



**FLORIDA
MUSEUM**
OF NATURAL HISTORY™

BULLETIN

A REVIEW OF *VIRBIA* (FORMERLY *HOLOMELINA*) OF AMERICA NORTH OF MEXICO (ARCTIIDAE: ARCTIINAE: ARCTIINI)

J. M. Zaspel, S. J. Weller, and R.T. Cardé

Vol. 48, No. 3, pp. 59-118

2008

The **FLORIDA MUSEUM OF NATURAL HISTORY** is Florida's state museum of natural history, dedicated to understanding, preserving, and interpreting biological diversity and cultural heritage.

The **BULLETIN OF THE FLORIDA MUSEUM OF NATURAL HISTORY** is a peer-reviewed publication that publishes the results of original research in zoology, botany, paleontology, and archaeology. Address all inquiries to the Managing Editor of the Bulletin. Numbers of the Bulletin are published at irregular intervals. Specific volumes are not necessarily completed in any one year. The end of a volume will be noted at the foot of the first page of the last issue in that volume.

Richard Franz, *Managing Editor*

Cathleen Bester, *Production*

Bulletin Committee

Richard Franz, *Chairperson*

Ann Cordell

Sarah Fazenbaker

Richard Hulbert

William Marquardt

Larry Page

Irvy R. Quitmyer

David W. Steadman, *Ex officio Member*

ISSN: 0071-6154

Publication Date: December 30, 2008

**Send communications concerning purchase or exchange
of the publication and manuscript queries to:**

Managing Editor of the BULLETIN
Florida Museum of Natural History
University of Florida
PO Box 117800
Gainesville, FL 32611-7800 U.S.A.
Phone: 352-392-1721
Fax: 352-846-0287
e-mail: lrfranz@flmnh.ufl.edu

A REVIEW OF *VIRBIA* (FORMERLY *HOLOMELINA*) OF AMERICA NORTH OF MEXICO (ARCTIIDAE: ARCTIINAE: ARCTIINI)

J. M. Zaspel¹, S. J. Weller^{2,3}, and R.T. Cardé⁴

ABSTRACT

The tiger moth genus *Virbia* Walker (Arctiinae: Arctiini) is redescribed and its biology and taxonomic history are reviewed. The recent placement of *Holomelina* Herrich-Schäffer as its junior synonym is examined. North of Mexico, 14 *Virbia* species are recognized, including two new species, *V. fergusoni* Zaspel and *V. rindgei* Cardé. Adult habitus photographs, a checklist, diagnoses, and complete descriptions are provided for all species. Genitalia of the new species are illustrated, and diagnostic character illustrations are provided for separating all previously described species. Locality information from over 12,000 specimens representing 16 museum collections [in the United States and Canada] is compiled and available in an electronic database on the Diversity of Life Website (at www.diversityoflife.org/virbia.html). As some species appear to be habitat specialists (e.g., *V. lamae* in bogs), photos of selected habitats are provided.

Key Words: Tiger moths, *Virbia*, Arctiidae, morphology, lepidopteran taxonomy.

TABLE OF CONTENTS

Introduction.....	60
Biology of <i>Virbia</i> in Canada and the United States.....	62
Taxonomic History of <i>Holomelina</i> and <i>Virbia</i>	68
Checklist of <i>Virbia</i>	72
Materials and Methods	73
Systematic Entomology of Genus <i>Virbia</i>	76
<i>V. aurantiaca</i>	77
<i>V. costata</i>	81
<i>V. fergusoni</i> n. sp.....	84
<i>V. ferruginosa</i>	87
<i>V. fragilis</i>	88
<i>V. immaculata</i>	89
<i>V. laeta</i>	91
<i>V. lamae</i>	94
<i>V. marginata</i>	97
<i>V. nigricans</i>	98
<i>V. opella</i>	101
<i>V. ostenta</i>	102
<i>V. rindgei</i> n. sp.....	104
<i>V. rubicundaria</i>	106
Acknowledgements.....	107
Literature Cited.....	107

¹ Dept. of Entomology and Nematology, P.O. BOX 110620 Natural Area Drive, University of Florida, Gainesville, FL 32611

² Dept. of Entomology, 1980 Folwell Ave., 219 Hodson Hall, University of Minnesota, St. Paul, MN 55108

³ Bell Museum of Natural History, University of Minnesota, 1980 Upper Buford Circle, St. Paul, MN 55108

⁴ Dept. of Entomology, Univeristy of California-Riverside, Riverside CA 92521

Zaspel, J.M., S.J. Weller, and R.T. Cardé. 2008. A Review of *Virbia* (Formerly *Holomelina*) of America North of Mexico (Arctiidae: Arctiinae: Arctiini). Bull. Florida Museum Nat. Hist. 48(3): 59-118.

INTRODUCTION

Colorful and enigmatic, the species of North American *Virbia* Walker, formerly *Holomelina* Herrich-Schäffer, have challenged lepidopterists' species concepts and occasionally their civility towards one another, since the mid-1800s (e.g., scientific exchanges reviewed in Smith, 1889). The phenotypic diversity of adults of some species is impressive. For example, within a single reared brood of *V. aurantiaca* (Hübner), several phenotypes occur, and several of these were named as species (Fig. 1). Such phenotypic diversity when combined with inadequate illustrations and descriptions of many species has resulted in complicated taxonomic history and confusion. Further, only subtle differences in genitalic morphology exist among the males of some species whose phenotypes are easily confused (e.g., *V. aurantiaca* and *V. nigricans* [Reakirt]) (Ferguson 1985; Forbes 1960; Cardé 1968, 1971).

Recently, a phylogenetic review of generic limits of *Virbia* proposed that *Virbia* (Walker 1854) and *Holomelina* (Herrich-Schäffer 1855) were congeneric, and *Holomelina* was placed as the junior synonym (Zaspel 2004; Zaspel & Weller 2006). Historically, these two genera have been associated with each other (e.g., Barnes & McDunnough 1917; Forbes 1939, Forbes 1960); Ferguson (1985) suggested that the genera might be congeneric when he described the *Holomelina* group.

Rare in Arctiidae, males possess a true scaphium, and many species also possess a subscaphium (Ferguson 1985; Zaspel 2004; Zaspel & Weller 2006).

As currently defined, *Virbia* is comprised of small to medium sized, slender, brightly colored species (Fig. 2). The genus is distributed from south central Canada (e.g., northern Manitoba) to the North Atlantic (e.g., Nova Scotia), south to central South America (Fig. 3) (Handfield 1999; Zaspel & Weller 2006). North American species (formerly *Holomelina*) are slender moths with red or pink adbasal regions in the hindwings (Figs. 2, 4). Neotropical species typically have the red pigment replaced with yellow hindwing patches (Fig. 5). Larvae possess homoideous crochets, a secondary loss of the smaller lateral crochets found in other arctiines (Kitching & Rawlins 1999; Jacobson & Weller 2002). Larvae are otherwise typical of Arctiini with clusters of secondary setae on raised verrucae (Kitching & Rawlins 1999; Jacobson & Weller 2002). Some North American species have been reared on dandelion and other introduced Plantaginaceae (e.g., Forbes 1960). Typical for Arctiini, larvae are reported as feeding on unidentified herbaceous plants; native hosts (pre-European settlement) are unknown (Ferguson 1985; Tietz 1972).

Although little is known about their biology, species in this genus have figured prominently in the literature on chemical ecology and pheromones (Roelofs &



Figure 1. Reared series, *Virbia aurantiaca* (Top Row: Female parent of brood, second and third rows: Males)

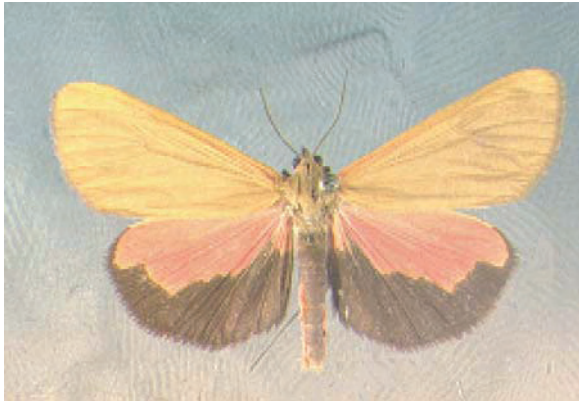


Figure 2. *Virbia ostenta* Edwards, Male.

Cardé 1971; Cardé & Roelofs 1973; Cardé 1974; Charlton & Roelofs 1991; Schal & Cardé 1985; Schal & Cardé 1986; Schal et al. 1987; Yin et al. 1991; Schal et al. 1998). *Virbia aurantiaca* was among the first non-pest lepidopterans to have its female pheromones characterized (Roelofs & Cardé 1971). Pheromone is synthesized in the fat body (Schal et al. 1998), transported through the hemolymph to the pheromone glands, and then released as a liquid aerosol (Meyer 1984; Schal et al. 1987).

Here, we provide a faunal treatment of the *Virbia* species occurring in North America north of Mexico, formerly placed in *Holomelina* Herrich-Schäffer. A generic diagnosis and description is provided for the ge-



Figure 3. General range distribution of the genus *Virbia*. Triangles = species originally placed in *Virbia*; stars = species formerly placed in *Holomelina*.

nus. We recognize 14 species. One of these, *V. marginata* (Druce), is primarily distributed in Central America with disjunct populations in Colorado, New Mexico, and Arizona; it has been treated previously as a synonym of *V. rubicundaria*. Two new species, *V. fergusonii* Zaspel and *V. rindgei* Cardé, are described. For all species, we provide diagnoses, descriptions, and illustrations of diagnostic male and female morphology (Figs. 11-32). The adult habitus of both sexes are figured (Figs. 27, Pls. 1-3), and we summarize life history information (e.g., larval hosts, voltinism, activity periods, and habitat). A database of over 12,000 specimens is available on-line through the Diversity of Life website (www.diversityoflife.org/virbia.html).

BIOLOGY OF *VIRBIA* IN CANADA AND THE UNITED STATES

Most of the information concerning the habitats and host plant use is derived from three sources: field notes of R. Cardé, unpublished sections of theses (Cardé 1971), and the Zaspel database of compiled label data. These data are supplemented with the few published rearing studies (Dyar 1897; Forbes 1910, 1960; Wyatt 1939; Ferguson 1953). Data are incomplete for many species, but we note general trends when possible. Details of species life histories are provided in the Biology sections for each species.

HABITAT

Virbia exhibit a high degree of local habitat restriction (Figs. 6 and 7), although most species have widespread distributions (e.g., *V. aurantiaca*, *V. ferruginosa*). Some phenotypically confusing species can be sorted simply by either habitat or locality information. For example, *V. lamae* Freeman has been collected only diurnally in bogs in the northeastern U.S. and Canada (Fig. 6) to the western edge of its range, Marathon County, Wisconsin (Ferguson 1954; Zaspel database). *Virbia nigricans* (Reakirt) has been collected only along a narrow corridor of secondary successional habitat comprised of old fields, power line cuts, and highway edges in western New Jersey (Hunterdon County) and extreme southeastern Pennsylvania (Philadelphia and Montgomery Counties; Cardé field notes, Zaspel database). *Virbia nigricans* has been confused historically with the dark form of *V. opella*, but these species are easily separated using adult habitus and locality. These species mate diurnally (Cardé 1971), and their genitalia are distinctive (see Diagnosis of *V. nigricans*). Another species with a highly specialized distribution is *V. rindgei* Cardé (n. sp.), which is found in open Ponderosa pine forests in the Black Hills

of South Dakota and Wyoming.

The remaining species appear to be more generalized in their habitat use, but their distributions are restricted. *Virbia rubicundaria* (Hübner) has been collected in tidal marshes on St. Catherine's island off the coast of Georgia and also in moist, inland situations near the southeastern U.S. ocean shores such as the Florida scrub community in Highlands Co., Florida (Cardé field notes; Zaspel database). Additional species with somewhat overlapping distributions can be separated based on habitat, wing pattern, or voltinism. For example, *V. ferruginosa* (Walker) is found in more open situations such as pitch pine - scrub oak barrens (Fig. 7), bogs, aspen parklands, and montane woods (Schmidt, personal communication), whereas *V. opella* appears to favor forested areas comprised of either deciduous woods or mixed hemlock and deciduous forest with a developed understory (Cardé 1965; Zaspel database). *Virbia aurantiaca* ranges from sand dunes and secondary succession old fields (Massachusetts) to the New Jersey Pine Barrens, and from the Badlands (North Dakota) to alfalfa fields (Indiana) (Zaspel database).

IMMATURE MORPHOLOGY AND BIOLOGY

Most larval descriptions provide a brief account of the number of instars and general appearance. The first descriptions of immature stages were of *V. aurantiaca* (Saunders 1869) and *V. opella* (Dyar 1897). In 1960, Forbes described mature larvae for three species, *V. laeta*, *V. aurantiaca*, *V. opella*, and the dark form of *V. opella* that he referred to as *nigricans*. He noted that larvae of all species he examined possessed homoideous crochets, two pairs of transverse verrucae on the prothoracic shield, and abdominal L1 located below the spiracle (Forbes 1960). Forbes (1960) described the larva of *V. aurantiaca* as dark, with black setae and verrucae, and a contrasting conspicuous broad pale dorsal band filling the space between verrucae. All the setae were barbed and increased in length caudally. Larvae of *V. laeta* are lighter than *V. aurantiaca*, pale gray with black verrucae and a cream-colored stripe on the frons; two types of setae were present, dentate, and feathery (Forbes 1960). The third species, *V. opella*, was similar in body coloration to *V. laeta* (dull gray) but had a black head and brown frons; its black setae were described as short and stiff. Forbes (1960) described a larva that he attributed to form *nigricans* (1960: 23) whose body color was a light orange base heavily dusted with gray; the setae were gray, not black. This larva was likely the dark form of *V. opella* and not *V. nigricans* based on the locality information provided and the rarity of *V. nigricans*. Thus, two morphs of *V. opella* larvae



Figure 4. *Virbia aurantiaca* Hübner, Male.



Figure 5. *Virbia hypophaea* Hampson, Male.

exist: a dull gray morph with black setae (typical *V. opella*) and a gray-orange morph with gray setae (dark form *V. opella*). Unlike the two previous species, *V. ferruginosa* larvae typically possess heteroideous crochets but have reduced lateral crochets (Schmidt, personal communication). Several species of *Virbia* have been reared on two introduced European plants, dandelion (Asteraceae) or plantain (Plantaginaceae), but native hosts are unknown (Forbes 1960; Tietz 1972).

ADULT BIOLOGY

Most of our detailed information on adult biology is limited to seven species representing the *V. aurantiaca* complex. This information is derived from the thesis work of Cardé (1971), supplemented by continuing field observations by Cardé. Roelofs & Cardé (1971) isolated and characterized female pheromone as 2-methylheptadecane (2Me-17c), the first saturated pheromone from the Lepidoptera, for seven species in the *V. aurantiaca* complex: *V. aurantiaca*, *V. ferruginosa*, *V. fragilis*, *V. immaculata*, *V. lamae*, *V. nigricans*, and *V. rindgei* (as an undescribed species) (Roelofs & Cardé 1971). 2Me-17c was used in pheromone traps to study diel periodicities of attraction flight times. In addition, chromosome numbers were characterized for seven species. Methods for those studies are described in

Cardé (1971). A summary of the data is published here for the first time (Table 1).

COLLECTING ADULTS

Some comments on methods for collecting adults in the *V. aurantiaca* complex illustrate how adults and particularly females (for initiation of laboratory colonies) were obtained. Nearly all of the males and females used in studies of the pheromone biology were collected by netting. All species can be collected by daytime flushing (e.g., walking through the habitat), even though species differ in whether females call and mate during the day or night. Afternoons are the most favorable time to collect; sunny and hot conditions are most conducive for flight. Flushed males fly in an erratic zigzag pattern, often for several meters or more, before landing; many males can be flushed a second or third time. Females have a reduced propensity to initiate flight, and the proportion of females flushed is low; this more sedentary behavior of females largely explains the great preponderance of males in collections. When females are flushed, their flight is readily distinguished: essentially a straight-line path with reduced velocity, usually lower altitude, and a much shorter distance than males, occasionally only decimeters. Upon landing in the herbage, females nearly always drop to ground level—males usually land on the herbage—and “play dead” (thanotosis). These females can be difficult to locate unless their precise trajectory has been tracked, and it is more efficient to net them on the wing if possible. Rarely, females can be flushed a second time. Daytime flushing of both sexes is presumably a defensive, predator avoidance reaction. Many species also are readily attracted to black light (males more strongly than females), and this collection method accounts for an abundance of museum specimens of *V. aurantiaca*, *V. ferruginosa*, *V. immaculata*, and *V. rubicundaria*. For day-mating species, *V. lamae* and *V. nigricans*, when black lights are placed in the precise locations where adults were collected diurnally, none are attracted to the lights. Oviposition behavior differs as well. Females of *V. aurantiaca* and *V. rubicundaria* lay eggs individually, not attached to a substrate; females of *V. ferruginosa*, *V. fragilis*, *V. immaculata*, *V. lamae*, *V. nigricans*, and *V. rindgei* lay attached, single-layer masses.

PREMATING REPRODUCTIVE ISOLATION

Among co-occurring species, isolation can be due to: 1) differences in pheromone, 2) rhythms of female release of pheromone, hereafter termed “calling,” and male response to pheromone, 3) exclusive seasonal flight periods, and 4) non-overlapping habitats.



Figure 6. *Virbia lamae*, habitat, Seawall Bog, Southwest Harbor, Maine (Photograph by R.T. Cardé).



Figure 7. *Virbia ferruginosa*, habitat, xeric outwash pitch pine - scrub oak barren in the Montague Plains Wildlife Management Area, Montague, MA. (Photograph by R.T. Cardé).

PHEROMONES

Distinctive pheromone channels can be achieved in moths by a variety of strategies, including varying ratios of the same constituents, or altering chain length, double bond position, number and/or configuration, chirality, or functional group (Cardé & Haynes 2004). Indeed, it is typical to have closely related and sibling species differ in their pheromone blends, such that these serve as a primary means of premating reproductive isolation.

The common pheromone constituent of the *V. aurantiaca* complex is 2-methylheptadecane (2Me-17c). Its presence in the female pheromone gland was confirmed for *V. aurantiaca*, *V. ferruginosa*, *V. fragilis*, *V. immaculata*, *V. lamae*, *V. nigricans*, and *V. rindgei* (listed as an undescribed species) (Roelofs & Cardé 1971). The compound 2Me-17c evoked levels of attraction in field trapping trials for all of the above species except *V. fragilis*, which was not tested. In addition, *V. rubicundaria* and *V. laeta* are attracted to 2Me-17c, although females have not yet been examined for the presence of 2Me-17c. In some species, such as *V. aurantiaca* and *V. rubicundaria*, the levels of male attraction relative to the density of field populations indicated that 2Me-17c serves as the primary component. Conversely, a comparatively poor level of attraction with 2Me-17c for *V. lamae* (Roelofs & Cardé 1971) suggests that additional pheromone components could be involved in communication. Indeed, in *V. lamae*, in addition to 2Me-17c, several of its analogues are present in the gland and emitted, including *n*-heptadecane, *n*-nonadecane, 2-methyloctadane, and 2-methylnonadecane (Schal et al. 1987). Field tests of *V. lamae* with mixtures of these constituents in naturally occurring ratios, however, do not have markedly improved attraction over 2Me-17c alone, leaving open the possibility that some species specificity awaits documentation of additional pheromone components. Differences in courtship behaviors among the species, another possible factor in reproductive isolation, have not been examined.

RHYTHMS OF FEMALE CALLING

Pheromone synthesized in oenocytes is transported via lipophorin to paired, tubular abdominal glands (Schal et al. 1998), each with a spine-beset opening at the abdominal tip (Yin et al. 1991). A calling female perches vertically and rhythmically protrudes the tip of her abdomen at a rate of ca. once per 1.5 sec (Cardé 1971; Cardé & Roelofs 1973). Pheromone is atomized into droplets, in pulses coincident with each gland extrusion (Schal & Cardé 1985). This release mechanism is evi-

dently common in arctiids but is not known among other moth lineages (Meyer 1984; Schal & Cardé 1986; Schal et al. 1987, 1998; review Hallberg & Poppy 2003). The amount of pheromone released is quite high among moths: in *V. lamae* up to 350 ng of 2Me17c in 10 min and 835 ng in 60 min (Schal et al. 1987).

The calling rhythm of *V. immaculata* has been demonstrated to be circadian (Cardé & Roelofs 1973). Presumably the rhythms of the remaining species in this complex also have a circadian basis; however, we refer to them here as diel rhythms, as their endogenous nature has not been confirmed formally. The calling rhythms illustrated (Figs. 8, 9), all were observed at a L:D of 16:8 at 24°C, but it is important to recognize that, like most calling and male response rhythms of moths, the expression of these rhythms is modulated by current and recent temperature regimes, with lower or decreasing temperatures generally advancing the rhythms of the night-calling species and delaying rhythms of the day-active species (Cardé & Roelofs 1973; Schal & Cardé 1986). Such temperature-induced modulation of calling periodicities, however, does not reduce their importance in isolation of some species pairs.

FLIGHT PERIODS AND HABITAT PREFERENCES

In addition to differences in diel rhythms and potential differences in pheromone blends, distinctive flight periods and habitat preferences isolate some co-occurring species. In Connecticut and Massachusetts, *V. aurantiaca* has two broods, with adults occurring mainly in secondary succession habitats (abandoned hay fields, power line cuts) from late May to late June and again in August. In the same areas, *V. ferruginosa* is single-brooded, with adult emergence in July in open scrub-oak forests. These habitat types can be contiguous, but the distinctive emergence patterns alone provide full isolation of the two species in southern New England. The female calling rhythms of both species from Connecticut overlap broadly (Fig. 8), with calling of *V. aurantiaca* peaking within the first hour of scotophase (dark segment of the light-dark cycle) and lasting about 4 hours (Fig. 8a) and calling of *V. ferruginosa* commencing after two hours of scotophase and also lasting for about 4 hours (Fig. 8d). Such differences in female calling rhythms would appear to provide only weak isolation for these two species, and, unlike most moths, the diel rhythm of male attraction in *V. aurantiaca* is considerably broader than the female's nocturnal calling rhythm: male attraction to synthetic pheromone occurs from mid-morning to evening (Cardé 1974). Although these temporal and habitat characteristics in concert provide effective isolation for *V. aurantiaca* and *V. ferruginosa* in south-

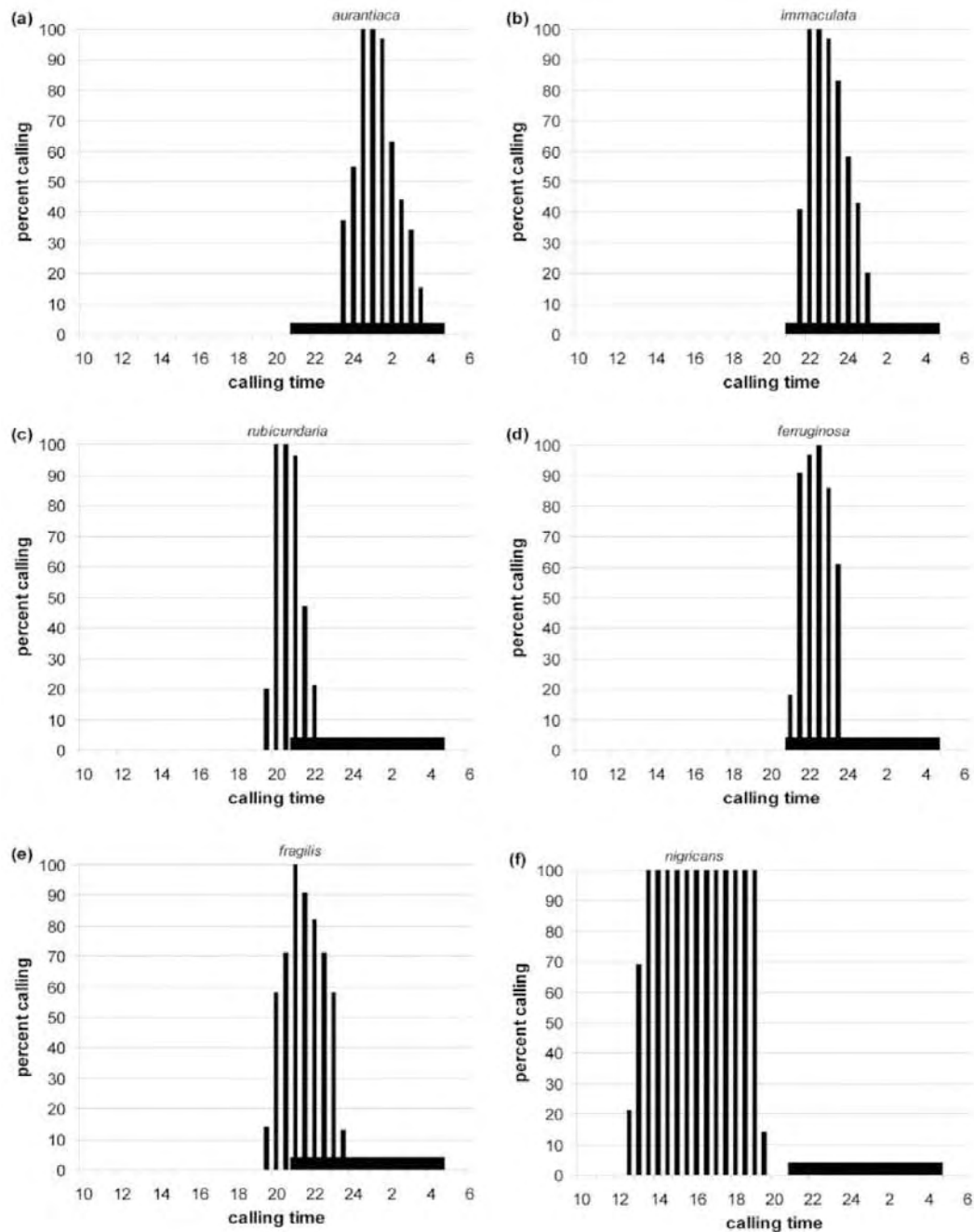


Figure 8. Calling periodicities of 2-day-old females in the *Virbia aurantica* complex. Observations were conducted every 30 minutes at 24° C in a 16:8 light:dark regime (see Cardé 1971 for methods). Time of scotophase indicated by the hatched bar. The sources for the lab colonies were: A-*V. aurantiaca*, East Haddam, CT.; B-*V. immaculata*, Dryden, NY; C-*V. rubicundaria*, Gainesville, FL; D-*V. ferruginosa* Branford, CT.; E-*V. fragilis*, Boulder, CO; and F-*V. nigricans*, Frenchtown, NJ.

ern New England, both species are single-brooded in Maine (Brower 1974), Nova Scotia (Ferguson 1954), and generally throughout southern Canada, sharing the same flight period from July to mid August. Some partitioning by habitat also seems important in Nova Scotia (Ferguson 1954).

In southeastern Pennsylvania (Philadelphia Co.), A.M. Shapiro collected *V. aurantiaca*, *V. nigricans*, and *V. immaculata* in the same old field, secondary succession habitat. *Virbia nigricans* is a day-calling species (Fig. 8f), whereas, as mentioned, *V. aurantiaca* calls in early evening (Cardé 1974), and *V. immaculata* (Cardé & Roelofs 1973) calls somewhat later in the evening (Fig. 8b). Such partitioning of calling times would afford some, but not complete isolation of *V. nigricans* from the other two species. The male response window of *V. aurantiaca* includes attraction in daytime in southeastern Pennsylvania as it does in the Connecticut population (Cardé 1974).

Similar levels of reproductive isolation by habitat preference and calling times should isolate *V. lamae* from *V. aurantiaca* and *V. ferruginosa* where they co-occur. *Virbia lamae* is a day-calling species (Schal & Cardé 1986; Schal et al. 1987), and it is exclusively a denizen of bogs.

Partial temporal (adult emergence, calling times) and spatial isolation occur for four species of the *V. aurantiaca* complex (Table 1). *Virbia aurantiaca* is bivoltine with adults emerging from May to June and again in August in southern New England and the mid-Atlantic United States (Cardé 1971); adults of *V.*

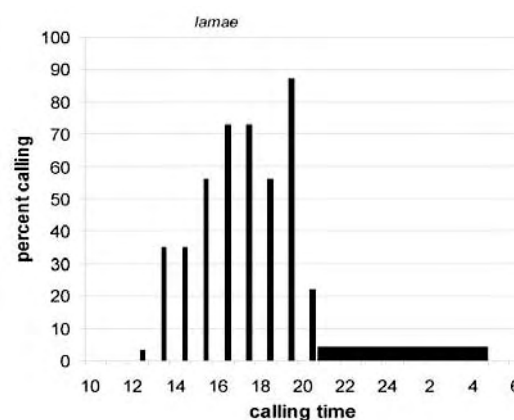


Figure 9. Calling periodicity of 2-day-old *Virbia lamae* females from Manistique, MI conducted hourly at 24° C in a 16:8 light:dark regime (see Schal and Cardé 1986 for methods). Time of scotophase indicated by the hatched bar.

aurantiaca emerge year-round in the south (Forbes 1960). *Virbia immaculata* is multivoltine in the north-central and northeastern United States, with adults emerging from late May and June and again in August and early September (Zaspel database). Two species, *V. ferruginosa* and *V. lamae*, are univoltine with a July flight period (Forbes 1960, Cardé 1971). *Virbia rubicundaria* and *V. nigricans* are multivoltine, with adults emerging year-round in the southeastern United States (Zaspel database).

For those species that occasionally overlap in emergence and locality, female calling times may be impor-

Table 1. Biological information for nine *Virbia* species (Cardé 1968 & 1971). n = chromosome number. — = information not available.

Species	Chromosome #	Female calls	Male attracted	Male comes to lure	Voltinism
<i>V. aurantiaca</i>	n = 25	yes	yes	10am-10pm	bi/multivoltine
<i>V. ferruginosa</i>	n = 32	yes	yes	night	univoltine
<i>V. fragilis</i>	n = 25	yes	yes	—	—
<i>V. immaculata</i>	n = 21	yes	yes	night	multivoltine
<i>V. lamae</i>	n = 28	yes	weak	day	univoltine
<i>V. nigricans</i>	n = 16	yes	very weak	day	multivoltine
<i>V. rubicundaria</i>	n = 23	yes	yes	night	multivoltine
<i>V. rindgei</i>	—	—	weak	day	—

tant in species discrimination. Three species are active and mate diurnally; four are active nocturnally (Table 1). Males of *V. aurantiaca* have the broadest known male activity period with male attraction to female pheromone from midmorning (10:00) to early evening (20:00) (Cardé 1974) (Table 1). *Virbia rubicundaria* females call nocturnally (Cardé 1971). As yet unidentified components of females' pheromone may confer some specificity in the males' response, resulting in diminished attraction of heterospecifics (Cardé 1971).

Even if occasional mating of heterospecifics occurs, the range of chromosome numbers among the species suggests that most hybrid combinations would be at a disadvantage (Table 1). Haploid numbers range from

16 (*V. nigricans*) to 32 (*V. ferruginosa*) (Table 1, Cardé 1971).

TAXONOMIC HISTORY OF *HOLOMELINA* AND *VIRBIA*

Here we review the taxonomic history of *Virbia*, including *Holomelina*. We also provide a taxonomic review of species, but limit ourselves to those that occur in North America north of Mexico, all of which formally were placed in *Holomelina*. We first review the extensive taxonomic history of *Holomelina*, and then review the literature for *Virbia*. Last, we present a brief summary of the recent phylogenetic study and its taxonomic implications (Zaspel & Weller 2006).

Table 2. Taxonomic History of *Virbia*. B & B = Barnes & Benjamin, B & MD = Barnes & McDunnough, G-M = Guérin-Méneville, N& D = Neumögen & Dyar.

Family	Genus	Species	Synonyms	Genus
Lithosiidae	<i>Lithosia</i>	<i>laeta</i> G-M	<i>treatii</i> Grote <i>rubropicta</i> Packard	<i>Crocota</i> <i>Lithosia</i>
	<i>Lithosina</i>	<i>opella</i> Grote	<i>flava</i> B & B <i>obscura</i> Stretch <i>belmaria</i> Ehrmann <i>rubricosta</i> Ehrmann	<i>Crocota</i> <i>Holomelina</i> <i>Holomelina</i> <i>Holomelina</i>
Geometridae	<i>Crocota</i>	<i>costata</i> Stretch.	<i>opelloides</i> Graef <i>intermedia</i> Graef <i>parvula</i> N. & D. <i>cocciniceps</i> Schaus <i>pallipennis</i> B & MD	<i>Crocota</i> <i>Crocota</i> <i>Crocota</i> <i>Eubaphe</i> <i>Eubaphe</i>
		<i>ferruginosa</i> Walker	<i>quinaria</i> Grote <i>choriona</i> Reakirt <i>trimaculosa</i> Reakirt <i>bucholzi</i> Wyatt	<i>Crocota</i> <i>Holomelina</i> <i>Crocota</i> <i>Holomelina</i>
		<i>ostenta</i> Edwards <i>immaculata</i> Reakirt <i>nigricans</i> Reakirt <i>rubicundaria</i> Hübner	<i>calera</i> Barnes <i>nigrifera</i> Walker <i>belfragei</i> Stretch <i>diminutiva</i> Graef <i>rosa</i> French	<i>Holomelina</i> <i>Cothocida</i> <i>Crocota</i> <i>Crocota</i> <i>Crocota</i>
	<i>Eubaphe</i>	<i>fragilis</i> Strecker <i>aurantiaca</i> Hübner	<i>bimaculata</i> Saunders <i>brevicornis</i> Walker	<i>Crocota</i> <i>Crocota</i>
		<i>lamae</i> Freeman <i>marginata</i> Druce		

TAXONOMIC REVIEW OF *HOLOMELINA*

The taxonomic history of *Holomelina* Herrich-Schäffer is intertwined with two other genera, *Eubaphe* (Hübner 1823) and *Crocota* (Hübner 1823). These two genera originally were described among a series of lithosiine genera, and subsequent authors inferred that Hübner considered these genera as Arctiidae (Watson et al. 1980). *Eubaphe* and *Crocota* are now placed in Geometridae (Fletcher 1954; Watson et al. 1980), but the associated geometrid and arctiid species were treated as *Eubaphe* for nearly 120 years (Beutenmüller 1898; Druce 1885; Schaus 1901; Forbes 1910; Barnes & McDunnough 1917, 1918; Freeman 1941; Ferguson 1954). Similarly, arctiid and geometrid species were described in *Crocota* through the 1800s (Walker 1854; Grote 1863; Graef 1887; Smith 1889) or treated as such in checklists (Neumögen & Dyar 1893a). When Hübner described *Eubaphe*, he listed a single species, *E. lobula* (Hübner 1823), and thus *E. lobula* is the type species by monotypy (Fletcher 1954). Hübner subsequently described *Eubaphe aurantiaca* (Hübner 1827); Herrich-Schäffer used *E. aurantiaca* as the type species for *Holomelina* (Herrich-Schäffer 1855). Unlike *Eubaphe* and *Crocota*, *Holomelina* has always been placed in Arctiidae (e.g., Holland 1903). Hampson (1920: 316) asserted that *Eubaphe* had priority over *Holomelina*, and most taxonomists followed Hampson until Fletcher (1954) revised *Eubaphe*. In his revision, Fletcher (1954) noted that the type species, *E. lobula*, was a geometrid, and “the next valid name to replace *Eubaphe* in the Arctiinae appears to be *Holomelina* Herrich-Schäffer 1855, the type species of which is *Eubaphe aurantiaca* Hübner” (Fletcher 1954: 155). However, as late as 1960, some authors considered *Eubaphe* to be the valid generic name for these arctiid species (e.g., Forbes 1960: 21). The confusion of three generic names, *Eubaphe*, *Crocota*, and *Holomelina*, has resulted in congeneric species and subspecies being described in different genera (Table 2).

Although *Holomelina* species (regardless of generic name) have been treated as Arctiidae, the three genera, *Holomelina*, *Eubaphe*, and *Crocota* have been placed in various subfamilies, including Lithosiinae (Walker 1854), Arctiinae (Neumögen & Dyar 1893a,b), and Eubaphianae (Smith 1889). Earlier authors associated *Eubaphe* and *Crocota* with Lithosiinae, listing these genera in sequence with lithosiine genera *Cisthene* and *Delphyre* in checklists (Stretch 1885), species’ descriptions (Walker 1854), and faunal treatments (Seitz 1914). *Eubaphe* (= *Holomelina*) was placed in Arctiini (Forbes 1960), and *Holomelina* subsequently has remained in Arctiini (Ferguson 1985; Franclemont 1983; Watson &

Goodger 1986; Jacobson & Weller 2002).

Discrimination of species was contentious in the 1800s (Smith 1889), and species taxonomy was further complicated with individual species and subspecies described in lithosiine genera (*Lithosia* author, *Brycea* Walker, *Boenasa* Walker, *Ptychoglene* Felder), arctiine genera (*Cothocida* Walker, *Cyturus* Grote), or geometrid genera (*Crocota* Walker, *Eubaphe* Walker) (Table 2). In some cases, subspecies were described in different genera than the original species (e.g. *Lithosia laeta* Guérin-Méneville and current synonym *Crocota treatii* Grote; Table 2). Descriptions were often cursory and so general, that they applied to several species without distinguishing among them, for example, *Crocota costata* Stretch (Stretch 1885). In phenotypically variable species, such as *V. costata* and *V. ferruginosa*, a proliferation of names resulted (Table 2).

Complicating matters further, some authors refused to acknowledge the work of others. In his *Preliminary Catalogue of the Arctiidae of Temperate North America with notes*, Smith (1889) states: “The matter has been further confused by Mr. Grote’s persistent refusal to refer to Mr. Reakirt’s species.” Even when authors discussed others’ work, agreement on species names could not be reached, resulting in the application of several names to the same species (see Smith 1889). Depending on the author treating the Nearctic fauna, the number of valid species ranged from five (Walker 1854) to 17 (Smith 1889), and the number of varieties ranged from none (Walker 1854) to seven (Neumögen & Dyar 1893a,b).

In the early 1900s, the species’ numbers were revised down to either six species (one variety) (Holland 1903) or eight species for the U.S. and Canadian fauna (Barnes & McDunnough 1917). Holland commented that “great confusion” existed concerning the number of species, and that larval rearing and mating studies were needed to resolve problematic species (Holland 1903: 115). Contemporary taxonomic treatments that included species occurring in Central and South America recognized 28 *Eubaphe* species and six varieties (Strand 1919) or 26 species, nine subspecies, and three varieties (Seitz 1914).

Little additional taxonomic activity occurred until the 1950s and 1960s. Ferguson (1954) reviewed the Canadian fauna and renewed interest in the genus. Ferguson (1954) noted that species in *Eubaphe* had been difficult for taxonomists for some time; he stated, “The old question of which is a species and which is not, still remains paramount” (Ferguson 1954: 212). In treating the *E. aurantiaca* species complex, Ferguson discovered that differences in male genitalia between *Eubaphe*

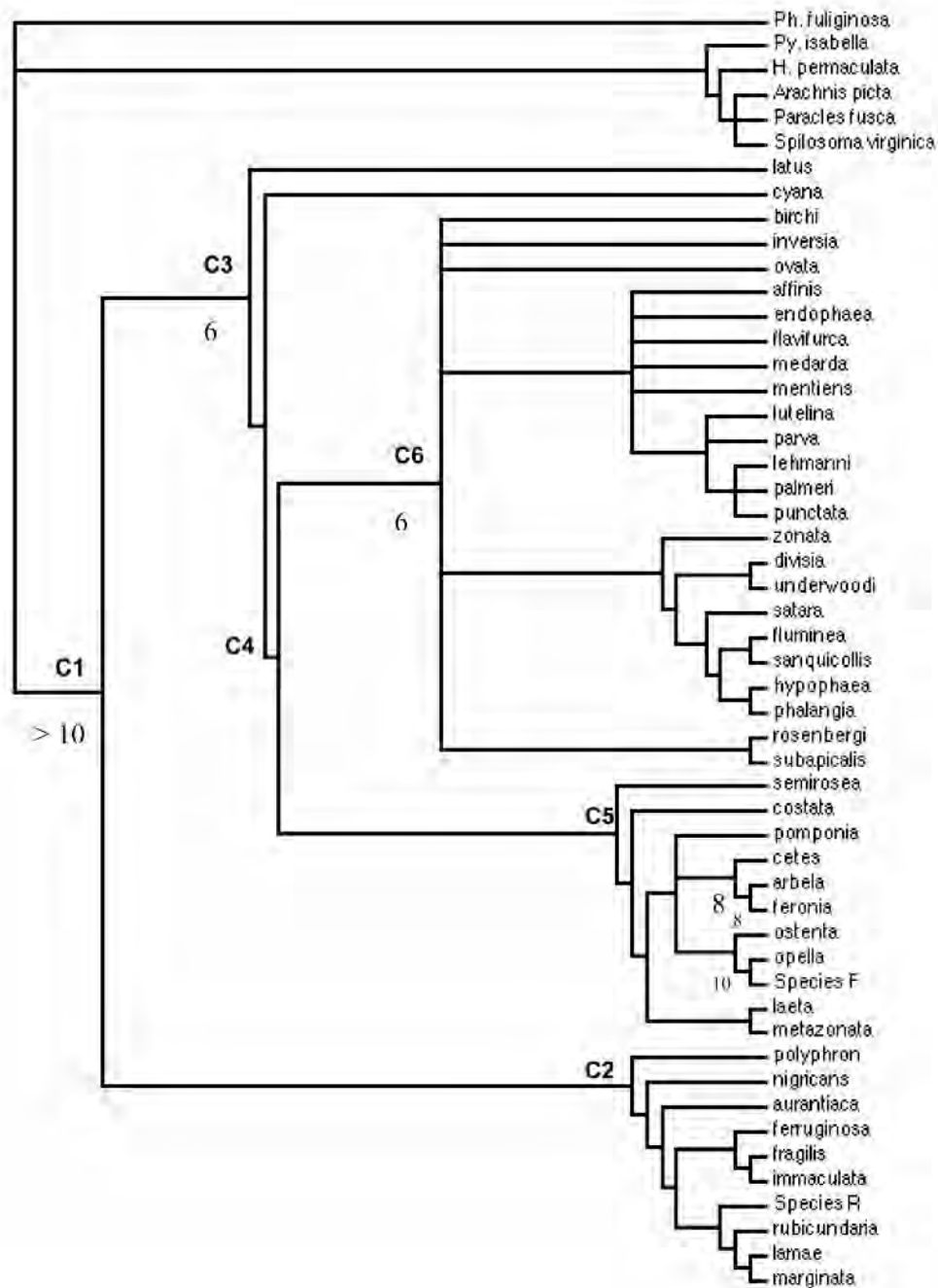


Figure 10. Strict consensus of 779 trees: $L = 1698$, $CI = 41$, $RI = 65$, resulting from the analysis of all taxa AT matrix. Numbers below the branch are decays, and unlabelled branches have a decay of 3. C1 – C6 = Clades 1 through 6. Parallel lines = species formerly placed in *Holomelina*, Solid lines = species originally placed in *Virbia*, dotted line = outgroups.

species were scarce, and offspring reared in the laboratory were phenotypically diverse, i.e., they did not match the parents. (Ferguson 1954: 212). Extensive reared series at the National Museum of Natural History (NMNH) document the array of phenotypes. Additional reared series are housed at the American Museum of Natural History (AMNH, Joseph Muller), Cornell University (CUIC, J. Franclemont material), and the University of California, Riverside (UCR, R. Cardé material).

Forbes (1960) provided a synopsis of the known biology of the genus and commented on the misuse of the generic name *Eubaphe*. He defended its usage as providing taxonomic stability in general usage (footnote 3a, Forbes 1960: 21). Forbes provided illustrations of diagnostic male genitalic features and a short key to the *H. opella* and the *H. aurantiaca* complex consisting of *H. aurantiaca*, *H. laeta*, and *H. lamae*. Other names were subsumed as varieties.

In 1965, Cardé published redescriptions of *H. aurantica*, *H. ferruginosa*, and *H. lamae* and provided a partial key to the Nearctic *Holomelina* species. Cardé (1965) commented on the sibling species in the *H. aurantiaca* complex, listing *H. aurantica*, *H. ferruginosa*, and *H. lamae* as distinct species. In this paper, Cardé provided commentary on the *H. aurantiaca* and *H. opella* complexes. He was the first to realize that *H. nigricans* was not a synonym of *H. opella* based on adult habitus and male genitalia (Cardé 1965). Cardé summarized additional preliminary findings stating, "Areas of uncertainty are currently under investigation." In 1968 and 1971, Cardé completed a set of taxonomic, chromosome, behavior, and pheromone studies on *Holomelina* for his M.S. and Ph.D. at Cornell University. His taxonomic work is not available under the International Code of Zoological Nomenclature (ICZN 1999), because unpublished theses do not constitute valid publications. He was unsuccessful in locating Hübner types for *H. aurantiaca* and *H. rubicundaria* (Cardé 1968, 1971), which complicated his attempts to determine their species' limits. Cardé's work included two new species that remained as manuscript names (Cardé 1968) until now. Although Cardé's taxonomic revisions were not published, Franclemont (1983) followed his treatment of *Holomelina* in the Checklist of the Moths of America north of Mexico (Hodges et al. 1983).

TAXONOMIC REVIEW OF *VIRBIA*

Virbia (Walker 1854) was described in Arctiidae and associated with lithosiine moths. Its familial placement has never been controversial (Nye et al. 1980;

Ferguson 1985). It is a typical member of the Arctiini except some species possess homoideous crochets (Forbes 1939, 1960; Ferguson 1985; Kitching & Rawlins 1999; Jacobson & Weller 2002). *Virbia* was erected by Walker (1854), and he described two species, *V. mentiens* and *V. luteilinea*. Kirby (1892) subsequently designated *V. mentiens* as the type species. Until recently (Zaspel 2004; Zaspel & Weller 2006), the only generic synonyms were *Bepara* Walker (described in Melameridae) and *Terna* Walker (described in Callimorphidae).

As of 1986, 31 of the 39 species placed in *Virbia* were described in *Virbia* (Watson & Goodger 1986). The remaining species were described in *Bepara* Walker, *Brycea* Walker, *Cothocida* Walker, *Josioides* Felder, *Phaeochlaena* Hübner, *Ptychoglene* Felder, or *Terna* Walker. Again, the small size of the moths led some authors to place these species in lithosiine genera (e.g., *Lithosia* Fabricius, *Josioides* Felder). A few species were described in other families: Geometridae (*Crocota* Hübner, *Eubaphe* Hübner), Dioptriidae (*Phaeoclaena* Hübner), and Noctuidae (*Phalaena* L.). In contrast to the turbulent taxonomic history of *Holomelina*, *Virbia* has received little revisionary attention. Specific nomenclature has been comparatively stable; there were only four synonyms and two subspecies recognized in the most recent checklist of neotropical species (Watson & Goodger 1986).

PHYLOGENETIC PLACEMENT OF *VIRBIA* AND *HOLOMELINA*

There has been a long taxonomic history of associating these genera. Herrich-Schäffer (1855) was the first to do so when he described *Holomelina*. He included *Phalaena medarda* Stoll (Fig. 11) as one of two species comprising *Holomelina*. Later authors did not follow him and placed *P. medarda* in *Virbia*. Seitz (1914: 294) noted that *Virbia* species were structurally much like *Eubaphe* but differed by the branching of the uppermost median vein of the forewing. For over 90 years, checklists and faunal treatments have associated *Eubaphe* and *Virbia* (e.g., Seitz 1914; Forbes 1939; Hampson 1920). Forbes (1939: 220) remarked that *Eubaphe* and *Virbia* were closely related and very unlike other arctiine genera. Ferguson (1985) listed characters uniting *Virbia* and *Holomelina* in the *Holomelina* generic group, and noted that they "might not be distinct" (Ferguson 1985: 199), in other words, congeneric.

Recent checklists (Hodges et al. 1983; Watson & Goodger 1986) treated *Virbia* and *Holomelina* as members of the Arctiini. Phylogenetic studies have come to the same conclusion (Kitching & Rawlins 1999; Jacobson & Weller 2002).

A phylogenetic analysis based on adult morphol-

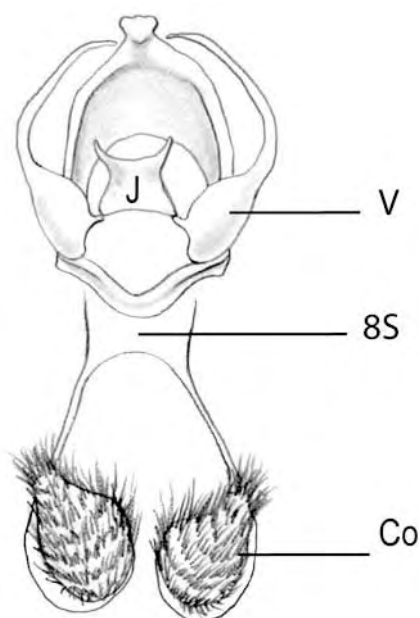


Figure 11. Male genital capsule, *Virbia medarda*. 8S = eighth sternite, Co = coremata (highly developed), J = juxta, V = valve (sacculus region).

ogy was conducted to determine whether *Holomelina* and *Virbia* were monophyletic with regards to each other (Zaspel 2004; Zaspel & Weller 2006). Those studies included 46 ingroup taxa (of 70 possible) and six arctiine species as outgroups. All *Holomelina* species, and about half the species of *Virbia* were included. Fifty-eight characters (195 states) were described and scored from non-genitalic and genitalic structures (Zaspel 2004; Zaspel & Weller 2006).

The maximum parsimony analysis yielded 779 trees with a length (L) of 1698, a consistency index (CI) of 41 and a retention index (RI) of 65 (Zaspel & Weller 2006; Fig. 10). The monophyly of the clade comprised of *Holomelina* and *Virbia* species was well supported. The clade had a decay index greater than 10 (Bremer 1992) and was supported by five unreversed synapomorphies: 1) M2 missing in the hindwing, 2) presence of a scaphium, 3) presence of a subscaphium, 4) apical hooks on the uncus, and 5) juxta ornamentation. The North American species with the *Holomelina* phenotype clustered into two clades, the *H. aurantiaca* clade and the *H. opella* clade. The *H. opella* clade was sister to the clade consisting of *Virbia*, the yellow and black phenotype (Fig. 10). Multiple trees resulted from conflicting resolutions of the apical clade of neotropical species, consisting of those species traditionally assigned to *Virbia*. Different analyses could not recover a reciprocally monophyletic *Virbia* and *Holomelina* (Zaspel

2004; Zaspel & Weller 2006). That is, the *H. opella* and *H. aurantiaca* clades were never grouped exclusive of *Virbia* species. Thus, the former *Holomelina* was an artificial assemblage of two different dispersal events from Mexico and the southwestern U.S. into Canada and the central and eastern U.S. (Zaspel 2004; Zaspel & Weller 2006). *Holomelina* (Herrich-Schäffer 1855) was placed as a junior synonym of *Virbia* (Walker 1854) (Zaspel 2004; Zaspel & Weller 2006) to reflect the results of the study. No subgenera were recognized because they would be either paraphyletic or typically treated as *Holomelina* (e.g., *V. opella* group).

SUMMARY

The taxonomic history of *Holomelina* is complicated by the confusion with geometrid generic names and the frequent acrimonious debates over species' limits among 19th century American lepidopterists. These debates were fueled by the phenotypic diversity of the moths. As noted in the Biology Section, a single species encompasses adult morphs found in monomorphic, co-occurring species. *Virbia*, in comparison, has had a relatively quiet taxonomic history.

The long-standing, phyletic association of *Virbia* and *Holomelina* was confirmed (Zaspel & Weller 2006), and in retrospect, the result was not surprising. The red and yellow hindwing coloration and species' distributions were the principal characters formally used to distinguish the genera. The phylogenetic study that supports this synonymy is discussed at length in Zaspel and Weller (2006). Below we provide an abbreviated checklist for the species. A checklist for the entire genus can be found in Zaspel and Weller (2006).

CHECKLIST OF *VIRBIA* FOR NORTH AMERICA

In this checklist, species are arranged alphabetically. Valid species are in bold with synonyms in italics. The genus in which a species was originally described follows the author name in parentheses, and an asterisk indicates that the type was examined. When the type is not from the United States, the country is noted.

Genus *Virbia* Walker 1854

- Bepara* Walker, 1865a
- Cathocida* Hampson, 1901, misspelling
- Cothocida* Walker, 1865b
- Crocata* authors, misspelling
- Crocota* authors, not Hübner, 1823
- Cyturus* Grote, 1866
- Eubaphe* authors, not Hübner, 1823
- Holomelina* Herrich-Schäffer, 1855

Terna Walker, 1865a

- V. aurantiaca* (Hübner, 1827) *Eubaphe*
bimaculata (Saunders, 1869) *Arctia*
*brevicornis** (Walker, 1854) *Crocota*
V. costata (Stretch, 1885) *Crocota*
opelloides (Graef, 1887) *Crocota*
*intermedia** (Graef, 1887) *Crocota*
*parvula** (Neumögen & Dyar, 1893b) *Crocota*
cocciniceps (Schaus, 1901) *Eubaphe*
*pallipennis** (Barnes & McDonnough, 1918)
Eubaphe

V. fergusonii Zaspel n.sp.

- V. ferruginosa** (Walker, 1854) *Crocota*
quinaria (Grote, 1863) *Crocota*
choriona (Reakirt, 1864) *Crocota*
trimaculosa (Reakirt, 1864) *Crocota*
*buchholzi** (Wyatt, 1963a,b) *Holomelina*

*V. fragilis** (Strecker, 1878) *Crocota*

*V. immaculata** (Reakirt, 1864) *Crocota*

V. laeta (Guérin-Méneville, 1832) *Lithosia*

treatii (Grote, 1865) *Crocota*

rubropicta (Packard, 1887) *Lithosia*

V. lamae (Freeman, 1941) *Eubaphe*

*V. marginata** (Druce, 1885) *Eubaphe* (Guatemala)

*V. nigricans** (Reakirt, 1864) *Crocota*

*nigrifera** (Walker, 1865b) *Cothocida*

V. opella (Grote, 1863) *Crocota*

flava (Barnes & Benjamin, 1925) *Eubaphe*

obscura (Stretch, 1885) *Crocota*

belmaria (Ehrmann, 1895) *Crocota*

rubricosta (Ehrmann, 1895) *Crocota*

*V. ostenta** (Edwards, 1881) *Crocota*

*calera** (Barnes, 1907) *Holomelina*

V. rindgei Cardé n. sp.

V. rubicundaria (Hübner, 1827) *Crocota*

belfragei (Stretch, 1885) *Crocota*

diminutiva (Graef, 1887) *Crocota*

rosa (French, 1890) *Crocota*

MATERIAL AND METHODS

SPECIMENS AND PREPARATION

Dissection methodology follows Winter (2000) and is fully described in Zaspel and Weller (2006). Variations on standard techniques include using only cold 10% KOH for 18-24 hours; most wings were not cleared and slide-mounted. This was done to ensure the small, fragile structures were not 'over cleared' prior to dissection. These moths have very fragile wings; therefore, 1-2 drops of 30% ethanol were added to the wings of pinned specimens for observation of venation. Larger, more robust wings placed briefly in weak bleach (30 seconds), and then standard procedures were followed

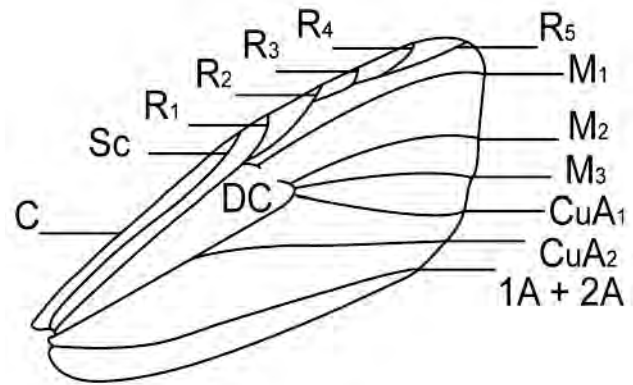
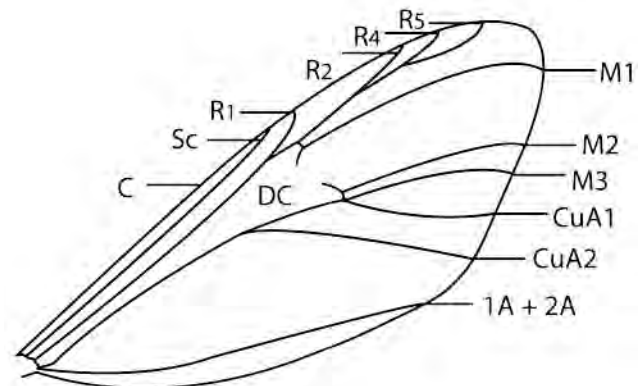
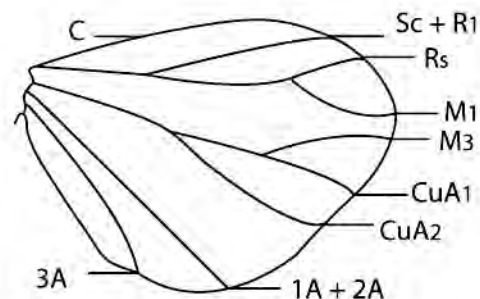


Figure 12. *Virbia aurantiaca*, male forewing, all R veins present. C = costa, Sc = Subcosta, R¹⁻⁵ = radial veins 1 – 5, M¹⁻³ = medial veins 1 – 3, CuA¹ - CuA² = cubital anal veins 1 and 2, A = anal veins.



A



B

Figure 13. *Virbia laeta*, male, A- Forewing, R² = R² + R³ fused or R³ absent. B- Hindwing, M² absent, Sc + R¹ = subcosta fused with radial vein 1, Rs = radial sector vein, other abbreviations as in Fig. 12.

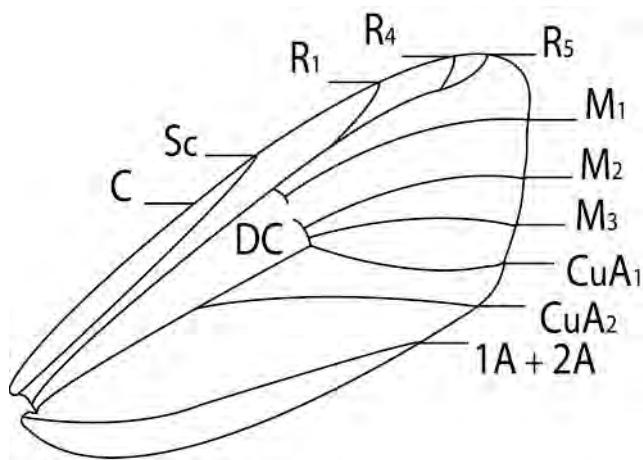


Figure 14. *Virbia cyana*, male forewing, R^2 and R^3 absent, $R^4 + R^5$ = fused other abbreviations as in Fig. 12.

for staining with eosin Y (1% in distilled water; Fisher Scientific, Pittsburgh, PA) and slide mounting. All preparations went through a dehydration series before mounting (Winter 2000). Balsam preparations went through two additional dehydration treatments of oil of clove (15 minutes), and then xylene (15 minutes) before slide mounting. Euparal mounts were transferred from the dehydration series into a final 15-minute treatment in Euparal essence (Bioquip, Garden City, CA) before slide mounting. Permanent slide mounts (Canada balsam [Sigma, St Louis, MO] or Euparal [Bioquip, Garden City, CA]) were made of abdominal pelts, genitalia, legs, wings, labial palps and antennae. Slides were placed on trays and cured in drying ovens for 24–48 hours. Terms for wing venation follow Scoble (1992). Terms for abdominal and genitalic morphology follow Klots (1970), Weller et al. (2000), Jacobson and Weller (2002) and Kristensen (2003). For females, when two bursae exist (double or connate condition), we could not determine which one was the appendix busa based on position or

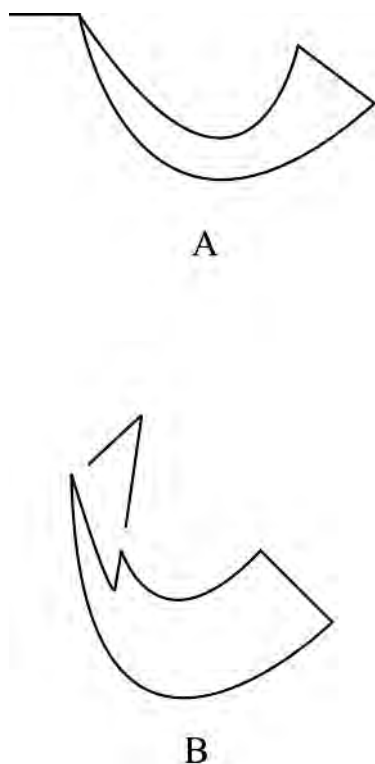


Figure 15. A. Condition of the tarsal claw, *Virbia aurantiaca*, simple; B. Condition of the tarsal claw, *Virbia cyana*, slightly bifid.

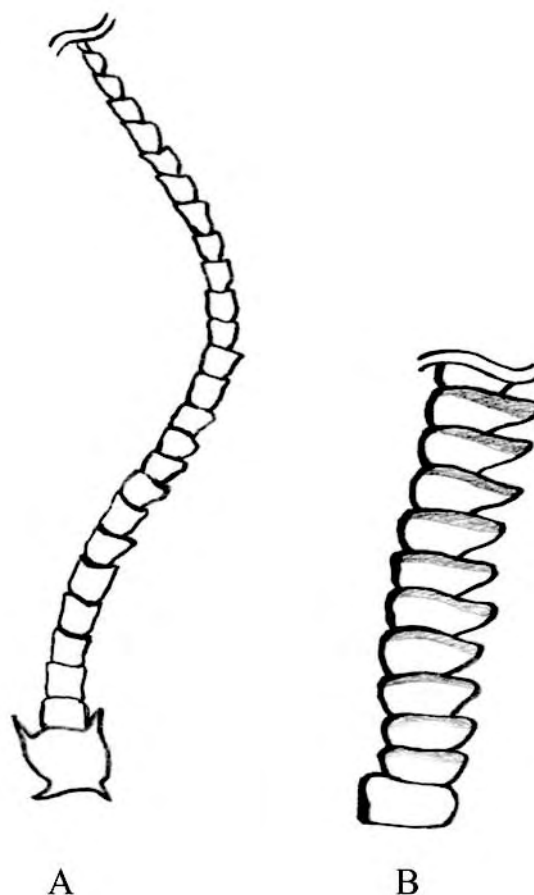


Figure 16. A. *Virbia opella*, male. An = antenna simple and ciliate.; B. *Virbia laeta*, male. An = antenna emarginate, asymmetrical flagellomeres.

presence of a signum. Therefore, we made no distinction between corpus and appendix in the descriptions.

MATERIAL EXAMINED

For the study of species limits, 180 specimens were dissected, representing the 14 species described below; dates from specimen labels have been standardized. In addition, a specimen-level database was compiled in Microsoft Excel that included locality data (label data), prior identifications, comments, and repository for specimens of *Virbia* species. The database includes over 12,000 entries from 16 collections (listed below) following the protocol of the NMNH (M. Pogue, personal communication). It is searchable and can be found on the Diversity of Life website at www.diversityoflife.org/virbia.html.

The following is a list of the institutional and private collections consulted during this study. The acronym of the institution or name of private collection is followed by the name of the individual that prepared the loan. Acronyms follow Heppner and Lamas (1982): AMNH - American Museum of Natural History, New York (E. Quinter); CMNH - Carnegie Museum of Natural History, Pennsylvania (J. Rawlins); CUIC - Cornell University Insect Collection, New York (J. Liebherr); CSU - Colorado State University, Colorado (P. Opler); E. H. Strickland Entomological Museum, University of Alberta, Alberta (F. Sperling); EMEC - Essig Museum of Entomology, University of California, Berkeley, California (J. Powell); FMNH - Field Museum of Natural History, Illinois (P. Goldstein); LACM - Los Angeles County Museum, California (J. Donahue); MSU - Mississippi State University, Mississippi Entomological Museum, Mississippi (R. Brown); UNSM - University of Nebraska State Museum, Nebraska (B. Ratcliffe); NMNH - National Museum of Natural History, Washington D.C. (M. Pogue); TAMU - Texas A and M University Insect Collection, Texas (E. Riley); UCONN - University of Connecticut Insect Collection, Connecticut (D. Wagner); UMSP - University of Minnesota Insect Collection, Minnesota (P. Claussen); RTC - Personal collection of R. Cardé, University of California-Riverside.

SPECIAL TERMS

Adbasal-This is the space before the basal bands in most other noctuids. In arctiids it can be present, but is usually lost, or fragmented and united with the antemedial band.

Basal-This represents the space between the basal and antemedial band.

Antemedial-This can be complete or fragmented. Be-

cause of this fragmentation, this band is almost always a composite of the basal and antemedial bands, and it is uncertain how often a true antemedial band occurs.

Medial-A band near the middle of the wing between the antemedial and postmedial areas, sometimes incomplete and apparent as a spot or bar near the costa.

Postmedial-This is the pale space beyond the postmedial line. This is often present as a full band.

Subterminal-This is a zigzag band running from a point on the costa about midway between the postmedial band and apex toward the tornus-the anal region or anal angle, merging with the postmedial band between M3 and Cu1, then bending sharply outward again. This band may be complete, fragmentary or absent.

SPECIES DESCRIPTIONS

Species were delimited primarily by differences in the male genitalia, especially characteristics of the vesica, phallus, and juxta. Female genitalia are diagnostic for some. Due to a redundant distribution of character states between species (e.g., little interspecific variation), diagnostic morphological characters typically are illustrated once and are referred to in multiple descriptions. Some *Virbia* species are almost indistinguishable by their genital characteristics; in addition, a variety of wing color patterns occur, rendering species determination difficult. Within the North American fauna, species range from pale pink and yellow (e.g., *V. ferruginosa* and *V. immaculata*) to deep red and brown (e.g., *V. ostenta*). Some species (e.g., *V. aurantiaca*) have wing patterns that vary within long reared series from a single female (Fig. 1). Although variable, these species do share common pattern elements with other arctiines. All specimens were examined under a true color lamp (OTTLITE®), and colors are described using the Naturalist's Color Guide (Smithe 1975).

In general, arctiids have greatly modified wing pattern systems compared to their closest relatives, the Noctuidae (Ferguson 1985, sensu Fibiger & Lafontaine 2005, not Lafontaine & Fibiger 2006). The forewing pattern typically consists of light stripes and spots against a darker background, a reverse of the classic noctuid pattern. The forewing pattern usually is based on six lightly colored, transverse bands on a dark background, these are almost always reduced to five or fewer, or lost, with many variations occurring within a genus (Ferguson 1985). Ferguson notes:

Two typical pattern systems occur on the forewings of many Arctiini: a lon-

gitudinal vein pattern and a supplementary longitudinal pattern consisting of paracostal, cubital, and postcubital band, also called the primary and secondary longitudinal patterns, respectively (Ferguson 1985:183).

Similarly, the basic hindwing pattern of Arctiini is reversed from the noctuid one, and consists of a colored background with either dark spots or dark outer-marginal borders (Ferguson 1985). A discal spot or spots may be present, but often are modified or lost (Ferguson 1985).

Nomenclature for pattern elements of *Virbia* follows Ferguson (1985). Descriptions of wing regions, patterns, and colors specific to *Virbia* species are defined in the "Specialized Terms" section. The described pattern elements are strictly for species' identification purposes and are not intended to be interpreted as homologies of pattern elements across Noctuoidea.

To facilitate the construction of consistent diagnoses and descriptions, DELTA (Descriptive Language for Taxonomy) was used (Dallwitz *et al.* 1993). Species descriptions were first constructed using DELTA, and then minor formatting changes were made.

SYSTEMATIC ENTOMOLOGY

Order LEPIDOPTERA

Family ARCTIIDAE

Subfamily ARCTIINAE

Tribe ARCTIINI

Genus *Virbia* Walker

Virbia Walker, 1854: p. 470. Type species: *Virbia mentiens* Walker, 1854.

Bepara Walker, 1865a.

Cathocida Hampson, 1901, misspelling.

Cothocida Walker, 1865b.

Crocata authors, misspelling.

Crocota authors, not Hübner, 1823.

Cyturus Grote, 1866.

Eubaphe authors, not Hübner, 1823.

Holomelina Herrich-Schäffer, 1855.

Terna Walker, 1865a.

Diagnosis (Figs. 1,2,4,5, Pl. 1-3).— These are relatively small arctiids, with forewing length ranging from 8.2 mm to 17.1 mm in males (N = 14) and from 8.7 mm to 18.5 mm females (N = 11). Antennae are typically simple and ciliate (Fig. 16A). Forewing with two predominant pattern types: dark forewings and hindwings with bright yellow markings (Fig. 5) or yellowish areas replaced with pink or reddish markings (e.g., *V. ostenta*)

(Fig. 4). Male genitalia are unique in Arctiini in the possession of a true scaphium (except for *V. cyana*) (Figs. 25A, B). The corpus bursa can be single, double, or connate with the corpus (Fig. 17C). *Virbia* can be separated from other Arctiidae by the loss or reduction of the M2 in the hindwing (Fig. 13B) and the scaphium.

Description.— *Adult habitus* (Figs. 1,2,4,5, Pl. 1-3): Head color uniform, but variable, from dark black (Fig. 2) or brown (Pl. 3, Nos. 2-3) to pinkish orange (Fig. 4). Third segment of labial palpus typically long, exceeding front by at least half its length; color variable from yellow to pink, gray, or varying intensities of brown. Ocelli absent. Thorax with dorsal and ventral scale coloration variable, from dark black (Fig. 5) or brown (Pl. 3, Nos. 2-3) to pinkish orange (Fig. 4). Forewing typically with R¹ - R⁵ all present (e.g., *V. aurantiaca*: Fig. 12), R³ absent or trace in *V. laeta* (Fig. 13A), and R², R³ absent or trace in *V. cyana* (Fig. 14). Hindwing with M² absent (Fig. 13B). Wing color pattern one of two main types (see diagnosis). Abdomen with color variable from dark black (Fig. 5) or brown (Pl. 3, No. 2) to pinkish orange (Pl. 2, No. 4). Sclerotization of male 8th sternite often species specific, shapes including: triangular (e.g., *V. phalangia*: Fig. 28A), oval (e.g., *V. opella*: Fig. 28B), pentagonal (e.g., *V. marginata*: Fig. 28C), pentagonal with expanded base (e.g., *V. divisa*: Fig. 28D), antecosta reinforced by transverse ridge, rectangular width greater than length (e.g., *V. luteilinea*: Fig. 28E), and M-shaped (e.g., *V. metazonata*: Fig. 28F). Coremata typically present, but variable developed. *Male genitalia*: Phallus typically with coecum penis rounded, occasionally weakly notched (e.g., *V. ferruginosa*: Fig. 22A). Vesica directed ventrally in most species, directed posteriorly in *V. latus*, *V. cyana*, and *V. polyphron*. Phallic sclerite typically present, but variable: narrow, rounded triangular (e.g., *V. ostenta*: Fig. 22B), wide and nodular (e.g., *V. aurantiaca*: Fig. 22C), triangular, blunt (e.g., *V. inversia*: Fig. 18A), sharp and triangular (e.g., *V. endophaea*: Fig. 18B), and square (e.g., *V. polyphron*: Fig. 18C). Vesica typically rugose with endophallus ornamentation on right side, under phallic sclerite present, either as ventral cornutuslike patch (e.g., *V. aurantiaca*: Fig. 22C) or peglike patches (e.g., *V. endophaea*: Fig. 18B). Genital capsule (Figs. 25A, 25B) dorsad with tegumen either M-shaped or concave (e.g., *V. costata*: Fig. 23A), with lobes (e.g., *V. aurantiaca*: Fig. 23B), or entire (e.g., *V. laeta*: Fig. 23C). Ventrad with uncus base typically cordate (e.g., *V. aurantiaca*: Fig. 23B). Ventrally directed hooks present on apex of uncus with bases fused or separate; usually two hooks present (e.g., *V. costata*: Fig. 23D), but only one in *V. semirosea* and lacking in *V. cyana*, *V.*

phalangia, and *V. polyphron*. Scaphium present (except *V. cyana*), conical (e.g., *V. laeta*: Fig. 23E), or flattened (e.g., *V. phalangia*: Fig. 23F). Costa typically elongate with apex entire (e.g., *V. laeta*: Fig. 25A), sometimes forked (e.g., *V. opella*: Fig. 27D). Saccus typically rounded, setose (e.g., *V. marginata*: Fig. 27C) infrequently thin, square (e.g., *V. feronia*: Fig. 27E). *Female genitalia*: Papillae anales convex, rounded; pseudopapillae anales typically present (e.g., *V. nigricans*: Fig. 24B), infrequently lacking. Posterior apophyses entire, long and slender. 8th tergite unornamented. Anterior apophyses entire, long and slender. Eighth sternite round, wide and entire. Location of ostium bursa just above 8th sternite, ornamentation of ventral edge variable: central broad indentation with small lateral prominences (e.g., *V. aurantiaca*: Fig. 17A), straight (e.g., *V. lamae*: Fig. 17B), split in center with lateral prominences (e.g., *V. opella*: Fig. 30A), small lateral prominences (e.g., *V. rubicundaria*: Fig. 30B), or toothed (e.g., *V. satara*: Fig. 30C). Shape of ductus bursa variable: rectangular (e.g., *V. aurantiaca*: Fig. 17A), hourglass-shaped (e.g., *V. lamae*: Fig. 17B), goblet-shaped (e.g., *V. opella*: Fig. 17C), or rectangular, tapering in middle of base (e.g., *V. metazonata*: Fig. 17D). Sclerotization of ductus bursa extending into corpus bursa, except in *V. marginata*. Corpus bursa with (e.g., *V. opella*: Fig. 17C) or without additional connate bursa (e.g., *V. aurantiaca*, *V. lamae*: Fig. 17A & B), typically with one to three round signa.

Discussion.— Species with the *Holomelina* pattern are often polymorphic, and several phenotypes may occur in a single brood (Fig. 1). Rearing studies are needed of species exhibiting the yellow-black *Virbia* phenotype to determine whether polymorphism is prevalent. In Mexico, species with *Virbia* and *Holomelina* patterns co-occur.

Both male and female genitalia are useful for distinguishing phenotypically confusing species. The lobing and ornamentation of the vesica (endophallus) is often species' specific. In several species, females exhibit species' specific ornamentation of the ostium bursa or corpus bursa, and several species have pseudopapillae anales (Fig. 24B).

These moths often are found misplaced in uncurated Geometridae, Notodontidae (*Josia*), or lithosiine arctiids. They can be separated from Geometridae by the placement of the tympana on the metathorax (versus on the base of the abdomen in Geometridae). They can be separated from *Josia* based on forewing venation (M^2 arising from mid discal cell in *Josia* and from near M^3 in *Virbia*). The hindwing venation (M^2 absent in *Virbia*) usually will separate these

species from other arctiids.

Virbia aurantiaca Hübner

Pl. 1 No. 5 (female), Nos. 3-4 (males)

Eubaphe aurantiaca Hübner 1827: 206 [type locality: Pennsylvania, USA].

Crocota bimaculata Saunders 1869: 5 [type locality: London, Ontario, Canada].

Crocota brevicornis Walker 1854: 2 [type locality: United States].

Crocota choriona Reakirt 1864: 371 [type locality: Philadelphia, Pennsylvania, USA].

Holotype.— The holotype of *Eubaphe aurantiaca* is lost according to Lloyd Martin, Curator of Lepidoptera at Naturhistorisches Museum, Wien (personal communication 6/25/2004). A neotype is designated here and labeled to ensure nomenclatural stability. The specimen was chosen from the nearest locality to the original type locality. The neotype, male [CMNH] is labeled: *Virbia aurantiaca* (Hbn. 1827) [RED LABEL]. Label data: At light New Lisbon, N.J. Aug. 7 1934, E.P. Darlington//Exch. A.N.S.P. GM. Acc. 20359.

Material examined.— Type material: Neotype designated above. All material is from the NMNH unless otherwise noted: **CANADA: Nova Scotia:** Lequille, 1.viii.1946, D. C. Ferguson (1 Male, JMZ100). **Quebec:** Temiscouata Co., 30.vi.1985, leg. George Hensel (1 Male, JMZ94). **MEXICO: Cordoba:** 16.v.1908, Fred Knab (1 Female, JMZ92). **Jalapa:** Wm. Schaus Collection (1 Male, JMZ93). **UNITED STATES: Arkansas:** Washington Co., Springdale Blue Spruce Campground, 28.v.1966, R. Heitzman, (1 Male, JMZ96). **Connecticut:** New Haven, Hamden, 3.ix.1967, D. C. Ferguson (1 Male, JMZ119). **Kansas:** Labette Co., Oswego, 3.vi.1966, Gary F. Hevel collector, at lights (1 Male, JMZ115). **Kentucky:** Oldham Co., Horner Bird Sanctuary 25.viii.1977, C. V. Covell Jr. (1 Male, JMZ113). **Maine:** Southwest Harbor, 21.vii.1936, near Colorado, *marginata* as in Barnes Collection 1937 (1 Male, JMZ183); Willimantic, 15.vii.1930, H. Wilhelm (1 Male, JMZ101). **Maryland:** Queen Annes Co., Gransonville Horsehead Sanctuary, 24.vii.1986, D. C. Ferguson (1 Female, JMZ109). **Michigan:** July Barnes Collection (1 Male, JMZ112). **Montana:** Sweetgrass Co., Big Timber Creek 7 mi. N. Big Timber, 29.vii.1966, D. C. Ferguson (1 Male, JMZ99). **New York:** Long Island, Greenport, viii (1 Male, JMZ103). **New Jersey:** Orange Mts., 24.vii.1937, Otto Bucholz (1 Female, 1 Male, JMZ110; JMZ111). **North Dakota:** Slope Co., Burning Coal Veins Pine Ridge, elev. 2500', T 136N, R 102W, Section 11, 21.vii.1982, Eric H. Metzler (2 Males, JMZ116; JMZ118). **Oklahoma:** Sequoia Co., Tenkiller

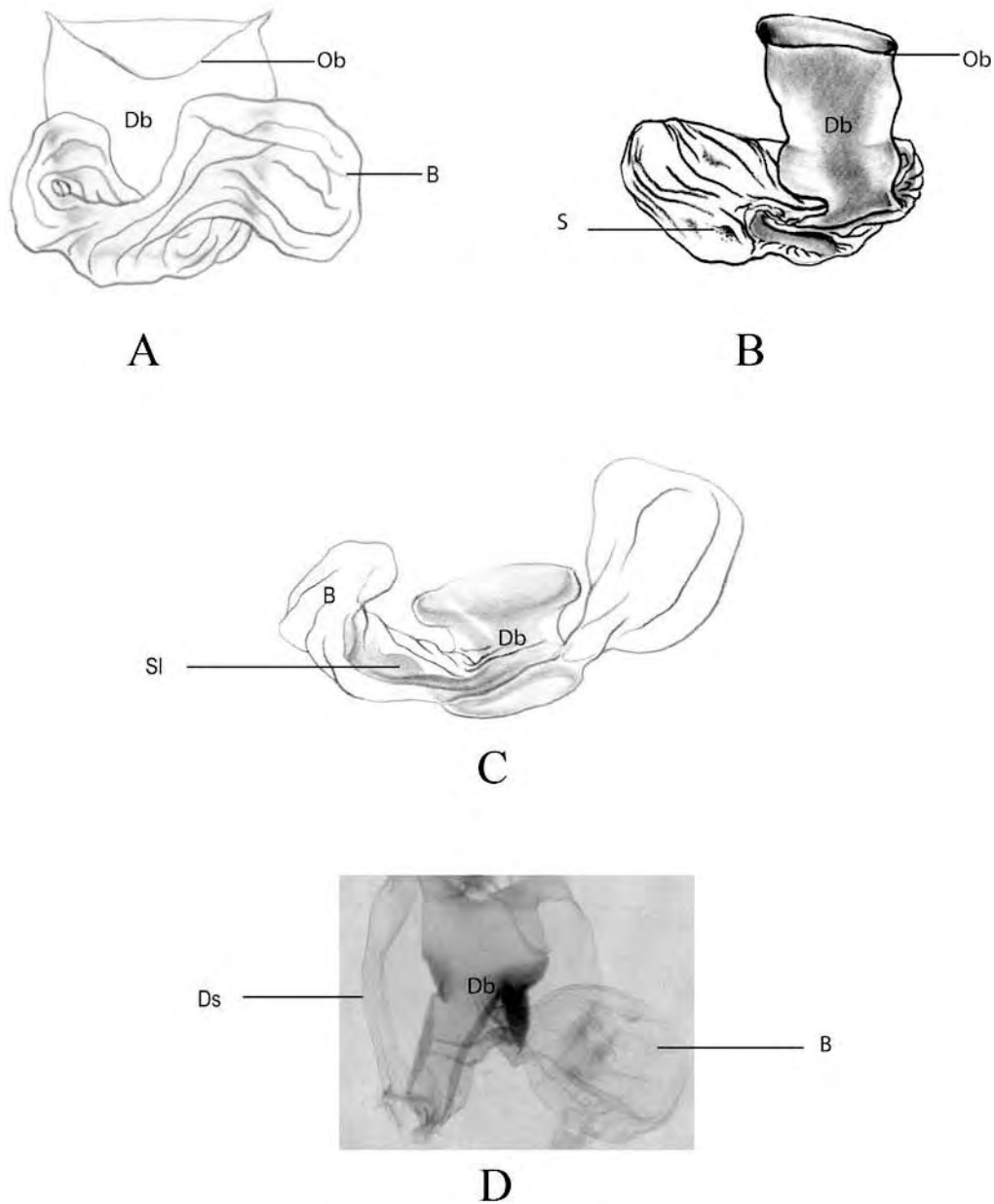


Figure 17. A. Bursa complex, *Virbia aurantiaca*, ventral view. B = bursa (membrane wrinkled), Db = ductus bursa (rectangular and narrowing toward ventor), Ob = ostium bursa (central, broad indentation and small lateral prominences); B. Bursa complex, *Virbia lamae*, ventral view. Db = ductus bursa (hourglass), Ob = ostium bursa (straight), S = signum; C. Bursa complex, *Virbia opella*, dorsal view. B = bursa (connate and arising from ductus, membrane of additional lobe wrinkled), Db = ductus bursa (goblet, sclerotization extending from ductus bursa into corpus bursa); D. Bursa complex, *Virbia metazonata*, dorsal view. B = bursa (connate, arising from ductus; membrane of additional lobe smooth), Db = ductus bursa (square).

Lake, 3 mi. W. Blackgum, 6-9.vii. 1979, D. & M. Davis (1 Male, JMZ117). **South Carolina:** McClellanville, Wedge Plantation, 22.iv.1974, D. C. Ferguson (1 Male, JMZ102). **Tennessee:** Nashville, 16-23.vi., Barnes Collection (1 Male, JMZ95). **Texas:** Concan, Garner Ste. Pk. 1.vi.1964, A. & M. E. Blanchard (1 Male, JMZ62), Hill Co., Lake Whitney Park, 21.iv.1985 (1 Male, JMZ98); Sinton, Welder Wildlife Foundation, 22.iv.1964, A. & M. E. Blanchard (1 Male, JMZ67); Cameron Co., Brownsville, 17.xi.1941, Collection of Fred Rindge, AMNH (1 Male, JMZ288); Santa Ana Wildlife Refuge, 21.x.1970, A. & M. E. Blanchard (2 Females, JMZ194; JMZ196). **Virginia:** Leesburg, 4.vii.1970, D. C. Ferguson, reared ex ovo on dandelion (1 Male, JMZ108). **Wisconsin:** Lindsey, 23.vii.1964, J. W. Barnes (1 Male, JMZ97). **Wyoming:** New Castle, 6 mi. N.W., 28.vi.1965, R. W. Hodges (1 Male, JMZ114).

Diagnosis. — *Virbia aurantiaca* may be confused with *V. ferruginosa*, *V. lamae*, *V. marginata*, *V. nigricans*, and *V. rubicundaria*, but it is most commonly confused with *V. ferruginosa*. The two species are separated using hindwing maculation and potentially emergence dates. The subterminal hindwing band of *V. aurantiaca* is solid, whereas the subterminal area of *V. ferruginosa* has a series of blotches and spots, not a solid band. In New York and neighboring states, *V. ferruginosa* emerges in July, whereas broods of *V. aurantiaca* emerge in June and August (Cardé 1965, 1974). Flight period is less reliable in the Maritime Provinces, northern Michigan, and northern Maine, where there is a single brood and the adult emergence of *V. aurantiaca* overlaps with *V. ferruginosa* (Zaspel database). In the southern states (e.g., Georgia, Florida), *V. aurantiaca* may be encountered anytime in the summer (Zaspel database, Adams personal communication).

Virbia aurantiaca can be separated from *V. nigricans* and *V. lamae* if detailed label data are available. *Virbia lamae* is a bog endemic and males fly (without flushing) diurnally. *Virbia nigricans* has been collected only in a narrow corridor of disturbed secondary forest on the border of western New Jersey (Hunterdon County) and eastern Pennsylvania (Philadelphia area). This species is much darker and smaller (wing length 8.2 mm) (Figs. Plate 2, Nos. 8,9) than *V. aurantiaca* (wing length 9.7 mm) (Pl. 1, Nos. 3-5). The shape of the juxta also separates the three species. In *V. aurantiaca*, the juxta is ovoid with the ventral margin expanding into a larger, orbicular shape (Fig. 20B), whereas in *V. lamae* and *V. nigricans*, it is cylindrical and emarginated as in *V. marginata* (Fig. 27C). In females, *V. aurantiaca* has pseudopapillae anales; the other two do not. Lateral prominences surround the ostium

bursa in *V. aurantiaca* (Fig. 26D) and *V. nigricans* but not *V. lamae* (Fig. 26B).

Virbia fragilis, a western species, occasionally is misidentified as *V. aurantiaca*, especially specimens from the western edge of *V. aurantiaca*'s range. *Virbia fragilis* is a much larger species (14 mm), and the hindwing color is flesh ocher and lacks subterminal markings. The phallic sclerite is wide and nodular in *V. aurantiaca* (Fig. 22C), whereas it is highly reduced in *V. fragilis*.

In Central America, *V. aurantiaca* co-occurs with *V. marginata* (range: Guatemala, Mexico, SW USA). Diagnostic differences are provided under *V. marginata*.

Occasionally, pale specimens of *V. aurantiaca* lack the subterminal hindwing band, and these can be confused with the boreal *V. immaculata* or *V. rubicundaria*, but *V. immaculata* is a larger species (forewing length 12 mm) and has a reduced phallic sclerite compared to *V. aurantiaca* (Fig. 22C), and *V. rubicundaria* is a smaller species (forewing length 8.9 mm). Females of *V. aurantiaca* can be confused with those of *V. rubicundaria*, but *V. rubicundaria* is restricted to the southeastern USA and is rarely sympatric with *V. aurantiaca*. *Virbia rubicundaria* females are also much smaller (forewing length 8.7 mm vs. 9.7 mm, respectively) and brighter than *V. aurantiaca* females (compare Pl. 2, No. 4, Pl. 1, No. 5).

Description.— Male habitus (Pl. 1, Nos. 3-4): Head dark clay throughout. Antennal scales dark clay. Third segment of labial palpus exceeding front of head by at least half of entire length, first and second segments salmon, apex of third segment grayish horn. Thorax dorsal and ventral scales clay throughout. Legs clay, tarsal claw simple (Fig. 15A). Forewing length 10 mm (N = 10); R¹-R⁵ all present, m³ present, extending to wing margin (Fig. 12). Dorsal surface ranging from clay to cinnamon throughout; ventral surface salmon. Hindwing dorsal surface peach red, typically with solid raw umber subterminal band, ventral surface salmon. Abdomen with dorsal and lateral abdominal scales clay to salmon, dorsal tergites occasionally with medium size fawn spot in center, size of spot tapering with each segment towards posterior, ventral abdominal scales yellow ocher throughout. Sclerotization of 8th sternite pentagon (Fig. 28C). Coremata reduced to small patches of scales on membranous lobes. Female habitus (Pl. 1, No. 5): Head clay. Antennal scales clay. Third segment of labial palpus exceeding front of head by at least half of entire length, all segments clay. Thorax dorsal, lateral, and ventral scales salmon to clay. Legs clay with patches of salmon scales on femora and tibiae, tarsal claw simple (Fig. 15A). Forewing length 9.7 mm (N

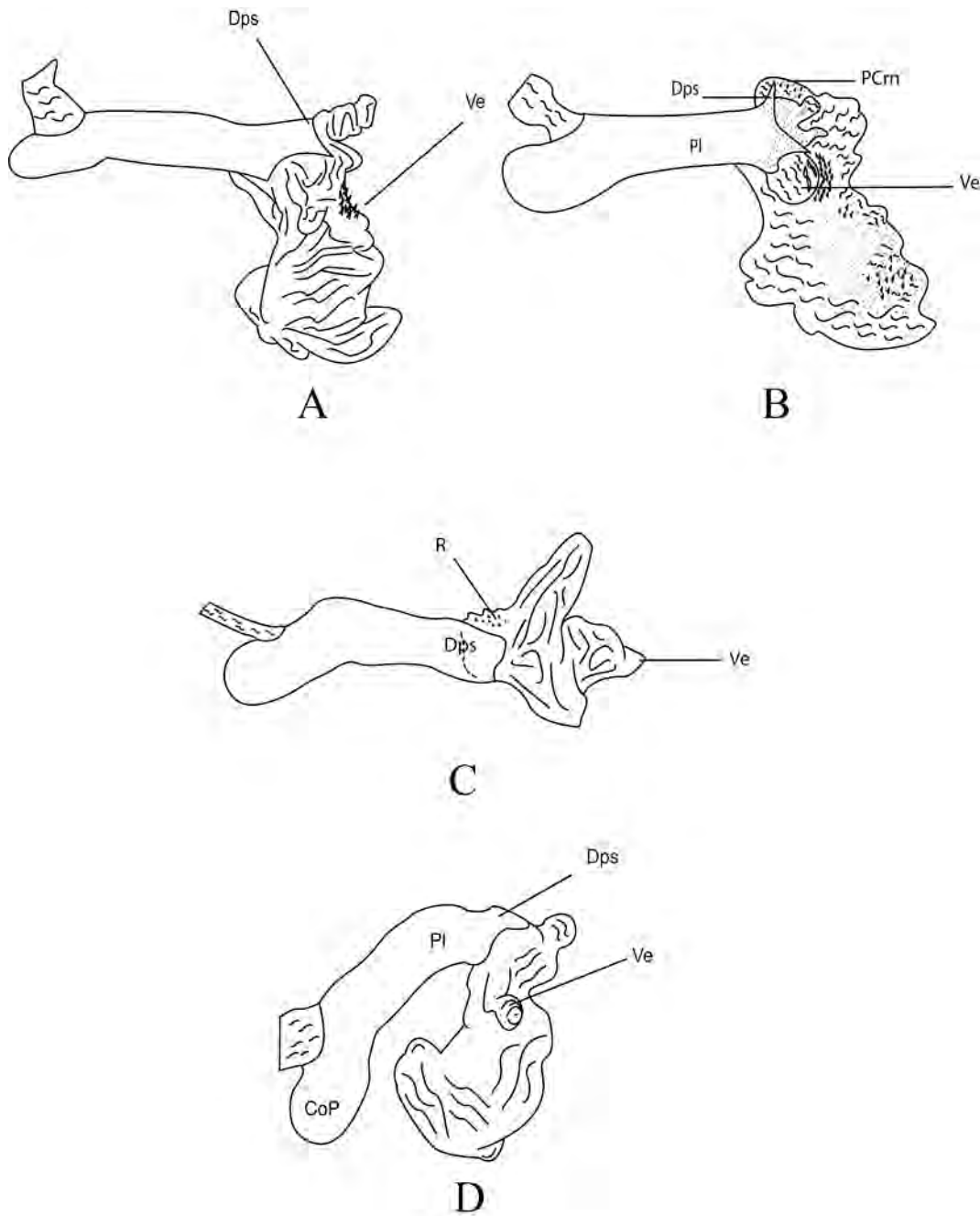


Figure 18. A. Phallus, *Virbia inversia* left, lateral view. Dps = phallic sclerite (triangular, blunt), Ve = vesica (upper medial-proximal projection on left side), Cp = patch of cornuti (on venter); B. Phallus, *Virbia endophaea* left, lateral view. Dps = phallic sclerite (triangular, sharp), PCrn = peglike patches of cornuti (under phallic sclerite), Pl = basiphallus (single sclerotized lobe-like projection at midpoint), Ve = vesica; C. Phallus, *Virbia polyphron* left, lateral view. Dps = phallic sclerite (square, rugose), R = rugose patch (under phallic sclerite), Ve = vesica (directed laterally), Ve1 = right dorsal lobe, Ve2 = left lateral lobe; D. Phallus, *Virbia costata* left, lateral view. CoP = coecum penis (rounded and orientation straight), Dps = dorsal phallic sclerite (narrow and rounded), Pl = basiphallus (inflected ventrally at base), Ve = directed (ventrally, membrane rugose, left side with membranous rugose projection).

= 10), venation same as in male. Forewing dorsal surface salmon to cinnamon with faint olive brown discal spot present, ventral surface salmon, peach red scales lining costal margin. Hindwing dorsal surface peach red with natal brown discal spot, natal brown subterminal markings as spots and blotches often not reaching posterior margin, ventral surface identical. Abdomen with dorsum intermixed with salmon and clay, occasionally with fuscous spots on all segments, lateral scales salmon with fuscous spots on all segments, ventrally intermixed with salmon and clay. Male genitalia: Phallus (Fig. 22C) with rounded coecum penis, straight, basiphallus inflected ventrally at midpoint, phallic sclerite wide, nodular. Vesica directed ventrally, membrane rugose, bilobed, elongate, second lobe sclerotized, lower left side of vesica with small membranous projection, right side of vesica with patch of cornuti under phallic sclerite. Genital capsule (Fig. 25A) with dorsum of tegumen lobed, sides of tegumen divergent, conjunctiva membranous (Fig. 23B). Uncus base cordate (Fig. 23B), ventrad with uncus apex fingerlike, bifid and with two fused hooks (Fig. 27A). Scaphium rounded, triangular. Subscaphium absent. Extensions of tegumen sclerotized. Juxta vertically ovoid with ventral margin expanding into larger orbicular plate (Fig. 20B). Costa of valva elongate and tip entire, 20 or more costal setae. Saccus horizontally obovate, broadly hooked toward costa. Saccus rounded, concave in center. Female genitalia (Figs. 26C & D, 17A): Pseudopapillae anales present. Pheromone glands membranous, branching before tip of anterior apophyses, moderately thick, greater than 1/8 but less than 1/4 width of 7th abdominal sternite. Ostium bursa slightly concave with small lateral prominences (Fig. 30). Ductus bursa rectangular, narrowing toward venter, sclerotization extending into corpus bursa (Fig. 17A). Corpus bursa with three signa, membrane of the corpus bursa wrinkled (Fig. 26C).

Variation. — The most common phenotype of *V. aurantiaca* is the 'red form' (Pl. 1, Nos. 3-5); however, a yellow phenotype resembling *V. marginata* (Pl. 3, No. 1) also occurs infrequently. Nearly all specimens of *V. aurantiaca* we examined have a characteristic round, un-notched coecum penis and a dorsally rounded tegumen. Rarely, red form individuals have a notched coecum penis as in *V. marginata* or *V. ferruginosa* (Fig. 22A). Some males from the South, specifically Texas, have darker raw umber forewings with a white annular spot and a smaller forewing length than specimens from the northeast.

Biology. — This species can be reared on dandelion and plantain (Forbes 1960, Cardé 1968), but its native host is unknown. Larvae feed readily on artificial

diet (Zaspel database). The chromosome number appears to be 25 (Cardé 1971). In southern Connecticut, two broods can be reared, with one emerging in June (peak emergence around June 20) and the other in August (Cardé 1971). Additional generations can be reared in the southern U.S., and the species is considered facultatively multivoltine (Forbes 1960). Females lay individual eggs unattached, like *V. rubicundaria* (Cardé, rearing notes). Females have been observed releasing pheromone nocturnally (Fig. 8), but males are attracted to pheromone from 10:00 to 22:00 hours (Cardé 1974).

Distribution. — This species is among the most widely distributed in the *V. aurantiaca* complex. In eastern North America, specimens have been collected from Manitoba and Nova Scotia, Canada, along the eastern seaboard, south to Cordoba, Mexico (see database for records from these localities). The western edge of its distribution is less clear. The species has been collected in Texas, Mississippi, Missouri, Tennessee, Louisiana, Oklahoma, Kansas, and North and South Dakota. We examined a single specimen from Montana that either represents a highly disjunct population or is misidentified.

Virbia costata Stretch

Pl. 1, No. 10 (female), Pl. 2, No. 1 (male)

Crocota costata Stretch 1885: 103 [type locality: Texas, USA].

Crocota opelloides Graef 1887: 42 [type locality: Texas, USA].

Crocota intermedia Graef 1887: 42 [type locality: Texas, USA].

Crocota parvula Neumögen & Dyar 1893b: 140 [type locality: western Colorado, USA].

Eubaphe cocciniceps Schaus 1901: 269 [type locality: "USA"].

Eubaphe pallipennis Barnes & McDonnough 1918: (1) 85, pl. 14, Fig. 14 [type locality: "USA"].

Material examined. — Type material: Holotype of *V. costata* not examined. Holotype *C. intermedia*: *Crocota intermedia* Texas, E.L. Graef Collector, 41D1//Collection Brklyn. Mus.//Type No. 34162 U.S.N.M.//*Crocota intermedia* Graef, type Tex. Coll. Edw. L. Graef, NMNH. Holotype of *C. parvula*: *Crocota intermedia parvula* Colo. Bruce//Col. B. Neumögen//Typicum Specimen//Type No. 33695 U.S.N.M.//41D2//*Crocota intermedia* v. *parvula* Type Female Neumögen, NMNH. Holotype *E. pallipennis*: *E. costata* v. *pallipennis* Type B & McD.//Glenwood Spgs., Col. July 16-23//47 B3 [sic.], NMNH. All material deposited in NMNH unless otherwise noted: **UNITED STATES: Arizona:** Yavapai Co., Mayer, 23.vii.1959, R. F. Sternitzky (1 Female, JZ220). **Colo-**

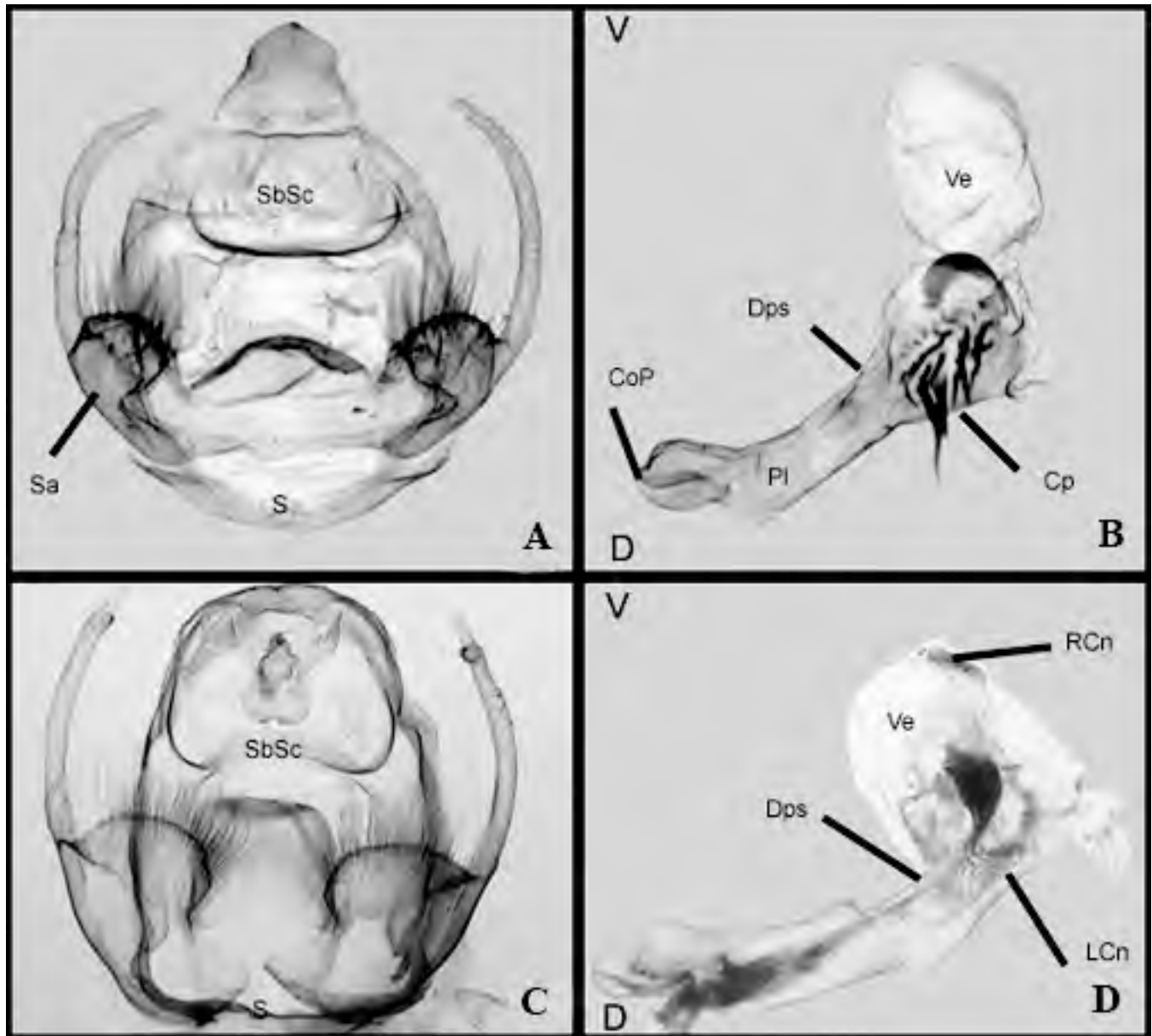


Figure 19. A. Male genital capsule *Virbia fergusonii*. S = saccus (rounded, concave in center), Sa = sacculus (peanut shaped), SbSc = subscaphium (completely surrounding anal tube); B. Phallus, *Virbia fergusonii*, left, lateral view. CoP = coecum penis (rounded), Cp = cornutal patch, D = dorsal, Dps = dorsal phallic sclerite (reduced), Pl = basiphallus (inflected ventrally at base), Ve = vesica, (bilobed, directed ventrally with rugose membrane, right side with patch of cornuti under phallic sclerite), V = ventral; C. Male genital capsule *Virbia opella*. SbSc = subscaphium (lobed and incomplete, e.g., not completely surrounding anal tube), S = saccus (rounded, concave midventrally); D. Phallus, *Virbia opella*, left, lateral view. D = dorsal, Dps = phallic sclerite (reduced), Ve = vesica (directed ventrally, membrane rugose, bilobed, elongate, second lobe rugose), LCn = left side of vesica (with ventral patch of cornuti), RCn = right side of vesica (with patch of cornuti under phallic sclerite), V = ventral.

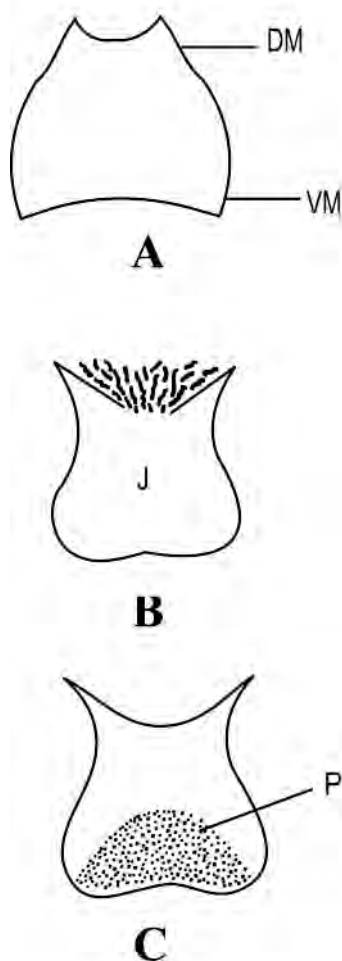


Figure 20. A. Juxta, *Virbia opella*: vertically ovoid with ventral margin (VM) expanding into large orbicular shape, dorsal margin (DM) concave with pointed edges; B. Juxta, *Virbia* (*H.*) *aurantiaca*: vertically ovoid, concave on both sides with ventral margin expanding into large orbicular shape; C. Juxta, *Virbia ferruginosa*: with transparent patches (P) present, (broadly rounded).

rado: Glenwood Springs, 16-23.vii., compared with type collection in Brooklyn Museum (1 Female, JZ60); 24-30.vii., *E. costata*, *pallipennis* paratype (1 Male, JZ65); La Plata Co., Durango, Elev. 6, 500 ft., 2.vii.1957, F. & P. Rindge, AMNH (1 Male, JZ273). **Oklahoma:** Comanche Co., Wichita Mts. Nat. W. Refuge, The Narrows, 10-18.vii.1984, D. & M. Davis (1 Male, JZ88). **Texas:** Alpine, 8-14.viii.1928, Poling collector, Barnes Collection (1 Male, JZ89); Brewster Co., Big Bend Nat'l Park, Green Gulch, 6.v.1972, A. & M. E. Blanchard, AMNH (1 Male, JZ256). **New Mexico:** Eddy Co., Big Canyon, Guadalupe Mts., 24.vii.1959, A. B. Klots, *Holomelina intermedia* i. *intermedia* det. by Graef,

AMNH (1 Female, JZ257).

Diagnosis.— This species is sexually dimorphic (Plate 1, No. 10; Plate 2, No. 1). Females superficially resemble *V. laeta* females and males, but *V. costata* is restricted to southwestern U.S., whereas *V. laeta* occurs in the north central and southern U.S. *Virbia costata* females are larger (wing length 13.5 mm) than males of *V. laeta* (wing length 11 mm), and smaller than females of *V. laeta* (wing length 17 mm).

Males of *V. costata* can be confused with males of *V. fragilis*, a western species, but the two can be separated by male genitalic characters. The genitalia of *V. costata* have a large subscaphium and a phallic sclerite that is narrow and rounded (Fig. 18D), whereas *V. fragilis* lacks a subscaphium and has a highly reduced phallic sclerite (not shown).

Description. Male habitus (Pl. 2, No. 1): Head flesh ocher throughout. Antennal scales tawny olive. Third segment of labial palpus short; first and second segments flesh ocher, third segment dark tawny olive. Thorax dorsal and ventral scales tawny olive throughout. Legs clay, tarsal claw simple (Fig. 15A). Forewing length 11.7 mm (N = 10), R³ absent, M³ present, extending to

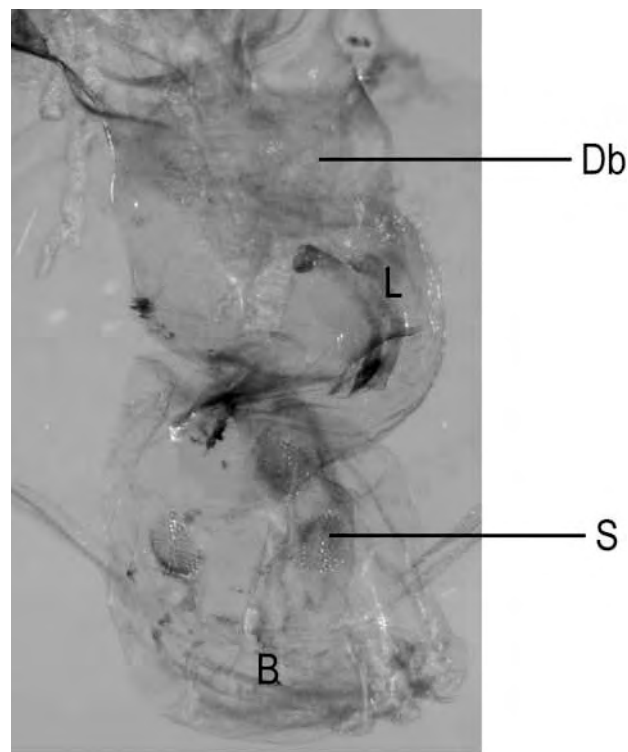


Figure 21. Corpus bursae, *Virbia ferruginosa*, dorsal view. B = bursa (connate and both bursae arising from ductus bursae), Db = ductus bursae, L = lobe of second bursa, S = signum (three signa present).

wing margin (Fig. 13), dorsal surface pale pinkish buff suffused with light salmon, ventral surface clay dusted with orange rufous. Hindwing dorsal surface flesh ocher with edges fringed with pale pinkish buff scales, ventral surface yellow ocher dusted with flesh ocher. Abdomen with dorsal, lateral, and ventral scales flesh ocher. Sclerotization of 8th sternite rectangular, length greater than width (Fig. 28E). Coremata reduced to small patches of scales on membranous lobes. Female habitus (Pl. 1, No. 10): Head clay, occiput ranging from salmon to peach red among specimens. Antennal scales clay. Third segment of labial palpus exceeding front of head by at least half of entire length, first and second segments salmon, third segment clay. Thorax dorsal and ventral scales clay with tufts of salmon on ventral surface near wing base. Legs tawny olive with light salmon scales on femora and tibiae, tarsal claw simple (Fig. 15A). Forewing length 13.5 mm (N = 10), venation as in male. Forewing dorsal surface solid clay to solid olive brown with salmon along costal margin, tapering toward wing tip, ventral side salmon to peach red with pattern beginning at proximal portion of adbasal region, expanding transversely to most distal portion of postmedial region, pattern meeting inner margin, inner margin with clay to fuscous scales extending from postmedial region to wing apex, occasionally slightly sinuate. Hindwing dorsal surface salmon, pattern beginning at proximal portion of adbasal region, pattern expanding transversely to most distal portion of postmedial region, extending to margin of clay to fuscous scales, inner margin extending from postmedial region to wing apex, occasionally slightly sinuate, in some specimens this postmedial region is with a thin, broken subterminal line, ventral surface identical. Abdomen with dorsal scales fuscous, lateral scales on first three segments salmon, lateral abdominal scales tapering toward posterior in fuscous scales, ventral side fuscous throughout. Male genitalia: Phallus (Fig. 18D) with rounded coecum penis, straight; basiphallus inflected ventrally at base, curved toward venter, phallic sclerite narrow and rounded. Vesica directed ventrally, membrane rugose, bilobed, elongate, second lobe membranous, left side of vesica with a rugose, lobed projection and cornutuslike patch located ventrally, right side of vesica with rugose patches under phallic sclerite. Genital capsule dorsally with tegumen m-shaped, conjunctiva weakly sclerotized (Fig. 23A). Uncus base cordate (Fig. 23B). Uncus apex triangular and with two distinct hooks. Scaphium rounded, triangular. Subscaphium completely surrounding anal tube (Fig. 25A), extensions of tegumen sclerotized. Juxta ovoid with ventral margin expanding into larger orbicular shape, dorsal margin concave with

pointed edges (Fig. 20A). Costa of valva elongate and tip entire, 20 or more costal setae. Sacculus clawlike, extending under juxta on both sides. Saccus rounded, concave in center. Female genitalia: Opening of ovipositor glandular, lacking pseudopapillae anales. Pheromone glands membranous and unbranched, moderately wide, greater than 1/8 but less than 1/4 width of 7th abdominal sternite. Ostium bursa slightly concave with small lateral prominences (Fig. 30B). Ductus bursa rectangular, narrowing toward venter, sclerotization extending into corpus bursa (Figs. 17A, 26C). Corpus bursa double, connate, with three signa, both bursae round with wrinkled membrane (Fig. 26C).

Variation.— There is almost no variation in size or color among males or females.

Biology. *Virbia costata* has been reared on plantain (Zaspel Database), but its native host is not known. A single flight period occurs in July in Arizona, New Mexico, Colorado and Oklahoma. Two flight periods occur in the Big Bend region (Texas): the first in June and the second in early August (Zaspel database).

Distribution. — This species occurs in the western United States; the eastern edge of its range is western Oklahoma; the northernmost record is from Colorado.

***Virbia fergusonii* Zaspel n. sp**

Pl. 3 Nos. 4 (female), 5 (male)

Holotype.— GA: Clinch Co., 7 mi. NE Fargo, 13.vii.1981, D. C. Ferguson//reared on *Taraxacum*//*Holomelina* MEM n. p. det. D. Ferguson//JMZ298, (Male), NMNH.

Paratypes.— **UNITED STATES: Alabama:** Baldwin Co., Bon Secour, NWR 30° 15' 46"N, 87° 45' 27"W, 12.v.1994, R. E. Seymour//in oak-pine forest//William Cross Expedition//Holo. n. sp. det. D. C. Ferguson, MESSU:MEM, (1 Female, JMZ299). **Florida:** St. Petersburg, Fla.//Barnes Collection, NMNH, (1 Female, 2 Males); Fla. Collection Wm. Schaus, NMNH, (1 Male); Putnam Co., Univ. of Florida Preserve, Welaka, 22.iii.1987//D.C. Ferguson Collector, NMNH, (1 Male); Cassia Lake Co. Fla., 8.v.1964 Taylor//Collection of Bryant Mather//16305//genitalic preparation 1865-112 Ring Cardé, NMNH (1 Male); Highlands Co., Highlands Hammock S. P., 12.vi.1987, T. L. Schiefer//*Holomelina* n. sp. det. D. C. Ferguson 1994, MESSU:MEM, (1 Female, JMZ312); Highlands Co., Highlands Hammock S. P., 12.vi.1987, T. L. Schiefer, MESSU:MEM, (1 Male); Highlands Co., Highlands Hammock S. P., 12.6.1987, T. L. Schiefer, MESSU:MEM, (1 Male); 15 mi. W. of Cocoa Beach, 19.iii.1966, R. H. Leuschner// LACM, (1 Male, JMZ313); 15 mi. W. of Cocoa Beach, 22.iii.1966, R. H. Leuschner//*Holomelina wyatti* Cardé det. Ring

T. Cardé, LACM, (1 Male); 15 mi. W. of Cocoa Beach, 31.iii.1966, R. H. Leuschner//*Holomelina wyatti* Cardé det. Ring T. Cardé, LACM, (1 Male); 15 mi. W. of Cocoa Beach, 22.iii.1966, R. H. Leuschner//LACM, (1 Male, JMZ214); 25 mi. W. of Cocoa Beach, 19.iii.1966, R. H. Leuschner//LACM, (1 Male, JMZ213); 15 mi. W. of Cocoa Beach, 19.iii.1966, R. H. Leuschner//*Holomelina wyatti* Cardé det. Ring T. Cardé, LACM (1 Male); 25 mi. W. of Cocoa Beach, 6.v.1966, R. H. Leuschner, LACM, (1 Male); Alachua Co., Gainesville, 15.v.1993, Jeff Slotten Collector, LACM (1 Male, JMZ215); Alachua Co., Gainesville, 7.v.1993, Jeff Slotten Collector, LACM, (1 Male); Alachua Co., Gainesville, 15.ix.1995, Jeff Slotten Collector, LACM (1 Male); Alachua Co., Gainesville, 5.iv.1993, Jeff Slotten Collector, 1 Male (LACM); Alachua Co., Gainesville, 3.iv.1993, Jeff Slotten Collector, LACM (1 Male); Alachua Co., Gainesville, 15.v.1993, Jeff Slotten Collector, LACM (1 Male); Alachua Co., Gainesville, 3.v.1993, Jeff Slotten Collector, LACM (1 Male); Alachua Co., Gainesville, 5.iv.1993, Jeff Slotten Collector, LACM (1 Male); Florida, Orange Co. Tosohatchee St. Preserve (off Rt. 520 Taylor CrRd), 12.v.2001, Jeff Slotten Collector; Deland, Fla. 16.iii.1953, H. Ramstadt, CNHM 1957 A.K. Wyatt Lepidoptera Colln.//male genitalia on slide #938 M.O. Glenn 12.xi.1962, FMNH (1 Male); Lakeland Fla. 21.vii.1941, McElhose Chicago N.H. Mus. (Al McElhose Collection)//male genitalia on slide #53 M.O. Glenn 24.v.1964. **Georgia:** Charlton Co., Okefenokee Natl. Wildlife Refuge, 19.iv.1991, D.C. Ferguson//Boardwalk Trail Chesser Island, NMNH (1 Female); Charlton Co., Okefenokee Natl. Wildlife Refuge, 1.x.1992, D.C. Ferguson//Boardwalk Trail Chesser Island Homestead, NMNH (1 Male); Charlton Co., Okefenokee Refuge Hdqtrs., near Folkston 4.v.1981, D.C. Ferguson, NMNH (1 Male JMZ64); Charlton Co., Trader's Hill, Folkston, 27.ix.1992, D.C. Ferguson, NMNH (1 Female, JMZ59); Clinch Co., 7 mi. NE Fargo, 7.v.1981, D.C. Ferguson//reared ex ovo on Taraxacum, NMNH (1 Male, JMZ210); Clinch Co., 7 mi. NE Fargo, 14.vii.1981, D. C. Ferguson//reared ex ovo on Taraxacum, NMNH (1 Male, JMZ211); Clinch Co., 7 mi. NE Fargo, 5.v.1981, D. C. Ferguson, NMNH (1 Male, JMZ212); Clinch Co., 7 mi. NE Fargo, 13.vii.1984, D.C. Ferguson, NMNH, (1 Male); Clinch Co., 7 mi. NE Fargo, 13.vii.1981, D. C. Ferguson//reared on Taraxacum//*Holomelina* MEM n. p. det. D. Ferguson 1994, MESSU:MEM (1 Male). **Mississippi:** Harrison Co., Long Beach 10.iv.1996, R. Kergosien, MESSU:MEM (1 Male). All material is from the NMNH collection unless otherwise noted: **UNITED STATES:** **Florida:** Putnam Co., Welaka, University Reserve, 17.iv.1973, D. C. Ferguson (1 Male, JMZ86). **Geor-**

gia: Atlanta, 17.v.1946, P. W. Fattig (1 Male, JMZ127); Clinch Co., 7 mi. NE Fargo, 5.v.1981, D. C. Ferguson//parent of brood (1 Female, JMZ185), Clinch Co., 7 mi. NE Fargo, 13.vii.1981, D. C. Ferguson//reared ex ovo on Taraxacum (1 Male, JMZ298). **South Carolina:** McClellanville, Wedge Plantation, 24.iv.1974, D. C. Ferguson (1 Male, JMZ85).

Etymology.— This species is named in honor of Dr. Douglas Ferguson. His reared series have been invaluable in establishing phenotypic diversity within and among species. Dr. Ferguson encouraged JMZ's interest in the revision of *Holomelina* and *Virbia*. His assistance and informed discussion of these moths is gratefully acknowledged.

Diagnosis.— The coloration is distinctive. This species is bright, geranium pink with varying amounts of dark brown scales on the hindwing adbasal and subterminal areas (Pl. 3, Nos. 4,5). This species can be confused with lighter *V. opella* males, but *V. ferguson* has much darker forewings and more pronounced contrast in the hindwings. Paler forms of *V. ferguson* lack the discal spot in the hindwing that occurs in *V. opella*. Two male and one female genitalic character can be used to separate this species from *V. opella*. The vesica of *V. ferguson* lacks a cornutuslike patch located ventrally on the left side of the vesica (Fig. 19B) that occurs in *V. opella* (Fig. 19D). The subscaphium is not lobed in *V. ferguson* (Fig. 19A) and is lobed in *V. opella* (Fig. 19C). Females of *V. ferguson* have a signum, while *V. opella* females lack signa (Fig. 17C). This species may be confused with the much smaller *V. rubicundaria*, but it can be separated from the latter as determined in the diagnosis of *V. rubicundaria*.

Description.— Male habitus (Plate 3, No. 5): Head raw umber, occiput peach red. Antennal scales grayish horn color. Third segment of labial palpus exceeding front of head by at least half of entire length, first and second segments peach red, third segment raw umber. Thorax dorsal and ventral scales raw umber. Legs cinnamon, with a mixture of peach red and clay on femora and tibiae, tarsal claw slightly bifid (Fig. 15B). Forewing length 11 mm (N = 10), R³ absent (Fig. 13), M³ present, extending to wing margin. Dorsal surface raw umber with dark fuscous on crossveins of discal spot forming a small transverse band, ventral surface geranium pink, terminal margins a fringe of raw umber. Hindwing dorsal surface peach red, subterminal region raw umber, occasionally meeting postmedial region in sinuate pattern, most specimens with raw umber scales shading in region from subterminal band along fold from discal cell to 3A, fuscous discal spot present or absent, ventral surface identical. Abdomen with dorsum gera-

nium pink with patches of fuscous on most segments, lateral and ventral scales buff throughout. Sclerotization of 8th sternite rectangular, length greater than width (Fig. 28E). Coremata absent. Female habitus (Pl. 3, No. 4): Head cinnamon, occiput salmon. Antennal scales fuscous. Third segment of labial palpus short, color same as in male. Thorax dorsal and ventral scales cinnamon. Legs raw umber with patches of geranium pink on femora, tarsal claw slightly bifid (Fig. 15B). Forewing length 12 mm (N = 10), venation as in male. Forewing dorsal surface cinnamon, occasionally with salmon costal margin, ventral surface peach red throughout. Hindwing dorsal surface peach red, terminal margins fringed with tawny scales, ventral surface identical. Abdomen with color same as in male. Male genitalia: Phallus (Fig. 19B) with straight rounded coecum penis, basiphallus inflected ventrally at base, curved toward venter, phallic sclerite reduced. Vesica directed ventrally when everted, membrane rugose, bilobed, elongate, second lobe of vesica rugose, right side of vesica with patch of cornuti under phallic sclerite (Fig. 19B). Genital capsule (Fig. 19A) dorsally with tegumen entire, conjunctiva sclerotized (Fig. 23C). Uncus base cordate (Fig. 23B), ventrad with uncus apex fingerlike, bifid, with two fused hooks (Fig. 27A). Scaphium conical, pointed. Subscaphium completely surrounding anal tube (Fig. 19A), extensions of tegumen sclerotized. Juxta ovoid with ventral margin expanding into larger orbicular shape, dorsal margin concave with pointed edges (Fig. 20A). Costa of valva elongate and tip forked; 20 or more costal setae (Fig. 19A). Saccus peanut-shaped (Fig. 19A). Saccus rounded, concave in center. Female genitalia: Pseudopapillae anales present (Fig. 24B). Pheromone glands membranous, branching after tip of anterior apophyses, moderately thick, greater than 1/8 but less than 1/4 width of 7th abdominal sternite. Ostium bursa straight, without lateral prominences (Fig. 17B). Ductus bursa hour-glass shaped (Fig. 17B), sclerotization extending from ductus bursa into corpus. Corpus bursa bilobed, typically with one signum, membrane smooth (Fig. 21).

Variation.— Some male specimens of this species are significantly lighter in color with a raw umber subterminus extending toward the wing base, forming a blotchy line where the vannus meets the remigium. The male genitalia of some individuals had costa apices that were entire (Fig. 19A) rather than bifid. No color variation in females was observed.

Biology.— *Virbia fergusonii* was reared on dandelion (*Taraxacum* spp.) by Ferguson. Its native host is not known. This species appears to have multiple broods with adult flight periods from mid-March

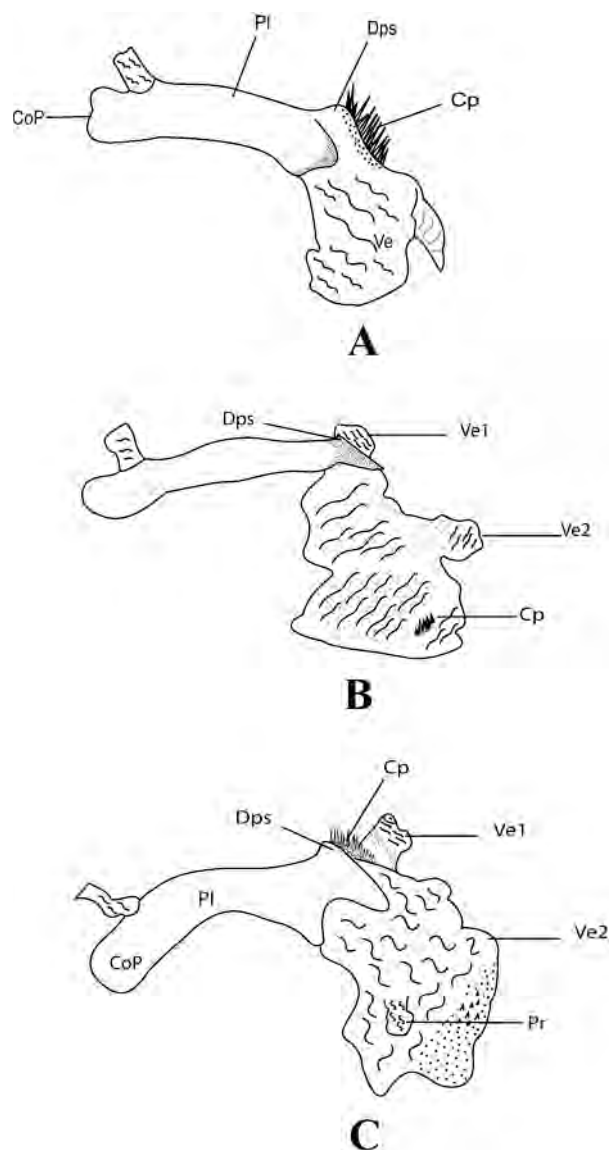


Figure 22. A. Phallus, *Virbia ferruginosa*, left, lateral view. CoP = coecum penis (slightly knotted, orientation straight), Pl = basiphallus (inflected ventrally at midpoint), Dps = phallic sclerite (lateral view, wide and nodular), Ve = vesica (directed ventrally, membrane bilobed, lobe membranous), Cp = patch of cornuti (under phallic sclerite); B. Phallus, *Virbia ostenta* left, lateral view. Dps = phallic sclerite (narrow and rounded), Ve = vesica (directed ventrally, membrane smooth, entire), Cp = patch of cornuti (located ventrally), Ve1 = right dorsal lobe, Ve2 = left lateral lobe; C. Phallus, *Virbia aurantiaca* left, lateral view. CoP = coecum penis (rounded, orientation straight), Pl = basiphallus (inflected ventrally at midpoint), Dps = phallic sclerite (wide and nodular), Ve = vesica (directed ventrally, with membranous projection = Pr), Cp = patch of cornuti (under phallic sclerite), Ve1 = right dorsal lobe, Ve2 = left lateral lobe.

through mid-July. A single specimen was taken in September (Georgia). One label indicates the habitat was a mixed oak-pine forest.

Distribution. — This species is restricted to the southeastern United States; the most northern specimen was collected in McClellanville, South Carolina, from Georgia and northern Florida west to Baldwin Co., Alabama.

Virbia ferruginosa Walker

Pl. 1, Nos. 6 (female), 7 (male)

Crocota ferruginosa Walker 1854: 535 [type locality, St. Martin's Falls, Albany River, Hudson's Bay, Ontario, Canada].

Crocota quinaria Grote 1863:30 [type locality, "Canada"].

Crocota trimaculosa Reakirt 1864: 371 [type locality, Philadelphia, Pennsylvania, USA].

Holomelina buchholzi Wyatt 1963: 100-102 [type locality, Suffolk, Virginia, USA].

Material examined. — Type material: Syntypes of *V. ferruginosa*: Hudson Bay, G. Barnston 11.1917//Arctiidae slide #907//photographed BM negative 43750, Hudson Bay, G. Barnston 11.1917, also "caterpillar with fine long brown hairs"//Arctiidae slide #43757//BM negative 43757; *Holomelina ferruginosa* data: label 284 Hudson Bay G. Barnston 11.1917, "*Crocota ferruginosa*", NHM. Holotype (synonym of *V. ferruginosa*): VA: Suffolk, 4.viii.1941, Otto Buchholz, C.N.H.M. Type Male *Holomelina aurantiaca* Wyatt, Buchholz Collection, ANMH. Paratypes of *V. ferruginosa*: VA: Suffolk, 19.vii.1941, Otto Buchholz, Reared Series//CNHM Paratype//*Holomelina*, AMNH (1 Female, 1 Male, JMZ279; JMZ278); Suffolk, Otto Buchholz, 24.vii.1941//CNHM Paratype//*Holomelina*, AMNH (1 Female, JMZ280). All material is from the NMNH collection unless otherwise noted: **CANADA:** **British Columbia:** Vancouver, 3.vii.1921, T. A. Moilliet/Blackmore Collection (1 Male, JMZ57). **Quebec:** Lac à la Tortue, 17.vii.1947, Eugene Munro (1 Male, JMZ90); Temiscouata Co., 30.vi.1985, leg. George Hensel (1 Male, JMZ94). **UNITED STATES:** **Connecticut:** New Haven Co., Guilford, 24.vii.1966, leg. Ring T. Cardé, RTC, (1 Male, JMZ315). **Illinois:** Edgebrook, 9.x.1947 A. K. Wyatt (1 Female, JMZ162); 11.x.1947, A. K. Wyatt, Bred (1 Male, JMZ161). **Indiana:** Tremont, 27.vii.1952, A. K. Wyatt, ex ova (1 Female, JMZ70); Tremont, 3.vii.1944, A. K. Wyatt (1 Female, JMZ316); 9.vii.1954, A. K. Wyatt//CNHM 1957 A. K. Wyatt Lepidoptera Collection, FMNH (1 Male, JMZ314). **Minnesota:** Olmstead Co. (1 Male, JMZ121). **Virginia:** Montgomery Co. (1 Female, JMZ195). **Wisconsin:** Oneida

Co., Lake Katherine, 10.vii.1960, M. M. Bower (1 Male, JMZ91).

Diagnosis. — *Virbia ferruginosa* can be confused with *V. aurantiaca*, *V. fragilis*, and *V. immaculata*. It can be separated from *V. aurantiaca* based on coloration and size as described in the diagnosis for *V. aurantiaca*. This species usually can be separated from *V. fragilis* by locality. *Virbia fragilis* is a western species found in the Rocky Mountain region, whereas *V. ferruginosa* typically occurs in the boreal north and eastern U.S. deciduous forests. The following male genitalic features can also be used to distinguish the two species: males of *V. ferruginosa* have a bilobed vesica and a knotted coecum penis (Fig. 22A), whereas those of *V. fragilis* have a single-lobed vesica and a rounded coecum penis (Fig. 22B). Females of *V. ferruginosa* have a connate, double bursae (Fig. 17C), whereas those of *V. fragilis* lack an additional bursa (Fig. 17A).

In the Eastern U.S., the geographic distribution of *V. ferruginosa* overlaps that of *V. immaculata*, but flight period is a reliable means of separating the two. The flight period of *V. immaculata* extends from late spring to early summer – but rarely July, and its second brood emerges in August; *V. ferruginosa*'s flight period is in July. Abdominal coloration often can be used to discriminate the two. The abdominal tergites of *V. ferruginosa* often have a central cinnamon brown spot, whereas *V. immaculata* typically does not. In *V. ferruginosa* males, the second lobe of the vesica bears a rugose or sclerotized patch (Fig. 22A) whereas in *V. immaculata* the second lobe is sclerotized and bears cornuti (Fig. 22C). Unlike *V. ferruginosa*, females of *V. immaculata* lack an additional bursa.

Description. — Male habitus (Pl. 1, No. 7): Head cinnamon brown. Antennal scales cinnamon brown. Third segment of labial palpus exceeding front of head by at least half of entire length, all segments salmon. Thorax dorsal and ventral scales cinnamon brown throughout. Legs clay throughout, tarsal claw simple (Fig. 15A). Forewing length 13.4 mm (N = 10), R¹-R⁵ all present, M³ present, extending to wing margin (Fig. 12). Dorsal surface cinnamon brown, with a faint olive brown discal spot present, ventral surface salmon with peach red scales lining costal margin. Hindwing dorsal surface pinkish warm buff, cinnamon brown subterminal markings as spots and blotches often not reaching posterior margin, exterior posterior margin occasionally fringed with cinnamon brown scales, discal spot cinnamon brown, ventral surfaces salmon. Abdomen light buff, with first segment on dorsal side a tuft of cinnamon brown, tergites often with a medium size cinnamon brown spot in center, size tapering with each segment

towards posterior. Sclerotization of 8th sternite pentagonal (Fig. 28C). Coremata reduced to small patches of scales on membranous lobes. Female habitus (Pl. 1, No. 6): Head clay. Antennal scales clay. Third segment of labial palpus exceeding front of head by at least half of entire length, all segments clay. Thorax clay. Legs cinnamon brown with patches of scales on femora and tibiae from salmon to buff, tarsal claw simple (Fig. 15A). Forewing length 15 mm (N = 10), venation same as in male. Dorsal surface cinnamon extending from wingbase through postmedial region, subterminal region clay color, with a faint natal brown discal spot present, although rare, some specimens with small white spot or several large spots in annular region, ventral surface dark salmon suffused with peach red scales. Hindwing dorsal surface peach red, with a natal brown discal spot, natal brown subterminal markings as spots and blotches often not reaching posterior margin, ventral surface identical. Abdomen with dorsum intermixed salmon and clay, occasionally with fuscous spots on all segments, lateral sides salmon color with fuscous spots on all segments, ventral sides a blend of salmon and clay. Male genitalia: Phallus (Fig. 22A) with coecum penis weakly notched, straight, basiphallus inflected ventrally at midpoint, curved toward venter, phallic wide, nodular. Vesica directed ventrally when everted, membrane rugose, bilobed, elongate, second lobe membranous; right side of vesica with patch of cornuti under phallic sclerite. Genital capsule with dorsum of tegumen lobed, sides of tegumen divergent (Fig. 23B), conjunctiva strongly sclerotized. Uncus base cordate (Fig. 23B), ventrad with uncus apex fingerlike, bifid, with two fused hooks (Fig. 27A). Scaphium rounded, triangular. Subscaphium absent, extensions of tegumen sclerotized. Juxta rectangular, tapering in center, expanding toward ventral base with backward directed barbs on dorsal margin, broadly rounded ornamentation present (Fig. 20C). Costa of valva elongate and apex entire, 20 or more costal setae. Saccus horizontally obovate, broadly hooked toward costa. Saccus rounded, concave in center. Female genitalia (Fig. 21): Pseudopapillae anales present (Fig. 24B). Pheromone glands membranous, branching after tip of anterior apophyses, moderately thick, greater than 1/8 but less than 1/4 width of 7th abdominal sternite. Ostium bursa slightly concave with small lateral prominences (Fig. 30B). Ductus bursa rectangular, narrowing toward venter, sclerotization extending into corpus bursa (Fig. 21). Corpus bursa double, connate, with one signum, both bursae round with wrinkled membrane (Fig. 21).

Variation.— In some males, the apex of the third labial palp segment is cinnamon brown or has a patch of

cinnamon brown scales. In others, the cinnamon brown subterminal markings form a large longitudinal band extending through the posterior margin.

Some males from reared series were curated under the name *V. buchholzi* (AMNH and FMNH). These males have bright yellow ochre scales throughout. Cardé (1968) proposed that *V. buchholzi* was a color variant of *V. ferruginosa*. Franclemont (1983) placed it as a junior synonym of *V. ferruginosa*. We have examined several *V. 'buchholzi'* specimens and agree that it is a color variant of *V. ferruginosa*.

Biology.— *Virbia ferruginosa* is univoltine with adults emerging during July. Larvae have been reared on dandelion (*Taraxacum* spp.; Cardé, Rearing Notes). Females release pheromone (exhibit calling behavior) at night (Fig. 8D).

Distribution.— This species occurs in Canada from Nova Scotia to British Columbia (Zaspel database). In the United States, it is sympatric with *V. aurantiaca* in the Northeast and upper Midwest. Its range extends south to Virginia, Mississippi, Missouri, and Louisiana. A few specimens superficially resembling *V. ferruginosa* have been collected in Colorado; however, it is likely that these specimens are *V. fragilis*.

Virbia fragilis Strecker

Pl. 2, Nos. 6 (female), 7 (male)

Crocota fragilis Strecker 1878: app: 1859 [type locality, Pagosa Springs, Colorado, USA].

Material examined.— Type material: Holotype of *V. fragilis*: *Crocota fragilis* Streck. Pagosa Springs Col. Orig. Type McCanley//*Crocota fragilis* Streck. Colorado, Pagosa Springs McCanley Orig. Type Strecker Colln. 27530 Field Museum Nat. Hist./Holotype det. A. Watson 1986//Genitalic preparation 201 Ring Cardé Genitalic preparation 201 Ring Cardé//Lepidoptera type photograph No. 184 Field Museum, FMNH. All material is from the NMNH collection unless otherwise noted: **CANADA: Alberta:** Lloydminster, 5.vii.1942, P. F. Bruggeman (1 Male, JMZ55). **British Columbia:** Arrowhead Lake//Barnes Collection (1 Male, JMZ226). **UNITED STATES: Colorado:** Denver, Chimney Gulch, 16-23.ix (1 Female, JMZ73). **New Mexico:** Las Vegas (1 Male, JMZ56). **South Dakota:** Pennington Co., Spring Creek Camp, 11 mi. NE Hill City, 31.vii.1955, F. & P. Rindge, AMNH (1 Male, JMZ274); Slate Creek, Black Hills, 9 mi. NW of Hill City, 6000', 20.vii.1964, D. C. Ferguson (1 Female, JMZ72); 9 mi. NW of Hill City, 6000' July 15, 1964 D. C. Ferguson (1 Male, JMZ193). **Utah:** Ephraim Sanpete Co., Major's Flat, 10.vii.1981, D. C. Ferguson (1 Male, JMZ192).

Diagnosis. — *Virbia fragilis* is easily confused with *V. immaculata*, *V. costata* males, and it is sometimes confused with *V. ferruginosa*. Characters separating *V. fragilis* and *V. ferruginosa* are given above.

Virbia fragilis and *V. immaculata* are geographically isolated from each other. *Virbia fragilis* occurs in western Canada and the western and southwestern U.S., whereas *V. immaculata* occurs in north central and eastern U.S. Males of *V. fragilis* tend to be larger (wing length 14 mm) than those of *V. immaculata* (wing length 12 mm). Male genitalia further distinguish them: the vesica of *V. fragilis* has a single lobe (Fig. 22B), whereas the vesica of *V. immaculata* is bilobed with the second lobe sclerotized.

Males of *V. fragilis* can be separated from *V. costata* based on genitalia. In *V. fragilis*, the phallic sclerite is reduced (Fig. 22B), the uncus apex is fingerlike and bifid with two hooks (Fig. 27A). In *V. costata*, the phallic sclerite is narrow and rounded (Fig. 18D), the uncus apex is triangular with two hooks (Fig. 23D). In females, *V. fragilis* possess pseudopapillae anales (Fig. 24B), and lack an additional bursa (Figs. 24A, 26C), whereas females of *V. costata* lack pseudopapillae anales and have a connate, double bursa (Fig. 17D).

Description. — Male habitus (Plate 2, No. 7): Head clay throughout. Antennal scales clay. Third segment of labial palpus exceeding front of head by at least half of entire length; all segments clay. Thorax dorsal and ventral scales clay throughout. Legs clay, with patches of flesh ocher scales on femora and tibiae; tarsal claw simple (Fig. 15A). Forewing length 14 mm (N = 10), R¹-R⁵ all present, M³ present, extending to wing margin (Fig. 12). Dorsal surface clay with cinnamon scales from wingbase through postmedial region, ventral surface flesh ocher. Hindwing dorsal surface flesh ocher throughout, ventral surface identical. Abdomen with dorsal, lateral and ventral scales warm buff. Sclerotization of 8th sternite rectangular, length greater than width (Fig. 28E). Coremata reduced to small patches of scales on membranous lobes. Female habitus (Plate 2, No. 6): Head color same as in male. Antennal color same as in male. Third segment of labial palpus exceeding front of head by at least half of entire length, color same as in male. Thorax color same as in male. Leg color same as in male, tarsal claw simple (Fig. 15A). Forewing length 12 mm (N = 2), venation as in male. Dorsal surface cinnamon extending from wingbase through postmedial region, costal margin peach red, terminal wing margins fringed with dark salmon scales, occasionally with a faint natal brown spot between medial and postmedial regions present. Although rare, some specimens with a small white spot in annellar region,

ventral surface dark salmon suffused with peach red scales. Hindwing dorsal surface peach red, with a natal brown discal spot, natal brown subterminal markings as spots and blotches often not reaching posterior margin of wing, ventral surface identical. Abdomen with color same as in male, but occasionally with patches of fuscous scales on all dorsal segments tapering towards posterior. Male Genitalia: Phallus with rounded coecum penis, straight, basiphallus inflected ventrally at midpoint, curved toward venter (Fig. 25C), phallic sclerite highly reduced (Fig. 22B). Vesica directed ventrally when everted, membrane rugose, bilobed, second lobe sclerotized, left side of vesica with a small membranous projection located ventrally, right side of vesica with a patch of cornuti located under phallic sclerite (Fig. 22C). Genital capsule dorsum of tegumen concave, bent inward, conjunctiva weakly sclerotized (Fig. 23A). Uncus base cordate (Fig. 23B), ventrad with uncus apex fingerlike, bifid, and with two hooks (Fig. 27A). Scaphium rounded, triangular. Subscaphium absent, extensions of tegumen sclerotized. Juxta cylindrical, emarginated, with ends barbed toward dorsum with broadly rounded ornamentation present (Fig. 20C). Costa of valva elongate and tip entire, 20 or more costal setae. Sacculus horizontally obovate, broadly hooked toward costa. Saccus rounded, concave in center. Female genitalia: Pseudopapillae anales present (Fig. 24B). Pheromone glands membranous, branching after tip of anterior apophyses, moderately thick, greater than 1/8 but less than 1/4 width of 7th abdominal sternite. Ostium bursa slightly concave with small lateral prominences (Fig. 30B). Ductus bursa rectangular, narrowing toward venter, sclerotization extending into corpus bursa (Fig. 17A). Corpus bursa with three signa, membrane wrinkled (Fig. 26C).

Variation.— One *V. fragilis* male with white discal spots on the forewings was found from Alberta, Canada. Few females were available for examination, but no size or color variation was observed.

Biology.— Little is known about the natural history of *Virbia fragilis*. It appears to have a single brood, emerging in July. Peak female pheromone release and calling behavior occurs in scotophase (e.g., between 20 and 23 hours; Fig 8E), similar to most species in the complex.

Distribution.— This species has been collected in open fields in the Black Hills, South Dakota and in Boulder, Colorado. The range extends north to Alberta and British Columbia, south to New Mexico.

Virbia immaculata Reakirt

Pl. 2, Nos. 2 (female), 3 (male)

Crocota immaculata Reakirt 1864: 372 [type lo-

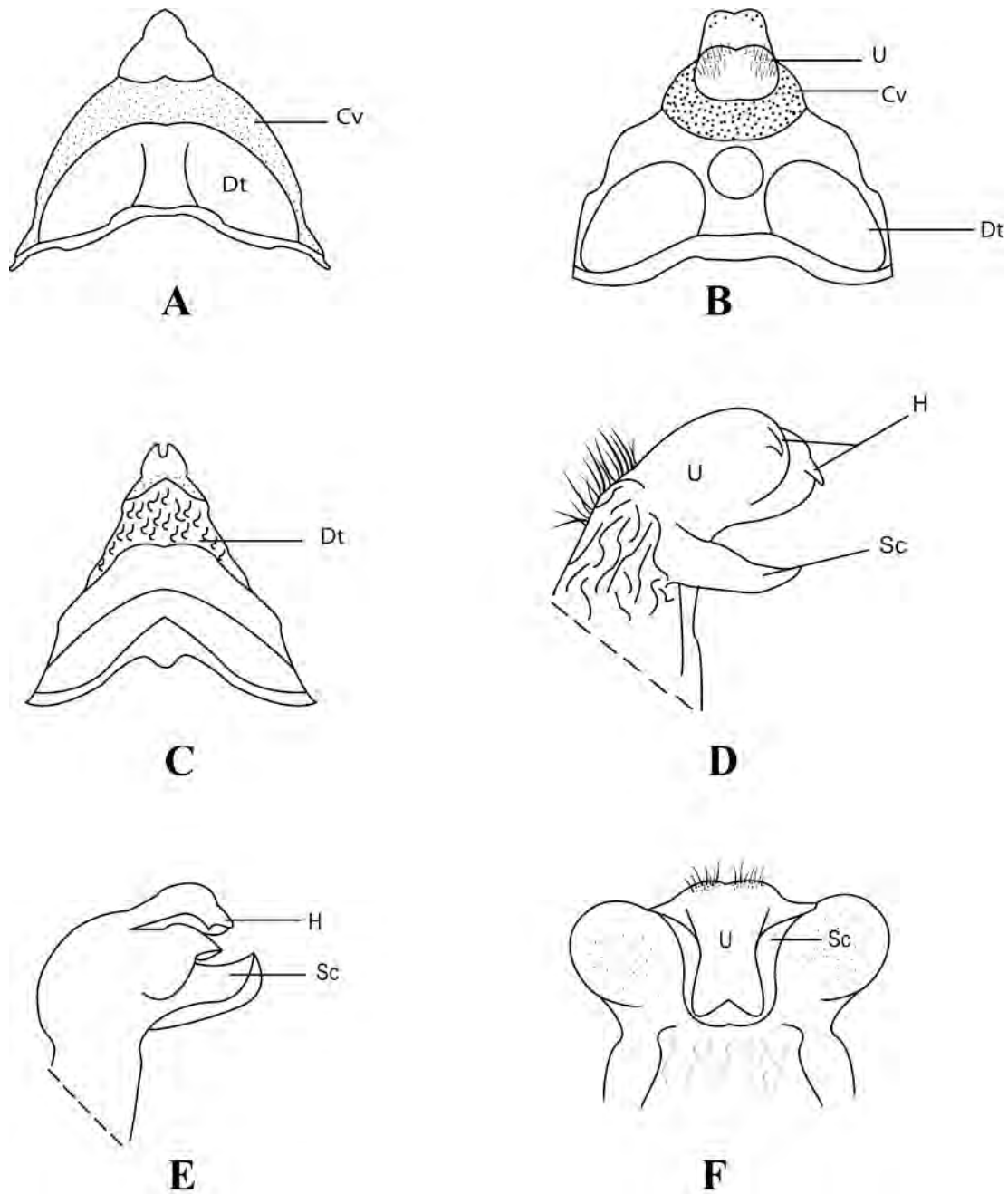


Figure 23. A. Dorsal view of uncus-tegumen complex, *Virbia costata*. Cv = conjunctiva (sclerotization weak), Dt = tegumen (concave, bent inward); B. Dorsal view of uncus-tegumen complex, *Virbia aurantiaca*. Cv = conjunctiva (sclerotization strong), Dt = tegumen (rounded with three-dimensional shapes on both sides with risen node in center), U = base of uncus (cordate); C. Tegumen, *Virbia laeta*. Dt = tegumen, entire); D. Uncus, *Virbia costata*, $\frac{3}{4}$ view. H = hooks of the uncus (two hooks present), U = uncus (apex an inverted heart-shape); E. Uncus complex, *Virbia laeta*, $\frac{3}{4}$ view. H = hooks of the uncus, Sc = scaphium (rounded, triangular); F. Uncus complex, *Virbia phalanga*, ventral view. U = uncus, Sc = scaphium (flattened).

cality, Philadelphia, Pennsylvania, USA]

Material examined. — Type material: Holotype of *V. immaculata*: Philadelphia, Pennsylvania//*immaculata* Reakirt//*C. immaculata* Reakirt Coll. Reakirt//Original Type, [sic.] FMNH. All material is from the NMNH collection unless otherwise noted: **UNITED STATES: Illinois:** Edgebrook, 10.x.1947, A. K. Wyatt, Bred//1019a (1 Male, JMZ105); 7.x.1947, A. K. Wyatt//CNHM 1957 Alex K. Wyatt Lepidoptera Collection (1 Female, 1 Male, JMZ309; JMZ310); Chicago, 8.x.1948, A. K. Wyatt//CNHM 1957 Alex K. Wyatt Lepidoptera Collection, FMNH (1 Male, JMZ308). **Indiana:** Tremont, 25.viii.1952, A. K. Wyatt, ex ova (1 Male, JMZ106). **Michigan:** Alpena, 10.vii.1931, Dr. G. W. Rawson//G. W. Rawson Collection 1962 (1 Male, JMZ126). **New York:** Boreas River, 8.vii.1937, L. R. Rupert (1 Male, JMZ104). **Pennsylvania:** New Brighton, 18.vi.1907//Merrick Museum//Barnes Collection (1 Male, JMZ125); Warrendale, 21.viii.1946, LACM (1 Male, JMZ191). **Wisconsin:** Racine, O. Meske Collection (1 Male, JMZ107).

Diagnosis.— *Virbia immaculata* can be confused with *V. fragilis*, *V. aurantiaca*, and *V. ferruginosa*. The characters for separating these are given above under the relevant species' diagnosis.

Description. — Male habitus (Pl. 2, No. 3): Head clay throughout. Antennal scales scales clay. Third segment of labial palpus exceeding front of head by at least half of entire length, all segments clay. Thorax dorsal and ventral scales clay. Legs clay, with patches of flesh ocher scales on femora and tibiae, tarsal claw simple (Fig. 15A). Forewing length 12 mm (N = 10), R¹-R⁵ all present, M³ present, extending to wing margin (Fig. 12). Dorsal surface clay with cinnamon extending from wingbase through postmedial region, ventral surface flesh ocher. Hindwing dorsal surface ocher, ventral surface identical. Abdomen with dorsal, lateral, and ventral abdominal scales warm buff. Sclerotization of 8th sternite rectangular, length greater than width (Fig. 28E). Coremata reduced to small patches of scales on membranous lobes. Female habitus (Plate 2, No. 2): Head color same as in male. Antennal color same as in male. Third segment of labial palpus exceeding front of head by at least half of entire length, color same as in male. Thorax color same as in male. Leg color same as in male, tarsal claw simple (Fig. 15A). Forewing length 12 mm (N = 10), venation as in male. Dorsal surface cinnamon extending from wingbase through postmedial region, posterior margins fringed with salmon scales, with a faint natal brown spot between medial and postmedial regions present, although rare, some specimens with a small white spot in annellar region,

ventral surface dark salmon suffused with peach red. Hindwing dorsal surface peach red, with a natal brown discal spot, subterminal markings as spots and blotches not reaching posterior margin, ventral surface identical. Abdomen with color same as in male. Male genitalia: Phallus with rounded coecum penis, straight, basiphallus inflected ventrally at midpoint (Fig. 22C), phallic sclerite reduced (Fig. 22B). Vesica directed ventrally when everted, membrane rugose, bilobed, second lobe sclerotized, left side with small membranous projection located ventrally (Fig. 22C), right side of vesica with patch of cornuti under phallic sclerite. Genital capsule with dorsum concave, bent inward (Fig. 23A), conjunctiva sclerotized. Uncus base cordate (Fig. 23B). ventrad with uncus apex fingerlike, bifid, with two hooks (Fig. 27A). Scaphium rounded, triangular. Subscaphium absent. Juxta cylindrical, emarginated, with ends barbed toward dorsum, broadly rounded (Fig. 20C). Costa of valva elongate and tip entire, 20 or more costal setae. Saccus horizontally obovate, broadly hooked toward costa. Saccus rounded, concave in center. Female genitalia: Pseudopapillae anales present (Fig. 24B). Pheromone glands membranous, branching before tip of anterior apophyses, moderately thick, greater than 1/8 but less than 1/4 width of 7th abdominal sternite. Ostium bursa slightly concave with small lateral prominences (Fig. 30B). Ductus bursa rectangular, narrowing toward venter, sclerotization extending into corpus bursa (Fig. 17A). Corpus bursa with three signa, membrane wrinkled (Fig. 26C).

Variation. — Females of *V. immaculata* from some localities (e.g., Indiana) are typically smaller (wing length = 11 mm) than in others (e.g., Illinois; wing length = 13 mm).

Biology.— *Virbia immaculata* has been reared on both dandelion (*Taraxacum*) and plantain (*Plantago*) (Zaspel database). This species is bivoltine with adults emerging in June and again in August. Calling occurs in scotophase or the dark period of the light-dark cycle (Fig. 8B) and is advanced by decreasing temperatures (Cardé et al. 1973). Six matings have been observed in an open field in Dryden, New York, all within 30 minutes of sunset (Cardé 1971).

Distribution.— This species occurs north of latitude 40 degrees, from the Eastern Coast of North America west to Manitoba. This species can also be found in Iowa, Illinois, and Indiana.

Virbia laeta Guerin-Meneville

Pl. 3, Nos. 6 (female), 7 (male)

Lithosia laeta Guerin-Meneville [1832] 1829-1844: 322 [type locality: "l'Amérique du Nord", USA].

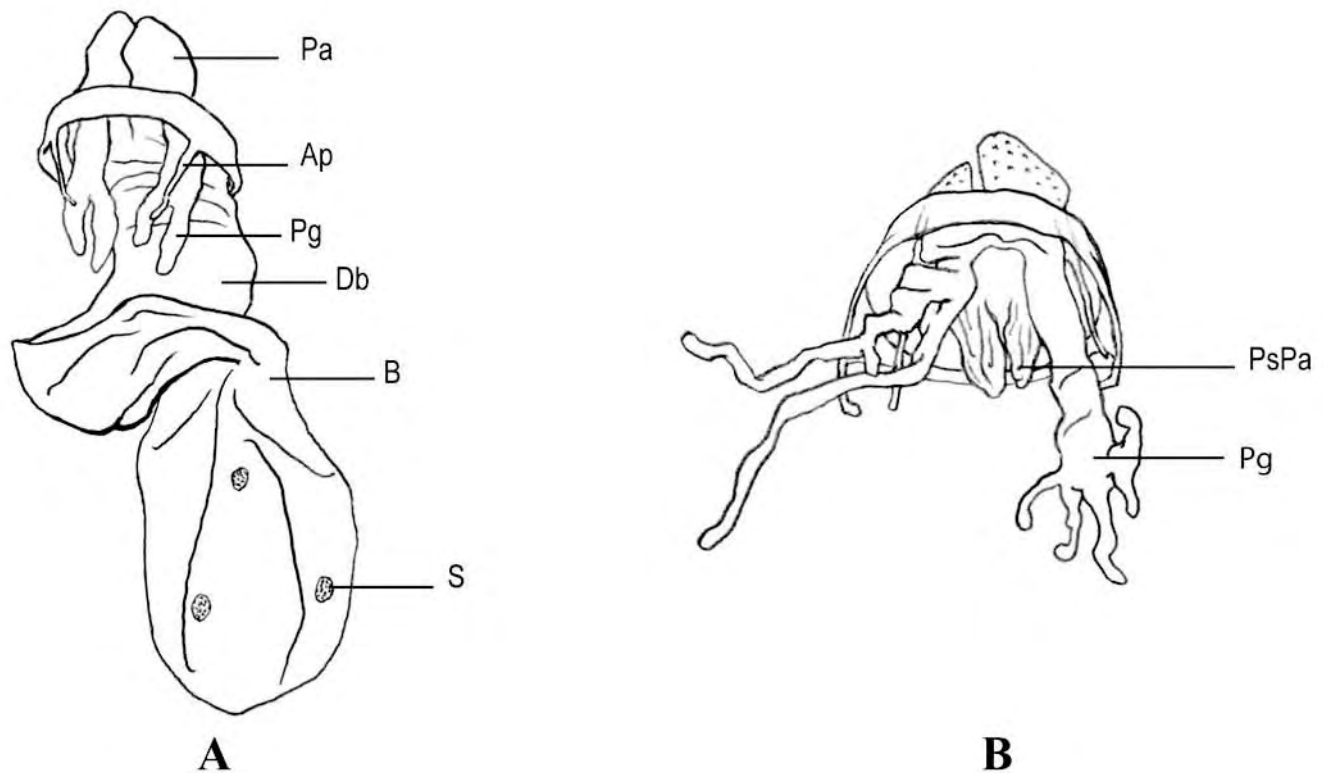


Figure 24. A. Female genitalia, *Virbia laeta*, dorsal view. Ap = anterior apophysis, B = bursa (smooth), Db = ductus bursa, Pa = papillae anales, Pg = pheromone glands, S = signum; B. Ovipositor, *Virbia nigricans*, dorsal view. Pg = pheromone glands, PsPa = pseudopapillae anales, internal view.

Crocota treatii Grote 1865: 322 [type locality, Massachusetts, USA].

Lithosia rubropicta Packard 1887: 52 [type locality, Rangle Lakes, Maine USA].

Material examined.— Type material: Holotype of *V. laeta*: Ex Mus AEO Dris Boisduval//Oberthur Collection//Type TF Höfer//Bd//47Bl NMNH. All material is from the NMNH unless otherwise noted: **CANADA: New Brunswick:** Canequet, 11.vi.1950, D. C. Ferguson (1 Male, JMZ78). **UNITED STATES: Arkansas:** Washington Co., Devil's Den St. Park, 21.vii.1966, R. L. Brown Collector (1 Male, JMZ124). **New Hampshire:** Claremont, 20.vi.1908, Collection Brklyn Museum (1 Male, JMZ80). **Florida:** Highlands Co., **Archbold Biological Sta.** 5.iv.1962, D. C. Ferguson (1 Male, JMZ79). **Maine:** Lincoln, 8.vii (1 Male, JMZ123). **Minnesota:** St. Paul, U. Farm, 22.vii.1935, A. A. Granovsky//light trap, UMSP (1 Male, JMZ122). **Missouri:** Willard, 19.vi., A. E. Brower//*Eubaphe laeta treatii* (1 Female, JMZ160). **Texas:** Jasper Co., Town Bluff, 6.vi.1967, A. & M. E. Blanchard (1 Male, JMZ159); Montgomery Co., Conroe, 12.iii.1967, A. & M. E. Blanchard (1 Male, JMZ77). **Wisconsin:**

Marathon Co., Township of Stettin, 6.vii.1978, Russell A. Rahn (1 Male, JMZ81).

Diagnosis.— Both sexes of this species superficially resemble *V. costata* females; however, *V. laeta* is restricted to northcentral and southern U.S. and *V. costata* is restricted to southwestern US. See the diagnosis of *V. costata* for additional diagnostic differences.

Description.— Male habitus (Pl. 3, No. 7): Head fuscous, occiput geranium pink. Antennal scales fuscous. Third segment of labial palpus short, first and second segments geranium pink, third segment fuscous. Thorax dorsal and ventral scales fuscous with small tufts of geranium pink at wing base. Legs fuscous to dark grayish brown, tarsal claw simple (Fig. 15A). Forewing length 11 mm (N = 10), R³ absent (Fig. 13), M³ present, extending wing margin. Dorsal surface fuscous to dark grayish brown with light salmon band running full length of costal margin, ventral surface dusted in light salmon. Hindwing dorsal surface geranium pink, pattern beginning at proximal portion of adbasal region, expanding transversely to distal portion of postmedial region, pattern extending down wing and meets inner margin of fuscous to dark grayish brown scales extending from

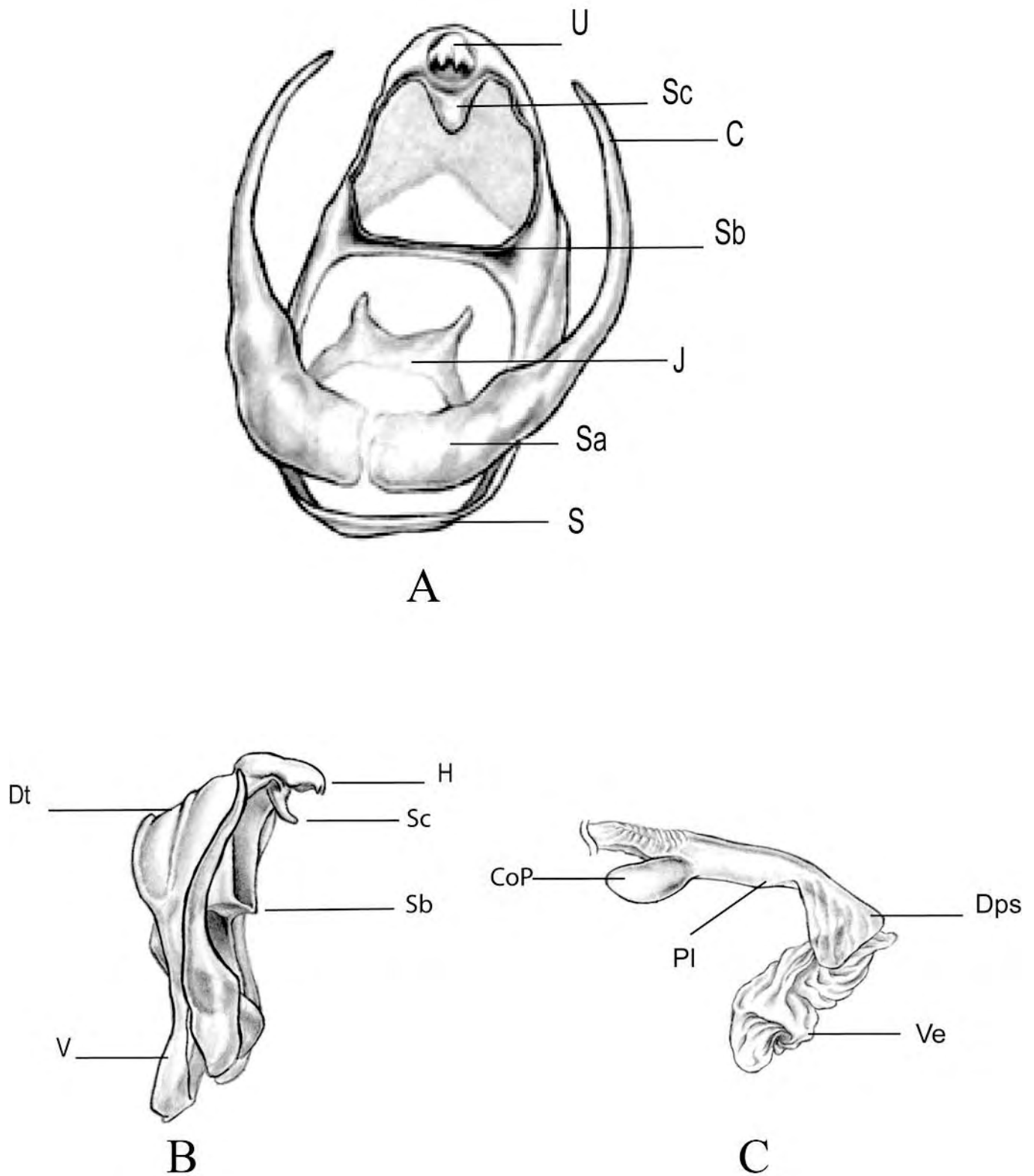


Figure 25. Male genitalic capsule of *Virbia laeta*. A- Ventral view, B- Lateral view; C- Left, lateral view of phallus. C = costa, CoP = coecum penis, Dps = dorsal phallic sclerite, Dt = dorsal tegumen, H = hook, J = juxta, PI = basiphallus, Sa = sacculus, S = saccus, Sb = subscaphium, Sc = scaphium, U = uncus, V = vinculum, Ve = vesica.

postmedial region to wing tip, occasionally with a slightly sinuate pattern, ventral surface identical. Abdomen geranium pink with small dark grayish brown spots in center of each abdominal tergite, lateral abdominal scales geranium pink, ventral abdominal scales fuscous to dark grayish brown. Sclerotization of 8th sternite rectangular shape, length greater than width (Fig. 20E). Coremata reduced to small patches of scales on membranous lobes. Female habitus (Pl. 3, No. 6): Head color same as in male. Antennal color same as in male. Third segment of labial palpus exceeding front of head by at least half of entire length, color same as in male. Thorax color same as in male. Leg color same as in male, tarsal claw simple (Fig. 15A). Forewing length 17 mm (N = 10), venation as in male. Dorsal surface color same as in male, ventral surface color same as in male. Hindwing dorsal surface color same as in male, ventral surface color same as in male. Abdomen with color same as in male. Male genitalia: Phallus (Fig. 25C) with rounded coecum penis, inflected ventrally, basiphallus straight, phallic sclerite absent. Vesica directed ventrally when everted, membrane smooth, entire, left side with small membranous projection located ventrally, right side of vesica with patch of cornuti (Fig. 22A). Genital capsule with dorsum entire (Fig. 23C), conjunctiva sclerotized. Uncus base cordate (Fig. 23B), ventrad with uncus apex slightly bifurcate, toothed, with two hooks (Fig. 25A). Scaphium rounded, triangular. Subscaphium completely surrounding anal tube, extensions of tegumen sclerotized. Juxta ovoid with ventral margin expanding into large orbicular shape (Fig. 25A). Costa of valva elongate and tip entire, 20 or more costal setae. Saccus blunt and extending under juxta, clawlike. Saccus rounded, concave in center. Female genitalia (Fig. 24A): Pseudopapillae anales present (Fig. 24B). Pheromone glands membranous, branching after tip of anterior apophyses, moderately thick, greater than 1/8 but less than 1/4 width of 7th abdominal sternite. Ostium bursa straight, without prominences (Fig. 17B). Ductus bursa rectangular, narrowing toward venter, sclerotization extending into corpus bursa (Fig. 17B). Corpus bursa with three signa, membrane smooth (Fig. 24A).

Biology.— Larvae have been reared on dandelion (*Taraxacum*) and plantain (*Plantago*) (Forbes 1960). Adults are typically found in pine woodlands (Heppner 2003). In Louisiana, *V. laeta* can be collected every month except December (Brou 2003). In Texas, two flight periods (March, June) appear to occur, but in more northern parts of the range, collection dates suggest a univoltine brood emerging in June and July.

Distribution.— New Brunswick south to Florida, west to Minnesota south to Texas.

Virbia lamae Freeman

Pl. 1, Nos. 8 (female), 9 (male)

Holomelina lamae Freeman 1941: 123 [type locality, Baddeck, Nova Scotia, Canada].

Material examined.— Type material: Holotype not examined. All material is from the NMNH collection unless otherwise noted: **CANADA: Nova Scotia:** Halifax Co., Bog Prospect Road, 21.vii.1852, D. C. Ferguson (1 Female, JMZ58); Mount Uniacke, 19.vii.1946, D. C. Ferguson//*Eubaphe lamae* Freeman//Otto Bucholz Collection, AMNH (1 Male, JMZ277). **UNITED STATES: Maine:** Seawall Bog, Acadia Pk. Mt. Desert Is., 29.vii.1966, leg. Ring Cardé//Female Parent of Brood (1 Female, 1 Male, JMZ296; JMZ295); Acadia Pk. Mt. Desert Is., 29.vii.1966, leg. Ring Cardé//Female Parent of Brood, RTC (1 Female, JMZ297). **Wisconsin:** Marathon Co., Township of Norrie, Russella (1 Male, JMZ63).

Diagnosis.— This species can be confused with *V. aurantiaca* and is occasionally misidentified as *V. marginata*. *Virbia lamae* and *V. marginata* have disjunct distributions; *V. lamae* occurs in the Northeastern U.S. and Canada, and *V. marginata* occurs in northern Central America with disjunct populations in the southwestern U.S.

Genitalic differences in both sexes separate *V. lamae* and *V. aurantiaca*. In male *V. lamae*, the juxta is cylindrical and emarginated as in *V. marginata* (Fig. 27C) whereas in *V. aurantiaca*, the juxta is ovoid with the ventral margin expanding into a larger, orbicular shape (Fig. 20B). In females, *V. aurantiaca* has pseudopapillae anales (Fig. 24B); *V. lamae* does not. The ostium bursa is unornamented in *V. lamae* (Fig. 26B); in contrast, lateral prominences surround the ostium bursa in *V. aurantiaca* (Fig. 26D). The dark coloration in the anal fold of the hindwing can also be used to separate *V. lamae* from *V. aurantiaca* and *V. marginata*.

Description.— Male habitus (Pl. 1, No. 9): Head ranging from clay color to fawn color among specimens. Antennal scales ranging from clay to fawn among specimens. Third segment of labial palpus exceeding front of head by at least half of entire length, all segments clay to fawn. Thorax dorsal and ventral scales from clay to fawn. Legs clay, tarsal claw simple (Fig. 15A). Forewing length 10 mm (N = 9); R¹-R⁵ all present, M³ present, extending to wing margin (Fig. 13). Dorsal surface clay with fawn extending from wingbase through postmedial region, ventral surface salmon color extending from wingbase through postmedial region, subterminal region natal brown often not reaching posterior margin, scales over veins retaining salmon scales. Hindwing dorsal surface from yellow ocher to salmon with a natal brown

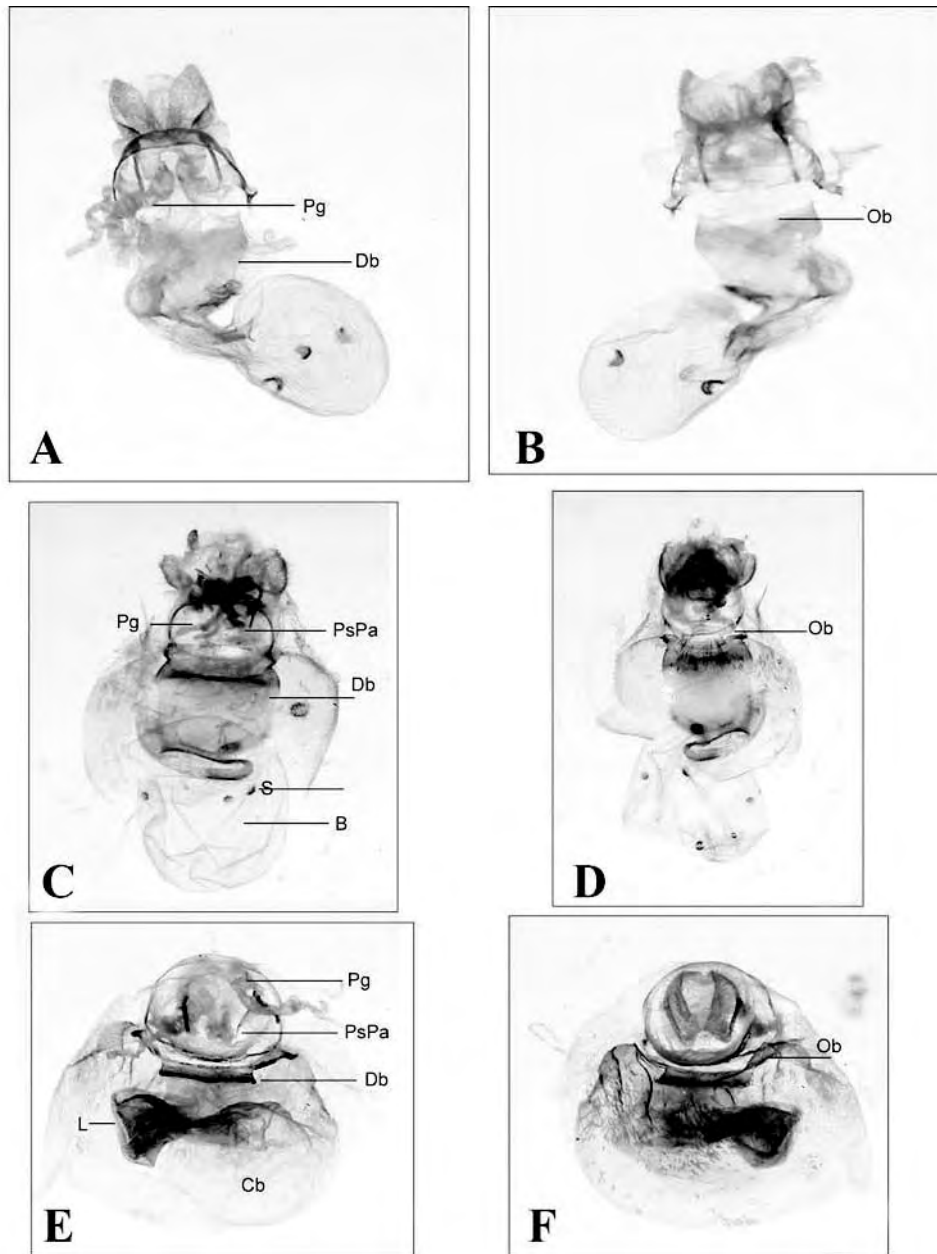


Figure 26. A. Female *Virbia lamae*, dorsal view. Db = ductus bursa (hourglass), Pg = pheromone glands (membranous, branching after tip of anterior apophysis, moderately thick); B. Female *Virbia lamae*, ventral view. Ob = ostium bursa (lacking lateral prominences); C. Female *Virbia aurantiaca*, dorsal view. B = bursa (with wrinkled membrane), Db = ductus bursa (rectangular, narrowing toward ventor, sclerotization extending into corpus bursa), Pg = pheromone glands (membranous, branching before tip of anterior apophysis, moderately thick), PsPa = pseudopapillae anales, internal view, S = signum (three present); D. Female *Virbia aurantiaca*, ventral view. Ob = ostium bursa (slightly concave with small lateral prominences); E. Female *Virbia opella*, dorsal view. B = bursa (connate and membrane smooth), Db = ductus bursa (goblet shape, sclerotization extending into corpus bursa), Pg = pheromone glands (membranous, branching after tip of anterior apophysis, thin), PsPa = pseudopapillae anales present; F. Female *Virbia opella*, ventral view. Ob = ostium bursa (split midventrally with two broad, lateral prominences).

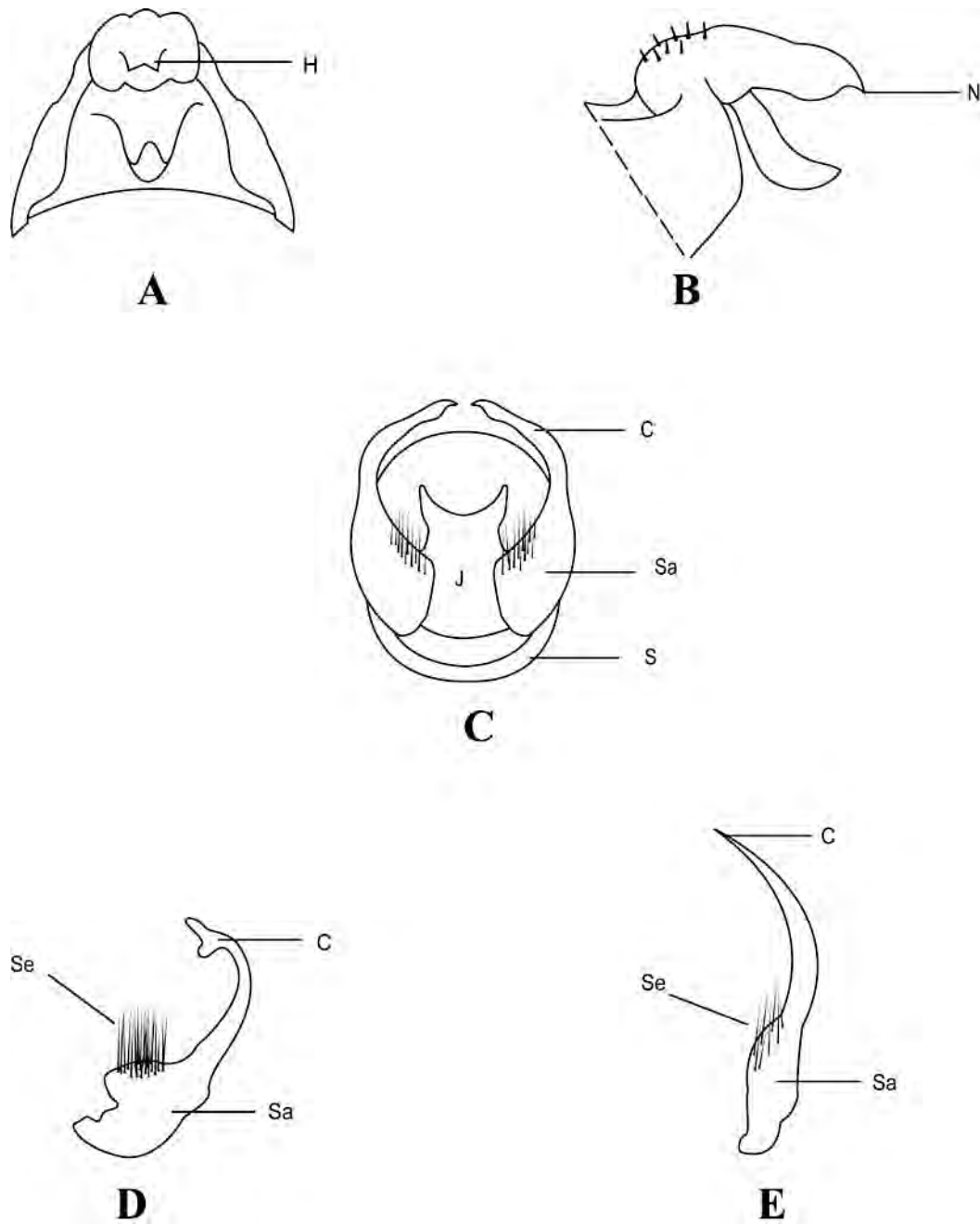


Figure 27. A. Uncus complex, *Virbia aurantiaca*, ventral view. U = uncus (fingerlike, with bifid apex), H = hooks; B. Uncus in lateral view, *Virbia marginata*. N = notch (rounded); C. Male genital capsule *Virbia marginata*. C = costa (distal tip entire), J = juxta (cylindrical, emarginated with ends barbed toward dorsum), Sa = sacculus (horizontally obovate, broadly hooked toward costa, with setae present), S = saccus (rounded, concave in center); D. Male genital capsule, *Virbia opella*. C = costa, (distal tip forked), Sa = sacculus (peanut-shaped), Se = setae; E. Male genital capsule, *Virbia feronia*. C = costa, (distal tip entire), Sa = sacculus (thin, square-shaped), Se = setae.

discal spot, natal brown subterminal markings a thick band often not reaching posterior margin, ventral surface identical. Abdomen with dorsal, lateral and ventral scales light buff with first segment on dorsal side a tuft of fawn scales, additional tergites occasionally with a medium size fawn spot in center, size of spot tapering with each segment towards posterior. Coremata absent. Female habitus (Pl. 1, No. 8): Head color same as in male. Antennal color same as in male. Third segment of labial palpus exceeding front of head by at least half of entire length, color same as in male. Thorax color same as in male. Legs clay, with patches of buff scales on femora and tibiae, tarsal claw simple (Fig. 15A). Forewing length 9.8 mm (N = 4), venation same as in male. Dorsal clay extending from wingbase through postmedial region, posterior margin cinnamon brown, occasionally faint natal brown spot between medial and postmedial regions present, large white annular spot present, ventral surface clay extending from wingbase through postmedial region, occasionally suffused with salmon scales, especially along costal margin, natal brown subterminal markings as spots and blotches often not reaching posterior margin, posterior margin clay with scales over veins retaining salmon scales. Hindwing dorsal surface salmon, with a large natal brown discal spot, natal brown subterminal markings as thick spots and blotches often not reaching posterior margin, ventral surface identical. Abdomen color same as in male. Male genitalia: Phallus with rounded coecum penis rounded and weakly notched (Fig. 22A), inflected ventrally, basiphallus straight, phallic sclerite wide and nodular (Fig. 22C). Vesica directed ventrally when everted, membrane rugose, bilobed, elongate, second lobe sclerotized, right side of vesica with patch of cornuti under phallic sclerite (Fig. 22A). Genital capsule with dorsum concave, bent inward, conjunctiva weakly sclerotized (Fig. 23A). Uncus base cordate (Fig. 23B), ventrad with uncus apex fingerlike, bifid, with two hooks (Fig. 27A). Scaphium rounded, triangular. Subscaphium absent, extensions of tegumen sclerotized. Juxta cylindrical, emarginated, with ends barbed toward dorsum (Fig. 27C). Costa of valva elongate and tip entire, 20 or more costal setae. Saccus horizontally obovate, broadly hooked toward costa. Saccus rounded, concave in center. Female genitalia: Lacking pseudopapillae anales. Pheromone glands membranous, branching after tip of anterior apophyses, moderately thick greater than 1/8 but less than 1/4 width of 7th abdominal sternite. Ostium bursa without lateral prominences (Figs. 17B, 26A, 26B). Ductus bursa hourglass shaped, sclerotization extending into corpus bursa (Fig. 17B). Corpus bursa with three signa, membrane wrinkled

(Fig. 17B).

Variation.— Of the material examined, *V. lamae* males rarely with white annellar spots on the forewings; no additional variation for males or females was observed.

Biology.— Larvae have been reared on plantain (*Plantago*) and dandelion (*Taraxacum*) (Zaspel database). This diurnal species can only be collected with nets in bogs during July and early August (Cardé, Field notes). Blacklighting in Seawall Bog, Southwest Harbor, Maine failed to attract any *V. lamae*, although these were abundant in daytime (Cardé personal observation).

Distribution.— This species can be collected in Nova Scotia, New Brunswick, Maine, Wisconsin, and Michigan. Locally, it is restricted to open peat bogs, usually near large bodies of water (maritime or Great Lakes).

Virbia marginata Druce

Pl. 2, No. 10 (female), Pl. 3, No. 1 (male)

Eubaphe marginata Druce 1885: 136, t. 13, f. 8 [type locality, Dueñas, Guatemala]

Material examined.— Type material: Holotype of *V. marginata*: Type Goodman-Salvin Collection, 97 53' Dueñas Guatemala, G.C. Champion//Type sp. figured E.C.A. Lep. Het. *Eubaphe marginata* Druce (NHM). All material is from the NMNH collection unless otherwise noted: **GUATEMALA**: Guatemala City, viii/ Barnes and Schaus Collection (2 Males, JMZ222; JMZ224). **MEXICO**: Jalapa, Schaus//ET Owen Donor (1 Female, JMZ69). **UNITED STATES: Arizona**: White Mts., Barnes Collection (1 Male, JMZ221). **Colorado**: Col. *remingtoni* det. Ring T. Cardé, LACM (1 Male, JMZ182); Denver, Barnes Collection (1 Male, JMZ184). **New Mexico**: Jemez Springs, Barnes Collection (1 Male, JMZ223); Sandoval Co., 1 mi. S. Sulfer Springs, 7800 ft., 31.vii.1961, F. & M. Rindge//Collected on NSF grant 69037, AMNH (1 Female, JMZ305).

Diagnosis.— *Virbia marginata* (Plate 2, No. 10; Plate 3, No. 1) has been treated as a synonym of *V. rubicundaria* (Plate 2, Nos. 4,5); however, these two species have very different phenotypes. Further, the distributions of the two species do not overlap. *Virbia marginata* occurs in Mexico, Guatemala and the southwestern U.S., whereas *V. rubicundaria* occurs in the southeastern U.S. Both sexes are morphologically distinct. Males of *V. marginata* have a tegumen that is concave (Fig. 23A), whereas those of *V. rubicundaria* have a lobed tegumen (Fig. 23B). Females of both species have an ostium bursa with lateral prominences (Fig. 30), however, *V. marginata* lack pseudopapillae anales and typically have one signum (Fig. 17B). Females of *V. rubicundaria* have pseudopapillae anales and possess

three signa (Fig. 24B). Occasionally, *V. marginata* is confused with *V. lamae* (Plate 1, Nos. 8,9); however, *V. lamae* is restricted to the northern U.S. and Canada, and the species are not sympatric.

Description.— Male habitus (Plate 3, No. 1): Head yellow ocher. Antennal scales yellow ocher. Third segment of labial palpus exceeding front of head by at least half of entire length, all segments yellow ocher. Thorax dorsal and ventral scales yellow ocher. Legs clay with patches of salmon scales on femora and tibiae, tarsal claw simple (Fig. 15A). Forewing length 10 mm (N = 10), R³ absent, M³ present, extending to edge (Fig. 13). Dorsal surface clay, ventral surface identical, but occasionally suffused with salmon scales. Hindwing dorsal surface yellow ocher, pattern beginning at proximal portion of adbasal region, expanding transversely to most distal portion of postmedial region, meeting inner margin of raw umber scales, extending from postmedial region to wing apex, occasionally with a slightly sinuate pattern, small raw umber discal spot present, ventral surface identical. Abdomen yellow ocher, dorsal tergites occasionally with a medium size fawn color spot in center, size tapering with each segment towards posterior. Sclerotization of 8th sternite pentagonal (Fig. 28C). Coremata reduced to small patches of scales on membranous lobes. Female habitus (Pl. 2, No. 10): Head cinnamon. Antennal scales cinnamon. Third segment of labial palpus short, cinnamon. Thorax cinnamon. Legs yellow ocher, tarsal claw simple (Fig. 15A). Forewing length 11 mm (N = 1); venation same as in male. Dorsal surface cinnamon, with a faint olive brown discal spot, ventral surface identical. Hindwing dorsal surface flesh ochre, pattern beginning at proximal portion of adbasal region, expanding transversely to most distal portion of postmedial region, meeting inner margin of dark raw umber, extending from postmedial region to wing apex, occasionally with a sinuate pattern, large dark raw umber discal spot present; ventral surface identical. Abdomen flesh ochre, dorsal tergites occasionally with a medium size dark raw umber spot in center, size tapering with each segment towards posterior. Male genitalia: Phallus rounded coecum penis rounded weakly notched (Fig. 22A), inflected ventrally, basiphallus straight, phallic sclerite wide and nodular (Fig. 22C). Vesica directed ventrally when everted, membrane rugose, bilobed, elongate, second lobe sclerotized, right side of vesica with patch of cornuti under phallic sclerite (Fig. 22C). Genital capsule (Figs. 27C) with dorsum of tegumen concave, bent inward (Fig. 23A), conjunctiva membranous. Uncus base cordate (Fig. 23B), ventrad with uncus rounded at sides with notch at center, with two hooks (Fig. 27B). Scaphium rounded, pointed. Subscaphium absent, extensions of tegumen

sclerotized. Juxta cylindrical, emarginated, with ends barbed toward dorsum. Costa of valva elongate and tip entire, 20 or more costal setae. Saccus horizontally obovate, broadly hooked toward costa (Fig. 27C). Saccus rounded, concave in center. Female genitalia: Lacking pseudopapillae anales. Pheromone glands membranous, branching after tip of anterior apophyses, thin, less than 1/8 width of 7th abdominal sternite. Ostium bursa slightly concave with small lateral prominences (Fig. 30B). Ductus rectangular, narrowing toward venter (Fig. 17A). Corpus bursa with one signum, membrane smooth (Fig. 17B).

Variation.— Some specimens collected in Colorado, New Mexico and the White mountains of Arizona are phenotypically identical to *V. marginata* and share the diagnostic conditions of the coecum penis and tegumen. Additional *V. marginata* specimens have been collected from Texas and Mexico, but are rare, making it difficult to examine population variation. The U.S. populations appear to have disjunct distributions from the main species' range. Potentially, these population isolates are genetically distinct species; however, adult morphology does not distinguish them.

Biology.— Unknown.

Distribution.— This species primarily occurs in Mexico, Guatemala, and Honduras. Specimens from New Mexico and Arizona are tentatively identified as *V. marginata* for reasons provided in Variation.

Virbia nigricans Reakirt

Pl. 2, nos. 8 (female), 9 (male)

Crocota nigricans Reakirt 1864: 371 [type locality, Philadelphia, Pennsylvania, USA].

Cothocida nigrifera Walker 1865b: 499 [type locality, "USA"].

Material examined.— Type material: Holotype of *V. nigricans*: *Crocota nigricans* Philadelphia, Pa. Reak. Type Coll. Reak.//*Crocota nigricans* Reak. Pennsylvania Philadelphia Type Coll. Reak. Strecker Colln. Field Museum of Nat. Hist.//genitalic preparation 172 Ring Cardé//Lepidoptera Photograph No. 186 Field Museum [sic.] FMNH. Holotype (synonym of *V. nigricans*): *Holomelina nigricans* "D.T." (green label) *nigrifera* Walker "*Cathocida nigrifera*" N. America, 62 85'//Arctiidae slide 969, BM negative 43760, NHM. All material is from the NMNH collection unless otherwise noted: **UNITED STATES: New Jersey:** Hunterdon Co., 10.vii.1964, Joseph Muller, ex ovo (1 Female, JMZ269); 16.vii.1964, Joseph Muller, ex ovo (1 Female, JMZ270); 11.vii.1964, Joseph Muller, ex ovo (1 Male, JMZ271); 25.vii.1964, Joseph Muller, ex ovo, AMNH (1 Male, JMZ272); Hunterdon Co. (1 Female, JMZ187).

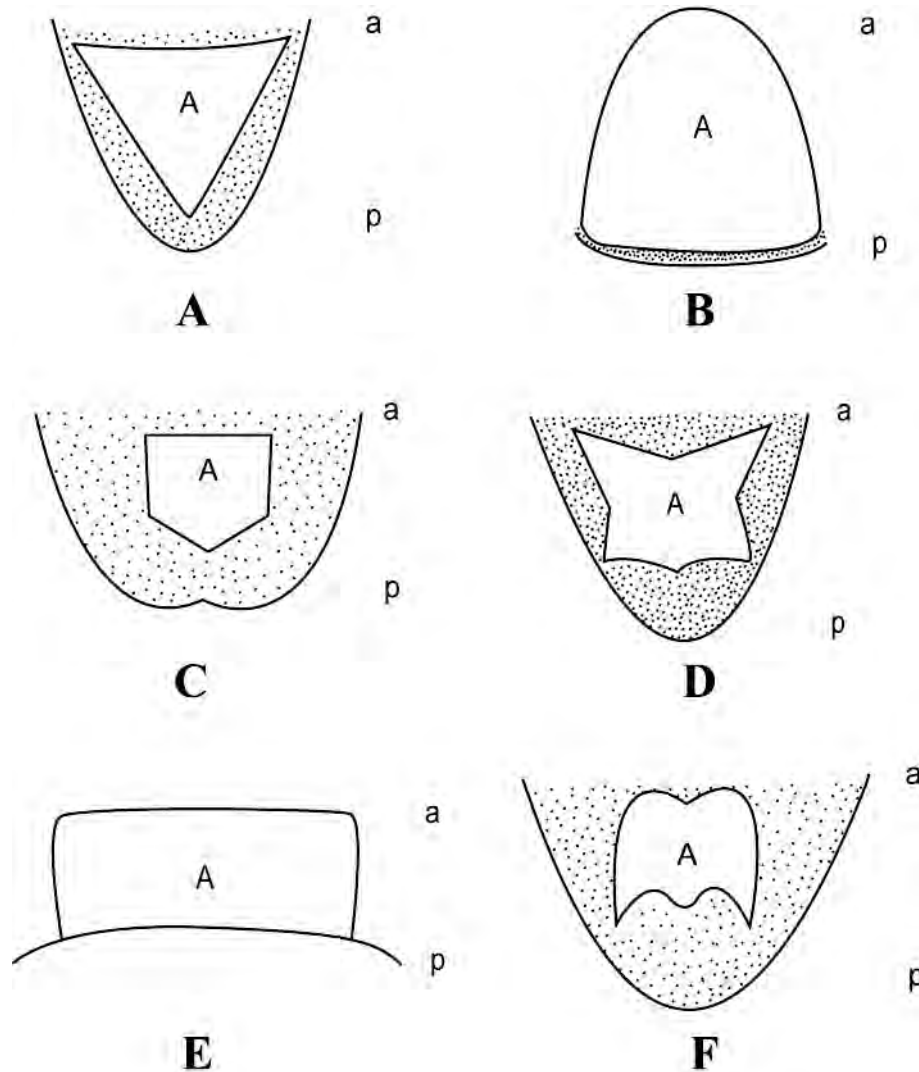


Figure 28. A. Male 8th sternite, *Virbia phalangia*. A = antecosta triangular, a = anterior, p = posterior; B. Male 8th sternite, *Virbia opella*. A = antecosta oval, egg-shaped, a = anterior, p = posterior; C. Male 8th sternite, *Virbia marginata*. A = antecosta pentagonal, a = anterior, p = posterior; D. Male 8th sternite, *Virbia divisa*. A = antecosta pentagonal with expanded anterior edge, a = anterior, p = posterior; E. Male 8th sternite, *Virbia lutelinea*. A = antecosta reinforced by transverse ridge, rectangular, width greater than length, a = anterior, p = posterior; F. Male 8th sternite, *Virbia metazonata*. A = antecosta M-shaped, a = anterior, p = posterior.

Diagnosis.— *Virbia nigricans* has been confused with dark *V. opella* specimens. *Virbia nigricans* is smaller (forewing length 9.3 mm), and the species restricted to western New Jersey and eastern Pennsylvania. *Virbia opella* tends to be larger (forewing length 11 mm) and has a wide geographic range. *Virbia nigricans* is a daymating species (Fig. 8F, Cardé 1971) and its habitat is secondary old fields. *Virbia opella* is active at night. Additionally, dark coloration in the anal fold of the hindwing can also be used to separate *V. nigricans* from *V. opella*.

Genitalia of both sexes are diagnostic. Males of *V. nigricans* lack a subscaphium and the costal tip is entire (Fig. 27C); males of *V. opella* possess a well-developed subscaphium and the costa tip is forked (Fig. 27D). Female *V. nigricans* have a corpus bursa with 3 signa (Fig. 26C), whereas *V. opella* females have a connate, double corpus bursa (Fig. 17C) and lack signa.

Description.— Male habitus (Plate 2, No. 9): Head buff to clay. Antennal scales raw umber. Third segment of labial palpus exceeding front of head by at least half of entire length, all segments buff to clay. Thorax dorsal and ventral scales buff to clay. Legs buff to clay, tarsal claw simple (Fig. 15A). Forewing length 8.2 mm (N = 10), R¹-R⁵ all present, M³ present, extending to edge (Fig. 12). Dorsal surface tawny buff from base, extending toward postmedial region, fading into clay color through subterminal region to wing apex, with a faint raw umber discal spot present, ventral surface light to dark flesh ocher, occurring in variable amounts. Hindwing dorsal surface natal to army brown extending from inner margin to outer edge, medial re-

gion flesh ocher extending from wingbase along anterior margin to postmedial region, with a natal brown discal spot, fringes buff to clay color, ventral surface identical. Abdomen buff to clay. Sclerotization of 8th sternite pentagonal (Fig. 28C). Coremata reduced to small patches of scales on membranous lobes. Female habitus (Plate 2, No. 8): Head same as in male, but in some specimens infused with orange-rufous. Antennal color same as in male. Third segment of labial palpus short, color usually same as in male or infused with orange-rufous. Thorax buff to clay. Legs buff or clay, tarsal claw simple (Fig. 15A). Forewing length 9.3 mm (N = 3), venation same as in male. Dorsal surface same as in male, occasionally suffused with orange rufous scale, ventral surface same as in male. Hindwing dorsal surface usually same as in male, some specimens with large discontinuous terminal bands dark sepia, ventral surface same as in male. Abdomen usually same as in males, some specimens suffused with orange rufous. Male genitalia: Phallus with rounded coecum penis, straight, basiphallus inflected ventrally at midpoint, phallic sclerite wide and nodular (Fig. 22C). Vesica directed ventrally when everted, membrane rugose, bilobed, elongate, second lobe sclerotized, right side of vesica with patch of cornuti under phallic sclerite (Fig. 22C). Genital capsule dorsally with tegumen concave, bent inward (Fig. 23A), conjunctiva membranous. Uncus base cordate (Fig. 23B). Ventrad with uncus apex fingerlike, bifid, with two fused hooks (Fig. 27A). Scaphium conical, pointed. Subscaphium absent. Juxta cylindrical, emarginated, with ends barbed toward dorsum (Fig. 27C). Costa elongate and tip entire, 20 or more costal setae. Saccus horizontally obovate, broadly hooked toward costa. Saccus rounded, concave in center. Female genitalia: Lacking pseudopapillae anales. Pheromone glands membranous, unbranched, thick, greater than 1/4 width 7th abdominal sternite (Fig. 24B). Ostium bursa slightly concave with small lateral prominences (Fig. 30B). Ductus rectangular, narrowing toward venter; sclerotization extending into corpus bursa (Fig. 17A). Corpus bursa with three signa, membrane wrinkled (Fig. 26C).

Variation.— Little variation exists among *V. nigricans* males; one specimen examined from Pennsylvania has slightly more pinkish coloration in the hindwing. Similarly, *V. nigricans* females can vary slightly in size and color.

Biology.— Larvae have been reared on artificial diet; the species is bivoltine with adults emerging in late May to June and again in early to mid August. Males are diurnal and weakly attracted to 2Me-17c (Cardé 1971). Females lay unattached eggs individually like the species *V. aurantiaca* (Cardé 1971).



Figure 29. Adult habitus: *Virbia opella* Grote, Male: 15 mi W of Cocoa, Orange County, Florida 19.iii.1966, R.H. Leuschner Coll., AMNH.

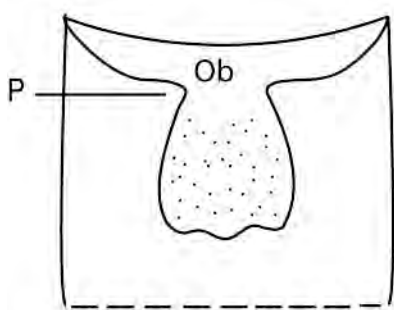
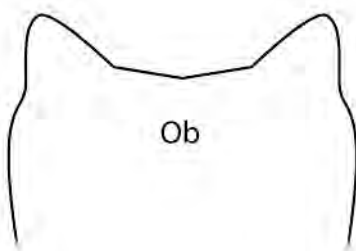
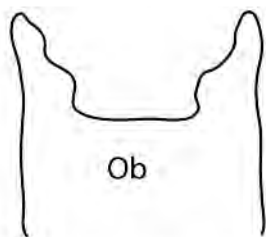
**A****B****C**

Figure 30. A. Ostium bursa, *Virbia opella*. Ob = ventral edge of ostium (split), P = lateral prominence; B. Ostium bursa, *Virbia rubicundaria*. Ob = ventral edge of ostium bursa (with small, lateral prominences); C. Ostium bursa, *Virbia satara*. Ob = ventral edge of ostium (toothed, with lateral prominences).

Distribution.— This species has a highly restricted distribution, occurring only in western New Jersey (Hunterdon Co.) and Pennsylvania (Philadelphia and Montgomery Cos.) in secondary secession habitats.

Virbia opella Grote

Pl. 3, Nos. 2 (female), 3 (male)

Crocota opella Grote 1863: 345 [type locality, Pennsylvania, USA]

Crocota flava Barnes & Benjamin 1925: 127-129 [type locality, Quincy, USA].

Crocota obscura Stretch 1885: 103 [type locality, Pennsylvania, USA]

Crocota belmaria Ehrmann 1895: 345 [type locality, Pittsburgh, Pennsylvania, USA].

Crocota rubricosta Ehrmann 1895: 345 [type locality Jeanette, USA].

Material examined.— Type material: Holotype not examined. All material is from the NMNH collection unless otherwise noted: **UNITED STATES: Illinois:** Quincy, Poling //Barnes Collection (1 Female, JMZ66); 1900.v., Poling //Barnes Collection (1 Female, JMZ158); 1900.vi., Poling //Barnes Collection (1 Male, JMZ157); Magnolia, 1951.ii., A. K. Wyatt, ex ova (1 Female, JMZ61). **Massachusetts:** Plymouth Co., E. Wareham Agr. Exp. Sta., 10.vii.1976, W. E. Tomlinson at black-light trap (1 Female, JMZ258); E. Wareham Agr. Exp. Sta., 27.vii.1977, W. E. Tomlinson at blacklight trap, AMNH (1 Male, JMZ261); Martha's Vineyard, F. M. Jones (1 Male, JMZ128). **New Jersey:** Cape May Co., Eldora, J. Muller //Offspring No. 5, 17.viii. (1 Female, JMZ268); Eldora, 1977.vi.1923, J. Muller (1 Female, JZ290); Eldora, Jos. Muller //offspring No. 5, 17.viii. (1 Male, JMZ267); Orange Mts., 6.ix., Otto Bucholz Collection, AMNH (1 Male, JMZ289); Lakehurst, *nigricans* (1 Male, JMZ83). **New York:** Horseheads, 30.viii.1943, L. R. Rupert //Bred ex ova Food: Dandelion//1022 *nigricans* (1 Male, JMZ84). **Pennsylvania:** New Brighton, 7.vii.1975 //Eubaphe *opella* (1 Male, JMZ82).

Diagnosis.— *Virbia opella* is a highly phenotypically variable species ranging from a dark charcoal form (Pl. 3, Nos. 2,3) to a pinkish form (Fig. 29). Nearly all have a brown discal spot in the hindwing, although the spot is obscured in the dark form (Plate 3, Nos. 2,3), and paler forms may lack the discal spot. This species is routinely confused with *V. nigricans*, and occasionally with *V. aurantiaca* and *V. ferruginosa*. *Virbia nigricans* is restricted to western New Jersey and eastern Pennsylvania, and is a much smaller, darker species (forewing length 9.3 mm) compared to the larger *V. opella* (forewing length 11 mm). For genitalic differ-

ences, see the Diagnosis of *V. nigricans*. *Virbia opella* is easily separated from *V. aurantiaca* and *V. ferruginosa* based on forewing venation; R^3 is absent or just a trace in *V. opella* and present in the other two species.

The pinkish form of *V. opella* (Fig. 29) can be confused with *V. fergusonii* (Fig. 91), but *V. fergusonii* has darker forewings and more pronounced color contrast in the hindwings. For genitalic differences, see the Diagnosis of *V. fergusonii*.

Description. —Male habitus (Fig. 28, Pl. 3, No. 3): Head olive brown. Antennal scales olive brown. Third segment of labial palpus exceeding front of head by at least half of entire length, first and second segments orange rufous, third segment olive brown. Thorax dorsal and ventral scales olive brown. Legs cinnamon, occasionally suffused with orange-rufous scales, tarsal claw slightly bifid (Fig. 15B). Forewing length 11 mm ($N = 10$), R^3 absent, M^3 present, extending to edge (Fig. 13). Dorsal surface olive brown to dark drab with a sepia discal spot present, ventral surface clay suffused with salmon extending from adbasal region through medial region. Hindwing dorsal surface identical to forewing, ventral surface identical. Abdomen olive brown, edges of tergites, pleurites and sternites layered with scales ranging from clay to orange rufous among specimens. Sclerotization of 8th sternite oval, egg shape (Fig. 28B). Coremata absent. Female habitus (Pl. 3, No. 2): Head cinnamon. Antennal scales fuscous. Third segment of labial palpus short; first and second segments range from clay to orange-rufous, third segment grayish horn. Thorax dorsal and ventral scales cinnamon. Legs intermixed with olive brown and clay, tarsal claw slightly bifid (Fig. 15B). Forewing length 12 mm ($N = 10$), venation as in male. Forewing dorsal surface cinnamon, faint fuscous discal spot present, ventral surface peach red, terminal margins a fringe of fuscous scales. Hindwing dorsal surface peach red, tufts of faint cinnamon scales extending out from wingbase tapering towards antemedial region with a dark fuscous discal spot present, ventral surface identical. Abdomen dorsal abdominal scales peach red, occasionally with fuscous spots on all segments, ventral and lateral scales peach red to clay, pattern of fuscous same as dorsal side. Male genitalia: Phallus (Fig. 19D) with rounded coecum penis, straight, basiphallus inflected ventrally at base, curved toward venter, phallic sclerite reduced. Vesica directed ventrally when everted, membrane rugose, bilobed, elongate, second lobe of vesica rugose, left side of vesica with patch of cornuti located ventrally, right side of vesica with patch of cornuti under phallic sclerite. Genital capsule (Fig. 19C) dorsum with tegumen entire, conjunctiva

membranous (Fig. 23C). Uncus base cordate, (Fig. 23B), ventrad with uncus apex fingerlike, bifid and with two hooks (Fig. 27A). Scaphium rounded, triangular. Subscaphium lobed and incomplete, extensions of tegumen sclerotized (Fig. 19C). Juxta ovoid with ventral margin expanding into larger orbicular plate, dorsal margin concave with pointed edges (Figs. 19C, 20A). Costa of valva elongate and tip forked, 20 or more costal setae. Saccus peanut shaped. Saccus rounded, concave in center. Female genitalia: Pseudopapillae anales present. Pheromone glands membranous, branching after tip of anterior apophyses, thin, less than 1/8 width of 7th abdominal sternite. Ostium bursa split with two, large, lateral prominences (Fig. 30A). Ductus bursa goblet shaped, sclerotization extending into corpus bursa (Fig. 17C). Corpus bursa double, connate, signa absent, both with smooth membrane (Figs. 17C, 26E).

Variation.— Some females of *V. opella* deviate greatly from the colors discussed in the description. Many females have olive brown to dark drab scales as in the males. Some females have these scales, but the pattern and color discussed in the description can be seen through these dark scales. Some females display the wing pattern and color discussed in the description, but are much brighter; these differences in wing color do not seem to be correlated with distribution (e.g., no pattern of geographic variation). This species is most closely related to and may even be confused with *V. fergusonii*. The most distinctive male genitalic characters that can be used to separate this species from *V. fergusonii* species are the presence of a cornutuslike patch located ventrally on left side of vesica and the lobing of the subscaphium. In addition, *V. fergusonii* females typically have a signum, while *V. opella* females are lacking signa. In addition to the morphological differences, wing color and pattern can be used to separate *V. opella* species from *V. fergusonii*.

Biology.— Larvae have been reared on dandelion (*Taraxacum*) (Forbes 1960; Heppner 2003; Zaspel database). *Virbia opella* is multivoltine, and adult males and females fly at night and can be collected at a black light in habitats ranging from oak forest to scrub oak (Martha's Vineyard, Massachusetts). In Louisiana, *V. opella* have three broods from November-February (Brou, personal communication).

Distribution.— This species occurs from Maine west to Illinois and south to Texas.

Virbia ostenta Edwards

Pl. 1, Nos. 1 (female), 2 (males)

Crocota ostenta Edwards 1881: 12 [type locality, Prescott, Arizona, USA].

Holomelina calera Barnes 1907: 10 [type locality, Huachuca Mts., Arizona, USA].

Material examined. — Type material: Holotype of *V. ostenta*: *Crocota ostenta* Type Hy. Ed./No 8195 Collection Hy. Edwards/Prescott Arizona/7600/Type No. A.M.N.H., AMNH. Holotype (synonym of *V. ostenta*): July 16-23//Huachuca Mts. Ariz.//*Holomelina calera* Type Barnes//Photograph Pl. 12 No. 3//Photograph Pl. 26 No. 4//47/BL, NMNH. All material is from the NMNH collection unless otherwise noted: **UNITED STATES: Arizona:** Santa Rita Mts., S. S. Nicolat Madera Canyon, 20.iii.1946 (1 Male, JMZ87); Huachuca Mts., 24-30.vii//Barnes Collection (1 Female, JMZ225).

Diagnosis. — *Virbia ostenta* is clay colored forewings accented with a costal streak of light salmon scales and with geranium pink extending from the proximal portion of the adbasal region and meeting with the dark brownish olive ground color (Pl. 1, Nos. 1, 2). Large for *Virbia*, the forewing length averages 17 mm. This species resembles *V. costata*, but *V. costata* is smaller (Forewing length 11 -12 mm) and has a darker forewing that lacks a costal streak. This species can also be mistaken for the Mexican *V. semirosea* Druce, but the forewing of *V. semirosea* is darker, closer in hue to *V. costata* females than *V. ostenta* and the hindwing of *V. semirosea* is more red than pink like *V. ostenta*.

Description. — Male habitus (Pl. 1, No. 2): Head yellow ocher. Antennal scales yellow ocher. Third segment of labial palpus exceeding front of head by at least half of entire length, first and second segments a blend of yellow ocher and light salmon scales, third segment dark clay infused with cinnamon. Thorax a blend of yellow ocher and clay. Legs dark brown, sepia, tarsal claw simple (Fig. 15A). Forewing length 17.1 mm (N = 10); R¹-R⁵ all present, M³ present, extends to edge (Fig. 12). Dorsal surface clay with a thin light salmon band running full length of costal margin, ventral surface dusted in light salmon. Hindwing dorsal surface dark brownish olive, pattern with geranium pink beginning at proximal portion of adbasal region, expanding transversely to most distal portion of postmedial region, extending halfway down wing and meets ground color with a sinuate margin, ventral surface identical. Abdomen dorsal side dark brownish olive, lateral geranium pink, ventral yellow ocher. Sclerotization of 8th sternite rectangular, length greater than width (Fig. 28E). Coremata absent. Female habitus (Pl. 1, No. 1): Head sepia. Antennal scales dark brown, sepia. Third segment of labial palpus exceeding front of head by at least half of entire length, all segments dark brown, sepia. Thorax dark brown, sepia. Legs yellow ochre with sparse patches

of light salmon on femora and tibiae, tarsal claw simple (Fig. 15A). Forewing length 18.5 mm (N = 4), venation same as in male. Dorsal surface antique brown with thin peach red band running full length of costal margin, ventral surface dusted in geranium pink. Hindwing dorsal surface fuscous, pattern with geranium pink beginning at proximal portion of adbasal region, expanding

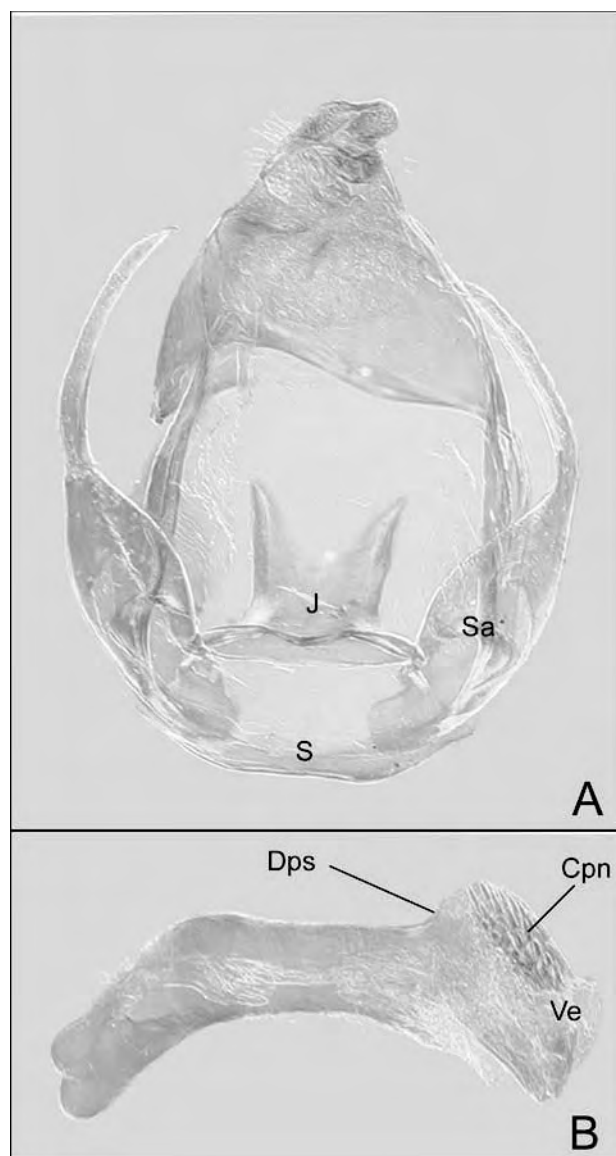


Figure 31. A. Male genital capsule *Virbia rindgei*. J = juxta (cylindrical, emarginated, with ends barbed toward dorsum), Sa = sacculus (horizontally obovate, broadly hooked toward costa), S = saccus (rounded, concave midventrally); B. Phallus, *Virbia rindgei*, left, lateral view. Dps = phallic sclerite (wide, nodular), Ve = vesica (bilobed, primary lobe elongate with smooth membrane, second lobe rugose), Cpn = patch of cornuti (right side of vesica under phallic sclerite).

transversely to most distal portion of postmedial region, extending halfway down wing and meets ground color with a sinuate margin, ventral surface identical. Abdomen fuscous. Male genitalia: Phallus (Fig. 22B) with rounded coecum penis, straight, basiphallus inflected ventrally at base, phallic sclerite present, narrow and rounded. Vesica directed ventrally when everted, membrane smooth, entire, left side with patch of cornuti located ventrally. Genital capsule with dorsum of tegumen concave, bent inward, conjunctiva weakly sclerotized (Fig. 23A). Uncus base cordate (Fig. 23B), ventrad with uncus apex slightly bifurcate, toothed with one hook (Fig. 23E). Scaphium rounded, triangular. Subscaphium completely surrounding anal tube (Fig. 19C), extensions of tegumen sclerotized. Juxta vertically ovoid with ventral margin expanding into larger orbicular shape, dorsal margin concave with pointed edges (Fig. 20A). Costa of valva elongate and tip entire, 20 or more costal setae. Saccus claw-like, extending under juxta on both sides. Saccus rounded, concave in center. Female genitalia: Lacking pseudopapillae anales. Pheromone glands membranous, branching before tip of anterior apophyses, thin, less than 1/8 width of 7th abdominal sternite. Ostium bursa slightly concave with small lateral prominences (Fig. 30B). Ductus rectangular, narrowing toward venter (Fig. 17A). Corpus bursa double, connate, three signa present in corpus, both bursae round with smooth membrane (Fig. 17D).

Variation.—Female *V. ostenta* specimens are rare in collections. Almost no variation in color or size was observed in either sex examined.

Biology.—Unknown.

Distribution.—*Virbia ostenta* is restricted to the southwestern U.S. (New Mexico, Arizona) and Mexico, occurring in mountain ranges.

***Virbia rindgei* Cardé n. sp.**

Pl. 3, Nos. 8 (female), 9 (male)

Holotype.—Reuter Canyon Camp 5 mi. N. of Sundance Crook Co., WYO., 5900 ft., 8.vii.1962, F., P. & M. Rindge//Collected on NSF Grant G-25314, Male, AMNH.

Paratypes.—**UNITED STATES: South Dakota:** Custer Pk.: S. Dak. Lawrence Co., 6794 ft., 1.vii.1962, F., P. & M. Rindge//JMZ307, Male, AMNH; Lead, Lawrence Co., S. Dak., 5200 ft., 25.vii.1953, F. & P. Rindge, Male, AMNH; Spring Creek Camp 11 mi. NE Hill City S. Dak., 30.vii.1955, F. & P. Rindge, Male, AMNH. **Wyoming:** Reuter Canyon Camp 5 mi. N. Sundance Crook Co., 5,900 ft., 10.vii.1962, F. P. & M. Rindge//Collected on NSF Grant G 25134//Genitalic preparations 1963-41 Ring Cardé, Male, AMNH; Reuter

Canyon Camp 5 mi. N. of Sundance Crook Co., 6100 ft., 13.vii.1959, F., P. & B. Rindge//JMZ276, Male, AMNH; Reuter Canyon Camp 5 mi. N. of Sundance Crook Co., 5900 ft., 8.vii.1962, F., P. & M. Rindge, Male, AMNH; Reuter Canyon Camp 5 mi. N. of Sundance Crook Co., 5900 ft., 8.vii.1962, F., P. & M. Rindge, Male, AMNH; Reuter Canyon Camp 5 mi. N. of Sundance Crook Co., 5900 ft., 9.vii.1962, F., P. & M. Rindge, Male, AMNH; Reuter Canyon Camp 5 mi. N. of Sundance Crook Co., 5900 ft., 9.vii.1962, F., P. & M. Rindge//Collected on NSF Grant G-25314//Genitalic Preparation 163-42 Ring Cardé, Male, AMNH; Reuter Canyon Camp 5 mi. N. of Sundance Crook Co., 5900 ft., 9.vii.1962, F., P. & M. Rindge//Collected on NSF Grant G-25314//Genitalic Preparation 164-65 Ring Cardé, Male, AMNH; Reuter Canyon Camp 5 mi. N. of Sundance Crook Co., 5900 ft., 3.vii.1962, F., P. & M. Rindge//Collected on NSF Grant G-25314//Genitalic Preparation 164-72 Ring Cardé, Male, AMNH; Reuter Canyon Camp 5 mi. N. of Sundance Crook Co., 5900 ft., 9.vii.1962, F., P. & M. Rindge//Collected on NSF Grant G-25314//Genitalic Preparation 164-82 Ring Cardé, Male, AMNH; 5-6 mi. N. of Sundance Crook Co., 5900-6300 ft., 4.vii.1962, F., P. & M. Rindge, Male, AMNH; Reuter Canyon Camp 5 mi. N. of Sundance Crook Co., 5900 ft., 8.vii.1962, F., P. & M. Rindge//166//Collected on NSF Grant G-25314, Female, AMNH. All material is from the NMNH collection unless otherwise noted: **UNITED STATES: South Dakota:** Gunnison Co., 6 mi. E. of Somerset, 29.vi.1959, leg. C. L. Remington (1 Female, JMZ306); Custer Park, 6500-6794 ft., 30.vii.1955, F. & P. Rindge (1 Male, JMZ311).

Etymology. —This species is named in honor of Dr. Fred Rindge. He is among the first to collect this species and recognize it as distinct from other species in the *V. aurantiaca* complex. Dr. Rindge has had an illustrious career as a Lepidopterist and his collections have greatly increased our knowledge of North American lepidopteran fauna.

Diagnosis.—*Virbia rindgei* might be confused with *V. aurantiaca*. Wing pattern, coloration and genitalia readily separate these species. *Virbia rindgei* males have much darker forewings with rusty undertones (Fig. Pl. 3, No. 8), while *V. aurantiaca* usually have solid brown forewings (Pl. 1, No. 4). The hindwings of *V. rindgei* have dark brown shading from the subterminal band along the fold from discal cell to 3A (often covering most if not all of the dark brown discal spot), whereas the subterminal area of *V. aurantiaca* is a solid band. *Virbia rindgei* females (Pl. 3, No. 9) have much brighter forewings than *V. aurantiaca* females (Pl. 1, No. 5). In males, the dorsal margin of the juxta of *V. rindgei* is

concave with pointed edges (Fig. 31A) whereas the juxta of *V. aurantiaca* lacks this elaborate dorsal margin (Fig. 20B). Female genitalia are not diagnostic. Although *V. aurantiaca* is widespread, it has not been collected in the Black Hills of South Dakota (Lawrence Co.) or Wyoming (Crook Co.).

Description. — Male habitus (Pl. 3, No. 8): Head mikado brown. Antennal scales mikado brown. Third segment of labial palpus exceeding front of head by at least half of entire length, first and second segments peach red, third segment mikado brown. Thorax mikado brown. Legs cinnamon, with patches of salmon color scales on femora and tibiae, tarsal claw simple (Fig. 15A). Forewing length 12 mm (N = 10); R^1 - R^5 all present, M^3 present, extending to edge (Fig. 12). Dorsal surface mikado brown, faint sepia discal spot present, ventral surface a mixture of salmon and peach red scales throughout, posterior margin a fringe of sepia. Hindwing dorsal surface peach red, subterminal region a thick band of sepia meeting postmedial region in sinuate pattern, in most specimens sepia scales shading in region from subterminal band along fold from discal cell to 3A, large sepia discal spot present, ventral surface identical. Abdomen clay, dorsal tergites occasionally with medium size sepia spot in center, size tapering with each segment towards posterior. Sclerotization of 8th sternite pentagonal (Fig. 28C). Coremata reduced to small patches of scales on membranous lobes. Female habitus (Pl. 3, No. 9): Head dark cinnamon. Antennal scales dark cinnamon. Third segment of labial palpus exceeding front of head by at least half of entire length, all segments dark cinnamon. Thorax mikado brown. Legs clay, with patches of salmon on femora and tibiae, tarsal claw simple (Fig. 15A). Forewing length 12 mm (N = 3), venation same as in male. Forewing dorsal surface mikado brown throughout, faint natal brown discal spot present, occasionally small white spot in annular region present, ventral surface identical, dusted with peach red. Hindwing dorsal surface peach red, subterminal region a thick band of sepia scales, meeting postmedial region in sinuate pattern, in most specimens, sepia scales shading in region from subterminal band along fold from discal cell to 3A with a large sepia discal spot, ventral surface identical. Abdomen dorsal, lateral, and ventral abdominal scales clay to peach red, dorsal tergites with large sepia spot in center, size tapering with each segment towards posterior. Male genitalia: Phallus with rounded coecum penis, inflected ventrally, straight, phallic sclerite wide and nodular (Fig. 31B). Vesica directed ventrally when everted, membrane smooth, bilobed, second lobe sclerotized (Fig. 22C), right side of vesica with patch of cornuti under phallic sclerite (Fig. 31B). Geni-



Figure 32. Male genital capsule *Virbia rubicundaria*. J = juxta (cylindrical and emarginated with ends barbed toward dorsum), Sa = sacculus (horizontally obovate and broadly hooked toward costa), S = saccus (rounded and concave midventrally).

tal capsule (Fig. 31A) with dorsum of tegumen lobed, sides divergent, conjunctiva membranous. Uncus base cordate (Fig. 23B), ventrad with uncus apex fingerlike, bifid, and with two fused hooks (Fig. 27A). Scaphium rounded, triangular. Subscaphium absent. Juxta cylindrical, emarginated, with ends barbed toward dorsum. Costa of valva elongate and tip entire, 20 or more costal setae. Sacculus horizontally obovate, broadly hooked toward costa. Saccus rounded, concave in center. Female genitalia: Pseudopapillae anales present. Pheromone glands membranous, branching after tip of anterior apophyses, moderately thick, greater than 1/8 but less than 1/4 width of 7th abdominal sternite. Ostium bursa slightly concave with small lateral prominences (Fig. 30B). Ductus bursa rectangular, narrowing toward venter, sclerotization extending into corpus bursa (Fig. 17B). Corpus bursa with three signa, membrane of the corpus bursa wrinkled (Fig. 26C).

Variation.— *Virbia rindgei* has a highly restricted distribution and is only known from specific localities in Colorado, South Dakota and Wyoming. This species is rare in collections and only represented by small series of mostly males in some of the larger collections (e.g., AMNH & NMNH), rendering further study difficult. Recent collecting attempts in South Dakota and Wyoming were unsuccessful (R.T. Cardé, D. Ferguson, J. Zaspel). This species has not been collected since the late 1970's.

Biology.— The larvae are not known. The moths were collected in Ponderosa Pine forest with an open

understory (Rindge unpublished field notes). From the label data, this species appears to be single brooded, with a flight in mid – late July, possibly early August. This species has been collected at elevations near or above 6000 feet.

Distribution.— This species has been collected at high elevations in Colorado, South Dakota and Wyoming.

Virbia rubicundaria Hübner

Pl. 2, Nos. 4 (female), 5 (male)

Crocota rubicundaria Hübner 1827: 256 [type locality, Georgia, USA].

Crocota belfragei Stretch 1885: 103 [type locality, Texas, USA].

Crocota brevicornis Walker 1854b: 536 [type locality, “USA”].

Crocota diminutiva Graef 1887: 42 [type locality, Texas, USA].

Crocota rosa French 1890: 133 [type locality, Texas, USA].

The holotype of *Crocota rubicundaria* is lost according to Dr. Lloyd Martin, Curator of Lepidoptera at Naturhistorisches Museum, Wien (personal communication 6/25/2004). A neotype is designated here and labeled to ensure nomenclatural stability. The specimen was chosen from the nearest locality to the original type locality. *Crocota rubicundaria* Hübner, neotype Male [NMNH] is labeled: *Virbia rubicundaria* (Hbn. 1827) [RED LABEL]. Label data: GA: Trader’s Hill, Folkston, Charlton County 27.ix.1992, D.C. Ferguson/JMZ59, Female, NMNH.

Material examined.— Type Material. Holotype lost. Syntype (synonym *V. rubicundaria*): *Holomelina brevicornis* syntype “140” Arctiidae slide 905 BM negative 43756, NHM. All material is from the NMNH collection unless otherwise noted: **UNITED STATES: Florida:** Gainesville, iv.1969, Dale Hubeck (1 Female, 1 Male; JMZ294, JMZ293); Highlands Co., Archibold Biological Station, 23.vi.1966, Ring T. Cardé (1 Male, JMZ291); Archibold Biological Station, 16.vi.1966, Ring T. Cardé, RTC (1 Male, JMZ292); Florida City, 20.iv.1947, Otto Bucholz //Otto Bucholz Collection (1 Male, JMZ252); Lakeland, 5.v.1912 (1 Male, JMZ253); Monticello, 4-8.x.1914, AMNH (1 Male, JMZ254); Lutz, F. W., 1.iv.1916, LACM (1 Male, JMZ190); Florida City, 23.iv.1947, Otto Bucholz //Otto Bucholz Collection (2 Females, JMZ248; JZ249); 15.iv.1947, Otto Bucholz //Otto Bucholz Collection, AMNH (1 Female, JMZ250). **Georgia:** Liberty Co., St. Catherine’s Island, 7-12.viii.1991, E. Quinter & A. Sharkov, AMNH (1 Female, JMZ251). **Texas:** Anderson Co., Tennessee Colony, 21.vii.1965, A. & M. E. Blanchard (1 Male,

JMZ188); Bosque Co., Laguna Park, 24.ix.1970, A. & M. E. Blanchard (1 Male, JMZ189).

Diagnosis.— *Virbia rubicundaria* females can be confused with *V. aurantiaca*, however, these species are rarely sympatric. See diagnosis of *V. aurantiaca*.

Virbia rubicundaria (Pl. 2, Nos. 4,5) can be confused with *V. fergusonii* (Pl. 3, Nos. 4,5), but these species can be separated based on size, coloration, and genitalia of both sexes. *Virbia rubicundaria* is typically smaller (wing length 9 mm) with a lighter forewing (clay with light salmon highlights) compared to *V. fergusonii* (wing length 11 mm) with darker raw umber coloration.

The male genitalia of *V. rubicundaria* lack a subscaphium (Fig. 32), the coecum penis is notched and the phallic sclerite is wide and nodular (Fig. 22C) whereas *V. fergusonii* males have a large subscaphium (Fig. 19A), a rounded coecum penis and reduced phallic sclerite (Fig. 19B). Females of *V. rubicundaria* have a single bursa (no additional bursae) ornamented with three signa (Fig. 26C). In contrast, females of *V. fergusonii* have a bilobed corpus bursa with a single signum (Fig. 26E).

Description.— Male habitus (Pl. 2, No. 5): Head clay with light orange hues. Antennal scales clay with light orange hues. Third segment of labial palpus exceeding front of head by at least half of entire length, all segments a blend of clay and flesh ocher. Thorax clay with light orange hues. Legs a blend of clay and flesh ocher, tarsal claw simple (Fig. 15A). Forewing length 8.9 mm (N = 10); R¹-R⁵ all present, M³ present, extending to edge (Fig. 12). Dorsal surface clay with light orange hues, ventral surface dark salmon. Hindwing dorsal surface flesh ocher, ventral surface ranging from identical to light salmon. Abdomen flesh ocher to dark. Sclerotization of 8th sternite pentagonal (Fig. 28C). Coremata reduced to small patches of scales on membranous lobes. Female habitus (Pl. 2, No. 4): Head color same as in male. Antennal color same as in male. Third segment of labial palpus exceeding front of head by at least half of entire length, color same as in male. Thorax same as in male. Legs same as in male, tarsal claw simple (Fig. 15A). Forewing length 8.7 mm (N = 10); venation same as in male. Forewing dorsal surface clay with light orange hues, ventral surface identical, dark salmon with a faint natal brown spot between medial and postmedial regions present. Although rare, some specimens with small white spot in annular region, ventral surface identical. Hindwing dorsal surface flesh ocher with a natal brown discal spot present, natal brown subterminal markings as spots and blotches often not reaching posterior margin, ventral surface identical. Abdomen same as in male. Male genitalia: Phallus with

rounded coecum penis and weakly knobbed (Fig. 22A), inflected ventrally, basiphallus straight, phallic sclerite wide and nodular (Fig. 22C). Vesica directed ventrally when everted, membrane rugose, bilobed, elongate, second lobe sclerotized, right side of vesica with patch of cornuti under phallic sclerite (Fig. 22C). Genital capsule (Fig. 31) dorsum with tegumen lobed, sides divergent, conjunctiva membranous. Uncus base cordate (Fig. 23B), ventrad with uncus apex fingerlike, bifid, with two fused hooks (Fig. 27A). Scaphium rounded, triangular. Subscaphium absent. Juxta cylindrical, emarginated, with ends barbed toward dorsum. Costa of valva elongate and tip entire, 20 or more costal setae. Sacculus horizontally obovate, broadly hooked toward costa. Saccus rounded, concave in center. Female genitalia: Pseudopapillae anales present (Fig. 24B). Pheromone glands membranous, branching before tip of anterior apophyses, moderately thick, greater than 1/8 but less than 1/4 width of 7th abdominal sternite. Ostium bursa with small prominences on both sides (Fig. 30B). Ductus bursa rectangular, narrowing toward venter, sclerotization extending into corpus bursa (Fig. 26C). Corpus bursa with three signa, membrane of the corpus bursa wrinkled (Fig. 26C).

Variation.— Little variation in color pattern exists among male *V. rubicundaria* specimens. Although rare, some males have a faint trace of a subterminal band on the hindwings. Some *V. rubicundaria* males from the southwest were slightly larger than those from Florida and Georgia. Of sixteen males, three had a rounded coecum penis, not gently notched. Some females have a brownish discal spot in the forewing and one specimen had a faint white spot in the annular region of the forewing. Female hindwing patterns were consistent.

Biology.— Larvae have been reared on dandelion (*Taraxacum*) and wild lettuce (*Lactuca floridana* Gaertner) (Zaspel Database). A multivoltine species, moths are collected year-round throughout its range.

Distribution.— This species is found in Georgia and Florida, and distributed along the Gulf Coastal States to east Texas.

ACKNOWLEDGMENTS

We thank Michelle DaCosta, Howard Frank, Ralph Holzenthal, William Miller, and three anonymous reviewers for helpful comments. We also thank Demetrios Vital for assistance with illustrations and Kevin Nixon for assistance with the website. This work was supported by SJW funding sources: NSF-DEB-9981416, NSF-REU supplement, and a Minnesota Experiment Station Project, MN-17-022. The project was also supported by JZ's funding: Bell Museum curatorial assistantships, the

Dayton Wilke Fund (Bell Museum), and a Collections Study Grant from the American Museum of Natural History.

LITERATURE CITED

- Barnes, W. 1907. New species of North American Lepidoptera. *Canadian Entomologist*, 39: 10–15.
- Barnes W., & F. H. Benjamin. 1925. Notes on some species of Lepidoptera in relation to the Stretch Collection. *Pan-Pacific Entomologist*, 1: 127–138.
- Barnes W., & J. B. McDunnough. 1917. Checklist of the Lepidoptera of Boreal America. Herald Press, Decatur, IL, U.S. 4 (1): 84–85.
- Barnes W., & J. B. McDunnough. 1918. Notes and new species. *Contributions to the natural history of the Lepidoptera of North America*, 4 (2): 61–208.
- Bremer, K. 1992. Ancestral areas: a cladistic reinterpretation of the center of origin concept. *Systematic Biology*, 41: 436–445.
- Brou, V. A. 2003. *Holomelina laeta* (Gr.-Men.) in Louisiana. *Southern Lepidoptera Newsletter* 25: 81.
- Brower, A. E. 1974. A list of the Lepidoptera of Maine—Part 1, the macrolepidoptera. *Life Sciences and Agriculture Experiment Station Tech. Bull.* 66: 1–136.
- Buettner, W. 1898. Bombycine moths of the vicinity of New York. *Bulletin American Museum of Natural History*, 10: 365–366.
- Cardé, R. T. 1965. Some taxonomic notes on the nearctic *Holomelina* with a partial key to species. *Journal of the Lepidopterists' Society*, 19: 69–76.
- Cardé, R. T. 1968. A revision of the *Holomelina aurantiaca* species group (Lepidoptera: Arctiidae). Master's thesis. Cornell University, Ithaca, N.Y.
- Cardé, R. T. 1971. Aspects of reproductive isolation in the *Holomelina aurantiaca* complex (Lepidoptera: Arctiidae). Ph.D. thesis. Cornell University, Ithaca, N.Y.
- Cardé, R. T. 1974. Diel periodicities of female calling and male pheromone attraction in *Holomelina aurantiaca* (Lepidoptera: Arctiidae). *Canadian Entomologist*, 106: 933–934.
- Cardé, R. T. & W. L. Roelofs. 1973. Temperature modification of male sex pheromone response and factors affecting female calling *Holomelina immaculata* (Lepidoptera: Arctiidae). *Canadian Entomologist*, 105: 1505–1512.
- Cardé & K. F. Haynes. 2004. Chapter 8. Structure of the pheromone communication channel in moths. *In Advances in Insect Chemical Ecology*, Edited

- by R. T. Cardé & J. C. Millar. Cambridge University Press p. 283 – 332.
- Charlton, R. E. & W. L. Roelofs. 1991. Biosynthesis of a volatile, methyl-branched hydrocarbon sex pheromone from leucine by arctiid moths (*Holomelina* spp.) Archives of Insect Biochemistry and Physiology, 18: 81-97.
- Dallwitz, M. J., T. A. Paine, & E. J. Zurcher. 1993. User's guide to the DELTA system: A general system for producing taxonomic descriptions. Edition 4. CSIRO Division of Entomology, Canberra, Australia.
- Druce, H. 1885. Biologia Centrali-Americana (Zoologia) Insecta, 1: 41–160. London.
- Dyar, H. G. 1897. The larva of *Crocota opella* Grote. Psyche, 8: 119.
- Edwards, H. 1881. Descriptions of two new species of Lithosiidae. Papilio, 1: 12.
- Ehrmann, G. A. 1895. A few remarkable variations in Lepidoptera. Canadian Entomologist, 26: 292–293.
- Ferguson, D. C. 1953. On the identity and status of *Eubaphe lamae* Freeman (Lepidoptera: Arctiidae). Canadian Entomologist, 85: 371–373.
- Ferguson, D. C. 1954. The Lepidoptera of Nova Scotia, Part 1 (Macrolepidoptera). Bulletin No. 2. Nova Scotia Museum of Science, Nova Scotia, Canada.
- Ferguson, D. C. 1985. Contributions toward reclassification of the world genera the tribe Arctiini, part 1: introduction and a revision of the *Neoarctia-Grammia* group (Lepidoptera: Arctiinae). Entomography, 3: 181–275.
- Fibiger, M., & J. D. Lafontaine. 2005. Systematic list of the Noctuoidea of Europe (Notodontidae, Nolidae, Arctiidae, Lymantriidae, Erebiidae, Micronoctuidae, and Noctuidae). Esperiana. Buchreihe zur Entomologie 11: 7-92.
- Fletcher, D. S. 1954. A revision of the genus *Eubaphe* (Lepidoptera: Geometridae). Zoologica, 39: 153–166.
- Forbes, W. T. M. 1910. New England Caterpillars, No. 2. *Eubaphe nigricans* Reakirt. Journal of the New York Entomological Society, 18: 163–164.
- Forbes, W. T. M. 1939. The Lepidoptera of Barro Colorado Island, Panama. Bulletin of the Museum of Comparative Zoology, Harvard, 85: 234–321.
- Forbes, W. T. M. 1960. Lepidoptera of New York and neighboring states. Part 4. Agaristidae through Nymphalidae including the butterflies. Agricultural Experimental Station, Cornell University, Ithaca, New York. Memoir p. 371.
- Franclemont, J. G. 1983. Arctiidae. In Check List of the Lepidoptera of America North of Mexico, including Greenland. Edited by R. W. Hodges, T. Dominick, D. R. Davis, D. C. Ferguson, J. G. Franclemont, E. G. Munroe, and J. A. Powell. E. W. Classey Ltd. and Wedge Entomological Research Foundation, London, England. p. 114–119.
- Freeman, T. N. 1941. New species of Canadian Lepidoptera. Canadian Entomologist, 73: 123–127.
- French G. H. 1890. Some new moths. Canadian Entomologist, 22: 133–135.
- Graef, E. L. 1887. Some new Bombycidae. Entomologica Americana, 3: 41–43.
- Grote, A. R. 1863. Additions to the catalogue of U.S. Lepidoptera. No. 2. Proceedings of the Entomological Society of Philadelphia, 2: 334–344.
- Grote, A. R. 1865. Descriptions of North American Lepidoptera. VI. Proceedings of the Entomological Society of Philadelphia, 4: 315–330.
- Guérin-Ménéville, F. E. 1832. Iconographie du Règne animal de G. Cuvier. Insectes: Paris and London, plates 1-110, p. 6-576.
- Hallberg, E., & G. Poppy. 2003. Exocrine glands: chemical communication and chemical defense. In Handbook of Zoology, Lepidoptera, Volume 2: morphology, physiology and development. Edited by N. P. Kristensen. W. de Gruyter, Berlin, Germany, p. 361–376.
- Hampson, G. F. 1901. Catalogue of the Lepidoptera Phalaenae in the British Museum. Volume 3. Trustees of the British Museum, London, England.
- Hampson, G. F. 1920. Catalogue of the Lepidoptera Phalaenae in the British Museum. Supplement 2. Trustees of the British Museum, London, England.
- Handfield, L. 1999. *Le guide des papillons de Québec*. Boucherville: Volume 1: 1-982, 123 color plates. Broquet, Boucherville, Québec.
- Heppner, J. B., and G. Lamas. 1982. Acronyms for world museum collections of insects, with an emphasis on neotropical Lepidoptera. Bulletin of the Entomological Society of America, 28: 305–315.
- Heppner, J. B. 2003. Arthropods of Florida and neighboring land areas, vol. 17: Lepidoptera of Florida, Div. Plant Industry, Fla. Dept. Agr. & Comsum. Serv., Gainesville. x + 670 pp., 55 plates.
- Herrich-Schäffer, G. A. W. 1850-1869. Sammlung neuer oder wenig bekannter aussereuropäischer Schmetterlinge. 6 Volumes. Regensburg, G. J. Manz.
- Hodges, R. W., T. Dominick, D. R. Davis, D. C. Ferguson, J. G. Franclemont, E. G. Munroe, & J. A. Powell. 1983. Check List of the Lepidoptera of America North of Mexico, including Greenland. E. W. Classey Limited and Wedge Entomological Re-

- search Foundation. London, England.
- Holland, W. J. 1903. *The Moth Book*. Doubleday and Page. New York, U.S.
- Hübner, J. 1823. *Zuträge zur Sammlung exotischer Schmettlinge*, Volume 2. Augsburg.
- Hübner, J. 1827. *Zuträge zur Sammlung exotischer Schmettlinge*, Volumes 3. Augsburg, Austria.
- ICZN: International Code of Zoological Nomenclature. 1999. Fourth Edition. The International Trust for Zoological Nomenclature xxix+305 pp. London.
- Jacobson, N. L., & S. J. Weller. 2002. A cladistic study of the Arctiidae (Lepidoptera) and a review of their biology. Thomas Say monograph series, Entomological Society of America. Lanham, MD, U.S.
- Kirby, W. F. 1892. A synomic catalogue of Lepidoptera Heterocera, Volume 1, Sphinges and Bombyces. Gurney and Jackson. London. England.
- Kitching, I. J., & J. E. Rawlins. 1999. Noctuoidea. In *Handbook of Zoology, Lepidoptera*, volume 1, Systematics and evolution. *Edited by* N.P. Kristensen. W. de Gruyter, Berlin, Germany, p. 355–401.
- Klots, A. B. 1970. Lepidoptera. In *Taxonomist's glossary of genitalia in insects*. *Edited by* S. L. Tuxon. Copenhagen, Munksgaard, p. 115–130.
- Kristensen, N. P. 2003. Chapter 2 In *Handbook of Zoology, Lepidoptera*, Volume 2: morphology, physiology and development. *Edited by* N.P. Kristensen. W. de Gruyter, Berlin, Germany, p. 361–376.
- Lafontaine, J. D. and M. Fibiger. 2006. Revised higher classification of the Noctuoidea (Lepidoptera). *Canadian Entomologist* 138: 610–635.
- Meyer, W. L. 1984. Sex pheromone chemistry and biology of some arctiid moths (Lepidoptera: Arctiidae): enantiomeric differences in pheromone perception. Master's thesis, Cornell University, Ithaca, New York.
- Neumögen, B., & H. G. Dyar. 1893a. A preliminary revision of the Bombyces of America north of Mexico. *Journal of the New York Entomological Society*, 1:153–158.
- Neumögen, B., & H. G. Dyar. 1893b. Notes on Lithosiidae and Arctiidae with descriptions of new varieties. *Entomological News*, 4: 138–143.
- Packard, A. S. 1887. Notes on certain Psychidae, with descriptions of two new Bombycidae. *Entomologica Americana*, 3: 51–52.
- Reakirt, T. 1864. Contributions towards a monograph of the genus *Crocota*. *Proceedings of the Entomological Society of Philadelphia*, 2: 371–373.
- Roelofs, W. & R. T. Cardé. 1971. Hydrocarbon sex pheromone in tiger moths (Arctiidae). *Science*, 171: 684–686.
- Saunders, W. 1869. On a supposed new Arctian. *Canadian Entomologist*, 2: 4–5.
- Scoble, M. J. 1992. *The Lepidoptera: form, function, and diversity*. Oxford University Press, New York.
- Schal, C. & R. T. Cardé. 1985. Rhythmic extrusion of pheromone gland elevates pheromone release rate. *Experientia*, 41: 1617–1619.
- Schal, C. & R. T. Cardé. 1986. Effects of temperature and light on calling behavior in the tiger moth *Holomelina lamae* (Freeman) (Lepidoptera: Arctiidae). *Physiological Entomology*, 11: 75–87.
- Schal, C., R. E. Charlton, & R. T. Cardé. 1987. Temporal patterns of sex pheromone titers and release rates in *Holomelina lamae* (Lepidoptera: Arctiidae). *Journal of Chemical Ecology*, 13: 1115–1129.
- Schal, C., V. Sevala, & R. T. Cardé. 1998. Novel and highly specific transport of a volatile sex pheromone by hemolymph lipophorin in moths. *Naturwissenschaften*, 85: 339–342.
- Schaus, W. 1901. Descriptions of new species of Heterocera. *Annals and magazine of Natural History* 7: 265–270.
- Seitz, A. 1914. *The Macrolepidoptera of the American Region, the American Bombyces and Sphinges*. The macrolepidoptera of the world, volume 6 (English edition). Alfred Kern, Stuttgart, Germany.
- Smith, J. B. 1889. Preliminary catalogue of the Arctiidae of temperate North America, with notes. *Canadian Entomologist*, 21: 194–197.
- Smithe, F. B. 1975. *Naturalist's color guide*. The American Museum of Natural History, New York. Color work by Hale Color Consultants, Baltimore.
- Strand, E. 1919. Arctiidae, subfamily Arctiinae. *Lepidopterorum Catalogus*, 22: 1–416. Junk, Berlin, Germany.
- Strecker, H. P. 1878. Section II. Lepidoptera. Family Bombycidae, In *Annual report upon the explorations and surveys in the Department of the Missouri, being Appendix SS of the annual report of the chief of engineers for 1878*. *Edited by* E.H. Ruffner. US Government Documents. Washington, D.C., p. 1859–1861.
- Stretch, R. H. 1885. Descriptions of new species of Heterocera. *Entomologica Americana*, 1: 101–107.
- Tietz, H. M. 1972. An index to the described life histories, early stages, and hosts of the Macrolepidoptera of the Continental U.S. and Canada. Volume 1. Allyn Museum of Entomology, Sarasota, FL, U.S.
- Walker, F. 1854. List of the specimens of Lepidopterous insects in the collection of the British Museum, 2: 279–581. Trustees of the British Museum, Lon-

- don, England.
- Walker, F. 1865a. List of the specimens of Lepidopterous insects in the collection of the British Museum, 31: 1–322. Trustees of the British Museum, London, England.
- Walker, F. 1865b. List of the specimens of Lepidopterous insects in the collection of the British Museum, 32: 323–706. Trustees of the British Museum, London, England.
- Watson, A., & D. T. Goodger. 1986. Catalogue of the neotropical tiger-moths. Occasional Papers on Systematic Entomology, 1: 1–71.
- Watson, A., D. S. Fletcher, & I. W. B. Nye. 1980. In The generic names of Moths of the World, Volume 2, Noctuoidea (part). Edited by I.W.B. Nye. Trustees of the British Museum (Natural History), London, England.
- Weller, S. J., R. B. Simmons, R. Boada, & W. E. Conner. 2000. Abdominal modifications occurring in wasp mimics of the Ctenuchine-Euchromiine clade (Lepidoptera: Arctiidae). Annals Entomological Society of America, 93: 920–928.
- Winter, W. D. Jr. 2000. Basic Techniques for Observing and Studying Moths and Butterflies. Memoirs of the Lepidopterists' Society, 5: 1–444.
- Wyatt, A. K. 1939. Notes on the identity of certain forms of *Eubaphe*. Canadian Entomologist, 71: 96–99.
- Wyatt, A. K. 1963a. A new subspecies of *Holomelina aurantiaca* from Virginia (Arctiidae). Journal of the Lepidopterists' Society, 17: 100–102.
- Wyatt, A. K. 1963b. *Holomelina aurantiaca buchholzi*, a correction. Journal of the Lepidopterists' Society, 18: 118.
- Yin, L. R. S., C. Schal, & R. T. Cardé. 1991. Sex pheromone gland of the female tiger moth *Holomelina lamae* (Lepidoptera: Arctiidae). Canadian Journal Zoology, 69: 1916–1921.
- Zaspel, J. M. 2004. Chapter 1: Review of generic limits of the tiger moth genera *Virbia* Walker and *Holomelina* Herrich-Schäffer (Lepidoptera: Arctiidae: Arctiinae) and their biogeography. Masters Thesis, University of Minnesota.
- Zaspel, J. M. & S. J. Weller, 2006. Review of generic limits of the tiger moth genera *Virbia* Walker and *Holomelina* Herrich-Schäffer (Lepidoptera: Arctiidae: Arctiinae) and their biogeography. Zootaxa. 1159: 1–68.

Plate 1: 1-10

1. Adult habitus: *Virbia ostenta* Edwards, Female: Huachuca Mountains., Arizona//Barnes Collection//24-30.vii., USNM.
2. Adult habitus: *Virbia ostenta* Edwards, Male: Williams, Coco-Nino Co., Arizona, 10.viii.1955, N. McFarland at light, LACM.
3. Adult habitus: *Virbia aurantiaca* Hübner, Male: Hartford Co., Farmington, Connecticut 9.vi.1961, leg. Ring T. Cardé, RTC.
4. Adult habitus: *Virbia aurantiaca*, Hübner, Male: Guilford Co., New Haven, Connecticut, 17.viii.1966, leg. Ring T. Cardé, RTC.
5. Adult habitus: *Virbia aurantiaca* Hübner, Male: Guilford Co., New Haven, Connecticut, 19.viii.1966, leg. Ring T. Cardé, RTC.
6. Adult habitus: *Virbia ferruginosa* Walker, Female: Edgebrook, Illinois 1-11.ix., A. Kwiat Bred//CNHM 1957 Alex. K. Wyatt Lepidoptera Colln, FMNH.
7. Adult habitus: *Virbia ferruginosa* Walker, Male: Guilford, New Haven CONN. 3.vii.1965 leg. Ring T. Cardé, RTC.
8. Adult habitus: *Virbia lamae* Freeman, Female: Seawall Bog, Acadia Pk., Mt. Desert Is., Maine 25.vii.1964, leg. Ring T. Cardé//Female parent of Brood, RTC.
9. Adult habitus: *Virbia lamae* Freeman, Male: Seawall Bog, Acadia Pk., Mt. Desert Is., Maine 29.vii.1966, leg. Ring T. Cardé, RTC.
10. Adult habitus: *Virbia costata* Stretch, Female: Prescott, Yavapai County Arizona 28.vii.1970, Collected by Lloyd Martin//*Holomelina intermedia* (Graef) det. Ring T. Cardé, RTC.

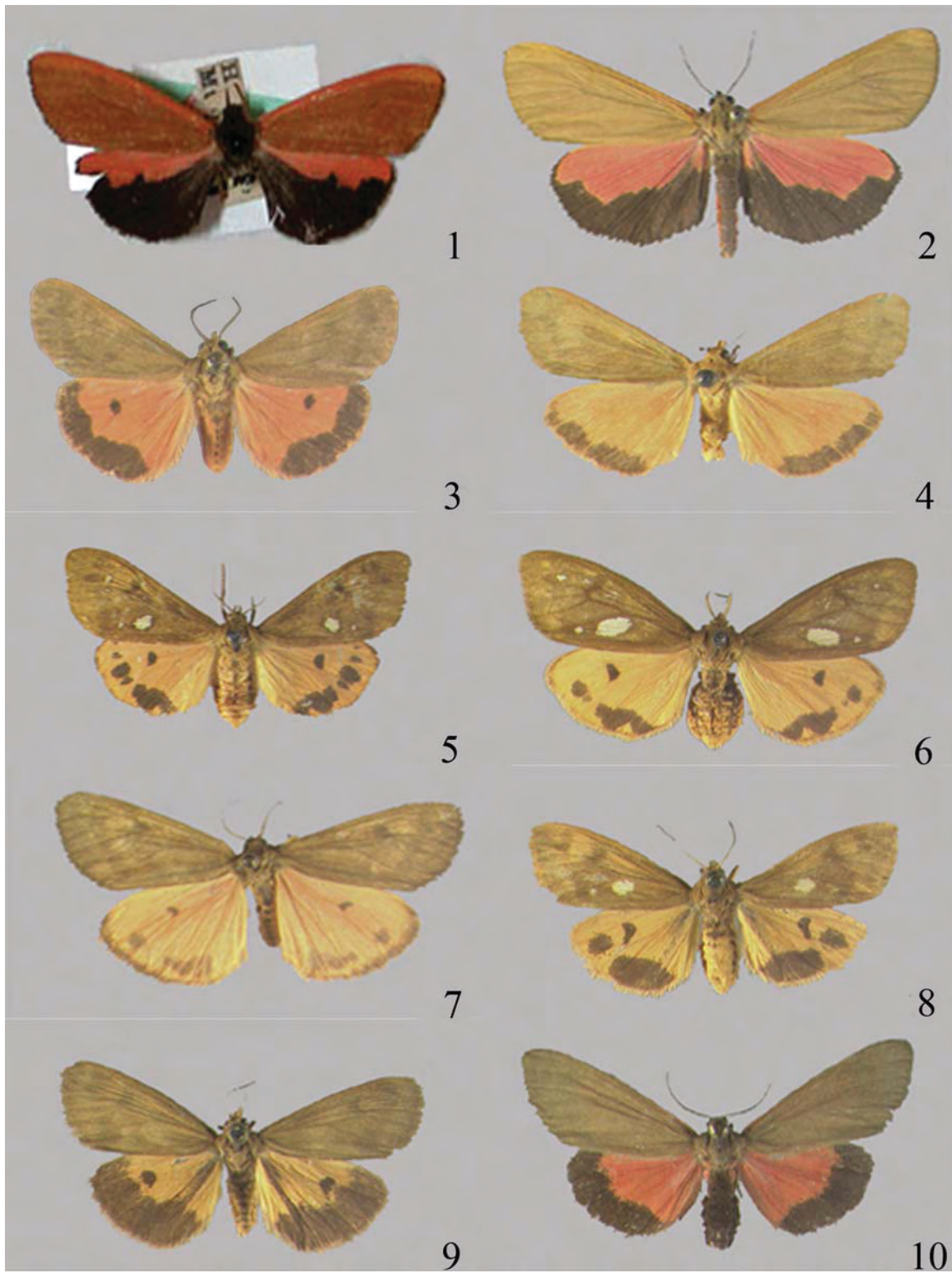


Plate 2: 1-10

1. Adult habitus: *Virbia costata* Stretch, Male: Otero Co. 11.v.1926, N. Mexico//Harold M. Bower Coll. Access'd C.A.C.M. 1964, FMNH.
2. Adult habitus: *Virbia immaculata* Reakirt, Female: Edgebrook Illinois, Bred 7.x.1947, A.K. Wyatt Coll.//CNHM 1957 Alex K. Wyatt Lepidoptera Colln., FMNH.
3. Adult habitus: *Virbia immaculata* Reakirt, Male: Edgebrook Illinois, Bred 7.x.1947, A.K. Wyatt Coll.//CNHM 1957 Alex K. Wyatt Lepidoptera Colln., FMNH.
4. Adult habitus: *Virbia rubicundaria* Hübner, Female: FLA., Highlands Co. Archbold Biol. Sta. 20.vi.1966, Ring T. Cardé, RTC.
5. Adult habitus: *Virbia rubicundaria* Hübner, Male: FLA., Highlands Co. Archbold Biol. Sta. 20.vi.1966, Ring T. Cardé, RTC.
6. Adult habitus: *Virbia fragilis* Strecker, Female: Spring Creek Camp 11 mi. NE Hill City Pennington County S.Dak., 1.viii.1955, F. and P. Rindge, AMNH.
7. Adult habitus: *Virbia fragilis* Strecker, Male: Custer Park Lawrence County, S. Dakota, 6500-6794 feet, 30.vii.1955, F. and P. Rindge, AMNH.
8. Adult habitus: *Virbia nigricans* Reakirt, Female: Hunterdon Co., New Jersey 11-16.v.1964, Joseph Muller//ex ovo, AMNH.
9. Adult habitus: *Virbia nigricans* Reakirt, Male: Frenchtown, New Jersey, Hunterdon Co. Rte.29/10 mi. N Rte. 519, 4.viii.1967, R. Cardé, RTC.
10. Figure 86. Adult habitus: *Virbia marginata* Druce, Female: 1 mile S. Sulfer Springs, Sandoval Co., New Mexico, 7800 ft., 31.vii.1961, F. and P. Rindge.//Collected on NSF grant G 9037, AMNH.

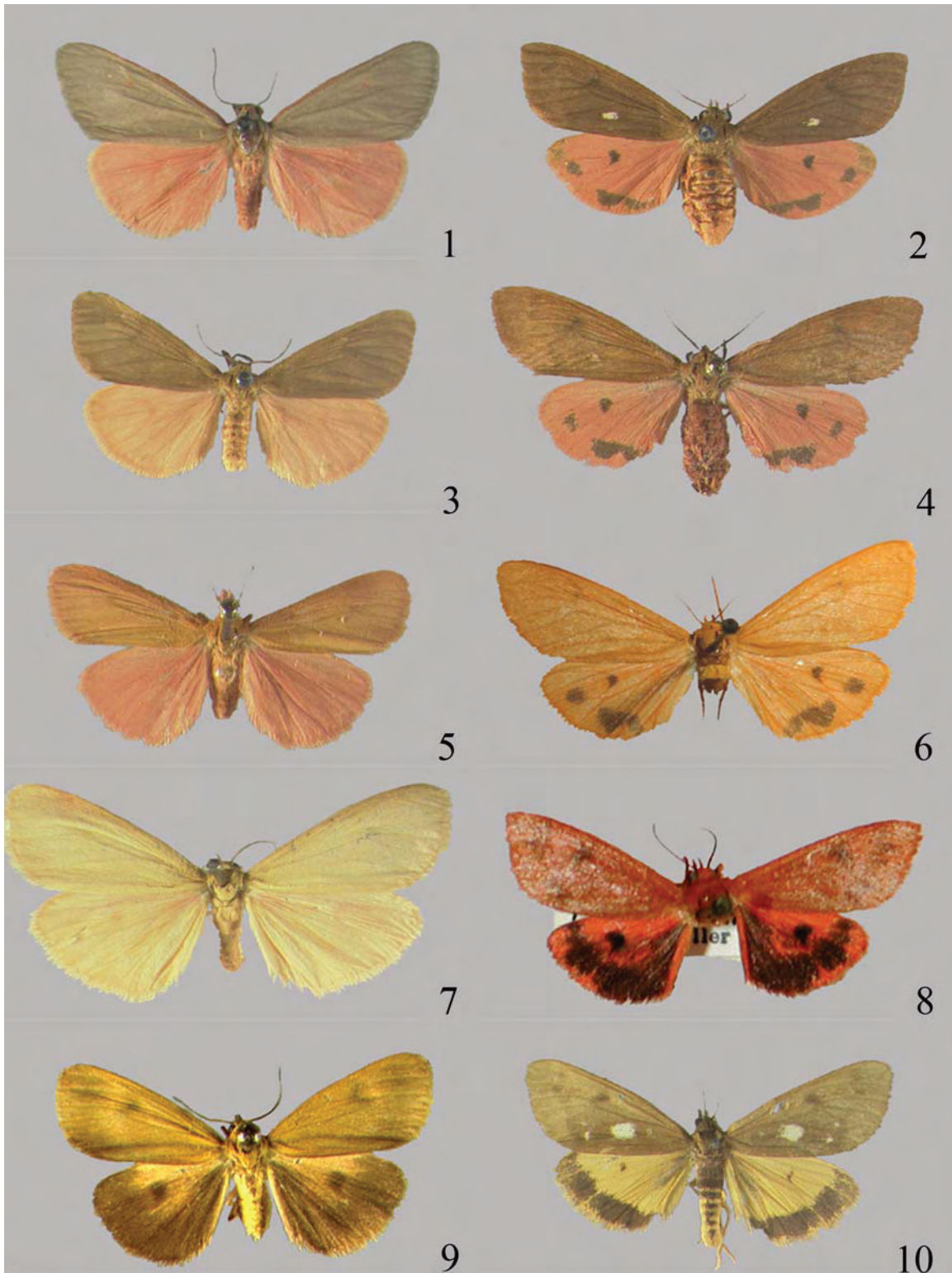


Plate 3: 1-9

1. Adult habitus: *Virbia marginata* Druce, Male: Guatemala City Guatemala//Schaus and Barnes coll//Dognin Collection//July//*Holomelina marginata*, USNM.
2. Adult habitus: *Virbia opella* Grote, Female: Magnolia Ill. ex ova ii.1951, A.K. Wyatt, USNM.
3. Adult habitus: *Virbia opella* Grote, Male: Magnolia Ill. ex ova 9.vii.1950, A.K. Wyatt//Otto Buchholz Collection, AMNH.
4. Adult habitus: *Virbia fergusonii* Zaspel, Female: FLA, Highlands Co., Highlands Hammock State Park, 12.vi.1987, T.L. Schiefer//*Holomelina* n. sp. det. D.C. Ferguson, MSU.
5. Adult habitus: *Virbia fergusonii* Zaspel, Male: GA: 7 mi. NE Fargo, Clinch Co., 13.vii.1981, D.C. Ferguson//Reared ex ovo on *Taraxacum*, USNM.
6. Adult habitus: *Virbia laeta* Guérin-Méneville, Female: Willard Missouri 19.vi., A.E. Brower//*Eubaphe laeta* Guérin-Méneville Treatii Grote, USNM.
7. Adult habitus: *Virbia laeta* Guérin-Méneville, Male: Marathon County Wisconsin, Township of Stettin 6.vii.1978, Russell A. Rahn, USNM.
8. Adult habitus: *Virbia rindgei* Cardé, Male: Custer Park South Dakota, Lawrence County, 1.vii.1962, F., P., & M. Rindge, AMNH.
9. Adult habitus: *Virbia rindgei* Cardé, Female: Spearfish Canyon, Black Hills South Dakota, 1.vii.1939, A.C. Frederick, USNM.



