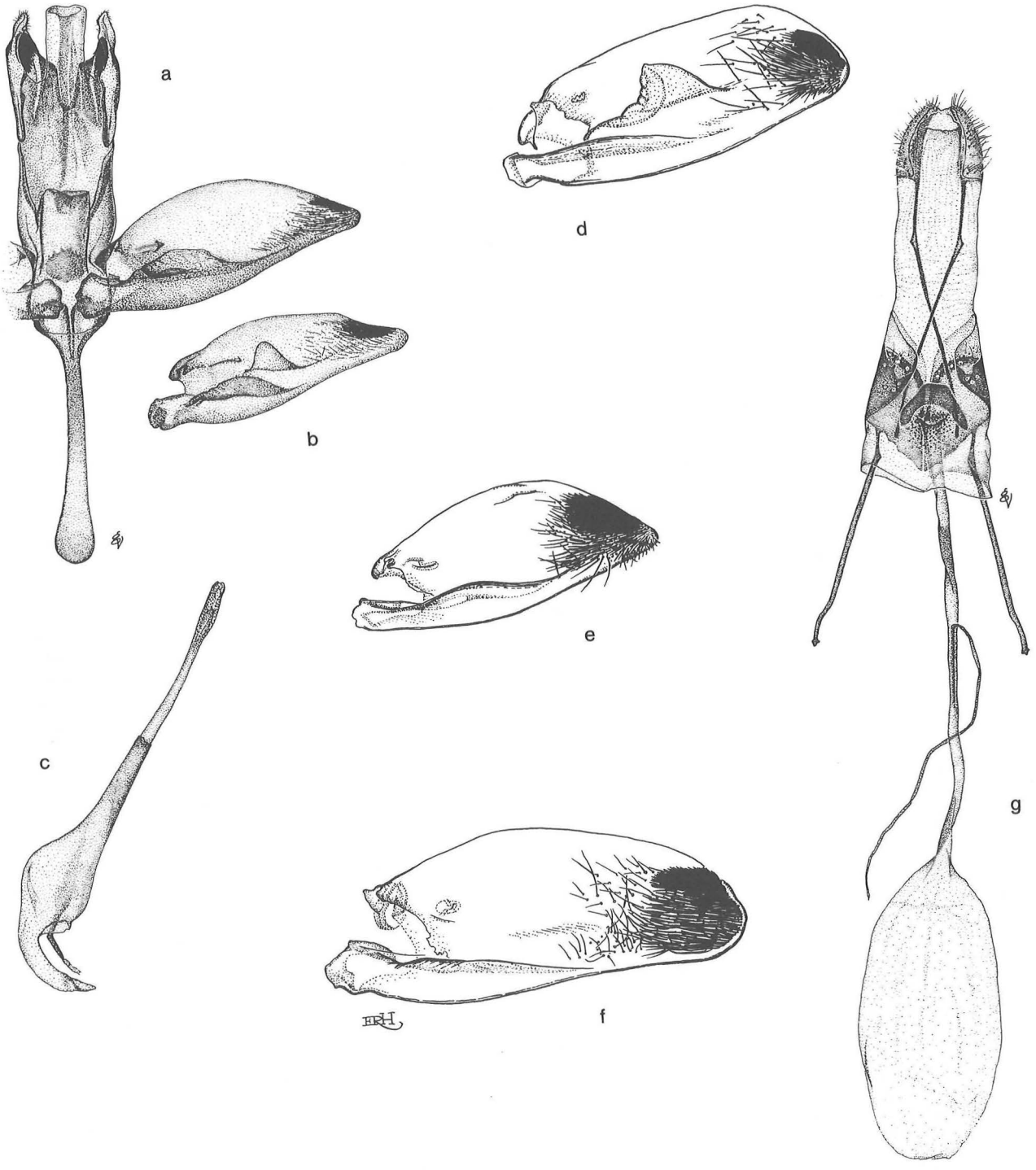

FIGURE 13: GENITALIA OF *MELITTIA* SPECIES

a, c, g. Melittia calabaza, a. Male genitalia (left valva and aedoeagus omitted) (USNM 76063); *c.* Aedoeagus (USNM 76063); *g.* Female genitalia (USNM 76067). *b.* Right valve of *Melittia cucurbitae* (USNM 76046). *d.* Right valve of *Melittia gloriosa* (USNM 75827). *e.* Right valva of *Melittia grandis* (USNM 75821). *f.* Right valve of *Melittia snowii* (USNM 75823).

brown black; ventrally veins powdered pale orange. Male genitalia similar to those of *grandis,* but with valva broadly rounded apically, not pointed as in *grandis,* and saccular ridge less prominent than in *grandis.* Wing length 8–12 mm; females tend to be larger than males.

This is the smallest species of *Melittia* in our fauna. The broad gray dorsal band on the abdomen and small size make *snowii* easily recognizable.

The following life history information has been extracted from various sources (Engelhardt, 1946; Stallings and Turner, 1944; Williams, 1913). Larvae produce galls on leaf petioles and often on the fruit of the food plant, *Cucurbita foetidissima* von Humboldt, Bonpland, and Kunth, a wild perennial, xerophytic species of cucurbit. Eggs are deposited on the vines or on the petioles of the leaves, usually near the apex of a shoot. Larvae bore into the tissue of the plant upon hatching and cause rapidly growing gall formations that, upon attaining full size, are 4 to 8 cm long and approximately 2.5 cm in diameter. Upon reaching full growth, the single larva per gall bores through the gall wall and enters the soil, where a pupal chamber is constructed some distance below the surface. Larvae overwinter as prepupae; adults emerge the following year. The moths have been captured from March through September.

Melittia snowii occurs from the Great Plains region in Kansas and Colorado south into Texas and southern Arizona; Mexican records are from the states of Nuevo Leon and Michoacan.

Melittia grandis (Strecker)
PL. 2. FIGS. 6, 8, 10; PL. A, FIG. 9. TEXT FIG. 13 *e* (RWH 2539).

Trochilium grande Strecker, 1881, *Can. Ent.,* **13**: 156.
Type locality: Texas. [FMNH]

Melittia beckeri Druce, 1892, *Ann. Mag. Nat. Hist.* (series 6), **1**: 276.
Type locality: Near Durango City, Mexico. [BMNH]

Melittia grandis variety *hermosa* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 186.
Type locality: Arizona. [USNM]

Though *grandis* is nearly as large as *gloriosa,* it is easily distinguished by the black abdominal bands on each segment and the pale-tipped scales on the wings and thorax. The abdominal pattern of *gloriosa* is quite different, and the scales on the wings and thorax are not pale tipped.

Adults: Head with vertex roughened, orange medially, smooth, olive green laterally and on shelflike scale process beneath antennae projecting over middle of eye, chaetosemata located posteriorly; occipital fringe white mixed with hairlike black scales; front orange; labial palpus roughened, orange; antenna brown black, strongly ciliate ventrally but not pectinate. Thorax olive green dorsally, orange ventrally, orange tufts laterally on metathorax, collar orange. Abdomen orange dorsally with broad band of brown black on posterior half of each segment, olive green medially on posterior ½ – ⅔ of most segments; ventrally, often with some brown black medially on most segments. Legs orange except for brown black dorsally on foretibia, on all tarsi that are additionally ringed with pale yellow or white at joints, on spurs, and dorsally on hindtibia and base of first tarsal segment; all spurs on hindtibia tufted on posterior edge, orange basally, white apically; and hindtarsus tufted dorsolaterally, orange. Forewing opaque, olive green, each scale tipped with either white, pale green, or pale yellow as on thorax; ventrally powdered variously with pale orange mostly basad. Hindwing hyaline, veins olive green, orange at base, occasionally powdered with orange throughout; fringe brown black on fore- and hindwings. Male genitalia similar to those of *gloriosa* except *grandis* lacks a projection in middle of valva above saccular ridge, a prominent structure on valva of *gloriosa.* The two species differ in other less prominent genital characters. The female genitalia are similar to those of *gloriosa*; however, *grandis* lacks a sclerotized portion of the ductus bursae that is present in the former species. Wing length 16–21 mm.

A color variant, "*hermosa,*" was described by Engelhardt (1946: 186) from two females. It differs from most *grandis* in having a broad, dorsomedial, olive-green band on the abdomen; olive-green patterns lighter, the scales tipped with pale yellow; the orange patterns relatively paler; and hindtibia laterally pale yellow.

Adults have been collected from April through September, depending on the locality and local weather variations. The frequency and quantity of rainfall is probably the most important single factor in the timing of pupation and adult emergence and, consequently, the duration of the life cycle. We observed that adults can be taken easily early in the day as they sit on the upper surface of the leaves of their host, *Cucurbita foetidissima.* As with *gloriosa,* the larvae feed in the large tubers and when fully

developed, burrow through the soil to near the surface, construct a tough leathery cocoon, and pupate soon thereafter. Eichlin, using sex attractant bait (E,Z 2,13-ODDA/Z,Z 3,13-ODDA 99:1, also effective for capturing *cucurbitae*), collected several males of *grandis* in southeastern Arizona.

Melittia grandis has been collected in Kansas, Texas, New Mexico, Arizona, extreme southeastern California, and northern Mexico.

Melittia gloriosa Hy. Edwards
PL. 2, FIGS. 1, 3, 5. TEXT FIG. 13 *d* (RWH 2540).

Melittia gloriosa Hy. Edwards, 1880, *Bull. Brooklyn Ent. Soc.*, **3**: 71.
Type locality: California. [AMNH]

Melittia superba Barnes and Lindsey, 1922, *Bull. Brooklyn Ent. Soc.*, **18**: 122.
Type locality: Seward County, Kansas. [USNM]
NOTE—*Melittia superba* Barnes and Lindsey, 1922, is a junior homonym of *Melittia superba* Rothschild, 1909.

Melittia lindseyi Barnes and Benjamin, 1925, *Proc. Ent. Soc. Washington,* **27**: 14.
NOTE—*Melittia lindseyi* Barnes and Benjamin, 1925, is a replacement name for *Melittia superba* Barnes and Lindsey, 1922.

Melittia barnesi Dalla Torre, 1925, *Lepidopterorum Catalogus,* **31** (Aegeriidae): 138.
NOTE—*Melittia barnesi* is a replacement name for *Melittia superba* Barnes and Lindsey, 1922.

Melittia gloriosa is one of the largest and most striking of the North American clearwing moths. Male: Head with vertex roughened, greenish tan; front white, perhaps with some gray dorsally; occipital fringe yellow; labial palpus thick, venter flattened, white, subventrally with line of long hairlike black scales; antenna unipectinate ciliate, brown black, slightly powdered white on one side, yellow on other side. Thorax mostly tan with yellow laterally before wings, yellow tufts at base of wings dorsally; collar with yellow; metathorax yellow. Abdomen dorsally with segment one dark brown, yellow on posterior margin; segments two and four tan medially; segments three and five pale yellow; the first five segments orange laterally; segments six, seven and anal tuft lustrous pale blue, with some white and pale-yellow powdering on six; posterior margin of all but first segment narrowly brown black; abdomen ventrally mixed pale yellow and white. Foreleg yellow except for white at apex of coxa and brown black around joints of tarsal segments. Midleg with femur brown black, pale yellow dorsally, yellow ventrally; tibia white, yellow dorsally and ventrally, spurs brown black; tarsus brown black with pale yellow at joints. Hindleg with coxa brown black, orange and yellow ventrally; tibia with the typical strong dorsal and mesial tufting that is orange basad of middle spurs, orange mesially beyond the spurs, brown black dorsally, ventrally, and laterally; pale yellow on basal half laterally and between middle and apical spurs; spurs brown black with tufts of white posteriorly on both lateral spurs; first tarsal segment tifted as for tibia but with brown black dorsoapically and pale yellow ventrally; remaining tarsal segments brown black, strongly tufted dorsomesially. Forewing opaque, dorsally tan, variously powdered with pale yellow, heaviest in apical area; fringe fuscous tipped with yellow; ventrally yellow or yellow orange. Hindwing mostly hyaline with orange on veins and at wing base, orange more diffuse on some specimens. Uncus deeply bifid, with each process tapering to a sharp point, gently curving to apex then slightly recurved; valva with saccular ridge naked, narrow; center of valva with an additional flat, strongly projecting, somewhat triangular process folded back on itself on its basal edge; ventral ⅔ of valva apex with dense patch of short black, pointed scales, becoming longer and less densely packed toward ventral margin of valva; and similar dense patches on uncus. Female differs from the male by having tan patterns of the male replaced with olive green; hindwing opaque, orange, though variously hyaline in the form "*lindseyi.*" Wing length 15–28 mm, females average larger than males.

Larvae bore in the large tubers of various cucurbitaceous plants, including *Cucurbita foetidissima, C. palmata* Watson, *C. digitata* Gray, *Marah fabaceus* (Naudin) and *M. oreganus* (Torrey and Gray) (Engelhardt, 1946; Thompson, 1927, 1929). The ability of *gloriosa* to utilize the two species of *Marah* is undoubtedly the reason why this *Melittia* is the only one to have extended its range through California to central Oregon. From the leathery cocoon in the soil, the pupa is able to work its way to the surface at the time of emergence with the aid of remarkable cutting and drilling structures on the pupal head and large, posteriorly directed spine rows on most abdominal segments. Depending on the locality, the moths have been found from May through October. As with *grandis,* adults of *gloriosa* can be found in the cool morning hours sitting docilely on the cucurbit leaves near the bases facing outward. The moths become more active as the am-

bient temperature increases and are capable of rapid flight.

Melittia gloriosa occurs from Kansas south to western Texas and Mexico, west through New Mexico and Arizona into southern California and the coastal islands, and north to central Oregon.

Melittia magnifica Beutenmüller
PL. 2, FIG. 12 (RWH 2541).

Melittia magnifica Beutenmüller [1900], *Bull. Amer. Mus. Nat. Hist.*, **12**: 151.
Type locality: Austin, Texas. [AMNH]

NOTE—Engelhardt (1946: 191) was dubious about the type locality of *magnifica*. He wrote that the type female was obtained by Beutenmüller from the late Josef Mattes, who once lived in Austin, Texas and who, according to Engelhardt, "loved bright, showy insects and freely exchanged for exotic species, but was careless about locality and date labels." Additionally, recent intensive studies on *Melittia* borers of cucurbits in the Austin area by T. Friedlander (personal communication) have failed to yield any specimens of this species. Because *magnifica* is now known from southern Baja California, Mexico, this suggests that Engelhardt probably was correct and that *magnifica* may not occur north of Mexico.

Beutenmüller characterized *magnifica* as the most beautiful and brilliant species of the genus. It was known only from the original female (labeled Austin, Texas) and an additional small faded female from near La Paz, Baja California Sur, Mexico. Recently a male was collected near the southern end of Baja California Sur. Adult: Head with vertex gray; occipital fringe gray mixed with some pale orange laterally; front gray; labial palpus orange with black apically; antenna blue black. Thorax blue black with orange laterally above wing bases; metathorax with deep orange tufts laterally. Abdomen entirely blue black. Legs mostly blue black. Wings opaque. Forewing with anterior portion and apical area blue black and posterior portion orange; fringe pale orange. Hindwing deep orange but ventrally with apical area blue black. Female genitalia similar to those of *grandis* and *gloriosa,* except in *magnifica* sclerite posterior to and extending laterally around ostium is U-shaped and uniformly narrow, not thicker medially. Wing length 15–18 mm.

No date of capture is given for the type; the female from southern Baja California was collected 2 August 1966 on *Cucurbita mixta*; the male was collected on 28 September 1981.

TRIBE
Osminiini Duckworth and Eichlin

Osminiini Duckworth and Eichlin, 1977, *California Dept. of Food and Agric., Occasional Papers Ent.*, **26**: 26.

The Osminiini are represented by two genera. They are distinctive relative to each other and unique within the Sesiidae. Very little biological information is available on the included species.

The tribe is defined as follows: Head with maxillary palpus 2-segmented, segments subequal in size; third segment of labial palpus about ½ length of second segment; antenna relatively strongly clavate, uniquely lacking ventral cilia in both sexes; eye index: 1.40–1.85; chaetosemata along posterior margin of vertex. Hindwing generally with anal veins somewhat degenerate, though variable. Male genitalia without specialized, apically furcated scales on valva or uncus; gnathos present, well developed. Female genitalia with signum.

KEY TO THE GENERA OF OSMINIINI

1. Forewing with veins R_4 and R_5 coincident; hindwing with M_3 and CuA_1 connate at corner of cell ..... *Calasesia* p. 58
— Forewing with veins R_4 and R_5 long stalked; hindwing with M_3 and CuA_1 short stalked .. .. *Osminia* p. 60

GENUS
Calasesia Beutenmüller

Calasesia Beutenmüller, 1899, *Jour. New York Ent. Soc.*, **7**: 256.
Type species: *Pyrrhotaenia coccinea* Beutenmüller, 1898. Monotypy.

Calasesia is a monobasic genus with the following characters: Head with eye index about 1.40; scale plate beneath scape of antenna absent. Forewing with vein R_5 missing (probably confluent with R_4). Hindwing with veins M_3 and CuA_1 connate at corner of cell. Male genitalia with valva quadrangular; hairlike scales scattered on apical portion, which is demarcated by ridge possessing an edge with four or five sharp, basally projecting points; uncus somewhat hood shaped, clothed with hairlike scales; gnathos sclerotized, thick, spoon shaped; aedoeagus nearly evenly wide throughout, with apical spine directed anteriorly; vesica shagreened, without cornuti. Female genitalia with ostium bursae very wide;

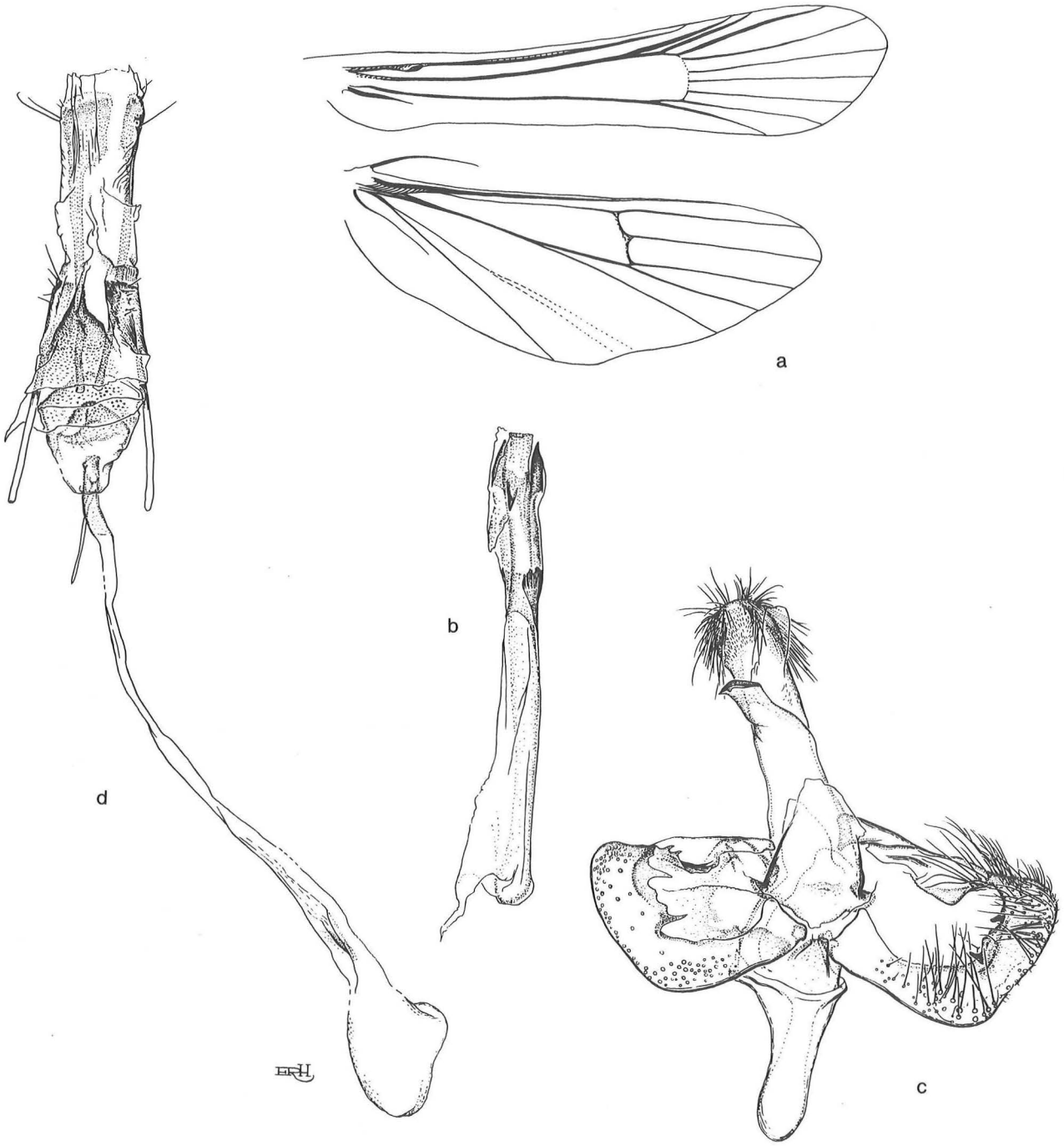

FIGURE 14: VENATION AND GENITALIA OF *CALASESIA COCCINEA*
a. Venation (USNM 75766). *b.* Aedoeagus (USNM 76138). *c.* Male genitalia (aedoeagus omitted) (USNM 76138). *d.* Female genitalia (USNM 76139).

ductus bursae initially from ostium bursae broad, membranous, narrowing to short, sclerotized section, continuing to small corpus bursae as narrow membranous tube; corpus bursae with signum near entrance of ductus bursae, an elongate, pigmented patch; ductus seminalis arising from ductus bursae just anterior to short sclerotized section.

Calasesia coccinea (Beutenmüller)
PL. 4, FIG. 2. TEXT FIG. 14 *a–d* (RWH 2544).

Pyrrhotaenia coccinea Beutenmüller, 1898, *Jour. New York Ent. Soc.*, **6**: 241.
Type locality: Albuquerque, New Mexico. [USNM]

Adult: Head with vertex roughened, blue black, some yellow at base of antenna; occipital fringe yellow dorsally and white laterally; front gray black, perhaps with some pale yellow laterally or mostly yellow and white; antenna blue black, without ventral cilia in either sex; labial palpus smooth, yellow with black apically. Thorax mostly blue black; collar blue black, orange lateroventrally; bright orange on tegulae, extending ventrally and posteriorly over base of wings. Abdomen entirely blue black; anal tuft short, poorly defined in both sexes. Legs blue black except for bright orange on basal half of forecoxa. Both pairs of wings opaque. Forewing dorsally bright orange except for rounded blue-black discal spot, broad blue-black band on outer margin, and white-tipped fringe; ventrally brown black with pale orange or pale yellow in cell and variously between veins apically. Hindwing brown black; fringe gray. Males and females are similar, and close examination of the tip of the abdomen is necessary to determine the sex of a given specimen. Wing length 6–8 mm.

The biology of *coccinea* is not known; however, some evidence suggests that this species may have a host association with certain species of legumes. Adults were captured in numbers in Kansas on *Hoffmanseggia falcaria* Cavanilles (Engelhardt, 1946: 134) and in New Mexico (according to specimen labels) on *H. jamesii* Torrey and Gray (Fabaceae). Five specimens were collected on the flowers of *Baileya pleniradiata* Harvey and Gray (Asteraceae). Most adults have been collected from July to early September, with a specimen from Texas taken at the end of April and 14 from Colorado in mid-June. Collection records are from southwestern Kansas, Colorado, New Mexico, southeastern Arizona, and western Texas.

GENUS
Osminia Le Cerf

Osminia Le Cerf, 1917, *in* Oberthür, *Études de Lépidoptérologie Comparée*, **14**: 327.
Type species: *Osminia ferruginea* Le Cerf, 1917. Monotypy.

Signaphora Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 131.
Type species: *Carmenta ruficornis* Hy. Edwards, 1881. Original designation.

Osminia consists of seven species, two of which occur in America north of Mexico (Duckworth and Eichlin, 1983). Six are known from Mexico (Eichlin, 1987), and the other, known only from southeastern Arizona, eventually may be discovered to occur in northern Mexico as well.

The genus is characterized as follows: Head with eyes large relative to size of head, extending dorsally on vertex behind antennal bases, often indented around antennal base and appearing overall somewhat kidneybean shaped, shortest distance between eyes across vertex less than greatest vertical height of eye with a ratio ranging from 9:10–3:10, depending on the species; ocellus large, conspicuous; vertex roughened, posterior margin with chaetosemata; small plate of scales beneath antenna projecting horizontally slightly over edge of eye; labial palpus roughened, elongate, projecting above front to slightly above highest level of vertex; antenna relatively strongly clavate, ½ – ⅔ length of forewing, lacking ventral cilia in both sexes; haustellum normal, not reduced. Forewing with R_4 and R_5 stalked for more than ½ their length. Hindwing with cell very long, extending to about ⅔ of wing length, veins from cell relatively short; M_3 and CuA_1 very short stalked. Male genitalia with valva mostly densely clothed with long dark hairlike scales; various spinelike processes, ridges, or projections near center of valva depending on species; without crista sacculi; vinculum relatively wide, with saccus relatively short, wide, broadly rounded apically; gnathos usually well developed, projecting, of various forms depending on species; uncus roof shaped, thickly clothed with long hairlike scales as on valva; aedoeagus narrow, apically with various sclerotization, and sometimes with dorsal and/or lateral processes. Female genitalia with ostium bursae quite different for each species, often complex; ductus bursae usually relatively short, gradually widening to oblong corpus bursae; corpus bursae with signum of various forms, most often a stout conical spinelike structure.

KEY TO THE SPECIS OF *OSMINIA*

1. Abdomen dorsally with more than one yellow or white band ..... *ruficornis* p. 61
— Abdomen dorsally with one white band .... *donahueorum* p. 62

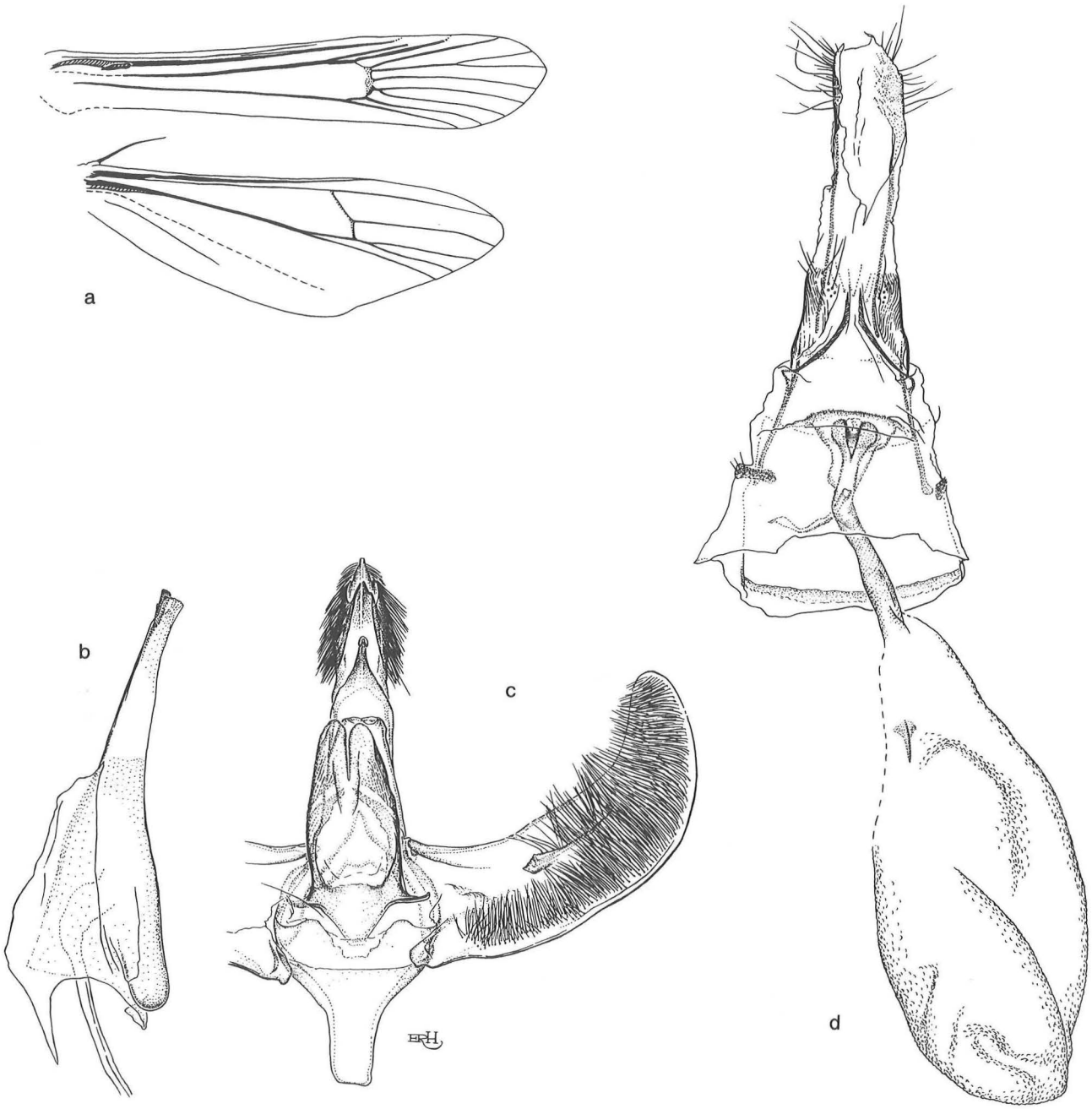

FIGURE 15: VENATION AND GENITALIA OF *OSMINIA RUFICORNIS*

a. Venation (USNM 75764). *b.* Aedoeagus (USNM 76140). *c.* Male genitalia (left valve and aedoeagus omitted) (USNM 76140). *d.* Female genitalia (USNM 76141).

Osminia ruficornis (Hy. Edwards)
PL. 4, FIGS. 4, 5. TEXT FIG. 15 *a–d* (RWH 2545).

Carmenta ruficornis Hy. Edwards, 1881, *Papilio,* **1**: 184.
Type locality: Georgia. [USNM]

Carmenta minuta Hy. Edwards, 1881, *Papilio,* **1**: 185.
Type locality: Georgia. [MSU]

Aegeria candescens Hy. Edwards, 1882, *Papilio,* **2**: 123.
Type locality: Arizona. [USNM]

Tarsopoda marcia Druce, 1889, *Ann. Mag. Nat. Hist.* (series 6), **4**: 81.
Type locality: Dos Arroyos, Guerrero, Mexico. [BMNH]

Osminia ruficornis is the most widely distributed species of the genus. Despite this fact, nothing has been discovered about its biology. Male: Head with vertex roughened, brown black mixed with much yellow; occipital fringe yellow dorsally, white laterally; front gray black with white laterally; antenna blue black dorsally, strongly powdered pale orange ventrally; labial palpus slightly roughened, yellow with some black dorsally. Thorax brown black; collar yellow ventrally; yellow spot at base of forewing. Abdomen brown black; segments two, four, six, and seven banded with yellow dorsally; ventrally, only segment four solid yellow or white. Legs with femora brown black; coxa of foreleg with yellow laterally; tibiae brown black, broadly ringed with yellow medially; tarsi golden yellow ringed with black at joints. Forewing opaque or with small hyaline streak in cell and just beyond discal spot; brown black, variously but lightly powdered with deep orange basally, in cell, and just beyond discal spot; ventrally powdered yellow basally and along costal margin. Hindwings hyaline except for brown black in narrow band on wing margins, on veins, and fringe; discal spot very narrow, pale yellow or orange; ventrally, most veins powdered with orange. Valva elongate with apex narrowed, rounded, and curved, projecting dorsally; inner surface of valva clothed with long, hairlike scales except for dorsomesial area; medially with triangular, spinelike processes arising from broad base in saccular region; saccus short, wide, and broadly rounded apically; uncus as described for genus; gnathos long, slender process with pointed, somewhat recurved apex; aedoeagus gradually tapering to sclerotized apex, vesica shagreened but lacking cornuti. Female similar to male but with one less abdominal band dorsally. Ostium bursae somewhat complex, generally well sclerotized, heart shaped; ductus bursae short, narrow at ostium bursae where ductus seminalis arises, gradually widening to obovate corpus bursae; corpus bursae with well-developed, spinelike signum. Wing length 4–7 mm.

Specimens from southern Arizona differ from the typical form by having more orange powdering on the forewings; abdominal banding white, not yellow; white on collar and mixed with yellow before wing bases, dorsally on labial palpus, mixed with yellow on coxae of forelegs and replacing yellow on tibiae of hindlegs. This color form corresponds to "*candescens*" Hy. Edwards.

Adults apparently tend to congregate at nectar sources during August and September and have been collected in numbers occasionally. K. Scarborough reported (personal communication) capturing males in traps baited with sex attractant (E,Z 2,13-ODDOH).

Osminia ruficornis occurs from Virginia to Florida and west to Missouri; and disjunctly from southern Arizona to southern Mexico.

Osminia donahueorum Duckworth and Eichlin
PL. 4, FIG. 3; PL. B, FIG. 2.

Osminia donahueorum Duckworth and Eichlin, 1983, *Smithsonian Contrib. Zool.*, **361**: 7.
Type locality: Madera Canyon, Santa Cruz County, Arizona. [LACM]

Adult: Head with vertex brown black with yellow or pale orange laterally and uniquely in a short streak medioposteriorly; occipital fringe brown black and mixed with pale yellow dorsally, white laterally; front and scale plate brown black; labial palpus slightly roughened, white with brown black dorsally and apically; antenna brown black, but strongly powdered pale orange on dorsoposterior side. Thorax brown black, variously overlaid with white, pale-yellow and pink scales; hairlike white scale tuft behind wings; with white stripe laterally from collar to wing base. Abdomen brown black, variously overlaid with white, pale-yellow, pale-orange, and pink scales; segment four with white band on posterior margin dorsally, widening laterally and becoming solid white ventrally. Legs mostly brown black, with forecoxa white, and with some white on ventral edge of femora, encircling hindtibia at medial spurs, on spurs, and somewhat on each tarsal segment. Forewing mostly opaque, with small area in cell and one in apical region just beyond discal spot appearing to be clear but consisting of white translucent scales; otherwise, brown black, variously powdered with white, pale-yellow and pink scales; ventrally with much white on basal ½. Hindwing mostly hyaline; margins brown black; fringe white toward wing base. Valva relatively narrow, strongly upcurved, with small spinelike projection near center; saccus relatively narrow; gnathos hood shaped, strongly indented medially. In female ostium bursae relatively simple compared with that of *ruficornis,* very broad and slightly pigmented, abruptly tapering to narrow short, somewhat sclerotized, rugose

ductus bursae that gradually widens into an obovate corpus bursae; corpus bursae with small conical signum that is relatively smaller than that of *ruficornis*. Wing length 4–7 mm.

Adults have been collected in late July, August, and early September. Most specimens of *donahueorum* were collected from flowers of a legume, *Cracca edwardsii* Gray, in the Bog Spring Camp Ground at 5,600 feet elevation in Madera Canyon, Santa Cruz County, Arizona by Kathy and Julian Donahue, for whom this species was named. Since the discovery of this species, R. Wielgus collected a series of adults from the same plant species in Carr Canyon, Cochise County (personal communication). This plant should be examined carefully for larvae to determine whether it is the host plant for *donahueorum*.

TRIBE
Sesiini Boisduval

Sesiini Biosduval1828, *Europaeorum Lepidopterorum Index Methodicus,* 29.
Type genus: *Sesia* Fabricius, 1775.

Aegeriini *sensu* Le Cerf, 1917, *In* Oberthür, *Études de Lépidoptérologie Comparée,* **14**: 148.
Type genus: *Aegeria* Fabricius, 1807.

NOTE—*Aegeria* Fabricius, 1807, is a junior synonym of *Sesia* Fabricius, 1775.

Two species of the genus *Sesia* comprise the fauna of the Sesiini in America north of Mexico. The tribe is better represented in the Palearctic Region.

The Sesiini are distinguished by the following characteristics: Head with second segment of maxillary palpus much larger than first segment; antenna relatively more strongly clavate than most Sesiinae. Forewing with vein R_4 terminating at apex, R_5 on outer margin. Hindwing with veins M_3 and CuA_1 connate at posterodistal corner of cell or very short stalked. Male genitalia: uncus and tegumen nearly same length, point of articulation clearly visible; anellus thin, straplike, lacking lateral fingerlike projections; gnathos of various forms, thick, well sclerotized; scales on valva and uncus thick, dark, spinelike or furcate apically; saccus short, fairly broad, projecting anteriorly at right angle to vinculum proper; aedoeagus stout throughout, with several short, stout cornuti in vesica. Ostium bursae relatively large, circular, surrounded by thickened membrane; ductus bursae stout, curved, with some sclerotization near ostium, ductus seminalis arising just beyond sclerotized area; corpus bursae relatively large, ovate to obovate, with or without weakly defined signum.

See the discussion under *Sesia* for life history information.

GENUS
Sesia Fabricius

Sesia Fabricius, 1775, *Systema Entomologiae,* 547.
Type species: *Sphinx apiformis* Clerck, 1759. Designated by Latreille, 1810, *Considérations générales sur l'Ordre naturel des Animaux,* 440.

Trochilium Scopoli, 1777, *Introductio ad historiam naturalem, sistens genera lapidum, plantarum et Animalium . . .*, 414.
Type species: *Sphinx apiformis* Linneaus, 1761. Designated by Curtis, 1831, *British Entomologist,* **8**: 372.

NOTE—*Sphinx apiformis* Linnaeus, 1761, is a junior homonym and junior synonym of *Sphinx apiformis* Clerck, 1759.

Aegeria Fabricius, 1807, *in* Illiger's *Magazin für Insektenkunde,* **6**: 288.
Type species: *Sphinx apiformis* Clerck, 1759. Subsequent designation by Westwood, 1840, *Introduction to the Modern Classification of Insects,* **2** (*Synopsis of the Genera of British Insects*): 89.

NOTE—*Sphinx apiformis* Clerck, 1759, was originally cited by Westwood, 1840, as *apiformis* Linnaeus, an incorrect authorship.

Sphecia Hübner, [1819], *Verzeichniss bekannter Schmettlinge* [sic], 127.
Type species: *Sphinx crabroniformis* Lewin, 1797. Designated by Bartel, 1912, *in* Seitz, *Die Gross-schmetterlinge der Erde,* **2**: 378.

NOTE—*Sphinx crabroniformis* Lewin, 1797, is a junior homonym of *Sphinx crabroniformis* [Denis and Schiffermüller], 1775. It is a junior synonym of *Sphinx bembeciformis* Hübner, 1797.

Setia Meigen, 1829, *Systematische Beschreibung Europaischer Schmetterlinge,* **2**: 103.

NOTE—*Setia* Meigen, 1829, is an incorrect emendation for *Sesia* Fabricius, 1775.

Trochilia Speyer and Speyer, 1858, *Geographische Verbreitung Schmetterlinge,* 327.

NOTE—*Trochilia* Speyer and Speyer, 1858, is an incorrect emendation for *Trochilium* Scopoli, 1777.

Sphecodoptera Hampson, 1893, *in* Blanford, *The Fauna of British India, including Ceylon and Burma,* **1**: 189.

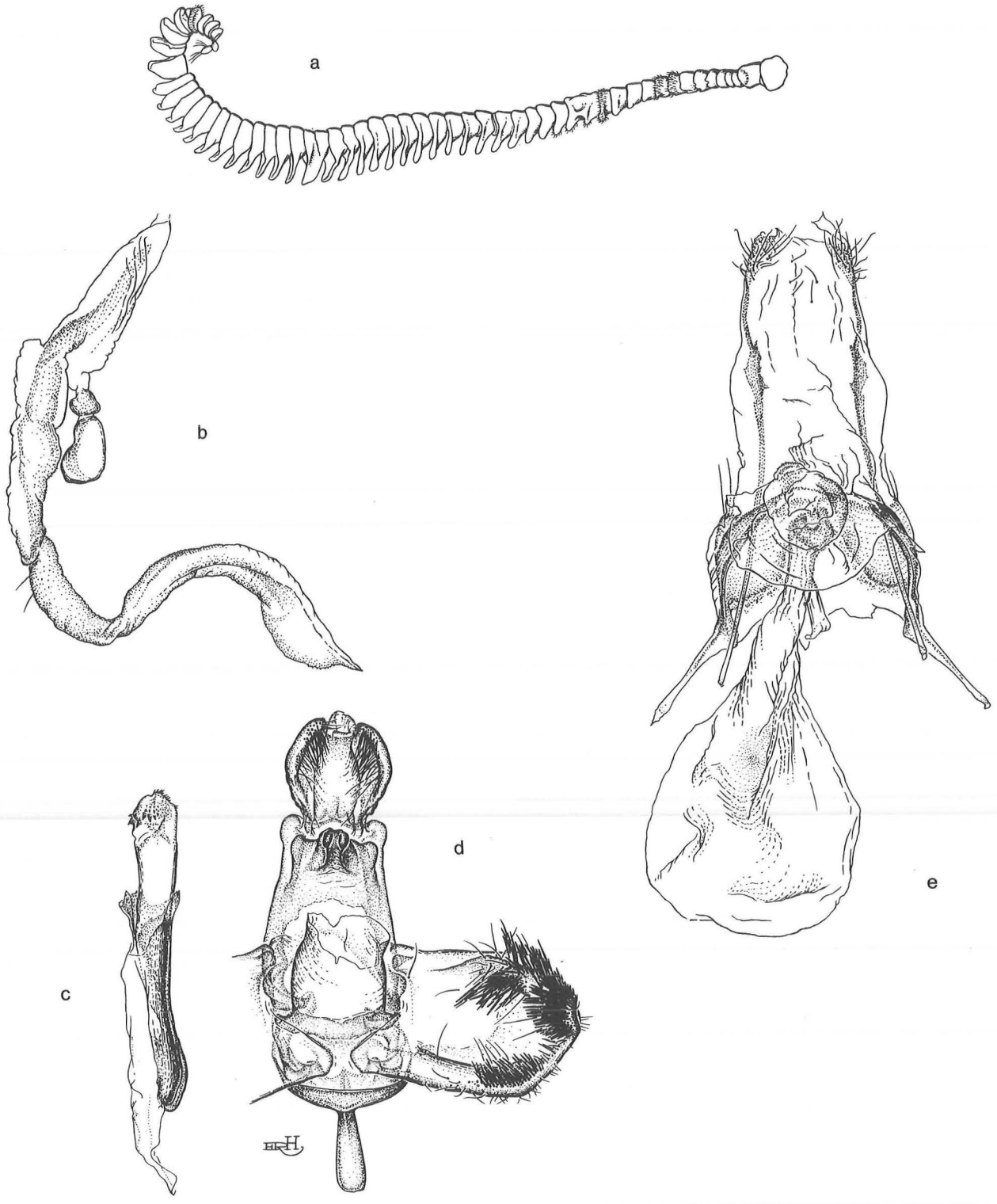

FIGURE 16: STRUCTURES OF SESIINAE (*SESIA APIFORMIS*)

a. Male antenna (USNM 75876). *b.* Maxillary palpus (USNM 75876). *c.* Aedoeagus (USNM 75815). *d.* Male genitalia (left valve and aedoeagus omitted) (USNM 75815). *e.* Female genitalia (USNM 75816).

Type species: *Sphecia repanda* Walker, 1856. Original designation.

Glossosphecia Hampson, 1919, *Novit. Zoologicae,* **26**: 83.
Type species: *Sphecia contaminata* Butler, 1878. Original designation.

Eusphecia Le Cerf, 1937, *Zeitchrift Österriechischen Entomologen-Vereines,* **22**: 106.
Type species: *Sesia pimplaeformis* Oberthür, 1872. Original designation.

The genus *Sesia* in North America consists of one introduced species and one native species. The larvae of both are borers in the trunks or exposed roots of willows and poplars (Salicaceae).

The genus is characterized by the following: Head with haustellum reduced, approximately ⅔ length of labial palpus; antenna of male ventrally ciliate-unipectinate; small, shelflike plate of scales beneath scape of antenna projecting horizontally slightly over eye, similar to *Melittia* species but less pronounced. Male genitalia with valva only slightly longer than wide, without crista sacculi; dark, spinelike scales confined mostly to marginal areas on apical ½; uncus wide, bilobed, with dark, spinelike scales of varying lengths apically on inner margin of lobes.

MacKay (1968a: 14) mentioned the following unique features of the larvae: Head with seta E^2 and its corresponding F^1 unusually close to each other; and anal shield with a small dark-brown spine medioposteriorly, sometimes minute and sometimes absent in late instars.

Both species of *Sesia* feed in several species of poplars and willows (Salicacaeae) and may cause severe injury when numerous. The larvae burrow in the cambium and solid wood in the trunks or in exposed roots. The life cycle takes two years. In the fall of the second year the larvae extend their galleries through the bark and construct elongate cocoons in the galleries, 1–1½ inches long, made of wood chips and lined with silk. They overwinter as larvae in the cocoons, pupate in the spring, and emerge as adults in May and June. Often where the larvae were in exposed roots, they will leave the roots and pupate in cocoons constructed in the surrounding soil. The adults emerge in the morning and crawl up the trunks of the trees where copulation may occur even before the wings of the females have dried. The males are attracted to pheromones emitted by the females and swarm around the tree trunks, looking much like hornets (*Vespula*).

KEY TO THE SPECIES OF *SESIA*

1. Thorax with broad, yellow, subdorsal patch extending from collar nearly to wing base; pecten of antenna as wide at base as antennal segment, tapering to a rounded point ..... *apiformis* p. 65

— Thorax subdorsally with narrow yellow patch behind collar and a thin longitudinal stripe extending posteriorly from this patch; pecten of antenna narrower than antennal segment and uniformly wide throughout ..... *tibialis* p. 66

Sesia apiformis (Clerck) (Hornet Moth*, Poplar Hornet Clearwing, Papillon Frelon, m., Fr.) PL. 2, FIGS. 14, 15. TEXT FIG. 16 *a–e* (RWH 2542).

Sphinx apiformis Clerck, 1759, *Icones Insectorum rariorum cum nominibus eorum trivialibus, locisque e C. Linnaei. . . Systema Naturae allegatis,* pl. 9, fig. 2.
Type locality: South England. [lost]

Sphinx crabroniformis [Denis and Schiffermüller], 1775, *Ankundung eines systematischen Werkes von den Schmetterlingen der Wienergegend,* 305.
Type locality: Vienna, Austria. [lost]

Sesia apiformis is widely distributed in the western and central Palearctic Region and was introduced into the United States sometime before 1880 according to Engelhardt (1946: 174). Male: Head with vertex roughened, yellow, a small rosette of short, dark setae (chaetosema) posterior to the ocellus; occipital fringe yellow mixed with brown black dorsally; front white laterally and on ventral ½, with brown black on dorsal ½ and in narrow band medially on ventral ½; labial palpus roughened, yellow with brown dorsally on first segment; antenna blue black dorsally, unipectinate, rami rust red with a broad base as wide as the segment and tapering to a rounded point. Thorax brown black with a broad yellow lateral patch before the wings; collar brown black, yellow sublaterally; posterior margin of mesothorax laterally with small patch of yellow; metathorax brown black with yellow scale tufts laterally. Abdomen mostly yellow but with brown black on all of segment one, posterior ⅔ of segment two, all of segment four except perhaps on anterior margin, variously on posterior portion of segment five medially and on posterior edge of all segments. Legs

with femora yellow, brown black ventrally; tibiae mixed pale orange, tan, and brown, pale yellow on inner surface, spurs tan; tarsi mostly tan with some pale yellow and brown; coxa of foreleg brown black, often mixed with yellow. Both pairs of wings hyaline, exept brown on veins, costal margin, costoapical region, fringe, and weakly defined discal spot; veins often dusted yellow ventrally. Gnathos well sclerotized, tapering to bifurcate apex; valva with dorsal and ventral margins nearly parallel, then converging to a rounded point, which is clothed with black, spinelike scales, a similar patch of scales ventroapically and another set of scales on a thick, sclerotized, dorsoapical ridge; aedoeagus clublike, vesica with several short, spinelike cornuti, some thick and some thin. Female similar to male but larger and more robust. Abdomen with segment five often heavily shaded brown or brown black. Tip of abdomen smooth and rounded. Tibiae and tarsi somewhat dull rust colored. Anterior apophyses short, about ⅓ length of posterior apophyses; segment eight heavily sclerotized and narrowed ventrally; margin of ostium bursae thickened, spinose; ductus bursae short, wide, membranous, projected dorsally from ostium bursae, then bending anteriorly, gradually widening to corpus bursae; corpus bursae ovate, with small oval, lightly pigmented, shagreened signum. Wing length 13–20 mm, with females usually larger than the males.

Hosts include *Populus* spp., including *P. nigra* Linnaeus, and *Salix* spp. (Salicaceae). For more specific details than given for the genus on the biology of this species, refer to Fibiger and Kristensen (1974). Adults were collected from May through August.

Nearctic records of *apiformis* are from Connecticut, New York, New Jersey, and Pennsylvania.

Sesia tibialis (Harris)

PL. 2, FIGS. 9, 11, 13; PL. B, FIG. 3. TEXT FIG. 17 *a–c* (RWH 2543).

Trochilium tibiale Harris, 1839, *Amer. Jour. Arts Sci.,* **36**: 309
Type locality: New Hampshire. [MCZ]

Melittia flavitibia Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 67.

NOTE—*Melittia flavitibia* Walker, 1856, is a replacement name for *Trochilium tibiale* Harris, 1839.

Trochilium pacificum Hy. Edwards, 1881, *Papilio,* **1**: 180.
Type locality: Washington Territory. [USNM]

Trochilium californicum Neumoegen, 1891, *Ent. News,* **2**: 108.
Type locality: California. [USNM]

Trochilium minimun Neumoegen, 1891, *Ent. News,* **2**: 108.
Type locality: Denver, Colorado. [USNM]

Aegeria tibialis variety *dyari* Cockerell, 1908, *Can. Ent.,* **40**: 330.
Type locality: Las Vegas, New Mexico. [USNM]

Aegeria tibialis variety *anonyma* Strand, 1925, *Lepidopterorum Catologus* (*Aegeriidae*), **31**: 124.
Type locality: Unknown. [unknown]

Aegeria tibialis variety *melanoformis* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 178.
Type locality: Keene Valley, Adirondack Mountains, New York. [USNM]

Sesia tibialis is closely related to *apiformis* based on their similar morphology and life history. It differs from *apiformis* as follows: Head with vertex yellow posteriorly, brown black anteriorly; front yellow laterally; labial palpus yellow but with brown black ventrally on first segment and sublaterally on second segment; antenna of male unipectinate, rami uniformly narrow from base to apex. Thorax with a much narrower yellow patch behind the collar and a thin, yellow subdorsal stripe most often extending to yellow patch that is posterior on mesothorax. Abdomen as for *apiformis* except in *tibialis* all segments are yellow ventrally, narrowly edged with brown black posteriorly. Legs with more yellow on coxae and femora. Valva produced dorsoapically; with spinelike scales along apical margin and a few medially in the center of valva, hairlike scales thinly scattered, and with similar spinelike scales inside lateral lobes of uncus; gnathos very broad and spatulate. Female similar to male but on average larger and more robust. Anterior apophyses comparatively longer than for *apiformis* but still only ½ the length of posterior apophyses; eighth segment not highly modified as for *apiformis*; ostium burase with sclerotized margin; corpus bursae obovate with narrow, longitudinal signum. This species averages smaller than *apiformis,* with wing length 12–19 mm. The females are generally larger than the males.

Engelhardt described the color form "*melanoformis*," which differs from the typical form primarily by having the abdominal segments mostly brown black with yellow confined to narrow bands on the anterior margin of each segment, and the wings with costal margin, veins, and discal spot brown black.

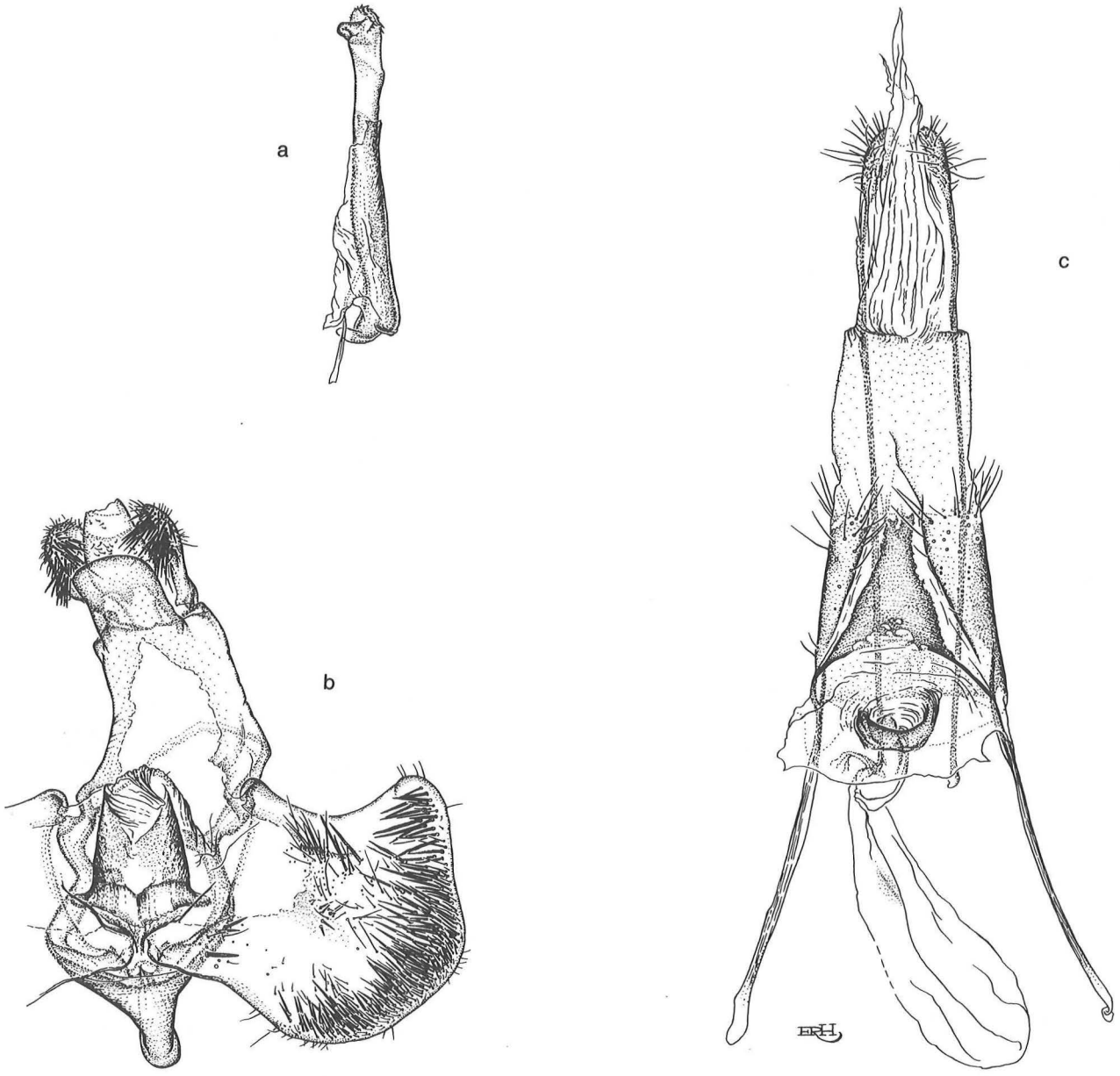

FIGURE 17: GENITALIA OF *SESIA TIBIALIS*

a. Aedoeagus (USNM 75817). *b.* Male genitalia (left valve and aedoeagus omitted) (USNM 75817). *c.* Female genitalia (USNM 75818).

The pale form "*pacifica*" Hy. Edwards has all abdominal segments except one and two entirely yellow or with brown black only on posterior edge of some segments. The form "*melanoformis*" occurs at higher elevations throughout the range of the species, whereas "*pacifica*" predominates in the western parts. The typical color form is mostly eastern in distribution but occurs with "*pacifica*" in the West.

Sesia tibialis has been associated with several species of Salicaceae, including *Populus alba* Linnaeus (silver poplar), *P. candicans* Aitken, *P. deltoides* Marsh (cottonwood), *P. fremontii* Watson (Fremont cottonwood), *P. tremuloides* Micheaux (quaking aspen), *P. trichocarpa* Torrey and Gray (black cottonwood) and *Salix* spp. (willows). The larvae bore beneath the bark in the cambium and solid wood of the lower trunk or exposed roots of the host tree. Adults have been collected from May through August. (Life history information was ex-

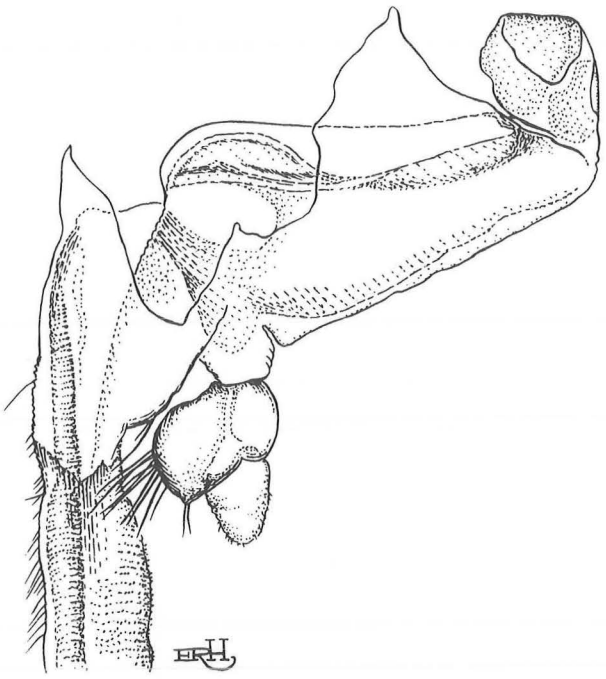

FIGURE 18: MAXILLARY PALPUS OF SYNANTHEDONINI (*ALCATHOE PEPSIOIDES*) (USNM 75896)

tracted from Engelhardt, 1946; and Anderson 1960). We have found sex attractants (mostly Z,Z-ODDA) to be very effective as baits for collecting males of *tibialis.*

Sesia tibialis occurs from Nova Scotia and New England to British Columbia, and the Rocky Mountains to the Pacific Coast.

TRIBE

Synanthedonini Niculescu

Synanthedonini Niculescu, 1964, *Linnaeana Belgica,* **3**: 40.
Type genus: *Synanthedon* Hübner, 1819.

Aegeriini *sensu* Naumann, 1971, *Bonner Zoologische Monographien,* **1**: 82.
Type genus: *Aegeria* of authors.

NOTE—*Aegeria* has been misidentified.

This tribe is a very large, relatively homogeneous group, and contains the most advanced and actively evolving group of species in the family. There are 86 species in eight genera in America north of Mexico.

The Synanthedonini are characterized as follows: Head small, eyes proportionately large; maxillary palpus with second segment greatly reduced; antenna clavate, often weakly so, male with short ventral cilia, apparently never pectinate; labial palpus either roughened or smoothly scaled; haustellum fully developed or reduced. Male genitalia with specialized bifurcate scales on valvae and socii; fused uncus-tegumen complex; valva in most species with crista sacculi differing depending on the species; juxta somewhat triangular with elongate, lateral, finger-like processes on membranous anellus, saccus narrow, vinculum narrow with small processes; gnathos well developed, consisting generally of a broad, shieldlike plate, often heart shaped, with medial, perpendicular plate (crista gnathi); specialized socii present, with dorsoanteriorly projecting, paired lobes (scopula androconialis) tapered to point, clothed with bifurcate scales; aedoeagus elongate, very narrow, with or without minute cornuti on vesica. Female genitalia with ductus bursae elongate, narrow, variously sclerotized, depending on species-group; ductus seminalis arising from differing points along ductus bursae, according to species-group; corpus bursae generally small, ovate, membranous, signum usually lacking.

According to MacKay (1968a: 26) the larvae of this tribe usually can be distinguished by the following two characters: Seta A^2, on head usually posterolateral to A^1, at least on one side of head; seta L-3 on prothorax usually posterodorsad to L-1, and L-1 therefore at apex of right or even obtuse angle formed by L-1, L-2, and L-3.

KEY TO THE GENERA OF SYNANTHEDONINI

1. Haustellum rudimentary, shorter than labial palpus ..... *Penstemonia* p. 132
— Haustellum coiled, longer than labial palpus 2
2. Hindleg with first tarsal segment much thickened with tufts of scales, more than twice as thick as second segment; male with elongate taillike extension from apex of abdomen ... *Alcathoe* p. 136
— Hindleg with first tarsal segment not thickened with tufts of scales, or if slightly thickened, not more than twice as thick as second segment; male without elongate taillike extension from apex of abdomen 3
3. Hindleg very long, tibia about three times longer than femur and first tarsal segment almost three times longer than femur ..... *Podosesia* p. 106
— Hindleg shorter, tibia at most two times longer than femur and first tarsal segment not more than 1½ times longer than femur 4

4. Apex of abdomen with long scale tufts (hair pencils), 5 on male and 2 on female; fore- and hindwings mostly opaque, blue black; abdomen with segment 4 orange or orange red .. *Sannina* p. 108

— Apex of abdomen without separate, long, scale tufts; scale pattern combinations not as above 5

5. Labial palpus with third segment approximately as long as the second segment; fore- and hindwings opaque; forewing with veins R_1 and R_2 coincident ..... *Hymenoclea* p. 140

— Without combination of characters as above 6

NOTE—Also see key to the species of *Palmia, Carmenta,* and *Synanthedon* (p. 69) that is based on external features to avoid the necessity of having to dissect each specimen to determine its correct genus.

6. Male with crista sacculi on ventral margin of valva projecting mesoventrad, gnathos without crista gnathi, apex of aedoeagus deeply bifurcate; female lacking sclerotization on ductus bursae, slight pigmentation on ventral margin of ostium bursae ..... *Palmia* p. 104

— Without above combination of genital characters 7

7. Male with distal portion of crista sacculi downcurved toward ventral edge of valva, saccus long, more than ⅓ length of valva; female with ductus bursae sclerotized for at least ½ its length, ductus seminalis arising from ductus bursae midway between ostium and corpus bursae or closer to corpus bursae ..... *Carmenta* p. 111

— Male with crista sacculi of various forms but distal portion not downcurved toward ventral edge of valva, saccus short, less than ⅓ length of valva; female with ductus bursae sclerotized for less than ½ its length, usually only near ostium bursae, ductus seminalis arising from ductus bursae closer to ostium than to corpus bursae ..... *Synanthedon* p. 73

KEY TO SPECIES OF *PALMIA, CARMENTA,* AND *SYNANTHEDON*

1. Labial palpus much thickened and roughened ventrally with outwardly projecting scales, most often mixed with longer, hairlike scales 2

— Labial palpus not much thickened, gently tapered toward apex, relatively smooth ventrally with scales mostly appressed, most often with scales flat and broad, not hairlike 27

2. Antenna at least ⅔ orange or yellow dorsally 3

— Antenna blue black or brown black dorsally, perhaps powdered lightly with some orange or yellow 8

3. Head with labial palpus mostly orange or brown black with mostly yellow or orange ventrally 4

— Head with labial palpus brown black mixed with white ventrally 7

4. Front brown black, perhaps some yellow scales laterally ..... *Synanthedon arizonensis* p. 95

— Front white laterally, often white or pale yellow medially 5

5. Occipital fringe orange ..... *Carmenta armasata* p. 114

— Occipital fringe not orange 6

6. Occipital fringe white laterally .. *Carmenta mimuli* p. 121

— Occipital fringe yellow laterally ... *Carmenta odda* p. 122

7. Abdomen ventrally mostly pale yellow ..... *Carmenta wellerae* p. 131

— Abdomen ventrally dark brown, perhaps lightly powdered with white on some segments .. *Carmenta wielgusi* p. 131

8. At least some orange or red on abdomen, perhaps confined to venter, if solid blue black, then both pairs of wings opaque 9

— No orange on abdomen, or perhaps lightly powdered with some orange ventrad, marked variously with yellow, or solid blue black or brown black, if solid black then both pairs of wings not opaque 14

9. Head with front white laterally 10

— Head with front solid black or with some yellow, orange, or red 12

10. Anal tuft mostly orange red ..... *Synanthedon canadensis* p. 86

— Anal tuft without orange red 11

11. Midleg and hindleg with tibiae orange ..... *Synanthedon fulvipes* p. 88

— Midleg and hindleg with tibiae mostly blue black ..... *Synanthedon culiciformis* p. 86

12. Hindleg with first tarsal segment laterally thickened with erect scales ..... *Synanthedon sapygaeformis* p. 94

— Hindleg with first tarsal segment not laterally thickened with erect scales 13

13. Head with vertex entirely blue black, or if orange then orange or red present on wings dorsally ..... *Synanthedon polygoni* p. 99

— Head with vertex orange or orange red, blue black mixed with some orange or orange red, or if solid blue black then no orange or red on wings dorsally ..... *Synanthedon novaroensis* p. 103

14. Head with front white or pale yellow laterally 15

— Head with front entirely blue black or gray black 21

15. Hindleg with tibia blue green, with pale yellow or white confined to distal end of tibia ..... *Synanthedon castaneae* p. 97

— Hindleg with tibia mostly yellow, blue black medially; solid orange; or black with white or yellow not confined to distal end 16

16. Occipital fringe white laterally 17

— Occipital fringe yellow or black laterally 18

17. Coxa of foreleg white or white and black ..... *Carmenta verecunda* p. 130

— Coxa of foreleg yellow and black ... *Carmenta querci* p. 126

18. Head with front blue black, white laterally ..... *Synanthedon decipiens* p. 94

— Head with front pale yellow; if white laterally, then front gray black with at least some pale yellow dorsally 19

19. Anal tuft with yellow medially; anal tuft of male may be entirely black, in which case tibia of hindleg more black than yellow ..... *Carmenta giliae* p. 118

— Anal tuft black medially; hindleg of male with tibia more yellow than black 20

20. Forewing with discal spot solid blue black, or with some yellow dorsally, yellow ventrally ..... *Synanthedon sequoiae* p. 104

— Forewing with discal spot orange or orange and black dorsally, orange ventrally ..... *Synanthedon rileyana* p. 80

21. Hindleg with tibia orange or orange and black 22

— Hindleg with tibia yellow and black, white and black, or entirely gray black 23

22. Hindleg with tibia entirely orange or with black only at base ..... *Synanthedon saxifragae* p. 92

— Hindleg with tibia black on apical half ..... *Palmia precaedens* p. 105

23. Head with occipital fringe white laterally; if yellow laterally, then coxa of foreleg entirely brown black ..... *Synanthedon sigmoidea* p. 92

— Head with occipital fringe yellow or black laterally, perhaps mixed with some pale yellow or white 24

24. Occipital fringe black dorsally; hindleg with first tarsal segment silver gray ..... *Synanthedon arctica* p. 85

— Occipital fringe yellow dorsally; if black dorsally, then underside of wings without light scaling; hindleg with first tarsal segment blue black or yellow 25

25. Anal tuft wedge shaped ..... male of *Synanthedon exitiosa* p. 101

— Anal tuft broadly rounded, fan shaped, truncate, or narrow 26

26. Forewing powdered with orange ventrally, occasionally mixed with some yellow ..... *Synanthedon chrysidipennis* p. 98

— Forewing powdered with yellow ventrally ..... *Synanthedon bibionipennis* p. 96

27. Labial palpus orange or yellow orange, often with brown black 28

— Labial palpus not as above 37

28. Anal tuft with at least some orange red or red dorsomedially 29

— Anal tuft without orange red or red dorsomedially, perhaps with some orange on tips of lateral scales 33

29. Abdomen orange red laterally and powdered orange red ventrally and dorsally, strongest on segments four and six ..... *Carmenta rubricincta* p. 127
— Abdomen not marked as above 30

30. Vertex of head black, perhaps with a few yellow-orange scales near posterior margin; forewing distad of discal spot with veins black dorsally, occasionally with a few pale-yellow scales 31
— Vertex of head mostly orange or orange red; if orange near posterior margin only, then forewing distad of discal spot with veins powdered yellow, apical region yellow between veins, or approximately distal ½ of forewing dark, opaque 32

31. Head with front white laterally; abdomen dorsally with narrow, pale bands; tibia of hindleg with much pale yellow ..... *Synanthedon acerrubri* p. 74
— Head with front solid blue black; abdomen dorsally without banding; tibia of hindleg blue black ..... *Synanthedon dominicki* p. 88

32. Forewing dorsally with apical region powdered yellow between veins; if brown black, then distal half of forewing dark, opaque ..... *Synanthedon acerni* p. 81
— Forewing dorsally with apical region brown black, powdered yellow only on veins ..... *Carmenta corni* p. 116

33. Antenna with pale yellow dorsally 34
— Antenna with apical third not pale yellow dorsally 35

34. Abdomen with orange red encircling all of segments 4 and 5; forewing dorsally with much orange in apical region ..... *Synanthedon bolteri* p. 85
— Abdomen dorsally with narrow yellow-orange band on segments 2 and 4; forewing dorsally without orange in apical region ... *Carmenta laurelae* p. 120

35. Forewing with at least distal half opaque; abdomen with at most two orange bands (one orange band =*Carmenta pyralidiformis* form "*auranti*," p. 125) ..... *Synanthedon alleri* p. 84
— Forewing mostly hyaline, or if more than half opaque then abdomen with more than two yellow, orange, or orange-red bands 36

36. Hindleg with tibia blue black, orange laterally only at spurs; abdominal bands orange red .. .. *Carmenta texana* p. 129
— Hindleg with tibia yellow or yellow orange, blue black laterally at base and apex; abdominal bands yellow or yellow orange .... *Synanthedon refulgens* p. 90

37. Labial palpus entirely brown black, or mostly white and brown, no trace of yellow 38
— Labial palpus mostly yellow, or pale yellow and brown black; if white present, always tinted yellow, or mixed with some yellow scales, or thorax with orange; if palpus entirely brown black, then forewings mostly hyaline 47

38. Labial palpus entirely brown or brown black 39
— Labial palpus mostly white with brown 42

39. Head with vertex orange .....*Synanthedon pini* p. 103
— Head with vertex brown black 40

40. Abdomen orange red except dorsally on first segment and laterally on anal tuft; head with front white laterally ..... *Synanthedon geliformis* p. 75
— Abdomen blue black dorsally, orange, if present, confined to segments four and five; head with front entirely blue black 41

41. Abdominal bands orange red, encircling all of segments four and five ... *Synanthedon rubrofascia* p. 90
— Abdominal bands, if present, dull orange on segment four; if bands on four and five, then venter of these two segments not completely orange ..... female of *Synanthedon exitiosa* p. 101

42. Forewing entirely opaque 43
— Forewing at least ⅓ hyaline 45

43. Forewing with dull orange medially, dark brown on costal margin and between veins CuA_1 and CuA_2 ..... *Carmenta ogalala* p. 123

— Forewing without dull orange medially 44

44. Antenna with dull white on apical third dorsally ..... *Carmenta subaerea* p. 127

— Antenna without white on apical third dorsally ..... *Carmenta suffusata* p. 128

45. Abdomen with at least three yellow bands dorsally ..... *Carmenta phoradendri* p. 124

— Abdomen with one or two white or pale-yellow bands dorsally or bands absent 46

46. Hindleg with tibia and tarsus blue black; tarsus ringed with white at joints and tibia ringed with white at spurs ..... *Carmenta prosopis* p. 124

— Hindleg with tibia brown, tarsus brown in female, gray or white in male; tibia and tarsus without white rings ..... *Carmenta albociliata* p. 111

47. Forewing ⅔ to entirely opaque, without orange or yellow powdering in apical region dorsally 48

— Forewing less than ⅔ opaque; if female with forewing at least ⅔ opaque, then antenna with white near apex, or either sex if mostly opaque then with discal spot mostly orange dorsally, or with apical region of forewing powdered with orange or yellow dorsally 50

48. Abdomen without banding .... *Carmenta mariona* p. 120

— Abdomen with at least one light-colored band dorsally 49

49. Abdomen with one or two light-colored bands dorsally ..... *Carmenta pyralidiformis* p. 125

— Abdomen with at least three light-colored bands dorsally ..... *Carmenta anthracipennis* p. 112

50. Foreleg with coxa white, occasionally slightly tinted yellow, or white and brown, or entirely brown black 51

— Foreleg with coxa yellow, pale yellow and white mixed, or yellow and brown black 56

51. Occipital fringe yellow dorsally 52

— Occipital fringe dorsally brown black, blue black, or white, or black mixed with a few yellow scales 54

52. Abdomen dorsally with three pale-yellow or white bands on male; two bands on female; male antenna without preapical white spot .. .. *Carmenta engelhardti* p. 118

— Abdomen dorsally with more than three yellow or pale-yellow bands in male, more than two in female; male antenna with preapical white spot 53

53. Abdomen dorsally with four pale-yellow bands in male, three bands in female ... *Carmenta ithacae* p. 119

— Abdomen dorsally with more than four yellow or pale-yellow bands ..... *Carmenta auritincta* p. 115

54. Abdomen dorsally with at least one narrow, pale-yellow, or white band on segment four, more bands may be faintly indicated .... *Synanthedon helenis* p. 89

— Abdomen unbanded, perhaps a few white scales present 55

55. Occurring east of the Rocky Mountains; male with labial palpus more often white than pale yellow ventrally; genitalia of male with apex of crista sacculi curved to ventral edge of valva; female with labial palpus most often entirely brown black, occasionally with some pale yellow ..... *Synanthedon proxima* p. 93

— Occurring from Rocky Mountains to West Coast; male with labial palpus more often yellow than white ventrally; genitalia of male with apex of crista sacculi not curved ventrad; female most often with labial palpus yellow ventrally but may be entirely brown black as above ..... *Synanthedon albicornis* p. 93

56. Forewing dorsally with discal spot mostly orange 57

— Forewing dorsally with discal spot brown black or blue black, perhaps narrowly outlined with yellow or orange 59

57. Hindleg mesially with tibia mostly dull orange, some brown black near distal spurs .... *Carmenta arizonae* p. 114

— Hindleg mesially with tibia bright yellow, much brown black on proximal half and near distal spurs ..... *Synanthedon mellinipennis* p. 99

58. Anal tuft primarily orange or orange red, or orange at least mixed basally ..... *Synanthedon richardsi* p. 75
— Anal tuft not orange, if orange, then blue black dorsomedially, or occipital fringe white laterally 59

59. Abdomen dorsally with at most one pale-yellow or white band; if more than one band, then bands white 60
— Abdomen dorsally with two or more yellow or orange bands 63

60. Head with front white or pale yellow laterally and occasionally ventrad .... *Synanthedon pictipes* p. 77
— Head with front entirely black; if pale yellow ventrally, then vertex yellow anteriorly 61

61. Occipital fringe blue black laterally; antenna without yellow powdering dorsally ..... *Carmenta welchelorum* p. 131
— Occipital fringe yellow laterally; antenna with at least some yellow powdering dorsally 62

62. Occipital fringe dorsally black or mixed with a few pale-yellow scales; head with vertex blue black, perhaps mixed with some pale yellow at posterior margin ..... *Synanthedon fatifera* p. 82
— Occipital fringe dorsally pale yellow; head with vertex often having much pale yellow on anterior half ..... *Synanthedon viburni* p. 82

63. Occipital fringe dorsally brown black, occasionally mixed with a few white or pale-yellow scales 64
— Occipital fringe dorsally white, yellow, or yellow orange, occasionally mixed with a few brown-black scales 65

64. Hindleg with tibia banded white; abdomen banded yellow on segments two, four, and five ..... *Synanthedon rhododendri* p. 77
— Hindleg with tibia banded pale yellow; abdomen banded yellow only on segments two and four ..... *Synanthedon pyri* p. 89

65. Occipital fringe white laterally 66
— Occipital fringe yellow laterally 69

66. Antenna with preapical white or pale-yellow spot ..... *Carmenta pallene* p. 123
— Antenna lacking preapical spot 67

67. Hindleg with first tarsal segment laterally mostly yellow ..... *Synanthedon scitula* p. 76
— Hindleg with first tarsal segment laterally black 68

68. Labial palpus laterally with brown at least on distal part of second segment ..... *Carmenta tecta* p. 128
— Labial palpus without brown on second segment ..... *Carmenta apache* p. 113

69. Labial palpus mostly dark brown laterally or dorsolaterally ..... *Synanthedon tipuliformis* p. 80
— Labial palpus yellow laterally, occasionally with some dark brown distally 70

70. Forewing ventrally with apical region powdered orange ..... *Synanthedon arkansasensis* p. 96
— Forewing ventrally with apical region powdered yellow 71

71. Hindwing dorsally with anal margin powdered yellow ..... *Synanthedon resplendens* p. 100
— Hindleg dorsally with anal margin unpowdered or with a few yellow scales basally 72

72. Abdomen dorsally with two yellow bands ..... *Synanthedon kathyae* p. 84
— Abdomen dorsally with more than two yellow bands ..... *Carmenta bassiformis* p. 115

GENUS

Synanthedon Hübner

Synanthedon Hübner, [1819], *Verzeichniss bekannter Schmettlinge* [sic], 129.
Type species: *Sphinx oestriformis* Rottemburg, 1775, now considered to be a synonym of *Sphinx vespiformis* Linnaeus, 1761. Designated by Newman, 1840, *in* Westwood, *Introduction to the Modern Classification of Insects,* **2** (*Synopsis of the Genera of British Insects*): 89.

Conopia Hübner, [1819], *Verzeichness bekannter Schmettlinge* [sic], 129.

Type species: *Sphinx stomoxiformis* Hübner, 1790. Designated by Bartel, 1912, *in* Seitz, *Die Gross-Schmetterlinge der Erde,* **2**: 376.

Austrosetia Felder, 1874, *in* C. Felder, R. Felder, and A. F. Rogenhofer, *Reis der österreichischen Fregatte Novara. . . ,* **2**: 2.
Type species: *Austrosetia semirufa* Felder, 1874. Monotypy.

Teinotarsina Felder, 1874, *in* C. Felder, R. Felder, and A. F. Rogenhofer, *Reis der österreichischen Fregatte Novara. . . ,* **2**: 9.
Type species: *Sesia longipes* Felder, 1861. Monotypy.

Pyrrhotaenia Grote, 1875, *Can. Ent.,* **7**: 174.
Type species: *Pyrrhotaenia floridensis* Grote, 1875. Original designation.

Ichneumenoptera Hampson, [1893], *The Fauna of British India, Including Ceylon and Burma,* **1**: 187.
Type species: *Ichneumenoptera auripes* Hampson, 1893. Original designation.

Vespamima Beutenmüller, 1894, *Bull. Amer. Mus. Nat. Hist.,* **6**: 87.
Type species: *Bembecia sequoiae* Hy. Edwards, 1881. Original designation.

Sanninoidea Beutenmüller, 1896, *Bull. Amer. Mus. Nat. Hist.,* **8**: 126.
Type species: *Aegeria exitiosa* Say, 1823. Designated by Walsingham, 1913, *in* Godman and Salvin, *Biologia Centrali-America. Insecta. Lepidoptera-Heterocera,* **4**: 196.

Thamnosphecia Spuler, 1910, *Die Schmetterlinge Europas,* **2**: 308.
Type species: *Sphinx culiciformis* Linnaeus, 1758. Original designation.

Scasiba Matsumura, 1931, *6000 Illustrated Insects of Japan-Empire,* 1017.
Type species: *Scasiba taikanensis* Matsumura, 1931. Monotypy.

Ramosia Engelhardt, 1946, *U. S. Natl. Mus., Bull.,* **190**: 22.
Type species: *Sesia bibionipennis* Boisduval, 1869. Original designation.

Sylvora Engelhardt, 1946, *U. S. Natl. Mus., Bull.,* **190**: 77.
Type species: *Trochilium acerni* Clemens, 1861. Original designation.

Tipulia Králíček and Povolný, 1977, *Věstník Československé Společnosti Zoologické,* **41**: 82.
Type species: [*Tipulia*] *tipuliformis* Clerck, 1759. Original designation.

We recognize 41 species of *Synanthedon* in America north of Mexico. The larvae of most species are borers in the trunks, stems or roots of various trees and shrubs; some feed in stems and roots of herbaceous perennials; and a few invade galls caused by other insects.

The genus is best defined on genital structures as follows: Male with valva having crista sacculi a small, nearly straight, oblique ridge, with variously modified scales, sometimes much expanded, modified, or absent; saccus short, less than ⅓ length of valva; bend of tegumen-uncus complex at a slightly obtuse angle. Female with ductus bursae elongate, slender, membranous, except for sclerotization confined on most species to posterior ⅓ or less; ductus seminalis arising from ductus bursae nearer ostium bursae than to corpus bursae, on posterior ⅓ in most species.

The arrangement of species into species-groups is based primarily on the general form of the crista sacculi of males. These groups essentially correspond to many of the genera used by previous authors, which were based mainly on one or two genital features of the type species of the genera. We have found the overall similarities among the species to be great and the differences very small, with significant overlap of character states from one group to another becoming evident as more of the species were studied.

Synanthedon acerrubri Englehardt
PL. 4, FIGS. 6, 7 (RWH 2546).

Synanthedon acerrubri Engelhardt, 1925, *Bull. Brooklyn Ent. Soc.,* **20**: 64.
Type locality: Newtown, Long Island, New York. [USNM]

Because of the orange-red to red anal tuft, *acerrubri* resembles *S. dominicki, S. acerni* and *Carmenta corni.* The species are separable on the basis of characters given in the key and by the genitalia. Males: Head with vertex brown black; front brown black, white laterally; occipital fringe orange; labial palpus mostly orange with apex mostly brown black; antenna brown black with pale-yellow or white preapical spot. Abdomen dorsally brown black but with very narrow pale-yellow bands on posterior edge of segments two, four, six, and seven, tending toward pale orange in posterior two segments; laterally mostly pale yellow except for segment three; anal

tuft orange red with brown black on basal ½. Legs laterally mostly brown black but forecoxa mostly white, tibiae with pale yellow at spurs, which are white, and tarsi ringed with pale yellow at joint of segments one and two. Forewing mostly hyaline, with brown black on strong discal spot and margins, often powdered lightly on costal margin, powdering more extensive ventrally. Hindwing hyaline with very narrow margins. Valva elongate; crista sacculi straight, extending beyond ventral margin of valva, continuous row of simple scales on dorsal edge; scopula androconialis slender, elongate. Female differs by having the abdomen more robust, often powdered with pale yellow dorsally on posterior segments, and anal tuft entirely orange red. Wing length 6–10 mm.

The larvae of *acerrubri* are borers in various species of maples (*Acer* spp., Aceraceae). They tunnel under the bark, usually on the branches. The newly hatched larvae apparently prefer to enter the tree at places where previous injury has occurred, including injury caused by other boring insect species. Pupation occurs in the spring within a cocoon made of wood chips and frass and situated near the surface of the bark. The adults fly from late April through the middle of August. The life cycle requires one year for completion (Engelhardt, 1925a: 65; 1946: 86). Several males have been captured in traps baited with an isomer of sex attractant (E,Z 2,13-ODDA) in Maryland, Georgia, and Florida.

Synanthedon acerrubri is known from Vermont and New York, west to Illinois and Nebraska, and south to Florida and Mississippi, with a single record from Nova Scotia.

Synanthedon geliformis (Walker)
PL. 3, FIG. 8 (RWH 2547).

Aegeria geliformis Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 46.
Type locality: United States. [BMNH]

Synanthedon geliformis is easily recognized with its dark opaque forewings and red abdomen. Predominantly tropical and subtropical, *geliformis* also occurs in coastal plain areas of the southeastern United States.

Male: Structures of the head (except for white laterally on the front) and thorax, including the legs, brown black. Abdomen entirely orange red, except for segment one, which is brown black, and anal tuft, which has brown black on margins. Forewing opaque, brown black. Hindwing hyaline with very narrow brown-black margins. Genitalia are of the same type as for *S. acerrubri,* but with valva broadly rounded apically, crista sacculi not extending to ventral margin, with row of black, spinelike scales on edge, crista sacculi widest on distal ½ and scopula androconialis and aedoeagus shorter than for *acerrubri.* Female similar to male but with hindwing often having a broader brown-black outer margin. Genitalia differ from those of *acerrubri* by having the short section of the ductus bursae posterior to the origin of the ductus seminalis sclerotized and pigmented. Wing length 6–9 mm.

Synanthedon geliformis is polyphagous, feeding in damaged areas of diverse plant families. It has been recorded from *Carya* spp. (pecan, hickory) (Juglandaceae), *Casuarina equisetifolia* Linnaeus (Australian pine) (Casuarinaceae), *Cornus* spp. (dogwood) (Cornaceae), and *Quercus* spp. (oaks, and galls on oaks) (Fagaceae) (Engelhardt, 1946: 177). Infestations are usually centered in abnormal areas of the host, such as galls, scars, or healing wounds. Otherwise, they are found as bark borers on the host tree. Adults have been captured or reared out in nearly every month of the year. Some have even been collected at black light. *S. geliformis* is one of the few clearwing moths capable of utilizing relatively unrelated host plants.

This species is known from the West Indies, eastern Mexico, and the Coastal Plain of South Carolina, Georgia and Florida.

Synanthedon richardsi (Engelhardt)
PL. 3, FIG. 9 (RWH 2548).

Conopia richardsi Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 87.
Type locality: Clark County, Georgia [USNM]

Although *richardsi* has a relatively wide distribution in the eastern United States, it is fairly rare in collections. Male: Head with vertex brown black; front mostly white with some brown black dorsally; occipital fringe yellow mixed with some brown black dorsally; labial palpus smooth, yellow with some brown black apically; antenna brown black but with apical ½ to ⅓ powdered white. Thorax dorsally brown black; ventrally pale yellow. Abdomen dorsally brown black; ventrally with pale yellow and white on segments two–five; anal tuft brown black mixed with orange or orange red dorsobasally, orange or orange red ventrally. Legs mostly yellow, but with forecoxa strongly mixed with white; femora brown black; tibiae basally and often distally brown black; tarsi alternating brown black and yellow. Forewing mostly hyaline but with broad brown-black

outer margin strongly orange between veins; other margins and discal spot brown black with some yellow basally and more extensively on costal margin ventrally. Hindwing hyaline with very narrow scaled margins; costal margin powdered yellow dorsally and orange ventrally. Genitalia are much like those of *geliformis* but with the apex of the valva somewhat pointed; scales on the crista sacculi simple, not spinelike; and the apex of the saccus truncate. Female differs from the male by having a broader orange apical area on the forewing; more white or pale yellow on the antenna; and the abdomen dorsally with a broad yellow band on the segment four, ventrally with pale yellow and white on all segments, and anal tuft short, brushlike, orange. Genitalia are similar to those of *geliformis.* Wing length 7–9 mm.

Nothing definite is known about the life history. A record of its capture from *Cephalanthus occidentalis* Linnaeus (buttonbush) (Rubiaceae) probably only indicates a nectar source and not a larval host plant, but the plant shares a common range with the moth and should be investigated.

Synanthedon richardsi ranges throughout the Piedmont and Appalachian Plateaus from Maryland south to Georgia and west to Ohio and Kansas.

Synanthedon scitula (Harris) (Dogwood Borer*, Pecan Borer, Sesie du Cornouiller, f., Fr.) PL. 3, FIGS 10, 11. TEXT FIG. 19 *a, b* (RWH 2549).

Aegeria scitula Harris, 1839, *Amer. Jour. Arts and Sci.,* **36**: 313.
Type locality: Not stated (United States). [MCZ]

Trochilium gallivorum Westwood, 1854, *Gardener's Chronicle and Agricultural Gazette,* **47**: 757.
Type locality: North America. [? Oxford]

Trochilium hospes Walsh, 1867, *Proc. Ent. Soc. Philadelphia,* **6**: 270.
Type locality: Rock Island, Illinois. [unknown]

Aegeria corusca Hy. Edwards, 1881, *Papilio,* **1**: 193.
Type locality: Texas. [AMNH]

Aegeria aemula Hy. Edwards, 1883, *Papilio,* **3**: 155.
Type locality: Unknown (North America). [USNM]

No other species of Sesiidae so far known has the ability to utilize such a wide array of host plants as does *S. scitula.* Apparently, many species of trees or shrubs having conditions attractive to the borer, such as malformations, galls, diseases or wounds, are subject to infestation in these areas of weaknesses. Outbreaks of this species occurring in orchards or on ornamental plantings can be of significant economic interest.

Male: Head with vertex brown black; front mostly white with brown black dorsomedially; occipital fringe dorsally yellow mixed with some brown black, white laterally; labial palpus smooth, yellow, often with some brown black apically; antenna brown black, scape yellow ventrally. Abdomen dorsally brown black with narrow band on posterior margin of segment two and a broader yellow band encircling segment four; ventrally variously powdered pale yellow medially on all segments except segment three; anal tuft brown black with yellow laterally. Legs with forecoxa pale yellow; femora brown black; tibiae mostly yellow, hindtibia with brown black basally and between spurs; tarsi yellow, perhaps mixed with some brown black. Forewing mostly hyaline with broad outer brown-black margin, powdered yellow between veins; costal margin and discal spot brown black; anal margin powdered yellow; ventrally with strong yellow powdering on costal margin. Hindwing hyaline with costal margin yellow. Genitalia like those of *richardsi* but with spinelike scales similar to *geliformis* on distal ½ of crista sacculi. The color form "*corusca*" in the southern portion of the range of *scitula* differs from the typical form by having the abdominal bands golden yellow, often with some golden yellow on the posterior margin of segments three and six, and the forewings have the broad outer margin strongly powdered with orange between the veins. Female similar to male except for abdomen more robust; ventrally mostly yellow on segments four, five, and six; and anal tuft brushlike with more yellow. Wing length 5–9 mm.

Synanthedon scitula has been recorded from black cherry, apple, quince (*Cydonia oblonga* Miller), mountain ash, *Crataegus* sp., ninebark (*Physocarpus opulifolius* (Linnaeus) (Maximowicz) (Rosaceae); dogwood (Cornaceae); chestnut, beech, oaks (Fagaceae); hazelnut (*Corylus* sp.), birch (Betulaceae); pecan, hickory (Juglandaceae); bayberry (*Myrica pensylvanica* Loiseleur-Deslongchamps), wax myrtle (*M. cerifera* Linnaeus) (Myricaceae); Japanese dwarf pine (*Pinus* sp.) (Pinaceae); willow (Salicaceae); rattan vine (*Berchemia scandens* (J. Hill)) (Rhamnaceae); and *Wisteria* sp. (Fabaceae). *Synanthedon scitula* has a one-year life cycle. Eggs deposited in midsummer to early fall hatch in eight or nine days under optimum conditions. The larvae

feed until pupation in late spring or early summer of the following year. The adults emerge in about eight to 12 days following pupation (Pless and Stanley, 1967). This species occurs throughout the eastern half of the United States and southern Canada (males respond to Z,Z-ODDA attractant bait: Karandinos et al., 1977; Neal and Eichlin, 1983; Nielsen et al., 1975; Snow et al., 1985; Solomon et al., 1982). Several males were trapped using sex attractants in Colorado (W. Meyers, personal communication). Adults have been found in various parts of the range from April to October.

Synanthedon pictipes (Grote and Robinson) (Lesser Peachtree Borer*; Petit Perceur du Pecher, m., Fr.)

PL. 3, FIGS. 12, 13; PL. B, FIG. 4, TEXT FIG. 20 *a, b* (RWH 2550).

Aegeria pictipes Grote and Robinson, 1868, *Trans. Amer. Ent. Soc.,* **2**: 182.

Type locality: Atlantic District, Pennsylvania. [lost]

Aegeria inusitata Hy. Edwards, 1881, *Papilio,* **1**: 201.

Type locality: Andover, Massachusetts. [AMNH]

Much has been written about the lesser peachtree borer, and a bibliography through 1975 for this species and *S. exitiosa* (Say) (peachtree borer) has been published (Holloway et al., 1977). It is a major economic pest of peach trees in the eastern half of the United State where it occurs. Both sexes resemble males of *exitiosa* and also can be confused with *fatifera* Hodges, *viburni* Engelhardt, *albicornis* Edwards, and *proxima* Edwards. The species can be separated on the basis of characters given in the key and by structures of the genitalia.

Adult: Head with vertex blue black, often mixed with pale yellow on posterior margin; front blue black, white laterally; occipital fringe blue black dorsally, pale yellow laterally; labial palpus very slightly roughened ventrally, pale yellow with brown black dorsolaterally to apex; antenna blue black. Abdomen blue black; segments one and two pale yellow laterally; ventrally with pale-yellow band on posterior margin of segment four; anal tuft blue black with trace of white on lateral margins. Legs blue black with pale yellow and white on forecoxa laterally, on tufts at tibial spurs and around joints of tarsal segments. Forewing hyaline with narrow, scaled margins, discal spot and veins brown black, weakly powdered pale yellow variously on some veins and margins dorsally but strongly pale yellow on discal spot and costal margin ventrally. Hindwing hyaline. Male genitalia with crista sacculi only slightly visible near the ventral edge of the valva; saccus very short; aedoeagus with minute lateral spinelike projections apically. Female genitalia with ductus bursae initially sclerotized, bell shaped, then very narrow, soon becoming membranous, at which point ductus seminalis arises, then elongate narrow and membranous to small, oval corpus bursae. Wing length 8–12 mm.

The larvae are borers beneath the bark in living tissue of Rosaceae and are found on the limbs, crotch of branches, or trunk above ground level (Holloway et al., 1977). Occasionally, they are found below ground level in older trees (Wiener and Norris, 1983). They prefer areas of previous injury or abnormality on the host such as fungus knots. Older vigorous trees with new injury are highly susceptible to borer infection. Trees less than three or four years old apparently are not suitable hosts under normal circumstances but have been known to be infested when injured or when in an extremely heavily infested area. Cultivated hosts include peach, plum, and cherry; native hosts are in the Rosaceae such as wild black cherry, bird cherry, wild plum, beach plum, Juneberry, and others. The lesser peachtree borer has two generations per year throughout most of its range. The number of larval instars varies to a maximum of seven under different conditions. Yonce et al. (1974) discovered that E,Z 3,13-ODDA was the predominant compound in the pheromone system of *pictipes,* and the synthesized material has been used successfully as bait to detect and monitor this species.

Synanthedon pictipes occurs in the eastern half of North America from Nova Scotia to Florida and west to Minnesota and Texas.

Synanthedon rhododendri (Beutenmüller) (Rhododendron Borer*)

PL. 3, FIG. 14 (RWH 2551).

Sesia rhododendri Beutenmüller, 1909, *Ent. News,* **20**: 82.

Type locality: Cheltenham, Pennsylvania. [USNM]

The small size and the banding on abdominal segments two, four, and five generally make it possible to discriminate *rhododendri* from other sesiids. Male: Head with vertex brown black; front brown black, white laterally; occipital fringe brown black dorsally mixed with some white, laterally mostly white or pale yellow; labial palpus smooth, yellow with brown

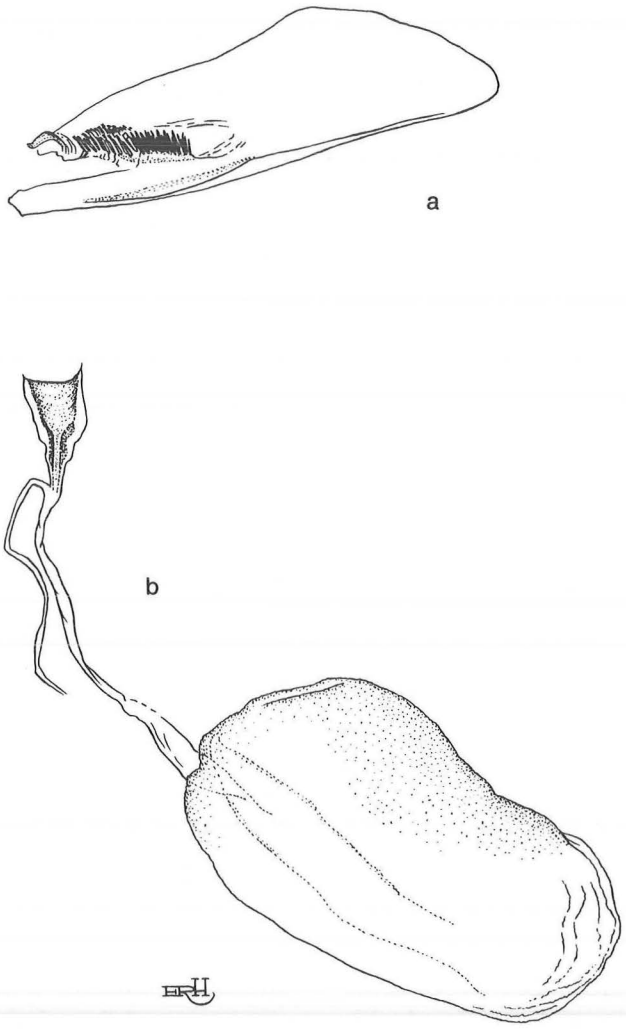

FIGURE 19: GENITALIA OF *SYNANTHEDON SCITULA*
a. Right valve (USNM 75736). *b.* Female genitalia (abdominal segments omitted) (USNM 75755)

black laterally to apex; antenna brown black. Abdomen brown black, banded yellow on posterior ½ of segments two, four, and five; yellow laterally on segments one and two; anal tuft broadly truncate, brown black with yellow laterally. Legs mostly brown black; forecoxa yellow, white laterally; tibiae with pale yellow or white medially and distally; tarsi with pale yellow or white at joints laterally, pale yellow mesially. Forewing mostly hyaline, margins and discal spot brown black, slightly powdered pale yellow on margins and between veins on broad outer margin, much more so ventrally. Hindwing hyaline with very narrow margins; ventrally with costal margin mostly pale yellow. Genitalia much like those of *pictipes* but aedoeagus lacking lateral spinelike processes; valva without noticeable crista sacculi but demarcated by patches of simple spatulate scales mixed with some spinelike scales, and like *pictipes,* with circular denuded area dorsal to this demarcation. Female similar to the male but anal tuft brushlike with pale yellow submedially. Genitalia with ductus bursae somewhat expanded posteriorly to ostium bursae, this section sclerotized. Wing length 5–7 mm.

Synanthedon rhododendri has been associated with *Rhododendron* spp. and *Kalmia latifolia* Linnaeus (mountain laurel) (Ericaceae). (For details of the life history, refer to Neal, 1982.) The larvae bore in the central pithy portions of small branches and twigs of their hosts or under the bark on older and larger parts of the plant (Engelhardt, 1946: 43). Adults have been taken from late May through early Au-

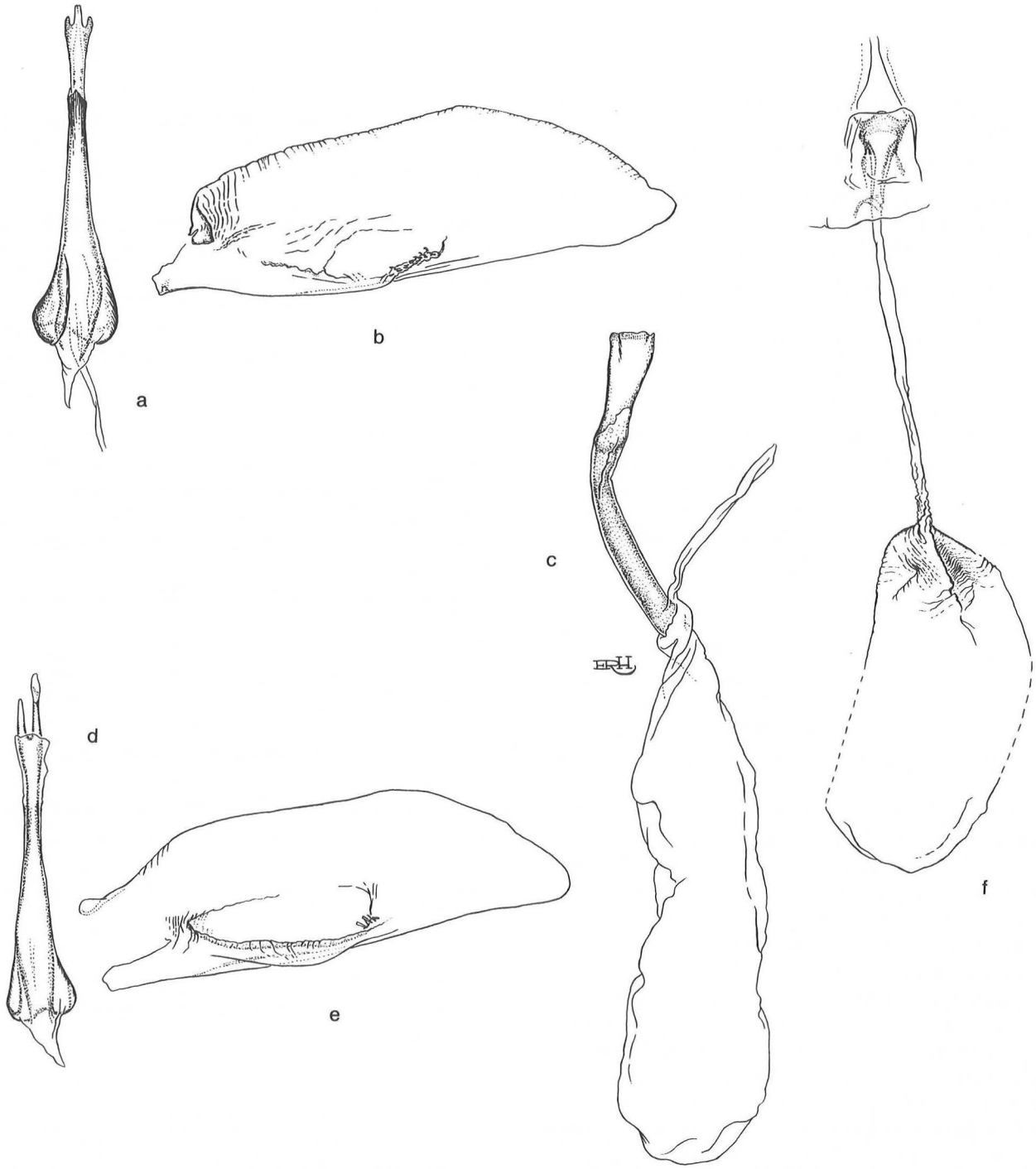

FIGURE 20: GENITALIA OF *SYNANTHEDON* SPECIES

a, b. Synanthedon pictipes, a. Aedoeagus (USNM 76037); *b.* Right valve (USNM 76037). *c.* Female genitalia of *Synanthedon rileyana* (abdominal segments omitted) (USNM 75950). *d–f. Synanthedon acerni, d.* Aedoeagus (USNM 75684); *e.* Right valve (USNM 75684); *f.* Female genitalia (part of eighth abdominal segment included) (USNM 75692).

gust. Attractant baits (Z,Z-ODDA) have been employed to collect males (Neal and Eichlin, 1983; Snow et al., 1985; Solomon et al., 1982).

It may occur with its host plants throughout the Appalachian Mountains and has been recorded from Massachusetts, Rhode Island, New York, Pennsylvania, Ohio, Maryland, North Carolina, South Carolina, Georgia, and Mississippi.

Synanthedon rileyana (Hy. Edwards)
PL. 2, FIGS. 16, 17. TEXT FIG. 20 *c* (RWH 2552).

Albuna rileyana Hy. Edwards, 1881, *Papilio,* **1**: 187.
Type locality: Cadet, Missouri. [AMNH]

Aegeria brunneipennis Hy. Edwards, 1881, *Papilio,* **1**: 191.
Type locality: Georgia. [MSU]

Aegeria hyperici Hy. Edwards, 1881, *Papilio,* **1**: 195.
Type locality: West Virginia. [AMNH]

Carmenta austini Engelhardt, 1946, *U. S. Natl. Mus., Bull.,* **190**: 57.
Type locality: Austin, Texas. [USNM]

NOTE—Engelhardt described *Carmenta austini* from two specimens, the holotype male from Texas and allotype female from Utah. The allotype is a specimen of *giliae.* The holotype is an oversized specimen of *Synanthedon rileyana.*

Synanthedon rileyana occurs mostly in the eastern half of the United States. It is the only species of Sesiidae north of Mexico known to have a solanaceous host. Based on the genitalia, *rileyana* appears to be intermediate between *Synanthedon* and *Carmenta* and may have to be placed elsewhere when the higher categories of the Mexican fauna have been defined.

Male: Head with vertex brown black; front pale yellow, often mixed with brown medially; occipital fringe yellow; labial palpus very strongly roughened, yellow with brown black laterally; antenna usually brown black, specimens from Texas with orange powdering dorsally. Thorax brown black; collar yellow on margins; yellow around base of wing; broad triangular patch of yellow beneath wing; metathorax yellow dorsally and on tufts laterally. Abdomen brown black with yellow bands encircling segments two–seven; anal tuft short, somewhat triangular with short flared tufts laterally, mostly brown black with yellow subdorsal stripe and yellow on lateral tufts; lateral scales on valva yellow. Legs with forecoxa yellow; femora brown black; tibiae yellow with brown black basally and distally; tarsi mostly brown, but with yellow or yellow orange at joints and intensely on first segment. Forewing mostly hyaline with narrow margins brown black or variously powdered orange red, especially on anal margin and between veins on outer margin, particularly in specimens from the Southwest; discal spot narrow, orange red, often with brown black on proximal edge. Hindwing hyaline with very narrow margins that are powdered orange ventrally; small triangular orange-red discal spot. Genitalia with ventral edge of valva nearly straight, becoming pointed apically; crista sacculi straight, not downcurved apically to ventral margin as on species of *Carmenta,* heavily clothed with bifurcate scales; saccus nearly ½ length of valva as in *Carmenta* species; scopula androconialis relatively short for *Synanthedon* species. Female similar to male but with broader outer margin on forewing; more brown black distally on hindtibia; and labial palpus with little or no brown black laterally. Genitalia of *Carmenta* type: ductus bursae sclerotized for most of its length, and ductus seminalis arising very near corpus bursae. Wing length 7–12 mm.

Larvae of *rileyana* have been reared in the main roots of *Solanum carolinense* Linnaeus (Somes, 1916), and they may utilize other species of Solanaceae as hosts. Because pupation takes place in silk-lined tubes constructed in the sandy soil near the host, evidence of the borers is the presence of the pupal exuviae protruding from the soil surface close to the plants (Engelhardt, 1946: 44). The sex attractant most effective for this species is E,Z-ODDOH alone or mixed with the acetate (Solomon et al., 1982; Snow et al., 1985). Adults have been collected from June to September.

Synanthedon rileyana is distributed from New York south to Florida and west to Wisconsin, Kansas, Texas, and Arizona. Engelhardt (1946: 57) described "*austini*" from Texas, which is larger, has much orange powdering in the outer margin of the forewing, and has orange powdered on the antenna dorsally.

Synanthedon tipuliformis (Clerck) (Currant Borer*; Currant Clearwing; Sesie du Groseillier, f., Fr.)
PL. 3, FIGS. 15, 16 (RWH 2553).

Sphinx tipuliformis Clerck, 1759, *Icones Insectorum rariorum cum nominibus eorum trivialibus, locisque e C. Linnaei . . . Systema Naturae allegatis,* pl. 9, figs. 1, 2.
Type locality: Not given. [unknown]

Sphinx salmachus Linnaeus, 1758, *Systema naturae. . . ,* **1** (Editio Decima, Reformata): 493.
Type locality: Europe. [Uppsala University]

NOTE—*Sphinx salmachus* Linnaeus, 1758 is an unused senior synonym of *Sphinx tipuliformis* Clerck, 1759.

Sphinx tipula Retzius, 1783, *Caroli Lib. Bar. De Geer. . . , genera et species insectorum et generosissimi auctoris scriptis extracit, digessit Latine quoad partem reddidit, et terminologiam insectorum Linneaum addidit,* 33.

NOTE—*Sphinx tipula* is an unnecessary emendation.

The currant borer is a cosmopolitan species in temperate regions wherever its host plants have been introduced; the original source is Europe. Male: Head with vertex brown black; occipital fringe yellow, mixed with some brown black dorsally; front brown black, white laterally; labial palpus smooth, yellow with broad brown-black band laterally; antenna brown black. Thorax brown black, dorsally with very narrow subdorsal yellow stripe and large patch of yellow beneath wing. Abdomen dorsally brown black with segments two, four, six, and seven very narrowly banded yellow on posterior margin; yellow laterally on segments one and two; ventrally brown black. Legs laterally mostly brown black but with yellow laterally on forecoxa; tibiae with spurs yellow and yellow bands around tibiae at both pairs of spurs; tarsi ringed with yellow at joints. Forewing mostly hyaline with relatively broad outer margin, large discal spot; margins and discal spot brown black, variously powdered yellow between veins on outer margin and anal margin; ventrally yellow powdering more extensive. Hindwing hyaline, costal margin and fringe near wing base pale yellow. Genitalia with valva having basal portion of sacculus devoid of scales, without crista sacculi but somewhat indicated by patch of dark simple scales on ventral margin of valva medially; saccus very short; scopula androconialis relatively long. Female like male except with three abdominal bands; anal tuft shorter, brushlike; forewing often with more yellow powdering apically between veins. Genitalia with ostium bursae at bottom of sclerotized U-shaped pocketlike area: initial posterior section of ductus bursae short, somewhat sclerotized, very narrow, tubular, with ductus seminalis arising at anterior end of this section, remaining anterior part of ductus bursae elongate, slender, membranous, expanding somewhat to obovate corpus bursae. Wing length 7–9 mm.

Host plants include species of *Ribes* (currants and gooseberries, Saxifragaceae) and to a lesser extent *Rubus* spp. (blackberries, Rosaceae) (Chambers and Halliday, 1954; Taschenberg, 1953; Taschenberg and Avens, 1964). Female moths deposit 20 to 60 eggs on young wood near the buds on the host plant. The newly hatched larva bores into the plant, feeding and maturing within the pith as it migrates downward in the cane. Overwintering occurs within the cane a short distance above ground level. The larva matures in the spring after some feeding, cuts a small circular exit hole nearly through the bark and pupates. The mobile pupa works itself out of the exit hole at the time of adult emergence, which may occur from late April to July in North America (Engelhardt, 1946: 42). A sex attractant blend has proven effective as a bait for capturing males (Szocs et al., 1985). K. Scarborough (personal communication) has captured males with a 99:1 blend of the isomers E,Z 2,13-ODDA/Z,Z 3,13-ODDA.

Synanthedon tipuliformis is known to occur in temperate regions of Europe, and was probably introduced into Asia, Australia, New Zealand, and North America. In North America *tipuliformis* is recorded from southern Canada and throughout the United States except in the Gulf Coast States and the desert Southwest.

Synanthedon acerni (Clemens) (Maple Callus Borer*; Sesie de l'Erable, f., Fr.)

PL. 2, FIGS. 18, 19; PL. 3, FIG. 17. TEXT FIG. 20 *d–f* (RWH 2554).

Trochilium acerni Clemens, 1860, *Proc. Acad. Nat. Sci. Philadelphia,* **12**: 14.
Type locality: Unknown [? Easton, Pennsylvania]. [lost]

Trochilium acericolum Germadius, 1874, *Amer. Naturalist,* **8**: 57.
Type locality: Champaign, Illinois. [unknown]

Pyrrhotaenia tepperi Hy. Edwards, 1881, *Papilio,* **1**: 203.
Type locality: Georgia. [MSU]

Sylvora acerni race *buscki* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 79.
Type locality: Gainesville, Florida. [USNM]

Adult: Head with vertex mostly orange or orange red, often with some brown black anteriorly; front brown, variously with orange or yellow medially, white laterally; occipital fringe orange; labial palpus very slightly roughened, orange; antenna brown black, scape orange. Thorax dorsally brown with subdorsal yellow stripe broadening posteriorly into scale tufts; ventrally yellow. Abdomen dorsally brown black with posterior edge of all but segment three gray, all segments variously powdered with gray and pale yellow, weakest on segment three; anal tuft mostly orange or orange red; ventrally yellow. Legs mostly yellow but with forecoxa orange, some

brown black on fore- and midfemora and tibiae, brown black distally on hindtibia. Forewing about ⅔ hyaline with very broad outer margin, which is strongly yellow between veins, brown black adjacent to fringe; characteristically broad, brown-black discal spot with an additional, somewhat diffuse, smaller spot slightly above and beyond discal spot, this spot more distinctive ventrally. Hindwing hyaline with narrow margins, some yellow apically between veins; discal spot large, triangular, brown black; fringe fuscous. Male genitalia with valva lacking a defined crista sacculi but with a narrow ridge projecting from near ventral margin of valva, naked; aedoeagus with bifurcate apex; scopula androconialis relatively short. Female genitalia with posterior portion of ductus bursae funnel shaped, sclerotized, abruptly narrowed to very narrow ductus bursae. Wing length 7–13 mm.

The color form "*buscki*" from Florida and Georgia differs from the typical form by having the head with front blue black medially; thorax mostly orange; abdomen with segments one and two orange dorsally, three to seven blue black; legs with much orange; forewing with apical area powdered orange between veins. The form "*tepperi*" from Georgia, Alabama and Mississippi is like "*buscki*" but has the abdomen dorsally blue black except for segment one; more extensively blue black on legs; forewing more nearly opaque, brown black and lacking yellow or orange powdering.

Larvae bore in *Acer* spp. (maples) (Aceraceae), including *A. rubrum* Linnaeus (red maple) and *A. saccharinum* Linnaeus (silver maple). They bore beneath the bark mostly on the trunk, overwintering as larvae in their galleries, and pupating in cocoons constructed in the gallery (Anderson, 1960; Baker, 1972; Boyd, 1953; Engelhardt, 1946: 79). Most adults have been collected in May, June, and July but as early as April in the South and as late as August in the Northeast. The isomer Z,Z-ODDA appears to be the major component of the sex attractant for *acerni* (Neal and Eichlin, 1983; Nielsen et al., 1975; Snow et al., 1985; Solomon et al., 1982).

The distribution of *acerni* closely matches the distribution given by Fowells (1965) for red maple, one of the preferred hosts of this species. It ranges from the East Coast to the Mississippi Valley, southern Canada, Nova Scotia to Ontario, and to the Gulf Coast. This is one of few sesiids that has been captured regularly at black light.

Synanthedon fatifera Hodges

PL. 2, FIG. 20. TEXT FIG. 21 *a–b* (RWH 2555).

Synanthedon fatifera Hodges, 1962, *Bull. Brooklyn Ent. Soc.*, **57**: 139.
Type locality: Mentor, Ohio. [USNM]

Adult: Head with vertex blue black, often with some pale yellow posteriorly; front blue black; occipital fringe blue black dorsally, often mixed with some pale yellow, pale yellow laterally; labial palpus smooth, pale yellow with brown black dorsolaterally to apex; antenna blue black with pale yellow dorsally on apical ⅓. Thorax blue black with pale-yellow spot beneath wing; very narrow, pale-yellow subdorsal stripe; pale-yellow tuft laterally on metathorax. Abdomen blue black with pale yellow laterally on segments one and four; anal tuft edged thinly with pale yellow. Legs blue black; forecoxa pale yellow laterally; tarsi pale yellow or white ventrally and at joint of segments four and five; tibiae with pale yellow or white on tufts at spurs, which are also pale yellow or white. Male genitalia generally of same type as *acerni* with valva lacking true crista sacculi but with another more ventral naked ridge extending along ventral margin of valva, curving dorsally, then once again parallel to ventral edge of valva; concave area dorsal to naked ridge with various patterns of dark simple flat truncate scales arranged roughly paralleling shape of the naked ridge; scopula androconialis more elongate than on *acerni;* aedoeagus expanded dorsally at ⅔, then abruptly narrowed to apex, not bifurcate apically as on *acerni.* Female genitalia with ductus bursae posteriorly expanding into short broadly funnel-shaped section, otherwise very narrow anteriorly to corpus bursae. Wing length 9–11 mm.

Adults have been reared from *Viburnum* spp., including *V. opulus nanum* Jacquin (Caprifoliaceae) (Hodges, 1962). Adults have been taken from late April to July, but most records are in mid- to late May.

The known range of *fatifera* has been greatly extended because of the work of several researchers (Karandinos et al., 1977; Neal and Eichlin, 1983; Nielsen et al., 1975; Sharp et al, 1968) who used various blends of sesiid sex attractants (mostly Z,Z-ODDA) in field surveys. Originally described from Ohio in 1962, it is now known from Wisconsin, southern Ontario to the Atlantic Coast states south to northern Florida. Eichlin identified a female reared from *Viburnum opulus* in Idaho, June 1982 (T. C. MacRae, personal communication).

Synanthedon viburni Engelhardt

PL. 3, FIGS. 18, 19. TEXT FIG. 21 *c–e* (RWH 2556).

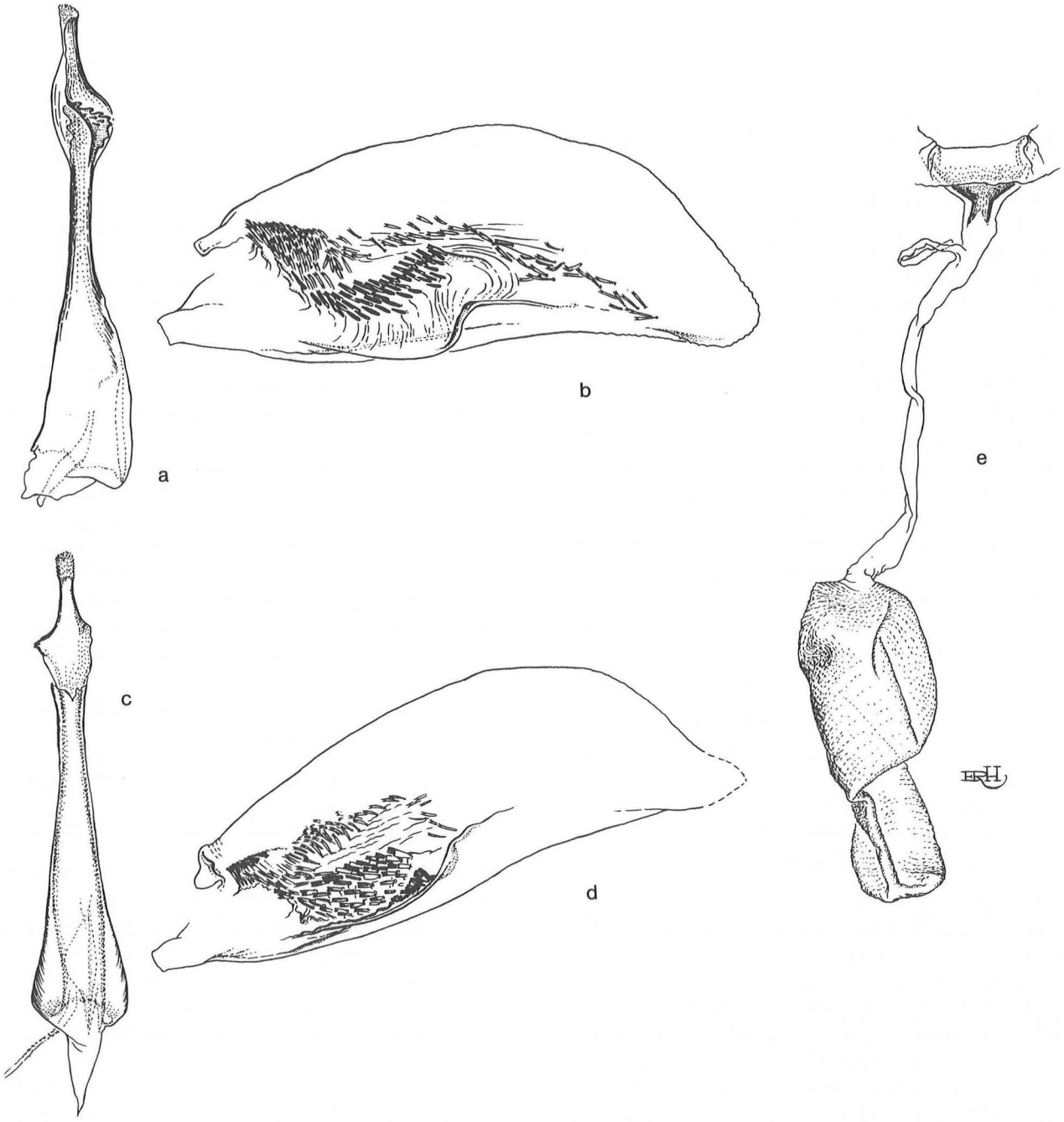

FIGURE 21: GENITALIA OF *SYNANTHEDON* SPECIES

a, b. Synanthedon fatifera, a. Aedoeagus (USNM 76121); *b.* Right valve (USNM 76121). *c–e. Synanthedon viburni, c.* Aedoeagus (USNM 75709); *d.* Right valve (USNM 75709); *e.* Female genitalia (abdominal segments omitted) (USNM 75710).

Synanthedon viburni Engelhardt, 1925, *Bull. Brooklyn Ent. Soc.,* **20**: 65.
Type locality: Woodhaven, South Long Island, New York. [USNM]

As the name indicates, *viburni* is a *Viburnum* borer like the previous species, *fatifera.* The two species are generally sympatric in their distribution and closely resemble each other. *Synanthedon viburni* differs from *fatifera* by the following: Only females have extensive pale-yellow area distally on dorsum of antenna, males only slightly powdered; vertex of head often mixed with much pale yellow anteriorly; occipital fringe pale yellow dorsally; second segment of abdomen dorsally with very narrow, pale-yellow

band on posterior edge. Male genitalia with scales in saccular depression of valva extending to ventral ridge, which distally expands somewhat and curves dorsally but does not recurve to become parallel with ventral margin of valva as on *fatifera.* Female genitalia similar to those of *fatifera.* Wing length 7–10 mm.

Synanthedon viburni has been recorded from *Viburnum* sp., *V. lantana* Linnaeus and *V. dentatum* Linnaeus. The larvae are bark borers, preferring areas that are swollen or distorted as a result of gall formations or abrasions. Pupation occurs in the spring in cocoons beneath the bark of the host plant (Engelhardt, 1925a; 1946). Most adults examined have been taken in May and June but some as late as mid-August. The males of *fatifera* and *viburni* respond to different stereo-isomers (*fatifera,* Z,Z-ODDA; *viburni,* E,Z-ODDA) of clearwing moth pheromone systems (Karandinos et al., 1977; and personal communication from various studies), and this selection for different combinations of isomers probably serves as a primary isolating mechanism between the two species.

The distribution of *viburni* is from Nova Scotia and Wisconsin south to Virginia and Illinois. Two females were reared at Fort Collins, Colorado.

Synanthedon alleri (Engelhardt)
PL. 2, FIG. 21. TEXT FIG. 22 *a* (RWH 2557).
Thamnosphecia alleri Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 124.
Type locality: Chickasaw, Alabama. [USNM]

Adult: Head with vertex brown black; front brown black with some white ventrally; occipital fringe orange; labial palpus smooth, orange, brown black at apex; antenna brown black. Thorax brown black with large orange spot beneath wing; narrow orange subdorsal stripe; orange lateral tufts on metathorax. Abdomen brown black with blue-green luster; dorsally with at least posterior ½ of segment four and most often similarly on segment five orange, occasionally both segments lacking orange; laterally with some orange on segments one and two; ventrally with segments four, five, six, and seven solid orange; anal tuft brown black, some white laterally; orange scales forming keel medioventrally. Foreleg mostly orange with brown black medially on coxa; midleg brown black with tibia orange mesially and on distal tuft, spurs and tarsus; hindleg with tibia orange, brown black at base and laterally between pairs of spurs, tarsus orange, occasionally with some brown black dorsally. Forewing mostly opaque, brown black, but variously hyaline basally in cell and between veins CuA and CuP; ventrally with some orange powdering weakly between veins apically, on discal spot, and more heavily basal to discal spot in cell and on costal margin. Hindwing hyaline with narrow margins; ventrally with some orange basally and on small discal spot. Male genitalia with crista sacculi of valva much expanded, with ventrally projecting extension subapically, and mesial surface heavily clothed with dark spinelike scales; aedoeagus relatively short, very narrow apically. A few specimens are nearly or entirely brown black. Female genitalia with ostium bursae located near posterior margin of segment eight in lightly sclerotized rugose area; ductus bursae elongate, slender, membranous; ductus seminalis originating near ostium bursae. Wing length 9–11 mm.

Engelhardt (1946: 125) stated that the habitat of *alleri* is open woodlands bordering on swamps. The immature stages are unknown. Adults of *alleri* have been found in Georgia, Florida, vicinity of Mobile, Alabama, and Mississippi. Using chemical attractants (E,Z-ODDA) in Georgia and Florida, workers have captured males in nearly all months of the year (Sharp et al., 1978; Sharp and Eichlin, 1979).

Synanthedon kathyae Duckworth and Eichlin
PL. 2, FIG. 22. (RWH 2579).

Synanthedon kathyae Duckworth and Eichlin, 1977, *Jour. Lep. Soc.,* **31**: 193.
Type locality: Halifax, Nova Scotia. [NSM]

Synanthedon kathyae differs from *alleri,* an apparent sibling species, by the following: Patterns that are orange in *alleri* are yellow on *kathyae;* forewing of *kathyae* mostly hyaline with narrow margins; basic ground color is blue black rather than brown black. The genitalia are similar. In the female the outer margin of the forewing is broader than that of the male.

Males have been attracted to the opposite stereoisomer (Z,Z-ODDA) (Duckworth and Eichlin, 1977a; Neal and Eichlin, 1983) of the chemical used to attract males of *alleri* (E,Z-ODDA) (Sharp et al., 1978; Snow et al., 1985). Ghidiu et al. (1987) reported rearing *kathyae* from ornamental holly trees (*Ilex* spp.) (Aquifoliaceae), described the injury, and outlined the borer's life history. Larval galleries are found in the host mostly at soil level, extending from just below to about 7 cm above the soil line. Frass accumulates on the ground at the root collar, and when raked away reveals cracked, loose bark that is easily removed to expose larvae and their tunnels.

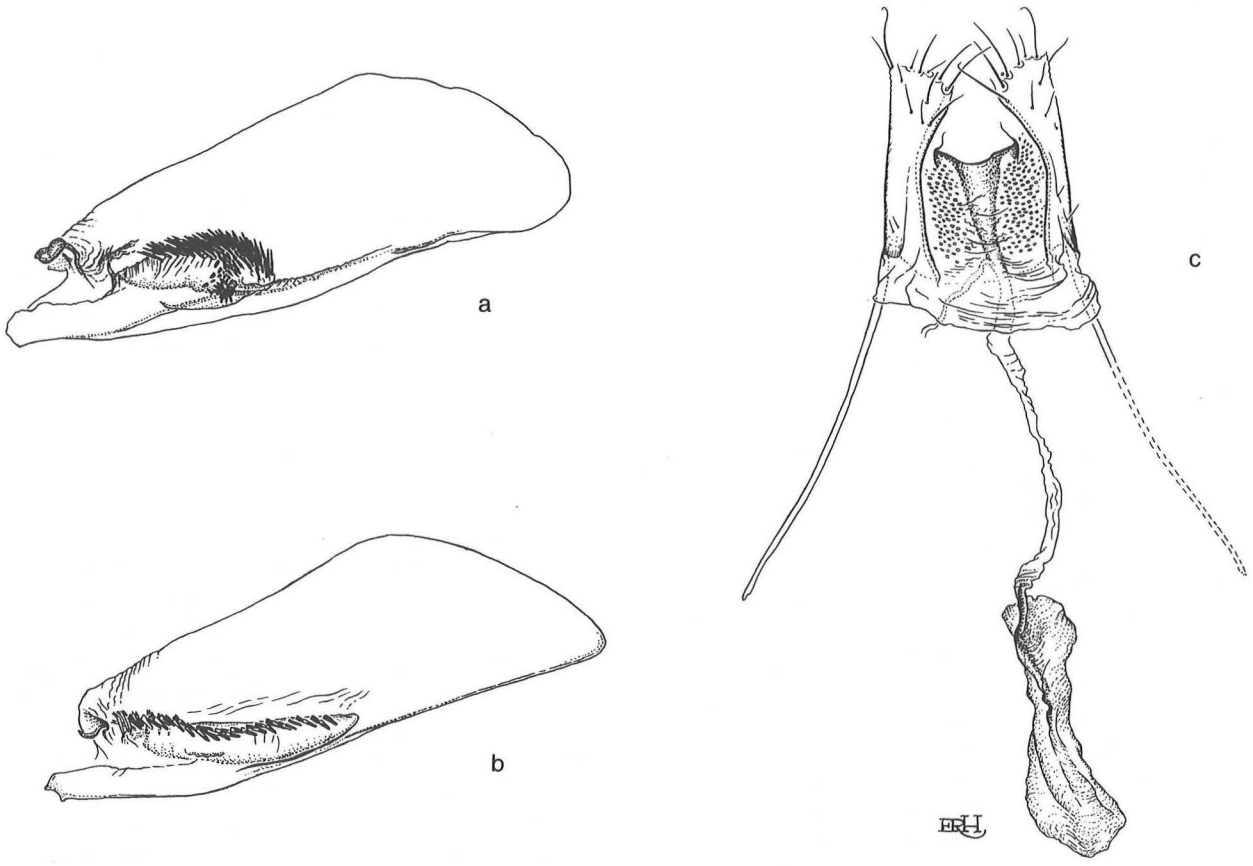

FIGURE 22: GENITALIA OF *SYNANTHEDON* SPECIES

a. Right valve of *Synanthedon alleri* (USNM 76011). *b, c. Synanthedon bolteri, b.* Right valve (USNM 75688); *c.* Female genitalia (abdominal segments 9 and 10 omitted) (USNM 75689).

The life cycle apparently requires one year to complete. Adults have been taken from May–July.

Synanthedon kathyae has been found in Nova Scotia, Massachusetts, New York, New Jersey, Maryland, and South Carolina.

Synanthedon arctica (Beutenmüller)
PL. 2, FIG. 23 (RWH 2558).

Sesia arctica Beutenmüller, 1900, *Can. Ent.*, **32**: 208.
Type locality: Kodiak, Alaska. [USNM]

Male: Head with vertex brown black, somewhat roughened; front brown black; occipital fringe brown black, perhaps mixed with some pale-yellow scales; labial palpus roughened, brown black; antenna brown black variously powdered with pale yellow or white on apical ½. Thorax brown black with yellow beneath wing. Abdomen brown black; dorsally with very narrow pale-yellow bands on posterior edge of segments two and four; anal tuft broadly truncate apically. Legs brown black except for white, pale yellow, or gray on hindtarsus, at least mesially. Forewing hyaline, dorsally with brown black on broad outer margin and broad discal spot; ventrally strongly powdered yellow on veins and margins and between veins in apical area. Hindwing hyaline with very narrow margins and small triangular discal spot; ventrally with costal margin mostly yellow. Genitalia with crista sacculi of valva much expanded, edge clothed with dark slender scales that are truncate apically, scales decreasing in length toward distal end of crista; saccus short and broad; aedoeagus elongate slender, minutely spined laterally, with several small, short, thick cornuti on vesica. The wing lengths of the two known specimens are 8 and 9 mm. The immature stages are unknown.

This little-known species has been recorded from two specimens, the male type from Kodiak and an additional male in the Carnegie Museum from Ruby, Alaska collected in July.

Synanthedon bolteri (Hy. Edwards)
PL. 3, FIG. 20. TEXT FIG. 22 *b, c* (RWH 2559).

Aegeria bolteri Hy. Edwards, 1883, *Papilio,* **3**: 155.
Type locality: Northern Illinois. [AMNH]

Although *bolteri* is a fairly wide ranging species, it is mostly subarctic to arctic in distribution; consequently, it is poorly represented in collections.

Male: Head with vertex brown black; front brown black, white laterally; occipital fringe brown black, often mixed with some white; labial palpus very slightly roughened, brown black dorsally and laterally, orange mesially and ventrally; antenna brown black with pale yellow on apical ⅓. Abdomen brown black with orange red encircling all of segments four and five and ventrally on segment six; anal tuft brown black edged with white; some pale yellow ventrally on valvae. Legs mostly brown black; forecoxa white laterally, epiphysis yellow, tarsus white ventrally; middle and hindlegs with tibiae tufted pale yellow or white at spurs and white mesially, tarsi pale yellow or orange mesially and at joints of first segment laterally. Forewing mostly hyaline but with broad outer margin strongly orange between veins, some orange on margins at base; ventrally with costal margin pale yellow. Hindwing hyaline with very narrow margins; fringe white toward wing base. Male genitalia similar to those of *arctica.* Female genitalia with ductus bursae posterior section short, sclerotized, funnel shaped, then gradually tapering to narrow membranous section continuing to corpus bursae. Wing length 6–9 mm.

Engelhardt (1946: 85) reported that *bolteri* is invariably associated with abnormal growths on low-growing *Salix* spp. (willows) caused by larvae of the coleopterans, *Cryptorhynchus lapathi* (Linnaeus) (Curculionidae) and *Saperda concolor* LeConte (Cerambycidae).

Adults appear from June to early August from southern Quebec and Rhode Island west to Colorado and Washington and north to the Northwest Territories and Alaska.

Synanthedon canadensis Duckworth and Eichlin
PL. 3, FIG. 21 (RWH 2560).

Synanthedon canadensis Duckworth and Eichlin, 1973, *Proc. Ent. Soc. Washington,* **75**: 157.
Type locality: Waterton, Alberta. [USNM]

Synanthedon canadensis is known from only two males, from two localities in southwestern Alberta. The orange anal tuft will separate *canadensis* from the few species in the same area with which it might otherwise be confused. Male: Head with vertex blue black, front blue black, white laterally; occipital fringe dorsally black mixed with yellow or yellow orange, dorsolaterally yellow or yellow orange becoming white ventrolaterally; labial palpus roughened, brown black dorsally and laterally, yellow orange ventrally and mesially; antenna dorsally powdered pale yellow for entire length. Thorax blue black; laterally with orange spot anteriorly and pale-yellow spot behind. Foreleg with coxa white, slightly tinted yellow; femur and tibia blue black, pale yellow ventrally. Midleg with coxa white; femur blue black; tibia blue black with white tufts near spur pairs; tarsus mostly yellow orange, blue black dorsally. Hindleg with coxa black basally, white apically; femur blue black; tibia blue black with much white in tufts around medial and apical spurs; tarsus yellow orange with blue black dorsally. Abdomen entirely blue black dorsally; orange with white on posterior half ventrally; anal tuft orange except mediobasally. Forewing mostly hyaline with margins and discal spot blue black but with apical area dull orange between veins; ventrally with orange on costal margin, in apical area, and on fringe. Hindwing hyaline; ventrally with costal margin and fringe dull orange. Genitalia much like those of *bolteri,* with crista sacculi much expanded, nearly straight, edge lined with short dark scales. Wing lengths of the two males are 7 and 8 mm.

The immature stages are unknown. The two males were collected in July at Waterton and Banff, Alberta. NOTE—A recently examined female was collected in a malaise trap, 1–6 July 1979, in Cache County, Utah.

Synanthedon culiciformis (Linnaeus) (Large Red-belted Clearwing)
PL. 2, FIG. 24. TEXT FIG. 23 *a* (RWH 2561).

Sphinx culiciformis Linnaeus, 1758, *Systema Naturae . . . ,* **1** (Editio Decima): 493.
Type locality: Europe. [lost]

Sphinx culex Retzius, 1783, *Caroli Lib. Bar. De Geer . . . genera et species insectorum et generosissimi auctoris scriptis extraxit, digessit Latine quoad partem reddidit, et terminologiam insectorum Linneaum addidit,* 33.
NOTE—*Sphinx culex* is an unnecessary emendation.

Sesia thynniformis Laspeyres, 1801, *Sesia Europaeae iconibus et discriptionibus illustratae,* 21.
Type locality: Europe (probably Darmstadt, Germany). [unknown]

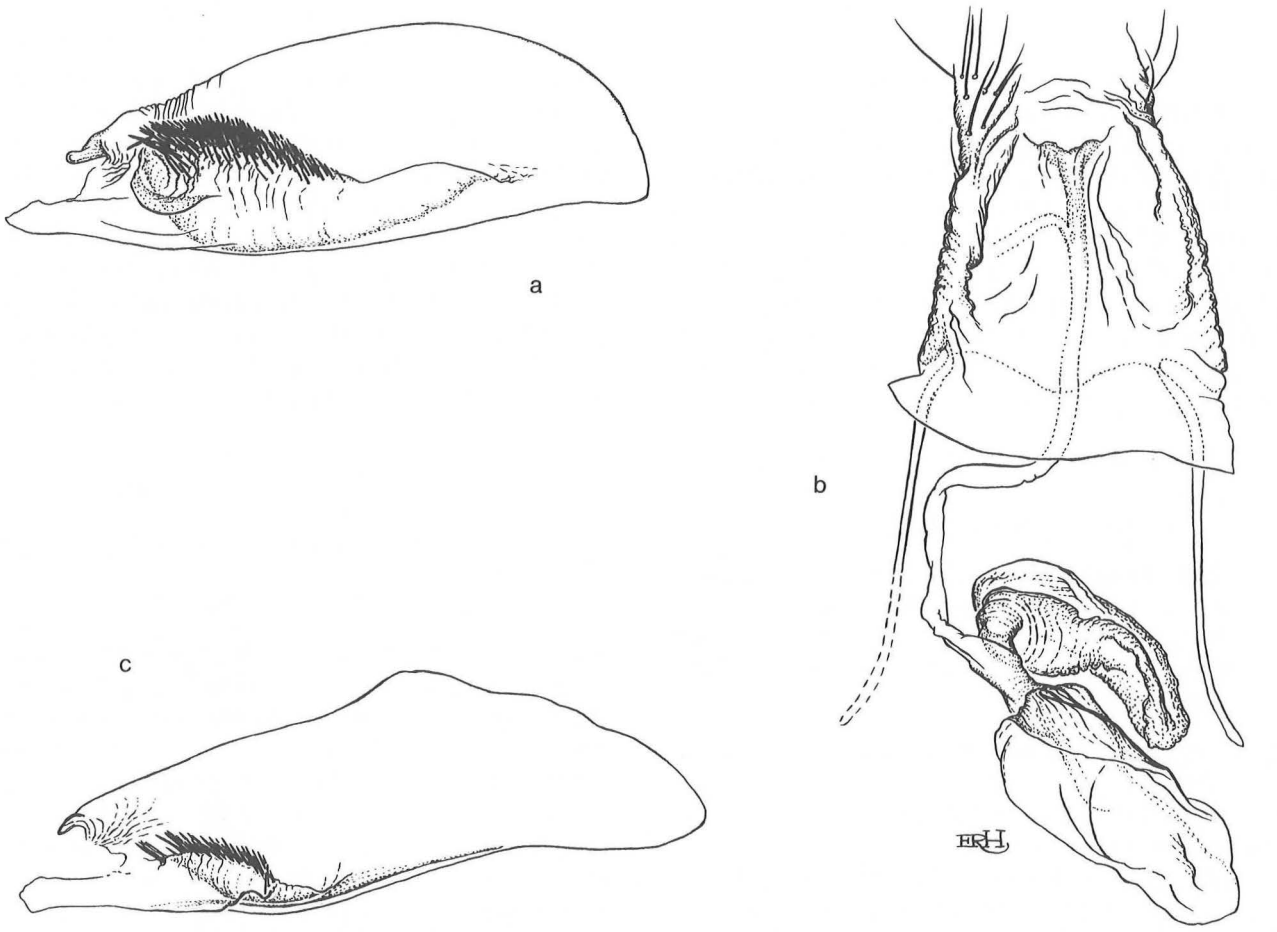

FIGURE 23: GENITALIA OF *SYNANTHEDON* SPECIES

a. Right valve of *Synanthedon culiciformis* (USNM 75730). *b.* Female genitalia of *Synanthedon fulvipes* (abdominal segments 9 and 10 omitted) (USNM 75733). *c.* Right valve of *Synanthedon pyri* (USNM 76039).

Sesia culiciformis variety *americana* Beutenmüller, 1896, *Bull. Amer. Mus. Nat. Hist.,* **8**: 136.
Type locality: Nevada. [AMNH]

Male: Head with vertex brown black; front brown black, white laterally; occipital fringe brown black, perhaps with some orange lateroventrally; labial palpus roughened, orange red, brown black dorsally; antenna brown black. Thorax brown black dorsally, mostly orange beneath wing; collar white subventrally. Abdomen brown black with slight blue-green iridescence; posterior margin of segment two orange red, segment four solid orange red dorsally and ventrally, laterally orange red from base to segment four. Legs mostly brown black with pale yellow to orange mesially, on tarsi and apically on hindtibia. Forewing mostly hyaline with margins and discal spot brown black, some orange powdering near base and on costal margin; ventrally powdered lightly between veins on outer margin. Hindwing hyaline with very narrow margins. Genitalia with crista sacculi greatly expanded, broadly curved, least expanded distally, with strong dark pointed spinelike scales on basal ⅔, scales shortest distally and all scales projecting basally; gnathos cupped, with crista gnathi strong, elongate, continuing anteriorly to near base of valva. The female is similar to the male but often with broader outer margin and more orange powdering on the forewing. Wing length 9–12 mm.

S. culiciformis is a holarctic species, known in North America from Alaska to Utah and California. The larvae are bark borers in Betulaceae, in Europe recorded primarily from *Betula* spp. (birches), but frequently also from *Alnus* spp. (alders) (among other hosts, Fibiger and Kristensen, 1974: 51; Popescu-Gorj et al., 1958: 99), whereas in North America they are primarily in alders (Engelhardt, 1946: 112) (although we have recently reared *culiciformis* from ornamental plantings of birch in Sacramento, Cal-

ifornia). Adults have been reared from *Alnus rhombifolia* Nuttall on several occasions. In those areas on the infested tree where larval burrowing is heavy, the damage may be evident externally by the blistered appearance of the dead bark. Preferred trees are those with injuries and those in disturbed or exposed areas (Anderson, 1960). Adults are most easily obtained by trapping with sex attractant baits or rearing but have been observed visiting flowers. Males are active responding to sex attractants (Z,Z-ODDA) in early April in Sacramento, California, May to July elsewhere, with some records in Washington dated August.

Synanthedon dominicki Duckworth and Eichlin
PL. 3, FIG. 22 (RWH 2562).

Synanthedon dominicki Duckworth and Eichlin, 1973, *Proc. Ent. Soc. Washington,* **75**: 158.
Type locality: Wedge Plantation, South Santee River, Charleston County, South Carolina. [USNM]

Until recently, this species was known only from the male holotype collected by D. C. Ferguson on the plantation of Richard B. Dominick, for whom the species was dedicated.

Male: Head with vertex blue black, mixed with orange posteriorly on Florida specimens; front blue black, perhaps some white near eyes; occipital fringe orange; labial palpus smoothly scaled, orange with brown black apically and in narrow band dorsally; antenna blue black, spotted white near apex (not so on Florida specimens). Thorax blue black with subdorsal orange stripe and orange beneath wings. Abdomen blue black except for some pale-orange powdering ventrally on segments 4–7; anal tuft mostly orange red except for blue black on basal ⅓ dorsally; exposed portions of genitalia orange red with keel of orange-red scales ventrally. Genitalia with crista sacculi not as expanded as previous species, nearly straight to ventral edge of valva then upcurving to distal end of crista, this latter portion naked; saccus short; scopula androconialis elongate. The female differs most noticeably from the male by having the forewings entirely opaque. Genitalia with ostial region well differentiated and the corpus bursae with a narrow membranous pouchlike protrusion. Wing length: male: 7–9 mm, female 9–10 mm.

The immature stages are unknown.

Several males were trapped in various locations in the Southeast, employing a recently identified isomer of sex attractant (E,Z 2,13-ODDA) (Schwartz et al., 1983). Thus, the known range of *dominicki* now extends from North Carolina, coastal South Carolina (holotype taken at black light) through Georgia, Alabama to west-central Florida. The species appears to be associated with wet or swampy hardwood forests. One female was netted when observed hovering over and intermittently landing on a small waterlocust (*Gleditsia aquatica* Marsh) (Fabaceae) (Brown et al., 1985a). It was not determined if this is the host plant. Males were observed to be active between 1300–1600 h, flight activity peaking at midafternoon (Brown et al., 1985a). The flight period occurs through March to mid-April.

Synanthedon fulvipes (Harris)
PL. 2, FIG. 25. TEXT FIG. 23 *b* (RWH 2563).

Aegeria fulvipes Harris, 1839, *Amer. Jour. Arts and Sci.,* **36**: 312.
Type locality: Massachusetts. [MCZ]

Synanthedon fulvipes appears to be most closely related to *culiciformis* but is found in northeastern North America; the latter is known only from northwestern North America.

Male: Head with vertex and occipital fringe brown black; front brown black with white laterally; labial palpus roughened, brown black dorsally and laterally, orange ventrally; antenna brown black, pale yellow apically. Thorax brown black with large orange patch beneath wings. Abdomen brown black, ventrally with segments one to four mostly orange and laterally orange on segments two to four; anal tuft brown black. Legs with coxae and femora brown black; tibiae and first tarsal segment orange, remaining segments brown black or with some orange especially on fore- and midtarsi. Forewing mostly hyaline, some orange on distal edge of discal spot and between veins R_2 and R_3; ventrally with costal margin mostly orange. Hindwing hyaline with very narrow margins. Female very similar, but orange on abdomen may extend dorsally as a narrow band on posterior margin of segment four. The male and female genitalia are similar to those of *culiciformis.* Wing length 8–12 mm.

Engelhardt (1946: 114) stated that this species was the only one indigenous to eastern United States with the food plant still unknown and suggested that it might occur on alder. A. E. Brower (Augusta, Maine) informed us that he has reared *fulvipes* from the bark of white birch (Betulaceae) in Maine. This host association was verified (personal communication) by having a specimen reared from *Betula,* probably *papyrifa,* by J. Roth in 1982 (Ohio Agri-

cultural and Development Center, Ohio State University, Wooster, Ohio). Adults have been taken from late May through mid-July.

Distribution records for *fulvipes* are from the northeastern United States and Canada, south to northern New Jersey and Pennsylvania, west to Manitoba and Minnesota. Two males were captured in Minnesota when they responded to a sex attractant (Z,Z-ODDA) in June 1986 (K. Scarborough, personal communication).

Synanthedon helenis (Engelhardt)
PL. 4, FIG. 8 (RWH 2564).

Carmenta helenis Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 50.
Type locality: Earl Grey, Saskatchewan. [USNM]

Male: Head with vertex and antenna brown black; front brown black, white laterally; occipital fringe brown black dorsally, white laterally; labial palpus smooth, brown black with yellow ventrally and mesially. Thorax brown black with yellow patch beneath wings. Abdomen brown black; dorsally with narrow yellow band on posterior margin of segment four, bands may be faintly indicated on segments two, six, and seven; ventrally with segments four to seven yellow; anal tuft brown black. Legs with forecoxa brown black, white laterally, often slightly tinted pale yellow; femora brown black; tibiae brown black with pale yellow at spurs; tarsi white, some brown black on distal segments; mesially, legs pale yellow. Forewing mostly hyaline, slightly pointed; discal spot broad, brown black with orange on distal margin; outer margin broad, brown black with orange between veins; costal margin brown black with orange powdering; ventrally strongly powdered orange and pale yellow. Hindwing hyaline with very narrow margins; ventrally with margins powdered orange. Genitalia like those of *arctica* and *bolteri* but with saccus narrow. Female like male except forewings somewhat more opaque. Genitalia have not been examined. Wing length 6 mm.

This species bears a superficial resemblance to *Carmenta ithacae* (Beutenmüller) and could be confused with it. However, the occipital fringe of *helenis* is brown black dorsally, yellow in *ithacae.*

Synanthedon helenis is known from three specimens collected in Manitoba and Saskatchewan. They were caught in early July.

Synanthedon pyri (Harris) (Apple Bark Borer*; Sésie du Pommier, f., Fr.; Pear Borer)
PL. 3, FIG. 23. TEXT FIG. 23 *c* (RWH 2565).

Aegeria pyri Harris, 1830, *New England Farmer,* **9**: 2.
Type locality: Massachusetts. [MCZ]

The range of *pyri* is more restricted than was reported by Engelhardt (1946: 119). Errors apparently resulted from misidentifications of specimens of *scitula* as *pyri,* the two species have a close resemblance. These errors also account for discrepancies in the reporting of host plant associations for the two species. Specimens of *pyri* and *scitula* can be differentiated on the basis of genital structures (in *pyri* crista sacculi expanded, dark spinelike scales along upper edge; in *scitula* with crista sacculi a low ridge, dark spinelike scales only on distal ½, bifurcate scales on proximal ½) and characters given in the key to species.

Male: Head with vertex brown black, scales extending somewhat over front; front brown black, white laterally and often ventrally; occipital fringe brown black dorsally, white laterally; labial palpus smooth, yellow with brown black laterally on apical ½; antenna brown black, often with some pale yellow apically. Thorax brown black, mostly pale yellow beneath wings. Abdomen brown black; dorsally with segments two and four narrowly banded yellow on posterior margin, occasionally some yellow on posterior edge of six; laterally with yellow on segments one, two, and four; ventrally mostly pale yellow or white; anal tuft brown black. Legs pale yellow mesially; coxae white and pale yellow; femora brown black; tibiae pale yellow medially and on tufts; tarsi brown black laterally, pale yellow ventrally and at joints. Forewing mostly hyaline with relatively narrow margins, brown black with some yellow powdering between veins on costal and outer margins and on veins near wing base; ventrally mostly yellow except for discal spot. Hindwing hyaline with very narrow margins; ventrally with costal margin mostly yellow. Genitalia somewhat like those of *arctica* and *bolteri* but with crista sacculi much shorter and saccus narrow. The female differs from the male as follows: Antenna pale yellow on apical ½; abdomen dorsally with band on segment four broader, ventrally with pale yellow or white only covering segment four and most of five, anal tuft brushlike and mixed with yellow laterally. Genitalia similar to those of *alleri.* Wing length 6–9 mm.

The host plants are Rosaceae (Brooks, 1920; Kelsey and Stearns, 1960; Woodside, 1952), including *Malus* sp. (apple), *Pyrus* sp. (pear), probably *Crataegus* sp. (hawthorn), and a single record from *Prunus* sp. (plum). Larvae are bark borers, preferring

previously injured or otherwise weakened trees. Records indicate a flight period from late May through August. K. Scarborough (personal communication) reported that male *pyri* were trapped using sex attractant bait (E,Z 2,13-ODDA/Z,Z 3,13-ODDA 99:1) in Ohio. Males of *scitula* were attracted mostly to the compound Z,Z-ODDA.

Specimens confirmed by us as *pyri* are from Nova Scotia to New Jersey, west to Illinois and Kentucky.

Synanthedon refulgens (Hy. Edwards)
PL. 2, FIG. 26; PL. 3, FIG. 24 (RWH 2566).

Aegeria refulgens Hy. Edwards, 1881, *Papilio,* **1**: 199.
Type locality: Georgia. [MSU]

Sesia marica Beutenmüller, 1899, *Jour. New York Ent. Soc.,* **7**: 254.
Type locality: Punta Gorda, Florida. [AMNH]

Sesia seminole Beutenmüller, 1899, *Jour. New York Ent. Soc.,* **7**: 255.
Type locality: Lake Worth, Florida. [AMNH]

Male: Head with vertex and antenna brown black; front gray black, white laterally; occipital fringe yellow; labial palpus smooth, yellow orange. Thorax brown black with narrow subdorsal yellow stripe; metathorax and lateral tufts yellow; mostly yellow beneath wings. Abdomen brown black with yellow bands on segments two, four, six, and seven. Legs with forecoxa mostly yellow orange, some brown black mesially, rest of foreleg mostly yellow orange; coxae and femora of mid- and hindlegs brown black, tarsi yellow orange; midtibia yellow orange with brown black dorsoapically; hindtibia roughened, yellow orange with brown black at base and distally. Forewing mostly hyaline but with outer margin suffused with brown black; narrow discal spot mostly orange. Hindwing hyaline. Genitalia with crista sacculi expanded, relatively straight, edge clothed with thick black scales. Female like male but with forewing generally more nearly opaque. Genitalia with ostium bursae posteriorly on segment eight in differentiated, elongate, pouchlike area; ductus bursae somewhat sclerotized on posterior ¼. Wing length 7–11 mm.

Synanthedon refulgens superficially resembles *arkansasensis* Duckworth and Eichlin but differs by the following: Forewing with outer margin most often suffused with brown black, discal spot narrower with much orange at least distally; abdomen without definite yellow banding on segments three and five; coxa of foreleg and labial palpus yellow orange, not bright yellow; genitalia of each species characteristic of different species groups. On the dorsal surface of the hindwing the margin and base of the fringe usually is unpowdered or very slightly so, but the fringe is strongly powdered orange on *arkansasensis.*

The life history of *refulgens* is not known. Adults have been captured in April, early May, July, August, and September. K. Scarborough (personal communication) reports that this species was collected using attractant bait (E,Z 2,13-ODDA/Z,Z 3,13-ODDA 99:1) in New Jersey, S. Carolina, Arkansas, Mississippi, and Missouri, which extends the known range considerably. L. Brown in Tampa (personal communication) reported having attracted this species in Florida to the same mixture of isomers of sex attractant. Captures of males in Rio Grande County, Colorado (W. Meyer, personal communication) are tentative, awaiting further verification.

Synanthedon refulgens is known from New Jersey, Georgia, and Alabama to central Florida, to Missouri, Arkansas, and Mississippi.

Synanthedon rubrofascia (Hy. Edwards)
PL. 2, FIG. 27; PL. 3, FIG. 25, TEXT FIG. 24 *a* (RWH 2567).

Aegeria rubrofascia Hy. Edwards, 1881, *Papilio,* **1**: 191.
Type locality: Georgia. [AMNH]

Male: Head with vertex, front, and occipital fringe brown black; labial palpus smooth, brown black with some pale yellow mesially at base. Thorax brown black, blue black dorsally. Abdomen blue black with segments four and five solid orange red and often with some orange red on six and seven. Legs blue black except for very pale-yellow tibial spurs and ventrally on tarsi. Genitalia similar to those of *refulgens* but with gnathos more elongate, lateral margins subparallel and crista gnathi much reduced; vesica of aedoeagus with six to ten minute cornuti. Female patterned like male but lacks pale yellow on palpus, wings, tibial spurs or tarsi; forewings entirely opaque, brown black, mostly hyaline in male with some yellow powdering on margins ventrally; hindwing hyaline as for male, perhaps with broader outer margin. Female genitalia with ostium bursae in posterior section of segment eight, U-shaped, in somewhat differentiated elongated pouchlike area; ductus bursae elongate, slender and membranous except for sclerotized posterior ¼. Wing length 8–11 mm.

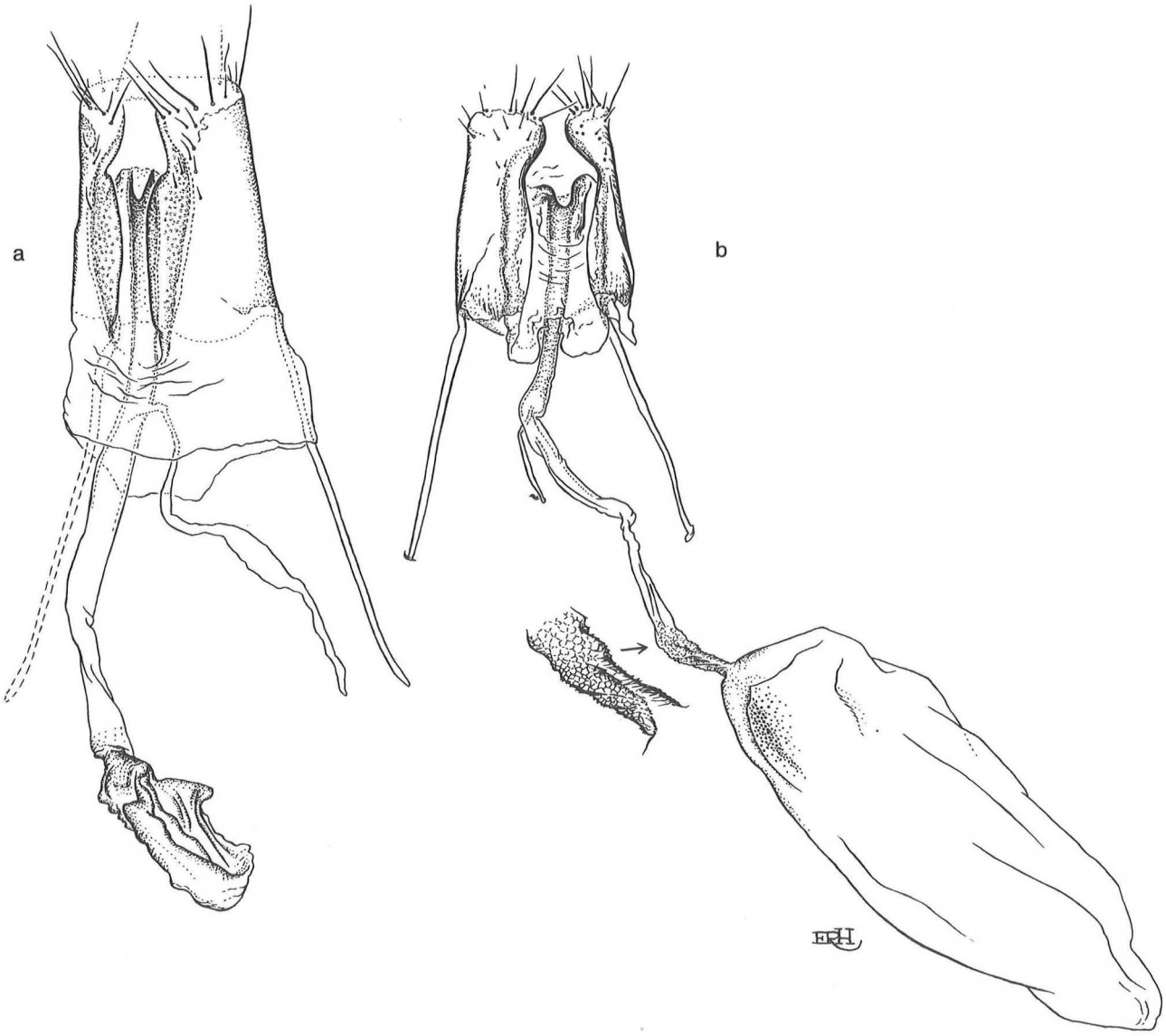

FIGURE 24: GENITALIA OF *SYNANTHEDON* SPECIES

a. Female genitalia of *Synanthedon rubrofascia* (abdominal segments 9 and 10 omitted) (USNM 75748). *b.* Female genitalia of *Synanthedon saxifragae* (abdominal segments 9 and 10 omitted) (USNM 75703).

The females of *rubrofascia* look like small females of *exitiosa* (Say). The abdominal bands on *rubrofascia* are more reddish and completely encircle the segments, whereas in *exitiosa* females the bands are orange and do not fully encircle the segments ventrally.

Larvae are borers beneath the bark of *Nyssa* sp. (sour gum) (Nyssaceae), and are more apt to be found in injured areas of mature trees (Engelhardt, 1946: 124). Adults have been captured mostly in May and June but as early as March in Florida and as late as mid-August to the north. Engelhardt reported that the moths are often attracted to flowers along swamp margins. Snow et al. (1985) reported capturing many males in traps baited with an equal mixture of the sex attractants Z,Z-ODDA/E,Z-ODDA. Using mixtures of the same isomers or baits containing mostly Z,Z-ODDA, other workers trapped *rubrofascia* in several locations (Neal and Eichlin, 1983; Nielsen et al., 1975; Reed et al., 1981; Sharp and Eichlin, 1979; Sharp et al., 1978; Snow et al., 1985).

Synanthedon rubrofascia occurs along the Gulf Coast from Louisiana to Florida and north on the Atlantic Coast to Maryland. Recent collections have come from Tennessee, Michigan, Indiana, and Massachusetts.

Synanthedon saxifragae (Hy. Edwards)
PL. 2, FIG. 28. TEXT FIG. 24 *b* (RWH 2568).

Aegeria saxifragae Hy. Edwards, 1881, *Papilio,* **1**: 190.
Type locality: Colorado. [AMNH]

Aegeria henshawii Hy. Edwards, 1882, *Papilio,* **2**: 56.
Type locality: Mingan Island, Labrador. [AMNH]

Male: Head with vertex, front, and antenna brown black; occipital fringe brown black, often with yellow laterally; labial palpus roughened, orange with brown black apically. Thorax brown black with large patch of orange beneath wings. Abdomen blue black. Forewing mostly hyaline with margins, veins, and discal spot brown black except for orange at base of wing and very lightly powdered on costal margin; ventrally with costal margin mostly pale orange and more strongly powdered orange on veins, outer margin, and somewhat on discal spot. Hindwing hyaline with very narrow margins, some orange toward wing base, more so ventrally. Legs orange except for brown black on coxae, most of femora laterally, dorsally on midtibia and basally on hindtibia. Genitalia as described for *rubrofascia* and *refulgens* but with saccus broadened apically, truncate; crista sacculi with small, scaled extension near distal end. Female similar to male but with tibiae mostly or entirely orange. Genitalia similar to those of *rubrofascia* but with ventral pouchlike area of segment eight more highly differentiated, somewhat rugose and sclerotized; corpus bursae larger, more elongate, with weakly defined signum near entrance of ductus bursae consisting of diffuse punctuations and slight brownish pigmentation. Wing length 10–11 mm.

The host plant of *saxifragae* is not known but is definitely not a saxifrage, according to Engelhardt (1946: 93).

Synanthedon saxifragae is a boreal species. There are scattered records from Laborador to Alaska, south in the higher elevations of the Rocky Mountains to Colorado and at about 4,500 ft elevation in the Sierra Nevada of California. All captures of adults were made in May, June, and July. Eichlin collected six specimens in El Dorado County, California using an artificial sex attractant (Z,Z-ODDA) as bait.

Synanthedon sigmoidea (Beutenmüller)
PL. 2, FIG. 29 (RWH 2569).

Sesia sigmoidea Beutenmüller, 1897, *Bull. Amer. Mus. Nat. Hist.,* **9**: 214.
Type locality: Walpole, Massachusetts. [AMNH]

The male of *sigmoidea* is as follows: Head with vertex, front, and antenna brown black; occipital fringe yellow, often white laterally; labial palpus roughened, yellow with brown black basally, mesially, and often at tip. Thorax brown black with large yellow area beneath wing extending narrowly subdorsad adjacent to collar; metathorax yellow dorsomedially. Abdomen brown black, dorsally with yellow on posterior margin of segments two, four, and seven, often also on six; laterally, yellow on one and two; ventrally, segment four entirely yellow and some yellow medially on five, six, and seven; anal tuft brown black edged with pale yellow. Legs with coxae and femora brown black; midtibia brown black, yellow spurs and apical tuft; hindtibia mostly yellow but with brown black dorsobasally and on distal ⅓; tarsi mostly yellow with some brown black dorsally on last segments, except on hindtarsus where first segment is solid yellow and remaining segments brown black dorsally, yellow ventrally. Forewing mostly hyaline with margins and discal spot brown black, weakly powdered orange on costal, anal, and outer margins and orange on distal ⅔ of discal spot; ventrally costal margin pale yellow to discal spot, powdered orange strongly in apical area between veins. Hindwing hyaline with very narrow margins, orange powdered variously on discal spot and costal margin; fringe at wing base yellow. Genitalia generally like those of *refulgens* but with saccus longer, about ⅓ length of valva; crista sacculi gently curved, extending more than ½ length of valva; crista gnathi expanded laterally and flared posteriorly forming broad diamond-shaped structure subequal in width to lateral portions of gnathos. Female generally like male; abdomen ventrally yellow only on segment four; anal tuft blunt, brown black with yellow subdorsally. Genitalia as described for *saxifragae,* perhaps ostium bursae closer to posterior margin of segment eight, ductus bursae slightly wider with origin of ductus seminalis closer to corpus bursae than to ostium bursae, signum very faint. Wing length 9–11 mm.

Of *sigmoidea,* Engelhardt (1946: 126) summarized, ". . . is a borer in low-growing willows in bays, along streams, and in depressions among sand dunes of coastal or lake regions." It has been reared from *Salix tristis* Aitkin (sage willow) (Salicaceae) growing in low places among coastal sand dunes. Swellings may be produced in branches and canes from heavy infestations of larvae. Adults are best ob-

tained by rearing and have a flight period from late July through September.

This species is widely distributed from Maine to Maryland; Appalachian Mountains south to the Carolinas; northern Midwest; Rocky Mountains south to New Mexico.

Synanthedon albicornis (Hy. Edwards)
PL. 3, FIGS. 26, 27. TEXT FIG. 25 *a* (RWH 2570).

Aegeria albicornis Hy. Edwards, 1881, *Papilio,* **1**: 201.
Type locality: Nevada. [MSU]

This is a species of western North America. Its sibling species, *proxima* Hy. Edwards, is similar in appearance and habits but occurs east of the Rocky Mountains to the Atlantic Coast. Other than for distribution, the two species can be separated on characters of the male genitalia; external features are too variable to be dependable for identification.

Male: Head with vertex brown black; front brown black, often with white scales lateroventrally; occipital fringe brown black, often mixed with pale yellow; labial palpus relatively smooth, brown black laterally, pale yellow ventrally, mixed with white basally and mesially; antenna brown black with preapical white patch dorsally. Thorax brown black with bluish iridescence, occasionally with a few yellow scales indicating narrow subdorsal stripe; much yellow beneath wing. Abdomen brown black with bluish iridescence; pale yellow laterally on segments one and two, occasionally forming narrow band on posterior margin of segment two dorsally. Legs with forecoxa brown black, often with much white laterally; other segments brown black laterally except for white tufts at tibial spurs and mostly white mesially. Forewing mostly hyaline with margins and discal spot brown black; ventrally with pale yellow on costal and anal margins. Hindwing hyaline with very narrow margins; fringe white near wing base; ventrally pale yellow on costal margin. Genitalia with valva elongate, narrow, bluntly pointed apically; crista sacculi narrow, about as high as length of scales on dorsal edge, slightly curved, terminating before reaching ventral edge of valva. Female differs from the male by having subdorsal stripe on thorax usually more pronounced; forecoxa often without white; labial palpus occasionally entirely brown black. Genitalia similar to those of *sigmoidea.* Wing length 9–11 mm.

Larvae live in various species of *Salix* (willows) (Salicaceae). They bore in the bark of large trees or in exposed roots, limbs or canes of smaller willows (Engelhardt, 1946: 83). Most adults have been taken from late June through August. Males have been captured using attractant baits (Z,Z-ODDA) in California (Sharp and Eichlin, 1979).

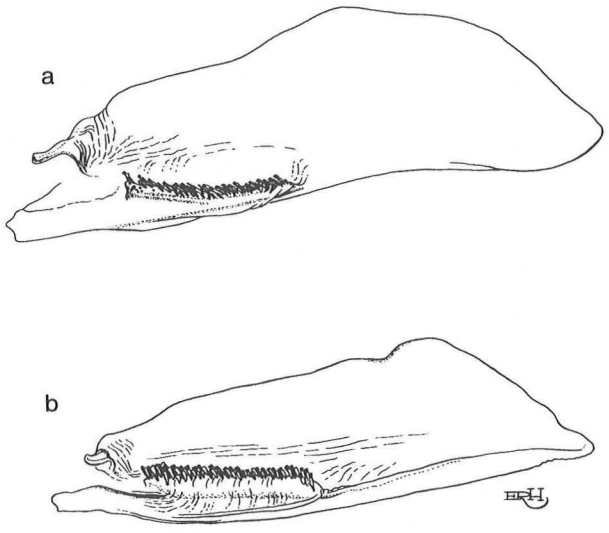

FIGURE 25: MALE GENITALIA OF *SYNANTHEDON* SPECIES
a. Right valve of *Synanthedon albicornis* (USNM 76024). *b.* Right valve of *Synanthedon proxima* (USNM 76038).

Records of *albicornis* are from Colorado, western Nevada, and California north to British Columbia and Northwest Territories. It is not known from most of the Great Basin or from east of the Rocky Mountains.

Synanthedon proxima (Hy. Edwards)
PL. 3, FIGS. 29, 30. TEXT FIG. 25 *b* (RWH 2572).

Aegeria proxima Hy. Edwards, 1881, *Papilio,* **1**: 201.
Type locality: White Mountains, New Hampshire. [MSU]

Albuna modesta Kellicott, 1892, *Can. Ent.,* **24**: 46.
Type locality: Columbus, Ohio. [unknown]

The male of *proxima* is much like the male of *albicornis* except for the following: Head with labial palpus mostly white instead of yellow ventrally and mesially; occipital fringe dorsally mixed with pale yellow; antenna, for the most part, without preapical white spot; thorax with better defined subdorsal yellow stripe; forewing generally with broader brown-black outer margin; genitalia with distal end of crista

sacculi downcurved to ventral margin of valva, much as for species of *Carmenta.* The female of *proxima* differs from the female of *albicornis* by frequently having the labial palpus solid brown black or with only a few pale-yellow scales. Like *albicornis* the female has large preapical white spots on the antenna, and the genitalia are similar. Wing length 8–10 mm.

Adults can be obtained by rearing from infested branches, canes, or exposed roots of low-growing willows (*Salix* spp.), generally in swampy or otherwise moist locations (Engelhardt, 1946; Baker, 1972). The flight period is from late April to mid-August.

The distributions of the two species are broadly separated with neither species occurring in the Great Plains. The range for *proxima* is from Nova Scotia and Maine, west to Manitoba and eastern Nebraska.

Synanthedon decipiens (Hy. Edwards)
PL. 3, FIG. 28; PL. 4, FIG. 9 (RWH 2571).

Aegeria decipiens Hy. Edwards, 1881, *Papilio,* **1**: 197.
Type locality: Colorado. [AMNH]

Aegeria imperfecta Hy. Edwards, 1881, *Papilio,* **1**: 198.
Type locality: Colorado. [AMNH]

Aegeria nicotianae Hy. Edwards, 1881, *Papilio,* **1**: 202.
Type locality: Texas. [USNM]

Aegeria rubristigma Kellicott, 1892, *Can. Ent.,* **24**: 211.
Type locality: Ohio. [AMNH]

This is a fairly wide ranging species, whose hosts are various species of *Quercus* (oaks) (Fagaceae). The male is as follows: Head with vertex brown black; front brown black, white laterally; occipital fringe yellow; labial palpus strongly roughened, yellow with brown black on first segment extending laterally on most of second segment; antenna brown black, often powdered yellow on basal ½. Thorax brown black, often lightly overlaid with hairlike pale-yellow or white scales; large yellow patch beneath wing; metathorax with dorsal surface and lateral tufts yellow. Abdomen brown black, dorsally with yellow on posterior margins of segments two, four, six, and seven; yellow laterally on one and two; ventrally with only segment four yellow; anal tuft brown black, tipped with yellow. Legs with foreleg mostly yellow; mid- and hindcoxa and femur brown black, tibiae strongly banded yellow in middle, spurs and distal tuft yellow; tarsi yellow except for some brown black laterally on first segment of hindtarsus. Forewing mostly hyaline, narrow margins brown black, orange red on discal spot and some powdered on margins between veins. Hindwing hyaline with very narrow margins. Genitalia like *albicornis* but with valva shorter, apex more broadly rounded, slightly curving ventrad; crista sacculi shorter; crista gnathi much less developed; aedoeagus somewhat swollen ⅓ distance from very narrow apex and with about three tiny spines on swollen part. Female similar to male but with labial palpus slightly less roughened and without as much brown black laterally; forewing generally with outer margin more suffuse, often with more orange powdering; abdomen with anal tuft brushlike, brown black with subdorsal yellow stripes. Genitalia with ostium bursae in membranous anterior portion of segment eight; ductus bursae slender, entirely membranous. Wing length 8–10 mm. The roughened palpus and genital structures distinguish *decipiens* from *refulgens,* to which it bears a superficial resemblance.

Though known to be a bark borer in oaks (*Quercus* spp., Fagaceae) (Heinrich, 1921), this species apparently prefers the large woody cynipid galls formed on several species of scrub oaks (Beutenmüller, 1897; Engelhardt, 1946: 92). Many males from various locations have been captured with attractant baits (mostly Z,Z-ODDA, but also with mixtures containing lesser quantities of E,Z-ODDA or E,Z,-ODDOH) (Neal and Eichlin, 1983; Sharp and Eichlin, 1979; Sharp et al., 1978; Snow et al., 1985; Solomon et al., 1982).

A wide ranging species, *decipiens* occurs from the Rocky Mountains to the Atlantic and Gulf Coasts. Most adult specimens were obtained in June and July but as early as March, April, and May in Alabama and Florida, and as late as mid-August in New Jersey.

Synanthedon sapygaeformis (Walker)
PL. 3, FIGS. 31, 32. TEXT FIG. 26 *a, b* (RWH 2573).

Aegeria sapygaeformis Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 45.
Type locality: United States. [BMNH]

Pyrrhotaenia floridensis Grote, 1875, *Can. Ent.,* **7**: 174.
Type locality: Enterprise, Florida. [AMNH]

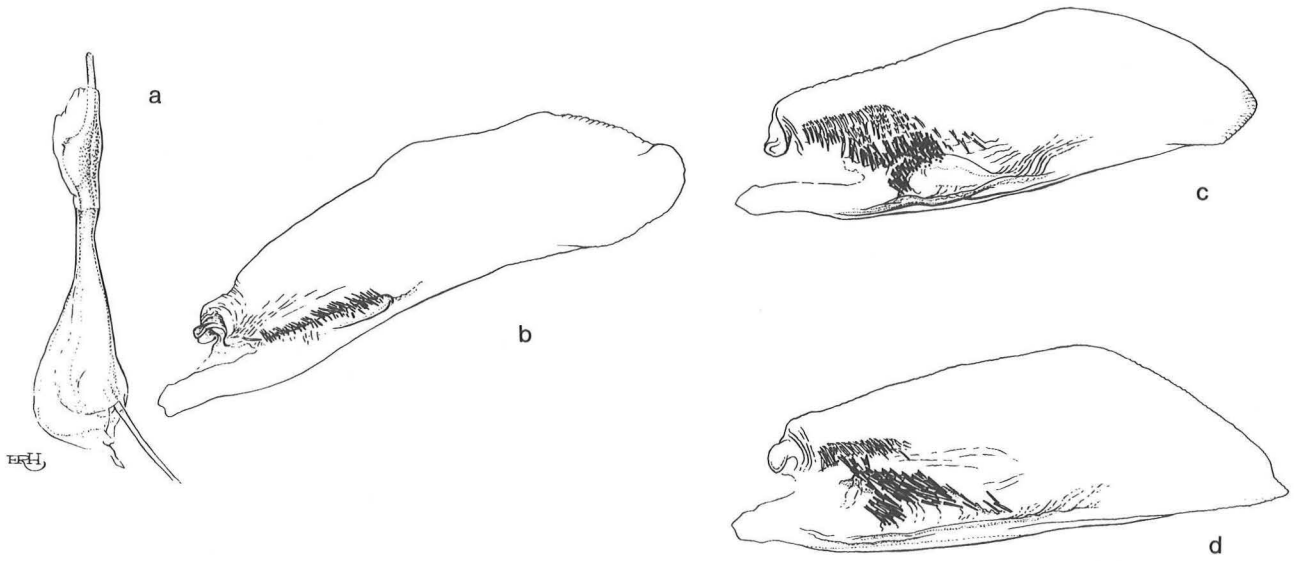

FIGURE 26: MALE GENITALIA OF *SYNANTHEDON* SPECIES

a, b. Synanthedon sapygaeformis, a. Aedoeagus (USNM 75697); *b.* Right valve (USNM 75697). *c.* Right valve of *Synanthedon arizonensis* (USNM 75636). *d.* Right valve of *Synanthedon bibionipennis* (USNM 75965).

Synanthedon sapygaeformis is known only from locations in Florida. Male: Head with vertex, front, and antenna brown black; occipital fringe orange; labial palpus roughened, orange, brown black basally and laterally. Thorax blue black; dorsally overlaid with hairlike pale-yellow scales, metathorax orange red; ventrally mostly orange. Abdomen blue black with segments four, five, six, and seven completely encircled with orange red on the typical color form; the form "*floridensis,*" apparently the more common form, has segments six and seven orange red dorsally, five blue black, and only segment four with orange red completely encircling; anal tuft blue black. Legs with forecoxa brown black, orange laterally; femora brown black; foretibia orange; mid- and hindlegs orange with brown black basally and between medial and apical spurs; tarsi orange with brown-black spot dorsomedially on first segment of hindleg. Forewing opaque except perhaps for narrow hyaline area above anal vein at wing base, brown black with discal cell orange red, and orange red variously powdered on costal margin basally, anal margin, and between veins in apical area, powdering more extensive ventrally. Hindwing mostly hyaline with broad outer margin, costal margin and minute discal spot orange; ventrally margins powdered orange. Male genitalia similar to those of *decipiens.* Female similar to male but with less brown black on labial palpus laterally. Genitalia similar to those of *decipiens.* Wing length 6–10 mm.

Besides having certain morphological features much the same, *sapygaeformis* and *decipiens* have similar habits. Both species are known to be inquiline borers in cynipid galls on various oaks (Engelhardt, 1946). The larvae of *sapygaeformis* have been observed developing within large woody galls that have enough living tissue to support the complete development of the borer (Morse, 1957). Adults apparently have an extended emergence period lasting from February to December with peak emergences in March and April (Sharp et al., 1978; Sharp and Eichlin, 1979). Males have been readily collected when responding to sex attractants (primarily Z,Z-ODDA) (Sharp et al., 1978; Sharp and Eichlin, 1979).

Distribution: Throughout subtropical Florida.

Synanthedon arizonensis (Beutenmüller)
PL. 2, FIG. 30. TEXT FIG. 26*c* (RWH 2574).

Gaea arizonensis Beutenmüller, 1916, *Can. Ent.,* **48**: 372.
Type locality: Pinal Mountains, Arizona. [USNM]

Male: Head with vertex brown black mixed with yellow laterally and anteriorly; front brown black, often with some pale-yellow scales laterally and at base of scape; occipital fringe yellow; labial palpus roughened, yellow orange with brown black lateroventrally; antenna orange except for apical ¼. Thorax brown black with subdorsal yellow stripe; metathorax and lateral tufts yellow; extensive yellow patch

beneath wing. Abdomen brown black; dorsally with yellow bands on all segments except three; ventrally banded on segments four, five, six, and seven; anal tuft brown black, yellow medially. Legs with forecoxa brown black, yellow laterally; femora brown black, perhaps some orange on forefemur, foretibia mostly orange; mid- and hindtibiae yellow with brown black on distal ⅓–½; all tarsi orange. Forewing with outer margin strongly suffuse, brown black but with much orange between veins; costal margin brown black, variously powdered orange mostly near wing base; most of broad discal spot and margins of discal cell orange; anal margin brown black, orange between veins; ventrally mostly orange except for some brown black on discal spot and veins apically. Hindwing hyaline with narrow margins and small discal spot mostly orange; fringe near wing base pale yellow. Genitalia with crista sacculi relatively short, arched, naked distally, and with a ventral extension from highest point of arch, clothed with dark scales, which are broadly expanded and nearly truncate apically; saccus short; aedoeagus with several minute cornuti on vesica. Female essentially like male except labial palpus entirely yellow; abdominal bands broader; anal tuft brushlike, entirely yellow; wings more extensively powdered with orange; overall size generally larger than male. Genitalia with posterior ½ of ductus bursae well sclerotized; ductus seminalis arising in area where ductus bursae becomes membranous. Wing length 10–14 mm.

The immature stages are unknown. *Synanthedon arizonensis* is known only from central and southeastern Arizona, and all adults were captured in June.

Synanthedon arkansasensis Duckworth and Eichlin

PL. 2, FIG. 31 (RHW 2575).

Synanthedon arkansasensis Duckworth and Eichlin, 1973, *Proc. Ent. Soc. Washington,* **75**: 154.

Type locality: Devil's Den State Park, Washington County, Arkansas. [USNM]

Male: Head with vertex and antenna blue black; front mostly blue black with white laterally, some pale yellow dorsolaterally beneath scape; occipital fringe yellow; labial palpus smooth, pale yellow. Thorax blue black with subdorsal yellow stripe; yellow on metathorax; mostly yellow beneath wing. Abdomen mostly blue black; dorsally with all segments except first edged posteriorly with yellow; ventrally with all segments except third usually edged posteriorly with yellow; yellow on lateral edge of anal tuft and on apexes of valvae. Legs with coxae and femora blue black, except forecoxa mostly yellow; foreleg with tibia and tarsus yellow; midleg with tibia yellow, blue black at spurs, tarsus yellow ventrally, blue black dorsally; hindleg with tibia blue black dorsolaterally, yellow ventrally and at spurs, tarsus blue black dorsally, yellow ventrally and in ring around distal end of first and fifth segments. Forewing about ⅔ hyaline, brown black with orange or yellow orange apically between veins and often outlining discal spot; ventrally powdered with orange or yellow orange on veins and in apical region between veins. Hindwing hyaline with some orange on coastal margin. Genitalia much as for *arizonensis,* aedoeagus with small spines apically, minute cornuti on vesica. Female similar to male except for more extensive orange powdering apically on forewing; abdominal bands wider, anal tuft mostly yellow with blue black laterally and medially. Genitalia similar to those of *arizonensis.* Wing length 7–10 mm.

As for *acerni,* many adults of *arkansasensis* have been captured at black lights. Its hosts and other aspects of its biology remain to be discovered. *Synanthedon arkansasensis* is known from Kansas, Oklahoma, Missouri, Arkansas, Kentucky, and Mississippi, east along the Gulf Coast to northern Florida and Georgia, and north along the Atlantic Coast to New Jersey. Adults have been collected mostly from June through August, but in northern Florida many have been taken through to December in traps baited with attractants (E,Z-ODDA or its alcohol E,Z-ODDOH) (Sharp et al., 1978; Sharp and Eichlin, 1979; Solomon et al., 1982).

Synanthedon bibionipennis (Boisduval) (Strawberry Crown Moth*, Sésie du Fraisier, f., Fr.)

PL. 3, FIGS. 33,34. TEXT FIG. 26*d* (RWH 2576).

Sesia bibionipennis Boisduval, 1869, *Ann. Soc. Ent. Belgique,* **12**: 64.

Type locality: California. [USNM]

Albuna rutilans Hy. Edwards, 1881, *Papilio,* **1**: 186.

Type locality: Virginia City, Nevada. [AMNH]

Aegeria lupini Hy. Edwards, 1881, *Papilio,* **1**: 192.

Type locality: Marin County, California. [AMNH]

Aegeria perplexa Hy. Edwards, 1881, *Papilio,* **1**: 192.
Type locality: Texas. [USNM]

Aegeria impropria Hy. Edwards, 1881, *Papilio,* **1**: 193.
Type locality: Washington Territory. [USNM]

Aegeria aureola Hy. Edwards, 1881, *Papilio,* **1**: 194.
Type locality: Nevada. [USNM]

Aegeria neglecta Hy. Edwards, 1881, *Papilio,* **1**: 197.
Type locality: Olympia, Washington. [AMNH]

Aegeria washingtonia Hy. Edwards, 1881, *Papilio,* **1**: 197.
Type locality: Washington Territory. [AMNH]

Aegeria hemizoniae Hy. Edwards, 1881, *Papilio,* **1**: 198.
Type locality: Nevada. [AMNH]

Aegeria madariae Hy. Edwards, 1881, *Papilio,* **1**: 201
Type locality: Saucelito [sic], California. [AMNH]

Synanthedon bibionipennis is a potentially destructive species to strawberries under cultivation and is very common in the Pacific Coast regions. Male: Head with vertex and front brown black; occipital fringe yellow; labial palpus roughened, yellow with row of elongate brown-black scales subventrally; antenna brown black, often powdered yellow on posterior margin, scape yellow. Thorax brown black with narrow subdorsal yellow stripe, metathorax yellow; mostly yellow beneath wing. Abdomen brown black; dorsally with segments two and four banded yellow on posterior ½, other segments may be variously banded on different individuals; yellow laterally; ventrally sparsely powdered yellow; anal tuft brown black, yellow laterally and ventrally. Legs with forecoxa mostly yellow; femora brown black, variously powdered yellow; fore- and midtibiae brown black dorsally, yellow ventrally; hindtibia mostly yellow but with brown black distally between pairs of spurs, mixed dorsobasally; tarsi mostly or entirely yellow. Forewing mostly hyaline, dorsally with broad, brown-black discal spot, often margined with yellow, broad, outer margin, variously powdered yellow between veins, some specimens extensively so; ventrally mostly yellow but with some brown black on discal spot and veins distally. Hindwing hyaline, with narrow margins, strongly powdered yellow on some specimens; fringe yellow near wing base; ventrally, opaque areas mostly yellow. Genitalia with crista sacculi narrow, straight, with ventral extension near middle, slightly basad, crista and extension heavily clothed with elongate, dark scales, somewhat clefted apically. Female similar to male except for: labial palpus without elongate, subventral, brown-black scales; forewing generally more nearly opaque, powdering often dull orange; yellow on wings and abdomen usually more extensive; anal tuft brushlike, brown black with yellow subdorsally to mostly yellow. Genitalia similar to *arizonensis.* Wing length 8–10 mm.

The following information is summarized from several sources (Engelhardt, 1946; Essig, 1958; Mote et al., 1929; Thompson, 1927). Adults have been reared from *Fragaria* sp. (strawberries), *Potentilla* sp., *Rosa* sp. (roses), *Rubus* spp. (raspberries, blackberries, boysenberries) (Rosaceae). The larvae bore in the roots near the crown or in the stems near the base of the host plant. They feed until September or October and then prepare a silken chamber in the burrow, in which they overwinter. Feeding is resumed the following spring. Just prior to pupation the mature larva bores to the outside above ground level, leaving an exit hole for the pupa and prepares a cocoon a short distance back from the exit hole. Pupation occurs about nine days following the formation of the cocoon, the pupal stage is about 23 days. At emergence the pupa pushes the cap off the cocoon and works itself partially out of the exit hole, from which position the adult emerges. Adult emergence occurs from April through mid-August. They often are seen taking nectar from flowers of various kinds. Female moths spend much time crawling among dead leaves and stems close to the crown of a host plant, depositing single eggs on the underside of various objects. In the laboratory one female may lay over 400 eggs on the average. In a study by Nielsen et al. (1978), the most effective sex attractant lure was a 2:1 blend of E,Z-ODDA/E,Z-ODDOH.

The range of *bibionipennis* is from the Rocky Mountains in Montana, south to northwestern Texas, and west to the Pacific Coast from British Columbia to California.

Synanthedon castaneae (Busck)
PL. 2, FIG. 32; PL. 3, FIG. 35 (RWH 2577).

Sesia castaneae Busck, 1913, *Proc. Ent. Soc. Washington,* **15**: 102.
Type locality: Lynchburg, Virginia. [USNM]

Until its rediscovery in the Southeast in 1985, *castaneae* had not been taken since 1933. Engelhardt (1946: 96) speculated that *castaneae,* a common species at the turn of the century, had become extinct, a result of the devastation of its only known host, *Castanea dentata* (Marsh) Borkhausen (American chestnut) (Fagaceae), by the chestnut blight.

Adult: Head with vertex brown black, mixed with some yellow posteriorly; front brown black, broadly white laterally; occipital fringe brown black; labial palpus roughened, yellow, brown black laterally to apex. Thorax brown black with narrow subdorsal yellow stripe; lateral tufts yellow; strongly yellow beneath wing. Abdomen brown black; dorsally very narrowly banded pale yellow on posterior margin of segments two, three, and four with band on four covering segment ventrally; laterally pale yellow extending from base to segment four; ventrally with yellow also on segment five medially; abdomen and thorax with blue-green iridescence. Legs with coxae mostly yellow; femora blue black; foretibia mostly yellow, mid- and hindtibiae blue black except for pale-yellow spurs and pale-yellow tuft distad; tarsi pale yellow to white mesially and ventrally and encircling joints of first segment, blue black dorsally and laterally. Forewing mostly hyaline with very narrow outer margin, light yellow powdering on margins, veins, and distal margin of discal spot; yellow powdering stronger ventrally. Hindwing hyaline; costal margin yellow; fringe yellow near wing base. Male genitalia with valva narrowed, elongate, with very short crista sacculi that has short portion curving ventrally. Female genitalia like those of *arizonensis* but with sclerotized portion of ductus bursae shorter, less than ⅓ total length of ductus; corpus bursae small, ovate. Wing length 10–12 mm.

The larvae are borers in the bark of the trunk of chestnut, preferring bruised places (Engelhardt, 1946: 96). The larva constructs a cocoon prior to pupation in the larval burrow. Moths emerge from May to July. *Synanthedon castaneae* occurs in the eastern Atlantic Coast states and Appalacian Mountain system to northern Florida. Recent collections in early May 1985 were made possible by the use of sex attractants (E,Z-ODDA) (Snow and Eichlin, 1986: 67). L. Brown (personal communication) reported it from northern Florida, and it was trapped in North Carolina, South Carolina, and Alabama by utilizing this attractant as bait. Snow and Eichlin (1986) suggest that several species of *Castanea* that occur in the range of the borer could serve as host plants, especially the most common species, *C. pumila* (Linnaeus) Miller.

Synanthedon chrysidipennis (Boisduval)
PL. 2, FIGS. 33, 34; PL. 3, FIG. 36 (RWH 2578).

Sesia chrysidipennis Boisduval, 1869, *Ann. Soc. Ent. Belgique,* **12**: 64.
Type locality: Los Angeles, California. [USNM]

Sesia tacoma Beutenmüller, 1898, *Jour. New York Ent. Soc.,* **6**: 240.
Type locality: Big Horn Mountains, Wyoming. [USNM]

Ramosia chrysidipennis race *wallowa* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 30.
Type locality: Elk Horn Mountains, Oregon, 5,000 ft. [USNM]

Male: Head with vertex and front brown black; occipital fringe yellow; labial palpus roughened, yellow mixed with brown black subventrally; antenna often powdered with yellow orange on posterior edge and ventrally on scape. Abdomen brown black; dorsally with narrow yellow bands on segments two, four, and six, widest on four, and some yellow scales on seven; ventrally with yellow band on four and often also on five and six; anal tuft with some yellow laterally at base. Legs: foreleg appearing somewhat hairy, mostly yellow but with brown black mesially on coxa, ventrally on femur and mixed dorsally on tibia; mid- and hindlegs with femora brown black, some yellow orange dorsally, tarsi yellow orange; midtibia brown black mixed with yellow laterally; hindtibia mostly yellow but with brown black at base and on distal ⅓. Forewing with costal margin brown black with some red-orange powdering, outer margin brown black, strongly suffused with red orange between veins and on veins in hyaline area, discal spot broad, brown black margined with red orange, anal margin mostly red orange; ventrally mostly red orange except narrowly at apex and on discal spot. Hindwing hyaline with very narrow margins brown black, margined inside with red orange, costa and veins red orange; fringe yellow at wing base. Genitalia similar to those of *bibionipennis* but with crista sacculi slightly thicker, with a few bifurcate scales on mostly naked apical ½ of crista. Female similar except with forewing more suffused red orange; labial palpus without brown black subventrally; abdomen dorsally more broadly banded yellow on segments two, four, and six and often some yellow on other segments; anal tuft brushlike, strongly mixed with yellow. Genitalia as described for *castaneae.* Wing length 9–12 mm.

Larvae have been recorded as boring in the roots

of *Polygonum davisiae* Brewer and *Polygonum* sp. (Polygonaceae) (Engelhardt, 1946: 30). Pupation takes place in cocoons in the larval burrow near the crown of the host plant, or the larvae may construct silk-lined tubes extending from the exit hole in the root to the soil surface to provide a means of escape for the mature pupa. Adults can be seen, often in large numbers, from late June through early August flying about the host plants in alpine meadows.

Synanthedon chrysidipennis has been found at higher elevations from British Columbia south to Utah and California.

Synanthedon mellinipennis (Boisduval)
PL. 2, FIGS. 35, 36 (RWH 2580).

Sesia mellinipennis Boisduval, 1836, *Histoire naturelle des Insectes: Spécies général des Lépidoptères,* pl. 14, fig. 12.
Type locality: Amerique septentrionale. [lost]

Albuna artemisiae Hy. Edwards, 1881, *Papilio,* **1**: 187.
Type locality: Sierra Nevada, California. [AMNH]

Aegeria seneciodes Hy. Edwards, 1881, *Papilio,* **1**: 198.
Type locality: California. [AMNH]

Although scattered records imply that *mellinipennis* is widely distributed in Pacific Coast regions, it has not been encountered frequently.

Male: Head with vertex and front brown black; occipital fringe yellow; labial palpus slightly thickened but not roughened, yellow; antenna brown black with scape yellow. Abdomen dorsally with yellow banding of various widths on all segments except three, which may have some yellow powdering; ventrally mostly yellow except toward base. Legs mostly yellow except for brown black on most of femora, dorsally on foretibia, and at base and on distal ⅓ of mid- and hindtibiae. Forewing mostly hyaline with fairly broad outer margin; discal spot with at least distal ½ orange; orange powdering between veins; ventrally with orange much more extensive. Hindwing hyaline with very narrow margins; fringe yellow at wing base; ventrally with margins and veins variously powdered with orange. Genitalia similar to those of *chrysidipennis* but without bifurcate scales. Female similar to male except forewing more nearly opaque with orange scaling more extensive; generally with yellow abdominal bands broader; and anal tuft brushlike, yellow with brown black medially. Genitalia similar to those of *arizonensis.* Wing length 10–12 mm.

Synanthedon mellinipennis may be confused with *chrysidipennis* but lacks roughened palpus; has orange powdering on wings, not orange red; and male genitalia lack bifurcate scales apically on crista sacculi. In the literature (Burke, 1933; Doane et al., 1936; Essig, 1926; Herbert, 1936; Keen, 1952), *mellinipennis* has been mistakenly used for *resplendens* Hy. Edwards (sycamore borer) (see Brown and Eads, 1965a; 1965b).

Williams (1909) reported having reared a few specimens of this species from a large decumbent trunk of *Ceanothus thyrsiflorus* Eschscholtz (Rhamnaceae). He observed the larvae boring in the solid wood and found pupae in cocoons under the bark. The larvae are likely to be found in the trunks of mature, weakened *Ceanothus* spp. Collection data indicate flight from mid-June through August.

Aside from a single record for British Columbia, *melinipennis* has been collected only in foothill regions of California.

Synanthedon polygoni (Hy. Edwards) (Buckwheat Root Borer)
PL. 2, FIG. 37; PL. 3, FIGS. 37–40 (RWH 2581).

Pyrrhotaenia polyoni Hy. Edwards, 1881, *Papilio,* **1**: 202.
Type locality: San Miguel, California. [AMNH]

Pyrrhotaenia fragariae Hy. Edwards, 1881, *Papilio,* **1**: 202.
Type locality: Colorado. [AMNH]

Pyrrhotaenia helianthi Hy Edwards, 1881, *Papilio,* **1**: 203.
Type locality: Virginia City, Nevada. [MSU]

Pyrrhotaenia achillae Hy. Edwards, 1881, *Papilio,* **1**: 203.
Type locality: San Rafael, California. [AMNH]

Pyrrhotaenia eremocarpi Hy. Edwards, 1881, *Papilio,* **1**: 203.
Type locality: Sierra Nevada, California. [AMNH]

Pyrrhotaenia meadii Hy. Edwards, 1881, *Papilio,* **1**: 204.
Type locality: Lake Tahoe, California. [AMNH]

Pyrrhotaenia orthocarpi Hy. Edwards, 1881, *Papilio,* **2**: 204.
Type locality: Washoe Lake, Nevada. [AMNH]

Aegeria praestans Hy. Edwards, 1882, *Papilio,* **2**: 98.
Type locality: Washington Territory. [USNM]

Pyrrhotaenia behrensii Hy. Edwards, 1882, *Papilio,* **2**: 123.
Type locality: Soda Springs, Shasta County, California. [AMNH]

Pyrrhotaenia animosa Hy. Edwards, 1883, *Papilio,* **3**: 156.
Type locality: Arizona. [USNM]

Pyrrhotaenia elda Hy. Edwards, 1885, *Ent. Amer.,* **1**: 49.
Type locality: Siskiyou County, California. [AMNH]

Sesia fragariae variety *semipraestans* Cockerell, 1908, *Can. Ent.,* **40**: 329.
Type locality: Florissant, Colorado. [USNM]

Synanthedon polygoni is the most polymorphic species of Sesiidae known to us. The ground color is blue black with various patterns of orange red on the wings, legs, and abdomen. The degree of opacity on the fore- and hindwings is highly variable. As one might expect from reviewing the history of clearwing moth taxonomy, most of the forms were named without regard for specific variability. Generally, the form "*fragariae*" with mostly hyaline forewings is found at higher elevations in the Sierra Nevada and Rocky Mountains, northward to Alaska. In the mountainous regions of Oregon and Washington, the form "*praestans*" predominates; it looks like a larger version of "*fragariae.*" The form "*animosa,*" which has females with totally opaque fore- and hindwings, is mostly from California, Arizona, and northern Mexico. The other color forms and all gradations between are found mostly at lower elevations in California and Arizona, including the coastal sand dunes. The patterns of the head are more stable and are as follows: Vertex blue black (orange red on "*praestans*"); front brown black; occipital fringe blue black, or mixed with orange red, or solid orange red; labial palpus roughened, orange red, blue black apically and often ventrally; antenna blue black. Wing length 7–12 mm, with "*praestans*" the largest of the forms.

Adults have been reared from the following hosts: *Eriogonum compositum* Douglas, *E. fasciculatum* Bentham, *E. gracile* Bentham, *E. inflatum* Torrey and Bentham, *E. latifolium sulphureum* (Greene), *E. parvifolium* Smith, *E. wrightii* Torrey and Bentham, *Polygonum paronychia* Chamisso and Schlechtendal (all Polygonaceae) (Engelhardt, 1946; Williams, 1909), and once from *Leptodactylon pungens hallii* (Parish) (Polemoniaceae) (Duckworth and Eichlin, 1978). The larvae tunnel into the root and somewhat into the stem. Reddish fecal pellets are extruded at the base of the plant and fill the abandoned portions of the galleries. The last 25–50 mm of the larval burrow serves as the pupal chamber, which is silk lined and leads to a thinly covered exit hole above ground level.

Synanthedon polygoni is a very commonly collected species, known from Chihuahua and northern Baja California, Mexico, north to Alaska. Adults are present as early as April and May in the coastal and southern parts of the range and June to August in the mountains and northern portions. They frequently visit flowers, not necessarily those of their host plants.

Synanthedon resplendens (Hy. Edwards) (Sycamore Borer)
PL. 3, FIGS. 41, 42 (RWH 2582).

Albuna resplendens Hy. Edwards, 1881, *Papilio,* **1**: 186.
Type locality: Soda Springs, Siskiyou County, California. [AMNH]

Synanthedon resplendens is often referred to in literature as the sycamore borer, because *Platanus racemosa* Nuttal (California sycamore, Platanaceae) is one of the preferred hosts.

Male: Head with vertex brown black or mixed with yellow anteriorly; front brown black or mixed with yellow ventrally; occipital fringe yellow; labial palpus smooth, yellow; antenna brown black. Thorax dorsally brown black with fairly broad subdorsal yellow stripe; metathorax yellow; mostly yellow beneath wings. Abdomen dorsally brown black with segments two, four, six, and seven broadly banded yellow and often some yellow on three and five; all segments yellow laterally; ventrally yellow except segment three and medially on two; anal tuft brown black medially, yellow laterally and ventrally. Legs with forecoxa mostly yellow, brown black mesially; femora brown black; tibiae mostly yellow but with brown black dorsally and laterally on distal ⅓; tarsi yellow ventrally and around joint of first segment, brown black dorsally. Forewing mostly hyaline, margins and discal spot brown black, powdered variously with yellow; ventrally mostly yellow except for discal spot and apical veins. Hindwing hyaline with very narrow margins; fringe yellow near wing base; ventrally with margins mostly yellow. Geni-

talia with crista sacculi small but thickly scaled, scales covering to distal end, ventral extension relatively long, straight, slanted toward base and nearly reaching ventral edge of valva, relatively small naked area on valva dorsad of crista sacculi. Female similar to male except forewing with much broader outer margin, much stronger yellow powdering between the veins; abdomen entirely yellow except anterior ½ of segment two and most of three; anal tuft brushlike, yellow. Genitalia with bursae well sclerotized on posterior ½, slightly expanded near ostium bursae; corpus bursae small, ovate. Wing length 8–12 mm.

In addition to sycamore, larvae of *resplendens* are bark borers in *Quercus agrifolia* Nee (coast live oak, Fagaceae) (Brown and Eads, 1965a; 1965b; Engelhardt, 1946) and were reported from *Persea americana* Miller (avocado, Lauraceae) (Ryan, 1928). Larvae usually are found in older and larger trees. Pupation occurs in the larval gallery in a cocoon, which incorporates frass and bits of chewed bark. As with nearly all sesiids, the exit is covered by a thin layer of bark, which is pierced by the mature pupa at the time of emergence. Adults can be reared with comparative ease from sections of infested bark. The moths are found mostly in June and July, but some have been collected as early as April in southern California and as late as August in the mountains. The adults confine most of their activities to the crown of the trees except for emergence and oviposition.

Synanthedon resplendens occurs from southern California to Washington and western Idaho.

Synanthedon exitiosa (Say) (Peachtree Borer*, Western Peachtree Borer, Perceur du Pecher, m., Fr.)

PL. 2, FIGS. 38–43; PL. B, FIG. 5. TEXT FIG. 27 *a–c* (RWH 2583).

Aegeria exitiosa Say, 1823, *Jour. Acad. Nat. Sci. Philadelphia,* **3**: 216.
Type locality: Unknown [eastern North America]. [lost]

Apis persica Thomas, 1824, *American Farmer,* **6**: 37.
Type locality: Baltimore, Maryland. [unknown]

Paranthrene pepsidiformis Hübner, *Zuträge zur Sammlung Exotischer Schmettlinge* [sic], 32.
Type locality: Georgia. [unknown]

Sesia xiphiaeformis Boisduval, [1875], *in* Boisduval and Guenée, *Histoire Naturelle des Insectes: Spécies général des Lépidoptères Hétérocères,* **1**: 409.
Type locality: United States. [USNM]

Sciapteron graefi Hy. Edwards, 1881, *Papilio,* **1**: 183.
Type locality: Nevada. [USNM]

Aegeria opalescens Hy. Edwards, 1881, *Papilio,* **1**: 199.
Type locality: Nevada. [USNM]

Aegeria exitiosa variety *fitchii* Hy. Edwards, 1882, *Papilio,* **2**: 55.
Type locality: Tallahassee, Florida. [AMNH]

Sannina pacifica Riley, 1891, *Insect Life,* **3**: 393.
Type locality: Santa Clara County, California. [USNM]

Sannina exitiosa variety *luminosa* Neumoegen, 1894, *Ent. News,* **5**: 331.
Type locality: Glendale, Long Island, New York. [USNM]

Sanninoidea exitiosa variety *edwardsii* Beutenmüller, 1899, *Bull. Amer. Mus. Nat. Hist.,* **12**: 160.
Type locality: Not stated [North America]. [AMNH]

Sanninoidea graefii [sic] variety *barnesii* Beutenmüller, 1900, *Jour. New York Ent. Soc.,* **8**: 254.
Type locality: Clear Creek Canyon, Colorado. [USNM]

Synanthedon exitiosa is not only polymorphic but is also strongly sexually dimorphic. The typical color form is found throughout eastern temperate North America into the Rocky Mountains, excluding most of the Great Plains. The predominant color form (previously treated as a subspecies by authors) in the Pacific Coast states is "*graefi,*" which also occurs commonly in the Rocky Mountains.

Male: Head with vertex brown black, often with pale yellow on typical form; front brown black; occipital fringe brown black laterally, variously pale yellow dorsally, more so on typical form; labial palpus thickened, somewhat roughened, typical form mostly pale yellow with brown black dorsolaterally; antenna brown black. Abdomen dorsally variable, brown black with narrow pale-yellow banding on posterior margin of some or all segments, or banding absent ("*graefi*"); ventrally brown black; anal tuft wedge shaped, pale yellow laterally. Legs brown black

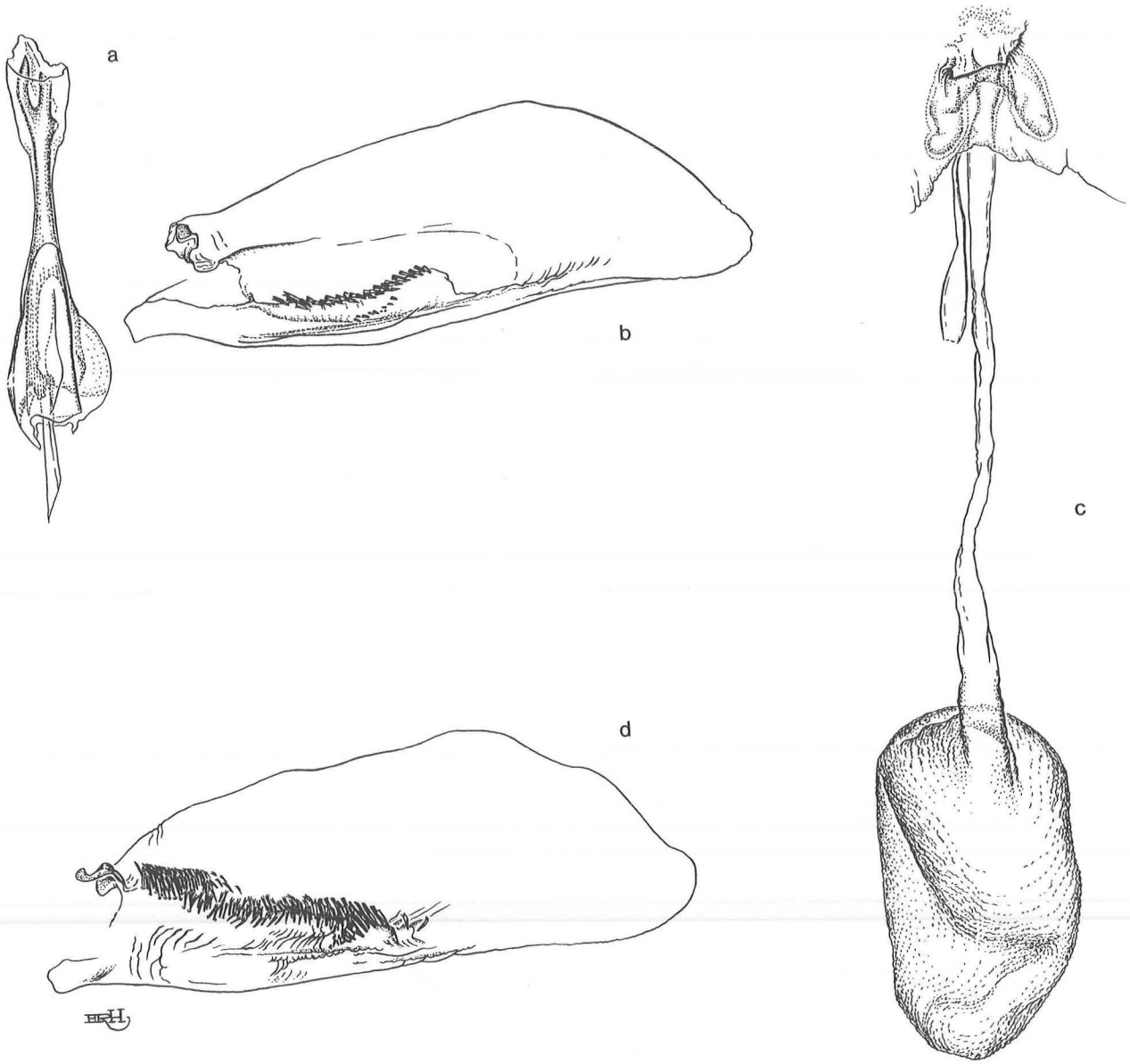

FIGURE 27: GENITALIA OF *SYNANTHEDON* SPECIES

a–c. Synanthedon exitiosa, a. Aedoeagus (USNM 75603); *b.* Right valve (USNM 75603); *c.* Female genitalia (part of eighth abdominal segment included) (USNM 75608). *d.* Right valve of *Synanthedon pini* (USNM 75762).

with pale yellow on tufts of tibiae at pairs of spurs. Body and legs usually with bluish iridescence. Wings mostly hyaline with very narrow margins, slightly wider on western examples. Genitalia with aedoeagus bifurcate apically; crista sacculi expanded somewhat distally, with ventral extension toward distal end clothed sparsely with dark scales. Female generally brown black overall; labial palpus somewhat thickened but smooth; abdomen with segment four ringed solidly with orange ("*exitiosa*"), or much less commonly also segment five ringed with orange ("*edwardsii*"), or completely brown black ("*graefi*"); forewing entirely opaque, brown black, except with various hyaline areas on some western specimens. Hindwing mostly hyaline though variously diffusely opaque from wing base outward, becoming more extensive on some specimens. Genitalia with very narrow ductus bursae, sclerotized on short section on posterior end. Wing length 6–15 mm, the smallest measurements are from dwarfed specimens, which are not uncommon in nature.

The peachtree borer is one of the most econom-

ically important species in the Sesiidae. Much has been written about its life history, biology, and control (see Holloway et al., 1977 for a bibliography through 1975). It is a pest on *Prunus persica* Batsch (peach) but also has been recorded from *P. amygdalus* Batsch (almond), *P. armeniaca* Linneaus (apricot), *P. cerasus* Linnaeus (sour cherry), *P. domestica* Linnaeus (European plum), *P. hortulana* Bailey (hortulan plum), *P. persica* var. *nectarina* Maximowicz (nectarine), *P. serrulata* Lindley (Japanese flowering cherry), *P. virginiana* var. *demissa* (Nuttall) (chokecherry), and probably occurs in various wild, native species of Rosaceae. The larvae bore beneath the bark and cambium just below ground level or above, if infestation is very heavy. Trees of all ages are subject to infestation by the borers, young trees often being killed. At maturity larvae in the crown below ground exit through the bark and tunnel to near the soil surface, where they construct cocoons. Larvae in the trunk above ground construct cocoons in the larval chamber just beneath the outer bark surface (Boyce, 1962; Smith, 1965). Adults have been taken as early as April and as late as October, with the most during midsummer. The first sesiid sex attractant found (Z,Z 3,13-ODDA) was identified from females of *exitiosa* and artificially synthesized (Tumlinson et al., 1974).

The generalized distribution of *exitiosa* is: United States and southern Canada, excluding most of Great Plains, Great Basin and desert Southwest.

Synanthedon novaroensis (Hy. Edwards) (Douglas-Fir Pitch Moth*)
PL. 2, FIG. 44 (RWH 2584).

Aegeria novaroensis Hy. Edwards, 1881, *Papilio,* **1**: 199.
Type locality: Navarro, Mendocino County, California. [USNM]

Parharmonia piceae Dyar, 1904, *Proc. Ent. Soc. Washington,* **6**: 106.
Type locality: Hoquiam, Washington. [USNM]

Sesia brunneri Busck, 1914, *Proc. Ent. Soc. Washington,* **16**: 143.
Type locality: Camas, Montana. [USNM]

Synanthedon novaroensis, pini, and *sequoiae,* referred to as pitch moth borers, are the only North American clearwing moths known to bore in Pinaceae. The biology of all three species is generally similar. The life cycle is thought to take two years to complete. The presence of larvae in a particular host is indicated externally by resinous nodules or pitch tubes, which are small and soft initially, becoming larger and harder later. Pupation occurs in silk-lined chambers in the pitch nodules.

Male: Head with vertex brown black with orange anteriorly and at antennal base; front orange, some brown black laterally; occipital fringe orange; labial palpus thickened, slightly roughened, orange, often with some brown black lateroapically; antenna brown black. Thorax mostly orange, brown black mediodorsally. Abdomen dorsally with orange bands on segments two, four, six, and seven, occasionally on all segments; ventrally orange; anal tuft mostly orange, brown black basally and medially. Legs mostly orange except for brown black on femora and distally on tibiae. Forewing mostly hyaline with somewhat broad outer margin, margins and discal spot brown black dorsally and ventrally. Hindwing hyaline. Genitalia with valva broadly rounded; crista sacculi heavily clothed with dark scales, ventral preapical extension leading to small naked outward projecting ridge parallel to ventral edge of valva. Female similar to male, perhaps with more orange on abdomen. Genitalia with posterior ⅓–½ sclerotized. Wing length 10–12 mm.

Larvae bore in the cambium and solid wood, primarily of spruces, but are also known from pines, particularly when associated with spruce (Brunner, 1915). Recorded hosts include: *Picea engelmannii* Parry ex. Engelmann (Engelmann spruce), *P. sitchenses* (Bongard) Carriere (Sitka spruce), *Pinus contorta* Douglas ex. Loudon (lodgepole pine), *P. monticola* Douglas ex. D. Don (western white pine), and *Pseudotsuga menziesii* (Mirbel) Franco (Douglas-fir) (Engelhardt, 1946: 150). Emergence of adults occurs from March to September, but mainly in June and July. Most adults have been obtained by rearing; they have been very seldomly observed in the field. However, we have used sex attractants (Z,Z-ODDA) as baits to capture males in several locations in California.

Synanthedon novaroensis is known from northern California to Alaska and east to Montana.

Synanthedon pini (Kellicott) (Pitch Mass Borer*; Nodulier du Pin, m., Fr.)
PL. 2, FIG. 45. TEXT FIG. 27*d* (RWH 2585).

Aegeria pini Kellicott, 1881, *Can. Ent.,* **13**: 5.
Type locality: New York. [lost]

Synanthedon pini is the eastern counterpart of the pitch borer complex and generally follows the distribution of its principal food plant, *Pinus strobus* Linnaeus (eastern white pine).

Male: Head with vertex mostly orange; front gray black; occipital fringe orange; labial palpus smooth, brown black, orange at base ventrally; antenna brown black. Thorax brown black, some orange beneath wings. Abdomen dorsally blue black except for orange covering most of segment four; ventrally orange except for segments one and two and usually three; anal tuft margined with orange, orange beneath. Legs brown black, often with some orange laterally on forecoxa. Forewing opaque, brown black. Hindwing hyaline but variously weakly suffused brown black anteriorly and apically; discal spot prominent. Genitalia similar to those of *novaroensis.* Female similar to male. Genitalia similar to those of *novaroensis.* Wing length 12–15 mm.

Synanthedon pini is biologically similar to *novaroensis* (Anderson, 1960; Heinrich, 1921). It has been recorded from *Picea abies* (Linnaeus) Karst. (Norway spruce) in addition to white pine. Prentice (1965) reports it also from *Picea glauca* Voss (white spruce), *Pinus banksiana* Lambert (jack pine), and *P. sylvestris* Linnaeus (Scots pine).

According to Engelhardt (1946: 130), *pini* occurs in southeastern Canada, south on the Atlantic Coast, in the Appalachian region, and in the Midwest. Though the distribution as given seems fairly extensive, specimens are relatively scarce in collections. The main flight period appears to be June and July.

Synanthedon sequoiae (Hy. Edwards) (Sequoia Pitch Moth*; Nodulier du Sequoia, m., Fr.)

PL. 2, FIG. 46 (RWH 2586).

Bembecia sequoiae Hy. Edwards, 1881, *Papilio,* **1**: 181.
Type locality: Mendocino County, California. [USNM]

Bembecia superba Hy. Edwards, 1881, *Papilio,* **1**: 181.
Type locality: Washington Territory. [USNM]

Aegeria pinorum Behrens, 1889, *Can. Ent.,* **21**: 163.
Type locality: Monterey, California. [lost]

The life history of *sequoiae* is similar to that of *novaroensis,* but *sequoiae* is primarily a borer in pines and the latter primarily in spruces; however, hosts are shared by both species.

Male: Head with vertex brown black mixed with yellow; front brown black, pale yellow laterally; occipital fringe yellow; labial palpus roughened, yellow with brown black laterally; antenna brown black. Thorax brown black with narrow yellow subdorsal stripe; yellow beneath wing; metathorax yellow. Abdomen dorsally with all but segments one and three broadly banded yellow; ventrally all segments mostly yellow; anal tuft brown black mixed with yellow. Legs mostly yellow except femora mostly brown black. Forewing hyaline with very narrow margins and narrow discal spot; ventrally powdered on costal margin and discal spot with yellow. Hindwing hyaline with very narrow margins; ventrally with yellow on coastal margin. Genitalia generally like those of *novaroensis.* Female similar to male, often with abdominal banding broader, and anal tuft mostly yellow, brushlike. Genitalia like those of *novaroensis.* Wing length 10–14 mm.

The known hosts for *sequoiae* include: *Pinus contorta* Douglas ex Loudon (lodgepole pine), *P. lambertiana* Douglas (sugar pine), *P. ponderosa* Douglas ex P. and C. Lawson (ponderosa pine), *P. muricata* D. Don (Bishop pine), and *P. radiata* D. Don (Monterey pine). To our knowledge, *Sequoia sempervirens* (D. Don) (redwood) never has been proven to be a host. Larval activity is mostly confined to the base of the tree, from which large amounts of pitch often can be seen exuding (see Furniss and Carolin, 1977: 140, fig. 73). The life cycle requires two years for completion. Adults are found from May to August, with peak emergence occurring in June and July. The attractant Z,Z-ODDOH (not -ODDA as mentioned in Duckworth and Eichlin, 1978: 43) and mixtures of isomers have been used to capture numbers of males (Nielsen et al., 1975; Nielsen et al., 1978).

Synanthedon sequoiae has been recorded from northern British Columbia (Prentice, 1965: 285) along the coast to Monterey County, California, and in the Rocky Mountains to Colorado (Engelhardt, 1946: 128).

GENUS
Palmia Beutenmüller

Palmia Beutenmüller, 1896, *Bull. Amer. Mus. Nat. Hist.,* **8**: 123.
Type species: *Sciapteron praecedens* Hy. Edwards, 1883. Original designation.

The genus contains one species for which very little information is known and few specimens are available. A comparison of the male genitalia indicates that *Palmia* is most similar to *Podosesia* Möschler. As with the latter, the crista sacculi is located on the ventral margin of the valva and projects me-

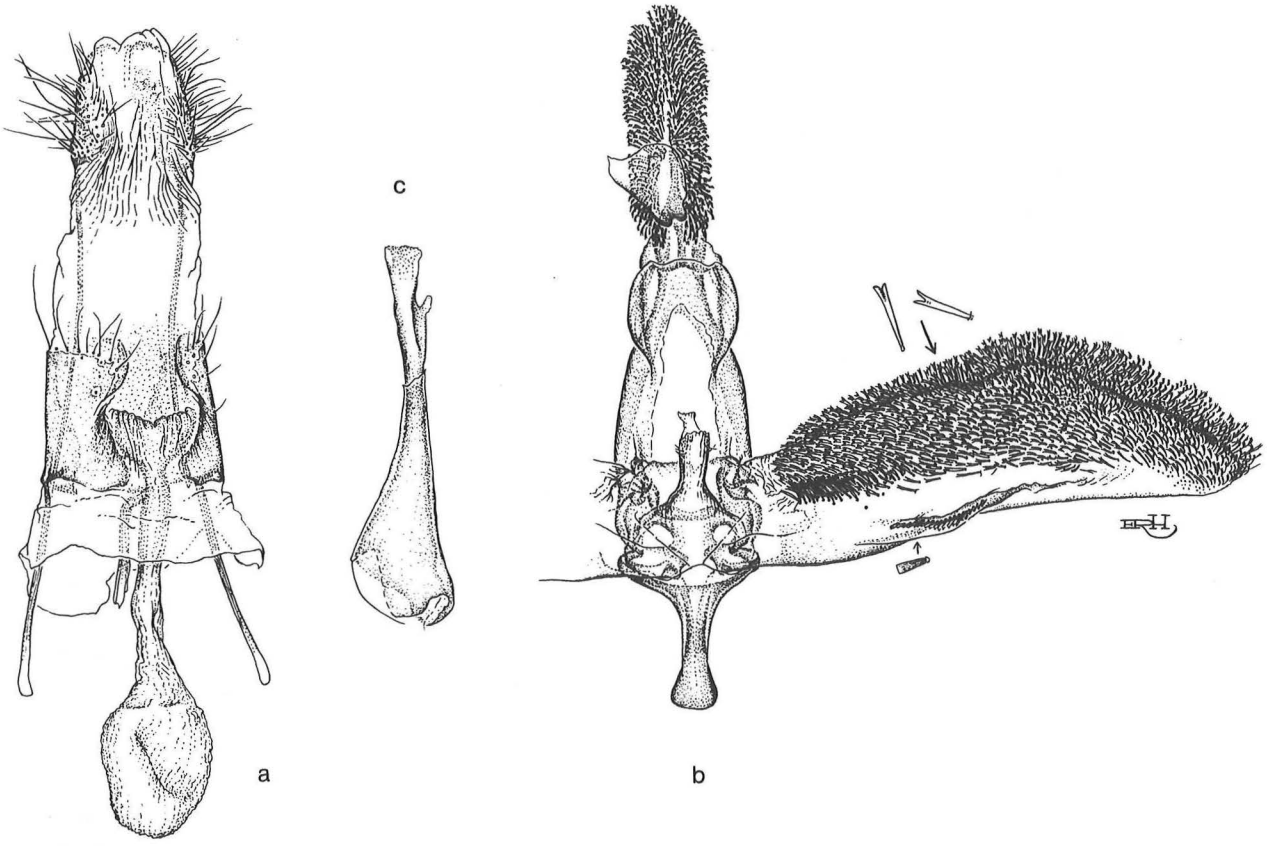

FIGURE 28: GENITALIA OF *PALMIA PRAECEDENS*

a. Female genitalia (USNM 75900). *b.* Male genitalia (right valve and aedoeagus omitted) (USNM 76035). *c.* Aedoeagus (USNM 76035).

soventrally; the saccus is less than ⅓ the length of the valva; the gnathos lacks a crista gnathi, with the lateral lobes projecting ventrally; the base of the valva has a flat, curved process directed toward the juxta; and the apex of the aedoeagus is deeply bifurcate. Female genitalia of *Palmia* lack sclerotization on the ductus bursae and have only slight pigmentation on the ventral margin of the ostium bursae, but are otherwise much like those of *Podosesia.*

The venation is typical for the Sesiinae except that veins R_4 and R_5 are stalked for more than ½ their total length. The slightly smaller second segment of the maxillary palpus is positioned laterally on the first segment, which has relatively long and thick setae apically. The haustellum is approximately twice as long as the labial palpus.

The immatures are unknown.

Palmia praecedens (Hy. Edwards)

PL. 2, FIG. 47. TEXT FIG. 28 *a–c* (RWH 2587).

Sciapteron praecedens Hy. Edwards, 1883, *Papilio,* **3**: 155.

Type locality: North Carolina. [USNM]

Males of *praecedens* were recently discovered (Duckworth and Eichlin, 1977c: 37). Male: Head with vertex brown black mixed with some yellow orange, posterior margin appearing bare as on species of *Podosesia* but, unlike the latter, *praecedens* apparently lacks the chaetosemata that are present in *Podosesia* species; front brown black, dull orange dorsally; occipital fringe yellow orange; labial palpus roughened, yellow orange mixed with brown black laterally; antenna pale yellow, powdered orange and apex brown black. Thorax brown black with tegulae strongly powdered rust red, a narrow rust-red stripe continuing posteriorly above wing, yellow orange anteriorly beneath wing. Abdomen brown black, but with segments five, six, seven, and anal tuft lemon yellow. Legs with coxae brown black, perhaps edged with orange red; femora brown black; tibiae orange with brown black apically; tarsi dull orange, sometimes with some orange, mostly on the first segment.

Both pairs of wings opaque except for hyaline basal ⅓, brown black powdered with orange red basally, variously in the cell on the forewing, and throughout the hindwing dorsally; ventrally with orange red much more prominent. Genitalia as illustrated and described for the genus. Female as for male, although the single female specimen has very little orange-red powdering dorsally on the wings. Genitalia as illustrated. Wing length 13–15 mm.

The immatures stages are unknown.

This species was known only from the type female, which was stated to have come from North Carolina, and two males from Arizona. The type lacks label data, but the two males were collected by Otto Buchholz in mid-March 1954 in Tucson, Arizona. The discovery of the males from Arizona makes the type locality suspect. The species is immediately recognizable by the lemon yellow on the posterior portion of the abdomen.

GENUS

Podosesia Möschler

Grotea Möschler, 1876, *Entomologische Zeitung zu Stettin,* **37**: 312.
Type species: *Grotea longipes* Möschler, 1876, now considered to be a junior synonym of *Aegeria syringae* Harris, 1839. Original designation.

NOTE—*Grotea* Möschler, 1876, is a junior homonym of *Grotea* Cresson, 1864 in the Hymenoptera, *Grotea* Moore, 1866 in the Lepidoptera, and *Grotea* Theobald, 1868 in the Reptilia.

Podosesia Möschler, 1879, *Entomologische Zeitung zu Stettin,* **40**: 246.

NOTE—*Podosesia* is a replacement name for *Grotea* Möschler, 1876.

Podosesia in North America contains two sibling species. It is related to *Palmia,* as is most evident upon examination of the genitalia. *Podosesia* species have uniquely elongated hindlegs, resulting from an unusual lengthening of the first tarsal segment, which is as long as the tibia. Characters of *Podosesia* are: Labial palpus with third segment about ⅔ length of second segment. Second segment of maxillary palpus somewhat pigmented and positioned laterally on first segment. Haustellum about twice length of labial palpus. Male genitalia with valva having bifurcate scales on dorsal ⅔, crista sacculi on ventral margin projecting ventrally with apical margin of crista having row of flattened, truncated scales; saccus less than ⅓ length of valva, relatively wide, either broadly rounded, concave, or flared into somewhat pointed extensions apically; gnathos without crista gnathi, lateral lobes of gnathos directed ventrad; aedoeagus heavily sclerotized and deeply bifurcate at apex, vesica with many minute spinelike cornuti. Female genitalia with ostium bursae recessed in a membranous pouch located mesoventrally in center of abdominal segment eight; ductus bursae sclerotized on a short section adjacent to ostium bursae; ductus bursae arising just beyond sclerotized area.

KEY TO SPECIES OF *PODOSESIA*

1. Male genitalia with apex of saccus expanded laterally into somewhat pointed projections, often curving ventrally; flight period after June (mostly August) ..... *aureocincta* p. 107

— Male genitalia with apex of saccus rounded, truncated, or slightly concave, never expanded laterally into pointed processes; flight period before end of July (mostly April, May) ... *syringae* p. 106

Podosesia syringae (Harris) (Ash Borer*; Lilac Borer*; Perceur du Frene, m., Fr.; Perceur du Lilas, m., Fr.)
PL. 2, FIGS. 49, 50. TEXT FIGS. 29 *a, b*; 30 *a, b* (RWH 2589).

Aegeria syringae Harris, 1839, *Amer. Jour. Arts and Sci.,* **36**: 331.
Type locality: Massachusetts. [MCZ]
NOTE—See Purrington and Nielsen, 1987, for discussion on the rediscovery of Harris's sesiid types.

Grotea longipes Möschler, 1876, *Entomologische Zeitung zu Stettin,* **37**: 313.
Type locality: North America. [lost]

Trochilium fraxini Lugger, 1891, *Psyche,* **6**: 109.
Type locality: Not given (Minnesota). [unknown]

The ash borers are a complex of two species. *Podosesia syringae* is known from species of ash, lilac, and a few other species of the Oleaceae, whereas the sibling species, *aureocincta,* is known only from species of ash (Purrington and Nielsen, 1977). Male of typical *syringae*: Head with vertex silver gray, chaetosemata lining the posterior margin; front gray brown; occipital fringe orange red; labial palpus roughened, orange red, brown black ventrally; antenna dorsally brown black on one side, yellow orange on other side, orange ventrally with relatively

long cilia. Thorax brown black, strongly powdered red on tegulae, above wing bases, and posteriorly dorsad on mesothorax; yellow spot beneath forewing to collar, yellow laterally on posterior margin of metathorax. Abdomen constricted somewhat at base, with pale yellow or white laterally on segments one and two, and yellow laterally on segment four; anal tuft pointed. Legs with coxae brown black, forecoxa edged with yellow and orange; femora brown black, ventral edge clothed with long, silky, white scales; foreleg with tibia orange, tarsus yellow; midleg with tibia orange outside, yellow inside and brown black basally and apically, tarsus yellow; hindleg with tibia brown black outside except for yellow at spurs and inside with yellow on basal half, brown black on apical half, first tarsal segment very long, as long as elongate tibia, yellow with brown black on apical half, other tarsal segments yellow, much shorter, and tarsi evenly tufted laterally, extending slightly over tarsal claws. Forewing opaque except for hyaline areas at base; dorsally brown black with red basally on margins; ventrally mixed with white and yellow basally and on costal margin, variously powdered with red, strongest in apical area. Hindwing mostly hyaline, but with veins, fringe, and discal spot brown black and wing margin variously suffused with brown black, lightly powdered with orange; ventrally strongly powdered with orange on some veins and wing margin. Genitalia as illustrated. Female similar to male but without the noticeably constricted abdomen. Genitalia as illustrated. Wing length 10–17 mm.

Specimens of *syringae* toward the southern portion of its range have increasingly more rust red, especially on the thorax and abdominal segments two and three. A color form "*fraxini*" in the western portions of the range has much more orange and red on the wings, and the abdomen has the posterior edge yellow on all but the first segment, segment four entirely yellow, and segments five, six, seven, and anal tuft mostly rust red, and the hindtibia entirely pale yellow or orange. Variations between the two extreme color forms occur, especially in the Midwest.

Solomon (1975) summarized with appropriate references the known host information for *syringae,* which include most of the native genera of Oleaceae in eastern North America, *Fraxinus pennsylvanica* Marshall (green ash), *F. americana* Linnaeus (white ash), *F. nigra* Marshall (black ash, from our records), *F. caroliniana* Miller (Carolina ash), various European and red ashes, *Syringa vulgaris* Linnaeus (lilac), French hybrid lilac (Nielsen and Balderston, 1973), *Chionanthus virginicus* Linnaeus (fringetree) (Engelhardt, 1946). Engelhardt also mentions *Ligustrum* sp. (privet) as a host. Eichlin recently discovered the borer in ornamental plantings of olive, *Olea europaea* Linnaeus in Sacramento, California. Nielsen and Balderston (1973) and Solomon (1975) present details of the biology of *syringae.* Larvae occur generally in the branches or trunk, but heaviest infestations have been observed in the lower trunk. Adults emerge as early as February in north-central Florida with peak emergence in the South occurring in April and May; in the North in June, ending by the end of July. Records of adults taken later than July are generally referable to *aureocincta.* According to collection data from the Tampa area in south Florida supplied by L. Brown (personal communiction), *syringae* emerges as early as the first part of December until July, and *aureocincta* adults appear from July until early December, so that one of the two species is present anytime during the year. Eichlin, using sex attractants (mostly Z,Z-ODDA), discovered a heavy population of a very light colored morph of *syringae* in Sacramento County, which seems to be spreading to other counties in nursery stock. This California population is active in the adult stage from late March to the end of May.

The range of *syringae* is from Nova Scotia to Florida, west to eastern Alberta, Utah, Colorado, and central Texas, and with a population in central California. Recently, Eichlin identified a female that had been reared from a damaged limb of an ash in a public park in Yakima, Washington, the first record of the ash borer from that state.

Podosesia aureocincta Purrington and Nielsen (Banded Ash Clearwing*)
PL. 2, FIG. 48 (RWH 2588).

Podosesia aureocincta Purrington and Nielsen, 1977, *Ann. Ent. Soc. Amer.,* **70**: 906.
Type locality: Wooster, Wayne County, Ohio. [USNM]

Podosesia aureocincta closely resembles the dark, typical color form of *syringae.* Adults of both sexes of *aureocincta* have a distinctive orange-yellow band on abdominal segment four, which is absent on the dark morph of *syringae.* The egg of *aureocincta* is blackish, about 1.0 mm long and has shallow reticulate sculpturing on the surface, while, by contrast, *syringae* eggs are tan, about 0.7 mm long and with raised reticulate sculpturing on the surface. In the male genitalia of *aureocincta* the apex of the saccus

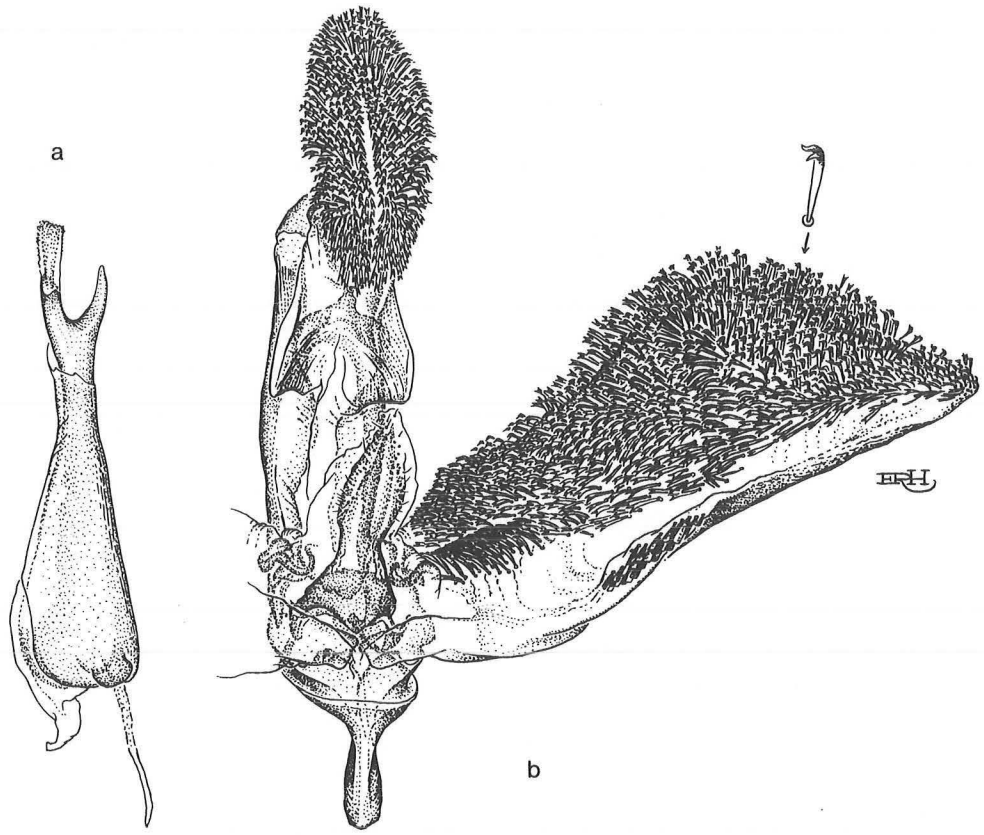

FIGURE 29: GENITALIA OF *PODOSESIA SYRINGAE*
a. Aedoeagus (USNM 75725). *b.* Male genitalia (left valve and aedoeagus omitted (USNM 75725).

is expanded laterally into somewhat pointed projections; but the apex of the saccus of *syringae* is usually rounded, truncated or slightly concave, never expanded laterally into pointed processes (Purrington and Nielsen, 1979). Adult flight period may occur anytime from July through December with the peak time after July for *aureocincta.*

To date, *aureocincta* is known only from *Fraxinus* spp. (ashes) (Oleaceae) (Purrington and Nielsen, 1977). Its life history is similar to that of *syringae* but differs basically in its later flight period and that males respond to a different mixture of attractant chemicals (blend of Z,Z:E,Z:Z,Z-ODDOH) (Nielsen and Purrington, 1978; Nielsen et al., 1979; Snow et al., 1985; Solomon, 1979). *Podosesia aureocincta* occurs from New York City, south to central Florida, and west to Indiana, Missouri (T. C. MacRae, personal communiction), and Texas.

GENUS
Sannina Walker

Sannina Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 63.

Type species: *Sannina uroceriformis* Walker, 1856. Original designation.

Sospita Hy. Edwards, 1882, *Papilio,* **2**: 57.
Type species: *Aegeria quinquecaudata* Ridings, 1862, now considered to be a junior synonym of *Sannina uroceriformis* Walker, 1856.

NOTE—*Sospita* Hy. Edwards, 1882, is a junior homonym of *Sospita* Rafinesque, 1815 in the Ctenophora, *Sospita* Reichenbach, 1853 in the Aves, *Sospita* Hewitson, 1860 in the Lepidoptera, and *Sospita* Stål, 1878 in the Orthoptera.

Phemonoe Hy. Edwards, 1882, *Papilio,* **2**: 97.

NOTE—Phemonoe is a replacement name for *Sospita* Hy. Edwards, 1882.

The single species of the genus is a root borer in persimmon. Based on comparative genital morphology, *Sannina* appears to be most similar to *Carmenta.* Characters of *Sannina* are: Male genitalia with crista sacculi of valva thickened distally, apex sharply curving to ventral margin of valva; and saccus about ⅓ length of valva, wide, slightly concave apically. As for species of *Carmenta,* female geni-

talia of *Sannina* with ductus bursae sclerotized for ⅔ length and ductus seminalis arising near corpus bursae. Head with minute second segment of maxillary palpus slightly pigmented and positioned laterally on larger first segment; third segment of labial palpus slightly more than ½ length of second segment; and haustellum greater than 2.5 length of labial palpus. Abdomen with long scale tufts (hair pencils) at tip: male with one short pair and one long pair of lateral tufts and one dorsomesial tuft; female with a short, rounded anal tuft and a pair of short, dorsolateral tufts.

MacKay (1968a) defined the genus in the larval stage by the conspicuous spinulation of the integument and the fusion of the V-1 pinacula on segments seven, eight, and nine.

Sannina uroceriformis Walker (Persimmon Borer*)

PL. 2, FIGS. 51, 52; PL. B, FIG. 6. TEXT FIG. 31 *a–d* (RWH 2590).

Sannina uroceriformis Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 64.
Type locality: United States. [BMNH]

Aegeria quinquecaudata Ridings, 1862, *Proc. Ent. Soc. Philadelphia,* **1**: 277.
Type locality: Middletown, Frederick County, Virginia. [unknown]

Saunina [sic] *uroceripennis* Boisduval, [1875], *in* Boisduval and Guenée, *Histoire Naturelle des Insectes: Spécies général des Lépidoptères Hêterocères,* **1**: 465.

NOTE—*Sannina uroceripennis* Boisduval, 1874 is an unnecessary replacement name for *Sannina uroceriformis* Walker, 1856.

Male: Head with vertex blue black, posterior margin naked with stiff, white chaetosemata thinly dispersed behind the ocelli; front blue black; occipital fringe blue black; labial palpus smooth, blue black, often lightly powdered with orange ventrally (Florida specimens with much orange mixed on vertex, occipital fringe and basal half of labial palpus); antenna blue black. Thorax blue black except for orange tegulae. Abdomen blue black, dorsally with segment four orange, sometimes extending onto segment five, and often with blue black medially (Florida specimens with some orange also on four ventrally; some Florida and Georgia specimens lack orange band); anal tuft with hair pencils as described for the genus. Legs blue black (Florida specimens

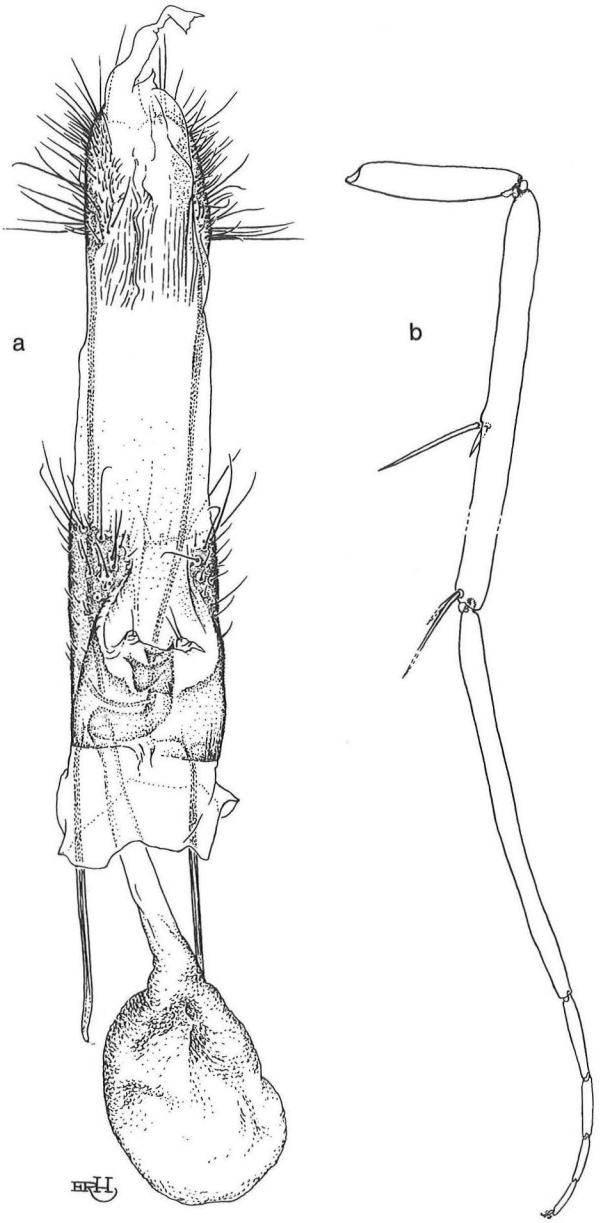

FIGURE 30: STRUCTURES OF *PODOSESIA SYRINGAE*
a. Female genitalia (USNM 75726). *b.* Male hindleg (scales removed) (USNM 75891).

with some orange at base of forecoxa). Forewing opaque, blue black. Hindwing blue black, opaque except basally between the veins. Genitalia with valva sharply pointed, dorsal half clothed with typical bifurcate scales, most thickly concentrated around the basal half of crista sacculi; crista sacculi clothed dorsally with thick, dark, pointed scales; crista gnathi of gnathos reduced; aedoeagus with eight or more thornlike spines on side of slightly swollen area on apical third, vesica with numerous minute cornuti,

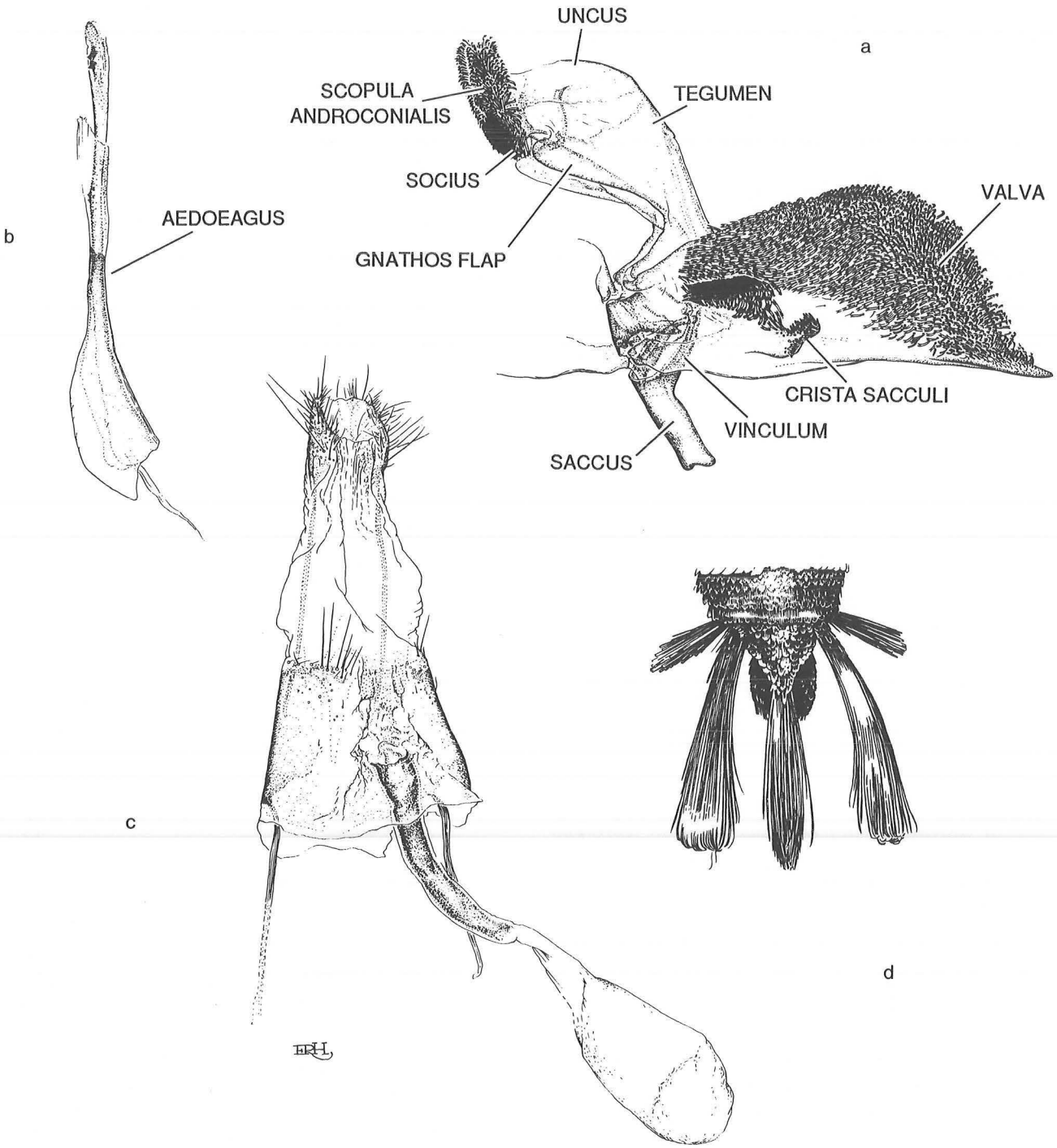

FIGURE 31: STRUCTURES OF *SANNINA UROCERIFORMIS*

a. Male genitalia (left valve and adeoeagus omitted) (USNM 75601). *b.* Aedoeagus (USNM 75601). *c.* Female genitalia (USNM 75602). *d.* Anal tufts.

one or more slightly larger than others. Female similar to male except for the short rounded anal tuft with only one pair of short hair pencils. Genitalia with area in which ostium bursae is situated uniquely somewhat sclerotized; ductus bursae heavily sclerotized on at least posterior ⅔ and slightly curving anteriorly; corpus bursae obovate and somewhat striate longitudinally. Wing length 12–17 mm.

The life cycle requires two years and occasionally three (Anderson, 1960). The eggs are dropped or placed near the base of the host, the larvae boring as far as 18 inches into the central root. The pupal cases, formed of frass and wood chips, extend out from the base of the tree, the pupa when disturbed dropping rapidly back into the larval burrow. Engelhardt (1946) states that this species closely resembles in movements and color patterns the pompilid wasp, *Lophopompilus atrox* (Dahlbom).

The distribution of *uroceriformis* is from New Jersey to Florida, and more commonly along the Gulf Coast and Mississippi Valley, extending west to Colorado, Montana, and western Texas. The western most records are outside the range of its only known host plant, *Diospyros virginiana* Linnaeus (common persimmon, Ebenaceae), which demonstrates the need for more detailed larval collecting. Adults fly in March to early May in the southern part of the range and in May and June elsewhere, except for specimens from Fort Davis, Texas, which were collected in August. In central Georgia, Snow et al. (1985) trapped several hundred males using specific sex attractants (mostly the 3,13 alcohols, E,Z-ODDOH and E,Z-ODDOH/Z,Z-ODDOH). Solomon et al. (1982) in Mississippi reported that a blend of the E,Z-ODDOH with Z,Z-ODDA (the acetate) (90:10) was twice as effective in attracting males of *uroceriformis* as was E,Z-ODDOH alone.

GENUS
Carmenta Hy. Edwards

> *Carmenta* Hy. Edwards, 1881, *Papilio,* **1**: 84. Type species: *Aegeria pyralidiformis* Walker, 1856. Original designation.

Our recent investigations of the neotropical fauna have revealed that the genus *Carmenta* and closely related genera contain a large portion of the sesiid species of that fauna. North of Mexico, *Carmenta* is represented by 30 species. Most species for which life histories are known have larvae that are borers in the stems and roots of herbaceous plants.

Carmenta is much like *Synanthedon* but differs in particulars of the genitalia as follows: Male with crista sacculi of valva downcurved to ventral margin, recurved toward base of valva in some species, this portion the only remaining part of the crista sacculi on some species; saccus more than ⅓ length of the valva; bend of the tegumen-uncus complex at approximately a right angle. Female with ductus bursae sclerotized on at least ½ its length for most species; ductus seminalis arising midway between posterior end and corpus bursae or nearer the latter in most species; most species without signum on corpus bursae as is also the case with *Synanthedon* species.

Based on genital features and similarities in behavior, *Carmenta* appears to be very closely related to the palearctic genus *Bembecia* Hübner, as used in the sense of Bradley et al. (1972) and Fibiger and Kristensen (1974).

Carmenta albociliata (Engelhardt)
PL. 3, FIGS. 43, 44. TEXT FIG. 32*a* (RWH 2591).

> *Synanthedon albociliata* Engelhardt, 1925, *Bull. Brooklyn Ent. Soc.,* **20**: 215.
> Type locality: Kerrville, Texas. [USNM]

Until recently, *albociliata* was known only from a small series of specimens from Kerr County, Texas. With the use of chemical attractants (Z,Z-ODDA) and attractants affixed to flight traps, the known range has been extended to the state of Nuevo Leon, Mexico (Sharp and Eichlin, 1979: 35).

Male: Head with vertex brown black, sometimes with some pale yellow laterally; front brown black; occipital fringe white; labial palpus smooth, white with brown dorsally and on third segment; antenna brown black. Thorax brown black with very narrow white subdorsal stripe; metathorax with white scale tufts laterally. Abdomen brown black with very narrow, white bands on posterior edge of segments two, four, six, and seven dorsally or bands absent; ventrally segments four, five, and six white; anal tuft elongate, narrow, brown black. Legs with forecoxa white with brown black mesially; femora brown black, white inside; mid- and hindlegs with tibiae brown black, white dorsally and apically, hindtibia roughened dorsally; hindtarsus light gray or white. Forewing mostly hyaline, brown black on margins, discal spot, and most veins, white on some apical veins; fringe white; ventrally with white more extensive on costal margin and veins. Hindwing hyaline, narrowly margined brown black, veins powdered white; fringe white. Genitalia with terminus of crista sacculi raised, recurved and not extending to ventral edge of valva, clothed with simple, pointed scales; lateral extensions of the juxta very long, extending to gnathos; saccus very long, over ⅔ length of valva; aedoeagus elongate, slender; vesica with several minute cornuti. Female differs from male as follows: Head with occipital fringe pale yellow dorsally, brown black laterally. Abdomen with segment

FIGURE 32: GENITALIA OF *CARMENTA* SPECIES

a. Right valve of *Carmenta albociliata* (USNM 75675). *b.* Right valve of *Carmenta anthracipennis* (USNM 76012). *c, d. Carmenta arizonae, c.* Right valve (USNM 75756); *d.* Female genitalia (abdominal segments omitted) (USNM 75757).

four dorsally broadly banded white on posterior half. Hindleg with tarsus brown black. Forewing with hyaline area much reduced, white on veins in remaining hyaline areas. Fringes of both pairs of wings brown black, not white. Genitalia somewhat atypical for species of *Carmenta,* having ductus bursae and ostium bursae membranous, slightly pigmented only at point of origin of ductus seminalis. Wing length 7–9 mm.

Host plants are unknown for *albociliata.*

Males from Mexico differ from the typical Texas specimens by having the occipital fringe brown black, slightly mixed with pale yellow dorsally; the fringe of the wings brown black, white only on hindwing toward the wing base; abdomen dorsally unbanded, some white laterally on anal tuft.

Specific records include: Kerrville, Kerr County, Texas; Speir Ranch, 3 miles north Uvalde, Uvalde County, Texas; 18 miles west of Linares, 2,700 feet elevation, Nuevo Leon, Mexico. Specimens have been collected in April, May, and June and in September and October, which may be an indication that *albociliata* is bivoltine.

Carmenta anthracipennis (Boisduval)
PL. 3, FIGS. 45–48. TEXT FIG. 32 *b* (RWH 2592).

Sesia anthracipennis Boisduval, [1875], *in* Boisduval and Guenée, *Histoire Naturelle des Insectes*: *Spécies général des Lépidoptères Hétérocères,* **1**: 392.
Type locality: Georgia. [USNM]

Carmenta sanborni Hy. Edwards, 1881, *Papilio,* **1**: 185.
Type locality: Andover, Massachusetts. [AMNH]

Aegeria morula Hy. Edwards, 1881, *Papilio,* **1**: 196.
Type locality: Texas. [USNM]

Male: Head with vertex, front and antenna brown black; occipital fringe golden yellow; labial palpus yellow with brown black on third segment. Thorax brown black with golden-yellow subdorsal stripe; golden-yellow spot beneath wing. Abdomen brown black; dorsally with narrow golden-yellow bands posteriorly on segments two, four, five, six, and seven; anal tuft brown black. Legs with forecoxa brown black mesially, golden yellow laterally; femora brown black, yellow mesially; tibiae brown black with some yellow medially outside, yellow inside; tarsi brown black dorsally, pale yellow ventrally, except first tarsal segment of hindleg, which is thickened and brown black. Forewing mostly opaque or entirely opaque, most often with small hyaline spot distad of discal spot and variously in cell, with some yellow powdering in hyaline areas, brown black dorsally; ventrally strongly powdered yellow on basal ⅔ and between veins in apical area. Hindwing mostly hyaline with brown black narrowly on margins, veins and fringe. Genitalia with terminal part of crista sacculi expanded and continued somewhat along ventral margin toward base of valva; valva broad, trapezoidal; vesica of aedoeagus with 12 or more short, stout cornuti. Female with forewing entirely opaque, with small yellow or white spot distad of discal spot; hindwing with margins more strongly diffused with brown black than male; legs entirely brown black except for yellow on forecoxa and at base of tibial spurs. Genitalia with ductus bursae ⅔ sclerotized, expanded in middle, at which point arises the ductus seminalis. Wing length 7–10 mm.

The form "*sanborni*" differs in the male by its more extensive hyaline areas on the forewing and yellow bands only on abdominal segments two, four, seven, and occasionally weakly indicated on six. Females of the form "*sanborni*" have abdominal banding only on segments two and four, often some yellow scales on segment six.

A very similar species, *pyralidiformis,* differs from *anthracipennis* by having only one or possibly two abdominal bands, and they apparently utilize different sex pheromones. The former is known only from *Eupatorium* spp. Otherwise, the two are sympatric in distribution and have similar genitalia.

Carmenta anthracipennis has been reared from species of *Liatris* Schreber (blazingstar) (Asteraceae) including: *L. punctata* Hooker and *L. scariosa* (Linnaeus) Willdenow. The larvae bore in the bulbous roots of plants in dry, sandy soil but not in swampy situations (Engelhardt, 1946: 48). Adults have been captured in late July and August but from September through October in the southernmost parts of its range. Some males have been captured using sex attractant baits (mostly Z,Z-ODDA, T. MacRae, personal communication; or Z,Z-ODDA/E,Z-ODDA 1:1, Snow et al., 1985).

The distribution of *anthracipennis* is based on scattered records from Massachusetts to Florida, west to Manitoba, Colorado, and Texas.

Carmenta apache Engelhardt
PL. 3, FIG. 49 (RWH 2593).

Carmenta apache Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 54.
Type locality: Prescott, Arizona. [UNNM]

Carmenta apache is one of several species of *Carmenta* known only from Arizona. Male: Head with vertex and antenna brown black; occipital fringe yellow dorsally, white lateroventrally; front brown black with white laterally; labial palpus yellow mixed with some brown black apically. Thorax brown black with wide, yellow subdorsal stripe; metathorax yellow; ventrally mostly pale yellow. Abdomen dorsally with yellow bands on posterior ½ of segments two, four, and six, band widest on fourth; anal tuft with some yellow laterally. Legs with forecoxa pale yellow, brown black mesially; femora brown black, often with some pale yellow; fore- and midtibiae mostly pale yellow with brown black apically, tufted pale yellow at spurs; hindtibia brown black with pale-yellow tufts at spurs; fore- and midtarsi mostly pale yellow with some brown black dorsally; hindtarsis brown black laterally, yellow around joints, pale yellow mesially. Forewing mostly hyaline; outer margin relatively broad, powdered yellow lightly between veins; discal spot thinly yellow on distal edge; yellow powdering stronger ventrally. Hindwing hyaline with very narrow margins, some yellow on costal edge; ventrally with yellow on anal margin and lightly on veins. Genitalia with valva comparatively narrow, pointed apically; saccus about ⅔ length of valva, slender. Female similar to male but with more yellow powdering on forewing and strong, yellow abdominal bands on segments two, four, five, and six. Genitalia with ductus bursae sclerotized for most of its length from ostium bursae, curving laterally,

mostly narrow but expanded just beyond origin of ductus seminalis, then membranous to rather large, oblong corpus bursae. Wing length 8–9 mm.

Nothing is known of the life history; one specimen had on its label the name *Acacia augusti* with no explanation, but this is an unlikely host plant. The moth may have been resting on the plant, feeding at flowers on the plant, or may utilize the plant as a host.

Adults of *apache* have been collected from July to early September in canyons near Prescott and several ranges in the southeastern portion of Arizona. It is known from fewer than 20 specimens.

Carmenta arizonae (Beutenmüller)
PL. 3, FIG. 50. TEXT FIG. 32 *c, d* (RWH 2594).

Sesia arizonae Beutenmüller, 1898, *Jour. New York Ent. Soc.,* **6**: 240.
Type locality: Summit of Mt. Union, 9,000 ft. [the summit is less than 8,000 ft. elevation], Arizona. [AMNH]

Carmenta arizonae is known from four females and one male. Male: Head with vertex brown black, mixed with some yellow anteriorly; front gray black with pale yellow laterally; occipital fringe yellow; labial palpus smooth, yellow; antenna brown black. Thorax mostly brown black with yellow orange beneath wings, yellow subdorsal stripe; metathorax yellow. Abdomen brown black with segments two–seven narrowly banded yellow, stronger banding on segments two, four, and six; anal tuft brown black with yellow. Legs with forecoxa mostly yellow, some brown black mesad; femora mostly brown black; tibiae yellow orange with brown black apically, tufts yellow orange; tarsi yellow orange except brown black laterally on hindlegs; all legs yellow orange mesially. Forewing mostly hyaline with costal margin and veins brown black, outer margin brown black, powdered orange between veins, anal margin orange, discal spot mostly orange with some brown black basally; ventrally with margins, discal spot, and most veins orange. Hindwing hyaline except for very narrow margins of brown black, orange on costal margin. Genitalia with valva elongate, tapered to rounded slightly downcurved apex; saccus comparatively thick, nearly ½ length of valva. Female like male except for more orange suffusion on forewing and abdomen; anal tuft short, yellow medially, brown black laterally. Genitalia with ductus bursae slender, somewhat sclerotized on posterior ⅔, anterior third curved laterad, expanded and sclerotized; ductus seminalis arises just posterior to expanded portion of ductus bursae; corpus bursae large, oblong. Wing length 7–9 mm.

The immature stages are unknown.

Adults apparently fly in July and August. At least two of the collection localities are above 6,000 feet elevation, and one specimen was collected on flowers of *Asclepias* sp. (milkweed).

Records for *arizonae* are from Mohave, Yavapai, and Cochise counties in Arizona.

Carmenta armasata (Druce)
PL. 2, FIGS. 53, 54 (RWH 2594.1).

Aegeria armasata Druce, 1892, *Ann. and Mag. Nat. Hist.,* (series 6) **9**: 275.
Type locality: Near Durango city, Mexico. [BMNH]

Male: Head with vertex mostly orange or orange and brown black mixed; front mostly or entirely white, perhaps mixed with some gray medially; occipital fringe orange; labial palpus thickened and roughened, orange, occasionally mixed with some brown black laterally; antenna orange on posterior side, brown black on anterior side. Thorax basically brown black but with subdorsal yellow stripe, much orange red powdered dorsally; metathorax yellow; mostly yellow beneath wing and yellow anteriorly at base of wing. Abdomen brown black with yellow bands on posterior part of all but segment three, bands somewhat broader ventrally, mixed with some orange red on anterior margin of yellow bands; anal tuft brown black mixed with pale yellow and orange red. Legs with forecoxa brown black with much orange laterally; femora mostly brown black; tibiae mostly orange but with brown black near apex; hindtibia with brown black dorsally and laterally on apical ½; tarsi orange except for first segment of hindtarsus, which is mostly brown black. Forewing mostly hyaline; narrow margins brown black with orange red between veins; discal spot orange red; ventrally with opaque areas orange. Hindwing hyaline with very narrow margins; small discal spot and veins powdered orange, much more so ventrally. Genitalia with valva having ventral ½ devoid of bifurcate scales; scopula androconialis short; saccus more than ½ length of valva. Female differs most noticeably by much broader outer margin of forewing and conspicuous orange red anal tuft. Wing length 13–16 mm.

The immature stages are unknown.

Carmenta armasata was not known from north of Mexico until a female specimen was collected by

R. O. Kendall, 26 October 1968, at San Antonio, Bexar County, Texas. In Mexico it has been collected at Nuevo Leon, 18 mi W Linares, 2,700′ elevation and near Durango city. Adults were collected in September and October.

Carmenta auritincta (Engelhardt)
PL. 3, FIGS. 51, 52 (RWH 2595).

Syanathedon auritincta Engelhardt, 1925, *Bull. Brooklyn Ent. Soc.*, **20**: 216.
Type locality: Baboquivari Mts., Pima County, Arizona. [USNM]

Male: Head with vertex brown black; occipital fringe yellow dorsally, white laterally; front mostly white with brown black dorsomedially; labial palpus pale yellow and white, often with brown black laterally and apically; antenna brown black with small preapical white spot. Thorax brown black; ventrally with yellow anteriorly and beneath forewing, becoming white posteriorly; collar brown black, yellow sublaterally; subdorsal yellow stripe; metathorax yellow. Abdomen brown black with narrow yellow bands on posterior margin of segments two, three, four, six, and seven dorsally; anal tuft with some pale yellow laterally; ventrally variously powdered white, strongest toward basal segments. Legs with forecoxa mostly white, perhaps slightly tinted pale yellow, some brown black mesially; femora brown black; fore- and midtibiae mostly white, hindtibia brown black with white to pale-yellow scale tufts at spurs; tarsi brown black, ringed with white at joints; legs mostly white mesially. Forewing mostly hyaline with margins, veins and discal spot brown black, thinly yellow on outer margin of discal spot; ventrally with yellow on costal and anal margins, on veins basad of cell, and lightly powdered yellow in apical area. Hindwing hyaline except for very narrow brown-black margins; pale yellow to white on fringe basad. Genitalia with distal part of crista sacculi projecting obliquely to ventral margin of valva, straight; saccus about ½ as long as valva; gnathos small; scopula androconialis longer than saccus. Female differs from male by the following: Antenna often without preapical white spot; legs with yellow replacing white of male; abdomen with all segments having at least a narrow posterior band of golden yellow, segments two, four, and six nearly solid yellow on well-marked specimens, anal tuft golden yellow with some brown black laterally. Genitalia with ductus bursae variously sclerotized on narrow posterior ⅔ which curves anteriorly, abruptly expanded and membraneous on anterior ⅓ to corpus bursae. Wing length 5–8 mm.

No host plants have been associated definitely with *auritincta.* This species is known from the mountains of Pima, Santa Cruz, and Cochise counties in Arizona and in Mexico from Sinaloa, south to Jalisco, Morelos, and Chiapas. Specimens have been collected in August and early September in Arizona and from July to October in Mexico. Some adults were taken in Malaise traps, some on the yellow flowers of an unidentified composite, and some were taken while sweeping *Lepidium* sp. (peppergrass) (Brassicaceae).

Carmenta bassiformis (Walker)
PL. 2, FIG. 55; PL. 3, FIGS. 53–55. TEXT FIG. 33 *a, b* (RWH 2596).

Aegeria bassiformis Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 39.
Type locality: United States. [BMNH]

Trochilium lustrans Grote, 1880, *Can. Ent.*, **12**: 213.
Type locality: Dayton, Ohio. [AMNH]

Aegeria aureopurpura Hy. Edwards, 1880, *Bull. Brooklyn Ent. Soc.*, **3**: 72.
Type locality: Dallas, Texas. [MCZ]

Aegeria bolli Hy. Edwards, 1881, *Papilio,* **1**: 191.
Type locality: Texas. [USNM]

Aegeria sexfasciata Hy. Edwards, 1881, *Papilio,* **1**: 193.
Type locality: Texas. [AMNH]

Aegeria consimilis Hy. Edwards, 1881, *Papilio,* **1**: 195.
Type locality: Long Island, New York. [AMNH]

Aegeria imitata Hy. Edwards, 1881, *Papilio,* **1**: 195.
Type locality: Pennsylvania. [USNM]

Carmenta bassiformis is widespread in the eastern half of the United States and common where it occurs, but local populations may be widely separated. As reported by Engelhardt (1946: 64), the adults tend to congregate at the flowers and on the foliage of the host plants, and will fly long distances to visit flowers.

Male: Head with vertex brown black; occipital fringe yellow; front brown black, white laterally; labial palpus smooth, yellow, occasionally with some

brown black apically; antenna brown black, with or without pale-yellow or white preapical spot. Thorax brown black with broad yellow area beneath wings, narrow subdorsal stripe; metathorax yellow. Abdomen brown black with all segments having narrow yellow band on posterior margin except five, which may have band faintly indicated; anal tuft with some yellow laterally; ventrally abdomen mostly yellow. Legs mesially and ventrally yellow; forecoxa yellow; femora brown black laterally; tibiae brown black laterally with yellow medially and apically, spurs pale yellow; tarsi mostly pale yellow with some brown black variously between joints dorsally and laterally. Forewing mostly hyaline but with relatively broad outer margin; margins and discal spot brown black, often variously powdered yellow between veins on outer margin; ventrally with more extensive yellow powdering on costal and outer margins. Hindwing hyaline with very narrow margins. Genitalia with valva elongate, narrow, bluntly pointed apically; crista sacculi thickly covered with bifurcate scales, recurved apically, abruptly raised to ventral margin and clothed with paler, short, simple scales; saccus nearly ½ as long as valva; gnathos small, somewhat pointed apically; base of soccii flared laterally; aedoeagus elongate, very narrow, vesica with at least 20 minute cornuti. Female similar to male but with antenna most often having pale yellow or white on apical ½–⅓; anal tuft mostly yellow with brown black basally, medially, and laterally. Genitalia with ductus bursae mostly sclerotized, narrow, curved anteriorly, with short, slightly expanded membranous section to corpus bursae. Wing length 6–12 mm.

The name "*bolli*" applies to females from the western part of the range, having the forewing more nearly opaque, varying to the extreme condition in which it is entirely opaque, and in some specimens the anal tuft is mostly brown black.

Carmenta bassiformis has been associated with *Vernonia crinita* Rafinesque, *V. noveboracensis* (Linnaeus) Willdenow (ironweed) and possibly *Eupatorium purpureum* Linnaeus (Joe-pye-weed) (Asteraceae). Engelhardt (1946: 64) reports that eggs are laid singly at the base of the host or on the foliage. Hatchling larvae enter the stems, eventually boring into the roots for the winter. They resume feeding in the spring and migrate back into the stems, girdling and causing the stems of the previous year's growth to break off several inches above ground level. These stumps contain the pupae during midsummer and can be collected at this time for rearing. Males respond to baits containing synthetic sex attractants (mostly blends of Z,Z-ODDA and Z,Z-ODDOH) (Neal and Eichlin, 1983; Sharp et al., 1978; Sharp and Eichin, 1979; Snow et al., 1985; Solomon et al., 1982).

The distribution of *bassiformis* is from Massachusetts and New York to Florida, west to Wisconsin, Kansas, and Texas. Adults fly in July to early September northward but as early as April through June in the southern and southwestern portions of the range.

Carmenta corni (Hy. Edwards)
PL. 2, FIG. 56; PL. 3, FIG. 56. TEXT FIG. 33 *c* (RWH 2597).

Aegeria corni Hy. Edwards, 1881, *Papilio,* **1**: 190.
Type locality: Purgatory Swamp, Massachusetts. [AMNH]

Aegeria infirma Hy. Edwards, 1881, *Papilio,* **1**: 195.
Type locality: Long Island, New York. [AMNH]

Male: Head with vertex brown black and orange mixed; occipital fringe orange; front pale yellow with some brown black medially, white laterally; labial palpus orange, slightly roughened ventrally and distally on second segment; antenna blue black with pale yellow on apical ⅓, absent on some specimens. Thorax dorsally brown black, strongly mixed with yellow orange; ventrally yellow; metathoracic tufts yellow. Abdomen dorsally brown black, variously powdered yellow on segments four, five, and six and often lightly powdered yellow on other segments; ventrally yellow; anal tuft dorsally brown black with orange medially, laterobasally, ventrally solid orange. Legs mostly yellow with brown black distally on tibiae and dorsolaterally between joints of tarsal segments. Forewing mostly hyaline but with broad, brown-black outer margin; broad, somewhat rectangular, brown-black to blue-black discal spot; costal margin brown black, strongly powdered yellow, yellow variously on all veins except apical area; ventrally with some yellow between veins in apical area. Hindwing hyaline with very narrow margins, costal margin yellow, fringe fuscous. Genitalia with crista sacculi abruptly arched apically, recurved, not extending to ventral margin of valva, clothed with many short, dark, simple scales; gnathos somewhat truncate apically; bases of soccii sclerotized, expanded laterally and downcurved; saccus more than ½ length of valva. Female much like male but with anal tuft entirely orange or orange red and some-

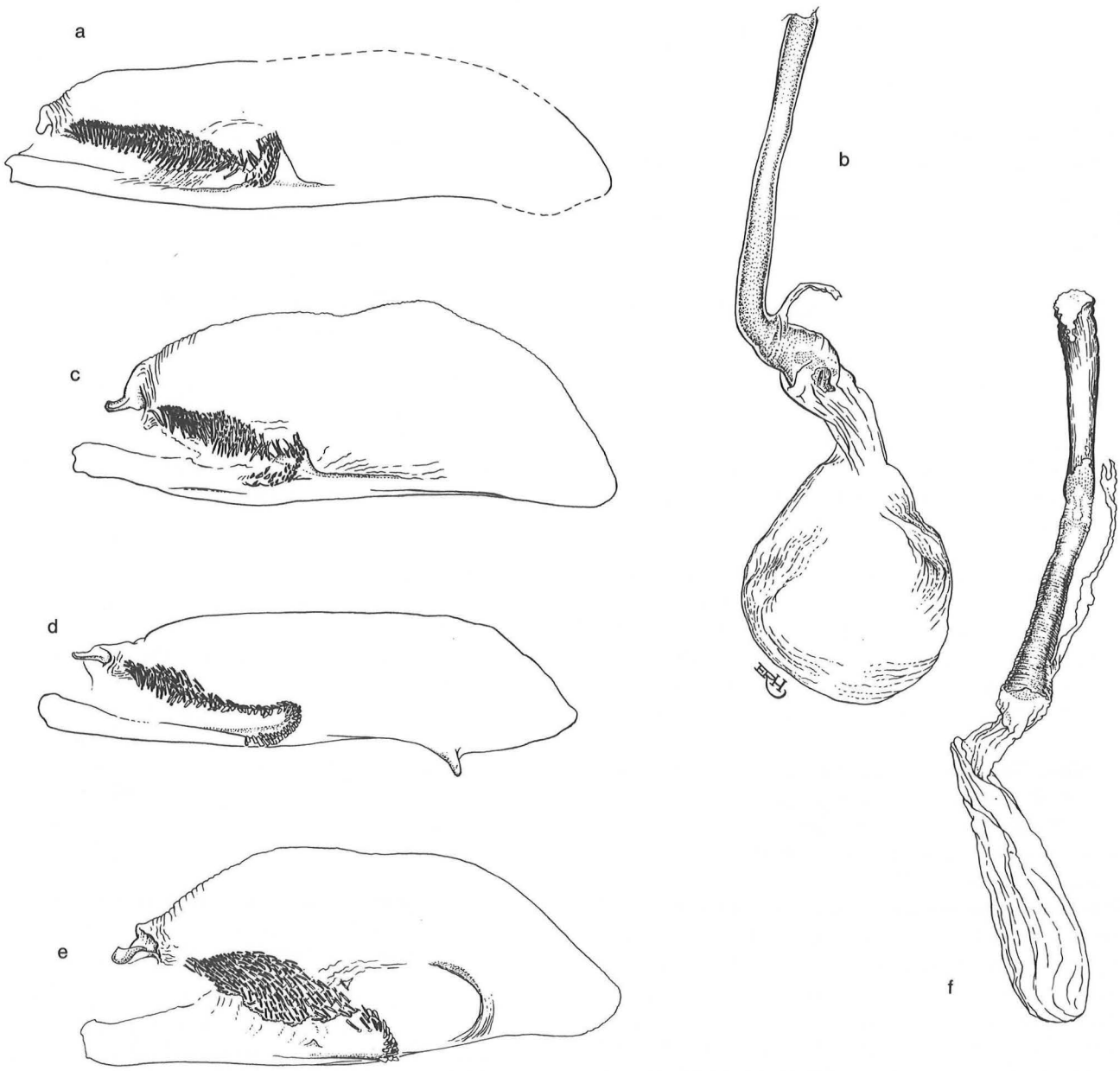

FIGURE 33: GENITALIA OF *CARMENTA* SPECIES

a, b. Carmenta bassiformis, a. Right valve (USNM 75667); *b.* Female genitalia (abdominal segments omitted) (USNM 76101). *c.* Right valve of *Carmenta corni* (USNM 75678). *d.* Right valve of *Carmenta engelhardti* (USNM 76114). *e, f. Carmenta giliae, e.* Right valve (USNM 75666); *f.* Female genitalia (abdominal segments omitted) (USNM 75665).

times with more yellow powdering on wings and abdomen. Genitalia similar to those of *bassiformis.* Wing length 6–11 mm.

Superficially, *corni* resembles *Synanthedon acerrubri,* a borer in maples, but the latter species has narrow, pale bands on some of the abdominal segments, very little, if any, orange on the vertex of the head, and little or no yellow powdering on veins just distal to the discal spot on the forewing.

The larvae are borers in the lower stems and roots of *Aster umbellatus* Miller (Asteraceae). The pupal chamber is prepared by enlarging the larval gallery in the lower stem, the exit hole being covered by thin layers of plant tissue. Pupation occurs in May, requiring two to three weeks for transformation to the adult. Apparently, the pupae are highly mobile, if need be, within the larval gallery, dropping down into the roots when disturbed (Engelhardt, 1946:

72). Adults fly from late May through July. The sex attractant Z,Z-ODDA was used as bait by T. C. MacRae in Missouri (personal communication) to capture *corni,* and the lure was placed in flight traps in New Hampshire by A. T. Eaton (personal communication), resulting in the capture of several males.

This species occurs from Nova Scotia to Alabama and west to Ontario, Wisconsin, Minnesota, and Missouri.

Carmenta engelhardti Duckworth and Eichlin

PL. 2, FIG. 57; PL 3, FIG. 57. TEXT FIG. 33 *d* (RWH 2598).

Carmenta engelhardti Duckworth and Eichlin, 1973, *Proc. Ent. Soc. Washington,* **75**: 158.
Type locality: Garden Canyon, 5,300 ft, Huachuca Mts., Cochise County, Arizona. [LACM]

Carmenta engelhardti superficially resembles several other species of *Carmenta,* which also occur in southern and southeastern Arizona. It should be separable on the basis of characters given in the key to species, but occasionally an examination of the genitalia may be necessary for positive identification.

Adult: Head with vertex and antenna brown black; occipital fringe yellow dorsally, white laterally; front gray black, white laterally; labial palpus smooth, white basally, brown black dorsolaterally on apical ½, pale yellow ventrally and mesially. Thorax brown black with narrow, subdorsal, yellow stripe; much yellow beneath wings. Abdomen brown black with narrow pale-yellow bands on posterior margin of segments two, four, six, and seven; ventrally usually with yellow only on segment four but occasionally also on five and six. Legs blue black with white on procoxa, at tibial spurs, around tarsal joints and mesially on all legs. Forewing mostly hyaline, margins and discal spot brown black, some yellow on outer margin between veins and in small patch on distal margin of discal spot; ventrally with yellow more extensive. Hindwing hyaline with very narrow margins; fringe fuscous, slightly tipped with white. Male genitalia with crista sacculi apically sharply recurved to ventral margin of valva; ventral edge of valva with small spinelike projection about ⅓ from apex. Female genitalia with ductus bursae only weakly sclerotized, expanded from origin of ductus seminalis to corpus bursae. Wing length 7–10 mm.

Soon after this species had been described, J. A. Powell, while collecting near Portal, Arizona, reported to us that he had seen some clearwing moths around a large malodorous shrub common in the area. We subseequently found the adult moths and successfully reared a female from a pupa located in the root of the shrub, later identified as *Brickellia rusbyi* Gray (Asteraceae). Eichlin returned to this same spot, South Fork crossing of Cave Creek, Cochise County, in late July 1987 and trapped several males using the following attractant bait: a mixture of the 3,13 compounds of Z,Z-ODDA/E,Z-ODDA/Z,Z-ODDOH in the ratio 20:1:3. Using this same bait, males were captured in other locations several miles apart.

Adults of *engelhardti* have been collected from the following counties in Arizona: Coconino, Pima, Santa Rita, Santa Cruz, and Cochise. It has also been taken in Hidalgo County, New Mexico. Adults fly from late July through August.

Carmenta giliae (Hy. Edwards)

PL. 2, FIGS. 58–60; PL. B, FIG. 7. TEXT FIG. 33 *e, f* (RWH 2599).

Aegeria giliae Hy. Edwards, 1881, *Papilio* **1**: 200.
Type locality: Colorado. [AMNH]

Albuna vitrina Neumoegen, 1891, *Ent. News,* **2**: 109.
Type locality: Fort Calgary, Northwest British Columbia. [USNM]

Aegeria deceptiva Beutenmüller, 1894, *Bull. Amer. Mus. Nat. Hist.,* **6**: 93.
Type locality: Colorado. [AMNH]

Carmenta giliae race *woodgatei* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 61.
Type locality: Fort Wingate, New Mexico. [USNM]

This polymorphic species inhabits the mid- to high elevations of the Rocky Mountains. A description of the male of the typical color form follows: Head with vertex brown black, occasionally mixed with some yellow; occipital fringe yellow; front mostly pale yellow with some brown black medially and white beneath scape; labial palpus strongly roughened, yellow with white mesially, long hairlike black scales lateroventrally on first and second segments, third segment smooth, yellow; antenna brown black. Thorax brown black, collar nearly blue black with yellow laterally; narrow yellow subdorsal stripe; large yellow area beneath wing; metathorax with yellow

tufts. Abdomen dorsally brown black but with broad yellow bands on segments two, four, six, and seven and narrow yellow bands on posterior margin of segments one, three, and five; ventrally yellow bands very wide; anal tuft brown black with yellow medially. Legs with coxae and femora brown black, strongly clothed with yellow hairlike scales laterally and ventrally; tibiae mostly yellow, hairy, with brown black toward apex and somewhat basally, tufts and spurs yellow; tarsi mostly yellow mixed with some brown scales. Forewing mostly hyaline with brown on narrow outer margin and costal margin, yellow or orange between Sc and R and lightly on veins and outer margin, discal spot orange with brown on basal edge, orange on anal margin; ventrally with veins and margins more strongly yellow. Hindwing hyaline except brown on very narrow margins, veins, and small discal spot, powdered with orange on margins at base of fringe; ventrally margins, veins, and discal spot yellow orange. Genitalia with valva wide, broadly rounded apically; crista sacculi densely covered with bifurcate scales with apex of crista gradually elevated, oblique to ventral margin of valva, then sharply recurved, clothed with pointed, black, simple scales; saccus nearly ⅔ length of valva. Female similar to male but without hairlike black scales on labial palpus; more orange on wings; and anal tuft brushlike, yellow. Genitalia with ductus bursae long, tubular, sclerotized except where divided in middle by short membranous area and short membranous section at entrance to corpus bursae. Wing length 8–13 mm.

Engelhardt (1946: 59) observed a female ovipositing on a species of wild *Geranium* (Geraniaceae) and found larvae in the roots on two separate occasions but was unable to rear any adults to verify the association. It remains for someone to collect infested root stock in early summer just prior to adult emergence to establish the host plant for *giliae.*

The color forms "*vitrina*" and "*woodgatei*" apply to specimens that are intermediates in an extremely variable species. A series of adults collected near Santa Fe, New Mexico contained specimens varying from the typical form to a form that is entirely black except for the front of the head. As evidenced by this sample of variably colored moths, the differences in maculation are not a consequence of altitude or latitude.

Carmenta giliae is known from northwestern British Columbia and Alberta to Arizona and New Mexico, usually at elevations above 4,000′ to 12,000′. Adults fly mainly in July and August, but some are taken in June or September.

Carmenta ithacae (Beutenmüller)
PL. 3, FIG. 58. TEXT FIG. 34 *a* (RWH 2600).

Sesia ithacae Beutenmüller, 1897, *Bull. Amer. Mus. Nat. Hist.,* **9**: 215.
Type locality: Ithaca, New York. [AMNH]

Aegeria koebelei Hy. Edwards, 1881, *Papilio,* **1**: 196. NEW SYNONYMY
Type locality: Tallahassee, Florida. [AMNH]

NOTE—Although the male holotype of *koebelei* is in poor condition, examination of the genitalia revealed that it is conspecific with *ithacae,* not *Synanthedon pyri.*

Adult: Head with vertex brown black; occipital fringe yellow; front gray black, white laterally; labial palpus smooth, yellow with brown black laterally and apically; antenna brown black with preapical white spot. Thorax with thin, yellow subdorsal stripe; some yellow beneath wings: yellow tufting on metathorax. Abdomen brown black, dorsally with very narrow pale-yellow bands on posterior edge of segments two, four, six, and seven, band on four encircling abdomen; ventrally variously powdered with pale yellow or white; anal tuft brown black, yellow laterally. Legs mostly brown black laterally with pale-yellow and white tufts at tibial spurs, some pale yellow on hindfemur and at joints of tarsi; forecoxa mostly white but tinted pale yellow, some brown black mesially. Forewing mostly hyaline with broad, brown-black outer margin, discal spot prominent, brown black, some yellow powdering apically and on costal margin; ventrally with margins and veins basad of discal spot yellow and variously powdered yellow between veins in apical area. Hindwing hyaline with very narrow brown-black margins. Male genitalia with crista sacculi at apex acutely recurved, terminating at ventral edge of valva; valva elongate, narrow, bluntly pointed apically; gnathos narrowed; scopula androconialis very long; saccus nearly ½ as long as valva. Female genitalia much like those of *bassiformis.* Wing length 6–8 mm.

The larvae have been reported as borers in the roots and lower parts of the stems of *Helenium autumnale* Linnaeus (sneezeweed) and *Heliopsis helianthoides* (Linnaeus) Sweet (Asteraceae) (Engelhardt, 1946: 68). Six specimens from Mexico (Nuevo Leon and Vera Cruz) were reared by A. S. McClay from *Parthenium hysterophorus* Linnaeus (Asteraceae). Males have been captured in traps baited with various sex attractants (mixtures containing mostly Z,Z-ODDA and small amounts of the E,Z isomer) in North Carolina, Wisconsin, Mississippi, and Texas.

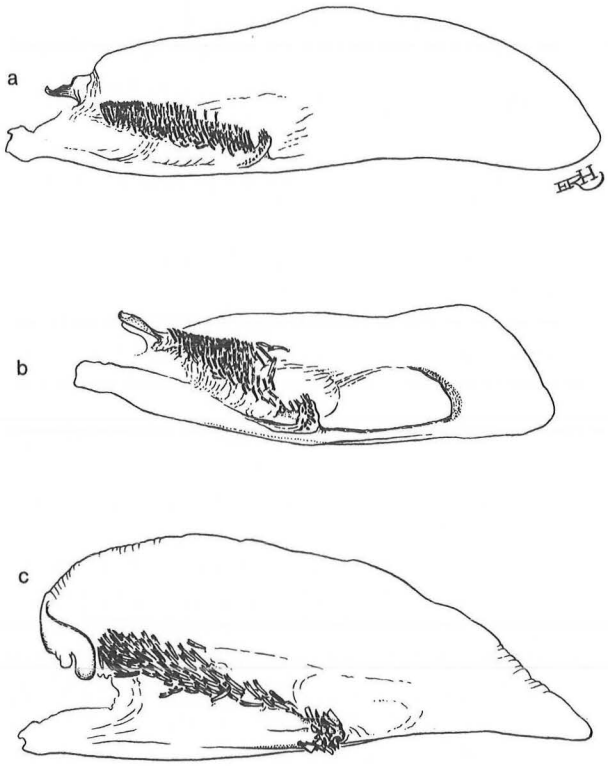

FIGURE 34: GENITALIA OF *CARMENTA* SPECIES

a. Right valve of *Carmenta ithacae* (USNM 75672). *b.* Right valve of *Carmenta querci* (USNM 75660). *c.* Right valve of *Carmenta mariona* (USNM 75637).

Much more collecting is needed to make sense of the distribution of what seems to be a wide-ranging species. Very scattered records are from New York to northern Florida, west to Manitoba, Wisconsin, and Mississippi. Additionally, it has been recorded from Kansas, Missouri, Texas, Colorado, New Mexico, Arizona, and eastern Mexico. Adults fly from June through mid-September.

Carmenta laurelae Brown, Eichlin, and Snow
PL. 2, FIG. 61.

Carmenta laurelae Brown, Eichlin, and Snow, 1985, *Jour. Lep. Soc.,* **39**: 262.
Type locality: Tampa, Florida. [USNM]

Carmenta laurelae was discovered as a result of studies utilizing sex attractants to survey for clearwing moths in the Tampa Bay area. Male: Head with vertex brown black; front brown black, white laterally; occipital fringe dorsally mixed brown black and yellow orange, yellow laterally; labial palpus smooth, brown black, orange yellow ventrally; antenna brown black powdered with some pale yellow dorsally. Thorax brown black with subdorsal orange-yellow stripe, orange yellow beneath wings. Legs brown black, dusted variously with yellow orange. Abdomen brown black, dorsally with narrow orange-yellow band on posterior margin of segment two, slightly broader band on segment four and very narrow band on segment seven; ventrally with narrow yellow-orange bands on posterior margin of segments four–seven; anal tuft squared off at tip, orange yellow on ends of lateral scales and on tip of abdomen ventrally. Forewing with apical region from discal spot outward opaque brown black, except for small hyaline area just distad of discal spot; ventrally powdered with orange yellow on costal margin and apically between veins. Hindwing hyaline. Genitalia typical for the genus but with saccus short, about ⅓ length of valva, apex bilobed. The female has not been collected. Wing length 9–10 mm.

The immature stages are unknown.

All specimens of *laurelae* were captured in sex attractant baited traps (Z,Z-ODDA) located in cypress swamps and adjacent floodplain forests in the Tampa Bay area (Brown et al., 1985b) and southern Georgia (K. Scarborough, personal communication). The males were most active around noon of each day during the flight period from mid-May to early June.

Carmenta mariona (Beutenmüller)
PL. 2, FIGS. 62, 63. TEXT FIG. 34 *c* (RWH 2601).

Sesia mariona Beutenmüller, 1900, *Jour. New York Ent. Soc.,* **8**: 254.
Type locality: Trimble Springs, Colorado. [USNM]

NOTE—*Sesia mariona* was correctly listed in the genus *Carmenta* (Duckworth and Eichlin, 1977c: 41) but should have been designated a "new combination" at that time.

This attractive and relatively rarely collected species is known from scattered locations in the Great Plains and Rocky Mountains. The broad, orange shoulder patches on the thorax of *mariona* distinguish it from all other North American sesiids with which it might be confused. Engelhardt's (1946) description (p. 31) and illustration (fig. 101) of the male is of an undescribed species, not *mariona.*

Male: Head with vertex brown black, yellow posteriorly; occipital fringe yellow dorsally, white laterally; front brown black; labial palpus somewhat flattened ventrally, white with some pale yellow,

brown black apically; antenna deep brown black. Thorax brown black with slight blue-green iridescence as on abdomen and legs; bright orange covering tegula and extending posteriorly over wing base; orange variously beneath wings. Abdomen brown black and slightly iridescent blue green. Legs with forecoxa mostly white; femora brown black, tibiae white laterally, brown black dorsally and ventrally, spurs white; hindtarsus white. Forewing opaque, brown black, slightly iridescent, with white streak in middle from center of cell, between M veins to outer margin; discal spot dull orange; posterior margin of wing orange. Hindwing mostly hyaline with brown-black, narrow margins; very narrow discal spot; fringe toward wing base white; ventrally with white on discal spot and some veins. Genitalia with crista sacculi apically a small, elevated, sharply recurved process, covered with simple scales; saccus relatively broad, more than ⅔ length of valva; scopula androconialis very short. Female differs from male by the following: Head with vertex pale yellow mixed with orange and some brown black, front mostly white. Legs with tibiae and tarsi brown black. Forewing opaque brown black, lacking white medially, ventrally with white on costal margin and in areas corresponding approximately to orange areas on dorsum. Hindwing usually entirely opaque, brown black. Genitalia with posterior ⅓ of ductus bursae heavily sclerotized, second ⅓ weakly sclerotized, anterior ⅓ expanded, membranous; ductus seminalis arising at point where membranous portion begins; corpus bursae with small, irregular, pigmented signum. Wing length 7–10 mm.

Larvae were found in the roots of a species of *Amsinckia* (Boraginaceae), and one adult was successfully reared from this plant from Oak Creek Canyon, Coconino County, Arizona (Engelhardt, 1946: 32). More recently (1983), adults were reared by G. Muenchow from pupae removed from tap roots of another boraginaceous plant, *Lithospermum incisum* Lehmann, emerging in April in Santa Cruz County, Arizona.

Individual records for *mariona* are from Nebraska, Kansas, Montana, Colorado, New Mexico, and Arizona. Specimens were taken in June, July, and early August.

Carmenta mimuli (Hy. Edwards)

PL. 3, FIG. 59. TEXT FIG. 36 *a–c* (RWH 2602).

Aegeria mimuli Hy. Edwards, 1881, *Papilio,* **1**: 200.
Type locality: Colorado. [AMNH]

Carmenta torrancia Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 56.
Type locality: Torrance County, New Mexico. [USNM]

Male (previously unknown): Head with vertex yellow orange, posterior margin with many long silky-white scales; occipital fringe dorsally brown black mixed with some white or pale yellow, laterally white; front white, some brown black ventrally; labial palpus strongly roughened, yellow orange ventrally, brown black on basal ½, white with yellow on distal half of second segment, third segment nearly as long as second, smooth, yellow orange; antenna yellow orange to near apex. Thorax brown black; collar yellow at least laterally; yellow subdorsal stripe on posterior half of mesothorax, mostly yellow beneath wings; metathorax yellow with white tufts laterally. Abdomen broadly banded yellow on all segments except one and three, which may have some yellow on posterior margin; ventrally mostly yellow except segment three, which is brown black; anal tuft yellow with brown black mediobasally and often laterally. Legs with coxae brown black, mixed with yellow and white laterally and distally; femora brown black; tibiae orange, brown black at base, hindtibia with some brown black distally, white medially; tarsi orange. Forewing mostly hyaline but with relatively wide outer margin brown black powdered with orange, discal spot orange, orange on veins near base and between veins Sc and R; ventrally, orange much more extensive. Hindwing hyaline with very narrow brown-black margins that are strongly powdered orange, especially on costal and anal margins; veins basally and narrow discal spot orange. Genitalia with scopula androconialis much reduced. Female differs from male by having labial palpus solid yellow orange; forecoxa solid yellow with white; forewing having more orange suffusions and occasionally more extensively opaque. Genitalia similar to those of *giliae* with ductus bursae having short membranous section in middle of elongate sclerotized portion. Wing length 8–11 mm.

Although adults have not been reared, specimen label data reveals that: A female was observed by M. Cazier in Cochise Co., Arizona, 1961, ovipositing on *Chamaesaracha coronopus* (Dunal) Gray (Solanaceae); and earlier, 1953, F. X. Williams observed several specimens of both sexes alighting only on *C. coronopus* in Mohave Co., Arizona. This plant is reported to occur on dry plains and mesas, 2,500–7,500 feet, from Kansas to Utah, south to northern Mexico. The hosts in Mexico are probably one or

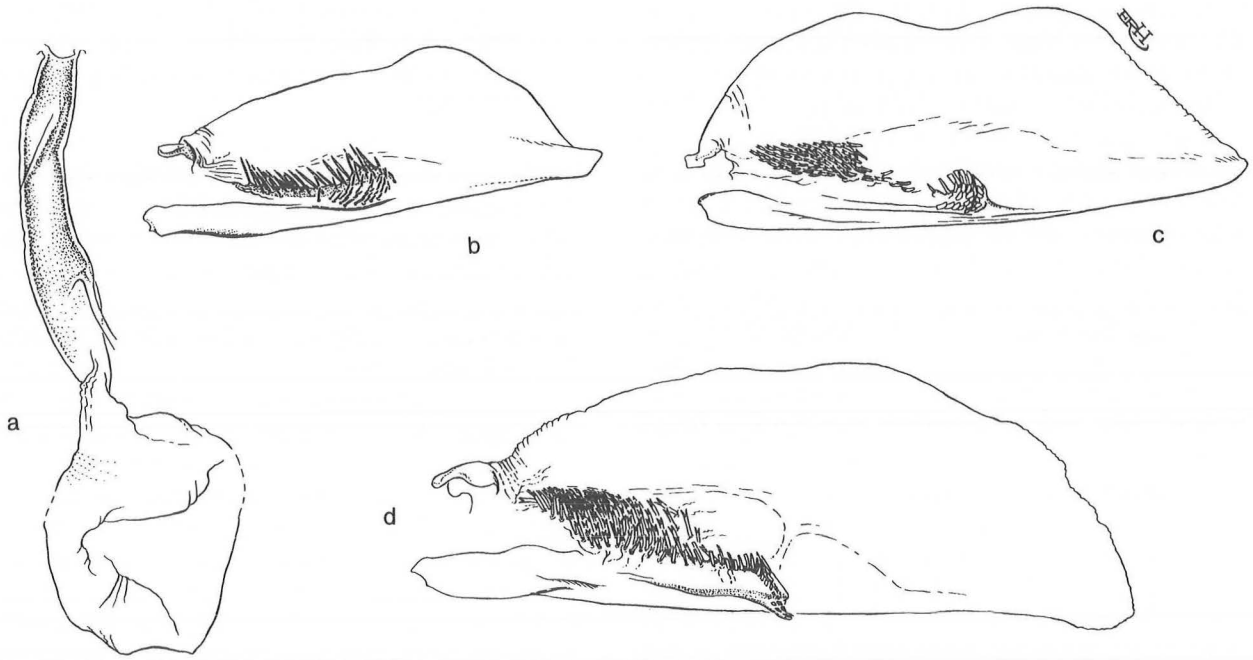

FIGURE 35: GENITALIA OF *CARMENTA* SPECIES

a. Female genitalia of *Carmenta pyralidiformis* (abdominal segments omitted) (USNM 75651). *b.* Right valve of *Carmenta subaerea* (USNM 76113). *c.* Right valve of *Carmenta suffusata* (AB[usck] 27 March 1939). *d.* Right valve of *Carmenta texana* (USNM 75670).

more of the several perennial solanaceous species found there.

Carmenta mimuli is related to *giliae,* based on similarities of their patterns and genitalia. The mostly orange hindtibia and orange antenna of *mimuli* will readily separate it from *giliae.* The most obvious character of the male genitalia for differentiating between the two species is the much reduced scopula androconialis of *mimuli.*

The range of *mimuli* extends from North Dakota, Montana, Utah, Colorado, and Missouri, south into Mexico as far as Oaxaca and around the southern and western margins of the Central Cordillera. Until recently very few specimens of *mimuli* were known. With the aid of sex attractants (mostly Z,Z-ODDA), many males of *mimuli* have been collected in Mexico, extending the range from eastern Chihuahua to Oaxaca, Jalisco, and Durango (Sharp and Eichlin, 1979). Adults have been collected in June through September.

Carmenta odda Duckworth and Eichlin
PL. 4, FIG. 13 (RWH 2603).

Carmenta odda Duckworth and Eichlin, 1977, *Jour. Lep. Soc.,* **31**: 195.
Type locality: Trenton, Edgefield County, South Carolina. [USNM]

The name *odda* was taken from the shorthand version of one of the major chemical components (Z,Z-3,13 octadecadien-l-ol acetate [Z,Z-ODDA]) of the sex attractants used as bait to capture this and numerous other species of Sesiidae, the data from which have contributed much to this study.

Adult: Head with vertex brown black mixed with yellow anteriorly; occipital fringe yellow; front brown black, white laterally; labial palpus roughened, yellow dorsally, brown black ventrally, mixed with some white; antenna brown black, powdered yellow dorsally. Thorax brown black with narrow yellow subdorsal stripe, mostly yellow beneath wings, and yellow on metathorax. Abdomen brown black but with all but segment three narrowly banded posteriorly with yellow, band widest on fourth; ventrally with segments one and two solid pale yellow, four banded yellow, others with some yellow on posterior margin. Legs with forecoxa brown black with yellow on lateral ½. Forewing mostly hyaline but opaque costal margin diffusely spreading apically to cover area to below M_1 at wing margin, basal ½ with wing powdered orange on veins and margins, outer ½ of discal spot yellow orange, yellow orange more extensive ventrally but apparently lacking powdering in apical area. Hindwing hyaline. Male genitalia with complex crista sacculi, which is unique among species

of North American Sesiidae (Duckworth and Eichlin, 1977a: 195, fig. 3); saccus about ⅓ length of valva. Wing length 9–10 mm.

The immature stages are unknown.

Recently, a female was netted; also, several males were trapped when responding to sex attractant baits in Florida and Georgia (Snow et al., 1985; Brown and Snow, 1986). The distribution of *odda* is South Carolina to Florida.

Carmenta ogalala Engelhardt
PL. 3, FIG. 60 (RWH 2604).

Carmenta ogalala Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 73.
Type locality: Durango, Colorado. [USNM]

NOTE—The male paratype from Graham County, Kansas has not been located. The female allotype from Jewel County, Kansas, a specimen in very poor condition, is *mariona,* based on examination of the genitalia.

Male: Head with vertex mixed brown black and yellow; occipital fringe pale yellow to white; front brown black and white; labial palpus smooth, white with brown black apically; antenna brown black. Thorax brown black with some blue-green iridescence; collar with orange laterally, blending into orange on tegulae, with orange extending posteriorly above base of wings; metathorax with white tufts laterally. Abdomen brown black with iridescent blue green, narrow white bands on posterior margin of segments four and seven, completely encircling four; ventrally, segments four through seven strongly powdered white; anal tuft brown black with some white laterally and laterally on genitalia. Legs mostly white with brown black on forecoxa mesially, on femora and ventrally on tibiae; tarsus of foreleg brown black, ringed with white at joints, other tarsi white with some brown black dorsoapically. Forewing opaque, brown black with orange streak in cell and spreading out distally to fill apical area between R_3 and M_3, orange posteriorly from CuA_2 to anal margin and from wing base to distal end of CuA_2; costal edge pale orange to pale yellow; ventrally with white in areas corresponding to areas of orange on dorsum. Hindwing mostly hyaline, with margins variously suffused with brown black, mixed with white on anal margin and some white on narrow discal spot; ventrally with white powdered on some veins, anal margin and outer margin. Genitalia differ from those of *mariona* only in the shape of the valva, not being strongly pointed as in the latter species. The female is unknown. Wing length 9–10 mm.

The immature stages are unknown.

Though resembling *mariona,* the male of *ogalala* differs by having white abdominal bands and much orange dorsally on the forewings.

Scattered records are from Wisconsin, Nebraska, and central and southwestern Colorado. Those from Nebraska tend to validate the Kansas paratype record. The few adults have been collected in June, July, and August, but nothing else is known of its habits.

Carmenta pallene (Druce)
PL. 3, FIG. 61 (RWH 2605).

Aegeria pallene Druce, 1889, *Ann. and Mag. Nat. Hist.,* (series 6) **4**: 80.
Type locality: Teapa, Tabasco, Mexico. [BMNH]

Male: Head with vertex brown black, yellow anteriorly; occipital fringe yellow, becoming white laterally; front brown black, white laterally, yellow medioventrally; labial palpus smooth, yellow with some brown black laterally and apically; antenna brown black with preapical white spot. Thorax brown black with very narrow yellow subdorsal stripe; mostly yellow beneath wings; metathorax yellow. Abdomen dorsally brown black, variously powdered yellow, narrowly banded on posterior edge of segments two, three, four, six, and seven, often on one; anal tuft brown black with yellow medially; ventrally mostly yellow. Legs with coxae mostly pale yellow; femora brown black; fore- and midtibiae mostly yellow, brown black near base and apex; hindtibia laterally brown black with yellow bands at spurs; yellow around joints of tarsal segments; mesially legs mostly yellow. Forewing mostly hyaline but with relatively broad, outer, brown-black margin, with yellow strongly between veins; other margins, veins and discal spot brown black with some yellow on distal edge of discal spot and extending slightly onto veins, some yellow on anal margin; ventrally with yellow powdering much more extensive. Hindwing hyaline with very narrow margins, costal margin mostly yellow. Genitalia with valva elongate, narrow; crista sacculi reduced to small recurved apical portion; saccus about ½ length of valva; gnathos small, crista gnathi much reduced; scopula androconialis very long. Female similar to male but with more yellow on the abdomen and wings; anal tuft brushlike, entirely yellow or yellow orange; abdominal segment four entirely yellow. As for some males, the yellow markings may be yellow orange. Genitalia with ductus bursae elongate, very

slender, posterior ½ sclerotized, anterior ½ membranous, abruptly expanded to corpus bursae, ductus seminalis arising from expanded portion. Wing length 6–9 mm.

No host plants are known for this species. The distribution of *pallene* extends from southeastern Arizona south to Sinaloa and Jalisco and southeast to Oaxaca and Tabasco, Mexico. The two male syntypes from Tabasco were collected in March and April; all other records are for August, October, and December. M. S. Wasbauer, utilizing flight traps baited with sex attractant (mostly Z,Z-ODDA), collected a few males of *pallene* near Portal, Arizona, August 1978, which represent the first records of this species north of Mexico.

Carmenta phoradendri Engelhardt (Mistletoe Borer)
PL. 2, FIG. 64; PL. 3, FIG. 64 (RWH 2606).

Carmenta phoradendri Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 51.
Type locality: San Antonio, Texas. [USNM]

Carmenta phoradendri and *tecta* are borers of mistletoe (*Phoradendron* spp.). Engelhardt reported *phoradendri* from Texas and *tecta* from Arizona, but *phoradendri* also occurs in Arizona.

Male: Head with vertex and antenna brown black; occipital fringe yellow dorsally, white laterally; front brown black, white laterally; labial palpus smooth, white with brown black laterally. Thorax brown black with narrow subdorsal stripe and much yellow beneath wing; metathorax with pale-yellow tufts. Abdomen brown black, dorsally with narrow yellow bands on posterior margin of segments two, three, four, five, and six; ventrally broadly banded on four, five, and six; anal tuft relatively broad, quadrate apically, with pale-yellow or white-tipped scales laterally. Legs mostly brown black powdered with white on forecoxa, pale yellow or white on tibiae lateromedially and distally, and pale yellow or white on tarsi at joints and ventrally. Forewing mostly hyaline, somewhat pointed apically, powdered with yellow between veins on outer margin and distally on discal spot, yellow powdering stronger ventrally. Hindwing hyaline, with very narrow brown black margins, powdered yellow on costal margin dorsally and ventrally. Genitalia with valva elongate, narrow, broadly rounded apically; terminal area of crista sacculi a short ridge, curving to ventral edge of valva, clothed with pointed, simple scales, terminal portion separated by denuded area from basal portion of crista sacculi, which is densely clothed with typical bifurcate scales; saccus more than ⅓ length of valva; scopula androconialis very long, over ½ length of valva; gnathos with lateral plates projecting ventrally. Female similar to male but with abdomen dorsally narrowly banded yellow on segments two, four, and six and often faintly indicated on three, ventrally pale yellow or white on most of segments four, five, and six; anal tuft brushlike, rounded apically, white laterally; forewing with outer margin somewhat broader, more suffuse, with more yellow on costal and outer margins and discal spot. Wing length 6–9 mm.

Larvae bore in the basal swellings of the branches and in the heavier portions of the main stems of *Phoradendron flavescens* (Pursh) Nuttall (mistletoe) (Loranthaceae) growing on *Prosopis glandulosa* Torrey (mesquite) (Fabaceae) (Englehardt, 1946: 52). Pupation occurs in silk-lined cocoons near the exit hole of the larval burrow. Reared material emerged in April, May, and June; but field-collected adults were captured in August and September. Engelhardt (1946: 53), while discussing the habits of *tecta,* mentioned that he had observed larvae in mistletoe growing on *Celtis* sp. (Ulmaceae) in the Santa Rita Mountains in Arizona but was unable to rear adults. This mistletoe may prove to be the host for *phoradendri* known from that area.

Carmenta phoradendri resembles *tecta,* but *tecta* lacks pointed forewings; lacks the broad anal tuft in the male; has a mostly yellow anal tuft in the female; both sexes have a very narrow yellow band on abdominal segment one dorsally that is not present on *phoradendri*; the labial palpus is mostly yellow with brown; and the coxa of the foreleg is mostly yellow.

Carmenta phoradendri is known from south-central Texas and southeastern Arizona.

Carmenta prosopis (Hy. Edwards)
PL. 4, FIGS. 10, 11 (RWH 2607).

Aegeria prosopis Hy. Edwards, 1882, *Papilio,* **2**: 99.
Type locality: Fort Grant, Arizona. [AMNH]

As the name implies this species is associated with *Prosopis* spp. (mesquites) (Fabaceae). Though relatively small, the adults are fairly common in collections, a result, in large part, of the abundance of host plants in the desert Southwest.

Male: Head with vertex and front brown black; occipital fringe brown black mixed with some white; labial palpus only slightly roughened ventrally, white with brown black dorso- and lateroapically; antenna brown black, more strongly clavate than most *Car-*

menta species. Thorax and abdomen brown black, except for narrow white band dorsally on posterior margin of segment two and some pale yellow or white laterally on anal tuft. Legs brown black with forecoxa white; tibiae banded white medially and apically; white around joints of tarsi. Wings mostly hyaline but with transparent scales creating whitish reflection; outer margin narrow, brown black often with some scattered white scales; costal margin and discal spot brown black; ventrally powdered with pale yellow and white. Hindwing hyaline with very narrow margins; fringe becoming white toward wing base. Genitalia with terminal portion of crista sacculi sharply recurved to ventral margin of valva; saccus about ½ length of valva; gnathos comparatively small; scopula androconialis short with bases strongly flared laterally. Female much like male except for broader margins and discal spot on forewing and brushlike anal tuft. Genitalia with long, slender, sclerotized part of ductus bursae gradually curving. Wing length 5–8 mm.

Many adults have been reared from galls on mesquite caused by species of the hymenopterous family Encyrtidae [NOTE—Engelhardt (1946: 77), when referring to these rearings, wrote of the ". . . small woody galls of the encyrtid genus *Tanaostigmodes* Ashmead . . . ," which, according to Krombein et al., 1979, *Catalog of Hymenoptera in America North of Mexico,* **1**: 875, is a genus of Eucharitidae, containing only ant parasites.] In addition, specimens have been reared from stem galls on *Mimosa biuncifera* Benth. in Texas (Engelhardt, 1936: 51) and Arizona. The life-cycle of *prosopis* has yet to be documented.

Carmenta prosopis occurs from western Texas, New Mexico, and southern Arizona south into Mexico in Sonora, Chihuahua, and Durango. Most adults were collected in June, July, and August but may appear as early as April and as late as November, according to specimen label data.

Carmenta pyralidiformis (Walker)
PL. 3, FIGS. 65, 66. TEXT FIG. 35 *a* (RWH 2608).

Aegeria pyralidiformis Walker, 1856, *List of the Specimens of Lepidopterous Insects in the Collection of the British Museum,* **8**: 44.
Type locality: United States. [BMNH]

Sesia nigella Hulst, 1881, *Bull. Brooklyn Ent. Soc.* **3**: 75.
Type locality: Fairport, Western New York. [AMNH]

Carmenta pyralidiformis variety *aurantis* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 47.
Type locality: Mobile, Alabama. [USNM]

Carmenta pyralidiformis is basically an eastern North American species, very similar to *anthracipennis* in most respects. Male: Head with vertex, front and antenna brown black; occipital fringe yellow; labial palpus smooth, yellow. Thorax brown black with narrow, subdorsal yellow stripe and much yellow beneath wings. Abdomen brown black, dorsally with two yellow bands, a wide band on segment four and a narrow band on posterior margin of segment seven. Legs laterally brown black except for some pale yellow on forecoxa, distal four segments of tarsi and scale tufts at spurs of tibiae; mesially legs mostly pale yellow, some yellow dorsally on hindtibia basally. Forewing brown black, opaque, though often with small hyaline spot both before and beyond discal spot with a few pale-yellow scales in these spots; ventrally with much yellow mostly basad of discal spot. Hindwing hyaline with very narrow margins. Genitalia very similar to those of *anthracipennis.* Female similar to male except abdomen has only one yellow band, a broad band on segment four; anal tuft consists of short lateral tufts; outer margin of hindwing usually broader. Genitalia similar to those of *anthracipennis.* Wing length 5–8 mm. The color form "*aurantis*" differs only by the yellow of the typical form being replaced by orange.

The known host plants include *Eupatorium album* Linnaeus, *E. perfoliatum* Linnaeus, *E. sessilifolium* Linnaeus (Engelhardt, 1946: 46), and according to the label data on two specimens from Missouri, "from roots of ironweed," (*Vernonia* sp.?) (Asteraceae). The larva bores in the roots but prepares a pupal chamber and exit hole near the base of the stem of the host plant prior to pupation, which usually occurs around July. The adults appear from late June through September. Males have been captured using sex attractants for bait (mostly E,Z-ODDOH or Z,Z-ODDA, Solomon et al., 1982; and K. Scarborough, personal communication).

Carmenta pyralidiformis occurs from eastern Canada, south to northern Florida, and west to Michigan and eastern Texas.

The form "*aurantis*" occurs in the southern portion of the range along the Gulf Coast, north along the Atlantic Coast to South Carolina. Adults of *pyralidiformis* and *anthracipennis* can be separated by the number of yellow bands on the abdomen: *pyralidiformis* has one or two, and *anthracipennis* has four or five.

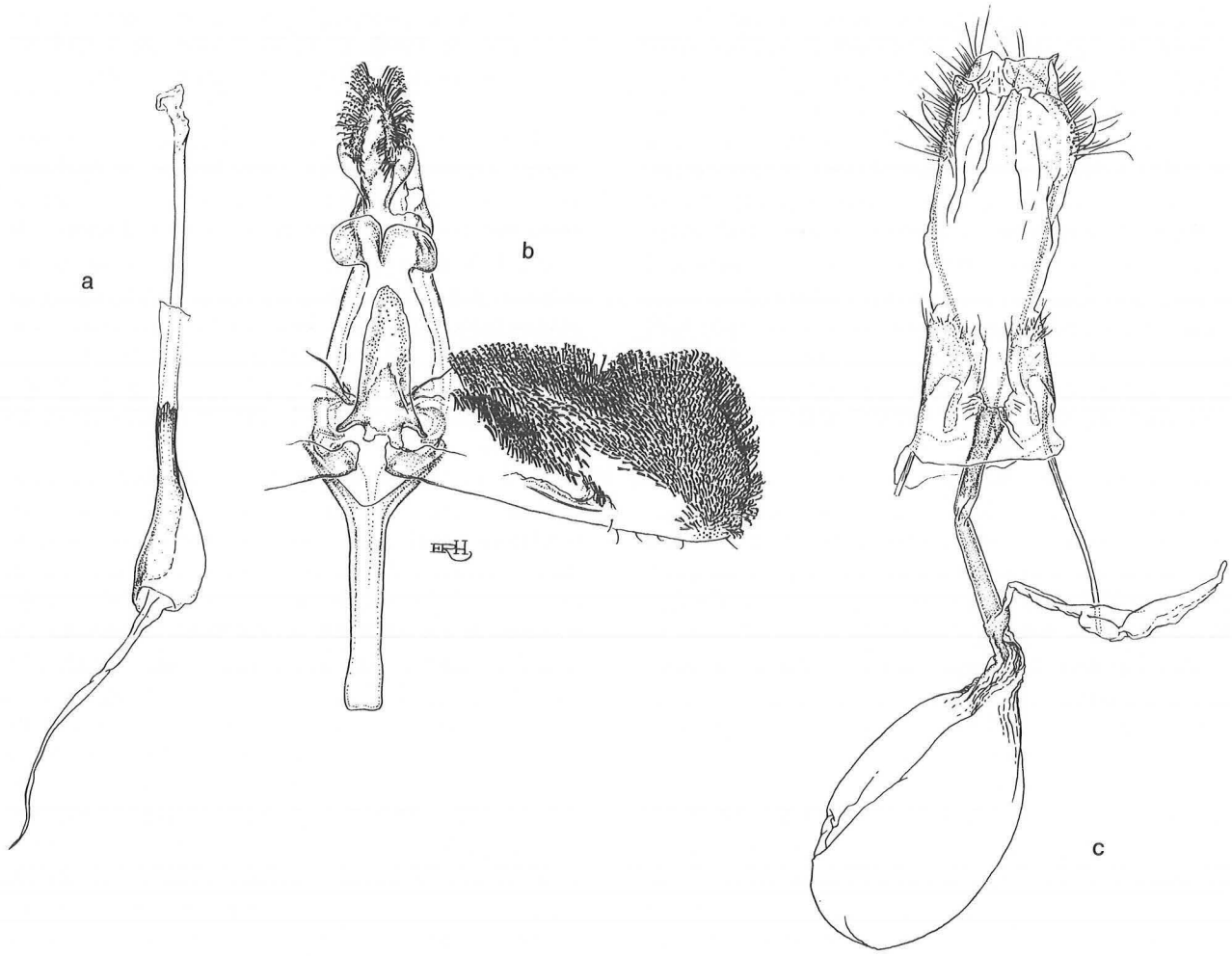

FIGURE 36: GENITALIA OF *CARMENTA MIMULI*

a. Aedoeagus (USNM 76111). *b.* Male genitalia (left valve and aedoeagus omitted) (USNM 76111). *c.* Female genitalia (USNM 76110).

Carmenta querci (Hy. Edwards)
PL. 3, FIG. 67. TEXT FIG. 34 *b* (RWH 2609).

Aegeria querci Hy. Edwards, 1882, *Papilio,* **2**: 98.
Type locality: Fort Grant, Arizona. [USNM]

Podosesia comes Heinrich, 1920, *Proc. U. S. Natl. Mus.,* **57**: 79.
Type locality: Bush Corral, Arizona. [USNM]

Male: Head with vertex brown black; occipital fringe yellow dorsally, white laterally; front brown with some pale yellow and white dorsally and ventrally; labial palpus strongly roughened, brown black with white or pale yellow dorsally and mesially, mixed with white laterally and ventrally; antenna short, approximately ½ length of forewing, strongly clavate, with yellow orange on posterior margin. Thorax brown black with yellow beneath wings, yellow stripe above wing on posterior ½ of mesothorax; metathorax yellow dorsally. Abdomen brown black, dorsally with wide yellow band on segment four encircling abdomen, narrow yellow bands on posterior margin of segments two, three, six, and seven; anal tuft brown black with yellow tipped with white posteriorly. Legs brown black except for yellow on mesial and lateral margins of forecoxa; pale yellow or white on tarsi, mostly mesially and ventrally; pale yellow on tufts at spurs and mesially on hindtibia. Forewing mostly hyaline with very narrow outer margin; veins often strongly powdered yellow orange; discal spot narrow, yellow orange; powdered yellow orange between veins on outer margin. Hindwing hyaline with orange on costal margin; fringe white at wing base. Genitalia with distal end

of crista sacculi recurved to ventral edge of valva, beyond which is a large, well-defined, concave area devoid of scales; saccus about ½ length of valva and subequal in length to scopula androconialis. Female much like male but with anal tuft brushlike, solid yellow; often with more yellow orange between veins on outer margin of forewing. Genitalia with ductus bursae sclerotized only on posterior ¼, membranous, expanded and irregularly shaped anteriorly; corpus bursae with small, poorly defined signum, consisting of a very lightly pigmented, granulose area. Wing length 5–8 mm.

Carmenta querci superficially resembles several other clearwing species from the same area but can be separated on the combination of shortened antenna with yellow orange on posterior surface and strongly roughened labial palpus. Adults have been reared from spongy cynipid (Hymenoptera) galls on *Quercus arizonica* Sargent and *Q. oblongifolia* Torrey (Fagaceae) (Engelhardt, 1946: 56), but nothing else is recorded pertaining to their biology. Specimens examined were captured or reared in February, March, May, July, and August.

Carmenta querci is known only from the following counties in Arizona: Mohave, Pima, Cochise, and Pinal.

Carmenta rubricincta (Beutenmüller)
PL. 3, FIG. 68 (RWH 2610).

Sesia rubricincta Beutenmüller, 1909, *Ent. News,* **20**: 84.
Type locality: Palmerlee, Cochise County, Arizona. [USNM]

The male of *rubricincta* is described for the first time as follows: Head with vertex brown black; occipital fringe yellow orange; front brown black with some white lateroventrally; labial palpus smooth, yellow orange, black apically; antenna blue black with preapical white spots. Thorax brown black with narrow orange band above wing on posterior ½ of mesothorax; mostly orange beneath wings; metathorax with orange red laterally. Abdomen brown black dorsally, orange red covering segment four and most of segments six and seven; laterally and ventrally mostly orange red; anal tuft orange red, brown black dorsolaterally and basally. Legs brown black, pale yellow mesially; pale yellow on forecoxa, tufts at spurs of tibiae, and around joints of tarsal segments. Forewing largely opaque except for hyaline areas in cell, anal region, and just distad of discal spot; mostly brown black but with much orange red on discal spot, wing base, and between veins in broad apical area. Hindwing hyaline with narrow brown-black margins, powdered orange red on margins ventrally. Genitalia with crista sacculi at apex nearly straight, oblique to ventral edge of valva; saccus elongate, about ¾ length of valva, relatively thick; gnathos small but fully developed with crista gnathi present; scopula androconialis short, about ½ length of saccus; aedoeagus elongate, slender, with several minute cornuti on vesica. Female similar to male but with forewing more nearly opaque. Genitalia with ductus bursae elongate, slender, mostly sclerotized, expanded near corpus bursae; ductus seminalis arising from area where ductus bursae expands; corpus bursae small, ovate, lacking signum. Wing length 6–8 mm.

No hosts are known for *rubricincta.*

Until recently this species was known only from the holotype female. In 1974 with T. Friedlander, we collected three males resting on a small oak. M. S. Wasbauer captured five more males in flight traps in 1978. These eight specimens were from Cochise County, Arizona. In addition, specimens have been taken from locations in Durango, Mexico; and J. Powell, J. Chemsak, and T. Friedlander in 1976 captured two males and one female in the vicinity of Iturbide, Nuevo Leon, Mexico, one of which was caught in flight around a small oak. Specimens were collected from late July to September. All were taken at elevations ranging from 5,400–7,000 feet. The distribution apparently follows a common pattern for sesiids in this area, which is along the escarpment surrounding the Central Plateau of Mexico and into southeastern Arizona.

Carmenta subaerea (Hy. Edwards)
PL. 4, FIG. 12. TEXT FIG. 35 *b* (RWH 2611).

Pyrrhotaenia subaerea Hy. Edwards, 1883, *Papilio,* **3**: 156.
Type locality: Arizona. [USNM]

This is a small, brown, rarely collected species. Male: Head with vertex brown; occipital fringe brown or mixed with pale yellow; front brown with some white lateroventrally; labial palpus white with brown apically; antenna dark brown with preapical pale-yellow or white spots. Thorax brown, perhaps with some pale yellow laterally on collar. Abdomen brown, banding if present, not distinguishable on specimens examined; anal tuft brown with white laterally and ventrally. Legs brown with pale yellow or white mesially, on forecoxa laterally, on tibial spurs and tufts, and at joints of tarsal segments. Forewing opaque, brown, weakly powdered pale

yellow. Hindwing mostly opaque, brown but with hyaline region basad between vein CuA and anal fold. Genitalia with crista sacculi well defined as on some species of *Synanthedon* but with poorly defined distal portion, composed of an area of simple, spinelike scales; saccus about ½ length of valva; gnathos a typical platelike structure but uniquely with crista gnathi flaring laterally, producing second platelike structure ventrad of first. Female, here described for the first time, is like the male and differs by abdomen having white laterally on segments one and two and a slight indication of a narrow white band on posterior margin of segment four laterally. Genitalia not typical for species of *Carmenta*: Posterior part of ductus bursae a long, narrow, sclerotized, funnel-shaped section, which is on a broad, flat, sclerotized, ventral plate, following part an elongate, narrow, smoothly sclerotized tube, as found on most *Carmenta* species, becoming membranous before entering corpus bursae; ductus seminalis arises at point where narrow tube connects to posterior funnellike section; corpus bursae somewhat egg shaped, oblique to ductus bursae. Wing length 5–7 mm.

The immature stages are unknown.

Based on the genitalia, *subaerea* appears to have some characters typical of *Synanthedon* and some typical of *Carmenta.* Its placement in *Carmenta* is tentative, and eventually it may need to be placed in a genus of its own. Superficially, *subaerea* closely resembles *suffusata,* but the former differs by the presence of preapical white spots on the antennae and the lack of white ventrally on the abdomen.

Carmenta subaerea is known from three males collected near Portal, Cochise County, Arizona, in early July, and a female from 6 mi N Alma, 5,000 ft, San Francisco River, Catron County, New Mexico, 13 July. The holotype has no further information than "Arizona."

Carmenta suffusata Engelhardt
PL. 3, FIG. 69. TEXT FIG. 35 *c* (RWH 2612).

Carmenta suffusata Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 74.
Type locality: McAlester, Pittsburg County, Oklahoma. [USNM]

Carmenta suffusata is a small, brown moth, known from few specimens. Male: Head with vertex mostly straw colored with brown medially; occipital fringe straw colored; front brown; labial palpus smooth, white with brown apically; antenna brown. Thorax brown with pale yellow and white beneath wings and in narrow band above wings on posterior ½ of mesothorax. Abdomen brown, dorsally with narrow white band on posterior margin of segment four; ventrally solid white on all but segments two and three. Legs mostly brown but with forecoxa white, variously white on all legs mesially, and white on tufts at tibial spurs. Forewing opaque, brown, weakly powdered white. Hindwing mostly opaque with small hyaline area basally, brown. Genitalia with valva pointed apically; crista sacculi with distal portion a small, sharply recurved ridge; saccus at least ⅔ length of valva. Female is like male but with hindwing entirely opaque. We were unable to locate the female paratype from Wallace County, Kansas. The other female paratype from Comanche, Oklahoma lacked the abdomen; therefore, the female genitalia of *suffusata* remain to be examined. Wing length 6–8 mm.

Though the type was labeled "bred from root" no plant name was given, and nothing is known of the life history of the species. J. R. Heitzman (personal communication) collected one male of *suffusata* in early June in Barber County, Kansas. He described the area as ". . . a beautiful prairie region." In the area were scattered, very small dwarf plum trees, on the leaves of which he had noticed a few other adults of the moth. Eichlin captured a specimen in June 1984, 20 mi NE of Uvalde, Texas. Sharp et al. (1978) and Sharp and Eichlin (1979) reported capturing three males in attractant (E,Z-ODDOH alone and as 1:1 mixture with Z,Z-ODDA) baited traps in Marion County, Florida in early June 1976 and 1978. The reared specimen emerged in April, while the other specimens were captured in June (Florida) and July.

Carmenta tecta (Hy. Edwards) (Mistletoe Stem Borer)
PL. 3, FIG. 62 (RWH 2613).

Aegeria tecta Hy. Edwards, 1882, *Papilio,* **2**: 56.
Type locality: Prescott, Arizona. [USNM]

Carmenta tecta resembles the other mistletoe borer, *phoradendri.* See the discussion of that species (p. 124) where differences between the two are given.

Male: Head with vertex and antenna brown black with pale yellow to white apically; occipital fringe yellow, white laterally; front brown black, white laterally; labial palpus relatively smooth, pale yellow with brown laterally. Thorax brown black with much pale yellow beneath wings and at anterior base of wings; mesothorax with narrow subdorsal yellow

stripe; metathorax yellow. Abdomen mostly brown black; dorsally with narrow posterior yellow bands on segments one, two, four, six, and seven, widest on four, occasionally some yellow on five also; ventrally with pale-yellow bands on segments four, five, six, and seven; anal tuft brown black, tipped with pale yellow or white laterally. Legs mostly brown black, forecoxa mostly pale yellow; pale yellow or white on most of foretibia, on basal ½ and tufts at spurs on midtibia, and on tufts at spurs on hindtibia; all legs pale yellow or white mesially and at joints of tarsal segments. Forewing mostly hyaline with brown-black narrow margins, veins and narrow discal spot; pale yellow orange on distal margin of discal spot, extending onto veins for short distance beyond discal spot, and on veins at wing base; ventrally with pale yellow orange more extensive on veins and margins. Hindwing hyaline with very narrow margins; pale yellow on costal margin dorsally and ventrally; fringe white at wing base. Genitalia with valva elongate, bluntly pointed apically; crista sacculi continuous, gently curved to ventral edge of valva; large areas on both sides of crista sacculi devoid of scales; saccus about ⅓ length of valva, which is relatively short for species of *Carmenta.* Female differs by having forewing more nearly opaque, with more pale orange on veins, and orange powdered between veins in apical area; abdomen with wider yellow bands, these bands on segments one, two, most of four, and six, sometimes also on five; anal tuft brushlike, mostly yellow with brown black mediobasally and laterally. Genitalia with ductus bursae narrow, sclerotized to origin of ductus seminalis, followed by short, expanded part, becoming narrower and membranous to oblong corpus bursae. Wing length 7–10 mm.

The larvae bore in the stems of *Phoradendron orbiculatum* Engelmann (Loranthaceae) (mistletoe). Its habits are similar to those of *phoradendri* (p. 124).

Carmenta tecta is known from the eastern half of Arizona and western New Mexico, generally in mountainous regions. Its habitat, according to Engelhardt (1946: 53), is groves of old live oaks supporting well-established colonies of mistletoe. Adults have been collected from April through September, but most were taken in May and June or August and September, possibly indicating two broods per season.

Carmenta texana (Hy. Edwards)
PL. 3, FIG. 63; PL. 4, FIG. 14. TEXT FIG. 35 *d* (RWH 2614).

Pyrrhotaenia texana Hy. Edwards, 1881, *Papilio,* **1**: 204.
Type locality: Texas. [USNM]

Pyrrhotaenia wittfeldii Hy. Edwards, 1883, *Papilio,* **3**: 156.
Type locality: Indian River, Florida. [AMNH]

Male: Head with vertex brown black, often orange laterobasally; occipital fringe orange; front brown black, orange ventrally; labial palpus smooth, orange with some brown black apically; antenna brown black. Thorax brown black; mesothorax mostly orange beneath wings, subdorsally with orange stripe; metathorax orange with orange lateral tufts. Abdomen brown black; dorsally with orange bands on posterior margin of segments two, four, six, seven, and occasionally five, widest on four, which encircles abdomen; ventrally with some orange on segment two, and solid orange medially from four through seven; anal tuft broad, truncate apically, brown black tipped with orange laterally; exposed portions of genitalia orange with strong brown-black medioventral keellike tuft. Legs laterally mostly brown black, forecoxa margined with orange; tibial tufts and spurs pale orange or yellow; pale orange or yellow at joints of tarsal segments; mesially mostly orange on all legs. Forewing more than ½ opaque, brown black with hyaline areas in cell, in anal region near wing base, and small hyaline area just distad of wide discal spot, some orange outlining hyaline areas and weakly powdered between veins Sc and R; ventrally with much orange on basal ⅔ and somewhat between veins in apical third; fringe lighter brown than ground color. Hindwing hyaline with narrow margins, orange on costal margin and anal fold. Engelhardt (1946: 66) stated that veins 11 and 10 (R_1 and R_2) are coincident, which is not true of all specimens. Some have the two veins fused only toward the wing margin as on most species of *Carmenta.* Genitalia with distal portion of crista sacculi oblique, extending slightly beyond ventral edge of valva, then acutely recurved and extending to about ½ the distance to the base of the valva; saccus about ⅓ length of valva. Female averages slightly larger in size than male; has orange scaling in place of hyaline areas of male except for small hyaline area just basad of discal spot; has anal tuft of abdomen brushlike, brown black. Genitalia with corpus bursae small, ovoid; otherwise, typical for species of *Carmenta.* Wing length 6–11 mm.

Larvae of *texana* bore in the crown roots and stems of the following food plants: *Artemisia* sp., *Eupatorium serotinum* Micheaux, *Grindelia* sp., and

Melanthera deltoidea Micheaux (Asteraceae) (Engelhardt, 1946: 66). One specimen was labeled with food plant *Ambrosia artemisiifolia* Linnaeus (common ragweed), which may represent a valid host. In addition, two specimens from separate localities in southern Florida were labeled, "on *Flaveria linearis*" Lagasca (Asteraceae), which may be flower visitation records.

This species has been collected frequently in traps baited with chemical sex attractants (Z,Z-ODDA) in Florida (Sharp and Eichlin, 1979), however, two were attracted to E,Z-ODDOH in Mississippi (Solomon et al., 1982). With the exception of the syntypes labeled simply "Tex." and the two Mississippi records, *texana* has been recorded from central Georgia to Key West, Florida. Adults have been captured from March to December in Florida, with peaks in June and September. Because its host plants occur all along the Gulf Coast (throughout North America), *texana* should be found commonly throughout the area.

Carmenta verecunda (Hy. Edwards)
PL. 3, FIGS. 70, 71 (RWH 2615).

Aegeria verecunda Hy. Edwards, 1881, *Papilio,* **1**: 190.
Type locality: Colorado. [MSU]

Carmenta nigra Beutenmüller, 1894, *Bull. Amer. Mus. Nat. Hist.,* **6**: 96.
Type locality: Utah. [AMNH]

Sesia florissantella Cockerell, 1908, *Can. Ent.,* **40**: 330.
Type locality: Florissant, Colorado. [USNM]

Euhagena hirsuta Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 172.
Type locality: Davis Mts., Texas, 5,000 ft. [USNM]

Male: Head with vertex roughened, brown black, often mixed with elongate, straw-colored or white hairlike scales especially posteriorly; front white, often straw colored medially; occipital fringe straw colored dorsally, white laterally; labial palpus roughened, white with brown black laterally and apically; antenna brown black, often with pale yellow apically. Thorax brown black with subdorsal pale-yellow or white stripe, pale-yellow or white bar at wing base anteriorly, mostly white with some pale yellow beneath wings; mesothorax overlaid with long silky white scales, similar scales in lateral tufts on metathorax. Abdomen dorsally brown black with bands white mixed with pale yellow on posterior margin of segments two, four, six, and seven, band widest on four, and occasionally some white on posterior margins of one and three; ventrally mostly white; anal tuft brown black with some pale yellow and white mixed basally and laterally. Legs mostly white with some brown black on femora, basally and distally on tibiae and variously on tarsi. Forewing mostly opaque with translucent areas variously or entirely covered with white scales; broad costal margin, discal spot, veins, and narrow outer margin brown black with pale yellow variously powdered on discal spot, between veins, and on costal edge of wing; ventrally mostly white. Hindwing partially translucent, white, with narrow margins, discal spot and veins brown black; some white on veins and margins ventrally; fringe fuscous, often tipped with white, and white on anal margin basally. Genitalia similar to those of *giliae* and, in particular, to those of *mimuli* because the scopula androconialis are much reduced. Female generally like male but with more brown black on wings and legs; labial palpus less roughened; abdomen with three pale-yellow or white bands dorsally; forewing nearly or entirely opaque; and hindwing with various suffusions of brown black, sometimes entirely opaque, brown black (color form "*nigra*"). Genitalia with elongate, slender ductus bursae sclerotized only on posterior ¼–⅓; corpus bursae with small, irregularly shaped signum. Wing length 5–9 mm.

Adults have been reared from the roots of *Lithospermum ruderale* Douglas (Boraginaceae) in Washington (Engelhardt, 1946: 75). In other areas of its range the host plants are probably other species of Boraginaceae (Duckworth and Eichlin, 1978). In Colorado, J. A. Scott collected a female on a flower of *Cryptantha jamesii* (Torrey) Payson, a perennial boraginaceous plant and potential host for *verecunda.* The specimens reared from *L. ruderale* emerged from April to June, but field-collected adults were taken from June to August. Details of the life history have yet to be documented.

The name "*florissantella*" applies to a single dwarf male specimen. The form "*nigra*" refers to very dark specimens with opaque, brown-black wings that lack the typical white powdering and with the legs mostly brown black. Another extreme color form "*hirsuta*" differs from the typical form by having the vertex of the head, the thorax, and the basal segments of the abdomen overlaid with long, silky, blue-white scales; abdomen with white bands on all but the first and third segments; and forewing with discal spot and anal margin mostly yellow orange, otherwise mostly hyaline.

Carmenta verecunda occurs from Manitoba to Washington; south to Oklahoma and western Texas; in the Rocky Mountains to Arizona; and in high elevations south into the Sierra Nevada of California.

Carmenta welchelorum Duckworth and Eichlin
PL. 4, FIG. 15 (RWH 2616).

Carmenta welchelorum Duckworth and Eichlin, 1977, *Pan-Pac. Ent.*, **53**: 175.
Type locality: Speir Ranch, 3 miles northwest of Uvalde, Uvalde County, Texas. [USNM]

This species, described from eight males, has not been collected again. Male: Head with vertex, front, and antenna blue black; occipital fringe pale yellow dorsally, blue black laterally. Thorax blue black with subdorsal yellow stripe and large yellow patch beneath wings. Abdomen blue black with bluish iridescence, narrow pale-yellow stripe laterally on segments one, two, and four; anal tuft tipped laterally with pale yellow to white. Legs blue black, pale yellow to white mesially, laterally on margin of forecoxa, on tibiae near spurs, and around joints of tarsal segments. Forewing mostly hyaline with narrow margins, veins and discal spot blue black, lightly powdered pale yellow on margins between veins and on veins just distad of discal spot; ventrally with more extensive yellow powdering. Hindwing hyaline with very narrow margins; ventrally with yellow on costal margin. Genitalia with apex of crista sacculi nearly perpendicular to ventral edge of valva; saccus about ½ length of valva; scopula androconialis nearly as long as saccus (for drawing of genitalia, see Duckworth and Eichlin, 1977b: 177). Wing length 8–10 mm.

The immature stages are unknown.

Because the specimens were collected in flight traps baited with sex attractants (mostly Z,Z-ODDA), no females were taken and remain unknown. All specimens were captured between 1200 and 1730 h in early June. No North American *Carmenta* have color patterns similar to *welchelorum.* This species superficially resembles the viburnum borers, *Synanthedon fatifera* and *S. viburni,* neither of which is known from Texas.

Carmenta wellerae Duckworth and Eichlin
PL. 4, FIGS. 16, 17 (RWH 2617).

Carmenta wellerae Duckworth and Eichlin, 1976, *Proc. Ent. Soc. Washington,* **78**: 304.
Type locality: Cuiteco, Chihuahua, Mexico. [USNM]

Male: Head with vertex blue black; front blue black, very narrowly white laterally; occipital fringe pale yellow dorsally (strongly mixed with white on some individuals), white laterally; labial palpus strongly roughened, sculptured so as to appear triangular in lateral aspects, blue black with white apically, mixed ventrally and mixed with pale yellow dorsally (Arizona specimens usually with palpus mostly white); antenna blue black but with posterior side yellow orange. Thorax blue black with narrow subdorsal yellow stripe, much yellow beneath wings and laterally on collar; metathorax yellow. Abdomen blue black, dorsally with yellow bands on segments two, four, six, and seven, occasionally with some yellow medially on five; ventrally with segments one and two completely pale yellow or white and mostly pale yellow on four through seven; anal tuft relatively poorly developed. Legs laterally blue black with forecoxa white distally and laterally, variously tinted pale yellow; tibiae mostly white mesially, often powdered yellow or pale orange on basal portion, tufts near spurs yellow, spurs white; tarsi white mesially and often laterally as well but blue black laterally on first segment. Forewing hyaline with very narrow margins, veins, and narrow discal spot brown black but variously powdered orange (strongly so in Arizona specimens) on margins, some veins, and on at least distal ½ or more of discal spot, orange powdering much more extensive ventrally. Genitalia with crista sacculi reduced, sharply recurved apically, not extending to ventral margin of valva; saccus slightly more than ⅓ length of valva (see Duckworth and Eichlin, 1976 for illustrations). Female like male but more robust; forewing with broader outer margin, more strongly powdered orange; white on legs of male mostly replaced with yellow on female. Genitalia with ductus bursae sclerotized for more than ½ its length from ostium bursae. Wing length 7–11 mm.

The immature stages are unknown.

The distribution of *wellerae* extends from the canyons of the Chiricahua and Huachuca Mountains, Cochise County, Arizona to southwestern Chihuahua, Mexico at elevations between 5,000 and 6,000 feet. All adults have been captured in August.

Carmenta wielgusi Eichlin
PL. 3, FIG. 72.

Carmenta wielgusi Eichlin, 1987, *Entomography,* **5**: 533.

Type locality: Sierra Vista, Cochise County, Arizona. [USNM]

Carmenta wielgusi was described from males only, because it was discovered by the use of sex attractants (E,Z-ODDA alone or mixed with Z,Z-ODDA).

Male: Head with vertex brown black, pale yellow anteriorly; front pale gray; occipital fringe white, some pale yellow dorsally; antenna with orange yellow dorsally; labial palpus expanded ventrally, brown black with white. Thorax brown black with subdorsal yellow stripe. Legs brown black with some white on forecoxae, tibial spurs and ventrally on femora; pale yellow on tibiae and at tarsal joints. Abdomen dorsally brown black with narrow yellow band on segments two and four; ventrally brown black; anal tuft relatively short, pale yellow medially. Forewing mostly hyaline, slight pale-yellow powdering on costal margin and between veins apically, few pale-orange scales on discal spot. Hindwing hyaline. Genitalia unique in several respects from most *Carmenta*: crista sacculi more expanded medially, with apex projecting outward and upward; distal edge of unscaled portion of valva forming upward projecting, rounded ridge. Wing length 8–9 mm.

The immature stages are unknown.

Superficially, *wielgusi* resembles *mimuli* and *wellerae* that also occur in southeastern Arizona. *Carmenta mimuli* and *wellerae* have orange scaling on the forewings and yellow banding on the abdomen ventrally; these patterns are lacking on *wielgusi.*

GENUS
Penstemonia Engelhardt

Penstemonia Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 14.
Type species: *Aegeria edwardsii* Beutenmüller, 1894. Original designation.

Penstemonia is similar to *Carmenta* but differs mainly by having a rudimentary haustellum. The genitalia are too similar to be useful in differentiating the species; therefore, differences in color patterns must be used, and positive identification can sometimes be difficult. In the forewing veins R_1 and R_2 are confluent near the wing margin. The genitalia are of the *Carmenta* type. In the male genitalia the crista sacculi of the valva are downcurved apically; saccus is elongate, more than ½ the length of the valva; scopula androconialis are elongate. In the female genitalia the ductus bursae is elongate, sclerotized except for a short section which is membranous to the corpus bursae; ductus seminalis arises near the corpus bursae.

Penstemonia contains five species, all from the western United States, particularly the Southwest. This is a perplexing complex; the species are difficult to define. Apparently, it is a recently evolving group of species, with similar genitalia and imperfectly understood variation in color patterns.

All known species are root borers in various species of *Penstemon* (beard-tongue) (Scrophulariaceae). The larvae tunnel from the roots into the stems prior to pupation, preparing a thinly covered exit hole at the top end of the burrow. The pupal chamber in the upper portion of the burrow is prepared by closing the lower end of the chamber with a plug made of chewed wood and silk, then somewhat enlarging the burrow, and making the sides of the chamber smooth and lining it with silk. Only one species reportedly makes a cocoon in which to pupate.

KEY TO SPECIES OF *PENSTEMONIA*

1. Antenna ciliate ventrally (males) 2
— Antenna not ciliate ventrally (females) 6

2. Anal tuft with lateral part elongate, extending well beyond tip of abdomen ..... *dammersi* p. 133
— Anal tuft without elongate lateral portions 3

3. Labial palpus, forecoxae, and hindtibiae mostly yellow ..... *clarkei* p. 133
— Labial palpus with some pale yellow but mostly white on basal half; forecoxae and hindtibiae white and black 4

4. Hindwing nearly or entirely opaque ..... *edwardsii* p. 134
— Hindwing hyaline, not opaque 5

5. Abdomen dorsally with pale-yellow or white band on segment six ..... *pappi* p. 135
— Abdomen dorsally without pale band on segment six ..... *hennei* p. 134

6. Hindwing mostly hyaline 7
— Hindwing mostly or entirely opaque 9

7. Abdomen dorsally with segment five mostly or entirely brown black ..... *clarkei* p. 133

— Abdomen dorsally with segment five mostly or entirely yellow 8

8. Front gray or gray black, some yellow occasionally present ventrally; forewing most often powdered orange medially and apically or unpowdered ..... *dammersi* p. 133

— Front yellow; forewing most often powdered with yellow medially and apically or unpowdered ..... *hennei* p. 134

9. Labial palpus yellow ..... *edwardsii* p. 134

— Labial palpus white, pale yellow mixed and dark brown apically ..... *pappi* p. 135

Penstemonia clarkei Engelhardt
PL. 3, FIG. 73; PL. 4, FIG. 18 (RWH 2618).

Penstemonia clarkei Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 18.
Type locality: The Dalles, Oregon. [USNM]

Male: Head with vertex and antenna brown black; front brown mixed with some pale yellow; occipital fringe yellow; labial palpus roughened, mostly yellow with some white basally and some brown black apically. Thorax brown black with narrow subdorsal yellow stripe and mostly yellow beneath wings; metathorax yellow. Abdomen dorsally with segments two, four, six, and seven mostly or entirely yellow, one with yellow on posterior margin and occasionally some yellow on three; anal tuft with yellow medially; ventrally with all segments, except third, mostly or entirely yellow, occasionally with some yellow also on three. Legs with forecoxa mostly yellow, some brown black mesially; femora mostly brown black with some yellow dorsally; tibiae mostly yellow with brown black at base and distally; tarsi mostly yellow with some brown black laterally on distal segments. Forewing generally opaque but usually with small hyaline area just beyond discal spot, mostly brown black but variously yellow in cell and on outer margin dorsally; ventrally mostly yellow except for discal spot and anal margin. Hindwing hyaline with narrow brown-black margins; ventrally strongly powdered yellow on margins and veins. Genitalia as described for the genus. Female: Head with front pale yellow, vertex mixed with yellow orange; abdomen broadly banded yellow on segments one, two, four, and six dorsally and on all but segment three ventrally, anal tuft shorter, brown black with two yellow stripes; forewing generally more opaque, often entirely so and with more yellow powdering. Genitalia as described for the genus. Wing length 5–10 mm (smallest specimens are occasional dwarfs from laboratory rearing).

Penstemonia clarkei has been reared only from *Penstemon richardsonii* Douglas in Oregon (Engelhardt, 1946: 19) and from an introduced weed, *Linaria genistifolia dalmatica* (Linnaeus) Miller (Dalmatian toadflax) (Scrophulariaceae) in Trinity County, California (Duckworth and Eichlin, 1978: 46). Before pupating the larvae construct firm, oval, silk-lined cocoons of frass and wood chips, which according to Engelhardt (1946: 19) is unique among species of *Penstemonia.*

Records of *clarkei* are from Montana, Idaho, Oregon, and California. In California it has been collected in the mountains in the north, along the Coast Range as far south as Alameda County, and along the western slope of the Sierra Nevada to Kern County. Records from the high elevations in the Sierras and the New York and Clark mountains in the eastern Mojave Desert (Duckworth and Eichlin, 1978: 46) represent a recently described species *pappi* (Eichlin, 1987), not *clarkei.* Adults have been captured from May through August, the earlier records from lower elevations and the southern parts of the range, and the latter records from higher elevations and northern parts of the range.

Penstemonia dammersi Engelhardt
PL. 4, FIGS. 19–21 (RWH 2619).

Penstemonia dammersi Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 19.
Type locality: Mt. Wilson, California. [USNM]

Penstemonia brevifolia Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 21.
Type locality: Greenhorn Mountains, California. [USNM]

Male: Head, thorax, and legs are essentially as described for *clarkei.* Abdomen with segments nearly entirely yellow, except anterior ½ of two and five and all of three; anal tuft uniquely with lateral part elongate, extending well beyond tip of abdomen. Forewing dorsally with broad outer margin, costal and anal margins, discal spot brown black with some dull-orange powdering throughout, generally about ½ hyaline, though somewhat variable; ventrally with costal margin yellow, powdered dull orange on veins before and beyond discal spot, and between veins in apical area. Hindwing hyaline with very narrow

margins; ventrally with dull orange on costal margin and some veins, yellow at base; fringe brown black, becoming yellow toward wing base. Genitalia with crista gnathi comparatively larger than on other *Penstemonia.* The form "*brevifolia*" differs by having the forewing more nearly opaque in the male to entirely opaque in the female, and with yellow banding only on abdominal segments one, two, and four but some yellow indicated on others; and on the head the antenna is overlaid with tan. Female much like male but with opaque areas of forewing somewhat more extensive and with more orange dorsally in cell and on discal spot; ventrally mostly orange and yellow; abdomen with posterior edge of segment three often yellow, and without elongate lateral anal tuft of male. Genitalia differ from those of other species in the genus by having a signum, consisting of an irregularly shaped, granulose, pigmented spot. Wing length 9–13 mm.

Adults have been reared from the following species of *Penstemon*: *breviflorus* Lindley, *cordifolius* Bentham, *spectabilis* Thurber, and *ternatus* Torrey. Adults emerge in August and September and may require two years to complete development (Engelhardt, 1946: 20).

The species occurs in the foothills and mountains of southwestern California.

Penstemonia edwardsii (Beutenmüller)
PL. 3, FIG. 74; PL. 4, FIGS. 22, 23. TEXT FIG. 37 *a–c* (RWH 2620).

Aegeria edwardsii Beutenmüller, 1894, *Bull. Amer. Mus. Nat. Hist.,* **6**: 92.
Type locality: Denver, Colorado. [USNM]

Sesia utahensis Beutenmüller, 1909, *Ent. News,* **20**: 83.
Type locality: St. George, Washington County, Utah. [USNM]

Male: The patterns of the head are much like those of *clarkei* except occipital fringe with some white laterally and labial palpus with basal half white, distal half yellow mixed with some brown black. Abdomen brown black, dorsally with segments four and seven nearly or entirely pale yellow, segments two and six narrowly banded pale yellow on most specimens; ventrally all but segment three mostly white; anal tuft with some pale yellow basally. Legs with white replacing the areas of yellow on *clarkei.* Forewing opaque, occasionally with small hyaline areas just distad and basad of discal spot, solid brown black or variously with pale yellow in cell and distad of discal spot; ventrally mostly yellow. Hindwing brown black, with or without yellow powdering; ventrally mostly yellow. Genitalia as for genus. Female differs from the male by: Head with front mostly pale yellow and labial palpus all yellow; abdomen dorsally with segments two, four, and six yellow, ventrally with segment five also yellow. Wings entirely opaque, dorsally brown black or variously powdered yellow or dull orange (form "*utahensis*" with extensive areas of yellow or dull orange dorsally on both pairs of wings); white areas on legs of male replaced with yellow on female. Genitalia typical for the genus. Wing length 7–11 mm (one dwarf measures 5 mm).

Adults have been reared from *Penstemon centranthifolius* Bentham, *P. parryi* Gray, and Engelhardt (1946: 16) observed larval work in *P. eatonii* Gray, *P. strictus* Bentham and *P. unilateralis* Rydberg, which he attributed to *edwardsii* but without successfully having reared adults for verification.

Penstemonia edwardsii has been found in the mountains in Utah, Colorado, New Mexico, and Arizona. Adults emerge from May to August, depending on local conditions.

Penstemonia hennei Engelhardt
PL. 3, FIGS. 75, 76 (RWH 2621).

Penstemonia hennei Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 16.
Type locality: San Bernardino County, California. [USNM]

Male: Head with vertex, front, and antenna brown black; occipital fringe yellow mixed with brown black dorsally, white laterally; labial palpus somewhat roughened, white with brown black apically. Thorax much like that of *clarkei.* Abdomen dorsally brown black with pale yellow or white on all of segment four and posterior ½ of segment seven, occasionally on posterior edge of segment two; ventrally mostly white except for segments three and seven. Legs as for *edwardsii.* Forewing with extensive hyaline areas in cell and anal region and just distad of discal spot, with yellow on veins in latter area, margins of cell, and lightly powdered between veins apically; patterns similar ventrally. Hindwing hyaline with very narrow margins; some pale yellow on veins and anal margin ventrally. Genitalia typical for the genus. Female differs from male by: Head with front yellow; labial palpus smooth, yellow; abdomen dorsally with segments two, four, five, and six broadly banded yellow, all segments yellow laterally, and all segments yellow except segment three ventrally; legs

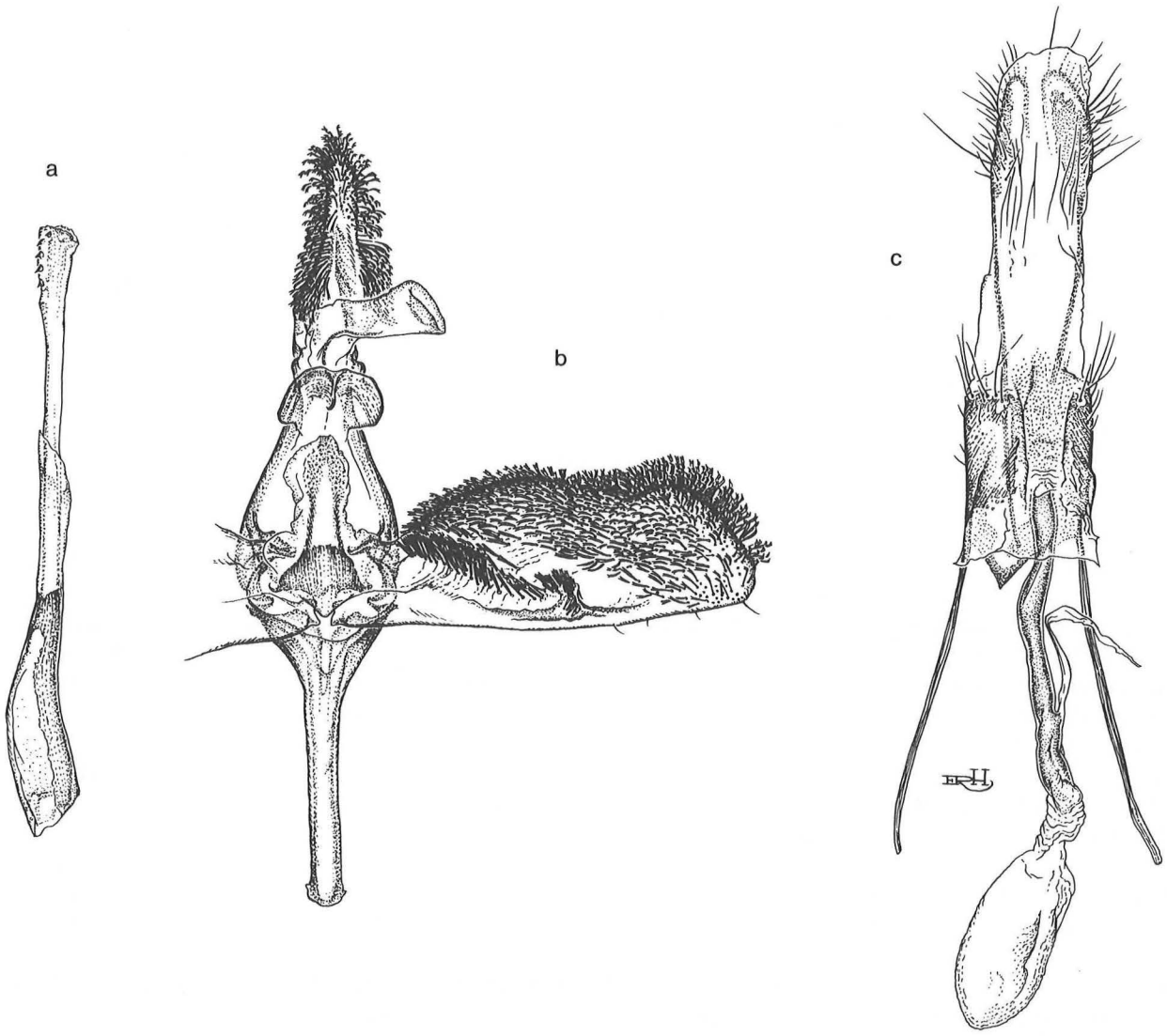

FIGURE 37: GENITALIA OF *PENSTEMONIA EDWARDSII*

a. Aedoeagus (USNM 76097). *b.* Male genitalia (left valve and adeoeagus omitted) (USNM 76097). *c.* Female genitalia (USNM 75618).

with yellow where white on male; forewing nearly or entirely opaque, hyaline areas of male yellow scaled in female. Genitalia typical for the genus. Wing length 7–12 mm.

Most adults have been obtained by rearing from *Penstemon spectabilis* Thurber from western San Bernardino and Riverside counties to southern coastal California. One specimen was seen from Santa Catalina Island. Some also have been reared from *P. parishii* Gray. The larvae bore in the crown roots and lower stems and can be detected by an accumulation of pale frass at the base of the plants (Engelhardt, 1946: 18). Specimens have been obtained from May to September.

Penstemonia pappi Eichlin

PL. 3, FIGS. 77, 78; PL. B, FIG. 8.

Penstemonia pappi Eichlin, 1987, *Entomography,* **5**: 534.

Type locality: New York Mountains, San Bernardino County, California. [USNM]

Male: Head with vertex brown black; front gray, white laterally or nearly or entirely white; antenna brown black, often powdered yellow; labial palpus somewhat roughened, mostly white, with some brown black dorsally and lateroapically, mixed with some yellow. Thorax brown black with white to pale-yellow stripe subdorsally. Abdomen brown

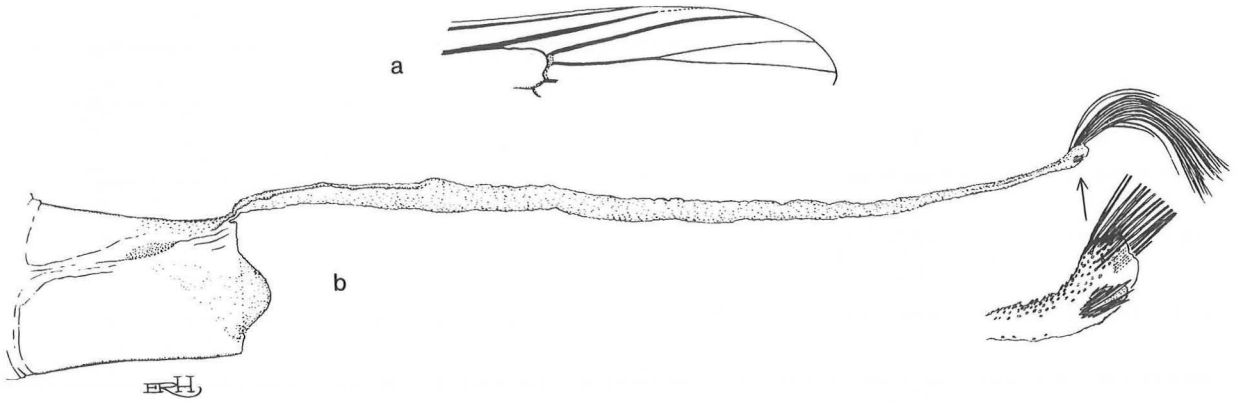

FIGURE 38: STRUCTURES OF *HYMENOCLEA* AND *ALCATHOE*

a. Radial veins of forewing, *Hymenoclea palmii* (USNM 75711). *b.* Anal appendage (scales removed), *Alcathoe* species (AB[usck] 20 Nov. 1933).

black, dorsally with pale-yellow to white bands on segments four and seven, narrow bands usually also on two and six; ventrally with bands on all but one and three. Legs brown black with white on forecoxae, tibiae, and first tarsal segment of hindlegs. Forewing mostly hyaline but with pale-yellow scaling variously. Hindwing hyaline. Genitalia as for other species of *Penstemonia.* Wing length 7–9 mm. Female differs greatly from male: Head with front white with some pale yellow or entirely yellow. Thorax and dorsal abdominal patterns yellow, not white as on male. Fore- and hindwings opaque, brown black, perhaps powdered with some pale yellow in cell, apical region, and between veins. Wing length 8–11 mm.

The definition of *pappi* is based on specimens reared from *Penstemon palmeri* Gray and several unidentified species of *Penstemon* (Eichlin, 1987: 534). All collections come from desert mountain ranges in southeastern California at elevations from 2,000 to 6,000 feet. The males resemble males of *hennei,* and the females look most like both sexes of *edwardsii.*

GENUS

Alcathoe Hy. Edwards

> *Alcathoe* Hy. Edwards, 1882, *Papilio,* **2**: 53.
> Type species: *Aegeria caudata* Harris, 1839. Original designation.

Alcathoe is unique in that the males, at least of the species found north of Mexico, have a long, slender, flexible, scaled process (text figure 38 *b*), which extends posteriorly from the dorsomedial posterior end of the eighth abdominal segment. This process is longer than the abdomen in many cases. On the head the third segment of the labial palpus is ½–⅔ the length of the second segment; haustellum is about three times the length of the labial palpus. The forewing has veins R_1 and R_2 coalescing to form a single vein. In the male genitalia the valva is broad, rounded apically; distal portion of crista sacculi curved toward ventral margin of valva as in *Carmenta,* continuing back toward base of valva as a sinuous, unscaled ridge; saccus is broad, about ⅛ or more as wide as long, somewhat truncated apically. The female genitalia have the ductus bursae sclerotized for more than ½ its length as for *Carmenta.* The genitalia are similar among the species and not useful for identification.

The larvae are borers in the roots and stems of species of *Clematis* (Ranunculaceae). There is a one year life-cycle, and pupation takes place in gall-like swellings in the host plant. The adults, especially the males, appear to mimic pompilid wasps of several genera in the Pepsinae both in color patterns and flight behavior. Most species have both a black and an orange color form, both forms potentially issuing from a single brood (Engelhardt, 1946: 108).

The closeness of the relationship of *Alcathoe* to *Carmenta* is evident in the general similarities of the genitalia and the larvae. MacKay (1968a) included *Alcathoe* in what she termed the *Carmenta* complex, containing the genus *Carmenta,* Genus I, and *Alcathoe.* She further stated that these genera are all closely related, doubtless of common origin, and share several morphological features.

North of Mexico, *Alcathoe* contains five species. Several undescribed species are in Mexico.

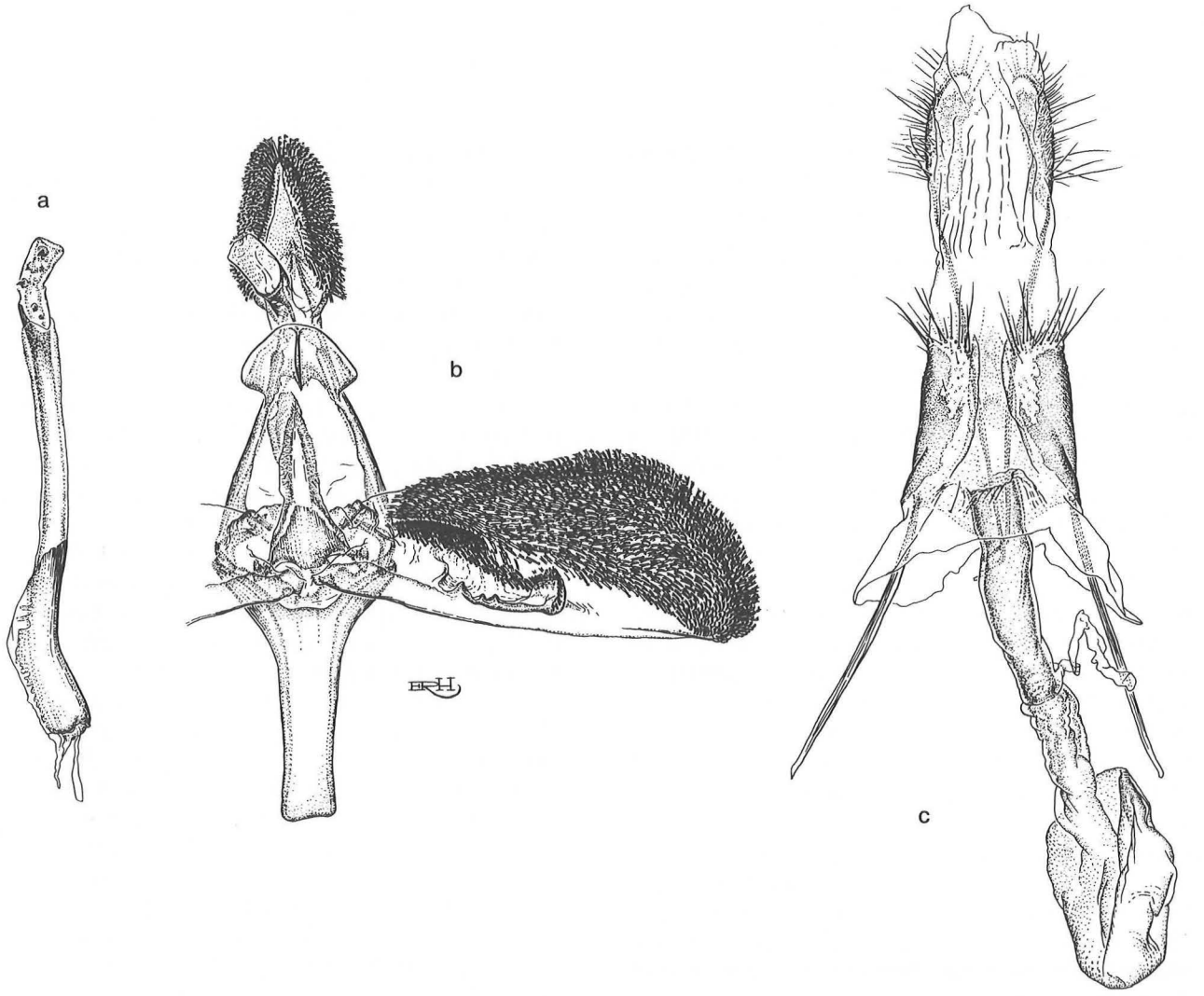

FIGURE 39: GENITALIA OF *ALCATHOE VERRUGO*

a. Aedoeagus (USNM 75721). *b.* Male genitalia (left valve and aedoeagus omitted) (USNM 75721). *c.* Female genitalia (USNM 75722).

KEY TO SPECIES OF *ALCATHOE*

1. Hindwing less than ½ opaque ..... *caudata* p. 137
— Hindwing more than ½ opaque 2
2. Hindwing entirely opaque ..... *verrugo* p. 139
— Hindwing with a hyaline area at base 3
3. Hyaline area at base of hindwing about ⅓ the total area of the wing, extending from anal margin to costal margin ..... *autumnalis* p. 138
— Hyaline area at base of hindwing much less than ⅓ the total area of the wing, restricted to region posterior to anal vein and sometimes a smaller region above anal vein 4
4. From mountains of Utah, Colorado, Nevada, New Mexico, Arizona, 4,000–8,000 ft. elevation ..... *pepsioides* p. 139
— From eastern United States ..... *carolinensis* p. 138

Alcathoe caudata (Harris)

PL. 4, FIGS. 27–30 (RWH 2623).

Aegeria caudata Harris, 1839, *Amer. Jour. Arts and Sci.*, **36**: 311.
Type locality: Massachusetts. [MCZ]

Alcathoe caudatum aberration *walkeri* Neumoegen, 1894, *Ent. News,* **5**: 331.
Type locality: Jamaica, Long Island, New York. [USNM]

Alcathoe caudata race *annettella* Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 103.
Type locality: Cincinnati, Ohio. [USNM]

Male: Head with vertex and front brown black; occipital fringe orange red; labial palpus smooth, yellow; antenna mixed yellow, brown black, and orange on basal ½. Thorax dark brown with some orange red on tegula; collar and narrow subdorsal stripe brown black. Abdomen dark brown dorsally, orange ventrally; anal tuft brown black; tubular anal process mostly yellow and about as long as abdomen. Legs with forecoxa mostly orange red; other coxae and femora brown black; tibiae orange red with brown black at apical tufts, mostly yellow on hindtibia between spurs; tarsi yellow except for first segment of hindtarsus, which is orange red and tufted laterally. Forewing of typical form opaque, brown black on apical ½, hyaline on basal ½; ventrally with orange at base of costal margin, perhaps slightly powdered orange on discal spot. Hindwing of typical form hyaline with very narrow brown-black margins and small discal spot; fringe brown black. Female differs from male by: Antenna entirely yellow dorsally; without long tubular anal process at tip of abdomen. Legs mostly brown black but with yellow orange on forefemur, tarsi, and ventrally on tibiae; first segment of hindtarsus tufted, brown black; some red mesodorsally on tibiae. Forewing entirely opaque. Wing length 7–15 mm.

The color form "*walkeri*" applies only to males, which lack the yellow, orange, or red of the typical form. The form "*annettella*" from Ohio applies to individuals having various suffusions of brown black on the hindwing in both sexes; the males have the forewing mostly opaque except for small hyaline areas basally.

Adults have been reared from *Clematis virginiana* Linnaeus (Ranunculaceae) (Engelhardt, 1925b: 156). Adults have been collected from June through August, occasionally emerging as early as May and as late as September. On 4 July 1974, 1830 h, T. P. Friedlander (personal communication) observed a mated pair resting on a shrub. When disturbed, the still attached pair flew upward to about 25 ft and returned, the male doing the forward flight.

The distribution of *caudata* ranges from Nova Scotia west to Ontario and Wisconsin and south to Florida and Louisiana.

Alcathoe autumnalis Engelhardt, REVISED STATUS
PL. 4, FIGS. 24, 25.

Alcathoe autumnalis Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 105.
Type locality: San Antonio, Texas. [USNM]

Male: Head, thorax, abdomen, and legs blue black. Forewing opaque, orange, strongly blue black on costal and anal margins from base to beyond cell and on other veins short of outer margin. Hindwing mostly opaque, orange, characteristically with large hyaline area basally, nearly ⅓ of total wing area, extending from anal margin to costal margin and subdivided into three regions by the veins. The female lacks the elongate anal appendage of the male, and the antenna is orange, but otherwise it is similar to the male. Wing length 12–18 mm.

Many specimens have been reared from *Clematis ligusticifolia* (Engelhardt, 1946: 106). *Alcathoe autumnalis* is known only from southern Texas but should occur with its host plant in Mexico. Adults are present in September and October.

In our discussion of the sesiid classification (Duckworth and Eichlin, 1977c: 44), we treated *autumnalis* as a new synonym of *carolinensis* Engelhardt. New information has caused us to reevaluate the status of each name and is discussed under *carolinensis.*

Alcathoe carolinensis Engelhardt
PL. 4, FIG. 26 (RWH 2622).

Alcathoe carolinensis Engelhardt, 1925, *Bull. Brooklyn Ent. Soc.,* **20**: 156.
Type locality: Black Mountains, North Carolina. [AMNH]

The holotype male is blue black with bluish iridescence, except where yellow orange on the anal appendage, tarsi, and mesoapically on hindtibia. The Florida specimen is in fairly poor condition, having been removed from a sticky-trap and cleaned in xylene. The wings are opaque except on the hindwing basally, where there is a rounded hyaline area below CuP and a narrow hyaline streak just above CuP. Overall, *carolinensis* is very similar to the Rocky Mountain species *pepsioides* Engelhardt, color form "*atra.*" Wing length 12–15 mm.

The immature stages are unknown.

Until recently, this species was known from a single specimen. Engelhardt (1946: 106), referring to this specimen, stated that it originally had no labels, but when asked, Beutenmüller thought he had col-

lected it on *Clematis* flowers in midsummer in the Black Mountains of North Carolina. Because there was doubt regarding the accuracy of the type locality and because the specimen closely resembles species from the Southwest and Mexico, we followed Engelhardt's suggestion (Duckworth and Eichlin, 1977c: 44) and considered it to be conspecific with *autumnalis* from Texas. However, J. L. Sharp, using a trap baited with a 3:1 blend of E,Z-ODDA/Z,Z-ODDA near Lowell, Florida, 6 October 1977, collected a second male of *carolinensis* (Sharp et al., 1977; Sharp and Eichlin, 1979), which apparently validates the North Carolina type locality and extends the known distribution. L. N. Brown, 1985, using a commercial preparation of E,Z-ODDA, collected three more specimens in Citrus County, Florida.

Several males were captured from mid-July through October in Indiana in traps baited with blends of E,Z/Z,Z-ODDA (Reed et al., 1981) and Georgia (Snow et al., 1985).

Alcathoe pepsioides Engelhardt
PL. 4, FIGS. 31–36. TEXT FIG. 18 (RWH 2624).

Alcathoe pepsioides Engelhardt, 1925, *Bull. Brooklyn Ent. Soc.*, **20**: 157.
Type locality: Durango, Colorado. [USNM]

Alcathoe pepsioides atra Engelhardt, 1925, *Bull. Brooklyn Ent. Soc.*, **20**: 158.
Type locality: Mountains near Jemez Springs, New Mexico. [USNM]

Alcathoe pepsioides ferrugata Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 105.
Type locality: Rifle, Colorado. [USNM]

Male: Head brown black, except front gray black. Thorax, abdomen and legs deep brown black. Forewing opaque, orange, variously powdered on basal ½ with orange red, costal margin and veins brown black. Hindwing orange with some orange red, mostly opaque but basally with hyaline rounded spot below CuP and occasionally a smaller hyaline streak just above CuP, veins brown black; wing fringes brown black. Female of each color form similar to respective male form, except antenna always yellow orange, and the elongate anal appendage is lacking. Wing length 10–16 mm.

The color form "*atra*" applies to those specimens which are entirely blue black. The color form "*ferrugata*" differs from *pepsioides* by the following: Yellow orange on antenna, labial palpus, and mixed on vertex of head; thorax strongly powdered orange, collar orange; abdomen rust colored, each segment narrowly edged with brown black posteriorly, anal tuft brown black, anal appendage dull orange brown; foreleg orange with tibia tufted brown black laterally; other legs with coxae and femora brown black, tibiae with orange medially, tarsi yellow orange; wings dull orange with much less brown on veins and costal margin of forewing. Specimens taken at the same time and place have color patterns intermediate to the extreme conditions.

Alcathoe pepsioides occurs in Utah, Colorado, New Mexico, Arizona, and western Texas. Adults have been reared from the host plant *Clematis ligusticifolia.* To insure success in obtaining adults the specimens should be collected relatively close to the time of the moth's emergence from July through early September (Engelhardt, 1925b: 157).

Alcathoe verrugo (Druce)
PL. 4, FIGS. 37–40. TEXT FIG. 39 *a–c* (RWH 2625).

Sannina verrugo Druce, 1884, *in* Godman and Salvin, *Biologia Centrali-Americana. Insecta. Lepidoptera-Heterocera,* **1**: 34.
Type locality: Esperanza (Sonora), Mexico. [USNM]

Alcathoe verrugo corvinus Engelhardt, 1946, *U.S. Natl. Mus., Bull.* **190**: 107.
Type locality: Arroyo Seco, S. Pasadena, California. [USNM]

Male: Head, abdomen, and legs brown black, anal appendage somewhat lighter in color apically. Wings completely opaque, orange, except for brown black on veins, wing base, fringe, costal margin and occasionally discal spot. Female similar to male but lacking elongated anal appendage. Wing length 8–15 mm.

The color form "*corvinus*" applies to individuals that are entirely brown black to blue black. From any rearing lot, adults of both color forms and a few specimens showing intermediate color patterns can be expected.

The lack of hyaline areas at the base of the wings separates *verrugo* from other North American *Alcathoe.*

Alcathoe verrugo is known to occur from southwestern California to Sonora, Mexico. The host plant, *Clematis ligusticifolia,* occurs over a much broader range than does the borer (Engelhardt, 1946: 107). Adults have been collected from June to September.

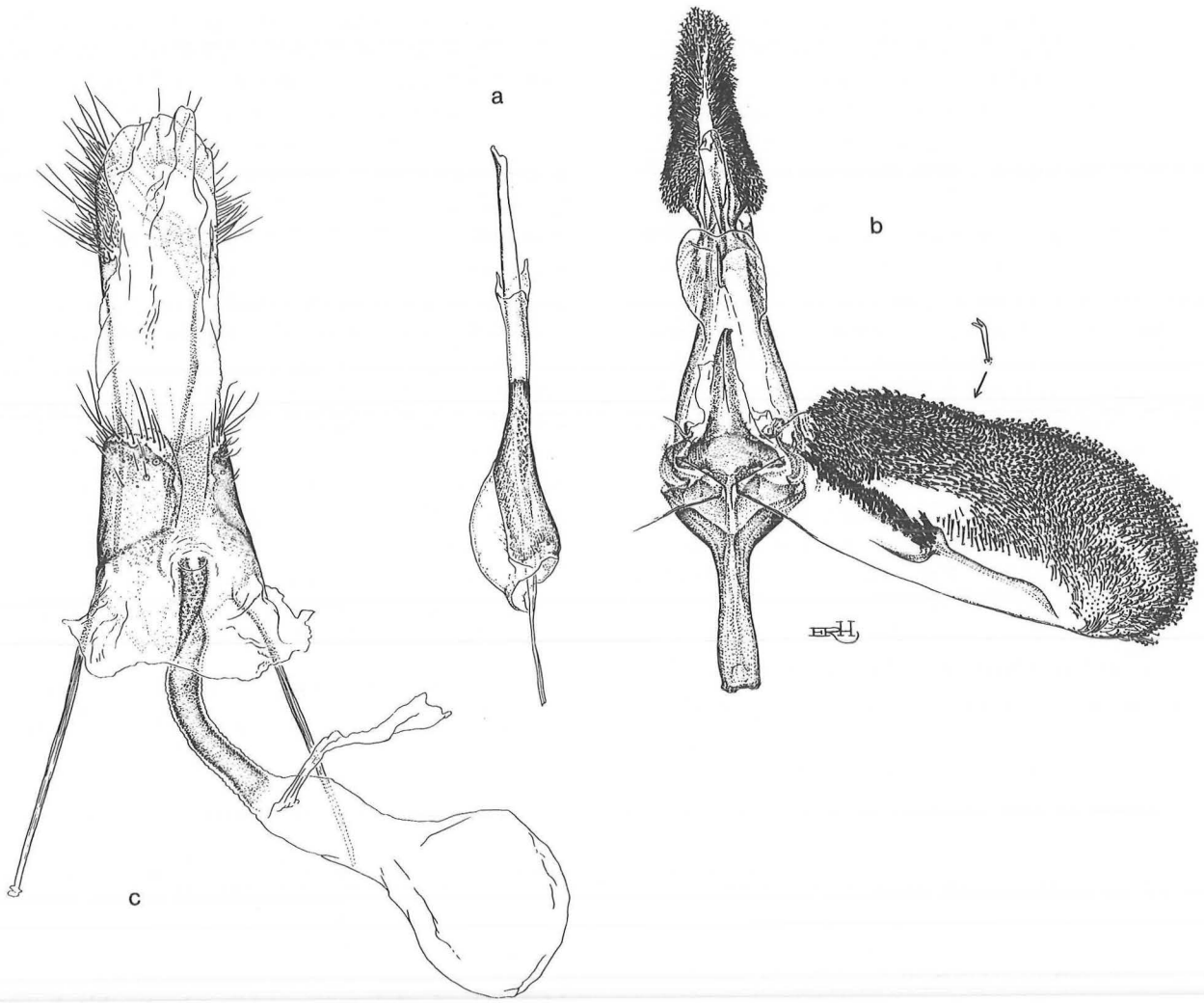

FIGURE 40: GENITALIA OF *HYMENOCLEA PALMII*

a. Aedoeagus (USNM 75711). *b.* Male genitalia (left valve and aedoeagus omitted) (USNM 75711). *c.* Female genitalia (USNM 75712).

GENUS

Hymenoclea Engelhardt

Hymenoclea Engelhardt, 1946, *U. S. Natl. Mus., Bull.* **190**: 98.
Type species: *Sesia palmii* Beutenmüller, 1902. Original designation.

Hymenoclea is a monobasic genus, most closely related to *Alcathoe,* the most notable difference is that the males of *Hymenoclea* lack the elongate caudal appendage. The genitalia are generally of the same type, and on the forewing of each, veins R_1 and R_2 coalesce to form a single vein. Other characters of *Hymenoclea* are: Head with maxillary palpus having two segments nearly equal in size, the second positioned laterally on the first; third segment of labial palpus nearly subequal to second segment; haustellum about two times length of labial palpus; hindwing with stalk of veins M_3 and CuA_1 very short. The adults exhibit much sexual dimorphism.

The larvae of the single included species *palmii* bore in the roots of *Hymenoclea* spp. (burrobush) (Asteraceae).

Hymenoclea palmii (Beutenmüller)
PL. 4, FIGS. 41, 42; PL. B, FIG. 9. TEXT FIGS. 11, 38 *a*, 40 *a–c* (RWH 2626).

Sesia palmii Beutenmüller, 1902, *Jour. New York Ent. Soc.,* **10**: 126.
Type locality: Phoenix, Arizona. [USNM]

Male: Head with vertex brown black mixed with some tan, rosette of chaetosema on posterior margin

behind each ocellus; front strongly roughened, appearing somewhat conical, tan, becoming darker brown laterally; occipital fringe brown black mixed with tan and white dorsally; labial palpus cream white, roughened with some brown black laterally, third segment nearly as long as second, mostly tan, smooth; antenna brown black dorsally, ventral cilia relatively long. Thorax brown black, mixed with tan beneath wings, on collar, tegula, and around wing base; narrow subdorsal cream-white stripe and another stripe mesially to posterior margin of mesothorax; metathorax with cream-white lateral tufts. Abdomen dark brown, often strongly powdered tan except for segment seven; anal tuft well developed, dark brown with cream white laterally. Legs with forecoxa cream white, brown medially; femora brown black; tibiae and tarsi brown and tan or mixed with cream white, somewhat lighter on tarsi. Forewing opaque, dorsally mostly tan, darker on margins, powdered yellow apically with a lighter spot just beyond discal mark, which is brown black, diffusing somewhat into cell; ventrally yellow orange before discal spot and just beyond. Hindwing opaque, mostly yellow orange, dusted brown on apical ½, discal spot and veins brown black, fringes fuscous. Genitalia with valva broadly rounded apically, crista sacculi extending nearly to ventral margin of valva with short naked recurved portion; saccus broad, truncated apically; vesica of aedoeagus with several short thornlike cornuti. Female: Mostly deep brown black, but with front medially gray brown; subdorsal stripe on mesothorax cream white with a vague hint of median stripe; second abdominal segment dorsally banded white on posterior ½; forewing with white powdering before and beyond discal spot or with very weakly scattered white scales. Genitalia with ductus bursae sclerotized posteriorly for more than ½ its length, slightly curving anteriorly, then broader and membranous to small, ovate corpus bursae; ductus seminalis arises in membranous part of ductus bursae. Wing length 10–17 mm.

Engelhardt observed that most often adults can be found near their host, *Hymenoclea monogyra* Torrey and Gray, along irrigation ditches and the banks of rivers. The larvae can tunnel into the roots several feet below the ground, pupating in the galleries close to the crown of the root (Engelhardt, 1946: 100). R. S. Wielgus (personal communication) studied a population of *palmii* for several years in a wash in Phoenix, Maricopa County, Arizona. He has observed the moths emerging, mating, and ovipositing. The timing of emergence seems geared to the onset of lower night temperatures and just as the plants come into flower bud. Females oviposit on host plants of all sizes, placing their eggs on plant scars, nodes, and injuries on stems about a foot or more above the ground. The specific host in Phoenix was identified by J. H. Lehr of the Desert Botanical Garden.

Hymenoclea palmii has been collected in Arizona, western Texas, and near La Burrera, Baja California Sur, Mexico, in September and October.

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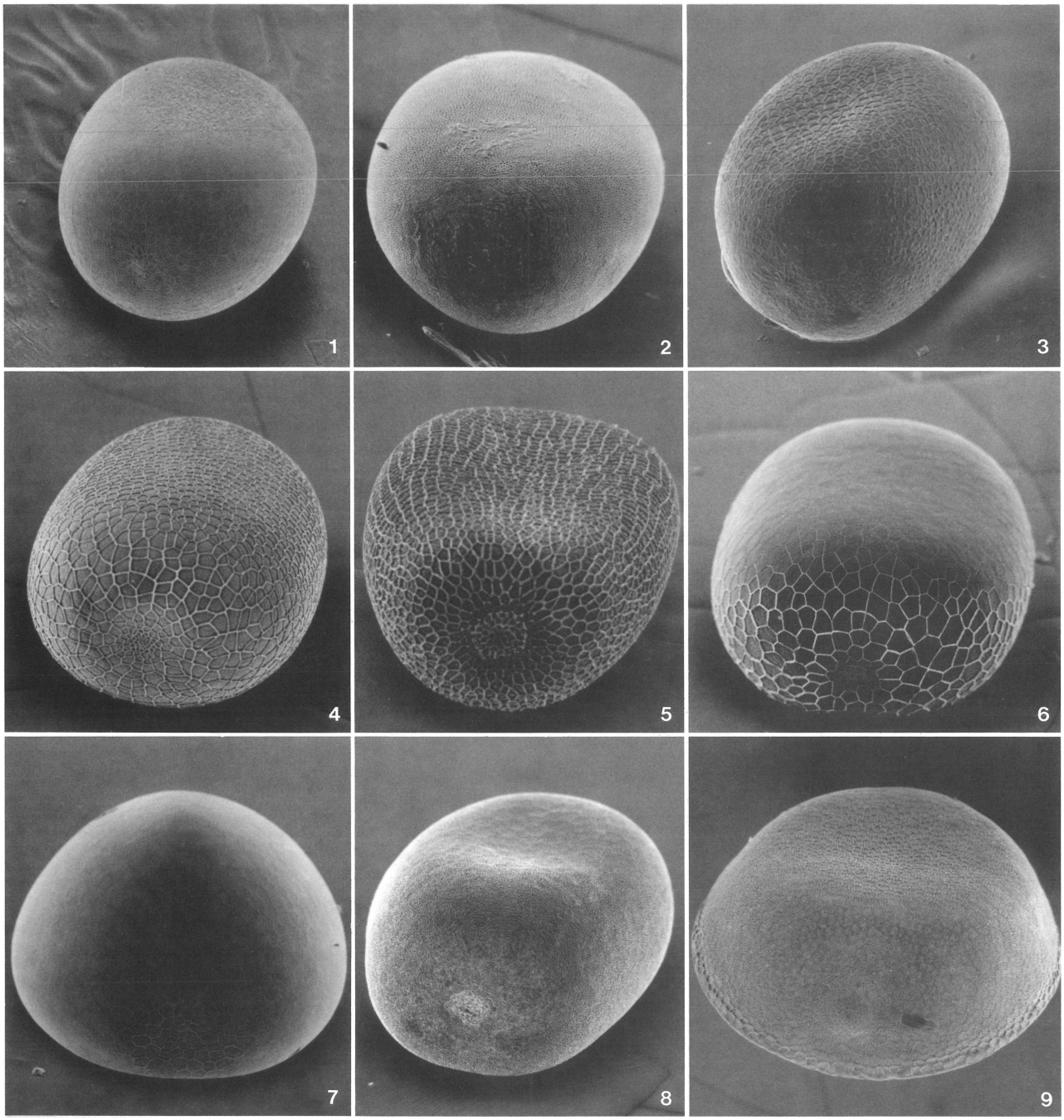
MONOCHROME PLATES

PLATE A: EGGS OF SESIIDAE (micropylar end)

1. *Pennisetia marginata* (Harris). (p. 17). 2. *Zenodoxus rubens* Engelhardt. (p. 25). 3. *Zenodoxus palmii* (Neumoegen). (p. 24). 4. *Cissuvora ampelopsis* Engelhardt. (p. 29). 5. *Paranthrene robiniae* (Hy. Edwards). (p. 34). 6. *Vitacea polistiformis* (Harris). (p. 39). 7. *Albuna fraxini* (Hy. Edwards). (p. 45). 8. *Euhagena nebraskae* Hy. Edwards. (p. 48). 9. *Melittia grandis* (Strecker). (p. 56).

PLATE B: EGGS OF SESIIDAE (micropylar end)

1. *Calasesia coccinea* (Beutenmüller). (p. 59). 2. *Osminia donahueorum* Duckworth and Eichlin. (p. 62). 3. *Sesia tibialis* (Harris). (p. 66). 4. *Synanthedon pictipes* (Grote and Robinson). (p. 77). 5. *Synanthedon exitiosa* (Say). (p. 101). 6. *Sannina uroceriformis* Walker. (p. 109). 7. *Carmenta giliae* (Hy. Edwards). (p. 118). 8. *Penstemonia pappi* Eichlin. (p. 135). 9. Hymenoclea palmi (Beutenmüller). (p. 140).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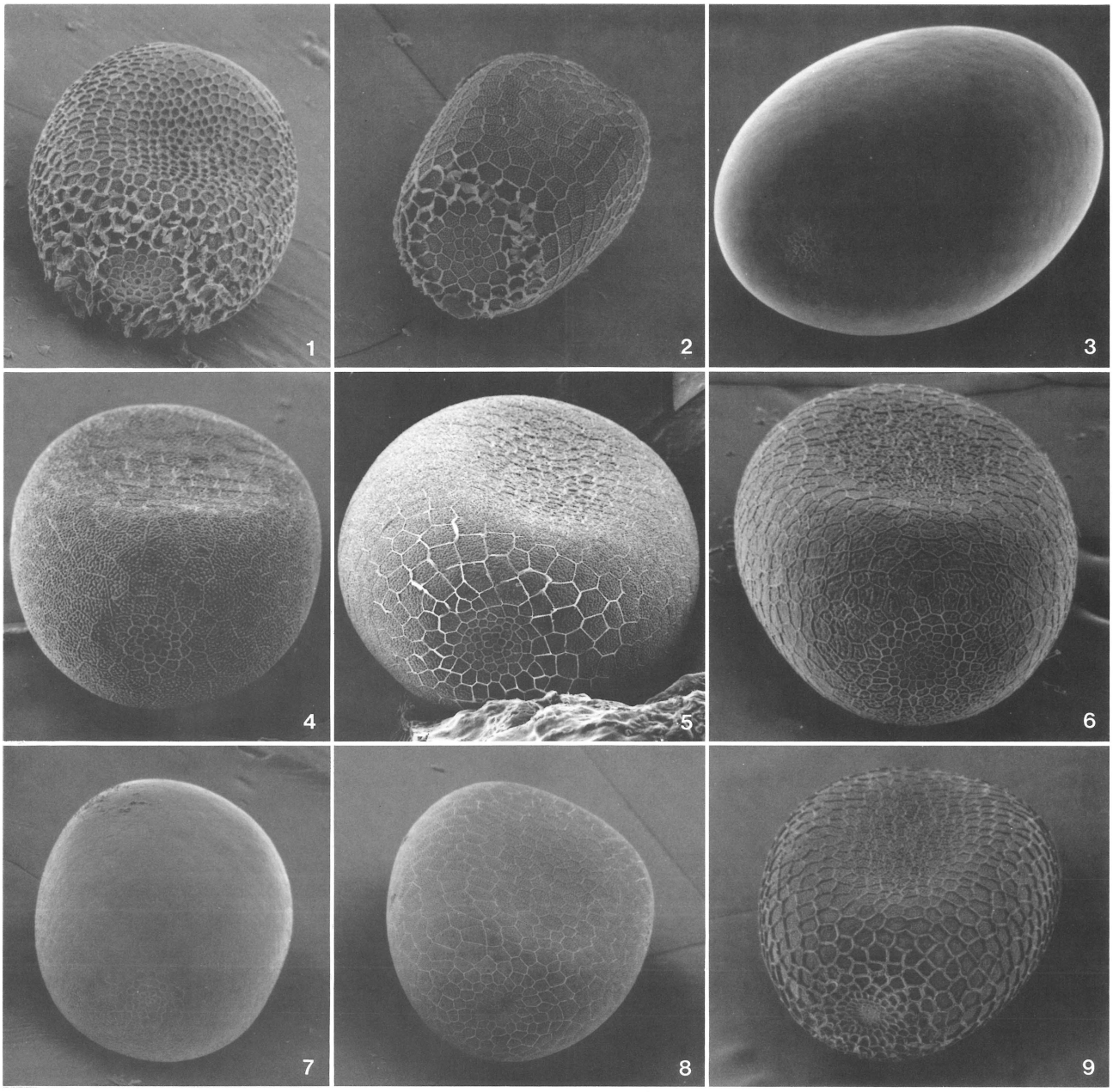
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COLOR PLATES

Sesioidea

PLATE 1

Sesioidea

SESIIDAE

figs. 1–61

NATURAL SIZE 1:1

1. *Pennisetia marginata* (Harr.), ♂. Puyallup, Washington, 6 August 1936, W. Baker (USNM). (p. 17).

2. *Pennisetia marginata* (Harr.), ♀. Puyallup, Washington, 6 August 1936, W. Baker (USNM). (p. 17).

3. *Pennisetia marginata* "*albicoma*" (Hulst), ♂. Pittsburgh, Pennsylvania, 24 August 1905, G. P. Engelhardt (USNM). (p. 17).

4. *Sophona snellingi* Eichlin, ♂. Holotype. La Burrera 450 m, B[aja]. C[alifornia]. Sur, Mexico, 27 August 1977, R. R. Snelling (LACM). (p. 20).

5. *Zenodoxus maculipes* G. & R., ♂. 1,816′, Barton Co., Kansas, 22 June 1912, F. X. Williams (USNM). (p. 23).
6. *Zenodoxus maculipes* G. & R., ♀. 2,650′, Sheridan Co., Kansas, 8 July 1910, F. X. Williams (USNM). (p. 23).
7. *Zenodoxus palmii* (Neum.), ♀. Arboretum, Superior, Arizona, 27 September 1937, G. P. Engelhardt (USNM). (p. 24).
8. *Zenodoxus palmii* (Neum.), ♂. Arboretum 3,000′, Superior, Arizona, 2 October 1937, G. P. Engelhardt (USNM). (p. 24).
9. *Zenodoxus palmii* "*incanae*" Engelh., ♂. Yuma, Arizona, 1 September 1935, G. P. Engelhardt (USNM). (p. 24).
10. *Zenodoxus palmii* "*sphaeralceae*" Engelh., ♂. Hooper, Whitman Co., Washington, 31 August 1933, J. F. G. Clarke (USNM). (p. 24).
11. *Zenodoxus palmii* "*wissadulae*" Engelh., ♀. Brownsville, Texas, 6 May 1919, Diven (USNM). (p. 24).
12. *Zenodoxus rubens* Engelh., ♂. Davis Mts., Jeff Davis Co., Texas, [no date], O. C. Poling (USNM). (p. 25).
13. *Zenodoxus rubens* "*bexari*" Engelh., ♂. Bexar Co., Texas, 2 October 1930, H. B. Parks (USNM). (p. 25).
14. *Paranthrene asilipennis* (Bdv.), ♀. Woodhaven, Long Island, New York, 28 May 1919, G. P. Engelhardt (USNM). (p. 32).
15. *Paranthrene asilipennis* (Bdv.), ♂. Woodhaven, Long Island, New York, 23 June 1919, G. P. Engelhardt (USNM). (p. 32).
16. *Cissuvora ampelopsis* Engelh., ♂. [no locality data), 30 July 1929, H. B. Parks (USNM). (p. 29).
17. *Paranthrene dollii* (Neum.), ♂. Newtown, Long Island, New York, May 1917, [no collector] (USNM). (p. 35).
18. *Paranthrene fenestrata* B. & L., ♀. Flys Peak 9,000–9,800′, Chiricahua Mts., Cochise Co., Arizona, 18 July 1927, J. A. Kusche (CAS). (p. 37).
19. *Paranthrene fenestrata* B. & L., (color form) ♂. Emory Pass 8,200–8,400′, Sierra Co., New Mexico, 11 July 1977, T. Eichlin (CDFA). (p. 37).
20. *Paranthrene fenestrata* B. & L., ♂. Emory Pass 8,200–8,400′, Sierra Co., New Mexico, 11 July 1977, T. Eichlin (CDFA). (p. 37).
21. *Paranthrene dollii* (Neum.), ♀. Newtown, Long Island, New York, 24 June 1920, G. P. Engelhardt (USNM). (p. 35).
22. *Paranthrene dollii* "*castaneum*" (Beutenmüller), ♀. Texas (USNM). (p. 35).
23. *Paranthrene dollii* "*fasciventris*" Engelh., ♀. Chicago, Illinois, 11 June 1920, G. P. Engelhardt (USNM). (p. 35).
24. *Paranthrene robiniae* (Hy. Edw.), ♀. Leonis Valley, California, out 28 July 1939, C. Henne (LACM). (p. 34).
25. *Paranthrene robiniae* (Hy. Edw.), ♂. Torrance, California, out 6 June 1939, C. Henne (LACM). (p. 34).
26. *Paranthrene robiniae* "*palescens*" Engelh., ♀. Needles, San Bernardino Co., California, 20 March 1967, C. R. Kovacic (CDFA). (p. 34).
27. *Paranthrene robiniae* "*perlucida*" (Bsk.), ♂. Missoula, Montana, 5 June 1914, J. Brunner (USNM). (p. 34).
28. *Paranthrene simulans* "*luggeri*" (Hy. Edw.), ♀. Woodhaven, Long Island, New York, 25 June 1915, G. P. Engelhardt (USNM). (p. 33).
29. *Paranthrene simulans* "*palmii*" (Hy. Edw.), ♀. Flatbush, Long Island, New York, 29 May 1919 (USNM). (p. 33).
30. *Paranthrene simulans* (Grt.), ♂. Newtown, Long Island, New York, 10 June 1914, G. P. Engelhardt (USNM). (p. 33).
31. *Paranthrene simulans* (Grt.), ♀. Union Co., New Jersey, 10 June 1923, O. Buchholz (USNM). (p. 33).
32. *Paranthrene simulans* "*luggeri*" (Hy. Edw.), ♂. Woodhaven, Long Island, New York, 16 June 1915, G. P. Engelhardt (USNM). (p. 33).
33. *Paranthrene simulans* "*palmii*" (Hy. Edw.), ♂. Longwood, Florida, 15 April 1930 (USNM). (p. 33).
34. *Paranthrene pellucida* Greenfield & Karandinos, ♂. Van Buren State Park, Van Buren Co., Michigan, 17 July 1986, W. H. Taft (CDFA). (p. 34).
35. *Paranthrene tabaniformis* (Rottemburg), ♀. Forest Pk., Long Island, New York, 15 May 1905, G. P. Engelhardt (USNM). (p. 36).
36. *Paranthrene tabaniformis* (Rottemburg), ♂. Pine, Indiana, 29 June 1914, A. Kwiat (FMNH). (p. 36).
37. *Paranthrene tabaniformis* "*denotata*" (Hy. Edw.), ♀. Edgebr. [?], 12 June 1930, A. W. Herz (FMNH). (p. 36).
38. *Paranthrene tabaniformis* "*oslari*" Engelh., ♂. San Juan Mts., Colorado, Oslar (USNM). (p. 36).
39. *Vitacea admiranda* (Hy. Edw.), ♀. 20 mi E Taxco, Guerrero, Mexico, 1 September 1965, A. R. Gillogly (LACM). (p. 41).
40. *Vitacea cupressi* (Hy. Edw.), ♂. Arizona (AMNH). (p. 41).
41. *Vitacea polistiformis* (Harr.), ♂. Cincinnati, Ohio, 31 July 1900, A. F. Braun (USNM). (p. 39).
42. *Vitacea polistiformis* (Harr.), ♀. Staten Island, New York, 14 August 1929, G. P. Engelhardt (USNM). (p. 39).
43. *Vitacea polistiformis* "*huron*" Engelh., ♂. Pentwater, Michigan, 20 July 1920, E. Liljeblad (USNM). (p. 39).
44. *Vitacea polistiformis* "*huron*" Engelh., ♀. Millers, Indiana, 11 July 1914, G. P. Engelhardt (USNM). (p. 39).
45. *Albuna fraxini* (Hy. Edw.), ♂. Platte Canyon, Colorado, 7 August 1920, Oslar (USNM). (p. 45).
46. *Albuna fraxini* (Hy. Edw.), ♀. Riverside, Illinois, 19 July 1929, E. F. Lustig (FMNH). (p. 45).
47. *Albuna fraxini* "*vitriosa*" Engelh., ♂. Willow Springs, Illinois, 3 August 1919, H. W. Harris (USNM). (p. 45).
48. *Vitacea scepsiformis* (Hy. Edw.), ♂. Hartsdale, New York, 21 July 1939, G. P. Engelhardt (USNM). (p. 40).
49. *Vitacea scepsiformis* (Hy. Edw.), ♀. Hartsdale, New York, 4 August 1940, G. P. Engelhardt (USNM). (p. 40).
50. *Albuna pyramidalis* (Wlk.), ♀. Hymers, Ontario, 24 June 1930 (USNM). (p. 43).
51. *Albuna pyramidalis* "*beutenmulleri*" Skin., ♀. Chamb. Ranch, Kane Co., Utah, 3 June 1981, C. R. Nelson (Utah State Univ.). (p. 43).
52. *Albuna pyramidalis* "*coloradensis*" Hy. Edw., ♂. Stockton, Utah, June (USNM). (p. 43).
53. *Albuna pyramidalis* "*montana*" Hy. Edw., ♂. Onion Valley 9,000′, Inyo Co., California, 17 July 1938 (USNM). (p. 43).
54. *Albuna pyramidalis* "*rubescens*" (Hulst), ♀. Rock Creek 8,000′, Colorado Springs, Colorado, 17 October 1937, G. P. Engelhardt (USNM). (p. 43).
55. *Euhagena emphytiformis* (Wlk.), ♂. Chickasaw, Mobile, Alabama, 22 September 1930 (USNM). (p. 46).
56. *Euhagena emphytiformis* "*solituda*" (Hy. Edw.), ♂. Turkey Creek 6,000′, Jeff. Co., Colorado, 7 August 1923 (USNM). (p. 46).
57. *Euhagena emphytiformis* "*solituda*" (Hy. Edw.), ♀. Turkey Creek 6,000′, Jeff. Co., Colorado, 7 August 1923 (USNM). (p. 46).
58. *Euhagena nebraskae* Hy. Edw., ♂. Chimney Gulch, Golden, Colorado, 5 October 1921, Oslar (USNM). (p. 48).
59. *Euhagena nebraskae* "*intensa*" Engelh., ♂. Mojave River bed, 1 mi S Rio Grande, Santa Barbara Co., California, 25 October 1964, C. Henne (LACM). (p. 48).
60. *Euhagena nebraskae* "*intensa*" Engelh., ♀. Mojave River bed, 1 mi S Rio Grande, Santa Barbara Co., California, 31 October 1965, C. Henne (LACM). (p. 48).
61. *Euhagena nebraskae* "*mormoni*" Engelh., ♂. Logan, Cache Co., Utah, 1 October 1970, L. V. Frandsen (Utah State Univ.). (p. 48).

SESIOIDEA: PLATE 1

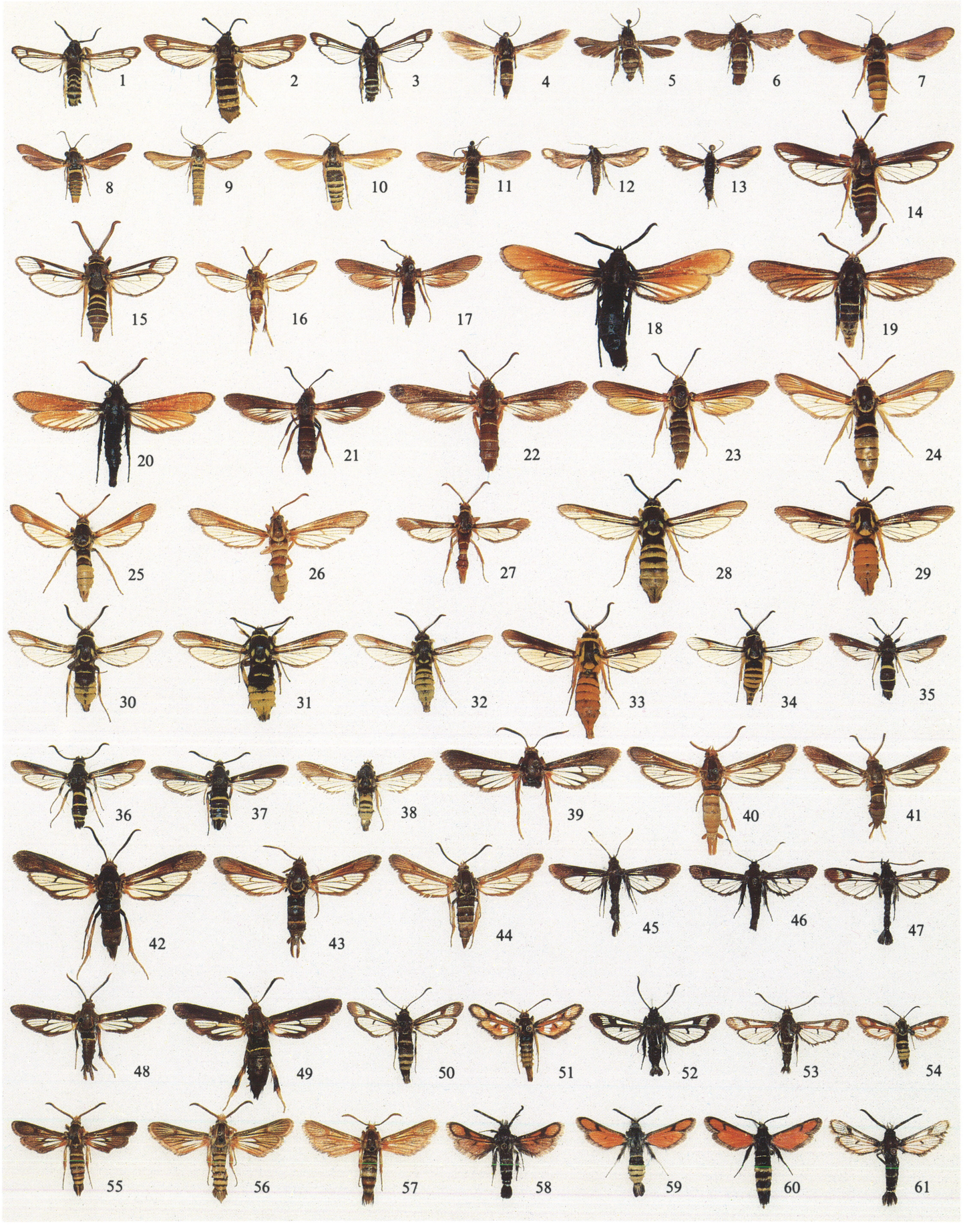


PLATE 2

Sesioidea

SESIIDAE

figs. 1–64

NATURAL SIZE 1:1

1. *Melittia gloriosa* Hy. Edw., ♂. Colorado River basin, NE Fertilla, Riverside Co., California, emerged 7 September 1938, C. Henne (LACM). (p. 57).
2. *Melittia calabaza* Duckworth & Eichlin, ♂. Los Reyes, Mexico, emerged June 1958, W. W. Gibson (CDFA). (p. 54).
3. *Melittia gloriosa* Hy. Edw., ♀. Colorado River basin, NE Fertilla, Riverside Co., California, emerged 4 October 1938, C. Henne (LACM). (p. 57).
4. *Melittia cucurbitae* (Harr.), ♀. Flatbush, Long Island, New York, 20 July 1929, G. P. Engelhardt (USNM). (p. 52).
5. *Melittia gloriosa* "*lindseyi*" B. & Benj., ♀. Caldwell, Kansas, 6 September 1943, Stallings and Turner (CNC). (p. 57).
6. *Melittia grandis* (Stkr.), ♂. Limpia Canyon, Jeff Davis Co., Texas, 3 June 1950, E. C. Johnston (CNC). (p. 56).
7. *Melittia snowii* Hy. Edw., ♀. Medicine Lodge, Barber Co., Kansas, 15 July 1929, G. P. Engelhardt (USNM). (p. 54).
8. *Melittia grandis* (Stkr.), ♀. 2,060′, Rush Co., Kansas, 28 July 1912, F. X. Williams (USNM). (p. 56).
9. *Sesia tibialis* "*melanoformis*" (Engelh.), ♂. Tioga Pass 9,400′, Tuolumne Co., California, 15 July 1976, T. D. Eichlin (CDFA). (p. 66).
10. *Melittia grandis* "*hermosa*" Engelh., ♀. Arizona (USNM). (p. 56).

11. *Sesia tibialis* "*pacificum*" (Hy. Edw.), ♂. Bouquet Canyon, Los Angeles Co., California, 10 June 1940, C. Henne (LACM). (p. 66).
12. *Melittia magnifica* Beutenmüller, ♂. Plana Los Cerritos, 11.2 mi S Todos Santos, Baja California Sur, Mexico, 28 September 1981, F. Andrews and D. Faulkner (CDFA). (p. 58).
13. *Sesia tibialis* (Harr.), ♂. Beaver Valley, Utah, July, G. P. Engelhardt (USNM). (p. 66).
14. *Sesia apiformis* (Cl.), ♂. Brooklyn, New York, May, G. P. Engelhardt (FMNH). (p. 65).
15. *Sesia apiformis* (Cl.), ♀. [no data] (YPM). (p. 65).
16. *Synanthedon rileyana* (Hy. Edw.), ♂. Willard, Missouri, 6 August 1919, Brower (USNM). (p. 80).
17. *Synanthedon rileyana* (Hy. Edw.), ♀. Tottenville, Staten Island, New York, 24 August 1920 (USNM). (p. 80).
18. *Synanthedon acerni* (Clem.), ♂. Woodhaven, Long Island, New York, 10 June 1921, G. P. Engelhardt (USNM). (p. 81).
19. *Synanthedon acerni* "*tepperi*" (Hy. Edw.), ♀. Mobile, Alabama, [no other data] (USNM). (p. 81).
20. *Synanthedon fatifera* Hodges, ♂. Sault Ste. Marie, Ontario, 22 May 1970, (CNC). (p. 82).
21. *Synanthedon alleri* (Engelh.), ♂. Chickasaw, Alabama, 13 September 1931, G. P. Engelhardt (USNM). (p. 84).
22. *Synanthedon kathyae* Duckworth & Eichlin, ♂. Prince George's Co., Maryland, 21 July 1978, John F. Reinert (USNM). (p. 84).
23. *Synanthedon arctica* (Beutenmüller), ♂. Ruby, Alaska, 21 July 1916 (CM). (p. 85).
24. *Synanthedon culiciformis* (L.), ♀. Bend, Oregon, 10 June 1918, H. J. Dietz (USNM). (p. 86).
25. *Synanthedon fulvipes* (Harr.), ♂. Daws Swamp, Ottawa, Ontario, 29 May 1938, C. H. Young (CNC). (p. 88).
26. *Synanthedon refulgens* (Hy. Edw.), ♂. Chickasaw, Alabama, 15 April 1930, G. P. Engelhardt (USNM). (p. 90).
27. *Synanthedon rubrofascia* (Hy. Edw.), ♀. emerged 5 June 1940, [no other data] (USNM). (p. 90).
28. *Synanthedon saxifragae* (Hy. Edw.), ♀. Gothic 9,500′, Gunnison Co., Colorado, 8 July 1961, T. Lincks (YPM). (p. 92).
29. *Synanthedon sigmoidea* (Beutenmüller), ♂. Amagansett, Long Island, New York, 29 August 1911, G. P. Engelhardt (USNM). (p. 92).
30. *Synanthedon arizonensis* (Beutenmüller), ♀. Chiricahua Mts., Cochise Co., Arizona, 8 June 1915, G. P. Engelhardt (USNM). (p. 95).
31. *Synanthedon arkansasensis* Duckworth & Eichlin, ♀. Devil's Den State Park, Washington Co., Arkansas, 5 July 1966, R. W. Hodges (USNM). (p. 96).
32. *Synanthedon castaneae* (Bsk.), ♀. Elizabeth, New Jersey, 7 July, O. Buchholz (FMNH). (p. 97).
33. *Synanthedon chrysidipennis* (Bdv.), ♂. 1.5 km SE High Lake 8,800′, Yellowstone N. P., Wyoming, 19 July 1979, R. E. Dietz (CDFA). (p. 98).
34. *Synanthedon chrysidipennis* (Bdv.), ♀. Lassen Pk. 7,500′, Shasta Co., California, 18 July 1949, C. I. Smith (CDFA). (p. 98).
35. *Synanthedon mellinipennis* (Bdv.), ♂. Lone Pine Rd., 3 mi E Wrightwood 6,000′, San Bernardino Co., California, 11 July 1970, J. Roberts and J. Honey (CDFA). (p. 99).
36. *Synanthedon mellinipennis* (Bdv.), ♀. Del Mar, San Diego Co., California, 6 July 1946, J. A. Comstock (LACM). (p. 99).
37. *Synanthedon polygoni* "*praestans*" (Hy. Edw.), ♂. Yreka, Siskiyou Co., California, 16 September 1977, F. D. Horn (CDFA). (p. 99).
38. *Synanthedon exitiosa* (Say), ♀. Aqueduct, New York, July 1918, G. P. Engelhardt (USNM). (p. 101).
39. *Synanthedon exitiosa* (Say), ♂. Aqueduct, New York, 25 June 1918, G. P. Engelhardt (USNM). (p. 101).
40. *Synanthedon exitiosa* "*barnesii*" (Beutenmüller), ♂. Denver, Colorado, 16 June 1875, Oslar (USNM). (p. 101).
41. *Synanthedon exitiosa* "*edwardsii*" (Beutenmüller), ♀. Ocqueoc Lake, Presque Isle Co., Michigan, 20 July 1975, E. and R. Hodges (USNM). (p. 101).
42. *Synanthedon exitiosa* "*graefi*" (Hy. Edw.), ♂. Corvallis, Oregon, 7 May 1917, B. G. Thompson (USNM). (p. 101).
43. *Synanthedon exitiosa* "*graefi*" (Hy. Edw.), ♀. Corvalliis, Oregon, 24 April 1957, R. G. Rosenstiel (USNM). (p. 101).
44. *Synanthedon novaroensis* (Hy. Edw.), ♀. Magna Bay, British Columbia, 1953 (CNC). (p. 103).
45. *Synanthedon pini* (Kellicott), ♂. T13N, R12W, Sec 33, Newaygo Co., Michigan, 17–21 June 1987, W. H. Taft (CDFA). (p. 103).
46. *Synanthedon sequoiae* (Hy. Edw.), ♀. Salmon Arm, British Columbia, 27 April 1954 (CNC). (p. 104).
47. *Palmia praecedens* (Hy. Edw.), ♂. Pueblo Del Sol, Huachuca Mts., Cochise Co., Arizona, 7 April 1988, R. Wielgus (CDFA). (p. 105).
48. *Podosesia aureocincta* Purrington & Nielsen, ♀. Stillwater, Payne Co., Oklahoma, 14 October 1970, D. C. Arnold (F. F. Purrington). (p. 107).
49. *Podosesia syringae* (Harr.), ♂. Flatbush, New York, 7 June 1926, G. P. Engelhardt (USNM). (p. 106).
50. *Podosesia syringae* "*fraxini*" (Lugger), ♂. Sacramento, California, 26 April 1980, T. D. Eichlin (CDFA). (p. 106).
51. *Sannina uroceriformis* Wlk., ♂. Willard, Missouri, 29 May 1921, A. E. Brower (FMNH). (p. 109).
52. *Sannina uroceriformis* Wlk., ♀. Missouri, 29 June 1920 (USNM). (p. 109).
53. *Carmenta armasata* (Druce), ♂. 18 mi W Linares 2,700′, Nuevo Leon, Mexico, 26 September 1975, J. Powell, J. Chemsak, T. Friedlander (CDFA). (p. 114).
54. *Carmenta armasata* (Druce), ♀. 18 mi W Linares 2,700′, Nuevo Leon, Mexico, 26 September 1975, J. Powell, J. Chemsak, T. Friedlander (CDFA). (p. 114).
55. *Carmenta bassiformis* (Wlk.), ♀. Pittsburgh, Pennsylvania, 20 August 1906, G. P. Engelhardt (USNM). (p. 115).
56. *Carmenta corni* (Hy. Edw.), ♀. Woodhaven, Long Island, New York, 12 June 1921, G. P. Engelhardt (USNM). (p. 116).
57. *Carmenta engelhardti* Duckworth & Eichlin, ♀. S Fork Cave Creek Canyon, Cochise Co., Arizona, emerged 8 August 1974, Eichlin (CDFA). (p. 118).
58. *Carmenta giliae* (Hy. Edw.), ♂. Wilson Peak, Colorado, [no date], Oslar (USNM). (p. 118).
59. *Carmenta giliae* "*vitrina*" (Neum.), ♂. Silverton, Colorado, 27 July (USNM). (p. 118).
60. *Carmenta giliae* "*woodgatei*" Engelh., ♂. White Mts., Arizona, [no date], Barnes (USNM). (p. 118).
61. *Carmenta laurelae* Brown, Eichlin, & Snow, ♂. Univ. South Florida, Tampa, Hillsborough Co., Florida, 7 May 1985, L. Brown (CDFA). (p. 120).
62. *Carmenta mariona* (Beutenmüller), ♂. Res. Sanctuary, Elgin 5,000′, Santa Cruz Co., Arizona, emerged April 1983, G. Muenchow (CDFA). (p. 120).
63. *Carmenta mariona* (Beutenmüller), ♀. Res. Sanctuary, Elgin 5,000′, Santa Cruz Co., Arizona, emerged April 1983, G. Muenchow (CDFA). (p. 120).
64. *Carmenta phoradendri* Engelh., ♀. San Antonio, Texas, 15 April 1928, G. P. Engelhardt (USNM). (p. 124).

SESIOIDEA: PLATE 2

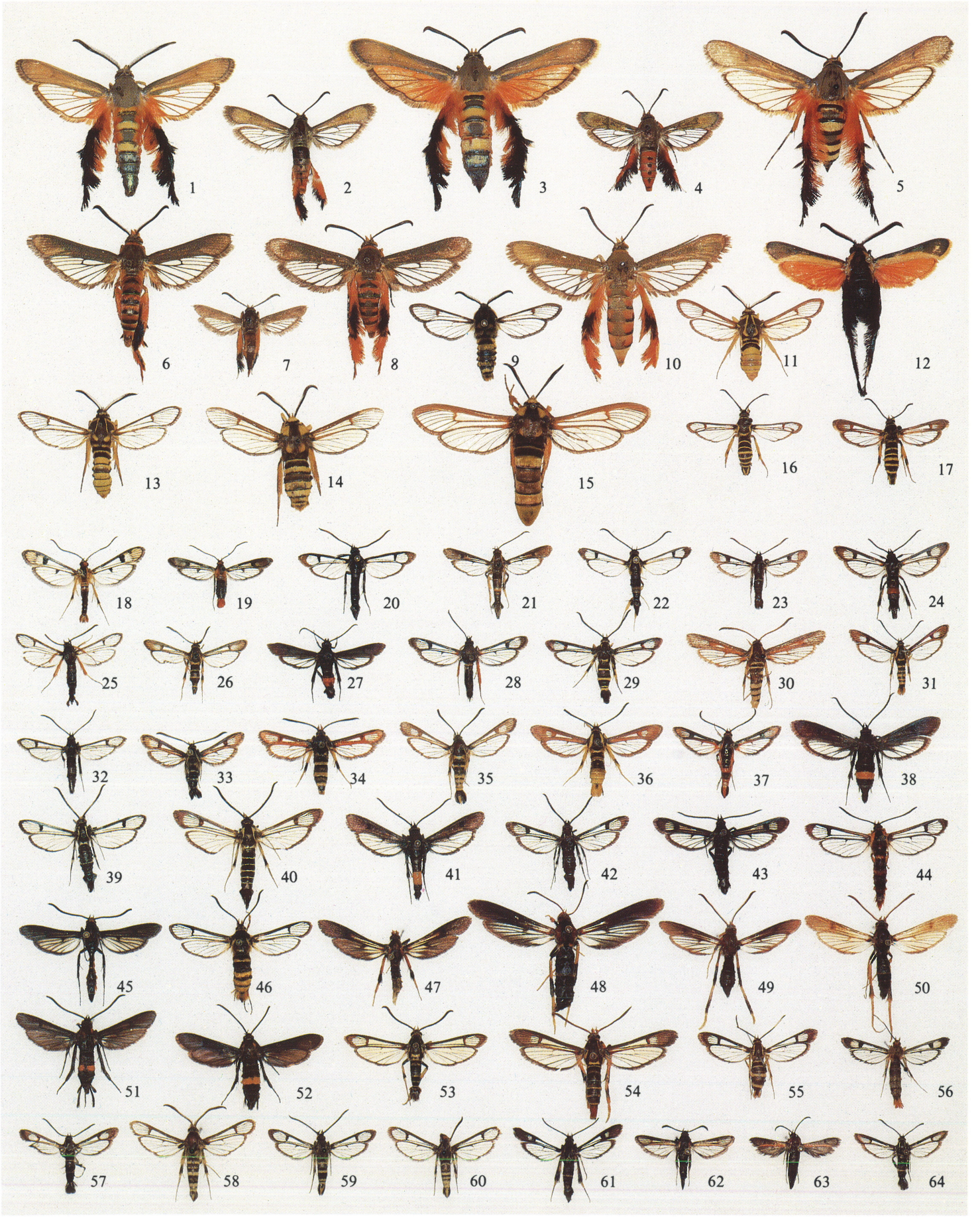


PLATE 3

Sesioidea

SESIIDAE

figs. 1–78

ONE AND ONE-HALF TIMES NATURAL SIZE 1.5:1

1. *Sophona greenfieldi* Eichlin, ♂. Holotype. Kitt Peak, Baboquivari Mts. 5,800′, Pima Co., Arizona, 17 August 1982, M. D. Greenfield (USNM). (p. 20).
2. *Zenodoxus canescens* Hy. Edw., ♂. Blythe, Riverside Co., California, 13 November 1936, C. Henne (LACM). (p. 21).
3. *Zenodoxus canescens* Hy. Edw., ♀. Blythe, Riverside Co., California, 13 November 1936, C. Henne (LACM). (p. 21).
4. *Zenodoxus heucherae* Hy. Edw., ♂. 2 mi S Grass Valley, Nevada Co., California, 27 June 1967, J. Powell (CAS). (p. 23).
5. *Zenodoxus mexicanus* Beutenmüller, ♂. Santa Elena Cyn., Big Bend, Texas, 8 August 1975, T. Friedlander (CDFA). (p. 24).
6. *Zenodoxus rubens* Engelh., ♀. 2.3 mi NW Rodeo, New Mexico, 16 September 1960, M. Cazier (CAS). (p. 25).
7. *Zenodoxus sidalceae* Engelh., ♀. Pullman, Washington, 31 July 1934, J. F. G. Clarke (USNM). (p. 26).
8. *Synanthedon geliformis* (Wlk.), ♂. Gainesville, Florida, 11 March 1929, G. P. Engelhardt (USNM). (p. 75).
9. *Synanthedon richardsi* (Engelh.), ♀. Clarke Co., Georgia, 15 June 1928, Richards (USNM). (p. 75).
10. *Synanthedon scitula* (Harr.), ♂. West Hills, Long Island, New York, 24 May 1915, G. P. Engelhardt (USNM). (p. 76).
11. *Synanthedon scitula* "*corusca*" (Hy. Edw.), ♀. Mobile, Alabama, 30 March 1930, G. P. Engelhardt (USNM). (p. 76).
12. *Synanthedon pictipes* (G. & R.), ♂. Colesville, Montgomery Co., Maryland, 2 June 1985, D. C. Ferguson (USNM). (p. 77).
13. *Synanthedon pictipes* (G. & R.), ♀. Edgebrook, Illinois, 2 June 1913, A. Kwait (FMNH). (p. 77).
14. *Synanthedon rhododendri* (Beutenmüller), ♂. Prospect Pk., Long Island, New York, 1 June 1918, G. P. Engelhardt (USNM). (p. 77).
15. *Synanthedon tipuliformis* (Cl.), ♀. Pinelawn, Long Island, New York, 16 May 1910, G. P. Engelhardt (USNM). (p. 80).
16. *Synanthedon tipuliformis* (Cl.), ♂. Pinelawn, Long Island, New York, 16 May 1920, G. P. Engelhardt (USNM). (p. 80).
17. *Synanthedon acerni* "*buscki*" (Engelh.), ♀. Gainesville, Florida, 6 May 1929, G. P. Engelhardt (USNM). (p. 81).
18. *Synanthedon viburni* Engelh., ♂. Brooklyn Botanical Garden, New York, 23 May 1930, G. P. Engelhardt (USNM). (p. 82).
19. *Synanthedon viburni* Engelh., ♀. Sheridan Nurs., Toronto, Ontario, 14 June 1912 (CNC). (p. 82).
20. *Synanthedon bolteri* (Hy. Edw.), ♂. Earl Grey, Saskatchewan, 4 July 1926, J. D. Ritchie (USNM). (p. 85).
21. *Synanthedon canadensis* Duckworth & Eichlin, ♀. Twin Cr., Logan Cn., Cache Co., Utah, 1– 6 July 1979 (Utah State Univ.). (p. 86).
22. *Synanthedon dominicki* Duckworth & Eichlin, ♂. Univ. South Florida, Tampa, Hillsborough Co., Florida, 13 March 1985, L. Brown (CDFA). (p. 88).
23. *Synanthedon pyri* (Harr.), ♀. Brooklyn, New York, 10 June 1906, G. P. Engelhardt (USNM). (p. 89).
24. *Synanthedon refulgens* "*seminole*" (Beutenmüller), ♂. Chickasaw, Alabama, 7 April 1930, T. Van Allen (USNM). (p. 90).
25. *Synanthedon rubrofascia* (Hy. Edw.), ♂. McClellanville, South Carolina, 14 August 1969, R. B. Dominick and C. R. Edwards (USNM). (p. 90).

26. *Synanthedon albicornis* (Hy. Edw.), ♂. Pasadena, Los Angeles Co., [California], out 3 May 1939, C. Henne (LACM). (p. 93).
27. *Synanthedon albicornis* (Hy. Edw.), ♀. Torrance, Los Angeles Co., [California], out 29 March 1939, C. Henne (LACM). (p. 93).
28. *Synanthedon decipiens* (Hy. Edw.), ♂. Biloxi, Mississippi, 29 May 1910, F. M. Jones (USNM). (p. 94).
29. *Synanthedon proxima* (Hy. Edw.), ♂. Staten Island, New York, 25 May 1921, G. P. Engelhardt (USNM). (p. 93).
30. *Synanthedon proxima* (Hy. Edw.), ♀. Ivoryton, Connecticut, June 1914 (USNM). (p. 93).
31. *Synanthedon sapygaeformis* (Wlk.), ♀. Jacksonville, Florida, [no date], Ashmead (USNM). (p. 94).
32. *Synanthedon sapygaeformis* "*floridensis*" (Grt.), ♀. Daytona, Florida, 10 October 1938, G. P. Engelhardt (USNM). (p. 94).
33. *Synanthedon bibionipennis* (Bdv.), ♂. Pullman, Washington, 9 May 1940, R. D. Shenefelt (USNM). (p. 96).
34. *Synanthedon bibionipennis* (Bdv.), ♀. Santa Clara Co., California, July [no other data] (USNM). (p. 96).
35. *Synanthedon castaneae* (Bsk.), ♂. Falls Church, Fairfax Co., Virginia, 13 June 1913, F. Johansen (USNM). (p. 97).
36. *Synanthedon chrysidipennis* "*wallowa*" (Engelh.), ♂. Elk Horn Mt. 9,000′, Oregon, 31 July 1938, G. P. Engelhardt (USNM). (p. 98).
37. *Synanthedon polygoni* (Hy. Edw.), ♂. Mint Canyon, Los Angeles Co., California, 26 April 1936, C. Henne (LACM). (p. 99).
38. *Synanthedon polygoni* (Hy. Edw.), ♀. Santa Monica Mts. 1,800′, Los Angeles Co., California, 5 March 1955, C. Henne (LACM). (p. 99).
39. *Synanthedon polygoni* "*animosa*" (Hy. Edw.), ♂. Burbank, Los Angeles Co., California, 10 April 1938, C. Henne (LACM). (p. 99).
40. *Synanthedon polygoni* "*animosa*" (Hy. Edw.), ♀. El Segundo Dunes 100′, Los Angeles Co., California, 6 June 1941, C. Henne (LACM). (p. 99).
41. *Synanthedon resplendens* (Hy. Edw.), ♂. P. Sycamore Grove, Los Angeles Co., California, out 18 June 1940, C. Henne (LACM). (p. 100).
42. *Synanthedon resplendens* (Hy. Edw.), ♀. P. Sycamore Grove, Los Angeles Co., California, out 23 June 1940, C. Henne (LACM). (p. 100).
43. *Carmenta albociliata* (Engelh.), ♂. 18 mi W Linares 2,700′, Nuevo Leon, Mexico, 24 September 1975, J. Powell, J. Chemsak, T. Friedlander (CDFA). (p. 111).
44. *Carmenta albociliata* (Engelh.), ♀. Allotype. Kerrville, Texas, October 1916, (USNM). (p. 111).
45. *Carmenta anthracipennis* (Bdv.), ♂. Chickasaw, Mobile [Co.], Alabama, 13 September 1929, Van Allen (USNM). (p. 112).
46. *Carmenta anthracipennis* (Bdv.), ♀. Chickasaw, Alabama, 28 September 1938, G. P. Engelhardt (USNM). (p. 112).
47. *Carmenta anthracipennis* "*sanborni*" Hy. Edw., ♂. Waukegan, Illinois, 27 August 1933, A. K. W. (USNM). (p. 112).
48. *Carmenta anthracipennis* "*sanborni*" Hy. Edw., ♀. Miller, Indiana, 10 August 1919, W. J. Gerhard (FMNH). (p. 112).
49. *Carmenta apache* Engelh., ♀. Prescott, Arizona, 1 July 1907 (?), Barnes (USNM). (p. 113).
50. *Carmenta arizonae* (Beutenmüller), ♂. Chisos Mts., Brewster Co., Texas, 10 August 1932 (USNM) (p. 114).
51. *Carmenta auritincta* (Engelh.), ♂. 2 mi W Pena Blanca Lk., Atasco[sa] Mts., Santa Cruz Co., Arizona, 13 August 1977, S. Kuba (CDFA). (p. 115).
52. *Carmenta auritincta* (Engelh.), ♀. Carr Canyon 5,400′, Huachuca Mts., Cochise Co., Arizona, 21–23 August 1972, R. R. Snelling (CDFA). (p. 115).
53. *Carmenta bassiformis* (Wlk.), ♂. Pittsburgh, Pennsylvania, 12 August 1906, G. P. Engelhardt (USNM). (p. 115).
54. *Carmenta bassiformis* "*bolli*" (Hy. Edw.), ♂. Pottawatomie Co., Kansas, 24 June 1933, R. H. Painter (USNM). (p. 115).
55. *Carmenta bassiformis* "*bolli*" (Hy. Edw.), ♀. Pottawatomie Co., Kansas, 24 June 1933, R. H. Painter (USNM). (p. 115).
56. *Carmenta corni* (Hy. Edw.), ♂. Woodhaven, Long Island, New York, 17 June 1926, G. P. Engelhardt (USNM). (p. 116).
57. *Carmenta engelhardti* Duckworth & Eichlin, ♂. S Fork Cave Creek Canyon, Cochise Co., Arizona, 7 August 1974, Eichlin (CDFA). (p. 118).
58. *Carmenta ithacae* (Beutenmüller), ♀. 5 mi W Pena Blanca, Santa Cruz Co., Arizona, 16 August 1974, Eichlin (CDFA). (p. 119).
59. *Carmenta mimuli* (Hy. Edw.), ♂. Pueblo Del Sol, Huachuca Mts., Cochise Co., Arizona, 2 September 1985, R. Wielgus (CDFA). (p. 121).
60. *Carmenta ogalala* Engelh., ♂. Durango, Colorado, Oslar (USNM). (p. 123).
61. *Carmenta pallene* (Druce), ♂. SW Res. Sta. 5,400′, 5 mi W Portal, Chiricahua Mts., Cochise Co., Arizona, 16–17 August 1978, M. S. Wasbauer (CDFA). (p. 123).
62. *Carmenta tecta* (Hy. Edw.), ♂. Kit [sic] Peak, Pima Co., Arizona, 17 August 1974, Eichlin (CDFA). (p. 128).
63. *Carmenta texana* (Hy. Edw.), ♂. Royal Palm Pk., Florida, 17 April 1929, G. P. Engelhardt (USNM). (p. 129).
64. *Carmenta phoradendri* Engelh., ♂. San Antonio, Texas, 7 June 1928, G. P. Engelhardt (USNM). (p. 124).
65. *Carmenta pyralidiformis* (Wlk.), ♂. Cincinnati, Ohio, 4 September 1901, A. F. Braun (USNM). (p. 125).
66. *Carmenta pyralidiformis* "*aurantis*" Engelh., ♂. Dog River, Mobile, Alabama, 31 [sic] September 1928, G. P. Engelhardt (USNM). (p. 125).
67. *Carmenta querci* (Hy. Edw.), ♂. Sabino Canyon, Pima Co., Arizona, emerged 10 March 1921, G. Hofer (YPM). (p. 126).
68. *Carmenta rubricincta* (Beutenmüller), ♂. 31.7 mi N Durango, Durango, Mexico, 22 July 1982 (SDNH). (p. 127).
69. *Carmenta suffusata* Engelh., ♂. 4 mi W Iturbide 5,500′, Nuevo Leon, Mexico, 24 September 1975, J. Powell, J. Chemsak, T. Friedlander (CDFA). (p. 128).
70. *Carmenta verecunda* (Hy. Edw.), ♂. Kamiack Butte, Washington, 22 April 1935, J. F. G. Clarke (USNM). (p. 130).
71. *Carmenta verecunda* (Hy. Edw.), ♀. Kamiack Butte, Washington, 12 May 1935, J. F. G. Clarke (USNM). (p. 130).
72. *Carmenta wielgusi* Eichlin, ♂. Holotype. Sierra Vista, Cochise Co., Arizona, 3 August 1984, R. Wielgus (USNM). (p. 131).
73. *Penstemonia clarkei* Engelh., ♂. Lewiston, Trinity Co., California, emerged 15 February 1978, R. Dunkle (CDFA). (p. 133).
74. *Penstemonia edwardsii* (Beutenmüller), ♂. Oak Creek Canyon, Flagstaff, Arizona, 29 June 1936, G. P. Engelhardt (USNM). (p. 134).
75. *Penstemonia hennei* Engelh., ♂. Mill Creek, San Bernardino Co., California, 16 August 1938, C. Henne (USNM). (p. 134).
76. *Penstemonia hennei* Engelh., ♀. Mill Creek, San Bernardino Co., California, 9 August 1937, C. Henne (USNM). (p. 134).
77. *Penstemonia pappi* Eichlin, ♂. Keystone Canyon 5,500′, New York Mts., San Bernardino Co., California, emerged 22 June 1968, C. Henne (LACM). (p. 135).
78. *Penstemonia pappi* Eichlin, ♀. Keystone Canyon 5,500′, New York Mts., San Bernardino Co., California, emerged 23 June 1968, C. Henne (LACM). (p. 135).

SESIOIDEA: PLATE 3

PLATE 4

Sesioidea

SESIIDAE

figs. 1–42

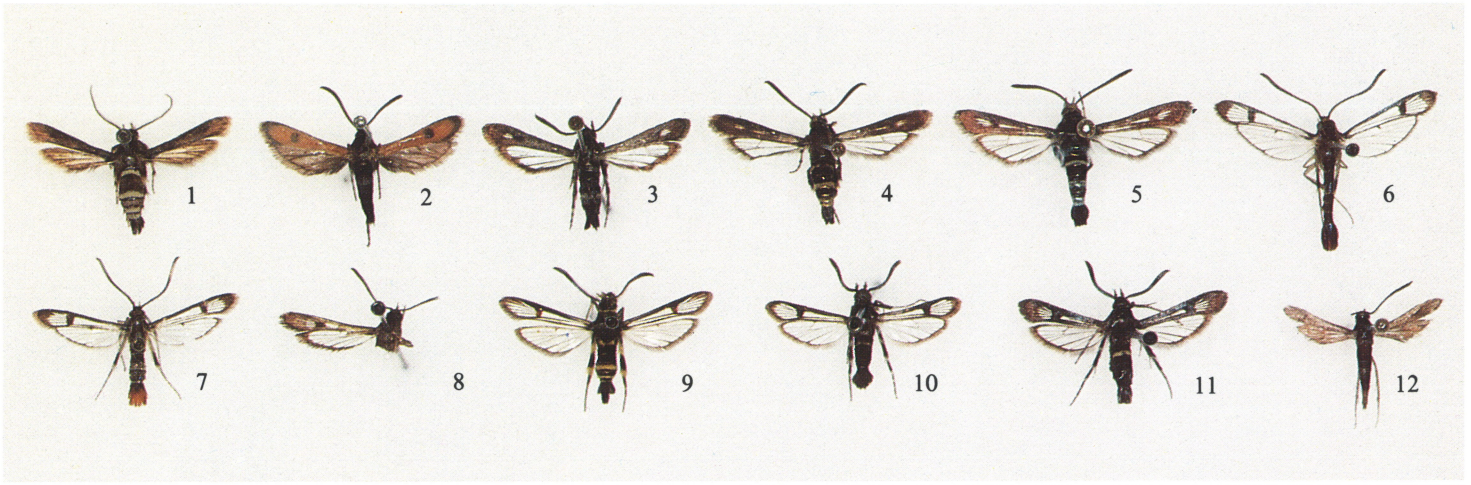
TWICE NATURAL SIZE 2:1 (1–12)

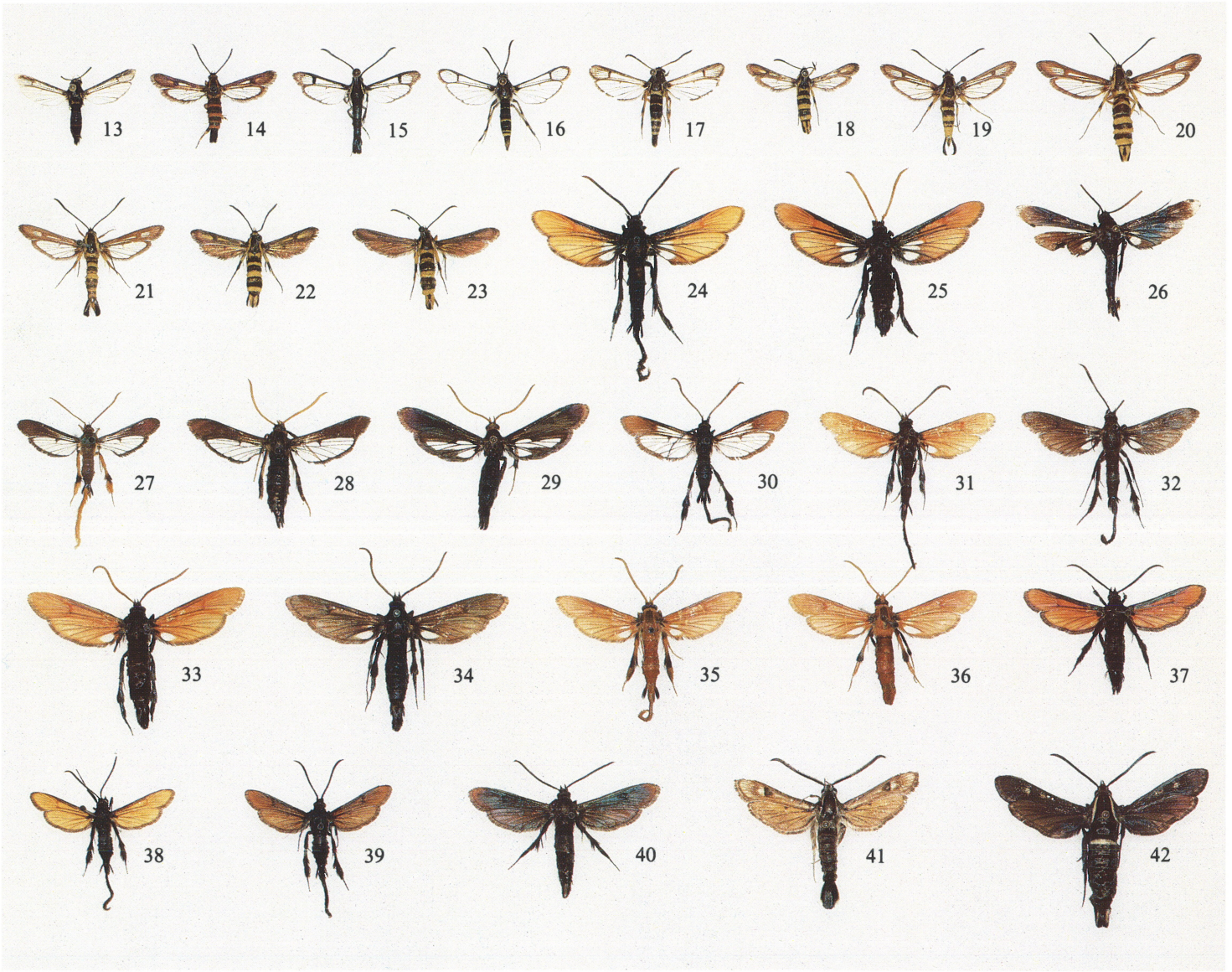
NATURAL SIZE 1:1 (13–42)

SESIOIDEA: PLATE 4

1. *Zenodoxus sidalceae* Engelh., ♂. Pullman, Washington, 9 May 1935, J. F. G. Clarke (USNM). (p. 26).
2. *Calasesia coccinea* (Beutenmüller), ♂. 1,962′, Clark Co., Kansas, June, F. H. Snow (USNM). (p. 59).
3. *Osminia donahueorum* Duckworth & Eichlin, ♀. Bog Springs Camp Ground 5,600′, Madera Canyon, Santa Cruz Co., Arizona, 3–5 August 1977, J. P. and K. E. Donahue (CDFA). (p. 62).
4. *Osminia ruficornis* (Hy. Edw.), ♂. near Warsaw, Benton Co., Missouri, 10 August 1967, J. R. Heitzman (FSCA). (p. 61).
5. *Osminia ruficornis* (Hy. Edw.), ♂. Madera Canyon, Santa Rita Co., Arizona, 15 August 1974, Eichlin (CDFA). (p. 61).
6. *Synanthedon acerrubri* Engelh., ♂. Jamaica, Long Island, New York, 25 July 1927, G. P. Engelhardt (USNM). (p. 74).
7. *Synanthedon acerrubri* Engelh., ♀. Jamaica, Long Island, New York, [no date], G. P. Engelhardt (USNM). (p. 74).
8. *Synanthedon helenis* (Engelh.), ♀. Allotype. Glen Souria, Manitoba, 2 July 1925, N. Criddle (USNM). (p. 89).
9. *Synanthedon decipiens* "*rubristigma*" (Kellicott), ♂. Newtown, Long Island, New York, 15 June 1906, G. P. Engelhardt (USNM). (p. 94).
10. *Carmenta prosopis* (Hy. Edw.), ♂. Alpine, Texas, 13 August 1927, G. P. Engelhardt (USNM). (p. 124).
11. *Carmenta prosopis* (Hy. Edw.), ♀. Alpine, Texas, 29 August 1927, G. P. Engelhardt (USNM). (p. 124).
12. *Carmenta subaerea* (Hy. Edw.), ♂. Cave Cr., Portal, Cochise Co., Arizona, 2–4 July 1972, J. Powell (UCB). (p. 127).
13. *Carmenta odda* Duckworth & Eichlin, ♂. Peach Co., Georgia, 19 June 1986 (CDFA). (p. 122).
14. *Carmenta texana* (Hy. Edw.), ♀. Royal Palm Pk., Florida, 17 May 1930, G. P. Engelhardt (USNM). (p. 129).
15. *Carmenta welchelorum* Duckworth & Eichlin, ♂. Holotype. Speir Ranch, 3 mi N Uvalde, Uvalde Co., Texas, 5 May 1977, Eichlin and Wasbauer (USNM). (p. 131).
16. *Carmenta wellerae* Duckworth & Eichlin, ♂. Sierra Vista, Cochise Co., Arizona, 13 July 1984, R. Wielgus (CDFA). (p. 131).
17. *Carmenta wellerae* Duckworth & Eichlin, ♀. SW Res. Sta. 5,400′, 5 mi W Portal, Chiricahua Mts., Cochise Co., Arizona, 14–15 August 1978, M. S. Wasbauer (CDFA). (p. 131).
18. *Penstemonia clarkei* Engelh., ♀. Toad Springs, 5 mi W Pine Hill, Kern Co., California, emerged 14 March 1985, Andrews and Eichlin (CDFA). (p. 133).
19. *Penstemonia dammersi* Engelh., ♂. Mt. Wilson 6,000′, California, 16 September 1936, G. P. Engelhardt (USNM). (p. 133).
20. *Penstemonia dammersi* Engelh., ♀. Mt. Wilson 6,000′, California, 23 September 1936, G. P. Engelhardt (USNM). (p. 133).
21. *Penstemonia dammersi* "*brevifolia*" Engelh., ♂. Greenhorn Mts., [California], 12 August 1939, C. Henne (USNM). (p. 133).
22. *Penstemonia edwardsii* (Beutenmüller), ♀. Box Canyon, Santa Rita Mts., Arizona, 10 May 1937, G. P. Engelhardt (USNM). (p. 134).
23. *Penstemonia edwardsii* (Beutenmüller), ♀. Oak Creek Canyon, Flagstaff, Arizona, 30 June 1936, G. P. Engelhardt (USNM). (p. 134).
24. *Alcathoe autumnalis* Engelh., ♂. San Antonio, Texas, 8 October 1930, G. P. Engelhardt (USNM). (p. 138).
25. *Alcathoe autumnalis* Engelh., ♀. San Antonio, Texas, 19 October 1936, G. P. Engelhardt (USNM). (p. 138).
26. *Alcathoe carolinensis* Engelh., ♂. Lowell, Marion Co., Florida, 6 October 1977, J. Sharp (CDFA). (p. 138).
27. *Alcathoe caudata* (Harr.), ♂. [no specimen data] (USNM). (p. 137).
28. *Alcathoe caudata* (Harr.), ♀. Monterey, Massachusetts, 6 August 1927, G. P. Engelhardt (USNM). (p. 137).
29. *Alcathoe caudata* "*annettella*" Engelh., ♀. Cincinnati, Ohio, 22 July 1917, A. E. Braun (USNM). (p. 137).
30. *Alcathoe caudata* "*walkeri*" Neum., ♂. Black Mt., North Carolina, 12 August 1929, G. P. Engelhardt (USNM). (p. 137).
31. *Alcathoe pepsioides* Engelh., ♂. Jemez Springs, New Mexico, 12 July 1937, G. P. Engelhardt (USNM). (p. 139).
32. *Alcathoe pepsioides* "*atra*" Engelh., ♂. Grand Junction, Colorado, 8 August 1933, G. P. Engelhardt (USNM). (p. 139).
33. *Alcathoe pepsioides* Engelh., ♀. La Esperanza Rch., Jemez Springs, New Mexico, 20 July 1929, G. P. Engelhardt (USNM). (p. 139).
34. *Alcathoe pepsioides* "*atra*" Engelh., ♀. Allotype. Glenwood Springs, Colorado, 24 July 1931 (USNM). (p. 139).
35. *Alcathoe pepsioides* "*ferrugata*" Engelh., ♂. Rifle, Colorado, 2 August 1927, G. P. Engelhardt (USNM). (p. 139).
36. *Alcathoe pepsioides* "*ferrugata*" Engelh., ♀. Glenwood Springs, Colorado, 27 July 1931, G. P. Engelhardt (USNM). (p. 139).
37. *Alcathoe verrugo* (Druce), ♀. Lower Santa Ana Canyon, Orange Co., California, out 18 July 1937, C. Henne (LACM). (p. 139).
38. *Alcathoe verrugo* (Druce), ♂. San Juan Capistrano, California, 9 July 1936, T. W. Hower (USNM). (p. 139).
39. *Alcathoe verrugo* "*corvinus*" Engelh., ♂. San Juan Capistrano, California, 6 July 1936, T. W. Hower (USNM). (p. 139).
40. *Alcathoe verrugo* "*corvinus*" Engelh., ♀. Lower Santa Ana Canyon, Orange Co., California, out 18 July 1937, C. Henne (LACM). (p. 139).
41. *Hymenoclea palmii* (Beutenmüller), ♂. Phoenix, Maricopa Co., Arizona, 17 October 1975, R. Wielgus (USNM). (p. 140).
42. *Hymenoclea palmii* (Beutenmüller), ♀. Phoenix, Maricopa Co., Arizona, 12 October 1975, R. Wielgus (USNM). (p. 140).

SESIOIDEA: PLATE 4





NOTES

1. ABBREVIATIONS FOR COLLECTORS AND COLLECTIONS

ABK	Alexander B. Klots
AEB	A. E. Brower
AMNH	American Museum of Natural History, New York
ANSP	Academy of Natural Sciences, Philadelphia
BM	Bryant Mather
BMNH	British Museum (Natural History), London
CAS	California Academy of Sciences, San Francisco
CDFA	California Department of Food and Agriculture, Sacramento
CM	Carnegie Museum, Pittsburgh
CNC	Canadian National Collection, Ottawa
CU	Cornell University, Ithaca
FMNH	Field Museum of Natural History, Chicago
FSCA	Florida State Collection of Arthropods, Gainesville
GS	Gayle Strickland
HUMB	Museum Alexander Humboldt, Berlin
INHS	Illinois Natural History Survey, Champaign
JBH	John B. Heppner
JGF	John G. Franclemont
JRH	J. Richard Heitzman
KWP	K. W. Philip
LACM	Los Angeles County Museum of Natural History
LEM	Lyman Entomological Museum, Montreal
MCZ	Museum of Comparative Zoology, Cambridge
MNSA	Museu Argentino de Ciencias Naturales "Bernardino Rivadavia," Buenos Aires
MSU	Michigan State University, East Lansing
MSUS	Mississippi State University, Starkville
NHMV	Naturhistorisches Museum, Vienna
NCSU	North Carolina State University, Raleigh
NSM	Nova Scotia Museum, Halifax
PMBC	Provincial Museum of British Columbia, Victoria
RHL	Ronald H. Leuschner
ROK	Roy O. Kendall
ROM	Royal Ontario Museum, Toronto
SDNH	San Diego Natural History Museum
SIUC	Southern Illinois University, Carbondale
UA	University of Alberta, Edmonton
UAF	University of Arkansas, Fayetteville
UBC	University of British Columbia, Vancouver
UCB	University of California, Berkeley
UCD	University of California, Davis
ULK	University of Louisville, Kentucky
UM	University of Michigan, Ann Arbor
UMC	University of Missouri, Columbia
UMO	University Museum, Oxford
USNM	National Museum of Natural History, Washington
UWM	University of Wisconsin, Madison
VAB	Vernon A. Brou
WEM	William E. Miller
WPC	Wedge Plantation Collection, McClellanville
YPM	Yale Peabody Museum, New Haven
ZSBS	Zoologische Sammlung des Bayerischen Staates, Munich

2. COMMON NAMES

The use of an asterisk "*" in the text denotes a name listed in *Common Names of Insects & Related Organisms 1982* published by the Entomological Society of America.

French-language common names have been taken from Auclair, J. L. et al., 1964, *French Names of Insects of Canada,* 3rd edition, published for the Quebec Society for the Protection of Plants by the Department of Agriculture and Colonization, Quebec. The abbreviation "m." after a name indicates that it is masculine, "f." that it is feminine.

3. CITATIONS OF AUTHORITIES

Authors' names without parentheses indicate that the specific name is associated with the genus in which it was described.

Authors' names in parentheses indicate that the specific name has been transferred from the genus in which it was described to another genus.

4. WING LENGTH

Wing length is the measurement in millimeters from the base to the apex of the forewing.

5. LOCATION OF TYPE SPECIMEN

The current location of the type specimen is given by the appropriate abbreviation in square brackets immediately following the type locality. The words "type lost" indicate that it no longer exists. If no information is given, a type may exist; but its present location was not determined.

6. NOMENCLATURE FOR LARVAL SETAE

Hinton's (*Trans. Royal Ent. Soc. London,* **97**: 1–37, 1946) terminology is used to refer to larval setae of the thorax and abdomen. Heinrich's (*Proc. Ent. Soc. Washington,* **18**: 154–164, 1916) terminology is used to refer to larval setae of the head.

INDEX TO ANIMAL NAMES

Principal entries are given in bold face
Plate references are given as (1:5)

Generic names cited only in combination with specific names, whether in synonymy or text, are not given in the index. Look for such entries under the specific name. For example, *Sciapteron seminole* will be found under *seminole,* but not under *Sciapteron.*

INDEX TO PLANT NAMES