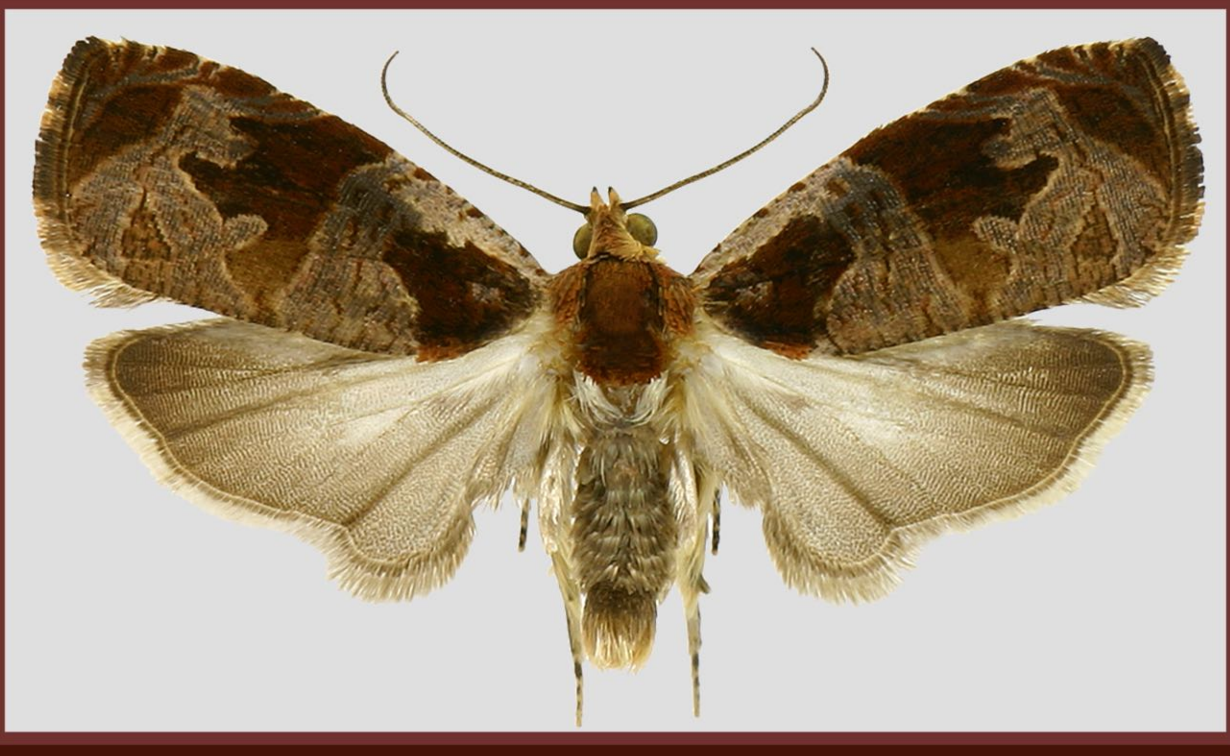
Olethreutine Moths
of the Midwestern United States

An Identification Guide

by

Todd M. Gilligan
Donald J. Wright
Loran D. Gibson



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An Identification Guide

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Todd M. Gilligan
2086 Canada Goose Drive
Loveland, Colorado 80537
tgilliga@gmail.com

Donald J. Wright
3349 Morrison Avenue
Cincinnati, Ohio 45220

Loran D. Gibson
2727 Running Creek Drive
Florence, Kentucky 41042

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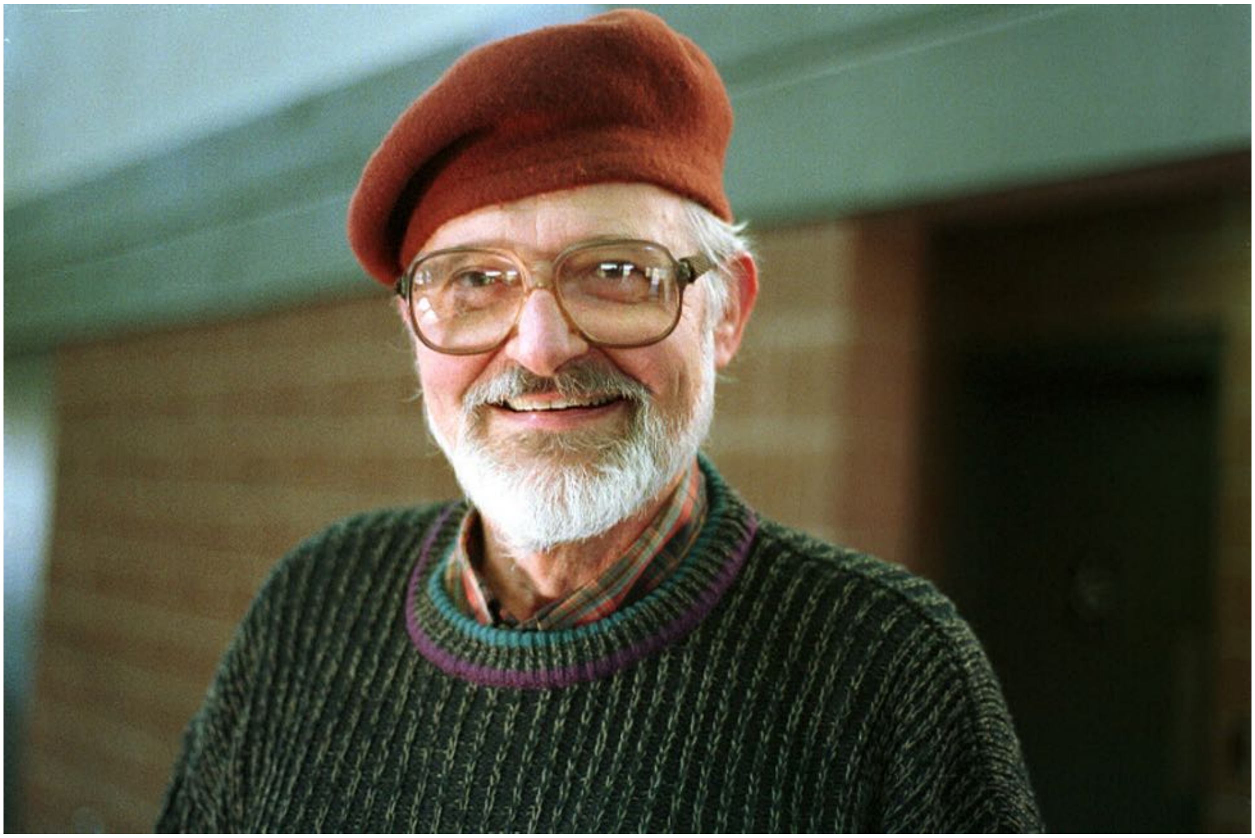
Front Cover: *Olethreutes footiana* (Fernald)

Abstract

The Olethreutinae comprise the second largest subfamily of Tortricidae, a worldwide family of "micro-moths" with larvae known for their leaf-rolling or stem- and root-boring habits. Host damage associated with such behaviors often has economic impact; consequently the best known olethreutines are those that are pests.

This volume is an identification guide to olethreutine moths that occur in the midwestern portion of the United States. It treats 306 species, which amounts to approximately one-third of the Nearctic fauna. Designed to be useful to both amateur lepidopterists and professional entomologists, it provides background information on the subfamily, key characters for genus- and species-level identification, life history summaries, more than 420 photographs of the adults, some 650 photographs of genitalic characters, and an introduction to the immature stages.

The book is divided into three parts. Part I presents an overview of the Olethreutinae followed by a collection of biographical sketches of individuals who have been influential in the development of Nearctic olethreutine taxonomy. It closes with a section on morphology that introduces the terms utilized in the species accounts and illustrates their application in a variety of situations. Part II presents the taxa, including a brief introduction to each genus and a detailed account of each species. The species accounts include: size, flight period, geographic distribution, biology, adult photos, genitalia photos, and notes on distinctive features. Part III is an overview of the immature stages. It features illustrations of olethreutine eggs, larvae, and pupae, a brief discussion of these stages, and basic information on rearing adults from eggs and larvae. A key to the larvae of some commonly encountered species and genera also is provided.



This book is dedicated to William E. Miller, an eminent tortricidologist with a generous nature and friendly spirit. His advice and encouragement inspired the authors' interest in the Olethreutinae and, in many subtle ways, informed and enabled the preparation of this volume.

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Acknowledgments

We are deeply indebted to many individuals for support and assistance, both in logistical matters involved in the creation of this volume and in fostering our interest in the Olethreutinae. Particularly influential have been John W. Brown, Richard L. Brown, William E. Miller, and Jerry A. Powell. Their contributions have ranged from assistance in specimen identification to technical advice on olethreutine morphology and systematics. Most importantly, they have provided the inspiration needed to take on a project such as this.

Our early interest in the Olethreutinae developed through our involvement in two regional organizations, The Society of Kentucky Lepidopterists and the Ohio Lepidopterists. We are very grateful for the many pleasant hours of fellowship in the field provided by past and present members of these groups, and we particularly appreciate our association with the two men whose leadership was fundamental to the development of these organizations, Charles V. Covell Jr. and Eric H. Metzler.

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The first author thanks Michael Gilligan for the myriad forms of support that only a father would supply. Finally, we thank our wives, Ella, Carol, and Pat, whose lives have been more than a little impacted by this project. It has been a long haul, and they bore the highs and lows with unusual grace and patience.

Todd M. Gilligan
Donald J. Wright
Loran D. Gibson

Introduction

The Olethreutinae is the second largest subfamily in the Tortricidae. It includes about 4300 species worldwide, of which approximately 900 occur in the Nearctic region. The larvae feed on the foliage, shoots, stems, roots, seeds, or fruits of various trees, shrubs, and herbaceous plants. Many of the hosts are grown commercially for fruit, timber, and/or landscaping, and often the associated olethreutines are considered pests.

This book is an identification guide to the olethreutines that are resident in the midwestern portion of the United States. It treats 306 species, roughly one-third of the North American fauna, and is intended to be used by amateur collectors and professional entomologists. Since many species can be recognized on the basis of forewing color and maculation, color images are provided of the adults. Nevertheless, examination of the genitalia often is required for a confident determination, so photographs are included of key male and female genitalia characters.

The area covered consists of a large portion of the 12-state region known as the Midwest together with the state of Kentucky (Fig. 1). The central portion of this territory was once rolling grassland and mixed deciduous forest. In Ohio, Indiana, Illinois, Iowa, northern Missouri and western Minnesota one still finds remnants of a former extensive tall-grass prairie ecosystem. The western states, Kansas, Nebraska, South Dakota and North Dakota, extend into the arid Great Plains, where the lush grasslands of the central states mix with the short-grass prairie of the eastern slope of the Rocky Mountains. To the north, Minnesota, Wisconsin and Michigan form the western part of a transition zone between the deciduous woodlands of eastern North America and the boreal forests of Canada. Southern Missouri features the dry oak-hickory habitat of the Ozark Highlands, and eastern Kentucky provides contact with the rich deciduous forest of the southern Appalachian Mountains. Needless to say, each of these ecosystems hosts its own characteristic mix of olethreutines.

Figure 1: Map of the continental United States, with covered region shaded.

We do not claim to do justice to all of these diverse ecosystems. Our coverage is biased toward the central and eastern portions of the region represented by the shaded area in Figure 1, where most of our fieldwork has been conducted. We omit a number of conifer-feeding species that are primarily associated with the boreal forest but which are encountered in the northern reaches of the Midwest. Our experience with the fauna of southern Missouri is limited, so there no doubt are olethreutines found in the Ozarks that are not included in these pages. Finally, there are many western species whose ranges extend eastward into portions of Kansas, Nebraska and the Dakotas. These insects, which are largely associated with the short- and mixed grass prairie ecosystems, present numerous unresolved taxonomic difficulties; we include only those that are relatively common and easy to identify.

Materials and Methods

Nomenclature

The olethreutine taxonomy in this volume follows Brown (2005) and Horak (2006). No taxonomic changes are proposed, and no new taxa are described.

The systematic arrangement differs from the most recently published North American checklist (Powell, 1983) in several respects. At the tribal level, the species covered here are now divided into the Bactrini, Olethreutini, Eucosmini, Enarmoniini, and Grapholitini. Bactrini contains the genera *Bactra* and *Endothenia*, which previously were placed in Olethreutini; Enarmoniini holds *Ancylis* and *Hystrichophora*, formerly in Eucosmini, as well as *Eucosmomorpha*; and Grapholitini replaces Lasperyresiini. The genera *Endopiza* and *Petrova* have changed to *Paralobesia* and *Retinia*, respectively, and *Catastega* has been resurrected from synonymy with *Epinotia*. Generic assignments have been revised for a few species: *Endothenia impudens* to *Hulda*, *Endothenia albolineana* to *Taniva*, *Olethreutes cespitana* to *Celypha*, *Olethreutes agilana* to *Pristerognatha*, *Hedya separatana* to *Metendothenia*, *Melissopus latiferreana* to *Cydia*, and *Ecdytolopha punctidiscanum* to *Gymnandrosoma*. *Endothenia nubilana*, *Olethreutes ferrolineana*, *Retinia virginiana*, *Rhopobota naevana* and *Epinotia celtisana* have been reinstated as valid species names. *Eucosma grotiana* is now a synonym of *Eucosma matutina*, Nearctic specimens formerly interpreted as *Notocelia trimaculana* are now recognized as *Notocelia rosaecolana*, and *Grapholita delineana* has been added to the North American checklist. Finally, our treatment includes fifteen species that have been described since the publication of the checklist.

In the Species Accounts section, the arrangement of species within genera is largely in agreement with the 1983 checklist, though some changes were made to satisfy space and formatting restrictions and to group similar looking species for ease of comparison.

Plant nomenclature follows the current scientific and common names in the USDA PLANTS Database (plants.usda.gov).

Material examined

The majority of specimens we examined are from the following institutional or private collections:

AMNH - American Museum of Natural History, New York, NY
BMNH - The Natural History Museum, London, United Kingdom
CNC - Canadian National Collection, Ottawa, Ontario, Canada
ILNHS - Illinois Natural History Survey, Champaign, IL
MEM - Mississippi Entomological Museum, Mississippi State, MS
MCZ - Museum of Comparative Zoology, Harvard University, Cambridge, MA
USNM - National Museum of Natural History, Smithsonian Institution, Washington, D. C.
GJB - G. J. Balogh, Portage, MI
LDG - L. D. Gibson, Florence, KY
TMG - T. M. Gilligan, Loveland, CO
RP - Ron Panzer, Oak Forest, IL
JTV - J. T. Vargo, Mishawaka, IN
DJW - D. J. Wright, Cincinnati, OH

Species distribution data were gathered from pin labels, literature records, and, in a few cases, unpublished inventories. We did not attempt to verify species determinations reported in the literature, but we did exercise discretion regarding historical reports we considered to be of questionable accuracy.

Information on the biology of individual species is scattered through the literature in journal articles, faunal studies, systematic treatments, and published larval host lists. We relied most heavily on Heinrich (1923, 1926), MacKay (1959), Prentice (1966), Ferguson (1975), Brown et al. (1983), Miller (1987), and Robinson et al. (2002). A few previously unpublished host plant associations are reported based on the authors' collecting experiences and specimen label information.

Label data associated with illustrated specimens can be found on the following web page: http://www.tortricid.net/olethreutinebook.asp.

Techniques

Techniques for the collection, preparation, and storage of adult specimens as well as the dissection and slide mounting of genitalia have become more or less standardized and are well described in the literature. Several frequently cited sources are listed below.

Adult photographs were taken using a Canon digital SLR camera (EOS-D60 or Digital Rebel), with specimens illuminated in an Aristo Lighting Technologies DA10 light box. Genitalia photographs were taken with a Nikon DXM1200 Digital Eclipse microscope camera on one of several Nikon compound microscopes. Close-up macro-photographs were taken using a DXM1200 camera on either a Wild M5A or Nikon SMZ1500 stereo microscope.

All images were edited in Adobe Photoshop CS v.8.0. In some instances the image is a composite of several layers integrated with CombineZ v.5.3 (Alan Hadley, www.hadleyweb.pwp.blueyonder.co.uk). Illustrations were produced in Adobe Illustrator CS v.11.0. Book design and layout were accomplished using Adobe InDesign CS v.3.0.

Technique references:

Clarke, J. F. G. 1941. The preparation of slides of the genitalia of Lepidoptera. Bulletin of the Brooklyn Entomological Society, 36:149-161.

Covell, C. V. 2005. A field guide to moths of eastern North America. Virginia Museum of Natural History, Publication No. 12. 496 pp.

Landry, J.-F., & Landry, B. 1994. A technique for setting and mounting Microlepidoptera. Journal of the Lepidopterists' Society, 48:205-227.

Robinson, G. S. 1976. The preparation of slides of Lepidoptera genitalia with special reference to the Microlepidoptera. Entomologist's Gazette. 27:127-132.

Winter, W. D. 2000. Basic techniques for observing and studying moths and butterflies. Memoirs of the Lepidopterists' Society, No. 5:1-444.

Part I:

The Olethreutinae

Overview

Tortricoidea is one of the principal superfamilies of microlepidoptera, surpassed only by Gelechioidea in number of described species. It consists of a single family, Tortricidae, which is divided (Horak, 1998) into the subfamilies Olethreutinae, Tortricinae, and Chlidanotinae. Of the three, Olethreutinae is the second largest, numbering some 4300 recognized species worldwide (Horak, 2006). It is represented in North America by approximately 900 species in 60 genera (Powell, 1983; Brown, 2005).

Family characters defining tortricid moths include: head rough-scaled above; scaling of lower frons short, appressed and upwardly directed; proboscis well developed and unscaled; labial palpi three-segmented and generally held horizontally or porrect, with apical segment short and blunt; maxillary palpi reduced; ocelli and chaetosema present; ovipositor lobes flat (Horak, 2006). Olethreutinae are distinguished by the presence of a single row of scales on each antennal segment (versus two in rest of the family) and by the fusion in the male genitalia of the juxta and caulis. The latter two characters are the principal evidence for the monophyly of the lineage (Horak, 2006).

The history of North American olethreutine systematics is probably best summarized by the four major checklists published in the 20th century: Fernald (1903), Barnes and McDunnough (1917), McDunnough (1939) and Powell (1983). Recent concepts regarding generic and species boundaries were compiled by Brown (2005) in Volume 5 of World Catalogue of Insects, the first worldwide checklist of Tortricidae. Over the years there have been some excellent publications illustrating the olethreutine faunas of various regions of the world, such as: “British Tortricoid Moths, Tortricidae: Olethreutinae,” by Bradley, Tremewan and Smith (1979), “Tortricidae of Europe,” by Razowski (2003, 2004) and “Olethreutine Moths of Australia,” by Horak (2006). The last includes the most up-to-date phylogenetic, taxonomic, and morphological information on the subfamily and sets the standard for future systematic work on this group. There are no truly comparable treatments of the Nearctic fauna. The monographs by Heinrich (1923, 1926), though badly dated at this point, constitute the only comprehensive revision of the subfamily. They lack illustrations of the adults, and only the second volume includes analysis of the female genitalia. Miller’s (1987) guide to the olethreutines of Minnesota, Wisconsin and Michigan is the only source of adult illustrations for a substantial portion of Nearctic olethreutines.

Olethreutine moths are commonly referred to as leaf-rollers or leaf-tiers because the larvae often web together leaves of the host. Yet, fully a third of the North American species are known or inferred to be borers in roots or stems of woody annuals or perennials, and others feed in the buds, twigs, seeds, or fruiting bodies of their hosts. Such life styles have resulted in the classification of a rather large number of these insects as pest species. Probably the best known example is the codling moth (*Cydia pomonella*), an insect recognized around the world as responsible for the “worm” holes in apples. Other extensively studied orchard pests include the grape berry moth (*Paralobesia viteana*), oriental fruit moth (*Grapholita molesta*), cherry fruit worm (*Grapholita packardi*), and lesser apple worm (*Grapholita prunivora*). Commercial nut growers contend with the filbertworm (*Cydia latiferreana*), pecan bud moth (*Gretchena bolliana*), and hickory shuckworm (*Cydia caryana*), which attack buds and developing fruits. Larvae of many species bore in newly developing twigs or attack freshly emerging spring buds, causing stunted growth and deformity of the host. Notorious examples include the spruce bud moth (*Zeiraphera canadensis*), European pine shoot moth (*Rhyacionia buoliana*), locust twig borer (*Ecdytolopha insiticiana*), boxelder twig borer (*Gypsonoma willingana*), and eye spotted bud worm (*Spilonota ocellana*).

Many of the economically important olethreutines were introduced to North America, and despite continuous vigilance by the U. S. Department of Agriculture, inadvertent immigrants continue to be discovered on this continent. In a world of global trade and travel, the risk of accidentally importing a taxon like the false codling moth (*Thaumatotibia leucotreta*), a widespread Old World citrus pest (Brown, 2006), is uncomfortably high. Such concerns have driven more than a century of research into control and elimination protocols, and they continue to justify the annual expenditure of large sums of tax dollars to intercept and identify potential invaders.

Historical Perspectives*

The study of Nearctic Olethreutinae dates from approximately the middle of the 19th century. New World "microlepidopterists" of that era tended to be professional men with avocational interest in natural history but little training in taxonomy. Gradually they were influenced, through correspondence with Old World experts, by systematic concepts that had been developing in Europe for nearly a hundred years. The lepidopteran "systems" of the late 1800's were largely based on conspicuous morphological features such as the color, shape, and venation of the wings, but the turn of the 20th century brought recognition of the taxonomic importance of the reproductive organs, and soon thereafter structural characters of the genitalia acquired a dominant role in generic and higher level classification. In the Olethreutinae, this transition was marked by the appearance in 1922 of Pierce and Metcalfe's "The Genitalia of the Group Tortricidae of the Lepidoptera of the British Islands."

Early students of the North American fauna were interested primarily in the description of new species. Most influential among the contributors were Clemens, Zeller, Fernald, Walsingham, and Kearfott.

James Brackenridge Clemens (1829 - 1867) was the first North American to be viewed as a specialist in the microlepidoptera. Born in Wheeling, West Virginia, he was educated at the University of Pennsylvania, where he earned a degree from the Medical Department in 1849. Rather than pursue the practice of medicine, he settled in Easton, Pennsylvania, and devoted his life to the study of natural history. He is credited with having described several hundred taxa. Many of those names, particularly at the generic level, have since been relegated to synonymy, but the most recent North American check list (Powell, 1983) includes approximately 40 valid olethreutine names of his authorship. Upon his death from typhoid fever, his wife presented his collection to the American Entomological Society, and today it resides at the Academy of Natural Sciences, Philadelphia. The fixation of types for Clemens' olethreutine species was undertaken by Darlington (1947) and Miller (1973).

Philipp Christoph Zeller (1808 - 1883) was an eminent European microlepidopterist of the mid-nineteenth century. In his later years, correspondents in various parts of the world referred specimens to him for determination or description. Most significant, as far as the North American fauna is concerned, were shipments from Louis Agassiz of specimens accumulated through his efforts to develop the collections at the Museum of Comparative Zoology, Harvard University. In a series of articles in the 1870's, Zeller published descriptions of many North American species. Thirty-four of his Nearctic olethreutine names are still in use today. Some of the syntypes for his species were returned to the Museum of Comparative Zoology, while others were retained in his private collection. These specimens can usually be recognized by handwritten, green, determination labels, but he was not completely consistent in that practice. After his death, Zeller's private collection was purchased by Walsingham, and it now resides in The Natural History Museum, London.

Charles Henry Fernald (1838 - 1921) was born at Fernald's Point, Mount Desert Island, Maine. In his youth he aspired to be a ship captain and spent the summers of his adolescent years at sea. As a young man, during the Civil War, he served three years in the Navy, mostly on blockade duty. Much of his education was acquired by what we today would call "independent study." He earned a MA degree from Bowdoin College and later was awarded a Ph.D. from Maine State College (now the University of Maine). Early in his career he taught natural sciences at Maine State College (1871-1886). In 1886 Fernald accepted a Professorship in Zoology at Massachusetts Agricultural College (now the University of Massachusetts), where he remained until retirement in 1910. There he developed a program in applied entomology, directing one of the first fights against the gypsy moth (discovered in Massachusetts in 1889). He acquired a national reputation as an admired teacher and mentor in this newly evolving field. Fernald was much concerned with nomenclatorial problems, and his major contributions to olethreutine systematics include two

* The biographical information presented here was summarized from various obituary notices, tributes, and personal documents. The primary sources were: Anonymous (1918), Braun (1921), Burgess (1921), Busck (1920), Ferguson (1963), Gibson (1919), Diakonoff (1966), Durrant (1920), Skinner (1914), Stainton (1883), and Wade (1955).

synonymic lists of the North American fauna (1882, 1903) and a self-published treatise on the genera of Tortricidae (1908). He described some 30 species of Olethreutinae, and 25 of those names are still in use. Today his private collection resides in the National Museum of Natural History, where his specimens can be recognized by yellow pin labels with the inscription "Fernald Collection." Miller (1970) studied the Fernald olethreutine syntypes and, where necessary, designated lectotypes.

Thomas de Grey, 6th Baron Walsingham (1843 - 1919) was the quintessential, Victorian, nobleman, naturalist. An ardent collector and expert authority on microlepidoptera, he amassed an enormous collection of moths from around the world, and described hundreds of new species from Europe, Africa, Asia, North America, and South America. Curiosity about the Nearctic fauna prompted him to undertake a collecting expedition in 1871-72 to northern California and Oregon, which was wild and hazardous country at the time. A chronicle of that trip, published by Essig (1941), makes for very interesting reading. In 1879 he published descriptions of the North American tortricid "types" then held by the British Museum, which had been augmented substantially by his collections from the California expedition. Today, seventy species described in that classic work remain as valid names. In the last quarter of the 19th century Walsingham was the accepted authority on North American Tortricidae, with collectors such as Fernald, Riley, Morrison, and Smith sending specimens to him for identification and description. He maintained correspondence with Fernald, whose opinions about generic classification influenced his treatment of the New World taxa, and he gave Fernald exemplars of many of his species. These specimens, which can be found in the National Museum of Natural History, are characterized by white, red-bordered, hand-written, determination labels. The Walsingham collections, containing some 50,000 microlepidopteran specimens, were gifted to the British Museum in 1910, but he continued to be involved with the museum and its collections until his death.

William Dunham Kearfott (1864 - 1917) was born in Berkeley County, West Virginia and settled in Montclair, New Jersey, where he earned his living as a mechanical engineer. An astute and enthusiastic collector, he maintained a large correspondence with other North American collectors and lepidopterists, notably Thomas U. Spalding in Utah and Annette F. Braun in Cincinnati, Ohio. He is perhaps best known for his 1907 paper in the Transactions of the American Entomological Society in which he described 159 new species of Tortricidae. To accommodate the need for so many new names, he devised an unusual method of constructing specific epithets which involved choosing an appropriate ending, such as "ana", and attaching prefixes generated by the successive letters of the alphabet, e.g., *bobana*, *cocana*, *dodana*, *fofana*, etc. These so called "nonsense names" were so offensive to Edward Meyrick (1912), who considered them "based on barbarous and unmeaning gibberish", that he went to the considerable trouble of proposing alternatives. Despite Meyrick's concerns, Kearfott's names are accepted as valid, and Meyrick's substitutes are nothing more than synonyms. Late in life Kearfott was forced to give up his study of microlepidoptera due to failing eyesight, and his collection was sold, mostly to the American Museum of Natural History and to Dr. William Barnes of Decatur, Illinois. The Barnes collection, which was rich in North American type material, eventually was acquired by the National Museum of Natural History. Syntypes of Kearfott's species generally are identified by red pin labels with the printed inscription "TYPE Collection of W. D. Kearfott," but there are enough examples of errors or omissions in this labeling that caution is advised in the interpretation of those specimens. In a 1942 catalogue of the microlepidopteran type material in the American Museum of Natural History, Klots cited lectotype designations, attributed to Heinrich, for many of Kearfott's species, but most of those designations are considered unsatisfactory since Heinrich's comments frequently were not sufficiently detailed to specify a particular specimen.

The second phase of North American olethreutine systematics, beginning in the early 1920's, was characterized by the work of Heinrich, McDunnough, and Obraztsov.

Wilhelm Carl Paul Gottlieb Heinrich (1880 - 1955) was born in Newark, New York, and educated at the University of Chicago, where he majored in Greek and Greek drama. He moved to Washington, D. C., in 1902 and passed the next several years working for various commercial establishments. In 1908 he went to New York with the intention of studying music composition under Edward McDowell, but McDowell died shortly thereafter, and Heinrich returned to Washington. He began employment with the U. S. Department of Agriculture in 1913. His 36 years of service with the USDA were based at the National Museum of Natural History, where he developed an international reputation as an expert on Tortricidae and Phycitinae. His revisions of Nearctic Eucosmini (1923) and Olethreutini and Grapholitini (1926) were the first publications to illustrate the genitalia of the North American species (males in Eucosmini; both males and females in Olethreutini and Grapholitini). These studies were based largely on material from the collections of

Kearfott and Barnes. Heinrich was unable to examine the Walsingham types, and as a consequence he made a number of errors in his interpretations of those species. Nevertheless, Heinrich's monographs remain the primary systematic references for the Nearctic fauna. The current North American check list contains 163 of Heinrich's olethreutine names. In addition to his entomological achievements, Heinrich was an accomplished musician and a published author of poetry, fiction, and many newspaper articles on topics of public interest.

James Halliday McDunnough (1877 - 1962) was born in Toronto, Ontario and educated at Jarvis Street Collegiate. He trained in Berlin, Germany, for a career as a professional violinist, but after a season with the Symphony Orchestra of Glasgow, Scotland, he returned to Berlin to study zoology at the Kaiser Wilhelm Institute, earning a Ph.D. in 1909. Back in North America in 1910, he took employment as the first curator of the private collection of Dr. William Barnes. His collaboration with Barnes resulted in numerous publications on the moths of North America, including a beautifully illustrated monograph on the genus *Catocala*, published by the American Museum of Natural History, and a five-volume series entitled "Contributions to the Natural History of the Lepidoptera of North America," published by The Review Press, Decatur, Illinois. In 1919 he was appointed chief of the Division of Systematic Entomology at the Canadian National Collection in Ottawa, Canada, and during his 28 years of leadership it developed into one of the premier insect collections in North America. Upon retirement in 1946, he moved to New York City as Research Associate of the American Museum of Natural History, but the death of his wife in 1950 prompted him to return to Canada. He spent his last twelve years in Halifax, Nova Scotia, where the Nova Scotia Museum of Science provided him with facilities for his continuing studies. McDunnough authored some 89 currently valid names of North American Olethreutinae, based largely on faunal studies conducted by himself and other field workers in the Canadian provinces. Most of the associated type material is deposited in the Canadian National Collection in Ottawa.

Nikolaï Sergeevich Obraztsov (1906 - 1966) was born in Rostov, in southern Russia. He was educated in the natural sciences at the Institute for Pedagogy in Nikolaev, and from 1934 to 1940 served in various capacities at the University of Kiev, including curator of Lepidoptera at the Zoological Museum. Deported to Germany in 1940 by the German army, he served from 1944 to 1946 as lepidopterist at the Zoological Institute at the University of Königsberg. He took postwar employment at the Zoologische Sammlung des Bayerischen Staates at Munich and earned a Ph.D. from the University of Munich in 1951. In that same year he and his family relocated again, this time to the United States, settling in Sea Cliff, New York. Supported by NSF research grants, he continued his lifelong studies of tortricid systematics as Research Associate of both the American Museum of Natural History and of the National Museum of Natural History. His most significant scientific contribution was "Die Gattungen der Palaearktischen Tortricidae," published in parts in Tijdschrift voor Entomologie from 1954 to 1968, the latter issues appearing posthumously. At the time of his death Obraztsov was working on a revision of the North American Olethreutinae, having visited European collections to examine, dissect, and photograph the type material contained therein. This project never came to fruition, and the specimens he selected for lectotypes were never formally designated in print. Nevertheless, his notes, drawings, and photographs were preserved at the American Museum of Natural History and are currently on long-term loan to the Mississippi Entomological Museum at Mississippi State University. Those materials are the best source of information this side of the Atlantic on the olethreutine types of Walsingham and Zeller.

The widespread use of cladistic methods and molecular data in the second half of the Twentieth Century revolutionized the field of systematics. Nevertheless, phylogenetic relationships within the Nearctic Olethreutinae are poorly understood, and a complete phylogeny for the group has never been proposed. There have been, however, a number of relatively recent revisionary works at the generic level: Adamski and J. W. Brown, 2001 (*Ecdytolopha*, *Gymnandrosoma*, and *Pseudogalleria*); Adamski and Peters, 1986 (*Apotomis*); R. L. Brown, 1980 (*Epinotia*, in part), 1986, 1992 (*Epinotia*, in part, and *Catastega*); Miller, 1978 (*Retinia*, in part), 1986 (*Pseudexentera*); Mutuura and Freeman, 1966 (*Zeiraphera*); Powell, 1964 (*Griselda* and *Chimoptesis*), 1968 (*Eucosma*, in part, the conifer cone feeding species); and Powell and Miller, 1978 (*Rhyacionia*).

From the point of view of stimulating interest in Nearctic Olethreutinae, the most significant event in recent years was the publication in 1987 of William E. Miller's "Guide to the Olethreutine Moths of Midland North America," the first regional subfamily treatment to include photographs of the adults. Miller received his training at Louisiana State University (B.S., zoology, 1950), The Ohio State University (M.S., entomology, 1951; Ph.D., entomology, 1955) and Michigan State University (M.S., forestry, 1961). He worked as scientist and project leader for the U. S. Forest Service from 1956 to 1981 and has been Adjunct Professor of Entomology at the University of Minnesota from 1976 to the present. For twenty years his “Guide” has been the primary reference for collectors and professional entomologists needing to identify olethreutines from eastern North America. It summarizes some twenty-five years of work in analyzing types, clarifying species concepts and describing new taxa. Miller has authored some 28 currently valid names of North American Olethreutinae.

Morphology

This section presents the nomenclature utilized in the species accounts. Terminology follows Horak (1984, 2006), Kristensen (2003), and Scoble (1992). Our emphasis is on those aspects of olethreutine morphology that are most useful in the identification of specimens to subfamily, genus and species.

Head

The tortricid head is described as rough scaled due to the long, anteriorly directed scales on the **vertex** and upper frons. Scaling of the lower frons is short, closely appressed, and upwardly directed. The proboscis is well developed and unscaled. The three-segmented **labial palpi** are usually held horizontally or porrect (Fig. 2e). In some cases they are upcurved, but the apical segment is porrect, short, and blunt (Fig. 2g). Maxillary palpi, though present, are greatly reduced and visible only under high magnification. Dorsally adjacent to the compound eye is a well developed ocellus and a patch of bristlelike setae called **chaetosema** (Figs. 2e, f). The antenna is scaled dorsally and usually has one or more rows of **sensilla** on the ventral surface. Olethreutines have a single ring of scales on each antennal segment (Figs. 2c, d), tortricines have two rings per segment (Figs. 2a, b). The basal segment of an insect antenna is called the **scape**, and the shaft is called the **flagellum**.

Wings

Though variable in shape, the olethreutine forewing is usually semirectangular, narrowing towards the base, with length-to-width ratio between 2 and 3.5. The terminology associated with its margins: **costa**, **apex**, **termen**, **tornus** and **dorsum**, is explained in

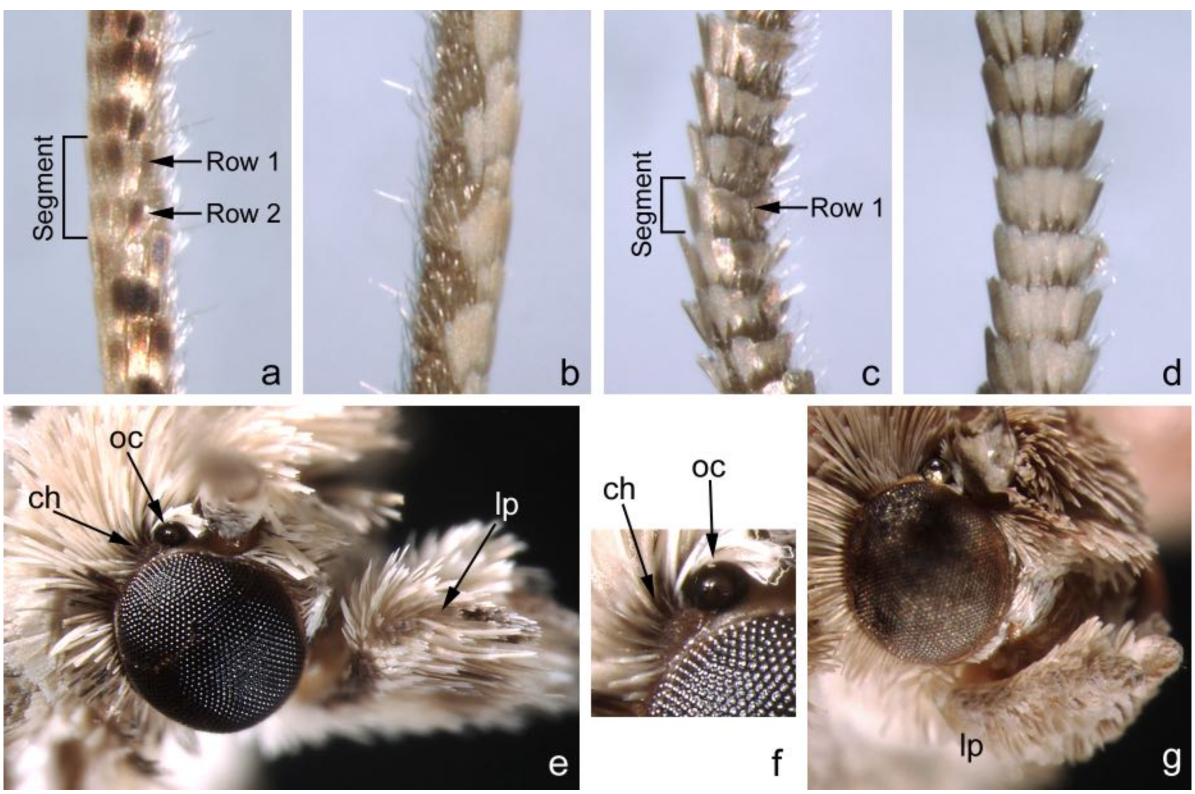

Figure 2: Details of head structures; **a, b:** antenna of Tortricinae with two rows of scales per segment; **c, d:** antenna of Olethreutinae with one row of scales per segment; **e:** head of *Bactra verutana* (ch, chaetosema; oc, ocellus; lp, labial palpus); **f:** details of chaetosema (ch) and ocellus (oc); **g:** head of *Cydia latiferreana* (lp, labial palpus).

Figure 3. In some males the basal portion of the costa has a narrow, closely appressed, dorsal flap called the **costal fold**. The hindwing is nearly as broad as and somewhat shorter than the forewing. It couples with the latter via the engagement of a frenulum at the base of the costa with a retinaculum on the ventral surface of the forewing. Specimens can be sexed by the structure of the frenulum (Figs. 4a, b): a single stout bristle in males, two or three finer bristles in females. Most olethreutines have a row of fine, hairlike scales called a **cubital pecten** on the hindwing at or just below the base of CuA (Fig. 5).

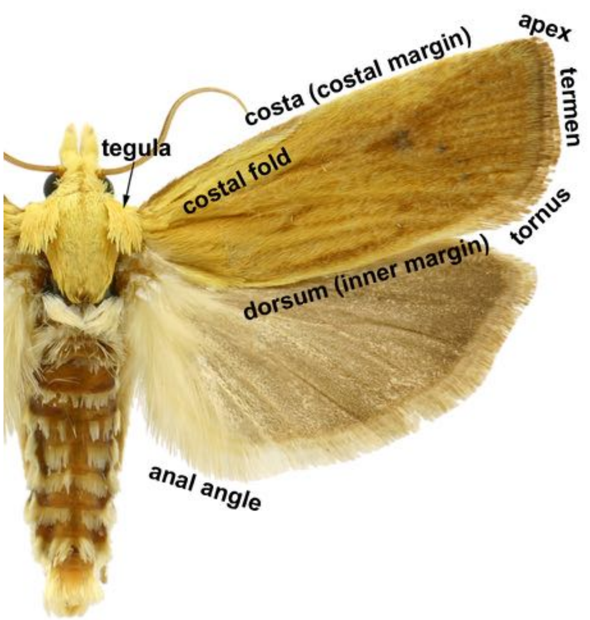

Figure 3: Terms used to describe wing margins and features.

Wing venation has long been considered an informative taxonomic character, with stalking, fusing, and/or absence of various veins contributing to the definitions of tribes and genera. It is now recognized that these features are not as stable as once supposed (even at the species level), but they still play an important role in classification. The ancestral olethreutine forewing venation, along with a generally accepted labeling scheme (Horak, 2006), is illustrated in Figure 6. It consists of a subcostal vein (**Sc**), a radial vein (the **radius**) with branches **R1** – **R5**, median branches **M1** – **M3** arising at about two thirds wing length and extending to the termen, a second radial vein (the **cubitus**) with two branches referred to as cubitus anterior 1 and 2 (**CuA1** and **CuA2**), a weakly developed cubitus posterior (**CuP**), which usually is present only at the tornal margin, and two anal veins with distal portions fused (**A1+A2**). The radius and cubitus, together with cross venation at the bases of the M-branches, enclose the **discal cell**. The latter is subdivided longitudinally by the M-stem (Ms) and the chorda (ch). In the hindwing the branching of the radius is reduced: Sc is fused with R1 (**Sc+R1**), and a single branch, the radial sector (**Rs**), runs to the apex. A third anal vein (**A3**) may be present or absent.

The terminology utilized here to describe forewing maculation is based on the system proposed by Brown and Powell (1991), and modified by Baixeras (2002), regarding the ancestral tortricid forewing pattern. This pattern consists of a series of relatively dark transverse bands, called **fasciae**, that extend from costa to dorsum and alternate with lighter **interfascial areas**. At the costa, the fasciae are flanked by small, pale, semirectangular marks called **strigulae**. The strigulae tend to occur in pairs, but frequently two coalesce into a solid mark. Often a thin line or band of metallic scaling, called a **stria**, emanates from

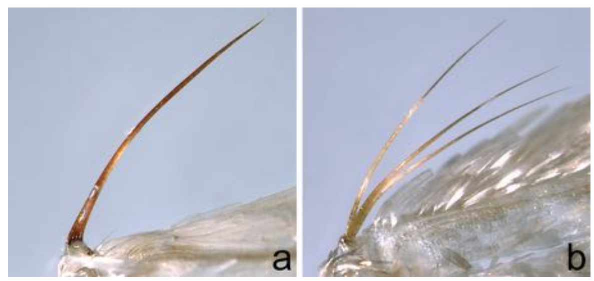

Figure 4: Frenulum details; **a:** single frenulum bristle in male; **b:** three frenulum bristles in female.

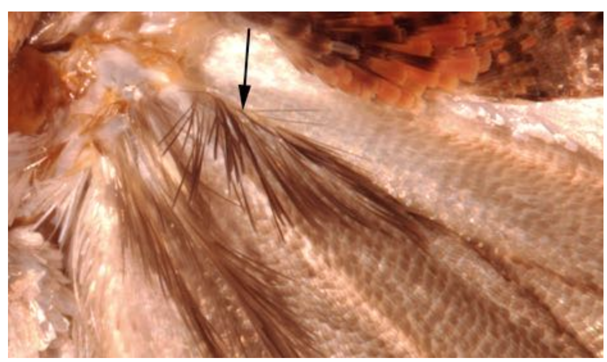

Figure 5: Hindwing cubital pecten.

between the paired strigulae and runs posteriorly or distally toward the dorsum or termen. Baixeras (2002) interpreted the ancestral arrangement as consisting of nine pairs of costal strigulae, with five associated fasciae termed **basal**, **subbasal**, **median**, **postmedian**, and **preterminal**. Figure 6 illustrates the pattern, with the pairs of strigulae numbered from base to apex and the stylized fasciae positioned appropriately relative to the strigulae. The strigulae are vein dependent: pairs 1-4

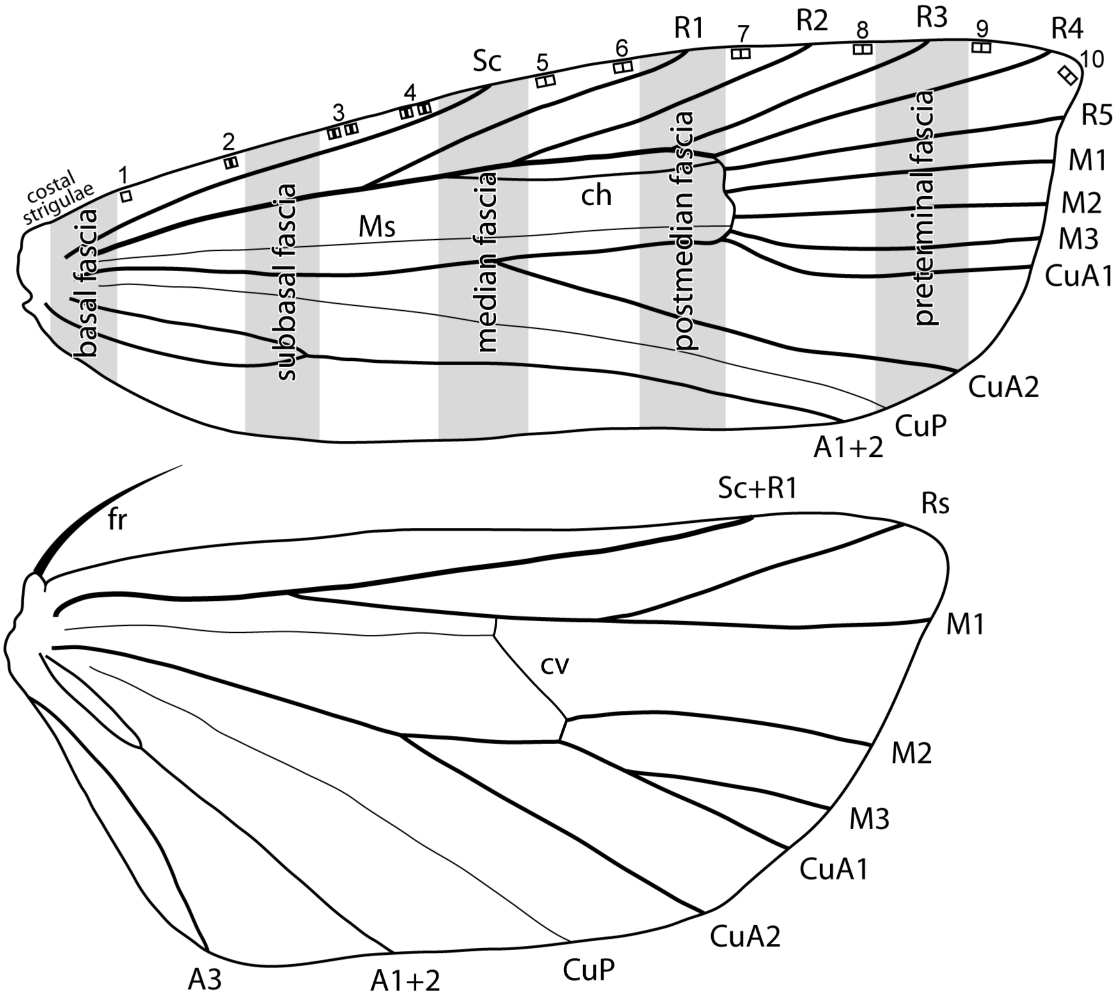

Figure 6: Wing pattern and venation of a generalized olethreutine (ch, chorda; cv, closing vein; fr, frenulum; Ms, M-stem). Costal strigulae and fasciae marked in approximate locations relative to each other and to veins.

precede Sc, 5 and 6 fall between Sc and R1, 7 between R1 and R2, 8 between R2 and R3, and 9 between R3 and R4.

Brown and Baixeras (pers. comm.) consider the fasciae to be bordered by (and hence defined by) striae, which, when fully expressed, run from strigulae on the costa to corresponding strigulae on the dorsum. However, in many Olethreutinae the dorsal strigulae are not evident, the striae are visible only near the costa, and the boundaries of the fasciae vary from partially expressed to not discernable. As a result, some of this fascial terminology can be inconvenient for purposes of describing maculation. For example, in genera like *Olethreutes*, there is a conspicuous streak of color in the postmedian region joining the costa to the termen, but it does not coincide with the postmedian fascia in the sense of Brown and Baixeras. In this context, as well as similar ones in other genera, we refer to this streak as the **postmedian band**. Another frequently occurring pattern element is a semitriangular patch of dark scales that is based on the dorsum near the tornus and extends anteriorly into the postmedian region of the wing. In some instances it appears to be fused with the median fascia, but in most cases it would be interpreted by Brown and Baixeras as a fragment of the postmedian fascia. We refer to this mark as the **pretornal patch**, a term often used by Heinrich (1926) in this context. Otherwise, our usage of fascial terminology corresponds with the concepts of Brown and Baixeras.

In North America one rarely finds an olethreutine moth in which all the elements of the ancestral pattern are expressed, and it is not unusual for the interpretation of the pattern to be complicated by dislocation, fusion, and/or fragmentation of fasciae.

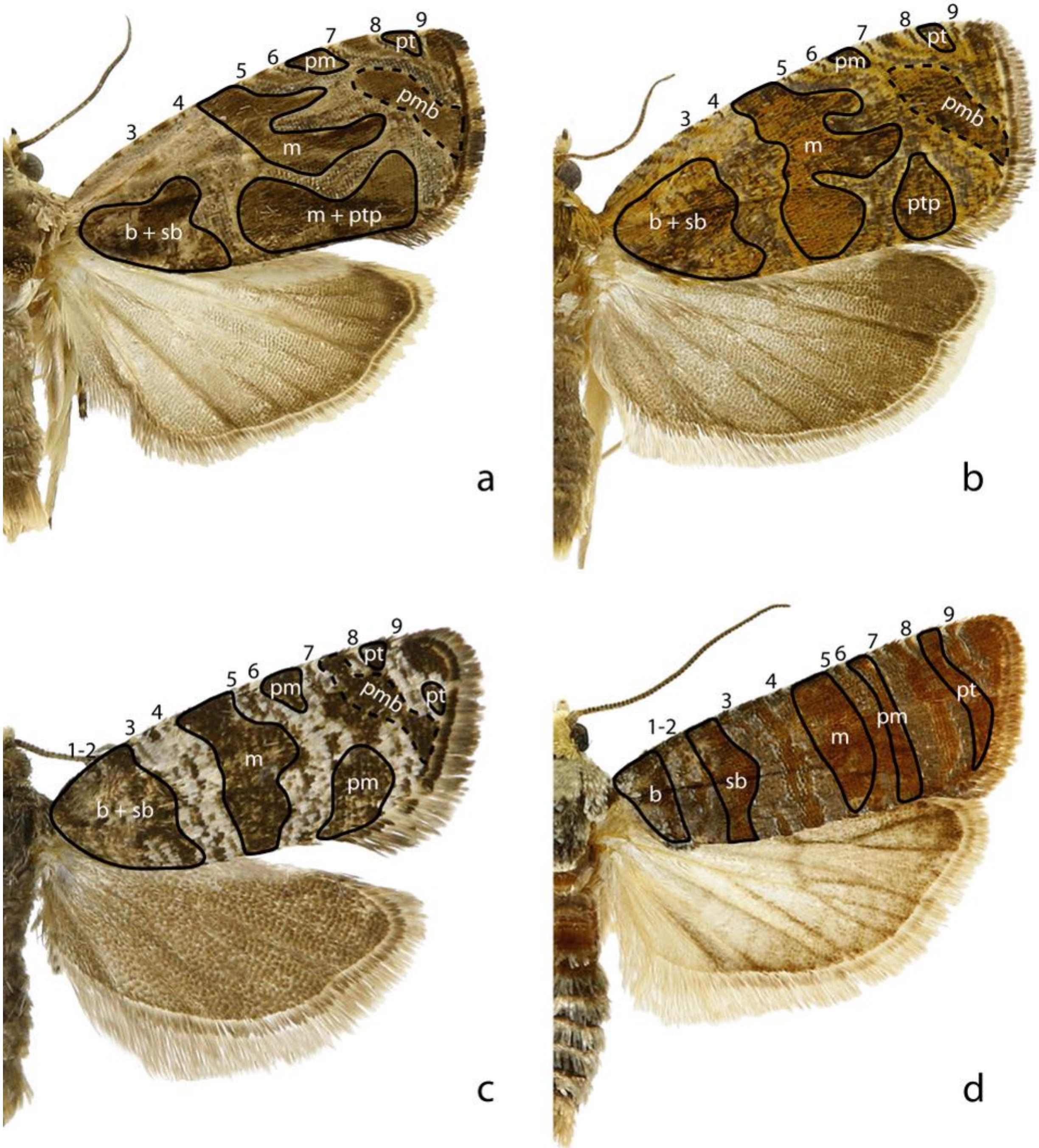

Figure 7: Examples of wing pattern elements (1-9, approximate location of costal strigulae; b, basal fascia; m, median fascia; pm, postmedian fascia; pmb, postmedian band; pt, preterminal fascia; ptp, pretornal patch; sb, subbasal fascia); **a:** *Olethreutes nigrana*; **b:** *Olethreutes sericorana*; **c:** *Taniva albolineana*; **d:** *Retinia comstockiana*.

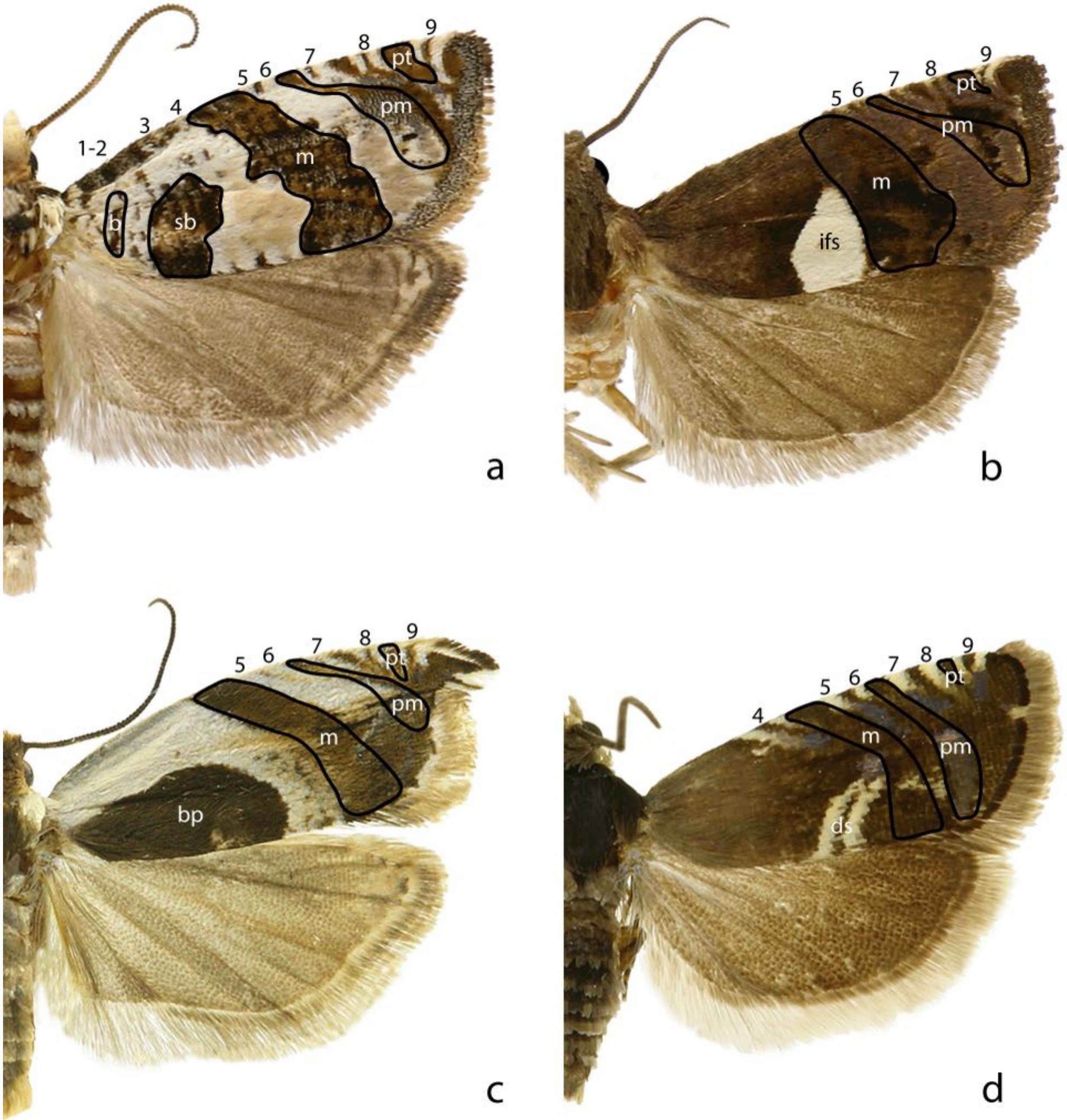

Figure 8: Examples of wing pattern elements, cont'd (1-9, approximate location of costal strigulae; b, basal fascia; bp, basal patch; ds, dorsal strigulae; ifs, interfascial spot; m, median fascia; pm, postmedian fascia; pt, preterminal fascia; sb, subbasal fascia); **a:** *Eucosma matutina*; **b:** *Epiblema gibsoni*; **c:** *Ancylis semiovana*; **d:** *Grapholita interstinctana*.

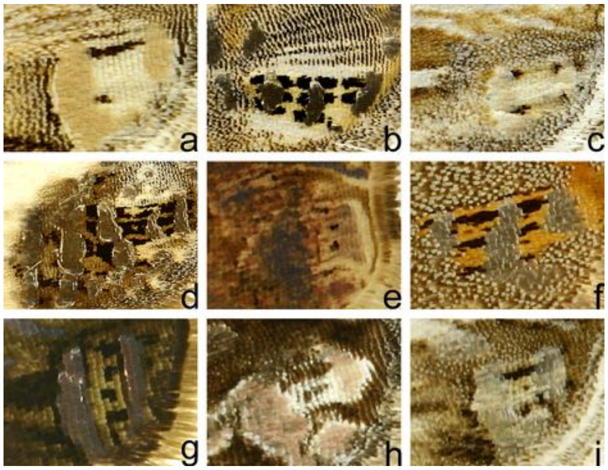

Figure 9: Examples of an ocellus in various species; **a:** *Suleima helianthana*; **b:** *Pelochrista scintillana*; **c:** *Phaneta argenticostana*; **d:** *Eucosma giganteana*; **e:** *Episimus argutanus*; **f:** *Hystrichophora taleana*; **g:** *Grapholita eclipsana*; **h:** *Sonia paraplesiana*; **i:** *Phaneta influana*.

In one frequently encountered modification, strigulae 1 and 2 are absent, and the basal and subbasal fasciae are confluent, forming what is termed a **basal patch**. Another common occurrence, the ocelloid patch (or **ocellus**), is an ovoid region anterior to the tornus that features a few dark dots or dashes on a lighter central field, the latter bordered basally and distally by transverse bands of lustrous scales (Figs. 9a-i). Those dashes and lustrous bands are sometimes interpreted as remnants of a postmedian fascia and of costal striae, respectively. Finally, unicolorous patches of scaling located between consecutive fasciae are referred to as **interfascial spots**. Figures 7 and 8 illustrate the application of this terminology in a few representative examples. Additional terms that apply to pattern elements peculiar to a particular genus are discussed in the corresponding generic introduction.

Abdomen

The lepidopteran abdominal segment is a membranous cylindrical structure that is reinforced dorsally and ventrally by a pair of sclerotized plates, the **tergum** and **sternum**, respectively. The ancestral condition in Insecta is eleven segments, but in Lepidoptera the terminal two or three are nearly unrecognizable due to extensive modification involved in the formation of the genitalia. The first sternum is absent in Tortricidae.

Male genitalia

The male genitalia are derived from modifications to the ninth and tenth abdominal segments. The ninth segment is a sclerotized ring, composed of tergum IX, the **tegumen**, and sternum IX, the **vinculum**. The intromittent organ, the **aedeagus**, is positioned in the center of the ring and flanked laterally by a pair of elongate, clasping processes, the **valvae**, which open and close laterally to grasp the female abdomen during copulation. The tenth segment is modified into diagnostically important appendages that include the **uncus**, **socii**, and **gnathos**. Structures of the male genitalia are illustrated in Figures 10 and 11.

The shape of the **valva** is important in generic and specific classification. Usually the valval geometry includes a medial constriction, a consequence of the concave curvature of the costal margin and some form of emargination of the ventral margin. The resulting neck divides the valva longitudinally into a distal portion, called the **cucullus**, and a basal portion, the ventral margin of which is referred to as the **sacculus**. The dorsal and ventral extremities of the cucullus may be produced, forming the **apex** and **anal angle**, respectively. The anal angle is often developed into a ventral projection supporting one or more stout spines. Numerous taxonomically informative patterns of setation and spine clustering are found on the margins and medial surface of the valva. To the extent that these patterns are generically idiosyncratic, they will be discussed in more detail in the introductions to the genera. The proximal margin of the medial surface of the valva is generally emarginated, forming what is called the **basal excavation**. On the medial surface of the valva, at or near the basal excavation, there often occur variously shaped processes that appear to be involved in securing the female abdomen during mating. One such structure, which occurs in *Retinia*, *Epiblema*, *Sonia*, and *Gypsonoma*, has been known historically as the **clasper**. For convenience, we shall utilize this term more generally for all the various forms of these clasping structures without implying homology with similar structures in other families such as Noctuidae.

The **uncus** is a sclerotized process, often medially divided, which is fused basally with the posterodorsal margin of tergum 9. The ancestral condition of the uncus in Lepidoptera is considered to be a matched pair of lobes, though in many olethreutine lineages fusing has reduced this structure to a single process. Even in the fused state one can often detect a weakly expressed medial line of division. Uncus development varies from the long bifid forms found in many species of *Epinotia* to a fully reduced condition in genera such as *Dichrorampha* and *Cydia*. Basally flanking the uncus is a pair of lightly sclerotized setose lobes called **socii**. Their shapes vary from long and fingerlike (e.g., *Retinia*) to completely undeveloped (e.g., *Paralobesia* and *Cydia*). In some genera they are modified into flat, broadly based projections or even hornlike structures. Their lateral surfaces are moderately to densely setose, and occasionally they support specialized setae or hair pencils (e.g., *Chimoptesis* or *Proteoteras*). In Olethreutinae, the **gnathos** is a narrow bandlike structure that joins the posterolateral edges of the tegumen somewhat below the socii and supports the distal terminus of the anal tube. Often only the lateral connections to the tegumen are substantially sclerotized, the medial portion being largely membranous.

A membranous diaphragm spans the posterior margin of the 9th abdominal ring. With the exception of an anal opening and a central perforation for the **aedeagus** (or penis), it effectively seals the distal end of the abdomen. The copulatory apparatus includes the **juxta**, a rigid semitriangular structure that articulates with the basoventral extremities of the valvae, the **anellus**, a variably cup-shaped sclerotized sheet surrounding the base of the aedeagus, and the **caulis**, a rigid stem connecting the juxta and the anellus. In Olethreutinae, these structures are fused into a compound unit that supports and directs the aedeagus. The aedeagus is more or less cylindrical and variably sclerotized. It accommodates a membranous **vesica** that everts during copulation to effect transfer of a packet of sperm called the spermatophore. The vesica often contains spines, called **cornuti**, which may or may not be shed during mating. Their number and deciduous or nondeciduous nature can be informative in species determinations.

Female genitalia

In females, the eighth, ninth, and tenth abdominal segments are modified to form the genitalia. The copulatory orifice, the ostium bursae (or **ostium**), is located on the eighth sternite and is surrounded by a sclerotized structure called the **sterigma**. The ostium allows entrance to the bursa copulatrix, which consists of the **ductus bursae** and the **corpus bursae**. Male sperm is deposited into the bursa copulatrix and transferred to the oviduct by means of the **ductus seminalis**. The ninth and tenth abdominal segments are modified into ovipositor lobes called **papillae anales** that surround the ovipore. Taxonomically significant structures of the female genitalia are illustrated in Figures 12 and 13.

The ancestral position of the ostium is in sternum VIII (e.g., *Bactra maiorina*), but in many olethreutines it appears to have been displaced anteriorly, often to a position within a deep invagination of the posterior margin of sternum VII (as in *Phaneta*, *Proteoteras*, and *Pseudexentera*). Surrounding the opening is the **sterigma**, which is usually separate from, but occasionally fused with, sternum VII. The portions of the sterigma lying anterior to and posterior to the ostium bursae are referred to as the **lamella antevaginalis** and **lamella postvaginalis**, respectively. Their shape and sculpturing are often diagnostically important at the genus and species levels.

The **ductus bursae** is a membranous tube that connects the ostium bursae to an internal, dilated, membranous sac called the **corpus bursae**. The lateral walls of the corpus bursae usually support one or two internally directed, sclerotized structures called **signa**. The **ductus seminalis** connects the oviduct to the ductus bursae, and in the vicinity of this junction there is often some degree of sclerotization of the ductus bursae.

At the distal extremity of the abdomen is a pair of flattened, setose lobes, the **papillae anales**. The membrane between them is perforated by the terminal openings of the anal tube and the oviduct. Muscles used to extend the genitalia attach to two pairs of long, slender, anteriorly projecting appendages, called the apophyses. The **apophyses posteriores** arise from the papillae anales, the **apophyses anteriores** from the anterior margin of tergum VIII.

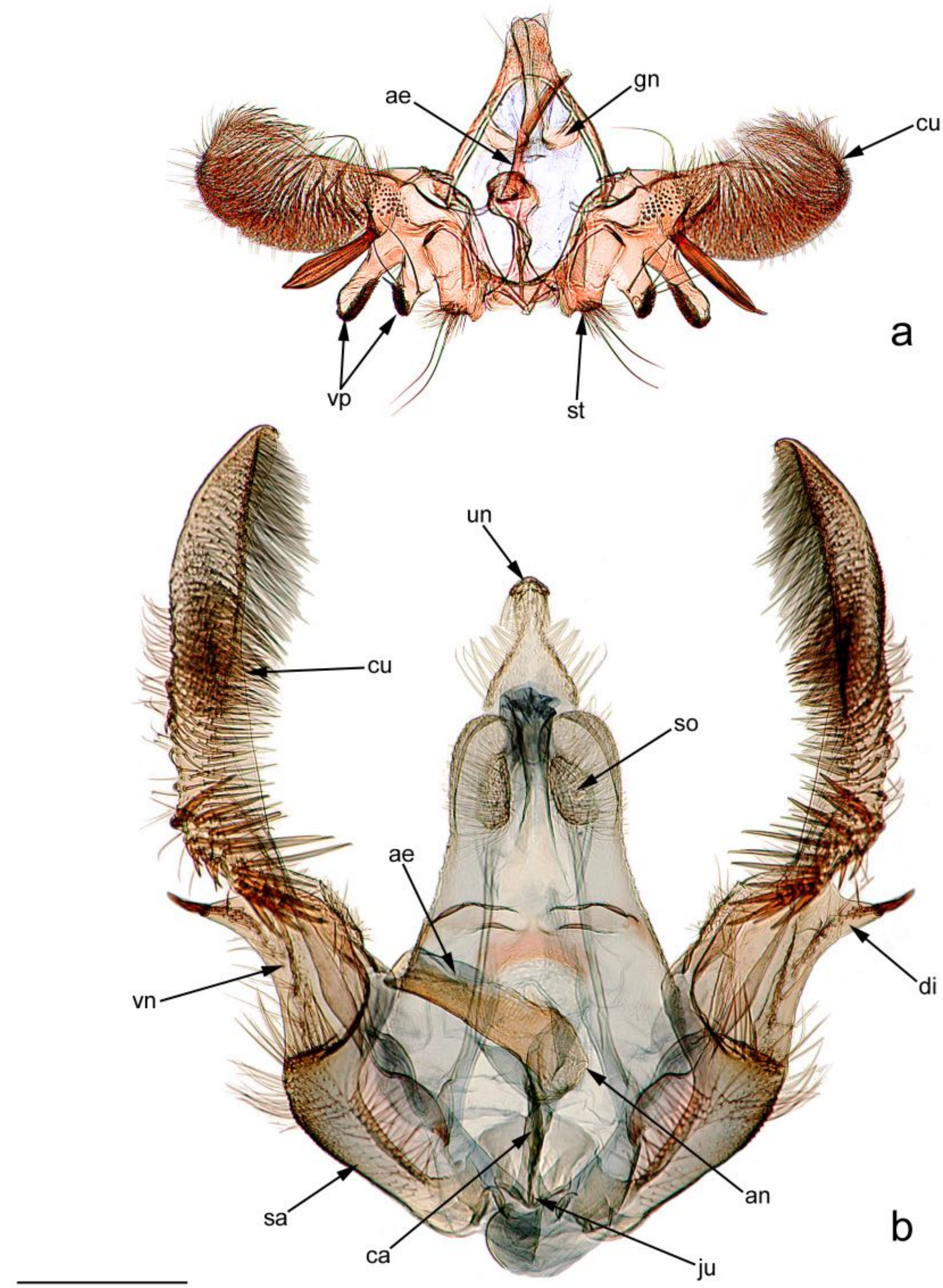

Figure 10: Male genitalia (ae, aedeagus; an, anellus; ca, caulis; cu, cucullus; di, digitus; gn, gnathos; ju, juxta; sa, sacculus; so, socii; st, saccular tuft; un, uncus; vn, valval neck; vp, ventral projections); **a:** *Paralobesia viteana*; **b:** *Olethreutes fagigemmeana*.

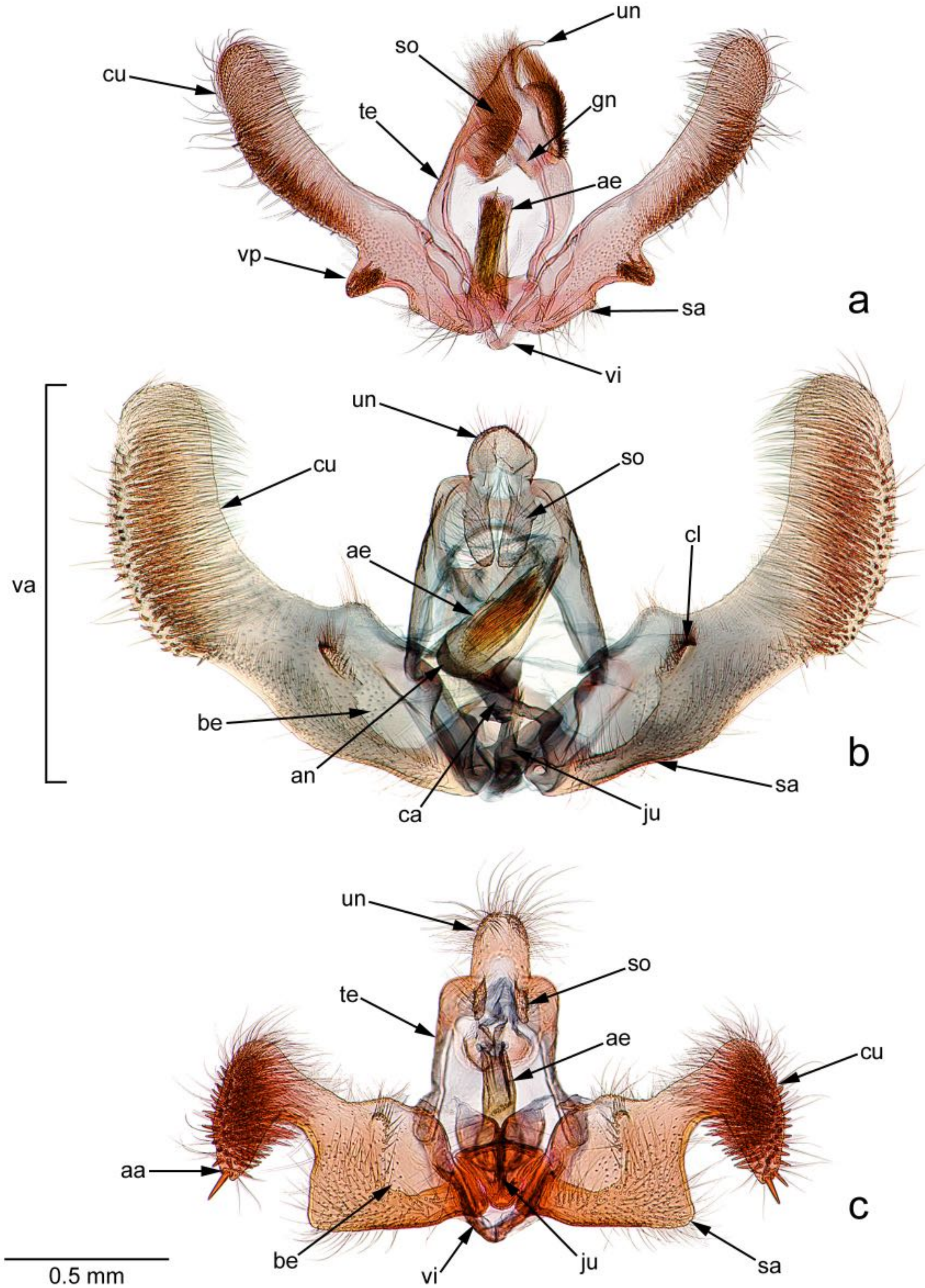

Figure 11: Male genitalia cont'd (aa, anal angle; ae, aedeagus; an, anellus; be, basal excavation; ca, caulis; cl, clasper; cu, cucullus; gn, gnathos; ju, juxta; sa, sacculus; so, socii; te, tegumen; un, uncus; va, valva; vi, vinculum; vp, ventral projection); **a:** *Episimus argutanus*; **b:** *Epiblema infelix*; **c:** *Eucosma smithiana*.

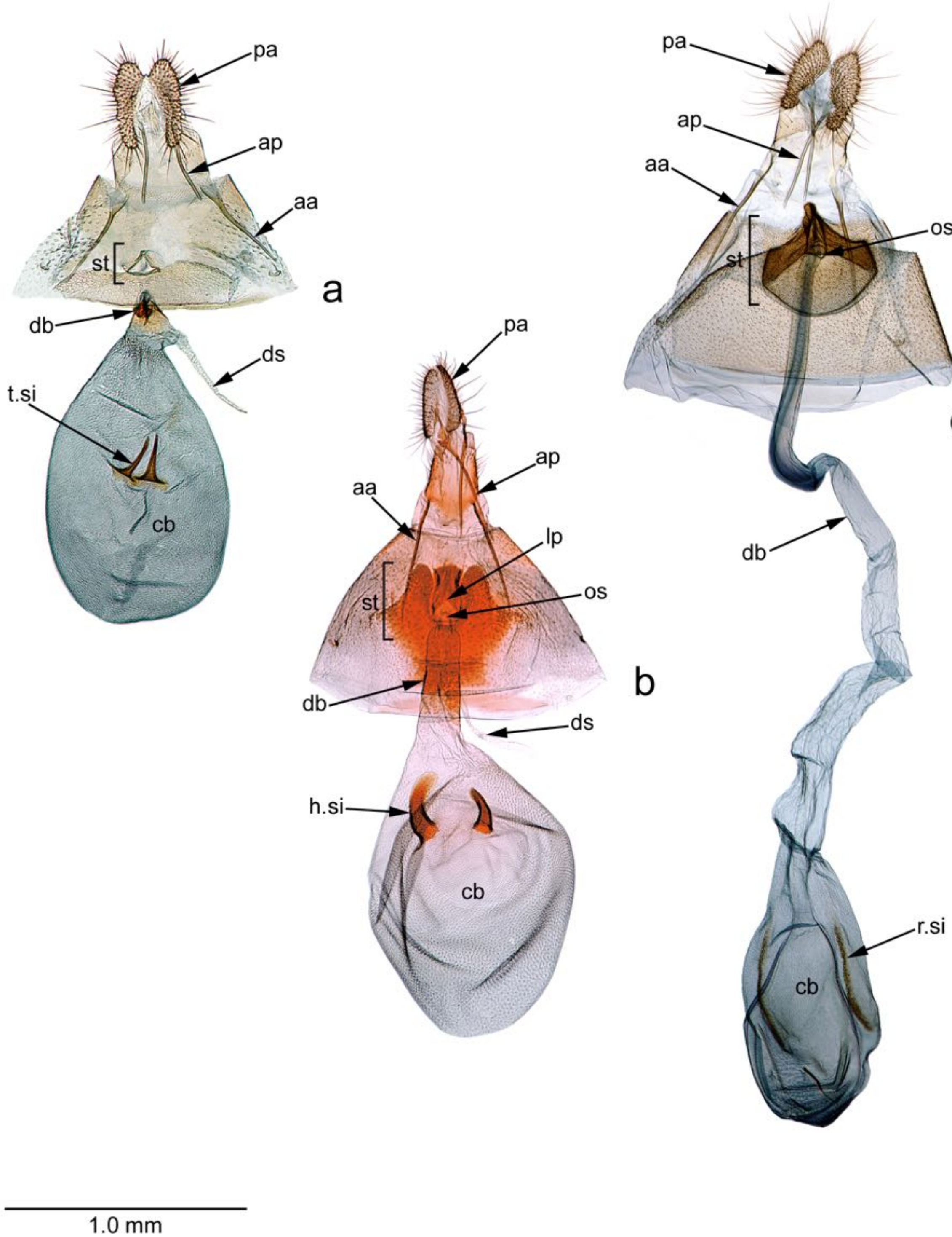

Figure 12: Female genitalia (aa, apophyses anteriores; ap, apophyses posteriores; cb, corpus bursae; ds, ductus seminalis; db, ductus bursae; h.si, hornlike signum; lp, lamella postvaginalis; os, ostium; pa, papillae anales; r.si, ridgelike signum; st, sterigma; t.si, thornlike signum); **a:** *Grapholita packardi*; **b:** *Phaneta raracana*; **c:** *Paralobesia liriodendrana*.

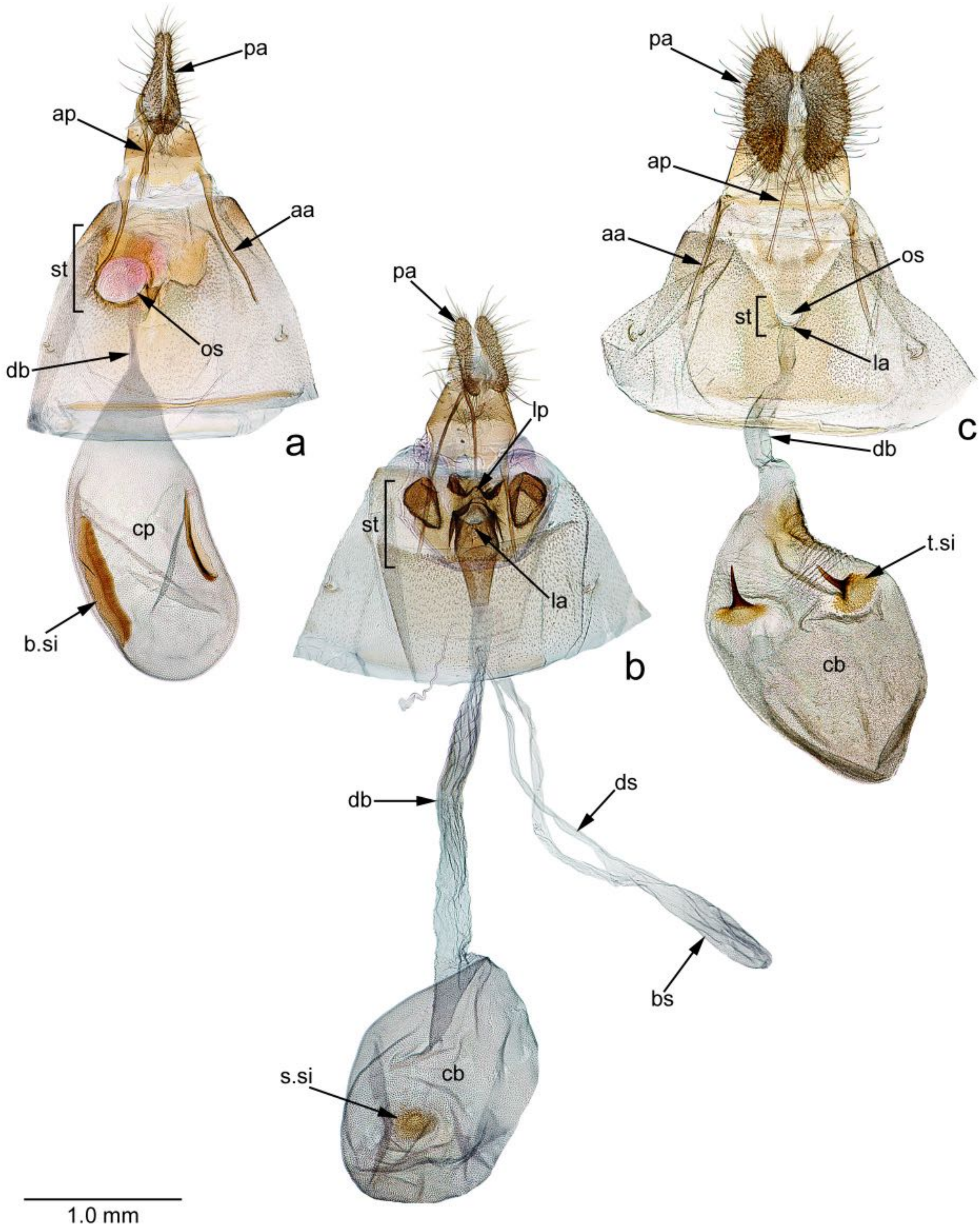

Figure 13: Female genitalia cont'd (aa, apophyses anteriores; ap, apophyses posteriores; bs, bulla seminalis; b.si, bladelike signum; cb, corpus bursae; ds, ductus seminalis; db, ductus bursae; la, lamella antevaginalis; lp, lamella postvaginalis; os, ostium; pa, papillae anales; s.si, scobinate signum; st, sterigma; t.si, thornlike signum); **a:** *Hystrichophora ochreicostana*; **b:** *Olethreutes appalachiana*; **c:** *Ecdytolopha insiticiana*.

Sex scaling

Olethreutine males exhibit a variety of modified scales that appear to be involved in scent production and dissemination, though their actual function has been verified in only a small number of cases (Brown & Miller, 1983). Specialized terminology has been employed in some instances, but our purposes will be served by lumping them all together under the title **sex scales**. Common examples include: scales enclosed by a costal fold at the base of the forewing (Fig. 15a, b), black scaling in patches or streaks on the abdomen and/or wing surface (Fig. 15g), and specialized scales or hair pencils on the hind tibia or abdomen (Figs. 14, 15c-f, h).

Figure 14: Sex scales on the abdomen of male *Talponia plummeriana*.

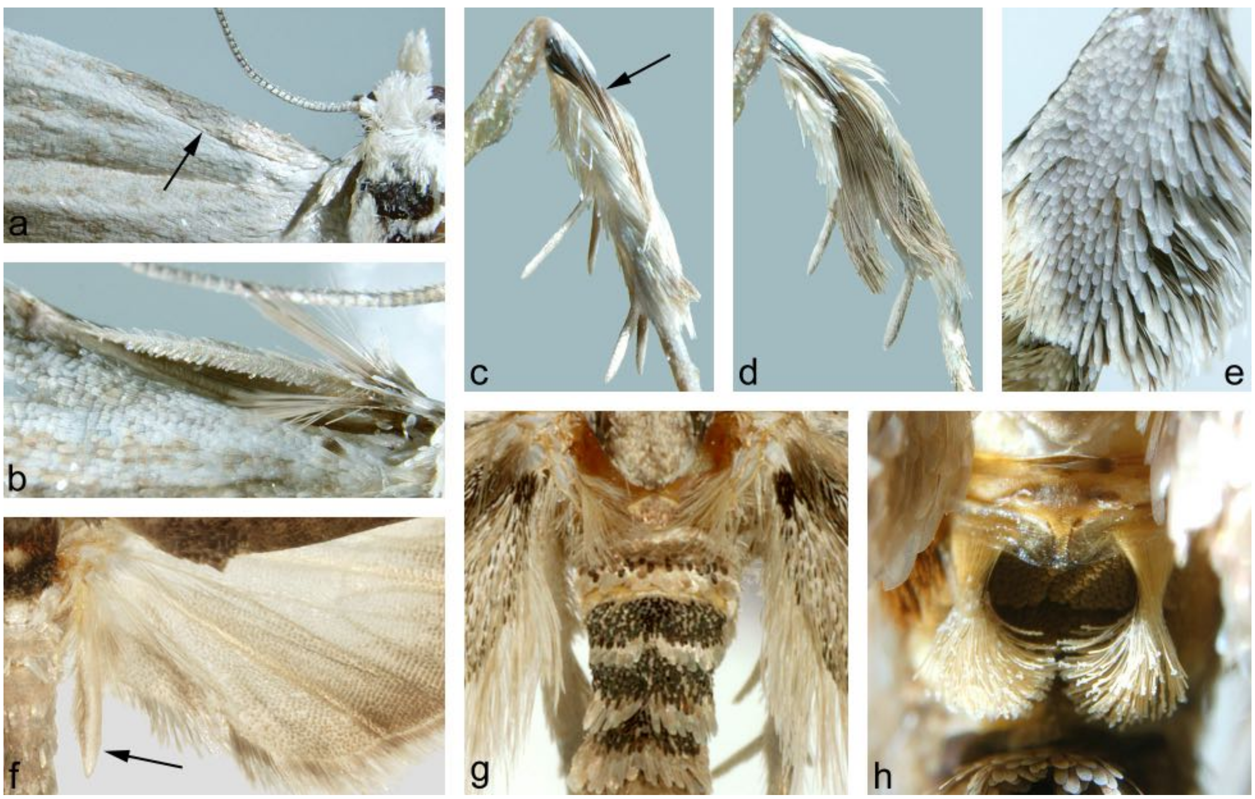

Figure 15: Examples of sex scales; **a:** costal fold in male *Eucosma*; **b:** open costal fold showing modified scales; **c:** male hind tibia, arrow denotes hidden hair pencil; **d:** exposed hair pencil on male hind tibia; **e:** modified scales on hind tibia of *C. latiferreana*; **f:** anal roll on the hindwing of male *Olethreutes*; **g:** black scaling on the abdomen of male *G. concitatricana*; **h:** Modified scales on the abdomen of male *G. punctidiscanum*.

Part II:

Species Accounts

Species Treated

In the list that follows, an identification number is assigned to each species treated. It serves to locate the descriptive commentary on a particular species in the Species Accounts section as well as the associated illustrations of the male and female genitalia in the latter part of the book. Following the list are several plates showing the species covered at approximately 1.5 times life size. They provide a visual indication of the relative sizes of the moths and are intended to direct the reader seeking a specimen determination to the appropriate part of the Species Accounts section.

Family Tortricidae

Subfamily Olethreutinae

Tribe Bactrini

Bactra Stephens, 1834
1. ***furfurana*** (Haworth, [1811])
2. ***maiorina*** Heinrich, 1923
3. ***verutana*** Zeller, 1875

Endothenia Stephens, 1852
4. ***heinrichi*** McDunnough, 1929
5. ***hebesana*** (Walker, 1863)
6. ***nubilana*** (Clemens, 1865)
7. ***montanana*** (Kearfott, 1907)
8. ***infuscata*** Heinrich, 1923
9. ***microptera*** Clarke, 1953

Tribe Olethreutini

Taniva Heinrich, 1926
10. ***albolineana*** (Kearfott, 1907)

Hulda Heinrich, 1926
11. ***impudens*** (Walsingham, 1884)

Episimus Walsingham, 1891
12. ***argutanus*** (Clemens, 1860)
13. ***tyrius*** Heinrich, 1923

Paralobesia Obraztsov, 1953
14. ***liriodendrana*** (Kearfott, 1904)
15. ***viteana*** (Clemens, 1860)
16. ***monotropana*** (Heinrich, 1926)
17. ***rhoifructana*** (Kearfott, 1904)
18. ***yaracana*** (Kearfott, 1907)
19. ***sambuci*** (Clarke, 1953)
20. ***spiraeifoliana*** (Heinrich, 1923)

Paralobesia (cont'd)
21. ***cyclopiana*** (Heinrich, 1926)

Lobesia Guenée, 1845
22. ***carduana*** (Busck, 1907)

Aterpia Guenée, 1845
23. ***approximana*** (Heinrich, 1919)

Eumarozia Heinrich, 1926
24. ***malachitana*** (Zeller, 1875)

Zomaria Heinrich, 1926
25. ***interruptolineana*** (Fernald, 1882)

Apotomis Hübner, [1825] 1816
26. ***capreana*** (Hübner, [1817])
27. ***deceptana*** (Kearfott, 1905)
28. ***removana*** (Kearfott, 1907)

Pseudosciaphila Obraztsov, 1966
29. ***duplex*** (Walsingham, 1905)

Orthotaenia Stephens, 1829
30. ***undulana*** (Denis & Schiffermüller, 1775)

Phaecasiophora Grote, 1873
31. ***confixana*** (Walker, 1863)
32. ***niveiguttana*** Grote, 1873

Olethreutes Hübner, [1822]
33. ***monetiferana*** (Riley, 1881)
34. ***nitidana*** (Clemens, 1860)
35. ***furfurana*** (McDunnough, 1922)
36. ***comandrana*** (Clarke, 1953)
37. ***olivaceana*** (Fernald, 1882)
38. ***subnubilus*** (Heinrich, 1923)
39. ***footiana*** (Fernald, 1882)
40. ***atrodentana*** (Fernald, 1882)
41. ***punctana*** (Walsingham, 1903)
42. ***connectus*** (McDunnough, 1935)

Olethreutes (cont'd)
43. ***inornatana*** (Clemens, 1860)
44. ***mysteriana*** Miller, 1979
45. ***mediopartitus*** (Heinrich, 1923)
46. ***exoletus*** (Zeller, 1875)
47. ***quadrifidus*** (Zeller, 1875)
48. ***tiliana*** (Heinrich, 1923)
49. ***sciotana*** (Heinrich, 1923)
50. ***appalachiana*** (Braun, 1951)
51. ***clavana*** (Walker, 1863)
52. ***nigrana*** (Heinrich, 1923)
53. ***viburnana*** (McDunnough, 1935)
54. ***merrickana*** (Kearfott, 1907)
55. ***hamameliana*** (McDunnough, 1944)
56. ***corylana*** (Fernald, 1882)
57. ***ochrosuffusana*** (Heinrich, 1923)
58. ***brunneopurpuratus*** (Heinrich, 1923)
59. ***ferrugineana*** (Riley, 1881)
60. ***fagigemmeana*** (Chambers, 1878)
61. ***sericorana*** (Walsingham, 1879)
62. ***melanomesa*** (Heinrich, 1923)
63. ***valdana*** (McDunnough, 1922)
64. ***versicolorana*** (Clemens, 1860)
65. ***permundana*** (Clemens, 1860)
66. ***malana*** (Fernald, 1882)
67. ***appendicea*** (Zeller, 1875)
68. ***concinnana*** (Clemens, 1865)
69. ***fasciatana*** (Clemens, 1860)
70. ***troglodana*** (McDunnough, 1922)
71. ***exaeresima*** (Heinrich, 1926)
72. ***lacunana*** (Freeman, 1941)
73. ***ferriferana*** (Walker, 1863)
74. ***auricapitana*** (Walsingham, 1879)
75. ***albiciliana*** (Fernald, 1882)
76. ***astrologana*** (Zeller, 1875)
77. ***coruscana*** (Clemens, 1860)
78. ***ferrolineana*** (Walker, 1863)
79. ***glaciana*** (Möschler, 1860)
80. ***bipartitana*** (Clemens, 1860)
81. ***trinitana*** (McDunnough, 1931)
82. ***griseoalbana*** (Walsingham, 1879)
83. ***osmundana*** (Fernald, 1879)

Celypha Hübner, [1825] 1816
84. ***cespitana*** (Hübner, [1814-1817])

Pristerognatha Obraztsov, 1960
85. ***agilana*** (Clemens, 1860)

Metendothenia Diakonoff, 1973
86. ***separatana*** (Kearfott, 1907)

Hedya Hübner, [1825] 1816
87. ***ochroleucana*** (Frölich, 1828)
88. ***nubiferana*** (Haworth, [1811])
89. ***chionosema*** (Zeller, 1875)
90. ***cyanana*** (Murtfeldt, 1880)

Evora Heinrich, 1926
91. ***hemidesma*** (Zeller, 1875)

Tribe Eucosmini

Rhyacionia Hübner, [1825] 1816
92. ***buoliana*** (Denis & Schiffermüller, 1775)
93. ***rigidana*** (Fernald, 1880)
94. ***adana*** Heinrich, 1923
95. ***busckana*** Heinrich, 1923
96. ***frustrana*** (Scudder, 1880)
97. ***aktita*** Miller, 1978

Retinia Guenée, 1845
98. ***comstockiana*** Fernald, 1879
99. ***virginiana*** (Busck, 1914)
100. ***albicapitana*** (Busck, 1914)
101. ***metallica*** (Busck, 1914)
102. ***gemistrigulana*** (Kearfott, 1905)
103. ***houseri*** (Miller, 1959)

Spilonota Stephens, 1829
104. ***ocellana*** (Denis & Schiffermüller, 1775)

Phaneta Stephens, 1852
105. ***formosana*** (Clemens, 1860)
106. ***essexana*** (Kearfott, 1907)
107. ***awemeana*** (Kearfott, 1907)
108. ***umbrastriana*** (Kearfott, 1907)
109. ***annetteana*** (Kearfott, 1907)
110. ***autumnana*** (McDunnough, 1942)
111. ***verna*** Miller, 1971
112. ***ochrocephala*** (Walsingham, 1895)
113. ***raracana*** (Kearfott, 1907)
114. ***ochroterminana*** (Kearfott, 1907)
115. ***marmontana*** (Kearfott, 1907)
116. ***tomonana*** (Kearfott, 1907)
117. ***parmatana*** (Clemens, 1860)
118. ***convergana*** (McDunnough, 1925)
119. ***kokana*** (Kearfott, 1907)
120. ***canusana*** Wright, 1997
121. ***ambodaidaleia*** Miller, 1983
122. ***influana*** (Heinrich, 1923)
123. ***ornatula*** (Heinrich, 1924)
124. ***clavana*** (Fernald, 1882)
125. ***argenticostana*** (Walsingham, 1879)
126. ***striatana*** (Clemens, 1860)

Phaneta (cont'd)
127. ***pallidicostana*** (Walsingham, 1879)
128. ***kiscana*** (Kearfott, 1905)
129. ***montanana*** (Walsingham, 1884)
130. ***stramineana*** (Walsingham, 1879)
131. ***olivaceana*** (Riley, 1881)
132. ***argutipunctana*** Blanchard & Knudson, 1983

Eucosma Hübner, [1823]
133. ***quinquemaculana*** (Robinson, 1869)
134. ***robinsonana*** (Grote, 1872)
135. ***ridingsana*** (Robinson, 1869)
136. ***heathiana*** Kearfott, 1907
137. ***morrisoni*** (Walsingham, 1884)
138. ***agricolana*** (Walsingham, 1879)
139. ***smithiana*** (Walsingham, 1895)
140. ***comatulana*** (Zeller, 1876)
141. ***vagana*** McDunnough, 1925
142. ***glomerana*** (Walsingham, 1879)
143. ***albiguttana*** (Zeller, 1875)
144. ***gloriola*** Heinrich, 1931
145. ***cocana*** Kearfott, 1907
146. ***monitorana*** Heinrich, 1920
147. ***tocullionana*** Heinrich, 1920
148. ***palabundana*** Heinrich, 1923
149. ***matutina*** (Grote, 1873)
150. ***giganteana*** (Riley, 1881)
151. ***bipunctella*** (Walker, 1863)
152. ***bilineana*** Kearfott, 1907
153. ***nandana*** Kearfott, 1907
154. ***landana*** Kearfott, 1907
155. ***simplex*** McDunnough, 1925
156. ***dosisignatana*** (Clemens, 1860)
157. ***similiana*** Clemens, 1860
158. ***derelicta*** Heinrich, 1929
159. ***wandana*** Kearfott, 1907
160. ***fulminana*** (Walsingham, 1879)
161. ***rusticana*** Kearfott, 1905
162. ***haydenae*** Wright, 2006
163. ***sombreana*** Kearfott, 1905
164. ***fiskeana*** Kearfott, 1905
165. ***consobrinana*** Heinrich, 1923
166. ***gomonana*** Kearfott, 1907
167. ***cataclystiana*** (Walker, 1863)

Pelochrista Lederer, 1859
168. ***argenteana*** (Walsingham, 1895)
169. ***scintillana*** (Clemens, 1865)
170. ***pallidipalpana*** (Kearfott, 1905)
171. ***corosana*** (Walsingham, 1884)
172. ***rorana*** (Kearfott, 1907)
173. ***zomonana*** (Kearfott, 1907)
174. ***womonana*** (Kearfott, 1907)

Pelochrista (cont'd)
175. ***milleri*** Wright 2007

Epiblema Hübner, [1825] 1816
176. ***luctuosissima*** Blanchard, 1985
177. ***boxcana*** (Kearfott, 1907)
178.a. ***strenuana*** (Walker, 1863)
178.b. ***minutana*** (Kearfott, 1905)
179. ***abruptana*** (Walsingham, 1879)
180. ***tripartitana*** (Zeller, 1875)
181. ***glenni*** Wright, 2002
182. ***resumptana*** (Walker, 1863)
183. ***benignatum*** McDunnough, 1925
184. ***scudderiana*** (Clemens, 1860)
185. ***carolinana*** (Walsingham, 1895)
186. ***obfuscana*** (Dyar, 1903)
187. ***desertana*** (Zeller, 1875)
188. ***dorsisuffusana*** (Kearfott, 1908)
189. ***iowana*** McDunnough, 1935
190. ***otiosana*** (Clemens, 1860)
191. ***infelix*** Heinrich, 1923
192. ***walsinghami*** (Kearfott, 1907)
193. ***gibsoni*** Wright & Covell, 2003
194. ***brightonana*** (Kearfott, 1907)
195. ***tandana*** (Kearfott, 1907)

Notocelia Hübner, [1825] 1816
196. ***rosaecolana*** (Doubleday, 1850)
197. ***illotana*** (Walsingham, 1879)
198. ***culminana*** (Walsingham, 1879)

Suleima Heinrich, 1923
199. ***helianthana*** (Riley, 1881)
200. ***cinerodorsana*** Heinrich, 1923

Sonia Heinrich, 1923
201. ***paraplesiana*** Blanchard, 1979
202. ***canadana*** McDunnough, 1925
203. ***vovana*** (Kearfott, 1907)
204. ***divaricata*** Miller, 1990

Gypsonoma Meyrick, 1895
205. ***haimbachiana*** (Kearfott, 1907)
206. ***salicicolana*** (Clemens, 1864)
207. ***adjuncta*** Heinrich, 1924
208. ***fasciolana*** (Clemens, 1864)
209. ***substitutionis*** Heinrich, 1923

Proteoteras Riley, 1881
210. ***aesculana*** Riley, 1881
211. ***willingana*** (Kearfott, 1904)
212. ***crescentana*** Kearfott, 1907
213. ***naracana*** Kearfott, 1907
214. ***moffatiana*** Fernald, 1905

Proteoteras (cont'd)

215. ***obnigrana*** Heinrich, 1923

Zeiraphera Treitschke, 1829

216. ***claypoleana*** (Riley, 1882)
217. ***canadensis*** Mutuura & Freeman, 1967

Pseudexentera Heinrich, 1940

218. ***cressoniana*** (Clemens, 1864)
219. ***mali*** Freeman, 1942
220. ***oregonana*** (Walsingham, 1879)
221. ***spoliana*** (Clemens, 1864)
222. ***haracana*** (Kearfott, 1907)
223. ***faracana*** (Kearfott, 1907)
224. ***sepia*** Miller, 1986
225. ***hodsoni*** Miller, 1986
226. ***maracana*** (Kearfott, 1907)
227. ***kalmiana*** McDunnough, 1959
228. ***vaccinii*** Miller, 1986
229. ***costomaculana*** (Clemens, 1860)
230. ***virginiana*** (Clemens, 1864)

Gretchena Heinrich, 1923

231. ***deludana*** (Clemens, 1864)
232. ***concubitana*** Heinrich, 1923
233. ***watchungana*** (Kearfott, 1907)
234. ***bolliana*** (Slingerland, 1896)
235. ***amatana*** Heinrich, 1923
236. ***delicatana*** Heinrich, 1923
237. ***concitatricana*** (Heinrich, 1923)
238. ***nymphana*** Blanchard & Knudson, 1983

Chimoptesis Powell, 1964

239. ***gerulae*** (Heinrich, 1923)
240. ***pennsylvaniana*** (Kearfott, 1907)

Rhopobota Lederer, 1859

241. ***naevana*** (Hübner, [1814-1817])
242. ***dietziana*** (Kearfott, 1907)
243. ***finitimana*** (Heinrich, 1923)

Epinotia Hübner, [1825] 1816

244. ***medioviridana*** (Kearfott, 1908)
245. ***madderana*** (Kearfott, 1907)
246. ***celtisana*** (Riley, 1881)
247. ***sotipena*** Brown, 1987
248. ***vertumnana*** (Zeller, 1875)
249. ***zandana*** (Kearfott, 1907)
250. ***nisella*** (Clerck, 1759)
251. ***criddleana*** (Kearfott, 1907)
252. ***xandana*** (Kearfott, 1907)
253. ***walkerana*** (Kearfott, 1907)
254. ***transmissana*** (Walker, 1863)
255. ***nonana*** (Kearfott, 1907)

Epinotia (cont'd)

256. ***nanana*** (Treitschke, 1835)
257. ***septemberana*** (Kearfott, 1907)
258. ***lindana*** (Fernald, 1892)

Catastega Clemens, 1861

259. ***timidella*** Clemens, 1861
260. ***aceriella*** Clemens, 1861

Tribe Enarmoniini

Ancylis Hübner, [1825]

261. ***nubeculana*** (Clemens, 1860)
262. ***subaequana*** (Zeller, 1875)
263. ***semiovana*** (Zeller, 1875)
264. ***brauni*** (Heinrich, 1931)

265.a. ***spiraeifoliana*** (Clemens, 1860)
265.b. ***burgessiana*** (Zeller, 1875)
265.c. ***laciniana*** (Zeller, 1875)
265.d. ***fuscociliana*** (Clemens, 1864)

266. ***platanana*** (Clemens, 1860)
267. ***metamelana*** (Walker, 1863)
268. ***comptana*** (Frölich, 1828)
269. ***divisana*** (Walker, 1863)
270. ***muricana*** (Walsingham, 1879)
271. ***diminutana*** (Haworth, [1811])

Eucosmomorpha Obraztsov, 1951

272. ***nearctica*** Miller, 2002

Hystrichophora Walsingham, 1879

273. ***taleana*** (Grote, 1878)
274. ***ochreicostana*** (Walsingham, 1884)
275. ***loricana*** (Grote, 1880)
276. ***vestaliana*** (Zeller, 1875)

Tribe Grapholitini

Dichrorampha Guenée, 1845

277. ***simulana*** (Clemens, 1860)
278. ***bittana*** (Busck, 1906)
279. ***incanana*** (Clemens, 1860)
280. ***sedatana*** (Busck, 1906)
281. ***leopardana*** (Busck, 1906)

Talponia Heinrich, 1926

282. ***plummeriana*** (Busck, 1906)

Pammene Hübner, [1825] 1816

283. ***felicitana*** Heinrich, 1923

Larisa Miller, 1978

284. ***subsolana*** Miller, 1978

Sereda Heinrich, 1923
285. ***tautana*** (Clemens, 1865)

Grapholita Treitschke, 1829
286. ***molesta*** (Busck, 1916)
287. ***packardi*** Zeller, 1875
288. ***prunivora*** (Walsh, 1868)
289. ***fana*** (Kearfott, 1907)
290. ***interstinctana*** (Clemens, 1860)
291. ***eclipsana*** Zeller, 1875
292. ***tristrigana*** (Clemens, 1865)
293. ***delineana*** (Walker, 1863)

Corticivora Clarke, 1951
294. ***clarki*** Clarke, 1951

Cydia Hübner, [1825] 1816
295. ***garacana*** (Kearfott, 1907)
296. ***albimaculana*** (Fernald, 1879)
297. ***lacustrina*** (Miller, 1976)
298. ***candana*** (Forbes, 1923)
299. ***caryana*** (Fitch, 1856)
300. ***gallaesaliciana*** (Riley, 1881)
301. ***pomonella*** (Linnaeus, 1758)
302. ***latiferreana*** (Walsingham, 1879)
303. ***toreuta*** (Grote, 1873)

Gymnandrosoma Dyar, 1904
304. ***punctidiscanum*** Dyar, 1904

Ecdytolopha Zeller, 1875
305. ***insiticiana*** Zeller, 1875

Pseudogalleria Ragonot, 1884
306. ***inimicella*** (Zeller, 1872)


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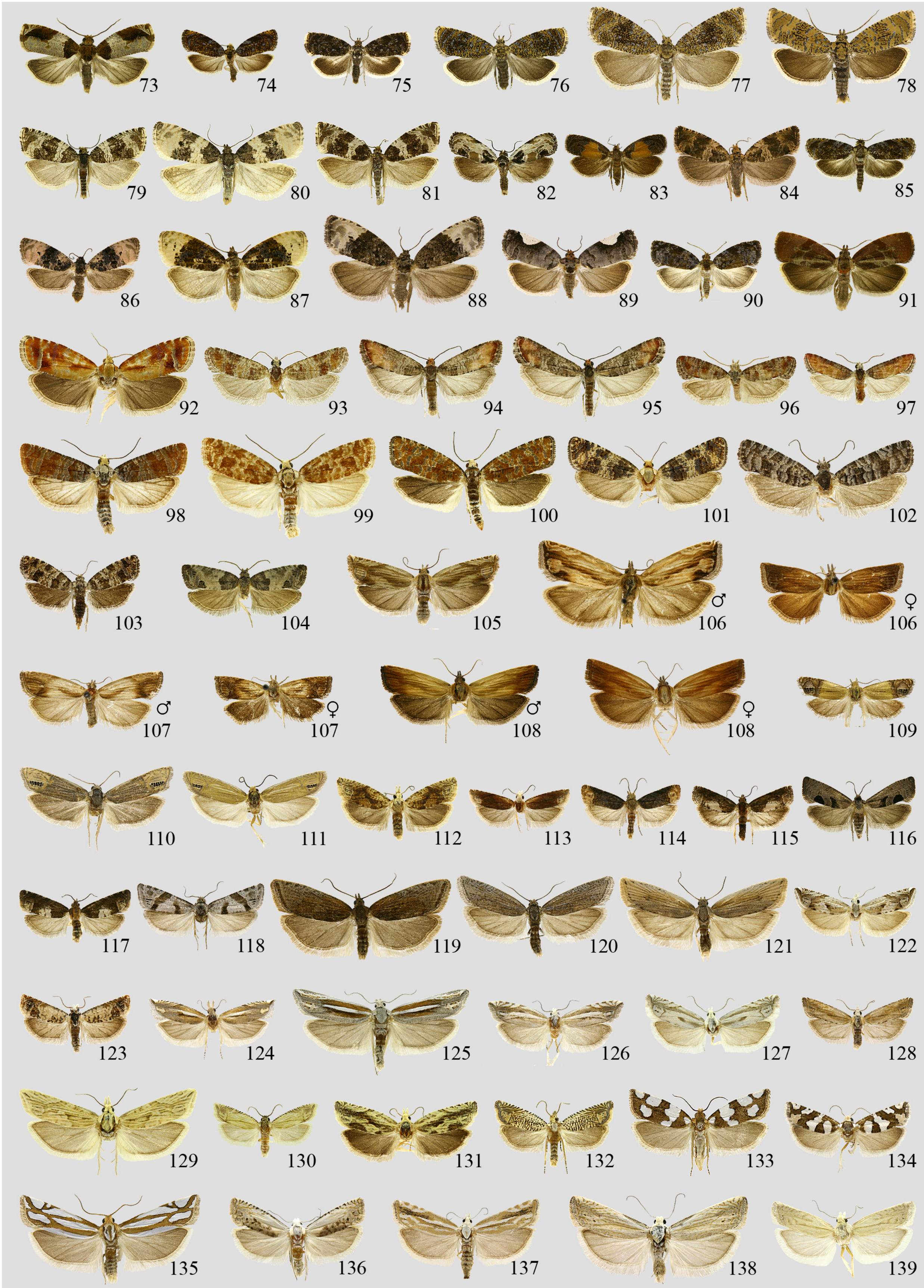
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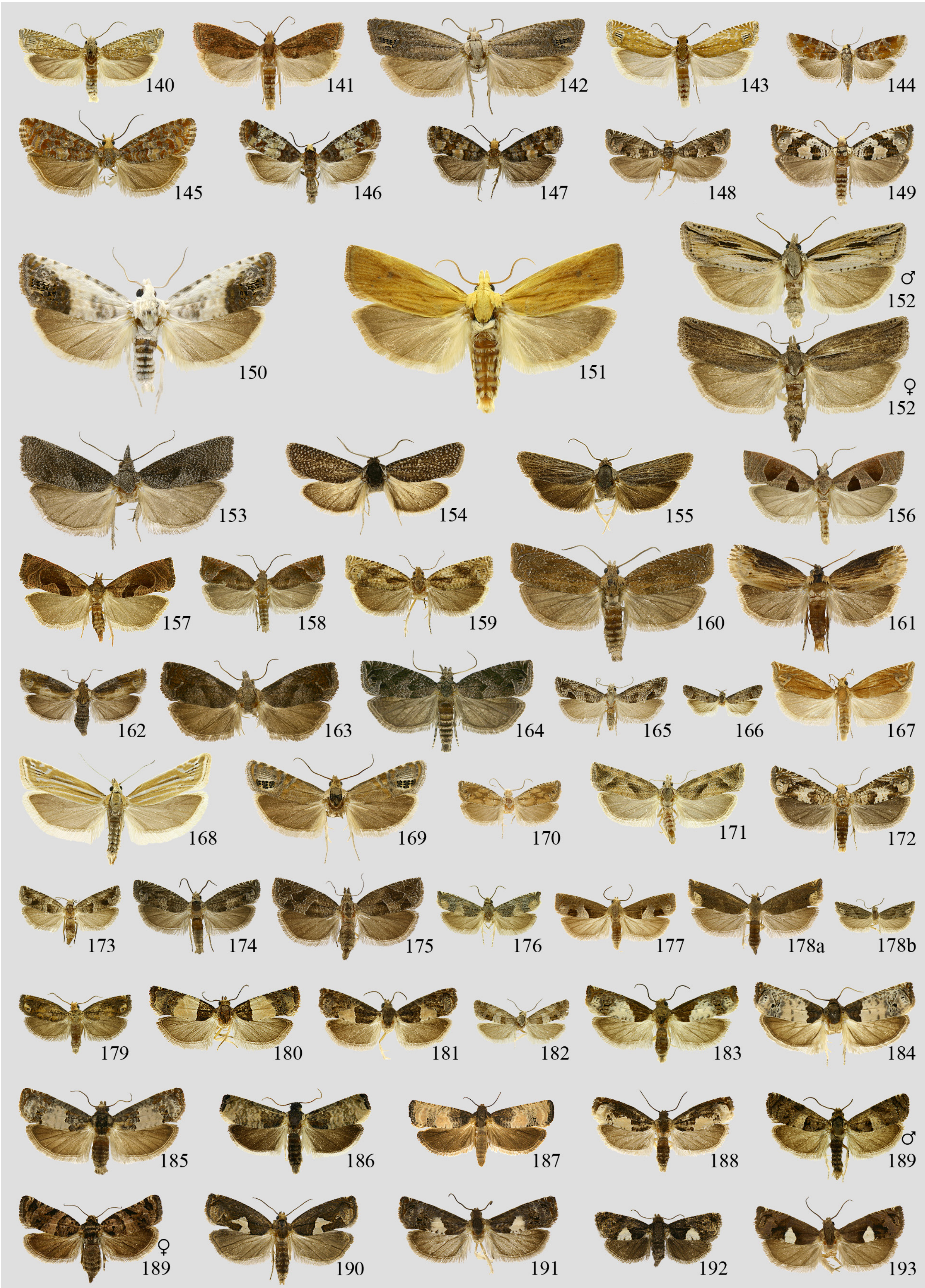
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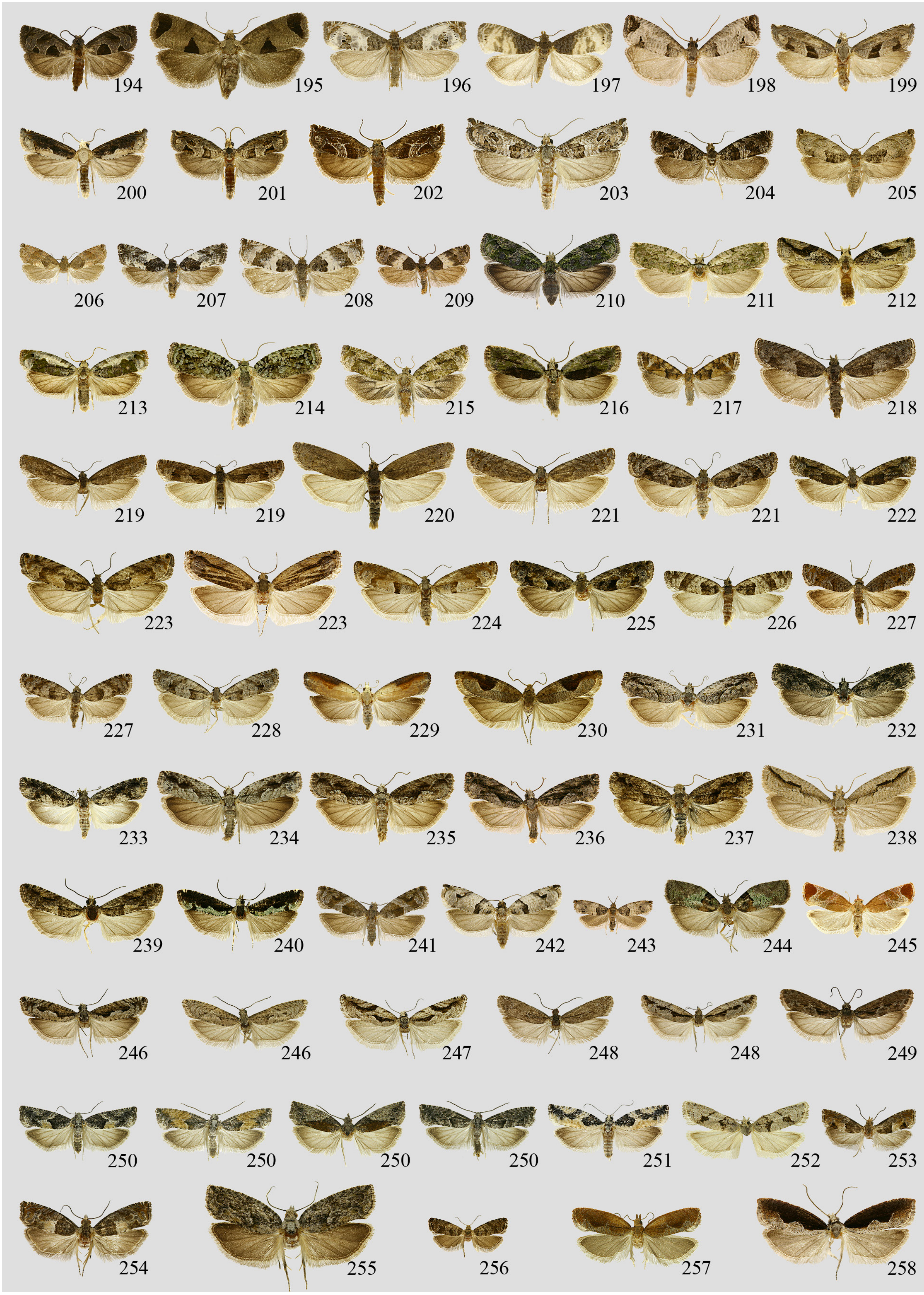
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Species Accounts

Each genus is introduced with comments on species richness, general distribution, larval habits, and generically idiosyncratic features of the genitalia and/or forewing shape and maculation. No attempt is made to diagnose genera, but selected characters that might help in genus-level determinations are discussed.

The images of the adults are scaled to a standard size (approximately one-half the page width), so image size varies from two to six times life size. Relative sizes can be estimated by referring to the plates on pages 32-36 or can be derived from the forewing length data. Information on each species is organized under the following headings:

FWL [forewing length] refers to the distance from base to apex, including fringe, and is used as a surrogate for insect size. The reported values are rounded to the nearest one-half millimeter and are based on both literature data and measurements made by the authors.

Flight Period is a rough indication of the months during which adults can be found in the field. The conclusions generally are based on data from throughout the range of the insect, and in many cases emergence times vary according to latitude.

Distribution refers to the geographic range of the insect. It is based on museum and literature records as well as data from various private collections, but for many species it is likely to be only a crude approximation to the actual range of the moth. In most cases we have described the smallest convex region that includes the available records, even though there often are large areas within that region from which no specimens have been recorded.

Biology presents a summary of the available information on the life cycle of the insect, including larval hosts and feeding habits. For most economically important species the literature on this subject is extensive, but in many instances the larval food plants are yet to be discovered.

Remarks consist primarily of comments intended to aid in species identification. Characters distinguishing the moth from similar looking taxa are discussed, and sometimes the reader is alerted to taxonomic uncertainties that may preclude a reliable determination.

Tribe BACTRINI

Genus *Bactra*

Bactra is a large genus with a worldwide distribution. There are seven species in North America, and we treat three found in the Midwest. The larvae are stem-borers on sedges and related plants. One species, *verutana*, has been studied as a possible biological control agent on nutgrass (Frick and Garcia, 1975). Though certain patterns of forewing maculation have been associated with the various species, these moths are variable, and forewing appearance alone is not a completely reliable basis for determinations.

The valva is divided into two lobes, one forming the cucullus, the other associated with the sacculus. There is a crescent-shaped clasper on the medial surface of one or the other of the lobes. The three Midwest species can be separated by the pattern of spines on the cucullus. In females, with the exception of *furfurana*, sternum VIII is joined with tergum VIII to form a complete, sclerotized, abdominal ring, and differences in the sclerotization of the membrane between abdominal segments VII and VIII serve to distinguish the species. In *furfurana*, the sterigma is not attached to the eighth tergite, and the intersegmental membrane is not sclerotized. All three species have a single, reticulate, pocketlike signum in the corpus bursae.

1. ***Bactra furfurana*** (Haworth)

FWL: 5.0-7.5 mm.

Flight Period: Mid-June through August.

Distribution: Throughout the United States; also the Palearctic and Japan.

Biology: Palaearctic hosts include *Juncus* (rush) and *Scirpus* (bulrush) (Razowski, 2003).

Remarks: Specimens with a fasciate forewing pattern are recognizable by maculation. Their subbasal and median fasciae are moderately well defined, though the color varies from blackish brown to yellowish brown, often with orange-brown highlights. There are no large spines on the cucullus, the clasper is on the saccular lobe, and the sterigma is not attached to tergum VIII.

2. ***Bactra maiorina*** Heinrich

FWL: 8.0-11.0 mm.

Flight Period: June and July.

Distribution: Vermont to North Dakota, south to Virginia, Mississippi and California.

Biology: Heinrich (1923b) reported that larvae feed on *Schoenoplectus fluviatilis* (river bulrush).

Remarks: This moth is generally larger than *furfurana* and *verutana*. Midwest specimens tend to be two-toned in appearance: tan from costa to radius, brown from radius to dorsum. Often there is a poorly defined dark dot at the distal end of the discal cell and some blackish-brown streaking on the median veins. Large spines line the ventral margin of the cucullus. In females, the intersegmental membrane has extensive, wavy, sclerotized patches flanking segment VIII.

3. ***Bactra verutana*** Zeller

FWL: 5.5-9.5 mm.

Flight Period: July to mid-October; April to December in California.

Distribution: Throughout the United States.

Biology: The larval host is *Cyperus* (flatsedge or nutgrass) (Poinar, 1964; Powell, 1997).

Remarks: Most specimens have two dark dots on the forewing, located approximately over the cubitus in the subbasal and median fasciae. They usually line up with other dark scaling to form a weakly defined longitudinal streak. Along the base of the fringe is a thin white line, preceded by a thin black line. There are two lines of stout spines on the cucullus: one on the ventral margin, the other on the medial surface adjacent to the ventral margin. The clasper is on the cucullus. In females the intersegmental membrane is thickened and folded inward, forming a trough that surrounds segment VIII, and on either side of segment VIII there is a small sclerotized patch at the bottom of the trough.

Genus *Endothenia*

Endothenia is a worldwide genus. Of the eleven recognized Nearctic species, we treat six. A seventh, *conditana*, which was described from California, has been reported from Illinois (Godfrey et al., 1987), but we cannot confirm that record. With the exception of *hebesana*, which is holarctic in distribution and common across North America, the life histories of these moths are poorly understood. In the few reported cases, the larvae feed in seeds, stems, and flowers of herbaceous plants.

Members of this genus have an easily recognized forewing appearance, but interspecific differences in color and forewing maculation can be subtle, and the occurrence of melanic forms complicates species-level determinations. Examination of the genitalia often is required for a positive identification. The valva has a long narrow neck, a very weakly differentiated cucullus, and a broadly expanded base. The base features a large clasperlike process on the medial surface, one of the distinctive characteristics of the genus. Its shape and setation are often diagnostic. The presence or absence of cornuti in the aedeagus also can be informative. In females, the anterior margin of tergum VIII is strongly sclerotized, forming a distinct narrow ring that connects to the sterigma. Some species can be identified by the sculpturing of the sterigma. In all cases, the ductus bursae is long and narrow, with lateral sclerotized patches at the constriction anterior to the ostium, and the corpus bursae has a single pocketlike signum.

4. *Endothenia heinrichi* McDunnough

FWL: 5.5-6.5 mm.

Flight Period: Mid-May through mid-August.

Distribution: Ontario to Iowa, south to Kentucky.

Biology: Unknown.

Remarks: Though similar in appearance to *montanana*, *heinrichi* is smaller and usually has a larger amount of white interfascial scaling beyond the median fascia. Males have a hair pencil on the hind tibia.

5. *Endothenia hebesana* (Walker)

FWL: 4.5-8.5 mm.

Flight Period: Mid-April through September.

Distribution: Southern Canada and the United States.

Biology: Recorded hosts include *Iris* (iris), *Agalinis* (false foxglove), *Veronica* (speedwell), *Antirrhinum* (snapdragon), *Verbena* (vervain), *Sarracenia* (pitcherplant), and others representing a total of eight plant families. The larvae feed primarily in seeds, and the life cycle is multivoltine in the southern part of the range (Heinrich, 1926; Miller, 1983b).

Remarks: This species is commonly referred to as the verbena bud moth. It can be an economic pest on ornamentals such as iris, vervain, snapdragons, and many others. Fresh specimens have a bluish-gray cast to the interfascial areas and conspicuous orange-brown scaling along the termen and the distal half of the costa. The postmedian band consists of three gray spots that are edged with black and joined to the costa and termen by orange-brown streaks. Males lack cornuti in the vesica and have numerous stout setae on both the apex and the lateral surface of the clasper. A collarlike, outwardly projecting flange borders the ostium laterally and posteriorly.

6. ***Endothenia nubilana*** (Clemens)

FWL: 6.5-10.0 mm.

Flight Period: Mid-June to mid-September.

Distribution: Quebec to Alberta, south to Maryland, Illinois, and California.

Biology: Larvae bore into the stem bases of *Stachys palustris* (marsh hedgenettle) (Putman, 1942).

Remarks: Forewing color varies from pale brown to greenish gray. The fascial markings are usually conspicuous but can be obscured by dark suffusion of the interfascial areas. The clasper has a square profile, with short thick setae on only one corner, and the aedeagus has 8-10 cornuti. The shape of the ostium is also diagnostic. Previously listed as a subspecies of the Palearctic *quadrimaculana* (= *antiquana*) by Heinrich (1926), *nubilana* was reinstated to species status by Miller (1983b) based on male genitalia.

7. ***Endothenia montanana*** (Kearfott)

FWL: 6.0-9.0 mm.

Flight Period: June to early July.

Distribution: New York to Alberta, south to North Carolina and Illinois.

Biology: Unknown.

Remarks: Forewing appearance is similar to *heinrichi* but a little darker. Both species have some white interfascial scaling beyond the distal margin of the median fascia. Males of *heinrichi* have a hair pencil on the hind tibia, those of *montanana* do not. The genitalia of the two species appear to be indistinguishable.

8. ***Endothenia infuscata*** Heinrich

FWL: 7.5-9.0 mm.

Flight Period: Mid-June through August.

Distribution: New York to Iowa, south to Maryland and Kentucky.

Biology: Unknown.

Remarks: The fasciae and interfascial areas are dark brown and dark gray, respectively, producing a uniformly dark forewing. The genitalia are quite similar to those of *montanana* and *heinrichi*. Like *montanana*, this species lacks a hair pencil on the male hind tibia.

9. *Endothenia microptera* Clarke

FWL: 4.5-5.0 mm.

Flight Period: June through August.

Distribution: Recorded from Illinois and Louisiana.

Biology: Unknown.

Remarks: This moth looks like a small version of *hebesana*, but the gray interfascial scaling lacks the bluish tint. The postmedian band is more uniform in width and color, and it extends all the way to the termen. The apex of the hindwing is not so acutely tapered as in *hebesana*, resulting in a more rectangular shape. Dissection is recommended for positive identification. There are one or two thick stubby setae on the lateral surface of the clasper but none at the apex, and the aedeagus has one small apical cornutus. The oval ostium projects slightly outward from the rectangular sterigma.

Tribe OLETHREUTINI

Genus *Taniva*

Taniva is a Nearctic genus erected by Heinrich (1926) for the one species treated below. Its history of synonymy under *Endothenia* and subsequent reinstatement are recounted in Dang (1990).

The male genitalia have a bifid uncus. On the ventral margin of the valval neck there is a bowllike cavity with a central longitudinal divider. The medial margin of the cavity has two or three lines of stout setae, and the lateral margin forms an acutely angled, ventrally projecting lobe. Up to four cornuti and some two dozen, stubby, almost scalelike internal projections are located in the vesica. The sterigma has a well developed lamella antevaginalis and long, tongue-shaped, posterolateral projections. One signum, a weakly expressed scobinate patch, is found in the corpus bursae.

10. *Taniva albolineana* (Kearfott)

FWL: 5.0-7.5 mm.

Flight Period: Mid-May to mid-July.

Distribution: Transcontinental in southern Canada, south to North Carolina, Tennessee and Idaho.

Biology: The larval host is *Picea* (spruce). A line of 2-8 eggs is deposited on the surface of a needle, and newly hatched larvae bore into the needle and mine the interior. Partially grown larvae overwinter in the needle or in an exterior nest of silk, frass and dead needles. Feeding resumes in the spring, and pupation occurs in a cocoon within the nest (Tashiro, 1974).

Remarks: Commonly referred to as the spruce needleminer, *albolineana* occasionally causes economic damage by infesting nursery stock. Adults are easily identified by the banded dark brown and white forewing appearance.

Genus *Hulda*

Hulda is a monotypic Nearctic genus that was once synonymized with *Endothenia* and subsequently resurrected by Dang (1990). Although the single species is widespread in the eastern half of North America, nothing has been reported regarding its life history.

Males have a strongly developed, hoodlike tegumen. The uncus is considered to be undeveloped, but the long fingerlike socii arising near the apex of the tegumen appear similar to an uncus. There are two clusters of stout spines on the medial surface of the valva: one at the distal end of the sacculus, the other associated with a clasperlike projection at the base of the neck. A third patch of smaller setae is located on the margin of the basal excavation. Females have a key-hole shaped ostium whose sides are mildly raised. The corpus bursae has a single scobinate patch.

11. *Hulda impudens* (Walsingham)

FWL: 5.5-7.5 mm.

Flight Period: Late May to early August.

Distribution: New Hampshire to Manitoba, south to North Carolina and Mississippi.

Biology: Unknown.

Remarks: The basal patch is uniformly blackish gray, with transverse black striations. The dorsal half of the blackish median fascia is usually well overlaid with olive-gold scaling, and the postmedian band is almost completely suffused with olive gold.

Genus *Episimus*

Nine species of *Episimus* have been recorded from North America, most of which are restricted to southern Florida and/or southwestern Texas (Heppner, 1994). Two are known from the Midwest, and in both cases the immatures are leaf-tiers. Midwestern specimens can be identified by forewing color and maculation but are not distinguished easily from similar looking species in Florida.

Prominent male genitalic characters include: a narrow pointed uncus, a medially upturned and pointed gnathos, and a long narrow valva with a ventral lobe at the distal end of the sacculus. The cucullus is poorly differentiated. Females have two thornlike signa in the corpus bursae and a sclerotized ring around the ductus bursae at the juncture with the corpus bursae.

12. *Episimus argutanus* (Clemens)

FWL: 4.5-7.0 mm.

Flight Period: Mid-May though late August.

Distribution: Transcontinental, from southern Canada to northern Mexico.

Biology: The larvae are leaf-rollers, utilizing a variety of plants including *Rhus* (sumac), *Toxicodendron* (poison ivy and poison oak), *Hamamelis virginiana* (witchhazel), and *Euphorbia* (spurge) (Heppner, 1994).

Remarks: The median fascia is represented by a dark brown dash at mid-costa. The distal margin of the subbasal fascia often can be detected, but frequently the basal half of the wing is uniformly mottled with reddish-brown and pale tan scales. There is a white line along the termen that is interrupted by both a lustrous gray stria extending from the costa and some brown scaling anterior to the ocellus.

13. *Episimus tyrius* Heinrich

FWL: 4.5-6.0 mm.

Flight Period: June to August; year round in Florida.

Distribution: New York to Texas, southeast to Florida.

Biology: The pimary host is *Acer* (red maple, silver maple, and southern sugar maple). Others include *Persea borbonia* (redbay) and *Prunus caroliniana* (Carolina laurelcherry) (Heppner, 1994).

Remarks: For some time *tyrius* has been considered a species of the Gulf and Atlantic Coast states, but recent Kentucky records extend the known range inland. The forewing is distinguished by its reddish appearance and by the whitish band along the dorsum. The central reddish-brown mark, a fragment of the subbasal fascia, does not extend to the dorsal margin.

Genus *Paralobesia*

Paralobesia consists of 18 species. All but one are Nearctic and were described from the northeastern United States or eastern Canada. At least a dozen have been reported from the Midwest. These moths are notoriously difficult to identify, and the task is complicated by the existence of numerous undescribed species with forewings that are virtually indistinguishable from one or another of the recognized taxa. Morphologically similar species are sometimes separated by host plant. We treat eight species for which authoritative determinations could be obtained. The larvae typically feed in fruits or seeds of the host. One species, the grape berry moth (*P. viteana*), is a significant pest of grapes.

Historically these species were associated with several genera: *Endopiza*, erected by Clemens in 1860 for *viteana*; *Polychrosis*, described by Ragonot for *botrana* (the European grape berry moth) in 1894; and *Lobesia*, introduced by Guenée in 1845. Inconsistencies in the application of *Polychrosis* and *Lobesia* prompted Obraztsov (1953) to describe *Paralobesia*, in which he placed most of the North American *Polychrosis* species and the European *andereggiana*. Later, Diakonoff (1973) reinstated *Endopiza*, treating *Paralobesia* as a synonym, and this was the position adopted by Powell in the 1983 checklist. Finally, Brown (2005, 2006) pointed out that *Endopiza* is a misspelling of *Endopisa*, a synonym of *Grapholita*, and that *Paralobesia* is the taxonomically correct name for the genus. Nevertheless, references to *Endopiza* and *Polychrosis* persist in the current economic entomology literature.

In the latter part of the 19th century, all Nearctic species in this group were treated as the European *botrana*, based on a misidentification of *viteana* by Zeller in 1871. Kearfott (1904), after studying series of specimens reared from various host plants, realized that *botrana* did not occur in North America and began separating species based on larval hosts. Later studies by Heinrich (1926) and McDunnough (1938) utilized genitalic characters, but the putative morphological differences are sometimes so subtle that host information is still crucial in making identifications. Our treatment omits *palliolana* (McDunnough), *aemulana* (Heinrich), *vernoniana* (Kearfott), and *slingerlandana* (Kearfott), all reported from the Midwest, for lack of reared specimens and/or of reliable male-female associations.

Males have two particularly striking valval features: a cluster of long setae (the **saccular tuft**) on the ventral margin of the sacculus and a U-shaped indentation in the ventral margin of the neck with an associated pair of facing padlike projections that are densely covered with short stubby setae. The length of the saccular tuft, the structure of the projections, and teeth on the aedeagus are useful taxonomic characters. In females, the sterigma is often cone-shaped, the ostium is sometimes edged with fine spines, and two small accessory sacs may be present on the anterior surface of the corpus bursae.

14. *Paralobesia liriodendrana* (Kearfott)

FWL: 5.0-7.5 mm.

Flight Period: Late April to August.

Distribution: New Jersey to Ohio, south to Florida.

Biology: Larvae feed on leaves of *Liriodendron tulipifera* (tuliptree), *Magnolia grandiflora* (southern magnolia), and *M. virginiana* (sweetbay) (Kearfott, 1904, 1907; Heinrich, 1926; Peterson, 1960). Early instars mine the underside of the leaf near the midrib; later instars fold the entire leaf and feed on the upper surface. Pupation occurs under a folded flap cut into the leaf (Kearfott, 1904; Peterson, 1960).

Remarks: Of the Midwest species, *liriodendrana* is second only to *cyclopiana* in size. The wing pattern is similar to that of *viteana* and *monotropana*, but genitalia are diagnostic. In males, the saccular tuft is longer than the valva. The neck has only one ventral projection, which arises at the base of the cucullus. Females have a uniquely sculptured sterigma and two, long, ridgelike signa. This is the only midwestern species with signa.

15. ***Paralobesia viteana*** (Clemens)

FWL: 4.5-6.0 mm.

Flight Period: March to August.

Distribution: Eastern North America.

Biology: The larval host is *Vitis* (grape). Eggs are laid individually and larvae develop within the grapes. Pupation occurs in a cresent-shaped fold cut into a leaf, and the pupa overwinters in the fallen leaf. There are two to three generations per year (Johnson & Hammar, 1912; Botero-Garcés & Isaacs, 2003).

Remarks: Commonly known as the grape berry moth, *viteana* is the primary lepidopteran pest of grapes in North America (Isaacs et al., 2005). For many years it was confused with *botrana*, the European grape berry moth, until Kearfott (1904) recognized that these names refer to two distinct species. Wing pattern is very similar to that of *liriodendrana* and *monotropana*, but *viteana* can be distinguished by genitalic characters. Males have a narrow sclerotized lobe projecting from the base of the cucullus that is not present in any other midwestern species. The proximal ventral projection on the neck is half the length of the distal projection.

16. ***Paralobesia monotropana*** (Heinrich)

FWL: 5.0-6.0 mm.

Flight Period: August to early September.

Distribution: Recorded from Ohio and Maryland.

Biology: Larvae feed in the seed capsules of *Monotropa uniflora* (Indianpipe) (Heinrich, 1926).

Remarks: Forewing pattern is similar to that of *viteana* and *liriodendrana*. The male genitalia resemble those of *sambuci* but have a row of teeth on the aedeagus instead of a single tooth. The sterigma is more elongated than in *viteana*, and the posterior margin of the ostium is unevenly serrated. This species may have a wider distribution than indicated; we limited data collection to specimens reared from *Monotropa*.

17. ***Paralobesia rhoifructana*** (Kearfott)

FWL: 5.0-6.0 mm.

Flight Period: April to May.

Distribution: Maine to Ohio, south to Virginia and Kentucky.

Biology: Larvae feed in seed heads of *Rhus* (sumac) and in seeds of *Cornus* (dogwood) and *Kalmia* (laurel) (Heinrich, 1926).

Remarks: The white hindwing separates *rhoifructana* from all other midwestern *Paralobesia* except *yaracana*. The forewing pattern of *yaracana* has conspicuous silvery-white striae that extend from costa to dorsum. Male genitalia are similar to those of *yaracana* and *spiraeifoliana*, but *rhoifructana* lacks small lateral teeth on the aedeagus. The female sterigma is cone-shaped, and the posterior margin of the ostium is smooth.

18. ***Paralobesia yaracana*** (Kearfott)

FWL: 5.0-6.0 mm.

Flight Period: April to June.

Distribution: Recorded from New York, Ohio, Ontario, and Pennsylvania.

Biology: Unknown.

Remarks: This species is distinguished from other midwestern *Paralobesia* by the silvery-white forewing striae that extend from costa to dorsum and by the extensive white coloration in the basal area of the hindwing. In male valval structure, *yaracana*, *spiraeifoliana*, and *rhoifructana* are nearly identical. The first two species have 2-3 small lateral teeth on the aedeagus, the last has none. The sterigma is cone-shaped, with needlelike teeth projecting from the edge of the ostium.

19. ***Paralobesia sambuci*** (Clarke)

FWL: 4.5-6.0 mm.

Flight Period: Late May to early September.

Distribution: Recorded from Illinois.

Biology: The larval host is *Sambucus nigra* ssp. *canadensis* (American black elderberry) (Clarke, 1953).

Remarks: Forewing appearance and male genitalia are very similar to those of *monotropana*. The aedeagus has only one tooth versus a row of teeth in *monotropana*. The sterigma is cone-shaped, with lateral surface fluted and the edge of the ostium smooth.

20. ***Paralobesia spiraeifoliana*** (Heinrich)

FWL: 4.5-5.0 mm.

Flight Period: May through August.

Distribution: New Hampshire to Wisconsin, south to Kentucky.

Biology: The reported larval host is *Spiraea salicifolia* (willowleaf meadowsweet) (Heinrich, 1926).

Remarks: Forewing pattern is similar to that of *yaracana*, but *spiraeifoliana* lacks white coloration on either wing. Male genitalia are virtually indistinguishable from those of *yaracana*; they differ from those of *rhoifructana* by having lateral teeth on the aedeagus. The female sterigma is cone-shaped with needlelike teeth projecting from the edge of the ostium. Host data may be necessary for a positive identification due to similarity between *spiraeifoliana* and other species not covered here.

21. ***Paralobesia cyclopiana*** (Heinrich)

FWL: 6.5-8.5 mm.

Flight Period: April and May.

Distribution: Pennsylvania to Kentucky, south to Florida and Texas.

Biology: Larvae feed in the seed pods of *Magnolia virginiana* (sweetbay) (Heinrich, 1926).

Remarks: This is the largest species of *Paralobesia* in the Midwest. Its forewing pattern is unmistakable. The genitalia are also unique. The ventral projections on the valval neck are greatly reduced, the aedeagus has a single lateral tooth, and the socii are unusually well developed. The female sterigma is semi-rectangular and densely covered with minute spinules.

Genus *Lobesia*

Lobesia is a worldwide genus containing more than 100 species. Two are found in the Nearctic Region, and one of those, *carduana*, occurs in the Midwest. The larva is a leaf-roller on thistle.

Obraztsov revised the genus in 1953 with the intention of reconciling inconsistencies he observed in *Polychrosis* and *Lobesia*. He described *Paralobesia*, distinguishing it from *Lobesia* by differences in wing venation and male genitalia, and transferred the North American species *Polychrosis carduana* (Busck) and *Polychrosis spiraeae* (McDunnough) to *Lobesia*. This is the arrangement adopted in the current world catalogue.

The general structure of the male genitalia resembles that of *Paralobesia*, but the valva lacks a saccular tuft, and one of the ventral projections on the valval neck appears to be fused with the sacculus.

22. *Lobesia carduana* (Busck)

FWL: 5.0-6.5 mm.

Flight Period: Late May to early August.

Distribution: New Jersey to Michigan, south to Maryland and Illinois.

Biology: Larvae feed in terminals and flowers of *Cirsium* (thistle) (Heinrich, 1926; Marshall & Musgrave, 1937).

Remarks: Forewing pattern and coloration are similar to those of *Paralobesia*. Frequently the area between the subbasal and median fasciae is suffused with white at the dorsum, creating the appearance of an interfascial spot, but this character is variable. Males lack the saccular tuft prominent in *Paralobesia*. The sterigma is hemispherical in shape, and its surface is densely spinulate. Distributional information presented here is based on relatively few records.

Genus *Aterpia*

The worldwide genus *Aterpia* has only one North American respresentative, *approximana*, which is one of two midwestern olethreutines having a blackish forewing with blue irrorations.

Distinctive male genitalic characters include: socii reduced; anellus enlarged; valva with a well defined cucullus, a large lobe at the distal end of the sacculus, and long setae projecting from the saccular lobe and the ventral margin of the neck. Females have a strongly sculptured sterigma, with densely spinulate outward projections laterally flanking the ostium. The ductus bursae is extensively sclerotized, and the corpus bursae has one signum, a scobinate indentation.

23. *Aterpia approximana* (Heinrich)

FWL: 6.0-7.5 mm.

Flight Period: June to early September.

Distribution: New Brunswick to Manitoba, south to New Jersey and Kentucky.

Biology: The larva is a leaf-roller on *Lysimachia* (yellow loosestrife) (Ferguson, 1975; Godfrey et al., 1987).

Remarks: This moth is easily confused with *Hedya cyanana*. Both species have a uniformly dark forewing, with black subbasal, median, and postmedian fasciae and lustrous blue interfascial scaling. Examination of the genitalia is usually necessary to separate the two. Besides having distinctly different genitalia, males appear to be distinguishable based on antennal sensilla length: equal to width of flagellum in *approximana*, at most half that length in *cyanana*.

Genus *Eumarozia*

Eumarozia is a small New World genus. The one North American member, *malachitana*, is widely distributed in the eastern half of the United States. The larva feeds on leaves of common persimmon.

In the male genitalia, the uncus is weakly developed, and the long triangular socii are narrow at the base, expanded medially, and sharply acute at the apex. The valva has a well defined neck with moderately strong and densely distributed setae along the distal and ventral margins of the cucullus. The most striking feature is the single long spine arising near the base of the cucullus. At the distal end of the sacculus there is a tuft of setae and a small clasperlike flange, the latter being an extension of the margin of the basal excavation. Females have a ringlike sterigma, a long narrow ductus bursae which is looped medially and sclerotized over its entire length, and two large triangular signa.

24. *Eumarozia malachitana* (Zeller)

FWL: 6.0-7.0 mm.

Flight Period: Late May through October.

Distribution: Michigan to Minnesota, south to North Carolina, Florida and Texas.

Biology: Larvae feed in rolled leaves of *Diospyros virginiana* (common persimmon) (Heinrich, 1926; Marshall & Musgrave, 1937).

Remarks: No other midwestern olethreutine has this distinctive combination of an olive-green median patch and pink terminal area, colors that fade rather quickly with specimen age. Genitalic characters are outlined in the generic introduction.

Genus *Zomaria*

Zomaria is a Nearctic genus consisting of three species. Two were described from Florida and appear to be restricted to the southeastern United States. The third, *interruptolineana*, is found in oak-pine woodlands in eastern North America where acid soils support an undergrowth of huckleberry and blueberry. It is easily identified by forewing pattern.

The male gnathos is medially developed into an elaborate structure with a hooked distal projection overhanging the aedeagus. The ventral margin of the valval neck is deeply invaginated. The resulting cavity has a tuft of long spines on its lateral margin and a narrow, pointed, spined projection on its medial margin near the sacculus. In females, an outwardly protruding ridge surrounds the ostium anteriorly and laterally, and the sterigma has long, tapering, lateral projections. The corpus bursae has one signum, which is in the form of a scobinate patch.

25. *Zomaria interruptolineana* (Fernald)

FWL: 5.0-7.0 mm.

Flight Period: Mid-April to August.

Distribution: New Hampshire to Minnesota, south to Florida and Texas.

Biology: Heinrich (1926) reported *Gaylussacia* (huckleberry) and *Vaccinium* (blueberry) as larval hosts. Capture dates suggest this species is bivoltine.

Remarks: The specific name likely refers to the interrupted brown to blackish-brown streak that follows the distal margin of the subbasal fascia from dorsum to mid-wing, crosses the middle tooth of the median fascia, and continues between M2 and M3 toward the termen. The signum has two, flat, thumb-shaped lobes projecting interiorly from the center of a scobinate patch.

Genus *Apotomis*

The Holarctic genus *Apotomis* has fifteen recognized species in North America. Most are confined to the Northeast, Canada, and/or the Rocky Mountains, where the larvae are leaf-tiers on willow, birch, or aspen. We treat three species that occur in the northern Midwest. Although forewing appearance is usually sufficient for determination to genus, it is often an inadequate basis for species identifications due to the large amount of intraspecific variation exhibited by the moths in this group. Examination of the genitalia is recommended.

The male valva has a thumblike projection at the distal end of the sacculus, a long narrow neck, and a spatulate cucullus. Interspecific differences can be quite subtle and tend to be formulated in terms of the number and size of the cornuti in the vesica, the setation of the saccular projection, and the geometry of the cucullus. In females, the long narrow ductus bursae has a sclerotized bend or loop, and the corpus bursae has two scobinate thimble-shaped signa. A detailed discussion of genitalic characters can be found in Adamski and Peters (1986), the most recent revision of the genus.

26. *Apotomis capreana* (Hübner)

FWL: 6.5-9.0 mm.

Flight Period: June to September.

Distribution: Nova Scotia and Massachusetts to British Columbia, south in the Rocky Mountains to Arizona and New Mexico, and south along the Pacific coast to northern California.

Biology: The larvae feed in webbed leaves of *Salix* (willow) and *Betula* (birch) (Adamski & Peters, 1986; Miller, 1987).

Remarks: This Holarctic species usually can be identified by the white distal portion of the forewing together with the white hook-shaped inflection in the distal margin of the median fascia. In northern parts of the Midwest it is sympatric with *funerea* (Meyrick), which has a similar appearance but lacks the distinct hook-shaped inflection.

27. *Apotomis deceptana* (Kearfott)

FWL: 7.5-10.0 mm.

Flight Period: July and August.

Distribution: Maine to Alberta, south into Michigan, Wisconsin and Minnesota.

Biology: Larval hosts include *Salix* (willow) and *Populus* (poplar) (Adamski & Peters, 1986).

Remarks: The blackish-gray basal patch and median fascia are well defined on the anterior half of the forewing but fade toward the dorsum. There is usually a black dash along the radius from the base to the distal margin of the basal patch. Interfascial areas are pale gray.

28. ***Apotomis removana*** (Kearfott)

FWL: 7.5-11.0 mm.

Flight Period: June to September.

Distribution: Nova Scotia to Alberta, south to Pennsylvania and Indiana in the east, to New Mexico and California in the west.

Biology: The larva feeds on *Populus tremuloides* (quaking aspen) (Adamski & Peters, 1986).

Remarks: The forewing is charcoal gray with white irrorations, producing what has been referred to as a calico appearance. Some phenotypes resemble *deceptana* but have a well defined postmedian fascia and a more complete basal patch and median fascia.

Genus *Pseudosciaphila*

The only Nearctic member of the genus (*Pseudosciaphila duplex*) is easily identified by forewing appearance and/or features of the genitalia. The larva is a leaf-roller on poplar.

The male valva has a long thin neck, a spatulate cucullus, two distinctive spine clusters on the sacculus, and a basal patch of setae on the lateral surface. There are clusters of spines at each apex of the bifid uncus. The female sterigma is a U-shaped plate with a prominent, collarlike, outward projection surrounding the ostium. The corpus bursae has two crescent shaped signa.

29. *Pseudosciaphila duplex* (Walsingham)

FWL: 9.0-12.5 mm.

Flight Period: Late May to late July.

Distribution: Quebec to British Columbia, south to Pennsylvania, Colorado and California.

Biology: The larva is a leaf-roller, preferring *Populus tremuloides* (quaking aspen) but also feeding on *Populus grandidentata* (bigtooth aspen). Other recorded hosts include *Populus balsamifera* (balsam poplar), *Acer* (maple), *Betula* (birch), *Alnus* (alder) and *Salix* (willow) (Prentice, 1966; McGregor, 1967).

Remarks: Typical specimens have a conspicuous basal patch and median fascia, with white interfascial scaling, but both light and dark unicolorous phenotypes are encountered occasionally. This is a common early summer moth in the upper Midwest.

Genus *Orthotaenia*

There are two recognized species of *Orthotaenia*, one described from Russia, the other from Austria. The latter, *undulana*, occurs in North America, where for many years it was known as *Badebecia urticana* (Hübner). It is a common leaf-roller across southern Canada and northern United States.

In males the uncus is pointed, the gnathos is spined medially, and the aedeagus has a single stout cornutus. The valva has a long narrow neck, a spatulate cucullus, and a ventral thumblike projection at the distal end of the sacculus. There are patches of strong spines on the ventral projection and at the base of the cucullus, and there is a line of similar spines along the ventral margin of the neck. The sterigma is ringlike around the ostium and has well developed, posterolateral, tongue-shaped projections. The ductus bursae is strongly sclerotized and expanded from ostium to ductus seminalis, and the corpus bursae has one scobinate patch.

30. *Orthotaenia undulana* (Denis & Schiffermüller)

FWL: 5.5-9.0 mm.

Flight Period: Late May through mid-July.

Distribution: New Brunswick to British Columbia, south to Kentucky, Arkansas and Arizona.

Biology: Prentice (1966) reported collections from sixteen tree species, but the preferred host appears to be *Populus tremuloides* (quaking aspen). Other frequently utilized hosts include *Populus balsamifera* (balsam poplar), *Salix* (willow), and *Betula* (birch). The larva is a leaf-roller.

Remarks: This moth is easily confused with several similar looking species of *Olethreutes* such as *valdana*, *trinitana*, and *glaciana*. Examination of the genitalia is recommended for positive identification.

Genus *Phaecasiophora*

Phaecasiophorsa is primarily a genus of the Oriental Region, but three species have been described from North America. One seems to be restricted to the southeastern coastal states; the other two, *confixana* and *niveiguttana*, are common in the Midwest. In forewing maculation they resemble members of *Olethreutes*, with a well developed complement of dark fasciae and lighter striate interfascial areas. Males have prominent dilated and tufted scaling on the hind tibia.

In the male genitalia, the uncus is a weakly developed triangular lobe, and the socii are semitriangular with broad bases. Both of these appendages are densely setose. The distal half of the valva is uniform in width, with the cucullus barely differentiated from the neck. In females, the lamella postvaginalis is a semirectangular plate with acute anterolateral corners that project below the abdominal membrane. The corpus bursae lacks signa.

31. *Phaecasiophora confixana* (Walker)

FWL: 8.0-9.5 mm.

Flight Period: May through August.

Distribution: New Hampshire to Michigan, south to Alabama and Texas.

Biology: Unknown.

Remarks: The fascial markings are brown, and the interfascial areas pale tan with brown to blackish-brown striations. Fresh specimens can have a greenish tint, and melanic individuals show considerable black suffusion in the fasciae. Most specimens have a streaked appearance due to longitudinal lines of light scaling on the fasciae. This moth is larger than the similar looking *niveiguttana*, and the tufted scaling on the male hind tibia is more pronounced than in the latter species.

32. *Phaecasiophora niveiguttana* Grote

FWL: 6.5-8.5 mm.

Flight Period: Mid-April through September.

Distribution: Massachusetts to Minnesota, south to Florida and Texas.

Biology: The host is *Sassafras albidum* (sassafras) (Heinrich, 1926). The larvae form a feeding shelter of tied leaves.

Remarks: Forewing maculation is very similar to that of *confixana*, but this species is smaller and has a more orange-brown appearance, with less prominent longitudinal streaking. Both species have a white dot on the median fascia at the distal end of the cell, but it is more conspicuous in *niveiguttana*. The female ductus bursae is longer and more strongly sclerotized in *niveiguttana.*

Genus *Olethreutes*

The worldwide genus *Olethreutes* reaches its greatest diversity in the Nearctic. It is represented by approximately 80 recognized species in North America, most of which are endemic to the eastern half of the continent; this guide treats 51. Some species are notoriously difficult to identify due to an abundance of interspecific similarities in color and forewing pattern and only subtle differences in genitalia. In many instances, knowledge of the host plant is necessary for a confident determination. Life history information is available for about two thirds of the Nearctic species, and in all cases the larvae are leaf-tiers or leaf-rollers on deciduous trees and shrubs.

Males of about half of the Nearctic species have a rodlike lobe extending from the anal angle of the hindwing, sometimes called the anal roll. This character once was used to recognize members of the former genus *Exartema*. Heinrich (1926) considered *Exartema* to be derived from *Olethreutes*, but Diakonoff (1973) synonymized the two genera under the latter name.

The *Olethreutes* lineage is quite homogenous with regard to wing pattern. Typically the basal, subbasal, and median fasciae are well expressed, and most species have a clearly defined postmedian band and pretornal patch. The basal and subbasal fasciae are often confluent, but the resulting basal patch tends to be incomplete anterior to the radius, the proximal portion of the costa being of lighter coloration. The median fascia has two distal projections, referred to as **teeth**, one located roughly over the radius, the other over the cubitus. In nearly all cases the forewing markings are edged with thin lines of lighter coloration. Interfascial areas are filled with pale lustrous scales, often a shade of gray, and are overlaid with striations that are concolorous with the fasciae.

In the male genitalia, the ventral margin of the valval neck is deeply invaginated, and the medial margin of the resulting cavity is strongly arched and often produced near the cucullus. The lateral edge of this cavity usually supports a fingerlike projection, called the **digitus**, the location of which relative to the sacculus and cucullus is diagnostically useful. The medial edge of the cavity bears a variety of spines and spine clusters that can be useful in separating species, though interspecific differences in these characters are sometimes quite subtle.

In females, the sculpturing of the sterigma is taxonomically informative. Members of the *Exartema* group have a pair of external projections laterally flanking the ostium and a third projection on the lamella postvaginalis posterior to the ostium that is usually divided medially into two distinct lobes. Intraspecific variation in these structures has rarely been studied, so their diagnostic reliability is uncertain. The non-*Exartema* species often have large scooped-out indentations in the sterigma on either side of the ostium and distinctive sculpturing of both the lamella postvaginalis and tergum IX. The corpus bursae has at most one signum and frequently has none. When present the signum usually takes the form of a scobinate patch.

33. ***Olethreutes monetiferana*** (Riley)

FWL: 9.0-11.0 mm.

Flight Period: Late April to early June.

Distribution: Pennsylvania and Ohio, south to South Carolina, Louisiana, and Arkansas.

Biology: Larvae have been reared on *Aesculus flava* (yellow buckeye) (Gibson & Merkle, 2007).

Remarks: The median fascia is overlaid with circular patches of the lighter interfascial color giving the forewing a spotted appearance. The resulting fragmented pattern distinguishes *monetiferana* from other eastern *Olethreutes*. The digitus arises near the sacculus, and the corpus bursae lacks a signum. Adults are sometimes active diurnally.

34. ***Olethreutes nitidana*** (Clemens)

FWL: 7.0-8.5 mm.

Flight Period: Mid-June to late August.

Distribution: Vermont to Wisconsin, south to Kentucky.

Biology: One individual was reared from tied leaves of *Acer* (maple) (Wright, unpublished).

Remarks: Orange-brown forewing color in combination with the long slender teeth of the median fascia is usually sufficient to identify *nitidana*. This species might be confused with orange specimens of *sericorana*, but the digitus arises near the cucullus in *sericorana* and near the sacculus in *nitidana*. Females of the two species can be separated by the sculpturing of the sterigma. The corpus bursae lacks a signum.

35. ***Olethreutes furfurana*** (McDunnough)

FWL: 6.5-8.5 mm.

Flight Period: Late May to early September.

Distribution: Vermont to Minnesota, south to Florida and Louisiana.

Biology: The reported larval host is *Rubus* (blackberry) (Miller, 1979).

Remarks: This dull greenish-gray moth shows little contrast between the fascial markings and dark lustrous-gray interfascial areas. The median fascia is darker at the costa. The digitus arises near the sacullus, and the corpus bursae lacks a signum.

36. ***Olethreutes comandrana*** (Clarke)

Holotype male

FWL: 6.5-7.0 mm.

Flight Period: Late May through July.

Distribution: Recorded from Illinois, Indiana, Michigan and Ohio.

Biology: Larvae feed on rolled leaves of *Comandra umbellata* (bastard toadflax) (Clarke, 1953).

Remarks: The forewing pattern of *comandrana* resembles that of *merrickana* but lacks the distinctive dark spot on the postmedian band of the latter species. Male specimens of the two species can be separated by the position of the digitus, which arises near the sacculus in *comandrana* and near the cucullus in *merrickana*. Female specimens of *comandrana* have a signum in the corpus bursae, those of *merrickana* do not.

37. *Olethreutes olivaceana* (Fernald)

FWL: 5.0-7.0 mm.

Flight Period: Late May to mid-August.

Distribution: Maine to British Columbia, south to Kentucky.

Biology: Larvae feed in rolled leaves of *Fragaria* (strawberry) (Miller, 1987).

Remarks: In fresh specimens the median fascia and postmedian band are strongly overlaid with olive-yellow scaling. This species is often confused with the similarly sized *troglodana*, but genitalia of the two are not alike. The digitus arises near the sacculus, and the corpus bursae lacks a signum.

38. *Olethreutes subnubilis* (Heinrich)

FWL: 6.0-8.0 mm.

Flight Period: Late June to early July.

Distribution: Maine and New York, south to Maryland and Kentucky.

Biology: Larvae feed on *Corylus* (hazelnut) (Heinrich, 1926).

Remarks: This species is superficially similar to *permundana*. Males can be distinguished by the position of the digitus: near the sacculus in *subnubilis*, near the cucullus in *permundana*. Females have a signum in the corpus bursae, those of *permundana* do not.

39. *Olethreutes footiana* (Fernald)

FWL: 8.0-9.0 mm.

Flight Period: Late June to early August.

Distribution: Vermont to Michigan, south to North Carolina and Kentucky.

Biology: Larvae have been reared from rolled leaves of *Hamamelis virginiana* (American witchhazel) and *Quercus* (oak) (Putman, 1935; Heinrich, 1926).

Remarks: The rich red-brown forewing markings contrast sharply with the pinkish-gray interfascial areas. The basal patch is incomplete, due to a narrow pinkish-white band along the costa from base to median fascia. In males, the anal angle of the hindwing is strongly produced, and the digitus, arising near the sacculus, has numerous blunt-tipped setae at the apex. The corpus bursae lacks a signum. Many museum specimens are reared and possess June emergence dates.

40. ***Olethreutes atrodentana*** (Fernald)

FWL: 8.0-9.5 mm.

Flight Period: July and August.

Distribution: Vermont to Manitoba, south to Mississippi.

Biology: The larva is a leaf-roller on *Quercus* (oak) (Prentice, 1966).

Remarks: Interfascial areas are yellowish white. The median fascia is nearly black at the costa, shading to yellowish olive at the dorsum. A blackish radial line in the discal cell is usually apparent on the median fascia and, to a lesser extent, in the basal patch, especially in worn individuals. The digitus arises near the sacculus, and the corpus bursae lacks a signum.

41. ***Olethreutes punctana*** (Walsingham)

FWL: 7.5-9.0 mm.

Flight Period: Mid-June to early August.

Distribution: Vermont to British Columbia, south to New Jersey and California.

Biology: The larva feeds in tightly rolled leaves of *Cornus* (dogwood) (McDunnough, 1933).

Remarks: Except for dark bars on the costa, the pale-olive median fascia and postmedian band are very weakly expressed. The anterior half of the basal patch is concolorous with the interfascial areas. The specific name derives from the small black dot in the discal cell, which contrasts sharply with surrounding pale coloration. The male digitus arises near the sacculus.

42. ***Olethreutes connectus*** (McDunnough)

FWL: 7.0-9.0 mm.

Flight Period: June through early September.

Distribution: Vermont to Michigan, south to Kentucky and Kansas.

Biology: Larvae feed in rolled leaves of *Cornus* (dogwood). Specific hosts include *C. foemina* (stiff dogwood), *C. sericea* ssp. *sericea* (redosier dogwood) (Godfrey et al., 1987), and *C. amomum* (silky dogwood) (Gibson, unpublished).

Remarks: The blackish posterior half of the basal patch aligns with the blackish anterior portion of the median fascia to form a dark shade from the base of the dorsal margin to mid-costa. It is only weakly interrupted by lighter scaling in the interfascial area, hence the name *connectus*. The costa from base to median fascia is whitish. Overall appearance is similar to that of *punctana*, including a dark patch of scales in the discal cell, though in this case the patch can be recognized as a tooth fragment of the median fascia. Like *punctana*, the digitus arises near the sacculus, but it lacks distal spines. The corpus bursae has a signum.

43. ***Olethreutes inornatana*** (Clemens)

FWL: 8.5-10.5 mm.

Flight Period: Early June to late August.

Distribution: New Hampshire to Minnesota, south to Alabama and Texas.

Biology: Larvae have been reared on *Prunus serotina* (black cherry) (Heinrich, 1926) and *Prunus virginiana* (chokecherry) (Godfrey et al., 1987). Other hosts reported by Heinrich (1926) are suspect due to possible misidentification of the adults.

Remarks: Adults of *inornatana* are superficially similar to those of *quadrifidus*. Both have a diffuse whitish streak from the base to the distal end of the discal cell, with darker scaling along the costa, termen and dorsum. Genitalic characters easily separate the two species. The digitus arises near the sacculus in *inornatana* but near the cucullus in *quadrifidus*. Females of *quadrifidus* have a signum, those of *inornatana* do not.

44. ***Olethreutes mysteriana*** Miller

FWL: 7.0-8.5 mm.

Flight Period: Late May to early August.

Distribution: Quebec to Wisconsin, south to New Jersey, Kentucky and Kansas.

Biology: The preferred host is *Ulmus americana* (American elm) (Miller, 1979), but several rearings have been reported from *Celtis occidentalis* (common hackberry) in Kentucky (Covell, 1999; Gibson, unpublished).

Remarks: Though similar to *inornatana* and *quadrifidus* in forewing pattern, this is generally a smaller species. It has often been confused with smaller specimens of *clavana* (Miller, 1979), complicating the interpretation of historical records, but the digitus is near the cucullus in *clavana* and near the sacculus in *mysteriana*. The corpus bursae lacks a signum.

45. ***Olethreutes mediopartitus*** (Heinrich)

FWL: 6.0-7.0 mm.

Flight Period: Uncertain; mid- to late May.

Distribution: Recorded from Kentucky, New York, and Virginia.

Biology: Two specimens reared on *Physocarpus* (ninebark) in NewYork emerged in late May (pin label, unpublished).

Remarks: This species is similar to *corylana* but smaller. Forewing fringe is pale except for dark marks at the apex and at the terminal end of the postmedian band; the fringe in *corylana* is reddish brown. The digitus is greatly reduced and arises near the sacculus. Females lack a signum in the corpus bursae.

46. ***Olethreutes exoletus*** (Zeller)

FWL: 6.5-8.0 mm.

Flight Period: June and July.

Distribution: Maine to Michigan, south and west to New Jersey, Ohio, and Iowa.

Biology: Larvae tie leaves of *Ribes* (currant) (Heinrich, 1926).

Remarks: The forewing is uniformly olive gray with no markings except a dark apical spot and, in fresh individuals, brownish-gray shading from the base of the dorsal margin to mid-costa. The digitus arises near the sacculus, and the corpus bursae does not have a signum.

47. ***Olethreutes quadrifidus*** (Zeller)

FWL: 8.0-9.0 mm.

Flight Period: June and July.

Distribution: Nova Scotia to British Columbia, south to Indiana.

Biology: Heinrich (1926) reported the larval host as *Cornus* (dogwood). Reports of rearings from *Prunus* (cherry) (Prentice, 1966; Godfrey et al., 1987) may be based on misidentifications of *inornatana*.

Remarks: Size and forewing pattern are similar to those of *inornatana*, but fresh specimens of *quadrifidus* often have red-orange scaling along the costa and white accenting on the cubital and median veins. Differences in genitalia are discussed under *inornatana*.

48. ***Olethreutes tiliana*** (Heinrich)

FWL: 9.0-10.0 mm.

Flight Period: June through mid-August.

Distribution: Vermont to Michigan, south to New Jersey and Missouri.

Biology: Larvae feed in tied leaves of *Tilia* (basswood) (Heinrich, 1926).

Remarks: Adults of *tiliana* are very similar in size and appearance to *lacunana* and some forms of *nigrana*. In *tiliana* and *nigrana*, the digitus arises near the cucullus; in *lacunana* the digitus is reduced to a rounded lobe at the distal end of the sacculus. Females of all three species lack a signum in the corpus bursae.

49. ***Olethreutes sciotana*** (Heinrich)

FWL: 9.0-10.5 mm.

Flight Period: Late May to early July.

Distribution: Recorded from Kentucky and Ohio.

Biology: The preferred larval host is *Aesculus glabra* (Ohio buckeye), though rearings on *Aesculus flava* (yellow buckeye) have also been reported (Braun, 1951). Larvae begin feeding in mid-April, forming shelters by tying adjacent leaflets together along the midrib. Indoor emergence of adults occurs in early to mid-May.

Remarks: This is one of the larger members of the genus. It has a drab olive appearance, and the median fascia is divided in the discal cell by a tan longitudinal dash. The digitus arises near the cucullus, and the corpus bursae has a signum. In the mid-Ohio River Valley, *sciotana* is sympatric with *ochrosuffusana*, a common species that shares the same food plants. Larvae of *ochrosuffusana* develop a week to ten days earlier that those of *sciotana*.

50. ***Olethreutes appalachiana*** (Braun)

FWL: 8.5-10.5 mm.

Flight Period: This moth appears to be known only from reared adults, whose emergence dates range from late May into early June.

Distribution: Eastern portions of Kentucky and Tennessee.

Biology: Larvae feed on tied leaves of *Aesculus flava* (yellow buckeye) (Braun, 1951).

Remarks: The forewing is similar in size and pattern to that of *sciotana*, but *appalachiana* has a distinctly reddish-brown appearance, with fasciae sharply defined against pinkish interfascial areas. The digitus arises near the cucullus, and the corpus bursae has a signum. Braun (1951) reported considerable variation in the sculpturing of the sterigma.

51. ***Olethreutes clavana*** (Walker)

FWL: 7.0-10.0 mm.

Flight Period: Early June to mid-August.

Distribution: Quebec to Wisconsin, south to Maryland and Kentucky.

Biology: Miller (1979) reported one specimen reared from *Corylus* (hazelnut).

Remarks: Adults of *clavana* resemble those of *nigrana*; both species have dark phenotypes with black shading along the dorsal margin of the forewing. The dark form of *clavana* has blackish-brown to olive-brown fasciae and considerable lustrous gray scaling in the interfascial areas. The dark form of *nigrana* is brighter, with more pink than gray interfascial scaling, and with reddish-brown to pale-olive fascial markings. Individuals of the two species without black dorsal shading are difficult to separate. Those of *clavana* tend to be golden brown versus blackish brown in *nigrana*.

52. ***Olethreutes nigrana*** (Heinrich)

FWL: 7.5-10.5 mm.

Flight Period: June through mid-August.

Distribution: Quebec to Wisconsin, south to New Jersey, Kentucky, and Illinois.

Biology: Larvae feed in tied leaves of *Acer saccharum* (sugar maple) (McDunnough, 1942; Prentice, 1966).

Remarks: Forewing pattern is constant, but variation in color produces many different looking phenotypes. The most easily recognized form has the area between CuP and the dorsal margin suffused with black. Even phenotypes that lack this dark shading exhibit traces of it along CuP. The color of the median fascia is variable: unicolorous brown or olive green to dark reddish brown at costa and dorsum with pale creamy white in the discal cell. Some *clavana* specimens also have the black dorsal shading, though usually to a lesser extent. They tend to be a little smaller and lack any of the pink to reddish brown coloration that is common in *nigrana*. The male genitalia of these two species are virtually indistinguishable, though the spines on the medial margin of the neck cavity are purported to be a little longer in *nigrana* (Miller, 1979). In both cases the digitus arises near the cucullus. Both species lack a signum, but subtle differences in sculpturing can be observed in the sterigmata.

53. ***Olethreutes viburnana*** (McDunnough)

FWL: 7.5-9.5 mm.

Flight Period: Early June through mid-July.

Distribution: Southeast Ontario to Wisconsin, south to Kentucky.

Biology: The larva feeds in tied leaves of *Viburnum lentago* (nannyberry) (Putman, 1935) and *V. prunifolium* (blackhaw) (Merkle, pers. comm.). Godfrey et al. (1987) reported *Prunus virginiana* (chokecherry) as a host, which may be based on a misidentification of the moth.

Remarks: The forewing fasciae are dark brown, and the interfascial areas are dark blue-gray, producing a very dark appearance, particularly in the basal half of the wing. The fasciae are edged with orange-brown, and the interfascial area anterior to the tornus is variably suffused with similar color. The whitish basal portion of the hindwing contrasts strongly with the base of the forewing. The digitus arises near the cucullus, and the corpus bursae lacks a signum.

54. ***Olethreutes merrickana*** (Kearfott)

FWL: 8.0-9.5 mm.

Flight Period: June to mid-August.

Distribution: Quebec to Wisconsin, south to North Carolina, Kentucky, and Missouri.

Biology: Rearings have been reported from *Ostrya virginiana* (hophornbeam) (McDunnough, 1944) and *Carya* (hickory) (Prentice, 1966).

Remarks: This moth resembles *corylana* and *hamameliana*. All three species have a whitish shade running diagonally from the base of the dorsal margin to just short of the apex, and none has a well expressed basal or subbasal fascia. The median fascia and postmedian band are reddish brown. The central portion of the latter is overlaid by a conspicuous black spot that connects basally to the central tooth of the median fascia. The digitus arises near the cucullus, and the corpus bursae lacks a signum.

55. ***Olethreutes hamameliana*** (McDunnough)

FWL: 8.0-9.5 mm.

Flight Period: Late May to mid July.

Distribution: Vermont to Wisconsin, south to North Carolina, Alabama, and Arkansas.

Biology: Larvae roll leaves of *Hamamelis virginiana* (American witchhazel) (McDunnough, 1944).

Remarks: Though similar to *merrickana*, the terminal portion of the forewing has more reddish suffusion in *hamameliana*, and there is only a trace of the black blotch that is so prominent on the postmedian band of *merrickana*. Some black scaling can be found on the central tooth of the median fascia, but it does not extend to the postmedian band. The digitus arises near the cucullus, and the corpus bursae lacks a signum.

56. ***Olethreutes corylana*** (Fernald)

FWL: 7.0-8.5 mm.

Flight Period: Mid-June to mid-July.

Distribution: New Hampshire to Manitoba, south to Washington D. C., Kentucky and Illlinois.

Biology: Larvae feed in tied leaves of *Corylus americana* (American hazelnut) (Heinrich, 1926).

Remarks: Though similar to *merrickana* and *hamameliana*, *corylana* is dull olive and considerably smaller. The only reddish scales on the forewing are in the fringe. The digitus arises near the cucullus, and the corpus bursae has no signum.

57. ***Olethreutes ochrosuffusana*** (Heinrich)

FWL: 9.0-10.5 mm.

Flight Period: June through mid-July.

Distribution: Michigan and Ohio, south to Louisiana and Kansas.

Biology: Larvae are leaf-tiers on *Aesculus* (buckeye) (Heinrich, 1926). Specific hosts include *A. glabra* (Ohio buckeye), *A. flava* (yellow buckeye) (Braun, 1951), and *A. pavia* (red buckeye) (Merkle, pers. comm.).

Remarks: Forewing markings are brownish gold, interfascial areas yellowish gray. The median fascia is fragmented and weakly expressed. The posterior margin of the basal patch aligns with the costal extremity of the median fascia to give the impression of a dark shade from base to mid-costa. The digitus arises near the cucullus, and the corpus bursae has a signum.

58. ***Olethreutes brunneopurpuratus*** (Heinrich)

Holotype female

FWL: 6.5 mm.

Flight Period: Uncertain; possibly July to late August, based on very few records.

Distribution: Recorded from Kentucky, Mississippi, New York, and Virginia.

Biology: Larvae tie leaves of *Alnus* (alder) (Heinrich, 1926).

Remarks: Very little is known about this species. It is small and dark, with brown fasciae that are generously overlaid with black scaling. The metallic interfascial scaling has a purplish tint. The digitus arises near the sacculus, and the corpus bursae lacks a signum.

59. ***Olethreutes ferrugineana*** (Riley)

Syntype male

FWL: 8.0-9.0 mm.

Flight Period: Uncertain; an adult reared by Braun emerged June 26 (Covell, 1999).

Distribution: Recorded from Kentucky, Missouri, and New Jersey.

Biology: The larval host is reported as *Prunus* (plum) (Riley, 1881).

Remarks: This species is known from only a few historical records. The specimen illustrated is a syntype. The digitus arises near the cucullus, and the corpus bursae lacks a signum.

60. ***Olethreutes fagigemmeana*** (Chambers)

FWL: 7.5-8.5 mm.

Flight Period: Mid-June to early August.

Distribution: Pennsylvania to Michigan, south to Mississippi.

Biology: Larval hosts include *Fagus grandifolia* (American beech) and *Ostrya virginiana* (hophornbeam) (Heinrich, 1926).

Remarks: The male forewing has yellowish-olive fasciae and silvery-gray interfascial areas. In females the distal portion of the forewing is suffused largely with orange, the interfascial scaling has a pinkish hue, and the costal portion of the basal area is whitish. The digitus arises near cucullus, and the corpus bursae lacks a signum.

61. ***Olethreutes sericorana*** (Walsingham)

FWL: 7.0-8.0 mm.

Flight Period: Mid-June to mid-July.

Distribution: Maine to Minnesota, south to Georgia and Mississippi.

Biology: Heinrich (1926) reported *Myrica* (bayberry) as a larval host, but *sericorana* is found at locations where this plant has not been recorded.

Remarks: The fasciae are dark brown and variably suffused with olive gold, producing an overall golden-brown appearance. The subbasal fascia is conspicuous posterior to the radius and nearly obsolete near the costa. The digitus arises near the cucullus, and the corpus bursae lacks a signum.

62. ***Olethreutes melanomesa*** (Heinrich)

FWL: 6.5-8.5 mm.

Flight Period: Early June into August.

Distribution: Maine to Michigan, south to New Jersey and Kentucky.

Biology: The larva feeds in *Kalmia* (laurel) terminals (Miller, 1987).

Remarks: Forewing appearance is similar to that of *permundana*, but the median fascia and postmedian band are darker. The distal margin of the median fascia is less strongly invaginated between the teeth. The male digitus arises near the cucullus, and females lack a signum in the corpus bursae.

63. ***Olethreutes valdana*** (McDunnough)

FWL: 6.5-9.0 mm.

Flight Period: Mid-June to mid-August.

Distribution: Nova Scotia to Manitoba, south to Washington D. C. and Illinois.

Biology: The larva ties terminal leaves of *Spiraea alba* (meadowsweet) (McDunnough, 1956). McDunnough (1956) reported what he judged to be an accidental occurrence on *Myrica* (sweetgale).

Remarks: Silvery-white interfascial areas strongly accentuate the blackish-brown forewing markings which are variably suffused with olive-gold scaling. The basal fascia is complete to the costa, distinguishing this moth from the superficially similar *versicolorana*. The digitus arises near the cucullus, and the corpus bursae lacks a signum.

64. ***Olethreutes versicolorana*** (Clemens)

FWL: 7.0-8.5 mm.

Flight Period: Mid-June to early August.

Distribution: New York to Wisconsin, south to Pennsylvania and Indiana.

Biology: Larvae have been reared on *Cornus* (dogwood) in Ontario (MacKay, 1959).

Remarks: Forewing appearance is similar to that of *valdana*, but in *versicolorana* the basal fascia is incomplete, the costa being white from base to median fascia. The digitus arises near the sacculus, and the corpus bursae lacks a signum.

65. ***Olethreutes permundana*** (Clemens)

FWL: 7.0-9.5 mm.

Flight Period: June and July.

Distribution: Nova Scotia to Manitoba, south to Alabama and Mississippi.

Biology: Larvae tie leaves of *Rubus* (blackberry and raspberry). Other hosts reported by Heinrich (1926) likely are based on misidentifications of the moth (McDunnough, 1956). Rearings from *Physocarpus opulifolius* (common ninebark) were reported by Wheeler & Hoebeke (1985).

Remarks: There is a long history of confusion regarding the proper identity of this species. Following McDunnough (1956), we restrict application of the name to the *Rubus* feeding species, which is common and widespread. To date, no one has proposed morphological characters that will reliably separate *permundana* from similar looking species reared on other hosts. The digitus arises near the cucullus, and the corpus bursae lacks a signum.

66. ***Olethreutes malana*** (Fernald)

FWL: 5.5-7.0 mm.

Flight Period: Late June into early August.

Distribution: Massachusetts to Wisconsin, south to Pennsylvania, Mississippi and Missouri.

Biology: Larvae feed on terminal buds and woody shoots of *Malus* (apple), occasionally reaching pest status (Chapman & Lienk, 1971).

Remarks: This species is distinguished by extensive white coloration in the forewing. The median fascia is represented by a dark spot on the costa, a dark dot in the discal cell, and some gray shading at the dorsal margin. The basal and subbasal fasciae are well expressed at the dorsal margin but barely discernable near the costa. Similarities with *griseoalbana* are discussed under that species. The digitus arises near the cucullus, and the corpus bursae has a signum.

67. ***Olethreutes appendicea*** (Zeller)

FWL: 6.0-8.0 mm.

Flight Period: Late May through August.

Distribution: Maine to British Columbia, south to North Carolina, Mississippi and Colorado.

Biology: Larvae feed on tied leaves of a large variety of deciduous trees and shrubs including: *Prunus* (chokecherry), *Acer* (sugar, red, and mountain maple), *Alnus* (red and speckled alder), *Fagus* (beech), *Betula* (white birch), *Salix* (willow), *Ribes* (currant), *Rubus* (raspberry), *Amelanchier* (serviceberry), and *Populus* (quaking aspen) (Prentice, 1966). Heinrich (1926) reported *Quercus* (oak); Godfrey et al. (1987) reported *Corylus* (hazelnut) and *Rhus* (sumac); the authors have reared it on *Gaylussacia* (huckleberry).

Remarks: The markings are blackish brown, with olive suffusion on the postmedian band and the dorsal portion of the median fascia. Interfascial areas are white. The digitus is greatly reduced and not spined. The corpus bursae has a signum.

68. ***Olethreutes concinnana*** (Clemens)

FWL: 5.0-7.5 mm.

Flight Period: Mid-May into early September.

Distribution: Quebec to Minnesota, south to North Carolina and Tennessee.

Biology: Uncertain; Henirich (1926) reported *Rubus* (blackberry) as a host, but Miller (1979) was unable to confirm the record.

Remarks: The dark appearance of this moth is due to a lack of contrast between the forewing markings and interfascial areas. In some individuals, the forewing is heavily suffused with black from base to median fascia. The valva lacks a digitus, and the medial margin of the neck cavity is completely lined with thin spines. The corpus bursae has a signum.

69. ***Olethreutes fasciatana*** (Clemens)

FWL: 5.0-8.0 mm.

Flight Period: Mid-May to early August.

Distribution: Quebec to Minnesota, south to Florida and Texas.

Biology: The larva is a leaf-roller on *Populus* (quaking aspen and balsam poplar) and *Salix* (willow) (Prentice, 1966).

Remarks: Although similar to *valdana*, *versicolorana*, and *Orthotaenia undulana*, *fasciatana* has only one white transverse band on the forewing. In fresh specimens the basal patch is nearly black, sharply contrasting with the adjacent interfascial area. The distal half of the wing is variably overlaid with olive-gold scaling. The valva lacks a digitus, but the lateral margin of the neck cavity has a dense cluster of setae near the sacculus and a small patch of thin spines near the cucullus. The medial margin of the cavity is lined with spines. The corpus bursa has a signum.

70. ***Olethreutes troglodana*** (McDunnough)

FWL: 6.0-7.0 mm.

Flight Period: Late May to early July.

Distribution: Quebec to Minnesota, south to Mississippi.

Biology: Unknown.

Remarks: This moth is similar in size and appearance to *olivaceana*, and dissection is recommended for positive identification. Unlike *olivaceana*, the valva lacks a digitus, and both margins of the neck cavity are lined with spines. The corpus bursae has a signum.

71. ***Olethreutes exaeresima*** (Heinrich)

FWL: 8.0-9.5 mm.

Flight Period: June through July.

Distribution: Michigan and Wisconsin, south to Kentucky and Texas.

Biology: The larva rolls leaves of *Cornus* (dogwood) (Heinrich, 1926). Specific hosts include *C. foemina* (stiff dogwood) and *C. racemosa* (gray dogwood) (Godfrey et al., 1987).

Remarks: Forewing pattern and color resemble those of *permundana*, but the two species are easily separated by genitalic characters. In *exaeresima* the digitus takes the form of a spatulate lobe which lacks spines but is densely setose; it arises near the sacculus. The narrow spined digitus of *permundana* arises near the cucullus. The corpus bursae lacks a signum.

72. ***Olethreutes lacunana*** (Freeman)

FWL: 8.0-9.0 mm.

Flight Period: Late May to mid-August.

Distribution: New England and Ontario, south to South Carolina and Indiana.

Biology: Unknown.

Remarks: Adults of *lacunana* are nearly identical to *tiliana* in forewing pattern and coloration, but the male genitalia resemble *exaeresima*. It differs from *exaeresima* in that the digitus is narrower and constricted at the base. The corpus bursae lacks a signum.

73. ***Olethreutes ferriferana*** (Walker)

FWL: 7.0-8.5 mm.

Flight Period: Late May to early July.

Distribution: Vermont to Indiana, south to North Carolina, Alabama and Arkansas.

Biology: The host is *Hydrangea arborescens* (wild hydrangea) (Heinrich, 1926). The larva feeds and pupates in a balloonlike enclosure formed by tying the edges of two terminal leaves.

Remarks: The reddish-brown forewing markings are unlike any other midwestern *Olethreutes*. The basal patch is complete, and the sharply delineated median fascia extends from costa to discal cell, merging with the postmedian band. The valva lacks a digitus. The neck cavity has a short line of thin spines located medially on the lateral margin, a line of strong spines on the distal half of the medial margin, and several thin spines on the basal surface of the cavity. The corpus bursae lacks a signum.

74. ***Olethreutes auricapitana*** (Walsingham)

FWL: 5.0-6.0 mm.

Flight Period: June and July.

Distribution: Nova Scotia to Missouri, south to Virginia and Alabama.

Biology: Heinrich (1926) reported *Betula lutea* (yellow birch) as a larval host.

Remarks: Except for gold edging along the apex and lustrous blue-gray interfascial scaling, the forewing appears black. Gold scaling on the frons and vertex of the head distinguish this species from *Pristerognatha agilana*, which has a brownish-gray head. The valva has strong spines on the medial margin of the neck cavity, clustering at the base of the cucullus, and a dense patch of weak spines on the basal end of the neck cavity. The corpus bursae has a signum.

75. ***Olethreutes albiciliana*** (Fernald)

FWL: 5.0-6.5 mm.

Flight Period: Mid-June to mid-July.

Distribution: Maine to British Columbia, south to South Carolina and Indiana.

Biology: The larva is a leaf-roller on *Spiraea* (spirea) and *Alnus* (alder) (Prentice, 1966; Ferguson, 1975).

Remarks: Although similar in size and coloration to *auricapitana* and *Pristerognatha agilana*, the forewing of *albiciliana* has yellowish-white fringe from the apex to mid-termen. In males the digitus is lacking, and the medial margin of the valval neck cavity is strongly produced and lined with stout spines. The uncus is narrower than that of *P. agilana* and *auricapitana*. Females have a signum in the corpus bursae.

76. ***Olethreutes astrologana*** (Zeller)

FWL: 5.5-8.5 mm.

Flight Period: Late May to mid-August.

Distribution: Maine to British Columbia, south to Alabama and New Mexico.

Biology: Unknown.

Remarks: Forewing pattern and color are similar to those of *coruscana* and *ferrolineana*, but *astrologana* tends to be smaller and darker. The three are best separated by genitalic characters, with *astrologana* being the most distinctive. The male valva lacks a digitus, and the uncus is bilobed. The other two species have a large digitus and a rounded uncus. All three females have a tacklike signum, but there are differences in the sculpturing of the sterigmata.

77. ***Olethreutes coruscana*** (Clemens)

FWL: 7.0-10.5 mm.

Flight Period: Late May to early August.

Distribution: New Hampshire to Minnesota, south to Virginia, Tennessee and Kansas.

Biology: Unknown.

Remarks: Of the three midwestern species with a blue-speckled, gold and black forewing, *coruscana* is the largest. Examination of the genitalia is recommended for distinguishing *coruscana* from *ferrolineana*. The males are nearly identical, but in *coruscana* the medial margin of the neck cavity has a line of spines from the top of the arch to the cucullus, whereas the central portion of that line is lacking in *ferrolineana* (Miller, 1985d). Comparison with *astrologana* is discussed under that species.

78. ***Olethreutes ferrolineana*** (Walker)

FWL: 6.5-9.5 mm.

Flight Period: Mid-April to mid-July.

Distribution: New Hampshire to Minnesota, south to North Carolina and Arkansas.

Biology: Unknown.

Remarks: This is a common species of old fields in the Midwest. It is similar to *astrologana* and *coruscana* but tends to have more gold on the forewing. Male genitalia of *ferrolineana* and *coruscana* are nearly identical, but *ferrolineana* lacks a continuous line of spines on the medial margin of the neck cavity (Miller, 1985d). Both *ferrolineana* and *coruscana* lack the bilobed uncus found in *astrologana*. Females of all three species can be separated by differences in the sterigmata.

79. ***Olethreutes glaciana*** (Möschler)

FWL: 5.0-8.0 mm.

Flight Period: June to mid-October.

Distribution: Labrador to British Columbia, south to North Carolina, Wisconsin and Arizona.

Biology: The larva is a leaf-roller on a variety of trees, including *Acer* (sugar maple), *Betula* (birch), *Salix* (willow), *Prunus* (chokecherry), and *Populus* (quaking aspen, balsam poplar, black cottonwood) (Prentice, 1966).

Remarks: This species is most similar to *bipartitana* and *trinitana*. The large digitus in *glaciana* has a setose medial surface and a large tuft of setae at the apex. The other two species lack a digitus. The corpus bursae has a signum.

80. ***Olethreutes bipartitana*** (Clemens)

FWL: 6.0-9.5 mm.

Flight Period: Late May to early September.

Distribution: Nova Scotia to Alaska, south to New Jersey, Indiana and Wyoming.

Biology: The larva feeds on *Spermolepis* (scaleseed) (Miller, 1987).

Remarks: Though similar in general appearance to *glaciana* and *trinitana*, the forewing beyond the median fascia tends to be more uniformly white, with only slight grayish scaling at the apex. Male genitalia are most similar to those of *trinitana*. The medial margin of the neck cavity is well produced with a semirectangular, rough-edged projection in *bipartitana* and a semitriangular smooth projection in *trinitana*. Both species have a prominent tuft of long setae: arising on the lateral margin of the cavity in *bipartitana*, on the base of the cavity in *trinitana*. The sculpturing of the sterigma is different in the two species. The female corpus busae has a signum.

81. ***Olethreutes trinitana*** (McDunnough)

FWL: 7.0-8.0 mm.

Flight Period: Early June to late July.

Distribution: Vermont to Wisconsin, south to Ohio and Indiana.

Biology: Unknown.

Remarks: Adults of *trinitana* can easily be confused with those of *glaciana* and possibly *bipartitana*. The lamella antevaginalis is greatly reduced in *trinitana* compared to the other two species. Differences in male genitalia are discussed under *glaciana* and *bipartitana*.

82. ***Olethreutes griseoalbana*** (Walsingham)

FWL: 6.0-7.0 mm.

Flight Period: Mid-May to late August.

Distribution: New Hampshire to Indiana, south to Alabama and Louisiana.

Biology: Unknown.

Remarks: The only other small whitish *Olethreutes* is *malana*, which lacks the black pretornal patch and the olive-green dorsal spot on the median fascia found in *griseoalbana*. The valva lacks a neck cavity. There is a patch of fine dense setae on the lateral surface of the basal portion of the valva, and the proximal end of the cucullus supports a cluster of stout spines. The lamella antevaginalis has a pair of flat, flaplike projections, and the corpus bursae has a signum.

83. ***Olethreutes osmundana*** (Fernald)

FWL: 5.0-6.5 mm.

Flight Period: June through August.

Distribution: Maine to Indiana, south to Florida and Louisiana.

Biology: Larvae feed on ferns, including *Osmunda regalis* (royal fern), *Osmunda cinnamomea* (cinnamon fern) and *Pteridium aquilinum* (western brackenfern) (Heinrich, 1926). A Kearfott record on *Ambrosia* (ragweed) seeds reported by Heinrich (1926) is likely incorrect.

Remarks: This species is characterized by the large orange patch on the dorsal margin, which overlays much of the median fascia and extends nearly to the costa. The valva lacks the usual neck cavity but has a cluster of spines near the cucullus. There is a single, nondeciduous cornutus at the apex of the aedeagus. The corpus bursae lacks a signum.

Genus *Celypha*

The one North American species of *Celypha*, formerly known as *Olethreutes cespitana*, has a worldwide distribution. It is a common transcontinental resident from southern Canada through the northern half of the United States but appears to be absent in the South and the desert Southwest.

84. *Celypha cespitana* (Hübner)

FWL: 5.5-8.0 mm.

Flight Period: May to September.

Distribution: New England to British Columbia, south to New Jersey, Kentucky, Colorado and California.

Biology: Hosts include *Trifolium* (clover) and *Fragaria* (strawberry) (Bennett, 1961); larvae build a feeding shelter of tied leaves. This species is multivoltine over much of its range.

Remarks: The fasciae are dark brown and usually well overlaid with olive-gold scaling. Interfascial areas are whitish with olive-gold irrorations. Forewing pattern is similar to that of *Olethreutes glaciana*, but *glaciana* is larger and has a more black-and-white appearance. Male genitalic characters include: ventral invagination of valval neck with strongly spined medial margin; lateral margin of valval neck developed into a triangular digitus with two stout setae on the medial surface; and two to three rows of spines on ventrolateral surface of valva from distal end of sacculus to mid-neck. The sterigma has a raised rim surrounding the ostium and large, semirectangular, lateral extensions, the latter being deeply depressed at the rounded corners posterior to the ostium. The surface of the sterigma is densely covered with minute spinules. The single signum is a scobinate patch.

Genus *Pristerognatha*

Until recently *Pristerognatha* was a strictly European genus, consisting of two species. Brown (2005) added the first North American species, *agilana*, by transferring it from *Olethreutes*. All three members of the genus have larvae that bore into stems of *Impatiens*.

85. *Pristerognatha agilana* (Clemens)

FWL: 4.5-7.0 mm.

Flight Period: May to early July.

Distribution: New York to Minnesota, south to Virginia and Mississippi.

Biology: The larva is a stem-borer in *Impatiens* (touch-me-not) (Heinrich, 1926, Putman, 1942).

Remarks: This moth is similar to *auricapitana*, but the scales of the vertex are brownish gray instead of yellow. The male valva lacks the digitus and ventral invagination of the neck found in many *Olethreutes*. There is a patch of densely packed setae at the distal end of the sacculus and an area of long, flat, blunt-tipped setae along the ventral margin of the neck. The female sterigma has an elevated ridge surrounding the ostium and triangular anterolateral projections. The corpus bursae lacks a signum.

Genus *Metendothenia*

Metendothenia consists of seventeen species, one of which, *separatana*, is found in the Nearctic. Previously placed under *Hedya*, *separatana* was transferred to *Metendothenia* by Diakonoff (1973), but this change was not reflected in the 1983 checklist.

86. *Metendothenia separatana* (Kearfott)

FWL: 5.5-7.5 mm.

Flight Period: Early May through August.

Distribution: Nova Scotia to Alberta, south to Georgia and Louisiana.

Biology: Recorded hosts include *Rosa* (rose), *Rubus* (blackberry), *Prunus* (black cherry), and *Crataegus* (hawthorn) (Chapman & Lienk, 1971). Heinrich (1926) reported *Delphinium* (larkspur) as a host, which seems unlikely. The larva is a leaf-roller.

Remarks: This species is similar to *Hedya nubiferana*, but *separatana* is smaller and has more whitish scaling in the dark basal portion of the forewing. It can be separated from *H. ochroleucana* by the well expressed, olive-gray, postmedian band and the black dot at the end of the discal cell, which is more prominent in *separatana*. The color of the apical region of the forewing varies from white to pink. A tuft of long setae originating from the base of the male cucullus distinguishes *separatana* from midwestern *Hedya*. The medial portion of the lamella antevaginalis is strongly raised above the otherwise flat platelike sterigma and is bordered laterally by a pair of thin spinulate ridges. The corpus bursae has two scobinate signa versus two tacklike signa in *Hedya*.

Genus *Hedya*

Hedya is a Holarctic genus of about 30 species. Four occur in North America, of which two were described from the Palearctic. All four reside in the Midwest, where the larvae are leaf-tiers, primarily on rose and apple. A fifth species, *separatana*, long considered a member of *Hedya*, was transferred to *Metendothenia* by Diakonoff (1973).

Males have an elongate cucullus, with strong spining on the medial surface along the ventral and basal margins. Conspicuous patches of setae are located on the ventral margin of the neck, at the distal end of the sacculus, and/or on a clasperlike projection on the margin of the basal opening. The female sterigma approximates a truncated cone, and its lateral surface is densely covered with minute spinules. The corpus bursae has two tacklike signa.

87. *Hedya ochroleucana* (Frölich)

FWL: 7.5-9.5 mm.

Flight Period: Late June through September.

Distribution: New Foundland to British Columbia, south to Virginia, Missouri and Arizona; also in the Palearctic.

Biology: Prentice (1966) reported larvae on *Rosa* (rose), as well as single rearings from *Malus* (apple) and *Sorbus* (mountain ash).

Remarks: The following forewing characters separate *ochroleucana* from *nubiferana* and *Metendothenia separatana*: the distal margin of the dark basal region is convex, the discal dot is greatly reduced, consisting of a few black scales, and the apical region is almost uniformly yellowish white. All three species can be distinguished on the basis of male and/or female genitalia.

88. *Hedya nubiferana* (Haworth)

FWL: 8.5-10.0 mm.

Flight Period: Late May through June.

Distribution: Rhode Island and New York, south to Delaware and Ohio; also Nova Scotia, Prince Edward Island, British Columbia and Washington.

Biology: Chapman and Lienk (1971) reported larval collections on *Malus* (apple) and *Craetegus* (hawthorn). On apple, the eggs are laid on a leaf and newly hatched caterpillars feed on leaves and sometimes on adjacent fruit. Third-instar larvae overwinter in a hibernaculum on the tree and then complete development in the spring on flower buds and leaves. This moth was introduced from Europe, where numerous other hosts have been recorded (Razowski, 2003).

Remarks: This Palearctic species is similar in appearance to *Metendothenia separatana* and *ochroleucana*. It is much larger than *separatana*. The apical region of the forewing is whitish, with gray and olive-gray markings. The distal margin of the dark basal region is approximately straight versus convex in *ochroleucana*. Worn individuals can be reliably separated by differences in genitalia.

89. ***Hedya chionosema*** (Zeller)

FWL: 6.5-8.5 mm.

Flight Period: Early June to mid-August.

Distribution: Quebec to Manitoba, south to North Carolina and Mississippi.

Biology: Chapman and Lienk (1971) reported rearings from *Malus* (apple), *Crataegus* (hawthorn), and *Pyrus coronaria* (crabapple). Larvae feed in a nest of tied leaves and overwinter in a silk shelter on the tree. Feeding resumes in the spring on new buds and leaves, and pupation occurs in a folded leaf.

Remarks: The gray forewing, white costal patch, and black fascial markings, distinguish this moth from all other midwestern olethreutines.

90. ***Hedya cyanana*** (Murtfeldt)

FWL: 5.5-7.0 mm.

Flight Period: Late May to late August.

Distribution: Connecticut to Manitoba, south to Virginia, Kentucky, and Kansas.

Biology: Marshall and Musgrave (1937) reported rearings from *Cirsium horridulum* (yellow thistle) and *Rosa eglanteria* (sweetbriar rose). The larvae are leaf-rollers.

Remarks: This species can be confused with *Aterpia approximana* based on forewing appearance, but the genitalia of the two species are distinctly different. In addition, males of *cyanana* appear to have antennal sensilla that are approximately half the length of those in *approximana*.

Genus *Evora*

Evora is a monotypic Nearctic genus that is closely related to *Olethreutes*. The single species, *hemidesma*, is a common moth in eastern North America and at times has been considered a nursery pest on *Spiraea*.

The male uncus is a well developed lobe with strong ventral spining at the apex. The valva has a broad but shallow cavity in the ventromedial surface of the neck. There is a spined triangular digitus located near the cucullus on the lateral margin of the cavity. The medial margin of the cavity is strongly produced and entirely spined. There are also two tufts of long setae projecting from the ventral margin of the valva beyond the distal end of the sacculus. In females, the sterigma is strongly sculptured, with a well developed lip at the anterior margin of the ostium. Only a faint indication of a sclerotized patch can be found on the corpus bursae.

91. *Evora hemidesma* (Zeller)

FWL: 6.5-9.0 mm.

Flight Period: Late May to early September.

Distribution: Maine to Manitoba, south to Virginia, Kentucky and Iowa.

Biology: The larvae feed in tied leaves of *Spiraea* (spirea). Second-, third-, or fourth-instar larvae overwinter in a tightly webbed leaf on the ground. Pupae have been found both in the foliage and in dried leaves on the ground (Roberts, 1966). This species is multivoltine in the Midwest.

Remarks: The forewing is reddish brown; fresh specimens have a pale lavender hue. The dark median fascia is the only conspicuous fascial element, but a faint subbasal fascia can often be detected. A pale gray line follows A1+A2, and the same coloration edges the median fascia and the distal margin of the subbasal fascia posterior to the radius.

Tribe EUCOSMINI

Genus *Rhyacionia*

Rhyacionia is a worldwide genus with twenty-three species described from North America. We treat six found in the Midwest. A seventh, *bushnelli*, reputed to occur from North Dakota to Missouri and west to the Rocky Mountains, is omitted for lack of morphological characters that reliably distinguish it from *frustrana*. This is one of several examples of allopatric pairs of sibling species discussed in Powell and Miller (1978), the most recent review of Nearctic *Rhyacionia*.

Members of this genus are known in the economic literature as pine tip moths because the larvae feed in new shoots and buds on species of pine. Resulting disfigurement of young trees, particularly in plantations, has prompted life history studies of many members of the genus. Best known is the introduced *buoliana*, a pest on red pine and Scots pine in the Great Lakes Region (Miller, 1967).

Because of interspecific similarities in forewing pattern and coloration, examination of the genitalia is often required for positive identification. Males have a thumblike projection on the ventral margin of the cucullus, the size and shape of which is useful in separating species. In some instances the shape and armature of the aedeagus are diagnostic. In females, the corpus bursae has two, small, tacklike signa, and the ductus bursae is at least partially sclerotized near the ostium. Differences in shape and structure of the sterigma are useful in species discrimination. Males do not have a costal fold.

92. *Rhyacionia buoliana*
(Denis & Schiffermüller)

FWL: 8.0-11.0 mm.

Flight Period: June and July.

Distribution: Nova Scotia to Wisconsin, south to Delaware, Kentucky and northeastern Missouri; southern British Columbia, Washington, and northwest Oregon.

Biology: Larval hosts are various species of *Pinus* (pine). Early instars mine needle bases; the third and fourth instars feed in buds and pass the winter under a shelter of pitch. Bud and shoot feeding resumes in the spring, and pupation takes place in a hollowed bud or shoot (Miller & Neiswander, 1959; Pointing, 1961, 1963; Powell & Miller, 1978).

Remarks: Introduced to North America early in the twentieth century, *buoliana* is commonly known as the European pine shoot moth. It is much larger than other midwestern *Rhyacionia* and is easily identified by the bright orange color of the forewing. *Eucosma gloriola* is somewhat similar in coloration but is much smaller, has a costal fold, and has very different genitalia.

93. ***Rhyacionia rigidana*** (Fernald)

FWL: 5.5-9.0 mm.

Flight Period: April and July.

Distribution: Maine to northern Missouri, south to northern Florida and eastern Texas.

Biology: Larval development has been recorded on at least ten species of *Pinus* (pine), both native and introduced. First generation larvae bore directly into new shoots; the second generation feeds initially on needles and attacks shoots in later instars. Pupation occurs in the larval tunnel. There are two broods per year (Miller & Neisweander, 1959; Berisford, 1974; Powell & Miller, 1978).

Remarks: Though similar in size and maculation to *frustrana*, the broad, gray, interfascial area between the basal patch and median fascia contributes to a paler overall appearance in *rigidana*. The two species are sympatric, and dissection is recommended for positive identification. The thumblike projection on the cucullus is rudimentary in *rigidana* but long and narrow in *frustrana*. The sterigma is cup-shaped in *rigidana* as opposed to a weakly developed ring in *frustrana*.

94. ***Rhyacionia adana*** Heinrich

FWL: 5.5-9.0 mm.

Flight Period: March through May.

Distribution: Massachusetts to Ontario, south to Alabama and Mississippi.

Biology: Larval hosts include *Pinus resinosa* (red pine), *P. banksiana* (jack pine), and *P. sylvestris* (Scots pine). The life cycle in the Midwest appears to be univoltine. Larvae initially mine needles and later feed on needle tissue within the needle sheaths and on contiguous bark. Late instars often bore in new shoots. Pupation occurs underground in a cocoon (Martin, 1960; Powell & Miller, 1978).

Remarks: This moth looks very much like *busckana*. Males can be separated by the antennal sensilla: long in *busckana* (2 times flagellum width), short in *adana* (0.3 times flagellum width). The aedeagus is long, smooth, and tapering to a point in *adana*; it is short with small lateral teeth in *busckana*.

95. ***Rhyacionia busckana*** Heinrich

FWL: 4.5-9.5 mm.

Flight Period: March to June.

Distribution: Maine to British Columbia, south to Florida and Texas; also Oregon and Colorado.

Biology: Larval hosts include *Pinus banksiana* (jack pine), *P. resinosa* (red pine), *P. sylvestris* (Scots pine) and *P. ponderosa* (ponderosa pine) (Powell & Miller, 1978).

Remarks: Forewing color and maculation resemble those of *adana*. Male genitalic differences are discussed under that species. Historically this moth has been confused with an eastern sibling species, *granti*, in which the length of the male antennal sensilla is twice that of *busckana* (Miller, 1985b).

96. ***Rhyacionia frustrana*** (Scudder)

FWL: 4.0-7.5 mm.

Flight Period: Multivoltine, with three generations per year in the Gulf States.

Distribution: Massachusetts to Missouri, south to Florida and Texas. Powell and Miller (1978) also report records from California, the Caribbean, and Central America.

Biology: The larvae feed on *Pinus* (pine) (Powell & Miller, 1978). This species is sympatric with *rigidana* and has similar larval habits. Berisford (1974) reported asynchronous life cycles in Georgia for the two species, *rigidana* having two broods per year, *frustrana* three.

Remarks: Commonly known as the Nantucket pine tip moth, this species looks very much like *rigidana* but usually has a more reddish-orange appearance. Differences in genitalia are discussed under *rigidana*. Young et al. (2006) pointed out that the authorship of the specific name, long attributed to Comstock, is referred properly to Scudder.

97. ***Rhyacionia aktita*** Miller

FWL: 4.0-7.0 mm.

Flight Period: March through May.

Distribution: Southern Maine to Texas, south to northern Florida.

Biology: Adults have been reared from pupae found in terminals of *Pinus rigida* (pitch pine), *P. taeda* (loblolly pine) and *P. elliottii* (slash pine) (Powell & Miller, 1978).

Remarks: Aside from a dark basal patch and a dark costal band, the forewing is pale reddish orange and lacks the gray and white transverse striations found in many *Rhyacionia* species. Though formerly considered to have a coastal distribution, *aktita* has been recorded recently as far inland as southern Kentucky.

Genus *Retinia*

In much of the literature this genus is known as *Petrova*. Our treatment includes six of the fourteen representatives in North America. Five have larvae that bore in pine twigs, using silk and exuded resin to build blisterlike feeding shelters, thus acquiring the common name pitch-blister moths. Three of the five have an annual life cycle, but *albicapitana* and *virginiana* require two years to complete development. Miller (1978b) presents some excellent illustrations of the pitch blisters. The life history of the sixth species, *gemistrigulana*, is not known.

Adults can usually be identified by forewing color and maculation. Males lack a costal fold. Distinctive male genitalic characters include: unusually long and narrow socii, a prominent clasper on the margin of the basal excavation, and, with the exception of *gemistrigulana*, a deeply invaginated ventral margin of the valva resulting in a particularly narrow neck. In females, the corpus bursae has two conelike signa, there is some sclerotization of the ductus bursae, and there is little in the way of interspecific differences in sterigma shape.

98. ***Retinia comstockiana*** Fernald

FWL: 7.0-10.5 mm.

Flight Period: May and June.

Distribution: Maine to New York, south to western North Carolina and eastern Tennessee.

Biology: Larval hosts include *Pinus rigida* (pitch pine), *P. sylvestris* (Scots pine), and *P. resinosa* (red pine). Late-instar larvae feed in developing shoots (Miller, 1978b).

Remarks: The forewing has dull reddish-orange fasciae and silvery-gray interfascial areas. In eastern Kentucky and southeastern Ohio this moth is encountered commonly on dry ridges and slopes, the preferred habitat of its native host, *P. rigida*. It has not been reported elsewhere in the Midwest.

99. ***Retinia virginiana*** Busck

FWL: 7.0-11.0 mm.

Flight Period: May and June.

Distribution: New Jersey to southeastern Ohio, south to western Virginia and eastern Kentucky.

Biology: *Pinus virginiana* (Virginia pine) is the primary host, with occasional utilization of *P. banksiana* (jack pine). The life cycle is biennial. First-year larvae feed on new shoots, often near terminal buds, beneath a shelter constructed of silk, frass and pitch. Overwintering occurs in the shelter, followed by migration to a branching node where the second-year pitch blister is constructed in a crotch. The larva passes the second winter in the pitch blister and pupates the following spring (Miller & Altmann, 1958).

Remarks: Known in much of the literature as *Petrova wenzeli* (Kearfott), this moth has bright brownish-orange fasciae and white to very pale orange interfascial areas, the latter with fine silvery-gray striations. Its close northern relative, *albicapitana*, is more reddish brown, with more silvery-gray interfascial scaling. The hindwing is nearly white in *virginiana* but dark gray in *albicapitana*.

100. ***Retinia albicapitana*** (Busck)

FWL: 5.0-10.5 mm.

Flight Period: May through July.

Distribution: Nova Scotia to eastern British Columbia, south to northern Michigan, Minnesota, and western Montana; south shore of Lake Michigan.

Biology: The preferred larval host is *Pinus banksiana* (jack pine). Reported hosts from western North America include *P. contorta* (lodgepole pine) and *P. ponderosa* (pondersosa pine). The life cycle is biennial, as described for *virginiana* (Turnock, 1953).

Remarks: The forewing is similar to that of *virginiana*, but the fasciae are duller red orange, the silvery-gray striations are conspicuous, and the costa and terminal margins are thinly lined with black scales. Genitalia of the two species are indistinguishable. Their ranges are disjunct, as are those of their respective hosts, *P. banksiana* and *P. virginiana*.

101. ***Retinia metallica*** (Busck)

FWL: 6.5-10.0 mm.

Flight Period: June and July.

Distribution: Minnesota to British Columbia, south to Colorado and California.

Biology: Larval hosts include *Pinus ponderosa* (ponderosa pine), *P. contorta* (lodgepole pine) and *P. sylvestris* (Scots pine). Blisters are formed on new shoots near the base of the terminal bud (Miller, 1978b).

Remarks: The range of *metallica* includes the northwestern corner of the Midwest, with specimens reported from Minnesota, South Dakota and Nebraska. The basal patch, median fascia and apical area are brownish and generously overlaid with lustrous gray scaling; these markings usually contrast strongly with the whitish interfascial areas.

102. ***Retinia gemistrigulana*** (Kearfott)

FWL: 7.5-11.0 mm.

Flight Period: Late May to early August.

Distribution: Massachusetts to Wisconsin, south to Florida and Texas; also recorded from Colorado.

Biology: Unknown.

Remarks: This species is recognized by its dark gray fasciae and silvery-gray interfascial areas. Unlike other midwestern *Retinia*, the valval neck is not narrowly constricted. The lamella postvaginalis is more strongly developed than the lamella antevaginalis, and its posterior margin is twice as broad as the ostium. In Kentucky *gemistrigulana* is found in the same type of habitat that supports *comstockiana* and *virginiana*.

103. ***Retinia houseri*** (Miller)

FWL: 5.5-7.5 mm.

Flight Period: June to mid-July.

Distribution: Ohio, south to Florida and Louisiana.

Biology: The larval host is *Pinus echinata* (shortleaf pine). Larvae begin feeding at needle bases and later bore in the inner bark of the shoot, forming a pitch blister. Development is completed in the spring, at which time feeding occurs primarily in the pith (Miller, 1963).

Remarks: Though similar in forewing maculation to *gemistrigulana*, adults are smaller, have a browner appearance, and have darker hindwings. Like its host, *houseri* is a resident of the southeastern states, but the species was described from Ohio.

Genus *Spilonota*

Spilonota is primarily a genus of the Palearctic, Oriental and Australian Regions. One species, *ocellana*, has a worldwide distribution. The larva has been reared on leaves and buds of a variety of deciduous trees, but apple and cherry seem to be the favored hosts. Considered a pest in orchards, this insect is known in the economic literature as the eye-spotted moth. Males have a notch in the base of the antenna and lack a costal fold.

104. *Spilonota ocellana*
(Denis & Schiffermüller)

FWL: 6.0-8.0 mm.

Flight Period: June through August.

Distribution: Nova Scotia to British Columbia, south to North Carolina, Ohio and California.

Biology: Preferred hosts are *Malus* (apple) and *Prunus* (cherry). Newly hatched larvae feed primarily on leaves. In the third-instar (mid-August to September) a hibernaculum is constructed, often in a spur crotch, where the larva overwinters. Feeding resumes in early spring on fruiting buds, leaves and blossoms, and pupation occurs in a leaf nest near the feeding site (Chapman & Lienk, 1971; Oatman et al., 1962).

Remarks: This species is widely distributed in fruit growing regions of the northern United States and southern Canada. It has both dark and light phenotypes, and forewing color and maculation are usually adequate for identification. Males have a distinctively shaped cucullus. Females have two thornlike signa and a well developed, troughlike lamella antevaginalis.

Genus *Phaneta*

In North America there are nearly 260 recognized species in the olethreutine lineage currently represented by the genera *Phaneta* and *Eucosma*. Heinrich (1923a) dealt with the unwieldy nature of this group by assigning to *Thiodia* the species that lack a costal fold on the male forewing and placing the rest in *Eucosma*, fully recognizing that this distinction was merely a convenience and lacked phylogenetic justification. The members of *Thiodia* were later transferred to *Phaneta* by Obraztsov (1952) in an attempt to reconcile the Nearctic and Palaearctic interpretations of these genera. Today there are 103 species of Nearctic *Phaneta*; this guide treats 28.

Life histories are known for relatively few of these moths, but in all reported cases the larval hosts are members of the Asteraceae. Larval feeding behaviors include webbing of terminal leaves (particularly in early instars) and boring into seeds, flower heads, stems and roots.

Most midwestern species can be identified on the basis of forewing color and maculation. Many exhibit only remnants of the ancestral forewing pattern, and in a number of cases the markings are decidedly longitudinal instead of transverse. A well developed forewing ocellus is a common occurrence in this genus.

The male valva has a clearly defined neck, and the apex and ventral angle of the cucullus are at least moderately developed. The cucullus has a densely setose medial surface but lacks large spines along the distal margin and at the ventral angle. Specimens can be referred to species groups based on valval shape, but interspecific differences within these groups are often subtle. In females, the posterior margin of sternum VII closely surrounds the sterigma on three sides and sometimes fuses with the lamella postvaginalis. The corpus bursae has two horn-shaped signa.

Phaneta formosana Species Group

The first ten names on the check list for North American *Phaneta* (Powell, 1983) apply to members of a species complex referred to here as the *formosana* group. These moths are similar in appearance, exhibit considerable variation in color and maculation, and present little in the way of distinguishing genitalic characters. Females are usually darker than males, but there are not many well documented male-female associations. It has long been suspected (e.g., Heinrich, 1923a) that some of these names refer only to phenotypes of perhaps three or four variable species, but to date only two synonymies have been proposed (Miller, 1983a).

We chose to discuss four names from this group: *formosana*, *essexana*, *awemeana*, and *umbrastriana*. The first three apply to recognizable species with distinguishing morphological features. Specimens associated with the name *umbrastriana* vary to the extent that identification to species is problematic, but we believe our treatment reflects prevailing practice. Fortunately, most of the primary types are in good condition, and we have relied on them in illustrating some of the adults.

105. *Phaneta formosana* (Clemens)

FWL: 8.5-9.5 mm.

Flight Period: Late May through June.

Distribution: Maine to Alberta, south to West Virginia and Ohio.

Biology: Putman (1942) reported larvae feeding on terminal leaves and in upper stems of *Solidago altissima* (Canada goldenrod).

Remarks: Dark brown suffusion of the forewing distinguishes this species from others in the complex. A radial streak from base to apex is detectable in all but the most darkly suffused specimens. Females are slightly darker than males. As in *umbrastriana*, the valva is long-necked and strongly arched laterally, and the cucullus is oriented perpendicular to the neck.

106. *Phaneta essexana* (Kearfott)

FWL: M 9.0-11.5 mm, F 8.0-9.0 mm.

Flight Period: May.

Distribution: Uncertain; New Jersey, Ohio and Kentucky.

Biology: Kearfott (1907) reared the syntypes on *Symphyotrichum patens* (late purple aster). Putman (1935) reported the larvae boring in stems of *Symphyotrichum novae-angliae* (New England aster).

Remarks: The male forewing is clay yellow with a dark brown radial streak from base to vertex. The brown coloration extends along the termen to the tornus and nearly surrounds the ocellus. Females are smaller than males. Their forewings are uniformly orange brown, with darker shading toward the termen. Both sexes have a diffuse whitish line along the termen. The valval neck is not arched laterally, and the cucullus is obliquely oriented with respect to the neck.

Lectotype male

Paralectotype female

107. *Phaneta awemeana* (Kearfott)

FWL: M 8.5-9.0 mm, F 7.5 mm.

Flight Period: May.

Distribution: Uncertain; recorded from Manitoba, New York, Ohio, and Quebec.

Biology: Unknown.

Remarks: Females are darker and smaller than males. In both sexes the basal portion of the forewing is pale clay yellow, the distal portion is dark orange brown, and the radial streak is interrupted medially. The ocellus is obscure and completely surrounded by the darker coloration of the terminal area. The valva is intermediate between *essexana* and *formosana*. Its costa is nearly straight, the cucullus is obliquely oriented with respect to the neck, and the lateral arching of the neck is only moderate.

Lectotype male

Paralectotype female

108. *Phaneta umbrastriana* (Kearfott)

FWL: 7.5-10.0 mm.

Flight Period: May to mid-June.

Distribution: New Hampshire to Manitoba, south to Virginia and Kentucky.

Biology: The authors have collected males and females flying diurnally together in a *Solidago* (goldenrod) patch in southern Kentucky, but no rearings have been reported that document a host association.

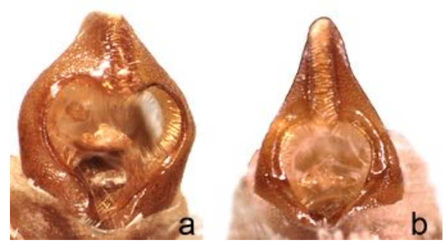
Remarks: Females are darker than males, the prevailing color is orange brown. A faint indication of a radial streak is usually discernable, more so in males, and the ocellus is obscure to undetectable. The valva is long-necked and strongly arched laterally, and the cucullus is oriented perpendicular to the neck.

male

female

Male valvae in the *Phaneta formosana* Species Group

The lateral arching of the valvae is useful in segregating males in the *formosana* species group. Shown are ventral aspects of male genitalia with scales removed: (**a**) is representative of the strong arching in *formosana* and *umbrastriana*; (**b**) illustrates the lack of arching in *essexana*. Not shown is *awemeana*, which is intermediate between the two images.



109. *Phaneta annetteana* (Kearfott)

FWL: 6.5-7.5 mm.

Flight Period: April and early May, possibly a second brood in August.

Distribution: Uncertain; recorded from Massachusetts, Ohio and Illinois.

Biology: Unknown.

Paralectotype female

Remarks: The illustrated specimen is a cotype collected in Cincinnati, Ohio, in 1905. There are very few modern records of this species. Specimens with a similar forewing appearance have been captured at various sites in eastern North America, but their taxonomic status has not yet been carefully investigated.

110. ***Phaneta autumnana*** (McDunnough)

FWL: 7.0-9.5 mm.

Flight Period: September to mid-October.

Distribution: Maine to North Dakota, south to South Carolina and Mississippi.

Biology: Unknown.

Remarks: Though identical in pattern to *verna*, this moth has a two-toned forewing appearance: brown on the basal two thirds, gold in the apical area. The costal margin may have a whitish streak but is usually suffused with brown. The two species are most easily separated by adult flight period: autumn for *autumnana*, spring for *verna*.

111. ***Phaneta verna*** Miller

FWL: 7.0-9.0 mm.

Flight Period: Mid-April through May.

Distribution: Nova Scotia to Manitoba, south to Florida and Colorado.

Biology: Unknown.

Remarks: Usually the entire forewing is pale brownish yellow, but some phenotypes are nearly identical in appearance to *autumnana*. The costa has a prominent white streak. Males of the two species can be distinguished by valval neck width: narrow in *autumnana*, twice as wide in *verna*.

112. ***Phaneta ochrocephala*** (Walsingham)

FWL: 6.5-7.5 mm.

Flight Period: Mid-August to early October.

Distribution: Maine to Manitoba, south to Georgia and Colorado.

Biology: The larval host is *Xanthium strumarium* (rough cockleburr) (Hare, 1977). Oviposition occurs on immature burrs, and young larvae feed on the seeds. Fully developed larvae overwinter in the stems, where pupation occurs the following summer.

Remarks: This is the only midwestern *Phaneta* with a brownish-yellow forewing and dark brown subbasal and median fasciae, the latter having a purplish hue in fresh specimens. Females might be confused with *Eucosma wandana*, but there are subtle differences in forewing pattern, and the genitalia are quite distinct.

113. ***Phaneta raracana*** (Kearfott)

FWL: 5.0-6.5 mm.

Flight Period: Mid-July to mid-September.

Distribution: Maine to Michigan, south and west to Florida, Texas and Arizona.

Biology: The larval host is *Solidago* (goldenrod) (Heinrich, 1923a).

Remarks: Easily recognized by its white head and rusty-red forewings, *raracana* is commonly encountered in old fields in late summer and early autumn.

114. ***Phaneta ochroterminana*** (Kearfott)

FWL: 5.0-6.5 mm.

Flight Period: Mid-July to early September.

Distribution: New Hampshire to Minnesota, south to Mississippi and Colorado.

Biology: The larvae form a feeding shelter from webbed flower heads on *Solidago altissima* (Canada goldenrod) (Putman, 1942).

Remarks: The blackish-brown forewing is variably overlaid with dark bluish-gray scales. Pale brown scales near the ocellus and apex produce the contrasting terminal coloration responsible for the specific name. This resident of old fields is commonly found in late summer.

115. ***Phaneta marmontana*** (Kearfott)

FWL: 4.5-6.5 mm.

Flight Period: Mid-May through July.

Distribution: New Hampshire to Alberta, south to New Jersey, Kentucky and Iowa.

Biology: Unknown.

Remarks: Though similar in appearance to *parmatana*, *marmontana* has more orange-brown coloration near the apex of the forewing and less variation in the shape and expression of the white interfascial spot. Flight periods of the two species overlap in July; *marmontana* flies in late spring to early summer, *parmatana* in late summer to early autumn.

116. ***Phaneta tomonana*** (Kearfott)

FWL: 5.5-7.0 mm.

Flight Period: Mid-August to mid-September.

Distribution: Maine to Wisconsin, south to South Carolina, Mississippi and Arkansas.

Biology: The larvae feed on *Symphyotrichum novae-angliae* (New England aster) (Putman, 1942).

Remarks: Though similar in appearance to *Eucosma consobrinana* and *Suleima helianthana*, *tomonana* has a dull brownish-gray forewing and lacks the white striations in *consobrinana* as well as the white ocellus that is prominent in *helianthana*. The genitalia of the three species are quite distinct.

117. ***Phaneta parmatana*** (Clemens)

FWL: 4.5-7.0 mm.

Flight Period: Mid-July to mid-September.

Distribution: Maine to Minnesota, south to Alabama, Louisiana and Colorado.

Biology: Larvae feed in flower heads of asters and overwinter in a cocoon constructed in the soil or plant litter (Putman, 1942).

Remarks: The white interfascial spot ranges from large and conspicuous to nearly undetectable. This variation was responsible for the creation of numerous synonyms during the early twentieth century (Miller, 1983a). The ocellus tends to be much whiter and the apex of the forewing more charcoal gray than in *marmontana*. This is a very common late-summer moth in eastern North America.

118. ***Phaneta convergana*** (McDunnough)

FWL: 7.5-8.0 mm.

Flight Period: May to early June.

Distribution: Michigan to Alberta, south to Kentucky.

Biology: Unknown.

Remarks: Very little is known about this species. It is identified easily by its pale gray forewing with greenish-brown fasciae. The central Midwest records come from dune habitat on the south shore of Lake Michigan.

119. ***Phaneta kokana*** (Kearfott)

FWL: 8.5-11.5 mm.

Flight Period: October through early November.

Distribution: Massachusetts to Manitoba, south to Kentucky.

Biology: Unknown.

Remarks: This species is poorly known, probably due to its late flight period. Distinguishing forewing characteristics include a strong dark line along the termen, extensive brown suffusion of the basal two thirds of the wing, and a moderately contrasting whitish-gray apical area. Similar looking *canusana* has a more uniform forewing color and flies in early spring rather than autumn.

120. ***Phaneta canusana*** Wright

FWL: 7.0-10.0 mm.

Flight Period: Mid-February to early April.

Distribution: West Virginia to Missouri, south to South Carolina and Mississippi.

Biology: Unknown.

Remarks: The early season flight period is the likely explanation for the scarcity of records of this species. It has been collected in Ohio and Kentucky on warm March evenings in woodland glades that support prairie vegetation. This species can be distinguished from *ambodaidaleia* by its brown-gray to gray forewing color and from *kokana* by its early spring flight time.

121. ***Phaneta ambodaidaleia*** Miller

FWL: 8.0-10.5 mm.

Flight Period: Mid-January to early April.

Distribution: New Jersey to Michigan south to South Carolina, Alabama and Texas.

Biology: Unknown.

Remarks: Similar looking *kokana* and *canusana* are brownish gray to gray in appearance while *ambodaidaleia* has a distinct brownish-yellow hue. The genitalia of the three species are nearly indistinguishable. In Ohio the flight period of *canusana* usually begins a week or two before that of *ambodaidaleia*, but the two moths can be found flying together in late March and early April.

122. *Phaneta influana* (Heinrich)

FWL: 6.0-7.5 mm.

Flight Period: Mid-June to mid-July.

Distribution: Uncertain; Manitoba, south to Iowa and Wyoming; the type locality is California.

Biology: Unknown.

Remarks: This is primarily a western species, but it is established in tall grass prairie preserves in north central Iowa. Wyoming specimens tend to be darker than those from the Midwest due to more brownish suffusion in the interfascial areas. A similar looking species, *musetta*, was described by Blanchard and Knudson (1983) from Texas and New Mexico.

123. *Phaneta ornatula* (Heinrich)

FWL: 5.5-7.0 mm.

Flight Period: Mid-June to mid-August.

Distribution: Maine to Minnesota, south to Florida and Texas.

Biology: The larval host is *Lactuca* (lettuce) (Putman, 1942).

Remarks: This little white-headed species is common in eastern North America. Its forewing pattern is unlike any other *Phaneta* found in the Midwest.

124. *Phaneta clavana* (Fernald)

FWL: 6.0-8.0 mm.

Flight Period: Late May to early September.

Distribution: Massachusetts to Minnesota, south to Indiana.

Biology: Unknown.

Remarks: Forewing appearance is somewhat similar to that of *argenticostana*, but *clavana* is smaller and lacks the uninterrupted, white, costal streak in *argenticostana*. The labial palpi are conspicuously bushy. Records from Indiana and Michigan are from dune habitat along the shore of Lake Michigan.

125. ***Phaneta argenticostana***
(Walsingham)

FWL: 8.0-11.0 mm.

Flight Period: April to June.

Distribution: Michigan to Washington, south to Texas and New Mexico.

Biology: Larvae have been reared on *Artemisia dracunculus* (tarragon) in Washington (Brown et al., 1983).

Remarks: The range of this species includes much of western United States, but populations appear to be localized. Midwestern sites where it has been collected are noted for their sandy soils, including dune habitat along the shore of Lake Michigan.

126. ***Phaneta striatana*** (Clemens)

FWL: 6.0-8.5 mm.

Flight Period: May to August.

Distribution: Maine to Alberta, south to Alabama and New Mexico.

Biology: Unknown.

Remarks: There are several species in the Great Plains with the *striatana* forewing pattern, which features a prominent white streak from base to ocellus. In most cases *striatana* can be distinguished by a lack of reddish-brown coloration posterior to the white streak and by the presence of a dark thin line along CuA2.

127. ***Phaneta pallidicostana***
(Walsingham)

FWL: 7.0-8.5 mm.

Flight Period: Mid-June to early August.

Distribution: Manitoba, south to Iowa and Colorado; the type locality is California.

Biology: Unknown.

Remarks: The forewing pattern resembles that of *striatana*, but this species is considerably larger and whiter. Despite the pale markings, a faint line following CuA2 can usually be detected. In both species the cucullus is broadly rounded at the anal angle. Midwestern records are from tall-grass prairie habitat.

128. ***Phaneta kiscana*** (Kearfott)

FWL: 5.0-7.0 mm.

Flight Period: June.

Distribution: New York to Michigan, south to Virginia and Arkansas.

Biology: Unknown.

Remarks: This species is recognized by its white head and pale yellowish-brown forewing, the latter with a weak brownish streak from base to apex. It is sometimes confused with *perangustana* (Walsingham), a larger western species with a more two-toned forewing appearance.

129. ***Phaneta montanana*** (Walsingham)

FWL: 9.0-11.0 mm.

Flight Period: May to mid-June, August to mid-September.

Distribution: Manitoba and Saskatchewan, south to Michigan, Colorado and Oregon.

Biology: Heinrich (1923a) reported larvae boring in roots of *Artemisia dracunculus* (tarragon) in Oregon. Records suggest the possibility of two broods per year.

Remarks: The forewing has a longitudinally streaked appearance due to pale whitish-yellow scaling along the veins. Expression of the subbasal and median fasciae is variable. This moth is related closely to *tarandana* (Möschler), *transversana* (Walsingham), and *clarkei* Blanchard & Knudson, and further study is needed to establish clear species concepts in this group.

130. ***Phaneta stramineana*** (Walsingham)

FWL: 5.0-6.5 mm.

Flight Period: August in the West, March to June in the South.

Distribution: Kansas and Colorado, south to Florida and California.

Biology: Brown et al. (1983) reported *Haplopappus* as a food plant in Texas and Arizona.

Remarks: This species is recognized by the straw-yellow forewing, the crisp black dashes on the costa, and the dual black lines along the termen.

131. ***Phaneta olivaceana*** (Riley)

FWL: 6.5-9.0 mm.

Flight Period: Mid-June through July.

Distribution: Nova Scotia to Iowa, south to Maryland and Illinois.

Biology: The larval host is *Solidago* (goldenrod) (Heinrich, 1923a).

Remarks: Fresh specimens are pale yellow to pale olive green, with brownish-black markings. A dark forewing streak from base to apex is quite prominent in some individuals and only weakly expressed in others.

132. ***Phaneta argutipunctana*** Blanchard & Knudson

FWL: 6.0-7.5 mm.

Flight Period: Late May to early September.

Distribution: Illinois to Colorado, south to Florida and Texas.

Biology: Unknown.

Remarks: There are several similar looking species in the Great Plains, but none with the black mark at the base of the antenna characteristic of this moth. Midwestern records are from remnant prairie preserves in the vicinity of Chicago, Illinois and sand prairie habitat in southwest Kansas.

Genus *Eucosma*

Eucosma is the largest genus in the Tortricidae with over 275 species worldwide. There are approximately 160 species in North America, most of which are found in the arid and mountainous regions of the West. In his 1923 review of Nearctic Eucosmini Heinrich distinguished *Eucosma* from *Phaneta* on the basis of a single character, the presence of a costal fold on the male forewing.

Not a great deal is known about the life histories of these moths. One small group associated with conifers is well studied due to seed mortality and twig damage in pine plantations caused by larval feeding. In all other known instances, the immatures are root- and/or stem-borers in Asteraceae. Old fields, prairies, and glades with well established populations of composites such as goldenrod, sagebrush, coneflower, and sunflower can be counted on to host a good variety of these insects.

The 35 species treated here can for the most part be identified by forewing color and maculation, but there can be considerable intraspecific variation. A little more than half of the species exhibit at least some elements of the ancestral fasciate forewing pattern, but in several cases (e.g., *ridingsana*) the markings have a distinctly radial quality. Some species are easily confused with similar looking moths in closely related genera (e.g., *Phaneta*, *Pelochrista*, and *Sonia*), so it is advisable to check tentative determinations with genitalia dissections.

The male valva generally has a well differentiated cucullus, often with stout setae sparsely distributed along its distal margin. In about half of the species the anal angle is strongly produced and supports one or more particularly long spines. The female papillae anales are generally flat and laterally facing, but in nearly one-third of the species (e.g., *agricolana* and its close relatives) they face ventrally and have a well developed pair of ventral extensions flanking the terminal openings of the anal tube and oviduct. The posterior margin of sternum VII is usually straight or weakly concave. In some cases it is strongly invaginated and laterally approximate to, but not fused with, the sterigma. The corpus bursae nearly always has two signa, often horn- or thorn-shaped.

133. *Eucosma quinquemaculana* Robinson

FWL: 7.0-9.0 mm.

Flight Period: September and October.

Distribution: New York to Mississippi, southeast to Florida.

Biology: Unknown.

Remarks: The forewing pattern is diagnostic. Most records come from Atlantic or Gulf states, but the range extends into southern Kentucky.

134. *Eucosma robinsonana* (Grote)

FWL: 4.5-8.0 mm.

Flight Period: May to September.

Distribution: Massachusetts to Minnesota, south to Florida and Texas.

Biology: Unknown.

Remarks: Though similar in appearance to *quinquemaculana*, this is a considerably smaller moth with different genitalia. Specimens in good condition have pink shading in the ocellus. The wide range of capture dates suggests a multivoltine life cycle. The papillae anales have ventral extensions.

135. ***Eucosma ridingsana*** (Robinson)

FWL: 7.0-13.0 mm.

Flight Period: July through September.

Distribution: Massachusetts to Washington, south to Mississippi and Arizona.

Biology: Hosts include: *Heterotheca villosa* (hairy false goldenaster) in Washington (Brown et al., 1983), *Gutierrezia* (snakeweed) in Arizona and California (Hetz & Werner, 1979; Powell & Opler, 2006), and *Grindelia hirsutula* (hairy gunweed), *Corethrogyne filaginifolia* (sandaster), and *Isocoma menziesii* (Menzies' goldenbush) in California (Powell & Opler, 2006). The larvae bore in roots.

Remarks: This is the most widespread of the "silver spotted" species of *Eucosma*. It is highly variable in size and forewing coloration but constant in genitalic characters. Though the range extends to the east coast, *ridingsana* is much more prevalent in the West.

136. ***Eucosma heathiana*** Kearfott

FWL: 7.0-8.5 mm.

Flight Period: July and August.

Distribution: Ontario to Manitoba, south to Ohio and Arkansas; Arizona and New Mexico.

Biology: Unknown.

Remarks: The black suffusion along the dorsal margin of an otherwise whitish forewing is diagnostic. This moth appears to be a close relative of *morrisoni*, *agricolana*, and *smithiana*, all of which are associated with prairie habitat in the Midwest. The papillae anales have ventral extensions.

137. ***Eucosma morrisoni*** (Walsingham)

FWL: 6.0-10.0 mm.

Flight Period: Late June to early September.

Distribution: Michigan to Manitoba, south and west to New Mexico and California; possibly Connecticut and New York.

Biology: Unknown.

Remarks: The black streak anterior to the ocellus is a good identifying character, but it can be difficult to detect in pale specimens. Forbes (1937) proposed the name *lathami* for what may be a disjunct population of *morrisoni* in the northeast, a possibility that deserves further investigation. The papillae anales have ventral extensions.

138. ***Eucosma agricolana*** (Walsingham)

FWL: 7.5-11.0 mm.

Flight Period: June and July.

Distribution: Maine to British Columbia, south to Mississippi, Arizona and California.

Biology: Brown et al. (1983) reported *Artemisia vulgaris* (common wormwood) as a larval host in Washington.

Remarks: Moths with the *agricolana* forewing pattern occur across North America but are most abundant in the Great Plains and Rocky Mountains. Size, coloration, and maculation are variable, genitalic characters are not. The different phenotypes likely comprise a complex of sibling species. A partial resolution involving two subspecies was proposed by Miller (1974). The papillae anales have ventral extensions.

139. ***Eucosma smithiana*** (Walsingham)

FWL: 6.5-9.0 mm.

Flight Period: June and July.

Distribution: Manitoba to British Columbia, south to Iowa, New Mexico and California.

Biology: The larva is a root-borer in *Chrysanthemum* (daisy) (Miller, 1974).

Remarks: Midwestern specimens have a nearly all white forewing, sometimes with subdued grayish striations similar to that in *agricolana*. The papillae anales have ventral extensions with three or four thick stubby setae along their ventral margins. Miller (1974) described a sibling species, *barbara*, based on subtle genitalic differences.

140. ***Eucosma comatulana*** (Zeller)

FWL: 5.0-9.0 mm.

Flight Period: July through September.

Distribution: Michigan to Montana, south to Texas and California.

Biology: Clarke reared *mandana*, a synonym of *comatulana* (Miller, 1985c), from roots of *Solidago* (goldenrod) (Brown et al., 1983).

Remarks: Forewing color and maculation appear to be variable, but genitalic characters are constant. The specimen illustrated is a good match to the holotype. This is a common species in the Great Plains. The papillae anales have ventral extensions.

141. *Eucosma vagana* (McDunnough)

FWL: 6.5-9.5 mm.

Flight Period: Mid-June through July.

Distribution: Minnesota to Maine, south to Texas and Mississippi.

Biology: Uncertain; Miller (1987) reported *Solidago* (goldenrod) as a host.

Remarks: This moth belongs to a complex of species that are quite similar in forewing pattern and genitalia. The group has a history of taxonomic confusion, rendering literature and rearing records unreliable. The most recent attempt to resolve these issues can be found in Miller (1985c). The specimen illustrated here compares favorably with the holotype of *vagana*.

142. *Eucosma glomerana* (Walsingham)

FWL: 8.0-13.5 mm.

Flight Period: Late June to early September.

Distribution: Quebec to Montana, south to Mississippi and Texas.

Biology: Unknown.

Remarks: It is conceivable that the two illustrated phenotypes represent distinct species, but no convincing argument in support of that position has been proposed. The brown form was described by Kearfott as *sandana*, but Powell (1983) treated this name as a synonym of *glomerana*.

143. ***Eucosma albiguttana*** (Zeller)

FWL: 6.5-9.5 mm.

Flight Period: July and August.

Distribution: Michigan to Colorado, south to Texas and New Mexico.

Biology: Unknown.

Remarks: The species group containing *albiguttana* needs revision. Names in current use, including *graciliana* Kearfott and *galenapunctana* Kearfott, refer to taxa that cannot be separated on the basis of forewing maculation. There are some distinctive genitalic characters, but they have yet to be associated accurately with the appropriate species. The specimen illustrated compares favorably with individuals collected at the type locality of *albiguttana* in east Texas. The papillae anales have ventral extensions.

144. ***Eucosma gloriola*** Heinrich

FWL: 6.5-7.5 mm.

Flight Period: April to early June.

Distribution: Maine to Minnesota, south to New Jersey and northern Indiana.

Biology: The larva bores in pine shoots, and pupation occurs in the soil. Recorded hosts include *Pinus strobus* (white pine), *P. banksiana* (jack pine), *P. sylvestris* (Scots pine), and *P. resinosa* (red pine) (DeBoo et al., 1971).

Remarks: This species is associated with eastern white pine in the New England and Great Lakes Regions. In the Midwest it has been recorded in northern Indiana and northeastern Ohio.

145. ***Eucosma cocana*** Kearfott

FWL: 8.5-11.0 mm.

Flight Period: Mid-April through May.

Distribution: Massachusetts to Minnesota, south to Florida and Mississippi.

Biology: Circumstantial evidence suggests that the larva is a cone feeder on *Pinus taeda* (loblolly pine), but *P. taeda* is not present at sites in Ohio and Kentucky where the moth has been collected. In these locations *Pinus rigida* (pitch pine) is considered the likely host (Powell, 1968).

Remarks: This is the largest of the cone feeding species of *Eucosma* in eastern North America. It has a grayer appearance and more subtle markings than *monitorana* or *tocullionana*.

146. *Eucosma monitorana* Heinrich

FWL: 6.5-9.0 mm.

Flight Period: Late April to early June.

Distribution: Pennsylvania to Minnesota, south to Virginia and Kentucky.

Biology: The larva bores in cones of *Pinus resinosa* (red pine); pupation occurs in the soil (Lyons, 1957; Barras & Norris, 1969). *Pinus virginiana* (Virginia pine) has been mentioned as another possible host (Powell, 1968).

Remarks: This species often flies in the company of *tocullionana*, which is similar in size, but the dark, reddish-brown, basal patch and broad, silvery-white, median band serve to distinguish *monitorana*.

147. *Eucosma tocullionana* Heinrich

FWL: 6.0-8.5 mm.

Flight Period: Late April to late June.

Distribution: Nova Scotia to Wisconsin, south to North Carolina and Tennessee.

Biology: The larva bores in cones of *Pinus strobus* (white pine). Other reported hosts include *Picea* (spruce), *Abies balsamea* (balsam fir), and *Tsuga canadensis* (eastern hemlock) (Powell, 1968).

Remarks: The interfascial area between the subbasal and median fasciae has a "figure 8" shape, with yellowish-orange coloration inside the whitish-gray loops.

148. *Eucosma palabundana* Heinrich

FWL: 6.5-8.0 mm.

Flight Period: June through early August.

Distribution: Michigan south and west to Illinois and Iowa.

Biology: Unknown.

Remarks: The fasciate forewing pattern and rose-colored ocellus serve to distinguish *palabundana*. In our experience it is associated with sandy soils. Knudson (1986) described the similar *rosaocellana* from Texas. The papillae anales have ventral extensions.

149. *Eucosma matutina* (Grote)

FWL: 6.5-9.0 mm.

Flight Period: July and August.

Distribution: New York to Montana, south to Mississippi and New Mexico.

Biology: Unknown.

Remarks: This is a common moth in the Midwest. The forewing maculation is constant, but the overall appearance is variable, depending on the amount of dark suffusion in the interfascial areas. The anal angle of the cucullus is strongly produced but lacks a stout spine.

150. *Eucosma giganteana* (Riley)

FWL: 8.5-17.5 mm.

Flight Period: July to mid-August.

Distribution: New Hampshire to North Dakota, south to Florida and Texas.

Biology: The larva is a root-borer in *Silphium perfoliatum* (cup plant) and *S. terebinthinaceum* (prairie rosinweed) (Heinrich, 1923a; Heitzman & Heitzman, 1987; Metzler et al., 2005).

Remarks: Size is highly variable, but color, maculation and genitalia are constant. Genitalic characters suggest that *giganteana* is a close relative of *bipunctella* and *bilineana*. All three are residents of the tall-grass prairie region of the Midwest.

151. ***Eucosma bipunctella*** (Walker)

FWL: 17.0-18.5 mm.

Flight Period: Mid-June to mid-July.

Distribution: Michigan and Wisconsin, south to Ohio, Missouri and Kansas.

Biology: Larvae have been reared from roots of *Silphium laciniatum* (compassplant) (Heinrich, 1923a).

Remarks: Forewing color varies from pale yellow to yellowish brown, the illustrated specimen being intermediate in this respect. All individuals show a dark dot, presumably the basis for the specific name, at the end of the discal cell.

152. ***Eucosma bilineana*** Kearfott

FWL: 10.0-14.5 mm.

Flight Period: June.

Distribution: Ohio to Manitoba, south and west to Missouri and Colorado.

Biology: A larval host in Illinois is *Helianthus tuberosus* (Jerusalem artichoke) (Brown et al., 1983).

Remarks: Forewing color varies from whitish tan to dark gray brown. Females are usually dark with barely discernable streaking, males lighter with two distinctive longitudinal streaks. This is a common tall-grass prairie insect.

male

female

153. ***Eucosma nandana*** Kearfott

FWL: 9.0-14.5 mm.

Flight Period: Late August to early October.

Distribution: Ohio to Manitoba, south to North Carolina and Iowa.

Biology: Unknown.

Remarks: The only other midwestern *Eucosma* with fine white speckling on a charcoal gray forewing is *landana*, which is smaller and has white rather than gray fringe on the hindwing. Females of *nandana* have a large sclerotized patch on the dorsal surface of the corpus bursae. Populations of this species are documented from remnant prairie sites near Chicago and on the south shore of Lake Erie.

154. ***Eucosma landana*** Kearfott

FWL: 10.0-11.0 mm.

Flight Period: Late April to early June.

Distribution: Wisconsin to central Saskatchewan, south to Oklahoma.

Biology: Unknown.

Remarks: The amount of whitish-gray suffusion in the forewing is variable. Some individuals are dark charcoal gray with light speckling; others are light gray with dark speckling. *Eucosma nandana* is larger with gray, rather than white, fringe on the hindwing.

155. ***Eucosma simplex*** McDunnough

FWL: 9.5-11.0 mm.

Flight Period: May.

Distribution: Michigan and Wisconsin, south to Kansas.

Biology: Unknown.

Remarks: This poorly known moth is similar to *landana* in size, shape, and genitalia, but its forewing is brown rather than gray and is longitudinally streaked rather than speckled.

156. *Eucosma dorsisignatana* (Clemens)

FWL: 6.5-11.0 mm.

Flight Period: Late August to mid-October.

Distribution: Nova Scotia to British Columbia, south to Georgia and Texas.

Biology: Larvae bore into the roots of *Solidago* (goldenrod) (Heinrich, 1923a).

Remarks: The subbasal fascia is incomplete, resulting in a prominent dark spot on the dorsal margin that extends only as far as the radius. In *similiana* this spot is joined to the median fascia.

157. *Eucosma similiana* (Clemens)

FWL: 6.5-10.5 mm.

Flight Period: Late July to mid-October.

Distribution: Nova Scotia to Manitoba and south to Georgia, Mississippi, and Colorado.

Biology: Larvae bore into rootstalks of *Solidago* (goldenrod) (Čapek, 1971).

Remarks: Contrast between forewing markings and interfascial areas is variable. The subbasal and median fasciae are connected in the discal cell; in the similar *dorsisignatana* they are disjunct. Both *similiana* and *dorsisignatana* are widely distributed in the Midwest and often are found flying together in late summer.

158. ***Eucosma derelicta*** Heinrich

FWL: 5.5-8.0 mm.

Flight Period: Mid-July to early September.

Distribution: Nova Scotia to British Columbia, south to Florida, Missouri and Colorado.

Biology: Larvae bore into roots of *Solidago* (goldenrod) (Heinrich, 1929; Čapek, 1971).

Remarks: This is a very common late-summer moth in prairie and old field habitat. The cucullus has a narrowly rounded apex, a straight distal margin and a strongly produced anal angle supporting a stout spine.

159. ***Eucosma wandana*** Kearfott

FWL: 7.0-9.5 mm.

Flight Period: Early June to mid-September.

Distribution: Ohio to Kansas, south to Florida and Texas.

Biology: The authors have observed adults in association with *Rudbeckia hirta* (blackeyed Susan), but no larval host has been documented.

Remarks: This species is known in the historical literature under the synonyms *uta* Clarke and *ustulatana* Blanchard & Knudson (Gibson & Miller, 1994). Forewing color varies from dark brown in males to brownish yellow in females. Fascial markings are constant, though sometimes difficult to discern on darker specimens. The papillae anales have ventral extensions.

160. ***Eucosma fulminana*** (Walsingham)

FWL: 10.0-13.5 mm.

Flight Period: Early June to mid-September.

Distribution: Michigan and Wisconsin, south to Texas and Wyoming.

Biology: Unknown; we have observed diurnal resting of adults on *Silphium terebinthinaceum* (prairie rosinweed) in southern Ohio, and light traps placed near this plant have, on occasion, produced numerous specimens of *fulminana*.

Remarks: Forewing color varies from rich medium brown to a dark grayish brown, but in all cases it is generously overlaid with silvery-gray irrorations.

161. ***Eucosma rusticana*** Kearfott

FWL: 9.0-12.0 mm.

Flight Period: Mid-June to mid-August.

Distribution: North Carolina to northern Illinois, south to Mississippi and Texas.

Biology: Unknown.

Remarks: Though widely distributed in the Midwest and readily identified by its forewing pattern, this moth is not well represented in collections. Some specimens from the Chicago area have a particularly melanic appearance (Wright, 2006).

162. ***Eucosma haydenae*** Wright

FWL: 6.0-8.0 mm.

Flight Period: Late May to early July.

Distribution: Recorded from Illinois and northern Iowa.

Biology: Unknown.

Remarks: The only records of *haydenae* are from prairie preserves in northeastern Iowa and in the vicinity of Chicago, Illinois. Forewing appearance is sufficient to distinguish this species from other midwestern *Eucosma*. The medial surface of the male valva has a conspicuous scooped-out emargination at the ventral margin of the neck. This species was named after Dr. Ada Hayden, a botanist and early advocate of prairie conservation in Iowa (Wright, 2006).

163. *Eucosma sombreana* Kearfott

FWL: 8.0-11.5 mm.

Flight Period: Mid-June to early September.

Distribution: Connecticut to Manitoba, south to Georgia, Louisiana and Kansas.

Biology: Larval hosts include *Helianthus giganteus* (giant sunflower), *H. tuberosus* (Jerusalem artichoke) and *H. decapetalus* (thinleaf sunflower) (Heinrich, 1923a; MacKay, 1959). The larva bores in the basal portion of the stalk, working its way into the tubers. When fully developed (October, November) it tunnels through the soil and hibernates in a cocoon about an inch below the surface. Pupation occurs in early summer, and adults emerge two weeks later (Heinrich, 1923a).

Remarks: This nondescript moth is common throughout the Midwest. The shape of the male valva is distinctive, and the valval neck has a scooped-out ventral emargination. These characters can often be observed by brushing a few scales off the end of the abdomen.

164. *Eucosma fiskeana* Kearfott

FWL: 7.5-11.0 mm.

Flight Period: Mid-June to mid-August.

Distribution: Virginia to Ohio and Illinois, south to Mississippi.

Biology: Unknown.

Remarks: In forewing appearance, *fiskeana* is similar to *Pelochrista milleri*, with which it can be found flying during July in woodland glades in southern Ohio. Genitalic differences easily distinguish the two species.

165. *Eucosma consobrinana* Heinrich

FWL: 5.5-7.0 mm.

Flight Period: August in the Midwest; March to May and September through November in Texas.

Distribution: South Dakota south to Mississippi and New Mexico.

Biology: Unknown.

Remarks: This is the smallest member of a confusing complex of western species associated with the name *pulveratana*. Current taxonomic knowledge of the group is inadequate for many species level determinations, but size seems to be a reliable diagnostic character for *consobrinana*. Forewing length is at least 2 mm shorter than in other members of the group.

166. ***Eucosma gomonana*** Kearfott

FWL: 4.5-5.0 mm.

Flight Period: Early April to mid-May.

Distribution: New Hampshire to Manitoba, south to Florida and Mississippi.

Biology: Unknown.

Remarks: This is the smallest *Eucosma* in eastern North America. The forewing pattern and valval shape are not likely to be confused with any of its congeners.

167. ***Eucosma cataclystiana*** (Walker)

FWL: 7.0-9.0 mm.

Flight Period: Late June to early September.

Distribution: Nova Scotia to Manitoba and Montana, south to Florida and Arizona.

Biology: The larva bores in the stem base and rhizomes of *Euthamia graminifolia* (flat-top goldentop) (Putman, 1942).

Remarks: Forewing color varies from pale yellowish brown to reddish brown. Most specimens show a patch of dark reddish-brown scales on the head. The concave termen of the forewing gives the apex a falcate appearance.

Genus *Pelochrista*

Neactic *Pelochrista* consists of approximately 25 named species, eight of which are encountered in the Midwest. Life histories have been reported for only a few species, and in those instances larval behaviors include feeding in flower heads and boring in stems and roots of Asteraceae.

Midwestern members of the genus can usually be identified by forewing appearance. The male cucullus has a strongly developed anal angle from which projects a particularly stout, spikelike seta. This character, as well as the shape of the cucullus, can usually be observed by brushing scales from the end of the abdomen. In females, sternum VII tends to be strongly sclerotized along its posterior and lateral margins, and often its posterior margin has a medial projection that partially shields the ostium bursae. The corpus bursae has two signa, the smaller of which is often mounted in a wrinkled, thickened or sometimes sclerotized portion of the membrane near the juncture of the ductus bursae and corpus bursae.

168. *Pelochrista argenteana* (Walsingham)

FWL: 8.0-12.0 mm.

Flight Period: June and July.

Distribution: North Dakota to British Columbia, south to Texas and California.

Biology: Unknown.

Remarks: The forewing comes in varying shades of straw yellow. The longitudinal silvery-white streaking is usually distinctive but is sometimes muted by yellow suffusion. Expression of the grayish-brown scaling on the veins is variable, but the thin black line along the base of the fringe is present in all phenotypes. This moth exhibits an unusually large amount of variation in the shape of the male cucullus (Wright, 2007b). Midwestern records are from Iowa and the Dakotas.

169. *Pelochrista scintillana* (Clemens)

FWL: 5.5-14.5 mm.

Flight Period: June through mid-August.

Distribution: Transcontinental, from southern Canada to the Gulf Coast.

Biology: Walker (1936) reported rearing several adults from sunflower heads in Kansas.

Remarks: The moths to which this name is currently applied are variable with regard to some aspects of forewing coloration but display the same basic forewing pattern and genitalia structure. The taxonomic status of the various forms is unresolved. Two of the phenotypes commonly found in the Midwest are illustrated here. In the Gulf States, adults have been captured as early as mid-April and as late as mid-October.

170. *Pelochrista pallidipalpana* (Kearfott)

FWL: 5.5-6.5 mm.

Flight Period: Late June to early August.

Distribution: Connecticut to Iowa, south to Georgia and Mississippi.

Biology: Unknown.

Remarks: Populations of this species seem to be localized, mostly in prairie habitat. The forewing pattern is distinctive but is infrequently obscured by extensive brown suffusion.

171. *Pelochrista corosana* (Walsingham)

FWL: 7.5-10.5 mm.

Flight Period: June through September.

Distribution: Minnesota to Montana, south to Texas and Arizona.

Biology: Unknown.

Remarks: A common resident of the Great Plains and the Southwest, *corosana* is variable in forewing coloration (Wright, 2007b). Specimens from the western reaches of the Midwest are olive brown to dark brownish gray. Forewing pattern is constant but can be hard to detect in some darkly suffused specimens. A line of whitish scales is nearly always present along the distal margin of the median fascia, and there is often a white streak along the anterior half of the termen.

172. *Pelochrista rorana* (Kearfott)

FWL: 7.0-9.0 mm.

Flight Period: May through mid-August.

Distribution: Illinois to Washington, south and west to New Mexico and Arizona.

Biology: The larva bores in roots of *Helianthus annuus* (common sunflower) in Washington (Brown et al., 1983).

Remarks: In the Midwest, *rorana*, *zomonana* and *womonana* form a group of closely related species. They are most easily distinguished by size, color, and forewing pattern, with *rorana* being the largest. Its fasciate forewing markings tend toward dark brown instead of gray and are usually well delimited by prominent white interfascial areas.

173. *Pelochrista zomonana* (Kearfott)

FWL: 5.0-6.5 mm.

Flight Period: June through August.

Distribution: Pennsylvania and Michigan to Kansas, south to North Carolina and Mississippi.

Biology: Larvae probably bore in stems and roots of *Chrysanthemum* (daisy) (MacKay, 1959).

Remarks: This is the smallest member of the *rorana* group. The fasciate markings tend to be incomplete toward the costa or at least interrupted on the radial vein.

174. *Pelochrista womonana* (Kearfott)

FWL: 5.0-8.0 mm.

Flight Period: Late June through late August.

Distribution: Maryland to Minnesota, south to Mississippi and Texas.

Biology: Larvae bore in roots of *Helianthus* (sunflower) (Rogers et al., 1979).

Remarks: The forewing pattern is very similar to that of *rorana*, but the interfascial areas are more suffused with brown and gray, resulting in a darker overall appearance. This is a common moth in the eastern half of the Midwest during July and August.

175. *Pelochrista milleri* Wright

FWL: 5.5-9.5 mm.

Flight Period: July and August.

Distribution: New Hampshire to Manitoba, south to Virginia and Arkansas.

Biology: One larva was reared on *Helianthus tuberosus* (Jerusalem artichoke) (Wright, 2007a).

Remarks: Forewing appearance is most similar to that of *Eucosma fiskeana*, but the two species are separated by genitalia. On occasion it has been confused with *Eucosma wandana*, but *milleri* is distinguished by the white edging of the forewing markings as well as by genitalic characters.

Genus *Epiblema*

There are 41 named species of *Epiblema* in the Nearctic Region, approximately half of which are found in the Midwest. Life histories have been reported for 11 of the 20 species included here, and in each case the larva is a stem- or root-borer in Asteraceae. In many instances the late-instar larva develops and pupates in the stem, and the plant responds by enclosing the feeding area in a conspicuous elongate gall.

Most midwestern species have a prominent interfascial spot on the dorsal margin of the forewing between the subbasal and median fasciae. Its expression is sometimes variable, but its color and shape are often sufficient for species determination. The basal and subbasal fasciae are usually confluent, forming a basal patch.

With the exception of *abruptana*, males have a prominent clasper, shaped roughly like a tetrahedron, on the margin of the basal excavation. In females, the lamella postvaginalis is well developed, the posterior margin of sternum VII is only weakly invaginated and not closely approximate to the lateral margins of the sterigma, and the corpus bursae has two signa.

176. *Epiblema luctuosissima* Blanchard

FWL: 5.0-6.5 mm.

Flight Period: April to November.

Distribution: Michigan to Colorado, south to Texas.

Biology: Unknown.

Remarks: This moth is similar in appearance to members of the *strenuana* complex. The expression of the interfascial spot is variable, and dissection is usually required for positive identification. Male valval shape is only subtly different from that of *strenuana*, but females of *luctuosissima* have much smaller signa in the corpus bursae. Spring and autumn records are from Texas.

177. *Epiblema boxcana* (Kearfott)

FWL: 5.5-7.5 mm.

Flight Period: Mid-May to mid-July; April in Texas.

Distribution: New Hampshire to Minnesota, south to Alabama and Texas.

Biology: Unknown.

Remarks: Closely related to members of the *strenuana* complex, *boxcana* is distinguished by the following forewing markings: a well defined dark basal patch, a grayish-white interfascial spot, and a small, dark, pretornal patch on the dorsal margin. The costal strigulae are not conspicuous.

178. ***Epiblema strenuana*** complex

E. strenuana (Walker)

E. minutana (Kearfott)

FWL: 4.5-8.5 mm.

Flight Period: Late June; mid-August to mid-September.

Distribution: Transcontinental, across southern Canada and south to Florida and New Mexico.

Biology: Larvae are stem-borers in *Ambrosia artemisiifolia* (annual ragweed) (Stegmaier, 1971) and *Parthenium hysterophorus* (Santa Maria feverfew) (McClay, 1987).

Remarks: Moths in this complex vary in size and coloration. The illustrations show the forms associated with the names *strenuana* (Walker) and *minutana* (Kearfott), but there is no consensus as to whether these represent distinct species. Roughly speaking, *strenuana* has been considered to be larger (FWL: 5.5-8.5 mm) and browner, *minutana* smaller (FWL: 4.5-7.0) and grayer. The current state of the taxonomy is summarized in Miller and Pogue (1984).

179. ***Epiblema abruptana*** (Walsingham)

FWL: 5.0-7.0 mm.

Flight Period: Mid June to early August in the Midwest; August to October in Texas.

Distribution: Michigan to Kansas, south to Florida and Texas.

Biology: Unknown.

Remarks: Specimens currently interpreted as *abruptana* are variable in size, color and forewing maculation, indicating the possibility of a complex of closely related species. Some show a weakly contrasting, yellowish-brown, interfascial spot at mid-dorsum, others are variously overlaid with blackish-brown markings. The specimen illustrated is a good match to Walsingham's syntypes, which come from Texas and were collected in October. Long standing confusion about the application of this name renders many literature records unreliable.

180. ***Epiblema tripartitana*** (Zeller)

FWL: 4.0-10.0 mm.

Flight Period: Early April to early August.

Distribution: Connecticut to Wisconsin, south to Florida and New Mexico.

Biology: Bottimer (1926) reported larvae boring in flower heads and stems of *Rudbeckia maxima* (great coneflower) in east Texas.

Remarks: The distinguishing feature of *tripartitana* is the white interfascial spot, which extends from dorsal margin to costa, forming a broad, white, medial band (Wright, 2002). Though widely distributed in eastern North American, this species appears to be most common in the southern states.

181. ***Epiblema glenni*** Wright

FWL: 5.0-8.5 mm.

Flight Period: Late May to mid-September.

Distribution: Michigan and Illinois, south to North Carolina, Tennessee and Missouri.

Biology: Unknown.

Remarks: Forewing maculation is similar to that of *tripartitana*, but the interfascial spot fails to reach the costal margin, and its irregular distal edge has a longitudinal jog at the cubitus. In the Midwest *glenni* is more common than *tripartitana*.

182. ***Epiblema resumptana*** (Walker)

FWL: 5.0-6.0 mm.

Flight Period: Mid-April to mid-June.

Distribution: Nova Scotia to Saskatchewan, south to New Jersey and Kentucky.

Biology: Adults have been observed in association with *Anaphalis margaritacea* (pearly everlasting) in Nova Scotia (McDunnough, 1959).

Remarks: Little seems to be known about this species. The contrast between fasciae and interfascial areas varies considerably, but the combination of forewing pattern and small size is usually adequate for identification. The male cucullus is broader and more rounded than in other midwestern *Epiblema*.

183. ***Epiblema benignatum*** McDunnough

FWL: 6.0-9.5 mm.

Flight Period: May to early July.

Distribution: Manitoba to Washington, south to Iowa, New Mexico, and California.

Biology: Clarke reared larvae from stems of *Artemisia vulgaris* (common wormwood) in Washington (Brown et al., 1983).

Remarks: The forewing pattern is very similar to that of *scudderiana*, but there are subtle differences in coloration: the ocellus and interfascial spot are white, and the basal and terminal areas are both blackish brown. This species does not have the blue-gray scaling often present in *scudderiana*.

184. ***Epiblema scudderiana*** (Clemens)

FWL: 6.5-10.5 mm.

Flight Period: Late May to early August.

Distribution: Maine to North Dakota, south to Florida and Texas.

Biology: Young larvae feed in tips of *Solidago* (goldenrod), late instars bore in the stems, inducing an elongate gall (Miller, 1976).

Remarks: This is a common resident of old fields and prairies. In typical midwestern specimens the postmedian region of the forewing is mottled with white and blue-gray. The large white dorsal patch nearly reaches the costa and is often overlaid with bluish-gray scaling.

185. ***Epiblema carolinana*** (Walsingham)

FWL: 6.5-10.5 mm.

Flight Period: Mid-June through late August.

Distribution: New Hampshire to Manitoba, south to Mississippi.

Biology: The larva bores in the stem base and roots of *Rudbeckia laciniata* (cutleaf coneflower) (Putman, 1942; Thompson & Guelph, 1928).

Remarks: Though superficially similar to *scudderiana*, this species has a duller appearance. The interfascial spot is overlaid with gray striations, and the basal patch is concolorous with the postmedian region. The two species are readily separated by male genitalia.

186. ***Epiblema obfuscana*** (Riley)

FWL: 7.5-10.5 mm.

Flight Period: May to July.

Distribution: Maine to Washington, south to North Carolina, Mississippi and Louisiana.

Biology: The larva bores in stems of *Solidago* (goldenrod) (Putman, 1942).

Remarks: In the Midwest, *obfuscana* is the only *Epiblema* with a pale gray forewing, black scaling along the anterior portion of the terminal margin, and a black hindwing. The whitish-gray interfascial spot often contrasts only weakly with adjacent scaling.

187. ***Epiblema desertana*** (Zeller)

FWL: 6.0-9.0 mm.

Flight Period: Mid-April through June; as early as February in Texas.

Distribution: Connecticut to Wisconsin, south to Florida and Texas.

Biology: The larva is a late-instar stem-borer in *Euthamia graminifolia* (flat-top goldentop), inducing an elongate gall (Miller, 1976a).

Remarks: The forewing pattern of *desertana* is similar to that of *obfuscana*, but its dirty white interfascial areas contrast strongly with the dark basal patch. In many specimens the interfascial spot has a pinkish tint. Males are distinguished by the pointed apex of the uncus.

188. ***Epiblema dorsisuffusana*** (Kearfott)

FWL: 7.0-9.0 mm.

Flight Period: June and July.

Distribution: Maine to Iowa, south Arkansas.

Biology: Unknown.

Remarks: The confluence of the interfascial spot and ocellus forms a large whitish area along the dorsal margin of the forewing, a character that distinguishes this species from *otiosana*.

189. *Epiblema iowana* McDunnough

FWL: 6.5-9.0 mm.

Flight Period: April and May.

Distribution: Ohio to Minnesota, south and west to Louisiana and Kansas.

Biology: The larva feeds in roots of *Ratibida pinnata* (pinnate prairie coneflower) (Clarke, 1953; Miller, 1985a).

Remarks: Fresh specimens can be identified by forewing maculation. Females have a fasciate pattern that is more developed than in other midwestern *Epiblema*. This moth has a strong preference for prairie habitat.

male

female

190. *Epiblema otiosana* (Clemens)

FWL: 5.0-9.5 mm.

Flight Period: May to September.

Distribution: Rhode Island to South Dakota, south to Florida and Texas.

Biology: The larva bores in stems of *Bidens frondosa* (devil's beggartick) (Decker, 1932) and *Ambrosia artemisiifolia* (annual ragweed) (Putman, 1942).

Remarks: The white interfascial spot is variable in size and shape and is sometimes reduced to near obsolescence. Typical specimens have a white longitudinal spur on the distal margin of the spot, projecting toward the ocellus. The similar looking *dorsisuffusana* has more extensive white scaling in the ocellus and along the dorsal margin.

191. ***Epiblema infelix*** Heinrich

FWL: 6.5-10.0 mm.

Flight Period: Early April to early July.

Distribution: Michigan south to western North Carolina and Mississippi.

Biology: Unknown.

Remarks: Fresh specimens are blackish gray, but flight-worn individuals often have a brownish-gray appearance. The white interfascial spot is conspicuous, and its semitriangular shape is usually diagnostic (Wright, 2002).

192. ***Epiblema walsinghami*** (Kearfott)

FWL: 6.0-8.0 mm.

Flight Period: Late April to early June.

Distribution: New Jersey to Illinois, south to Kentucky.

Biology: Unknown.

Remarks: Little is known about this species. Circumstantial evidence suggests that it may be diurnal (Wright & Covell, 2003), which would explain the scarcity of specimens in collections. Forewing appearance is similar to that of *infelix*. Female *walsinghami* have two signa of markedly different size versus two of the same size in *infelix*. Males are distinguished easily by genitalia.

193. ***Epiblema gibsoni*** Wright & Covell

FWL: 6.0-9.5 mm.

Flight Period: Early June to mid-August.

Distribution: Southern Michigan to Missouri, south to South Carolina and Mississippi.

Biology: Unknown.

Remarks: Most specimens can be identified by the shape of the immaculate, white, interfascial spot, but in some instances brown suffusion renders the spot nearly indiscernible. In July *gibsoni* is common in prairies and glades east of the Mississippi River (Wright & Covell, 2003).

194. *Epiblema brightonana* (Kearfott)

FWL: 5.0-7.5 mm.

Flight Period: July to early September.

Distribution: Nova Scotia to South Dakota, south to North Carolina and Mississippi.

Biology: Unknown.

Remarks: The white edged forewing markings readily distinguish *brightonana* from other midwestern *Epiblema*. The subbasal fascia is incomplete toward the costa, resulting in a conspicuous dark spot on the dorsal margin.

195. *Epiblema tandana* (Kearfott)

FWL: 9.0-10.5 mm.

Flight Period: June though August.

Distribution: New Jersey to Minnesota, south to Kentucky.

Biology: The larva is a root-borer in *Rudbeckia laciniata* (cutleaf coneflower) (Godfrey et al., 1987).

Remarks: The forewing appearance of this species is similar to that of *Notocelia culminana*, but *tandana* has a uniformly dull-brown forewing with dark brown markings and lacks a basal patch. Genitalia of the two species are not similar.

Genus *Notocelia*

There are four Nearctric species of *Notocelia*. We treat three found in the Midwest, two of which are known to feed on rose.

Males have a costal fold. The valva has a clasper on the margin of the basal excavation that is similar to that of *Epiblema*. In addition to several deciduous cornuti, there are two shorter cornuti permanently affixed to the vesica near the distal end of the aedeagus. The sterigma is a semirectangular plate with the ostium located slightly anterior to the center. The corpus bursae has two signa.

196. *Notocelia rosaecolana* (Doubleday)

FWL: 6.5-9.0 mm.

Flight Period: May and June.

Distribution: Newfoundland to Michigan, south to Alabama and Missouri.

Biology: The larvae feed in buds, twigs and webbed leaves of *Rosa* (rose) (Razowski, 2003).

Remarks: This Holarctic species has often been confused with *trimaculana* (Haworth), a nearly identical looking Palearctic taxon. Males of *rosaecolana* can be distinguished by the presence of melanic sex scaling near the base of the hair pencil on the hindwing between vein 3A and the anal margin (Miller et al., 2000). In Europe *rosaecolana* is considered a pest on cultivated roses.

197. *Notocelia illotana* (Walsingham)

FWL: 6.5-8.5 mm.

Flight Period: Late May to early July.

Distribution: Maine to British Columbia, south to Kentucky, Colorado and California.

Biology: Unknown.

Remarks: Forewing appearance is most similar to that of *rosaecolana*, but the basal patch is larger and darker, and the distal markings are paler and less distinct. The valval neck is wide, with a convex bulge on the ventral margin, and the anal angle of the cucullus is less strongly developed than in *rosaecolana*.

198. ***Notocelia culminana*** (Walsingham)

FWL: 7.0-8.5 mm.

Flight Period: July to September.

Distribution: Nova Scotia to British Columbia, south to District of Columbia, Kentucky, New Mexico and California.

Biology: The larva is a leaf-tier on *Rosa* (rose) (MacKay, 1959).

Remarks: This widespread species is easily identified by the pale ground color of the forewing and the dark semitriangular patch at the termen. Worn specimens might be mistaken for *Epiblema tandana*, but the latter has a browner overall appearance and lacks the basal patch. Questionable cases can be resolved by examining the genitalia.

Genus *Suleima*

Suleima is a Nearctic genus consisting of seven species, most of which are endemic to the Southwest and/or Pacific coast states. The two treated here are associated with sunflowers and are widely distributed in the Midwest.

Males lack a costal fold. The valva is spatulate, with very little constriction at the neck and with a series of moderately stout setae evenly spaced along the ventral margin of the cucullus. Uncus and socii are weakly developed. Females have a semi-cylindrical sterigma, an elongate sclerotized patch on the ductus bursae, and two signa in the corpus bursae.

199. *Suleima helianthana* (Riley)

FWL: 6.5-9.0 mm.

Flight Period: Mid-May through August.

Distribution: New York to South Dakota, south and west to Mississippi and California.

Biology: Late-instar larvae bore in buds, stems, stalks, bracts, and seeds of *Helianthus* (sunflower). Pupation occurs in a cocoon constructed in the feeding cavity (Satterthwait, 1948).

Remarks: Forewing color varies from light tan to gray brown. The entire costa is marked with thin dark dashes associated with the strigulae, and the ocellus is white and conspicuous. The subbasal and median fasciae fade toward the costa, leaving two dark brown marks on the dorsal margin. Forewing apperance is most similar to that of *Eucosma consobrinana* and *Phaneta tomonana*, but the genitalia of the three species are different.

200. *Suleima cinerodorsana* Heinrich

FWL: 5.5-8.0 mm.

Flight Period: Mid-July to early September.

Distribution: Quebec to Michigan, south to Kentucky and Iowa.

Biology: The larva bores in stems of *Helianthus* (sunflower) (Putman, 1942).

Remarks: The head, dorsal surface of the thorax, central field of the ocellus, and dorsal margin of the forewing are white. The region anterior to the cubitus is black, with some orange-brown coloration along the distal half of the costa. The black color often extends to the dorsum along the basal margin of the ocellus, interrupting the white dorsal band.

Genus *Sonia*

Sonia was proposed by Heinrich (1923a) for three Nearctic species which possess four radial forewing veins instead of the usual five (R4 and R5 are united). The number of recognized species has since grown to seven, but there are members of the genus encountered in the Midwest that do not seem to be accommodated by the available names. Larval hosts are known for four species, and in each case the immatures are root-borers in Asteraceae. Our treatment includes three midwestern species and one from the West with a range extending into Kansas.

The third segment of the labial palpus is usually blackish brown and distinctly darker than the second segment. Basal segments of the antenna tend to be black, sharply contrasting with white scaling on the scape. These characters are conspicuous and, with few exceptions (e.g., *Epiblema abruptana*), are sufficient for generic placement of midwestern specimens. Males have a costal fold.

Interspecific differences in genitalia are subtle at best. Male valval shape is quite uniform across the genus. There is a small clasper on the medial surface of the valva that is located somewhat distant from the margin of the basal excavation. The female genitalia exhibit subtle differences in the shape of the sterigmata but are otherwise indistinguishable.

201. *Sonia paraplesiana* Blanchard

FWL: 6.0-7.5 mm.

Flight Period: Late June to mid-August in the Midwest, April in Florida, June through November in Texas.

Distribution: New York to South Dakota, south to Florida and Texas.

Biology: Unknown.

Remarks: Typical specimens have a grayish-white interfascial spot at mid-dorsum that connects distally to the ocellus, dividing the median fascia into two prominent dark marks, one at the distal end of the cell, the other on the dorsum. This character seems to be variable. Blanchard (1979) distinguished *paraplesiana* from the similar looking *constrictana* (Zeller) based on subtle differences in maculation and sterigma shape. He suggested that *constrictana* is restricted to Gulf Coast states, a region in which the two species appear to be sympatric.

202. *Sonia canadana* McDunnough

FWL: 5.5-8.5 mm.

Flight Period: Late June to early September.

Distribution: Southern Ontario to Manitoba, south to northern Kentucky.

Biology: Larvae bore in roots of *Solidago* (goldenrod) (Ĉapek, 1971).

Remarks: The light interfascial spot is often suffused with brown scaling, but its lateral margins are usually conspicuous and appear as thin white edging along the subbasal and median fasciae. The median fascia is interrupted by a spur extending distally from the interfascial spot.

203. ***Sonia vovana*** (Kearfott)

FWL: 6.5-10.5 mm.

Flight Period: July through September.

Distribution: Kansas to Idaho, south to New Mexico and California.

Biology: Larvae have been reared from roots of *Gutierrezia* (snakeweed) and *Isocoma* (goldenbush) in California and Arizona (Powell & Opler, 2006).

Remarks: This is a common species in the Great Plains and in the arid regions of the Southwest. It is easily distinguished from other *Sonia* species by the light brownish-gray ground color and the well defined subbasal fascia. Midwestern records come from western Kansas.

204. ***Sonia divaricata*** Miller

FWL: 6.0-8.0 mm.

Flight Period: Mid-May to mid-July.

Distribution: Kentucky to Missouri, south to Mississippi.

Biology: Unknown.

Remarks: The median fascia is unbroken and only weakly constricted, and the interfascial spot tends to be brighter than in other *Sonia* species. Miller (1990) noted the weakly bifid uncus as a distinguishing feature of the male genitalia, but this condition can be observed in both *canadana* and *paraplesiana*; usual slide mounting techniques often induce bending of the upper tegumen, making this character difficult to detect.

Genus *Gypsonoma*

Gypsonoma is a primarily Holarctic genus with seven recognized species in North America. The five found in the Midwest are associated with poplar, aspen or willow; the larvae are leaf-rollers or twig-borers. Forewing pattern in this genus is rather uniform, with basal patch and median fascia well defined and separated by a contrasting interfascial band of lighter coloration. Males lack a costal fold.

In the male genitalia there is a prominent clasper on the margin of the basal excavation and a cluster of long scales on the tegumen near the point of articulation with the vinculum. All but *haimbachiana* have a distinctive narrow flange along the distal margin of the cucullus. Females have two tacklike signa, some sclerotization of the ductus bursae, and interspecific differences in the sculpturing of the sterigma.

205. *Gypsonoma haimbachiana* (Kearfott)

FWL: 5.5-7.5 mm.

Flight Period: June to mid-August.

Distribution: Maine to Minnesota, south to Georgia and Texas.

Biology: The larval host is *Populus deltoides* (cottonwood). Newly hatched larvae construct a silk feeding shelter near a midrib or vein and feed on leaf tissue. The second-instar bores into a fresh shoot, and development is completed in the resulting tunnel. Pupation occurs in a silk cocoon in a bark crevice or on the ground. There are several generations per year, the last overwintering as a second-instar larva in a hibernaculum constructed on the bark or in a hollowed bud (Morris, 1967).

Remarks: The maculation is similar to that of *fasciolana*, but the forewing has an overall grayish appearance, the interfascial areas are darker and contrast less with the fasciae, and the median fascia is much more weakly expressed. The other weakly marked species in the Midwest, *salicicolana*, is much smaller and has a browner forewing.

206. *Gypsonoma salicicolana* (Clemens)

FWL: 4.5-5.5 mm.

Flight Period: June to early July.

Distribution: New Hampshire to Manitoba, south to Florida and Louisiana.

Biology: The larva feeds in rolled leaves of *Salix* (willow) (Prentice, 1966).

Remarks: This is the smallest midwestern *Gypsonoma*. The basal patch, though well defined, often differs little in color from the adjacent interfascial area, and the median fascia tends to be indistinct. Forewing color varies from light brown to grayish brown. In some Iowa specimens with similar maculation and male genitalia, the interfascial areas have a metallic blue cast.

207. *Gypsonoma adjuncta* Heinrich

FWL: 5.5-7.0 mm.

Flight Period: June through mid-July.

Distribution: Nova Scotia to British Columbia, south to New York and Arizona.

Biology: Prentice (1966) reported a single collection of a leaf-rolling larva on *Populus tremuloides* (quaking aspen).

Remarks: The basal patch is black and sharply defined; the white interfascial band is divided medially with blackish-gray scaling, producing white costal and dorsal patches. No other midwestern *Gypsonoma* has as much black to charcoal-gray scaling on the forewing.

208. *Gypsonoma fasciolana* (Clemens)

FWL: 6.0-8.0 mm.

Flight Period: June to late July.

Distribution: Nova Scotia to British Columbia, south to New Jersey, Arkansas, and Wyoming.

Biology: The larva is a leaf-roller on *Salix* (willow), *Populus balsamifera* (balsam poplar), and *Populus tremuloides* (quaking aspen) (Prentice, 1966).

Remarks: This moth is distinguished from other midwestern *Gypsonoma* by the two white interfascial bands on the forewing bordering the dark median fascia. In specimens from Wyoming these areas are moderately suffused with brownish-gray irrorations.

209. *Gypsonoma substitutionis* Heinrich

FWL: 4.5-6.0 mm.

Flight Period: Mid-June to mid-August.

Distribution: Nova Scotia to British Columbia, south to Maryland and Illinois.

Biology: The preferred larval host seems to be *Populus tremuloides* (quaking aspen), but larval collections have been reported on *Quercus* (oak), *Populus grandidentata* (bigtooth aspen), and *Populus balsamifera* (balsam poplar) (Prentice, 1966).

Remarks: Though similar to *fasciolana*, *substitutionis* is smaller and lacks a second whitish interfascial band beyond the median fascia. The two species can be separated by the shape of either the valva or the sterigma.

Genus *Proteoteras*

Proteoteras is a Nearctic genus. Six of the eight recognized species are found in the Midwest, five of which are associated with maple. Life histories are well studied in some cases due to twig and bud damage and subsequent tree deformity caused by the larvae in boxelder plantations in the Canadian Prairie Provinces (Peterson, 1958). Larvae typically feed on leaves or leaf buds during the summer, overwinter in the fourth- or fifth-instar in an excavated bud, and complete development in the spring in tunnels bored in new shoots. This last activity usually induces the formation of a spindle-shaped gall which is easy to recognize in the field.

These moths are noted for their greenish forewing color and the presence of raised scale patches near the cubital vein. Males have a hair pencil just posterior to the costa on the dorsal surface of the hindwing, a feature that usually is concealed under the forewing in prepared specimens. Males also have distinctive patterns of melanic sex scaling located near the hair pencil, on the ventral wing surfaces, and occasionally on the dorsal surface of the hindwing. Males lack a costal fold.

Members of this genus exhibit some striking modifications of the male genitalia. The lateral surface of the valva has 3-6 long flattened setae arranged in a row near the ventral margin of the neck. The number is variable within species and sometimes between valvae of a particular specimen. Pencils of long hairlike setae emanate from the distal extremities of the socii. In females the lamella postvaginalis is long and narrow, and the lateral and anterior margins of the sterigma are fused with sternum VII. The corpus bursae has two signa.

210. *Proteoteras aesculana* Riley

FWL: 6.0-9.0 mm.

Flight Period: March to October.

Distribution: Nova Scotia to British Columbia, south to Florida, Mississippi, and California.

Biology: The larva bores in buds and terminal shoots of *Acer* (maple), the preferred host being *A. negundo* (boxelder). Pupation is presumed to occur on the ground (Solomon, 1995). A multivoltine life cycle seems likely in the South (Powell, 1962).

Remarks: Newly emerged moths are dark green, but worn specimens usually are faded. The crescent mark from mid-costa to apex is composed of both black and dark green scales and does not contrast strongly with the adjacent wing color. Males have black scaling on the ventral surface of the forewing anterior to the distal portion of the discal cell and on the ventral surface of the hindwing along Sc+R1. The subcostal hair pencil on the dorsal surface of the hindwing is surrounded with white scaling, which itself is edged with black scaling.

male ventral aspect

male hindwing dorsal aspect

211. ***Proteoteras willingana*** (Kearfott)

FWL: 7.0-9.0 mm.

Flight Period: Mid-May to October.

Distribution: Maine to British Columbia, south to Maryland and Texas.

Biology: The larval host is *Acer negundo* (boxelder). Early-instar larvae feed on the leaf surface beneath a silk shelter, skeletonizing the leaf. The fourth-instar passes the winter in a hibernaculum constructed in a hollowed leaf bud. Feeding commences in spring in a healthy leaf bud, and the fifth-instar bores into a new twig, where the larva completes development. Pupation occurs on the ground. (Peterson, 1958).

Remarks: The pale gray forewing is mottled with pale olive green and is speckled lightly with black. There are no well defined fascial markings. Males have black scaling along the costa on both surfaces of the hindwing and along the costa on the ventral surface of the forewing. Some specimens have a uniformly brownish-gray appearance.

male ventral aspect

male hindwing dorsal aspect

212. ***Proteoteras crescentana*** Kearfott

FWL: 7.0-9.0 mm.

Flight Period: Late May to mid-July.

Distribution: New Hampshire to Alberta, south to Alabama and Texas.

Biology: The larva bores in terminal shoots of *Acer negundo* (boxelder) (Wong et al., 1983; Solomon, 1995).

Remarks: The forewing is only faintly tinted with pale green, and the black crescent is sharply defined, contrasting strongly with the adjacent coloration. Males have a small amount of black costal scaling on the dorsal surface of the hindwing but none on the ventral surface of either wing.

male ventral aspect

male hindwing dorsal aspect

213. ***Proteoteras naracana*** Kearfott

FWL: 6.5-8.0 mm.

Flight Period: Mid-May through June.

Distribution: Connecticut to Wisconsin, south to Arkansas.

Biology: Godfrey et al. (1987) reported *Acer* (maple) as the larval host in central Illinois.

Remarks: This species is identified easily by forewing pattern. Males have a costal streak of black scaling on the ventral surface of the hindwing and a small patch of similar scaling on the ventral surface of the forewing adjacent to the discal cell at mid-costa. The hair pencil on the dorsal surface of the hindwing is brown, and the adjacent costal scales are pale gray.

male ventral aspect

male hindwing dorsal aspect

214. ***Proteoteras moffatiana*** Fernald

FWL: 7.0-9.5 mm.

Flight Period: Late June to early September.

Distribution: Nova Scotia to Minnesota, south to North Carolina and Mississippi.

Biology: Larval hosts are *Acer saccharum* (sugar maple), *A. rubrum* (red maple), and *A. saccharinum* (silver maple) (Prentice, 1966). Larvae feed initially in terminal buds, where they overwinter. In spring they move to new buds and mine emerging shoots (Simmons & Knight, 1973; Solomon, 1995). Rearings have also been reported on *Rosa* (wild rose) and *Sambucus* (elderberry) (Godfrey et al., 1987).

Remarks: The bright green color in fresh specimens is distinctive. The forewing is generously mottled with black scaling, and a weakly defined black crescent from mid-costa to apex is usually detectable. Males have black costal scaling only on the ventral surface of the hindwing. The costal scales adjacent to the hair pencil on the dorsal surface of the hindwing are pale greenish gray.

male ventral aspect

male hindwing dorsal aspect

215. ***Proteoteras obnigrana*** Heinrich

FWL: 6.5-8.0 mm.

Flight Period: June to August.

Distribution: Maine to southern Ontario, south and west to Kentucky and Illinois.

Biology: Unknown.

Remarks: Forewing appearance is similar to that of *aesculana*, but the green tends to be lighter and the dark median fascia terminates at the tornus instead of turning toward the apex to form a crescent. Males have extensive black sex scaling on both surfaces of the hindwing and on the ventral surface of the forewing, but none adjacent to the hair pencil on the dorsal surface of the hindwing.

male ventral aspect

male hindwing dorsal aspect

Genus *Zeiraphera*

This primarily Holarctic genus is represented by eight species in North America. One, *claypoleana*, is common in the central Midwest, where the larva feeds on buckeye. The other seven are associated with fir, spruce, or tamarack and range across Canada and northern portions of the United States. Of the latter group, we treat only *canadensis*, which is a pest on white spruce.

Heinrich (1923a) noted that appearance and larval behavior of *claypoleana* suggest an affinity to *Proteoteras*, but both he and Mutuura and Freeman (1966) placed the species in *Zeiraphera* based on genitalic similarities with the conifer feeding members of the genus. Males do not have a costal fold.

216. *Zeiraphera claypoleana* (Riley)

FWL: 6.0-8.5 mm.

Flight Period: May and June.

Distribution: Ohio to Missouri, south to North Carolina and Mississippi.

Biology: The reported host is *Aesculus glabra* (Ohio buckeye) (Heinrich, 1923a), but other species of *Aesculus* are likely utilized in the South. The young larva bores in a leaf petiole and later instars form a feeding shelter from webbed wilted leaflets. The damaged leaf eventually falls, and pupation occurs on the ground.

Remarks: The black forewing markings are variable in both sexes. Most records are from reared specimens, suggesting that adults are not very strongly attracted to ultraviolet light. Buckeye is one of the first trees to leaf out in the spring, and the larval nests are easy to spot in April and early May. Affected leaves always have a bored petiole.

217. *Zeiraphera canadensis* Mutuura & Freeman

FWL: 6.0-6.5 mm.

Flight Period: Mid-July to mid-August.

Distribution: Canada and northern United States.

Biology: The larvae are needle feeders on *Picea glauca* (white spruce), *P. mariana* (black spruce) and *Abies balsamea* (balsam fir). Overwintering occurs as an egg. Larvae hatch in spring as buds start to burst, begin feeding on developing needles under broken budcaps, and complete development in shelters of webbed needles and budcaps. Pupation occurs in the soil (Pilon, 1965).

Remarks: Historically, this moth was long considered to be *Z. ratzeburgiana*, introduced from Europe, but Mutuura and Freeman (1966) recognized it as a distinct species. It is known in the economic literature as the spruce bud moth due to its reputation as a pest on white spruce. The yellowish coloration on the forewing and shape of the valva make identification of males relatively straightforward.

Genus *Pseudexentera*

Pseudexentera is a Nearctic genus with seventeen recognized species. The thirteen species treated here are common woodland residents that fly in early spring. The larvae are leaf-tiers on trees and shrubs. Most of these moths are dull brown and/or gray, with variable forewing maculation, and consequently the genus has a long history of species misidentification. Miller's (1986) revision provides a thorough discussion of the historical errors and remains the best reference for interpreting records and larval hosts reported in the earlier literature. The genus was also reviewed by Cho (1987) in an unpublished Master's thesis.

The species with fasciate forewing patterns can be difficult to distinguish due to the presence of considerable intraspecific variation and the fact that differences in genitalia (see Cho, 1987) often are very subtle. Nevertheless, assignment to the genus is straightforward. Most species have an elongate forewing with a sharp indentation near the middle of the termen (most easily observed from the ventral side). Males lack a costal fold. Genitalic features characteristic of the genus include the shape of the valva and the elongate sterigma that is surrounded on three sides and fused with sternum VII.

218. *Pseudexentera cressoniana* (Clemens)

FWL: 8.0-10.5 mm.

Flight Period: Late February to early May.

Distribution: New York to Wisconsin, south to South Carolina and Texas.

Biology: The larva feeds on *Carya* (hickory) (McDunnough, 1940).

Remarks: This is a dark gray species with rather subdued fascial markings. There tends to be a greater amount of contrast in females between the dark basal patch and the lighter median area. Males are easily identified by the thornlike projection from the ventral margin of the cucullus, which gives the anal angle a forked appearance; this character can be observed by brushing aside scales at the end of the abdomen.

219. *Pseudexentera mali* Freeman

FWL: 6.0-8.0 mm.

Flight Period: Late February through May.

Distribution: Nova Scotia to Wisconsin, south to Mississippi.

Biology: The larva feeds in buds, tied leaves, and sometimes fruits of *Malus* (apple). Pupation occurs on the ground (Chapman and Lienk, 1971).

Remarks: This apple pest has both fasciate and unmarked phenotypes. Both show a pale orange-brown suffusion on the distal third of the wing. The unmarked form is similar in appearance to *Epinotia vertumnana* but is recognized as a *Pseudexentera* by the medial indentation in the terminal margin of the forewing. Females tend to have a well defined basal patch and a weakly expressed median fascia.

220. ***Pseudexentera oregonana*** (Walsingham)

FWL: 6.5-10.0 mm.

Flight Period: Mid-March through May.

Distribution: British Columbia to Nova Scotia, south to Ohio and Utah.

Biology: The larva is a leaf-roller on *Populus tremuloides* (quaking aspen) and *Salix* (willow). Pupation occurs on the ground (Miller, 1986b).

Remarks: This species is a resident of the aspen belt across southern Canada and northern United States. Adults come in both fasciate and unmarked phenotypes. The unmarked form can usually be recognized by unicolorous gray-brown forewings.

221. ***Pseudexentera spoliana*** (Clemens)

FWL: 6.5-9.5 mm.

Flight Period: Mid-February through May.

Distribution: New Brunswick to Wisconsin, south to South Carolina and Texas.

Biology: The larval host is *Quercus* (oak) (Miller, 1986b).

Remarks: Typical *spoliana* is grayish brown with a distinctly fasciate forewing pattern. The expression of the fasciae is variable, and the contrast between fasciae and adjacent ground color is often minimal. The subbasal and median fasciae are usually complete. This is a very common moth in the Midwest in March and April.

222. ***Pseudexentera haracana*** (Kearfott)

FWL: 6.0-8.0 mm.

Flight Period: April to mid-June.

Distribution: Nova Scotia to Minnesota, south to Florida and Texas.

Biology: The larval host is *Quercus* (oak) (Cho, 1987).

Remarks: There are two forewing markings that are helpful in identification: a longitudinal black bar at the distal end of the discal cell, which often connects to mid-costa and/or apex forming a crescent, and a basal patch that is divided into black posterior and brownish anterior portions. In general appearance *haracana* is somewhat similar to *Chimoptesis gerulae*, but the genitalia of the two species are different, and *Chimoptesis* lack the sharp medial indentation on the terminal margin of the forewing.

223. ***Pseudexentera faracana*** (Kearfott)

FWL: 7.5-10.0 mm.

Flight Period: March through May.

Distribution: New York to Michigan, south to South Carolina and Mississippi.

Biology: The larval host is *Castanea dentata* (chestnut) (Miller, 1986b).

Remarks: As currently understood, *faracana* has both streaked and fasciate phenotypes, but there appear to be very few modern records of the streaked type. Few American chestnut trees survived the blight introduced to North America around 1900, but sprouts from old trunks persist. Whether these are adequate to support the rather wide ranging moth we now recognize as *faracana* is not known.

224. ***Pseudexentera sepia*** Miller

FWL: 6.0-9.0 mm.

Flight Period: Early March to mid-May.

Distribution: Quebec to Manitoba, south to Maryland and Mississippi.

Biology: Unknown.

Remarks: The forewing is pale yellowish brown with a conspicuous mark on the dorsum formed by blackish-brown scaling on the posterior half of the subbasal fascia. No other *Pseudexentera* possess this combination of characters.

225. ***Pseudexentera hodsoni*** Miller

FWL: 6.5-9.0 mm.

Flight Period: February through April.

Distribution: Pennsylvania to Illinois, south to Florida and Texas.

Biology: The larval host is *Quercus* (oak) (Miller, 1986b).

Remarks: There is some variability in the amount of white and yellow-brown scaling in the lighter portions of the forewing, but the pattern is constant. Blackish-brown scales on the posterior half of the subbasal and median fasciae produce two conspicuous dark marks on the dorsal margin. In some specimens the basal and subbasal fasciae are confluent, forming a basal patch which is blackish-brown toward the dorsum and paler near the costa.

226. ***Pseudexentera maracana*** (Kearfott)

FWL: 6.0-8.0 mm.

Flight Period: February to mid-May.

Distribution: Quebec to Minnesota, south to Mississippi and Texas.

Biology: The larval host is *Crataegus* (hawthorn) (Miller, 1986b).

Remarks: The basal patch and median fascia are complete and contrast sharply with the lighter ground color. Though similar in appearance to *vaccinii*, *maracana* tends to have a broader median fascia and paler interfascial regions.

227. ***Pseudexentera kalmiana*** McDunnough

FWL: 5.5-7.0 mm.

Flight Period: Mid-April to early June.

Distribution: Newfoundland to Michigan, south to New Jersey.

Biology: McDunnough (1959) reared one adult male from *Kalmia*. Ferguson (1975) reported *Kalmia angustifolia* (sheep laurel) as a host.

Remarks: The forewing pattern is similar to that of *maracana*, but the fasciae are not defined as sharply, the interfascial areas are not as white, and the distal portion of the wing is suffused with orangish-brown coloration.

228. ***Pseudexentera vaccinii*** Miller

FWL: 6.0-8.0 mm.

Flight Period: Mid-March to mid-May.

Distribution: Massachusetts to Minnesota, south to South Carolina and Mississippi.

Biology: The larva feeds on *Vaccinium* (blueberry) (Miller, 1986b; Cho, 1987).

Remarks: This species is similar to *maracana*, but the forewing tends to have a grayer appearance, and the median fascia is much thinner at the costa.

229. *Pseudexentera costomaculana* (Clemens)

FWL: 6.5-8.0 mm.

Flight Period: April to mid-July.

Distribution: Nova Scotia to Michigan, south to North Carolina and Mississippi.

Biology: The larval host is *Hamamelis virginiana* (American witchhazel). Early instars feed in terminal leaf buds, later instars tie a narrow fold at the edge of a leaf (McDunnough, 1954).

Remarks: Forewing color and maculation are diagnostic. Males have a thornlike spine projecting from the middle of the distal margin of the cucullus. The closely related *virginiana* is similar in forewing pattern and male genitalia but is brown rather than yellowish orange. Adults in the Midwest fly in April and May.

230. *Pseudexentera virginiana* (Clemens)

FWL: 7.0-9.5 mm.

Flight Period: March to early May.

Distribution: New York to Michigan, south to South Carolina and Arkansas.

Biology: Unknown.

Remarks: Forewing pattern is similar to that of *costomaculana*, but the ground color is brown instead of yellow orange, and *virginiana* has a weakly expressed dark basal patch. Genitalia of the two species are indistinguishable.

Genus *Gretchena*

Gretchena is a New World genus consisting of twelve species, eight of which are endemic to the woodlands of eastern North America. Reported larval hosts include hickory, alder, and walnut, but there is not a great deal known about the biology of these insects. Adults emerge in the spring and often are captured along with species of *Pseudexentera*, but some apparently multivoltine species have flight periods continuing well into summer. One species, *bolliana*, is a pest on pecan.

Forewing color ranges from pale gray to blackish gray. Most species have a black mark anterior to the ocellus and another on each of the median and subbasal fasciae, combining to form a sometimes interrupted streak from base to apex. It is difficult to make determinations based on maculation alone, particularly with flight-worn specimens, but genitalic characters usually are diagnostic. Males have a prominent projection at the anal angle of the cucullus, the shape and armature of which are distinctive for each species. In females, the posterior margin of sternum VII shields the ostium, and its shape is useful for identification (Brown, 1982). Both of these characters can be examined by brushing scales from the end of the abdomen. Males lack a costal fold.

231. *Gretchena deludana* (Clemens)

FWL: 6.5-8.5 mm.

Flight Period: Mid-April to early June.

Distribution: Massachusetts to Michigan, south to Virginia, Mississippi, and Kansas.

Biology: Unknown.

Remarks: The pale gray forewing has thin black streaking anterior to the ocellus, along the distal margin of the subbasal fascia, and in the discal cell, but the combination is much less pronounced than in similar looking *bolliana*. Flight periods of the two species overlap in June; *deludana* is more likely to be found in April and May, *bolliana* in summer and fall. The male genitalia of the two species are distinct.

232. *Gretchena concubitana* Heinrich

FWL: 7.0-9.0 mm.

Flight Period: April and May.

Distribution: Connecticut to Michigan, south to Florida and Mississippi.

Biology: The holotype was reared from *Carya* (hickory) (Heinrich, 1923a).

Remarks: This moth is similar in size and coloration to *amatana* and *concitatricana*, but the black forewing markings are considerably less distinct, particularly in the discal cell and anterior to the ocellus. Interfascial areas appear silvery gray, versus dirty whitish gray in *amatana* and brownish gray in *concitatricana*. Examination of the genitalia is recommended for positive identification.

233. ***Gretchena watchungana*** (Kearfott)

FWL: 5.5-8.0 mm.

Flight Period: Mid-April through May.

Distribution: Maine to Minnesota, south to Virginia and Louisiana.

Biology: The larva feeds on *Alnus* (alder) (Krauth et al., 1977).

Remarks: The hindwing is white with blackish-gray scaling on the margins. Other midwestern *Gretchena* have grayish-brown hindwings.

234. ***Gretchena bolliana*** (Slingerland)

FWL: 7.0-9.0 mm.

Flight Period: Late June to October.

Distribution: New Jersey to Minnesota, south to Florida and Texas.

Biology: The preferred host is *Carya illinoiensis* (pecan) with larvae feeding on buds and leaves (Moznette et al., 1931). Rearings have also been reported from *Juglans* (walnut) and species of *Carya* (hickory) (Heinrich, 1923a). The life cycle is multivoltine with as many as six generations in the southern part of the range.

Remarks: Known as the pecan bud moth in the economic literature, this species can be a pest on nursery stock. In specimens from the Midwest, the black markings forming the radial streak usually contrast sharply with the surrounding pale gray scaling, but southern specimens often have interfascial areas that are nearly as black as the streak. The shape of the cucullus is distinctive.

235. ***Gretchena amatana*** Heinrich

FWL: 7.5-9.0 mm.

Flight Period: Late April to early June, also August.

Distribution: New Hampshire to Wisconsin, south to Mississippi.

Biology: Unknown.

Remarks: Forewing color and maculation are similar to those of *concitatricana*, but the interfascial areas are whitish gray in *amatana* instead of brownish gray. Males are readily identified by the shape of the cucullus. Females have the posterolateral corners of sternum VII produced laterally into semirectangular lobes, a character not found in other midwestern *Gretchena*.

236. ***Gretchena delicatana*** Heinrich

FWL: 6.5-8.5 mm.

Flight Period: April to June.

Distribution: Connecticut to southern Ontario, south to Maryland and Mississippi.

Biology: Unknown.

Remarks: This moth seems to be most common in the Northeast. Forewing appearance is nearly indistinguishable from that of *amatana*. The male cucullus is more rectangular than in *amatana*. Females lack semirectangular lobes on the posterolateral corners of sternum VII.

237. ***Gretchena concitatricana*** (Heinrich)

FWL: 7.0-9.0 mm.

Flight Period: April to early August.

Distribution: New York to Iowa, south to Alabama and Arizona.

Biology: Unknown.

Remarks: Specimens in good condition can be identified by the brownish cast of the forewing. Males have black sex scaling on the dorsal surface of both the abdomen and the basal portion of the hindwing, and there is similar scaling on the ventral surface of both wings along the radial and cubital veins. No other midwestern *Gretchena* has these features.

238. ***Gretchena nymphana*** Blanchard and Knudson

FWL: 8.5-10.0 mm.

Flight Period: Late March to early June.

Distribution: Maryland south to South Carolina and Texas.

Biology: Unknown.

Remarks: The few available records suggest that *nymphana* is more common in the Gulf Coastal and Southern Atlantic States, but one specimen has been collected in southern Kentucky. Distinguishing characters include: relatively large size, pale ground color with light brown irrorations, and a prominent, black, radial streak. The posterior margin of the streak is edged with pale brown.

Genus *Chimoptesis*

Chimoptesis is a small Nearctic genus with one species from California (*habrosana*), one from the Gulf States (*matheri*), and two from eastern North America. The last two, *gerulae* and *pennsylvaniana*, are spring woodland species, often flying along with *Pseudexentera* and early *Epinotia* species. Adults of the California species have been associated with *Quercus agrifolia* (California live oak) (Powell, 1964), but to date there have been no rearing reports that confirm larval hosts. Males have a costal fold.

In males the structure and setation of the tegumen and socii are distinctive. Females have a ringlike sterigma that is fused with sternum VII, and the posterior portion of the ductus bursae is a sclerotized cylinder.

239. *Chimoptesis gerulae* (Heinrich)

FWL: 6.5-9.0 mm.

Flight Period: Late February to early April.

Distribution: Pennsylvania and Ohio, south to Florida and Mississippi.

Biology: Unknown.

Remarks: Forewing color and maculation are variable: the whitish interfascial spot at mid-dorsum can be prominent or obscure, the basal patch may be unicolorous or divided into a brown costal portion and a blackish posterior portion, and scaling along the apical half of the costa may be yellowish-brown or blackish-brown. All forms have two black longitudinal dashes, one in the discal cell, the other anterior to the ocellus. Dark specimens can be confused with *Pseudexentera haracana*, but they lack the sharp indentation at mid-termen of the forewing prominent in *Pseudexentera* species.

240. *Chimoptesis pennsylvaniana* (Kearfott)

FWL: 6.5-8.0 mm.

Flight Period: March and April.

Distribution: Massachusetts to Illinois, south to Florida and Texas.

Biology: Unknown.

Remarks: The forewing is largely black, with a contrasting, irregularly-shaped, green band along the dorsal margin that is interrupted by a black mark just short of the tornus. The dorsal surface of the head is white. When the moth is at rest, the white head combines with the green band to form a conspicuous, light, medial streak. The dorsal band fades to brownish white when exposed to some preserving or killing agents.

Genus *Rhopobota*

Rhopobota is a worldwide genus. The three representatives in North America are all present in the Midwest, where they are primarily associated with cranberry or holly. One, *naevana*, is a pest on cultivated cranberry, and its larva is known in economic literature as the black-headed fireworm.

The forewing has a distinctly pointed apex, a condition produced by a pronounced concave emargination of the termen from R5 to M1. Males lack a costal fold. The three Nearctic species have similar forewing color and maculation, with well defined basal and subbasal fasciae (usually coalescing into a basal patch), a weakly expressed median fascia, and a dark spot at the apex.

In the male genitalia, the uncus is medially concave and undeveloped but dorsolaterally produced into a pair of projections whose size and shape are diagnostic. The socii are long and densely setose. In females the lateral margin of the lamella postvaginalis are fused with sternum VII, the surface of the corpus bursae is sclerotized near the junction with the ductus bursae, and the corpus bursae has two signa.

241. *Rhopobota naevana* (Hübner)

FWL: 5.0-7.0 mm.

Flight Period: Late May into late August.

Distribution: Nova Scotia to British Columbia and Oregon, south to North Carolina and Mississippi.

Biology: Hosts include *Vaccinium* (cranberry), *Erica* (heath), *Ilex mucronata* (catberry) and *Ilex verticillata* (common winterberry), among others (Brown, 1983). On cranberry larvae tie terminal leaves and attack flowers and fruits (Landry et al., 2002).

Remarks: The white interfascial forewing scaling is not as extensive as in *dietziana* and *finitimana*, producing a darker overall appearance. Expression of the median fascia is variable. The flattened dorsolateral projections of the uncus are narrow basally but distally expanded into semiretangular lobes, and the socii are long, upturned and distally fused. The valva has a fingerlike clasper on the proximal margin of the medial surface and a line of stout setae along the ventral margin of the neck. The sclerotization of the corpus bursae consists of two dorsolateral patches joined medially by a distinct arch.

242. *Rhopobota dietziana* (Kearfott)

FWL: 5.0-7.5 mm.

Flight Period: April to mid-August.

Distribution: Maine to Colorado, south to Florida and Texas.

Biology: Larvae feed on leaves of *Ilex verticillata* (common winterberry) (Heinrich, 1923a).

Remarks: Vertex and scape are bright white, as is the third segment of the labial palpus. The basal and subbasal fasciae are separated by a band of grayish-white interfascial scaling; the other two midwestern species have a solid basal patch. The dorsolateral projections of the uncus are long, thin, and antennalike, and the sclerotization of the corpus bursae nearly surrounds the juncture with the ductus bursae.

243. ***Rhopobota finitimana*** (Heinrich)

FWL: 4.5-5.0 mm.

Flight Period: June and July.

Distribution: Nova Scotia to Michigan, south to Alabama and Texas.

Biology: Larval hosts include *Ilex mucronata* (catberry) and *Ilex verticillata* (common winterberry) (Ferguson, 1975).

Remarks: This is the smallest of the North American *Rhopobota*. It is most similar to *dietziana* but has a solid basal patch and a dark head. The male cucullus is semitriangular, with an unusually long spine located on the medial surface just below the rounded acute apex. The posterolateral projections of the uncus are long, flattened, and of uniform width.

Genus *Epinotia*

Epinotia is the third largest genus in the Nearctic Eucosmini, consisting of approximately 70 recognized species. Most are found in western North America, northern United States, or southern Canada. We treat fifteen species from the Midwest, several of which present multiple phenotypes. A costal fold is present in some species and absent in others. Larval feeding habits include webbing leaves of deciduous trees or woody shrubs, boring in catkins, and mining conifer needles.

Of the midwestern species, the most difficult to identify are the members of the *vertumnana* group: *celtisana*, *sotipena*, *vertumnana*, *zandana*, and *xandana*. These dull brownish-gray moths are among the first olethreutines to emerge in the spring, and they exhibit considerable variability in forewing color and maculation. Genitalia can be useful in separating the species but differences are often subtle. Brown (1986) provides a detailed discussion of these issues.

In the male genitalia, the uncus is usually well developed and bifid, the socii are variably shaped and occasionally produced into substantial hornlike structures, the anellus includes a sclerotized plate that extends dorsally over the aedeagus, and the valva often has a cluster of short thickened setae at the distal extremity of the sacculus. Females exhibit interspecific differences in the sculpturing of the sterigma and sternum VII. The corpus bursae has two signa and conspicuous patches of minute spinules on the inner surface, particularly near the juncture with the ductus bursae.

244. *Epinotia medioviridana* (Kearfott)

FWL: 6.5-8.0 mm.

Flight Period: Mid-July to late September.

Distribution: Southern Quebec to North Dakota, south to North Carolina and Kentucky.

Biology: The larva feeds on *Rubus odoratus* (purpleflowering raspberry), webbing a leaf into a pouchlike shelter (MacKay, 1953).

Remarks: This species is easily recognized by its dark basal patch and green interfascial scaling. Males have a costal fold. Adults are most likely to be encountered in late August or early September.

245. *Epinotia madderana* (Kearfott)

FWL: 6.0-7.0 mm.

Flight Period: June and July.

Distribution: New Brunswick to Saskatchewan, south to Ohio and Illinois.

Biology: Unknown.

Remarks: This is another species with distinctive forewing coloration: pale brownish-orange basal patch, dark reddish-orange terminal area. Males have a costal fold. There are only a few records from the Midwest; *madderana* is more common to the north and east.

246. ***Epinotia celtisana*** (Riley)

FWL: 6.0-8.0 mm.

Flight Period: February to April.

Distribution: Pennsylvania to Wisconsin, south to Mississippi and Texas.

Biology: The larval host is *Celtis* (hackberry) (Brown, 1986).

Remarks: Forewing color and maculation are variable. The dark form has a fasciate pattern and well defined costal strigulae, features that usually distinguish it from the longitudinally streaked phenotype of *vertumnana*. The light form is similar to *xandana* but lacks the strong median fascia characteristic of the latter species. Males have a costal fold. In the Midwest adults fly mostly in March.

247. ***Epinotia sotipena*** Brown

FWL: 6.0-8.0 mm.

Flight Period: March through early May.

Distribution: Quebec south to Maryland, Mississippi, and Missouri.

Biology: Unknown.

Remarks: Forewing maculation consists of a dark basal dash and a crescent-shaped mark that arises at mid-costa and terminates at the apex. In some phenotypes (not illustrated), the crescent is divided at the distal end of the discal cell into two components: a curved fragment of the median fascia and a preapical spot. Males have a costal fold. Some dark specimens of *celtisana* are similar in appearance, but their markings are more aligned in a broken streak from base to apex.

248. *Epinotia vertumnana* (Zeller)

FWL: 5.5-7.5 mm.

Flight Period: February to April.

Distribution: Southern Quebec and Ontario, south to Mississippi and Texas.

Biology: The larva feeds on *Crataegus* (hawthorn) (Brown, 1986).

Remarks: This is another species with distinctly different phenotypes. The brownish-gray form lacks forewing markings; the light gray form has a black longitudinal streak that is often interrupted at the distal end of the discal cell. Males have a costal fold.

249. *Epinotia zandana* (Kearfott)

FWL: 6.0-8.5 mm.

Flight Period: March and April, as early as mid-February in Texas.

Distribution: Massachusetts to Michigan, south to Mississippi and Texas.

Biology: The larva feeds on *Crataegus* (hawthorn) (Brown, 1986).

Remarks: The forewing is blackish-gray and the markings are often barely distinguishable from the ground color. This species also has a longitudinally streaked phenotype (not illustrated). Males have a costal fold.

250. *Epinotia nisella* (Clerck)

FWL: 6.5-7.5 mm.

Flight Period: June through August.

Distribution: Southern Canada, south to western Pennsylvania and Colorado.

Biology: The larvae feed primarily in catkins of *Populus tremuloides* (quaking aspen) but have been reported occasionally on buds and leaves of *Salix* (willow), *Betula* (birch), *Alnus* (alder), and *Acer* (maple) (Miller, 1986a).

Remarks: This Holarctic species has multiple phenotypes. It is common in southern Canada and the northern United States, and its range extends as far south as Chicago, Illinois. The male genitalia have long hornlike socii.

251. ***Epinotia criddleana*** (Kearfott)

FWL: 6.5-8.0 mm.

Flight Period: July to early September.

Distribution: Southern Canada, south to Iowa and Colorado.

Biology: Late-instar larvae feed between two tied leaves. The primary host is *Populus tremuloides* (quaking aspen), but larval development has been reported on *Salix* (willow) and *Quercus macrocarpa* (bur oak) (Kusch, 1967).

Remarks: This moth was once considered to be a variety of *nisella*. The black crescent from mid-costa to apex and the black basal patch are good identification marks, but the crescent is often poorly expressed near mid-costa. The whitish ground color is occasionally suffused with gray. Males have a costal fold.

252. ***Epinotia xandana*** (Kearfott)

FWL: 6.0-8.0 mm.

Flight Period: Late February to early April.

Distribution: Pennsylvania to Illinois, south to Mississippi and Texas.

Biology: Unknown.

Remarks: Midwestern specimens of *xandana* have a pale gray forewing with a well defined black median fascia. The black distal border of the basal patch gives the impression of a second transverse line. A darker phenotype was reported from Mississippi by Brown (1986). Males have a costal fold.

253. ***Epinotia walkerana*** (Kearfott)

FWL: 4.5-6.0 mm.

Flight Period: Late July to September.

Distribution: Massachusetts to southern Ontario, south to Virginia and Illinois.

Biology: The larva feeds in catkins on *Corylus* (hazelnut) (MacKay, 1959).

Remarks: Though similar in forewing pattern to *transmissana*, *walkerana* is much smaller and has a more yellowish brown appearance. It has been recorded from Illinois and Ohio, but *walkerana* appears to be more common in the Northeast. Males have a costal fold.

254. ***Epinotia transmissana*** **(Kearfott)**

FWL: 7.0-8.5 mm.

Flight Period: Mid-June to August.

Distribution: Nova Scotia to Minnesota, south to Delaware and Illinois.

Biology: Larvae feed on *Salix* (willow) (Prentice, 1966).

Remarks: The brown forewing coloration has a reddish hue, especially near the apex. This is a common mid-summer species in the eastern half of the Midwest. Males have a costal fold.

255. ***Epinotia nonana*** **(Kearfott)**

FWL: 8.0-11.0 mm.

Flight Period: August to early October.

Distribution: Minnesota to Colorado, south to Ohio.

Biology: Unknown.

Remarks: The forewing markings are not well defined, but one can usually make out the distal margin of a basal patch. Some specimens show indications of a crescent-shaped mark from mid-costa to apex. Males lack a costal fold. This is the largest of the midwestern *Epinotia*.

256. ***Epinotia nanana*** **(Treitschke)**

FWL: 4.0-5.5 mm.

Flight Period: May through mid-June.

Distribution: Quebec and Ontario, south to New Jersey and Kentucky; also recorded from British Columbia.

Biology: The larva is a needle-miner on spruce, preferring *Picea abies* (Norway spruce) in eastern Canada (Daviault & Ducharme, 1966; Lindquist & Harnden, 1966).

Remarks: Known in the economic literature as the green spruce leaf miner, this Holarctic species can be a pest on ornamental spruce. It is recorded from Ohio and Kentucky but is most common in the native spruce regions of Canada and northern United States.

257. ***Epinotia septemberana*** (Kearfott)

FWL: 6.5-8.0 mm.

Flight Period: Late August to late October.

Distribution: Nova Scotia to Minnesota, south to North Carolina and Mississippi.

Biology: *Rhododendron canadense* (rhodora) was reported as a larval host in Nova Scotia (Brown, 1980).

Remarks: This striking species is identified easily by its forewing color and late-season flight period. The anterior half of the wing varies in color from reddish orange to brownish orange. The serpentine grayish band along the dorsal margin is similar to that of *lindana*. Males lack a costal fold.

258. ***Epinotia lindana*** (Fernald)

FWL: 7.0-10.0 mm.

Flight Period: Late August to early November.

Distribution: New Brunswick to Southern Manitoba, south to Pennsylvania, Kentucky, and Wyoming; also British Columbia south to California.

Biology: The larva feeds in the spring in rolled or tied leaves of *Cornus* (dogwood) and then estivates for four to six weeks in a cocoon constructed on the ground. Pupation occurs in August (McDunnough, 1933).

Remarks: The nearly black anterior half of the forewing together with the grayish serpentine band along the dorsum makes this distinctive species easy to identify. Males lack a costal fold.

Genus *Catastega*

Clemens (1861) erected *Catastega* for three eastern North American species with larval shelters in the form of a serpentine tube webbed to the underside of a leaf. Failing to carry the immatures to eclosion, he based the descriptions on larvae, separating species by food plant, so there are no adult types. Rearings by Fyles (1894) and Dyar (1903) associated adults with the names *timidella* and *aceriella*, but the third species remains a mystery. Heinrich (1923a) treated *Catastega* as a synonym of *Epinotia*, but Brown (1986) resurrected the genus and later (1992) described several new species from the southwestern United States.

Both *timidella* and *aceriella* are common, spring, woodland species in the Midwest. Forewing color and maculation are usually sufficient for identification. Male genitalic characters include a bifid uncus, broadly based socii, a cuplike anellus, a long narrow valval neck, and a weakly differentiated cucullus. In females, the sterigma is semicylindrical, with a very weakly developed lamella postvaginalis, and the corpus bursae has two signa. Males lack a costal fold.

259. *Catastega timidella* Clemens

FWL: 7.0-9.0 mm.

Flight Period: May and June.

Distribution: New York to Minnesota, south to North Carolina, Mississippi and Texas.

Biology: The larval host is *Quercus* (oak) (Heinrich, 1923a).

Remarks: Size and coloration are suggestive of *Gretchena*, but in most specimens the forewing is more strongly two-toned in appearance: blackish gray anterior to the radius, whitish gray posterior to the cubitus. *Catastega* is separated easily from *Gretchena* by genitalic characters.

260. *Catastega aceriella* Clemens

FWL: 5.5-8.5 mm.

Flight Period: Mid-April to mid-July.

Distribution: Maine to Minnesota, south to North Carolina and Mississippi.

Biology: Preferred larval hosts are *Acer saccharum* (sugar maple) and *Acer rubrum* (red maple). The larva builds a tubular shelter of silk and frass on the underside of a leaf and feeds on the lower surface, skeletonizing the leaf. Overwintering occurs in a cocoon on the ground in a capsule-shaped chamber constructed by webbing together two leaf surfaces (Côté & Allen, 1973). Rearings have also been reported from *Crataegus* (hawthorn) and *Fagus grandifolia* (American beech) (Prentice, 1966).

Remarks: Commonly referred to as the maple trumpet skeletonizer, this species is recognized by the whitish-gray forewing color and the dark, chevron-shaped, subbasal fascia. It might be confused with pale phenotypes of *Epinotia celtisana*, but the genitalia are distinct.

Tribe ENARMONIINI

Genus *Ancylis*

Ancylis is a worldwide genus with approximately 130 described species. The exact number of North American representatives is uncertain due to the presence of several unresolved species complexes, but Powell (1983) lists 35 names. The larvae tend to be leaf-rollers or leaf-tiers. A few species such as the strawberry leaf-roller (*comptana*) and the apple leaf-folder (*nubeculana*) are economic pests.

Heinrich (1923a) revised the North American fauna, keeping the genera *Anchylopera* and *Ancylis* separate based on differences in hindwing venation. In 1955 McDunnough undertook a revision of *Anchylopera* and concluded that "only by the study of bred series of specimens from known food plants could an adequate idea of each individual species and its range of variation be obtained." Though he abandoned the project after publishing two short papers (McDunnough, 1955, 1956), he examined many type specimens from the BMNH and the USNM and corrected several errors in Heinrich (1923a). He also described several new species based on subtle morphological differences, but it is likely that many of those names will prove to be synonyms.

By the time Miller's olethreutine guide appeared in 1987, *Anchylopera* was recognized as a synonym of *Ancylis*. Miller covered all of the *Anyclis* species included here except *brauni* and *fuscociliana*. We follow his concepts of species groups. The *spiraeifoliana* complex consists of *spiraeifoliana* (Clemens), *burgessiana* (Zeller), *laciniana* (Zeller), and *fuscociliana* (Clemens), the last inclusion having been suggested by Heinrich (1923a). The *subaequana* complex contains *subaequana* (Zeller), *galeamatana* (McDunnough), and *sheppardana* (McDunnough), but of these only *subaequana* has been reported from the Midwest. The species in each group share similar wing patterns and genitalia but differ in forewing coloration. Current knowledge of the biology of these moths is insufficent to determine how many distinct species are represented by the various phenotypes.

Specimens can be placed in *Ancylis* based on either wing pattern or male genitalia, but a combination of these characters may be needed to identify individuals to species. The forewing has a conspicuous falcate apex. Most of the species treated here have a well defined basal patch, the shape and color of which is sometimes diagnostic. The males generally have a bifid uncus and an acute, projecting, saccular angle. The size or absence of these structures can be helpful in species determinations. Females have a simple cone-shaped sterigma and two, long, bladelike signa. It is unknown if subtle differences in the female genitalia are useful in species discrimination.

261. *Ancylis nubeculana* (Clemens)

FWL: 6.5-8.0 mm.

Flight Period: Late April through July.

Distribution: Maine to Minnesota, south to Missouri.

Biology: Larvae feed on leaves of *Malus* (apple), *Pyrus* (pear), *Amelanchier* (serviceberry), *Crataegus* (hawthorn), and others (Miller, 1987). Early instars feed on the underside of the leaf in a silk web; later instars fold the leaf lengthwise and feed on the upper surface. The last-instar overwinters in a fallen leaf and pupates in the spring (Chapman & Lienk, 1971).

Remarks: Commonly referred to as the apple leaf-folder, *nubeculana* once was considered a pest of apple, but it currently does not cause major economic damage (Chapman & Lienk, 1971). The white and gray forewing, contrasting dark brown basal patch, and two black apical marks distinguish this species from other midwestern *Ancylis*.

262. ***Ancylis subaequana*** complex

A. subaequana (Zeller)

FWL: 6.0-7.5 mm.

Flight Period: Mid-May to early August.

Distribution: Maine to South Dakota, south to North Carolina.

Biology: Unknown; McDunnough (1956) reported *Myrica* (sweetgale) as a possible host.

Remarks: Following Miller (1987), we treat this group as a species complex consisting of *subaequana*, *galeamatana*, and *sheppardana*; the last two were described by McDunnough from Nova Scotia and Quebec, respectively. McDunnough based his two species on slight differences in genitalia, the consistency of which has not been tested in large series of specimens. Wing coloration varies within the group. Specimens can be separated from the similar looking members of the *spiraeifoliana* complex by the lack of a brown median fascia and the presence of a semicircular bulge on the anterior margin of the basal patch. Male genitalia are distinguished by an extremely long and slender aedeagus (Heinrich, 1923a) and the lack of a well developed bifid uncus.

263. ***Ancylis semiovana*** (Zeller)

FWL: 6.5-8.0 mm.

Flight Period: Late May through August.

Distribution: Quebec to Minnesota, south to North Carolina and Alabama; also recorded from British Columbia.

Biology: MacKay (1959) reported examining larvae from *Ceanothus*. The authors have observed *semiovana* flying diurnally in a patch of *Ceanothus americanus* (New Jersey tea).

Remarks: This is one of the larger *Ancylis* species encountered in the Midwest. It has a distinctive forewing pattern consisiting of an immaculate white costa and a sharply defined brown median fascia that extends to the tornus and connects there to brown coloration running along the termen. The basal patch is uniformly dark brown. Male genitalia are similar to those of the *spiraeifoliana* group.

264. ***Ancylis brauni*** (Heinrich)

FWL: 5.0-6.5 mm.

Flight Period: Early April to mid-July.

Distribution: Recorded from Illinois and Ohio.

Biology: Larvae have been reared on *Rhamnus alnifolia* (alderleaf buckthorn) and *R. lanceolata* (lanceleaf buckthorn) (Heinrich, 1931).

Remarks: The forewing pattern features a thin line of white scales edging the anterior margin of the brown to dark-brown basal patch. The costa is light brown or tan from base to median fascia, where it becomes heavily suffused with blackish-brown scaling. The ventral margin of the valva is less strongly emarginated than in other midwestern *Ancylis*, resulting in a wide neck and a weakly developed angular corner of the sacculus. Heinrich named *brauni* in honor of the eminent microlepidopterist Annette Frances Braun.

265. *Ancylis spiraeifoliana* complex

FWL: 4.5-8.0 mm.

Flight Period: Late March to early August.

Distribution: Northeastern United States, west to Iowa, south to North Carolina and Texas.

Biology: Larvae feed on a variety of hosts, including *Corylus* (hazelnut), *Prunus* (cherry), *Castanea* (chestnut), *Crataegus* (hawthorn), *Malus* (apple), *Quercus* (oak), *Spiraea* (spirea), *Ulmus* (elm), and others (Chapman & Lienk, 1971; Heinrich, 1923a; McDunnough, 1955; Miller, 1987). First-instar larvae feed under a silk patch, and later instars construct a chamber or tent by folding the leaf. Overwintering occurs as a last-instar lava, and pupation occurs in the spring (Chapman & Lienk, 1971; McDunnough, 1955).

Remarks: We interpret *spiraeifoliana*, *burgessiana*, *laciniana*, and *fuscociliana* as members of a species complex in which the limits of the constituent taxa are too poorly understood to permit species level determinations. This position is consistent with comments by Miller (1987) and Heinrich (1923a) regarding phenotypic variation within the group. The descriptions of all four species were based on specimens that were assumed to have utilized different larval hosts, but that distinction is now known to be unreliable. In each case, the forewing has a prominent basal patch and a well defined, brown, median fascia which connects the costa to two, black, longitudinal dashes anterior to the ocellus. Traditionally, species such as *burgessiana* and *laciniana* were separated by the color of the dorsal patch, a character now considered to be too variable to be diagnostic. The anterior margin of the basal patch is always smooth and convex (despite the apparent indentation in the illustration of *spiraeifoliana* caused by a fold in the wing), and this feature distinguishes the *spiraeifoliana* group from the *subaequana* complex. The illustrations are representative of the traditional applications of the four names. The genitalia associated with these different forms are indistinguishable, so future progress in establishing species boundaries will probably have to rely on studies of long series of reared individuals.

A. spiraeifoliana (Clemens)

A. burgessiana (Zeller)

A. laciniana (Zeller)

A. fuscociliana (Clemens)

266. ***Ancylis platanana*** (Clemens)

FWL: 5.0-7.5 mm.

Flight Period: Late March to September; shorter in the north.

Distribution: Maryland to Ontario, south and west to Florida and Arkansas.

Biology: The larval host is *Platanus* (sycamore). Eggs are laid on the underside of a leaf; early-instar larvae feed under a silk web on the underside of the leaf, later instars skeletonize and fold the leaf and pupation occurs within the fold (Denmark, 1960). Clemens (1860) reported two generations in the north, but there are as many as four in the sourthern part of the range (Denmark, 1960).

Remarks: This species is identified by its pale appearance. The basal patch is often incomplete to nearly absent. In genitalia, *platanana* is nearly identical to members of the *spiraeifoliana* complex, and it may be very difficult to separate a well-patterned specimen from species such as *laciniana* or *burgessiana*.

267. ***Ancylis metamelana*** (Walker)

FWL: 4.5-6.0 mm.

Flight Period: May through September.

Distribution: Across southern Canada and the northern half of the United States, ranging as far south as Virginia.

Biology: Larvae feed in folded leaves of *Trifolium repens* (white clover), *T. pratense* (red clover), and *T. hybridum* (alsike clover) (Miller, 1987).

Remarks: Described in 1863, *metamelana* was treated by Heinrich (1923a) as a synonym of *spiraeifoliana*, based on the opinion of Walsingham, but was reinstated as a valid name by McDunnough (1955). Though the two species have very similar forewing patterns, *metamelana* males lack the bifid uncus possessed by all members of the *spiraeifoliana* complex. In addition, individuals of *metamelana* are generally smaller and consistently have a yellowish-brown cast to the forewings. The basal patch may be complete or suffused with pale ground color, in the latter case often taking the shape of a dark brown crescent on the dorsal margin.

268. ***Ancylis comptana*** (Frölich)

FWL: 4.5-7.0 mm.

Flight Period: Late March through August.

Distribution: Continental United States and southern Canada.

Biology: The preferred larval hosts are *Rubus* (blackberry, raspberry) and *Fragaria* (strawberry), but larvae have also been observed on clover. Early instars feed on the underside of a leaf beneath a silk patch; later instars roll or fold the upperside of the leaf. Overwintering occurs as a prepupa, pupation takes place in the spring, and adults emerge as early as March in southern locations. Two to four generations develop per year (Fink, 1932; Heinrich, 1923a).

Remarks: Commonly known as the strawberry leaf-roller, this Holarctic species was first reported in the United States in the mid-1860's. Although the larva feeds only on the leaves of its host, damage to strawberry plants in infested areas has been estimated to cut fruit yields by as much as 50% (Fink, 1932). Forewing color is variable, but all specimens have a silvery-gray to white interfascial area between the basal patch and median fascia. The basal patch may be complete or extend only from dorsum to radius, as in *metamelana*. Male genitalia have a bifid uncus and socii that tend to be smaller than those in the *spiraeifoliana* group.

269. ***Ancylis divisana*** (Walker)

FWL: 4.5-7.5 mm.

Flight Period: Late May to mid-August.

Distribution: Eastern North America.

Biology: Larvae feed in the rolled leaves of *Quercus* (oak) and *Platanus occidentalis* (American sycamore) (Miller, 1987).

Remarks: This species is instantly recognized by its unique forewing pattern. The reddish-brown basal patch is surrounded by gray and bordered distally by a thin white line. The remainder of the forewing is yellowish brown. A thin black line runs along the termen from below the apex to CuA1. In the male genitalia the anal angle of the cucullus is strongly developed, and the socii are greatly reduced. A similar species, *apicana*, which was described from northeastern United States and Canada, has male genitalia identical to *divisana*, but the fasciae and strigulae on the distal half of the forewing are well defined.

270. ***Ancylis muricana*** (Walsingham)

FWL: 4.0-5.5 mm.

Flight Period: Mid-May to early August.

Distribution: Massachusetts to Illinois, south to Virginia; also reported from Louisiana and Texas.

Biology: Larvae feed on *Fragaria* (strawberry), *Cornus* (dogwood), *Rubus* (blackberry, raspberry), and others (Miller, 1987).

Remarks: Specimens of *muricana* have a dark reddish-brown appearance. The basal patch is not well defined and may be suffused heavily with gray. The median fascia is interrupted by lighter orange-brown coloration that extends towards the apex and contains two or three black dashes. The genitalia resemble those of *divisana*. Riley (1881) described specimens reared from *Cornus* as a separate species, *cornifoliana*, but Heinrich (1923a) treated them as a subspecies of *muricana*.

271. ***Ancylis diminutana*** (Haworth)

FWL: 5.0-8.5 mm.

Flight Period: Late May through August.

Distribution: Continental United States and southern Canada; also Europe.

Biology: Larvae feed on *Salix* (Miller, 1987; Razowski, 2003).

Remarks: This species is recognized by the grayish-brown forewings and the lack of a well defined basal patch. In dark specimens, the grayish-white serpentine band running along the dorsum is suggestive of *Epinotia lindana*. The male valva is not constricted at the neck, and the anal angle is weakly developed.

Genus *Eucosmomophra*

Eucosmomorpha consists of four species, one of which occurs in North America. The Nearctic species, *nearctica*, has a rather wide distribution, but nothing is known of its life history. Larvae of *E. albersana*, a closely related Palearctic species, are leaf-rollers on plants in the family Caprifoliaceae (honeysuckle).

Distinctive male genitalic characters include: uncus reduced; sacculus densely covered with long fine setae; neck long and narrow; cucullus reduced, with anal angle supporting one long, thick seta. In females, the sterigma is a U-shaped plate, and the corpus bursae has two signa, one tapering from a broad base to a hooked apex, the other narrow and tubelike.

272. *Eucosmomorpha nearctica* Miller

FWL: 3.5-5.5 mm.

Flight Period: Late April to late August.

Distribution: Recorded from Kentucky, Michigan, Mississippi, North Carolina and Saskatchewan.

Biology: Unknown; collection records suggest two generations per year.

Remarks: The earliest records, dating from 1961 in Michigan, initially were interpreted by Miller (1983) as the Palearctic *albersana*. He later (2001) concluded the North American specimens represented a different species, which he described as *nearctica*. Fresh specimens are recognized by the yellowish forewing color and brown fascial markings. There is often a conspicuous dark mark on the postmedian fascia anterior to the ocellus. Diagnostic genitalic characters include the shape of the valva, the large thick seta at the anal angle of the cucullus, and the unusually shaped signa in the corpus bursae.

Genus *Hystrichophora*

Hystrichophora is a Nearctic genus consisting of eleven species which range through much of central and western North America. We treat four midwestern species, of which one, *loricana*, is known only from the holotype. In the few instances in which life history information is available, the larvae feed in stems and roots of Fabaceae. The genus has recently been revised by Gilligan (2008).

Males have genitalia unlike any other members of the Tortricidae. The valvae are asymmetrical and split into saccular and costal lobes, which in some species are quite variable. The eighth abdominal segment is modified in many species and may aid in identification. The female sterigma is asymmetrical, a unique feature in Nearctic Olethreutinae, and signa shape ranges from long and bladelike to short and thornlike.

There are two unnamed species in the Midwest that superficially resemble *taleana*. Their descriptions by Gilligan (2008) did not appear in time for inclusion here, but notes for distinguishing them from *taleana* are provided in the species accounts.

273. *Hystrichophora taleana* (Grote)

FWL: 7.0-8.0 mm.

Flight Period: Late May through July.

Distribution: Ohio to Wisconsin, south to Missouri and Kansas.

Biology: Larvae have been reared from *Amorpha canescens* (leadplant) in Illinois and Wisconsin, but the full life history of *taleana* is not known. A similar species feeds in stems and terminals of *Amorpha*, causing a galllike enlargement. Records from Ohio suggest that *taleana* may utilize other larval hosts.

Remarks: This species can be common in midwestern prairie remnants during June and early July. Two similar species, distinguishable by forewing pattern and head color, have been described by Gilligan (2008). The pale brown head and uniformly grayish-brown forewings with dull orange fasciae distinguish *taleana*. The other two species have either a bright orange head or large, dark brown to black interfascial patches along the dorsal margin of the forewing. All three lack the pale yellow coloration on the costal margin of the forewing in *ochreicostana*.

274. *Hystrichophora ochreicostana* (Walsingham)

FWL: 6.5-10.0 mm.

Flight Period: June to early August.

Distribution: North Dakota to Montana, south to Texas; also recorded from Utah.

Biology: Unknown.

Remarks: This species is distinguished from *taleana* and its relatives by the pale yellow costa on the basal half of the forewing. The saccular lobes of the valvae in the male genitalia are different from those of *taleana*. The heavily modified sterigma and long narrow papillae anales distinguish female *ochreicostana* from other *Hystrichophora*. This species is most often encountered in the Great Plains and appears to have a single generation per year based on adult capture dates.

275. ***Hystrichophora loricana*** (Grote)

Holotype male

FWL: 8.0 mm.

Flight Period: Unknown.

Distribution: Recorded from Ohio.

Biology: Unknown.

Remarks: Described in 1880 from a single male labeled "Dayton, Ohio," the holotype is the only known example of this species. It initially was placed in *Ancylis* based on the falcate apex of the forewing, but Heinrich dissected the specimen in the mid-1920's and found the genitalia to be surprisingly similar to that of *vestaliana*. The strong metallic reflections and pronounced forewing apex distinguish it from all other midwestern olethreutines.

276. ***Hystrichophora vestaliana*** (Zeller)

FWL: 6.5-11.0 mm.

Flight Period: Late May to mid-August.

Distribution: Missouri to Montana, south to Texas and Arizona; also Florida.

Biology: Unknown.

Remarks: This species is recognized by its bright white forewings. Many specimens have prominent dark marks on the costa (delimiting the strigulae) and an isolated postmedian dot, while others are almost entirely white. This appears to be primarily a western species. The Florida records may represent a disjunct population or could indicate that the range is much broader than currently documented.

Tribe GRAPHOLITINI

Genus *Dichrorampha*

Dichrorampha consists of more than 110 species, the majority of which are found in the Palearctic Region. In North America the genus is represented by thirteen species; the five treated here range throughout the Midwest. In known life histories, the larval hosts are members of the family Asteraceae (Razowski, 2003).

Miller (1983d) reviewed *simulana*, *bittana*, and *sedatana*, proposing five new synonymies and resolving many taxonomic problems, but he was unable to obtain reliable male-female associations for *simulana* and *bittana* due to the large amount of variation in forewing appearance exhibited by these species. Our female genitalia illustrations are based on his conclusions and should be considered tentative until confirmed by series of reared specimens.

Members of *Dichrorampha* have a reduced ocellus and a row of four black dots along the termen of the forewing. All the species illustrated here have a distinct notch in the termen near the apex. Males can be distinguished by valval characters. In females, the ostium bursae and the posterior portion of the ductus bursae are heavily sclerotized, the latter sclerotization sometimes extending anteriorly half the distance to the corpus bursae. All females have a single horn-shaped signum (Razowski, 2003).

277. *Dichrorampha simulana* (Clemens)

FWL: 5.5-8.0 mm.

Flight Period: June through August.

Distribution: Continental United States and Canada.

Biology: Unknown.

Remarks: Variability in forewing appearance makes it impossible to separate *simulana* from *bittana* based on maculation. The dorsal strigulae may be distinct or fused, the latter state producing an interfascial spot that varies in color from yellow to white. That same coloration often diffuses into the tornal area. Males lack the preapical spur on the aedeagus and the tonguelike projection on the basal excavation of the valva that are characteristic of *bittana* (Miller, 1983d). Males of both species have a costal fold, distinguishing them from *sedatana*.

278. ***Dichrorampha bittana*** (Busck)

FWL: 5.0-7.5 mm.

Flight Period: June through August.

Distribution: Nova Scotia to Wisconsin, south to Missouri.

Biology: Unknown.

Remarks: Forewing appearance is highly variable and indistinguishable from that of *simulana*. Ground color varies from golden-brown to grayish brown, the lighter markings are yellow to white, and the dorsal strigulae may be fused or distinct. Males are recognized by the presence of a tiny preapical spur on the aedeagus and a tonguelike projection off the basal excavation of the valva (Miller, 1983d). Males of both *bittana* and *simulana* have a costal fold, those of *sedatana* do not.

279. ***Dichrorampha incanana*** (Clemens)

FWL: 4.0-5.0 mm.

Flight Period: June through early September.

Distribution: Pennsylvania to Ohio, south to North Carolina and Kentucky.

Biology: Unknown.

Remarks: Little is known about the distribution of this species because it is poorly represented in collections. Some fresh specimens resemble species of *Grapholita* because of the white costal strigulae. Distinctive features of the male genitalia include: basal excavation large, neck narrow, saccular angle approximately 90°, anal angle of the cucullus well defined and projecting towards sacculus. In females, the posterior extremity of the ductus bursae has a heavily sclerotized twist and is fused with a ridge that extends laterally from the ostium bursae.

280. *Dichrorampha sedatana* (Busck)

FWL: 5.0-8.0 mm.

Flight Period: May through July.

Distribution: Ontario to Washington, south to Pennsylvania and California; also recorded from Alaska and the Palearctic.

Biology: Larvae feed in roots of *Chrysanthemum* (daisy) (Razowski, 2003).

Remarks: This species is characterized by the uniformly brown forewing, which is infused with yellow scales beyond the median fascia. Males lack the costal fold found in *bittana* and *simulana*. The neck of the valva tapers slightly to the cucullus, which has a rounded, weakly projecting anal angle. A circular sclerotized plate surrounds the ostium, and the ductus bursae is sclerotized half the distance to the corpus bursae.

281. *Dichrorampha leopardana* (Busck)

FWL: 4.0-5.0 mm.

Flight Period: Late May to late August.

Distribution: Maryland to Kansas, south to Florida.

Biology: Larvae feed on *Verbesina* (crownbeard) and pupate inside rolled leaves (Heinrich, 1926).

Remarks: This is the smallest midwestern *Dichrorampha*. Its distinctive wing pattern is unlikely to be confused with that of any other species. The forewing is primarily yellow and orange, with many black and silver striations. The neck of the male valva narrows evenly, the cucullus is rounded, and the anal angle is well developed. The ductus bursae is sclerotized over nearly its entire length.

Genus *Talponia*

Heinrich (1926) proposed *Talponia* for *plummeriana*, a species which had been described by Busck in the genus *Hemimene* (now *Pammene*). The genus currently contains one other species described from Guatemala. Larvae of *plummeriana* feed in the flowers of *Asimina* (pawpaw) (MacKay, 1959).

Forewing appearance is similar to that of *Dichrorampha*, with a series of black dots along the termen and a notch below the apex. The female genitalia resemble those of *Dichrorampha*, but males have well developed socii and a long narrow valva with a weakly defined cucullus.

282. *Talponia plummeriana* (Busck)

FWL: 5.0-6.0 mm.

Flight Period: Late May to July.

Distribution: Delaware to Ohio, south to Alabama and Mississippi; also Mexico.

Biology: Larvae feed in the flowers of *Asimina* (pawpaw) (MacKay, 1959).

Remarks: Forewing color and maculation is sufficient to distinguish this species from other midwestern olethreutines. In males the uncus is undeveloped; the socii are long, narrow, and ventrally projecting; and there are two tufts of sex scales on the abdomen (Fig. 14). The ductus bursae is sclerotized near the ostium bursae, and the sterigma has sharply acute lateral extensions.

Busck named this moth after Plummers Island, Maryland, a field site frequented by many famous lepidopterists over the past century. Located nine miles north of the White House in the middle of the Potomac River, the island was leased and then purchased by the Washington Biologists' Field Club in the early 1900's. Ownership was transferred to the National Park Service in the 1960's with the understanding that use of the site would remain open to members of the Field Club. The island is one of the most continuously sampled field sites in the United States with faunal surveys continuing to this day (Brown, 2001; Shetlera et al., 2006).

Genus *Pammene*

Pammene is primarily a Palearctic genus consisting of approximately 90 species. Of the six Nearctic members, only *felicitana* has been recorded from the Midwest. Komai (1999) reviewed the Palearctic species.

Males have a reduced uncus, lack socii, and have several cornuti in the vesica. Females have two thornlike signa and a short ductus bursae with a sclerotized ring.

283. *Pammene felicitana* Heinrich

FWL: 5.0-6.5 mm.

Flight Period: Late April to early August.

Distribution: Quebec to Colorado, south to Mississippi and Louisiana.

Biology: Unknown.

Remarks: This moth is recognized by the following combination of characters: white palpi, a white band along the dorsal margin of the forewing from base to median fascia, and a black line at the base of the fringe that is interrupted by three terminal strigulae. The male cucullus has a well developed anal angle and stout setae along the distal and ventral margins. The female lamella postvaginalis is a rectangular plate.

Genus *Larisa*

Larisa was described by Miller (1978a) for a single species, *subsolana*, which is widely distributed in the eastern United States.

Genitalic characters of *Larisa* are distinctive. Males have a bifid uncus, a pair of long fingerlike processes called hami that project from the tegumen below the uncus, a saccular tuft, and one or more long slender setae that project ventrally from the anal angle of the cucullus. In females, the sterigma has hornlike processes at the posterolateral corners, the short ductus bursae is extensively sclerotized, and the corpus bursae has a pair of thornlike signa.

284. *Larisa subsolana* Miller

FWL: 4.0-6.0 mm.

Flight Period: Mid-April to early August in the Midwest.

Distribution: Massachusetts to Michigan, south to Florida and Texas.

Biology: Larvae have been reared on *Carya illinoinensis* (pecan) (Brown et al. 1983). The long flight period suggests more than one generation per year (Miller, 1978a).

Remarks: Fresh specimens can be identified by size and forewing pattern. The basal patch and median fascia contrast sharply with the pale gray interfascial area. Genitalic characters are discussed in the introduction to the genus. The common occurrence of this moth in woodlands of eastern North America suggests that it likely utilizes other species of *Carya* (hickory) besides pecan.

Genus *Sereda*

Sereda is comprised of the type species, *Halonota tautana* described from Virginia, and a second species from New Guinea. Heinrich (1926) distinguished the genus from *Grapholita* and *Cydia* by the absence of a cubital pecten on the hindwing. The North American species is a common oak feeder that flies in the spring.

The ventral margin of the valva is deeply emarginated, producing a narrow neck of uniform width, the cucullus has an acute but rounded apex and an evenly rounded anal angle, and the saccular angle is approximately 90°. In females, the ductus bursae has a sclerotized twist anterior to the ostium, and the corpus bursae has two thornlike signa.

285. *Sereda tautana* (Clemens)

FWL: 5.0-6.0 mm.

Flight Period: Mid-April to late May.

Distribution: Ontario to Michigan, south to Texas.

Biology: The larval host is *Quercus rubra* (northern red oak) (Prentice, 1966).

Remarks: Forewing pattern is somewhat similar to species of *Grapholita*, with white costal strigulae, silvery-gray striae, and a row of black dots along the termen. For most of the last century this moth was referred to as *lautana*, after Fernald (1882) altered the name based on an assumed misspelling in the original description. Miller (1973) found no record of a misspelling in his review of Clemens' type specimens.

Genus *Grapholita*

Grapholita is a worldwide genus consisting of approximately 120 recognized species. We treat eight of the more than twenty found in North America, including several well known pests. Because of their economic importance, life histories and control methods are well documented for many of these species.

Most midwestern species are small. The forewing has a line of black scales at the base of the fringe. All but *molesta* and *packardi* have bright costal strigulae, a tenth strigula at a shallow indentation on the termen near the apex, and several light streaks on the dorsum, interpreted to be dorsal strigulae. In males, the uncus and socii are not developed, the valval neck is constricted ventrally, the cucullus is ovate, and the eighth abdominal sternite has two tufts of filiform sex scales. In females, the ductus bursae is short. There are two prominent thornlike signa in the corpus bursae in all but *interstictana* and *tristrigana*. The most recent general treatment of the genus is Komai's review (1999) of Palaearctic *Grapholita* and allied genera.

286. *Grapholita molesta* (Busck)

FWL: 5.0-6.5 mm.

Flight Period: Early May to late September.

Distribution: Worldwide.

Biology: Larval hosts include *Malus* (apple), *Prunus* (peach, cherry), *Pyrus* (pear), and other members of the family Rosaceae (Rothschild & Vickers, 1991). Early-instar larvae burrow into the shoots, and later instars feed in fruits. Three generations develop in the North, six or seven in the South (Dustan, 1960).

Remarks: Known in the economic literature as the oriental fruit moth, *molesta* is a worldwide pest of fruit crops (Rothschild & Vickers, 1991). In North America, to which it was introduced from Japan, it primarily affects peach growers, and its life cycle is synchronized with the peach growing season. The dull grayish-brown forewings are essentially unmarked except for a line of black dots in the preterminal fascia. The sterigma has rectangular lateral extensions with sharply pointed posterolateral projections. Though superficially similar, the western *G. libertina* has male genitalia like those of *packardi* (Heinrich, 1926).

287. *Grapholita packardi* (Zeller)

FWL: 3.5-5.0 mm.

Flight Period: May to June.

Distribution: Eastern United States, west to Texas.

Biology: Larvae cause damage similar to that of *molesta*, feeding in the shoots and fruits of *Crataegus* (hawthorn), *Malus* (apple), *Pyrus* (pear), *Prunus* (peach, cherry), and others. Larvae overwinter on the host and pupate in the spring (Wieres & Riedl, 1991).

Remarks: This species is commonly known as the cherry fruit worm. Light phenotypes have well expressed silvery striae and contrasting fasciae; dark phenotypes might be confused with *molesta* but are considerably smaller. Males are recognized by the conspicuous dark sex scaling on the dorsal surface of the hindwing and by the unconstricted valval neck, which is nearly as wide as the cucullus. Females have a distinctive triangular ostium.

288. *Grapholita prunivora* (Walsingham)

FWL: 4.0-5.5 mm.

Flight Period: May to August.

Distribution: Southern Canada and continental United States except for the extreme South.

Biology: Larvae feed in the fruits of *Crataegus* (hawthorn), *Malus* (apple), *Pyrus* (pear), and *Prunus* (plum, cherry), but damage is limited to a shallow tunnel around the calyx end of the fruit. This species is bivoltine over much of its range (Chapman & Lienk, 1971).

Remarks: Known as the lesser apple worm, *prunivora* occurs where apple, plum, and cherry are grown in North America (Chapman & Lienk, 1971). Distinguishing forewing features include: pale yellow costal strigulae, silvery striae, a well defined ocellus with 3-4 black dashes, and a line of yellow scales preceding the black terminal line. The male cucullus has an angular apex and an evenly rounded anal angle. The female sterigma is ringlike, with weakly sclerotized lateral extensions.

289. *Grapholita fana* (Kearfott)

FWL: 4.0-5.0 mm.

Flight Period: Late May to late August.

Distribution: New England to Kansas, south to North Carolina and Arkansas.

Biology: Larvae feed in the buds and flowers of *Desmodium* (ticktrefoil) (Heinrich, 1926).

Remarks: Forewing appearance is similar to that of *interstinctana*, but the ocellus has a clearly expressed central field that is crossed by 4-5 black longitudinal dashes. The male valval neck is only weakly constricted, and there is a narrow flange extending along the distal margin of the cucullus from apex to anal angle. The female ductus bursae is sclerotized anterior to the sterigma.

290. *Grapholita interstinctana* (Clemens)

FWL: 4.0-6.0 mm.

Flight Period: Late May to early September.

Distribution: Maine to Alberta, south to Missouri.

Biology: The preferred host is *Trifolium pratense* (red clover), but *Helianthus* (sunflower) and other species of *Trifolium* (clover) are also utilized. The larvae are solitary seed-feeders in the flower head. They overwinter on the host in the last-instar and pupate in the spring. There are two generations in the North and a partial third in the South (Wehrle, 1924).

Remarks: Commonly called the clover seed caterpillar, *interstinctana* has been reported to be a significant pest of clover (Folsom, 1909). It differs from the similar looking *fana* in the form of the ocellus: a gray bar with darker edging in *interstinctana* versus a pair of lustrous bars bordering a lighter central field in *fana*. The costal margin of the male valva is nearly straight, and the ventral invagination of the neck is V-shaped.

291. ***Grapholita eclipsana*** Zeller

FWL: 4.0-7.5 mm.

Flight Period: April to August.

Distribution: Maine to Wisconsin, south to Mississippi and Texas.

Biology: Larvae have been reared on *Amorpha canescens* (leadplant) (Godfrey et al., 1987). Capture dates suggest multiple generations per year.

Remarks: The basal portion of the hindwing is white and translucent, distinguishing *eclipsana* from other midwestern *Grapholita*. The male cucullus has a weakly projecting anal angle. The female ductus bursae is wide and twisted, with two heavily sclerotized spinulate patches anterior to the ostium.

292. ***Grapholita tristrigana*** (Clemens)

FWL: 4.5-8.0 mm.

Flight Period: April to July.

Distribution: Eastern United States.

Biology: Larvae feed in seed pods and stems of *Baptisia* (wild indigo) and *Lupinus* (lupine) (Miller, 1982).

Remarks: Forewing pattern resembles that of *delineana*, with numerous white costal strigulae and two pairs of dorsal strigulae, the latter not always clearly separated. Males are distinguished by the even taper of the aedeagus, females by the absence or near absence of signa in the corpus bursae.

293. ***Grapholita delineana*** (Walker)

FWL: 4.5-6.5 mm.

Flight Period: Mid-May to late August.

Distribution: New York to Minnesota, south to Missouri.

Biology: Larvae feed in the stems and developing seeds of *Cannabis sativa* (marijuana). Infested plants show a swelling in the stem and possibly an entrance hole with extruded frass. The moth completes two to three generations per year (Miller, 1982).

Remarks: This native of East Asia has extended its range into Russia, Europe, and North America along with the commercial production of hemp. The earliest records in North America date from 1943 (Miller, 1982). Forewing pattern is similar to that of *tristrigana*, but the dorsal strigulae are usually narrower and distinctly separated. Males are distinguished by the abrupt narrowing of the aedeagus, females by the presence of large dual signa in the corpus bursae.

Genus *Corticivora*

Corticivora is a Nearctic genus containing some of the smallest olethreutine moths in North America. It was proposed by Clarke (1951) for the single species *clarki*, which he named after Austin H. Clark, a former curator at the United States Museum of Natural History. It remained monotypic until Brown (1984) described two additional species: *chica*, from Florida, and *parva*, which ranges through the southeastern States and north to Massachusetts. Our treatment includes only *clarki*, which is broadly distributed in the Midwest.

294. ***Corticivora clarki*** Clarke

FWL: 4.0-5.5 mm.

Flight Period: Late May through August.

Distribution: Northeastern United States, west to Illinois, south to Arkansas; also recorded from Washington.

Biology: Larvae have been reared from bark of *Pinus resinosa* (red pine) (Clarke, 1951).

Remarks: This is a pale gray moth with a well expressed fasciate forewing pattern. The basal and subbasal fasciae are separated by a whitish band of interfascial scaling. The only midwestern olethreutine of similar size and forewing appearance is *Eucosma gomonana*, but the two species are readily separated by genitalic characters.

Genus *Cydia*

Cydia is a worldwide genus with more than 200 described species. It contains some notorious economic pests, such as the codling moth (*pomonella*), filbertworm (*latiferreana*), and hickory shuckworm (*caryana*). In many species the larvae feed on seeds of the host and are commonly called seedworms. Historically, these moths have been placed in other genera (*Laspeyresia*, *Carpocapsa*, *Melissopus*), and incorrect generic assignments persist in much of the economic literature (Brown, 2006).

Approximately fifty species of *Cydia* are recorded from North America. We treat nine that are encountered in the Midwest. Two of those, *latiferreana* and *toreuta*, are considered species complexes (Miller, 1987). In *latiferreana*, wing pattern, size, and genitalia vary extensively (Brown, 1983). Heinrich (1926) recognized seven forms (A-G) based on differences in the shape of the male tegumen and aedeagus but did not diagnose separate taxa. With regard to *toreuta*, Abrahamson and Kraft (1965) alleged that individuals feeding on *Pinus resinosa* (red pine) and those feeding on *Pinus banksiana* (jack pine) are separate species. Close relatives of *toreuta* have been described from the South and the West, but further investigation will be required to establish clear species boundaries within this group.

The only consistent morphological character uniting members of *Cydia* is a thickened anal fold in the hindwing containing a hair pencil and modified sex scales (Horak, 2006). In most males the uncus and socii are undeveloped, and the sacculus is convex, with a setose ridge leading to a constriction in the neck. All of the females treated here have two thornlike signa.

295. *Cydia garacana* (Kearfott)

FWL: 5.5-6.5 mm.

Flight Period: Late June to late July.

Distribution: Ontario to Minnesota, south to Texas.

Biology: The larval host is *Populus* (Brown et al., 1983).

Remarks: The two pairs of grayish-white dorsal strigulae distinguish *garacana* from other *Cydia* treated here. Examination of the genitalia is recommended to avoid confusion with superficially similar species, such as *populana* and *flexiloqua*, that occur in the northern and western parts of the Midwest. Males have a moderately constricted valval neck. The female lamella postvaginalis is a semirectangular plate approximately twice as long as wide. There is a patch of sclerotization on the ductus bursae posterior to the ductus seminalis.

296. *Cydia albimaculana* (Fernald)

FWL: 5.0-7.0 mm.

Flight Period: Late May to September.

Distribution: Maine to North Dakota, south to Arkansas.

Biology: Larvae feed beneath the bark of *Populus* (Miller, 1987). Collection dates suggest the possibility of multiple generations per year.

Remarks: This species has a bright white interfascial spot on the dorsum and a black bar (a fragment of the median fascia) running from costa to radius. In males the aedeagus is long and serpentine, and the anal angle of the cucullus is densely lined with stout setae. Females have a pear-shaped sterigma and a small sclerite on the ductus bursae posterior to the ductus seminalis.

297. *Cydia lacustrina* (Miller)

FWL: 8.5-9.5 mm.

Flight Period: Late March to May.

Distribution: Recorded from Illinois, Louisiana, and Michigan.

Biology: Unknown.

Remarks: Of the midwestern *Cydia*, *lacustrina* is second in size only to *pomonella*. The forewings are grayish white, with a black streak running from base to apex and some white suffusion on the dorsal margin. The male valva tapers evenly to the cucullus, which has a strongly produced anal angle and a densely setose medial surface. The sacculus has a ridge with a row of stout setae. The sterigma is rectangular, and the posterior half of the wide ductus bursae is sclerotized.

298. *Cydia candana* (Forbes)

FWL: 6.0-8.0 mm.

Flight Period: April and May.

Distribution: Pennsylvania to Minnesota, south to Virginia and Kentucky.

Biology: Larvae feed in seeds of *Acer* (maple) (Miller, 1987).

Remarks: The fascial markings are composed of blackish-gray white-tipped scales; the interfascial areas are lustrous gray. Characters distinguishing this species from similar looking *caryana* include: hindwing uniformly grayish brown, males with a cubital pecten in a pouch on the hindwing (Miller, 1987), valval neck with prominent ventral spur at base of cucullus, and lamella postvaginalis broader than ostium.

299. *Cydia caryana* (Fitch)

FWL: 5.0-7.0 mm.

Flight Period: April through September.

Distribution: Eastern United States, west to New Mexico.

Biology: The larval host is *Carya* (hickory), including *C. illinoinensis* (pecan) (Miller, 1987). Larvae tunnel into nuts and husks and overwinter in husks on the ground. There are four or five generations per year in southern States (Payne & Heaton, 1975).

Remarks: Commonly referred to as the hickory shuckworm, *caryana* inflicts considerable damage on pecan crops (Payne & Heaton, 1975). Despite chemical and biological control efforts, it has spread along with commercial pecan orchards and is now found as far west as New Mexico (Davis & Lucero, 1993). The whitish patch on the upper basal half of the hindwing distinguishes *caryana* from *candana*. The male hindwing lacks a cubital pecten (Miller, 1987), the aedeagus is slender and forked, and the sterigma is semirectangular, with length more than twice width.

300. *Cydia gallaesaliciana* (Riley)

FWL: 5.0-6.5 mm.

Flight Period: May to late June.

Distribution: Nova Scotia to Manitoba, south to Texas.

Biology: Larvae feed in galls on stems of *Salix* (willow) (Heinrich, 1926).

Remarks: This species is identified by the white basal and costal areas of the forewing. The ventral emargination of the valval neck is evenly rounded. The lamella postvaginalis is nearly square and has a pronounced anterior projection on the posterior margin of the ostium.

301. *Cydia pomonella* (Linnaeus)

FWL: 6.5-11.0 mm.

Flight Period: April to September.

Distribution: Worldwide.

Biology: Larvae cause extensive damage by feeding on seeds inside the fruits of *Malus* (apple), *Pyrus* (pear), *Juglans* (walnut), and *Prunus* (plum) (Falcon & Huber, 1991). Females lay eggs singly on fruits, stems, or leaves of the host. Larvae overwinter under tree bark and pupate in the spring. Several generations are produced per year in the Midwest (Wearing et al., 2001).

Remarks: The codling moth is one of the most widely distributed and important pests of pome fruits and walnuts in the world (Falcon & Huber, 1991). Global distribution from its origin in Eurasia has been primarily through the movement of infested apple trees and fruits (Wearing et al., 2001). Adults are identified by gray forewings with numerous silver striations and a dark golden-brown ocellus. Males have a ventrally projecting spur at the base of the cucullus. In females, the ductus bursae is short, sclerotized, and folded.

302. *Cydia latiferreana* complex

C. latiferreana (Walsingham)

FWL: 6.0-9.5 mm.

Flight Period: May to October.

Distribution: North America.

Biology: This species been reared from *Quercus* (oak), *Castanea* (chestnut), *Corylus* (hazelnut and filbert), and *Fagus* (beech) (Brown, 1983). Larvae feed within nuts until mature, overwinter in the soil or leaf litter, and pupate the following spring. There are also reports of larvae infesting oak galls produced by cynipid wasps (Pucat, 1994).

Remarks: Commonly known as the filbertworm, this species is a pest on cultivated filberts and hazelnuts. It is extremely variable, and the different forms are believed to constitute a species complex (Brown, 1983; Miller, 1987). Males have dorsally projecting extensions of the tegumen that may be long and narrow or short and stout. Some phenotypes have a variable slender projection arising from the lateral surface of the aedeagus. Heinrich (1926) designated seven forms (types A-G) based on variations in these characters; our genitalia illustration shows a type F male from New York.

303. *Cydia toreuta* complex

C. toreuta (Grote)

FWL: 5.0-7.5 mm.

Flight Period: Late May to mid August.

Distribution: Pennsylvania to Minnesota, south to Texas.

Biology: Larvae feed in cones of *Pinus*, including *P. taeda* (loblolly pine), *P. banksiana* (jack pine), *P. contorta* (lodgepole pine), *P. echinata* (shortleaf pine), *P. resinosa* (red pine), and *P. virginiana* (Virginia pine) (Heinrich, 1926; Harbo & Kraft, 1969; Miller, 1987). They bore between the cone scales, consume the seeds, and overwinter in a tunnel at the center of the cone (Harbo & Kraft, 1969).

Remarks: This moth, which is commonly referred to as the eastern pine seedworm, is currently interpreted as a complex of unresolved species. Placement to complex is straightforward based on the distinctive forewing pattern. Abrahamson and Kraft (1965) considered individuals utilizing *Pinus resinosa* (red pine) to be a different species from those feeding on *Pinus banksiana* (jack pine). Superficially similar species include *ingens* (Florida) and *piperana* (western), but Heinrich (1926) interpreted *toreuta* as being restricted to the eastern United States north of Florida.

Genus *Gymnandrosoma*

Gymnandrosoma consists of seven New World species, five from the Neotropics, one from south Florida, and one that is broadly distributed in eastern North America. We treat only the last species, *punctidiscanum*, which recently was returned to this genus from *Ecdytolopha* by Adamski and Brown (2001).

Male genitalic characters include: uncus and socii undeveloped, valva with moderately constricted neck, cucullus with rounded apex and short stout setae evenly distributed along distal margin, and medial surface with ridge of stout setae near ventral margin from neck to anal angle. In females, the corpus bursae has two large thornlike signa and extensive wrinkling of the membrane near the juncture with the ductus bursae. Males have sex scaling on the abdomen, terga, hind tibia, and/or anal margin of the hindwing (Adamski & Brown, 2001).

304. *Gymnandrosoma punctidiscanum* Dyar

FWL: 8.0-12.0 mm.

Flight Period: May through September in the Midwest.

Distribution: Massachusetts and southern Ontario to Wisconsin, south to Florida and Texas.

Biology: Larvae feed on *Robinia* (locust) (Prentice, 1966). Adamski and Brown (2001) reported two specimens from Canada with *Quercus rubra* (northern red oak) indicated as the host.

Remarks: Forewing color ranges from brown to blackish gray. All specimens have a distinct white dot in the median fascia at the base of M1. The interfascial area beyond the median fascia may be concolorous with the rest of the wing or contrastingly lighter. Males have distinctive sex scaling on the dorsal surface of the abdomen.

Genus *Ecdytolopha*

Ecdytolopha is a New World genus consisting of ten species. Only one is commonly encountered in the Midwest, the locust twig borer (*insiticiana*). A second, *mana*, has been reported from Missouri but is primarily southern in distribution. Adamski and Brown (2001) recently reviewed the genus.

Genitalic characters are similar to those of *Gymnandrosoma*, but the male valva lacks the setose ridge on the ventral margin of the neck and has a less strongly defined anal angle.

305. *Ecdytolopha insiticiana* Zeller

FWL: 9.0-13.5 mm.

Flight Period: May through September.

Distribution: Transcontinental in the United States and southern Canada; most common in the East.

Biology: Larvae bore in the twigs of *Robinia pseudoacacia* (black locust), attacking new growth and forming galls that can disfigure the tree (Solomon, 1985). Last-instar larvae overwinter in the leaf litter; adults emerge in the spring. Two generations are produced per year in the South (Adamski & Brown, 2001).

Remarks: Commonly known as the locust twig borer, this species can cause significant damage to ornamentals in nurseries and plantations (Solomon, 1995). Wing pattern is sufficient to separate *insiticiana* from other midwestern olethreutines. This species can be distinguished from other *Ecdytolopha* by the presence of a hairpencil on the male hindwing and by the female genitalia (Adamski & Brown, 2001).

Genus *Pseudogalleria*

Pseudogalleria was established by Ragonot in 1884 for *inimicella*, a species Zeller had described in the pyralid genus *Galleria*, presumably because of its superficial similarity with *Galleria mellonella*, the greater wax moth. The caterpillars bore in stems of greenbriar, which is widely distributed in eastern North America. Adamski and Brown (2001) reviewed the genus along with its close relatives *Ecdytolopha* and *Gymnandrosoma*.

The structure of the male tegumen is very similar to that of *Gymnandrosoma* and *Ecdytolopha*. The cucullus lacks stout setae on its distal margin but has several setae that are distributed along a distinctive ridge on the medial surface that curves from the distal extremity of the sacculus to the apex. The female genitalia also resemble those of *Gymnandrosoma* and *Ecdytolopha*, but the signa are smaller and the membrane of the corpus burse is less wrinkled.

306. *Pseudogalleria inimicella* (Zeller)

FWL: 8.0-11.0 mm.

Flight Period: April through September.

Distribution: Maine to Manitoba, south to Florida and Texas.

Biology: Larvae bore in stems and roots of *Smilax herbacea* (carrion flower) (Heinrich, 1923a; Putman, 1942). The long flight period suggests at least two generations per year.

Remarks: Fresh specimens are easily identified by forewing color and maculation, which are unlike any other North American olethreutine. The pale termen and associated reddish-brown crescent-shaped mark are usually discernable, even in moderately worn specimens.

Male Genitalia

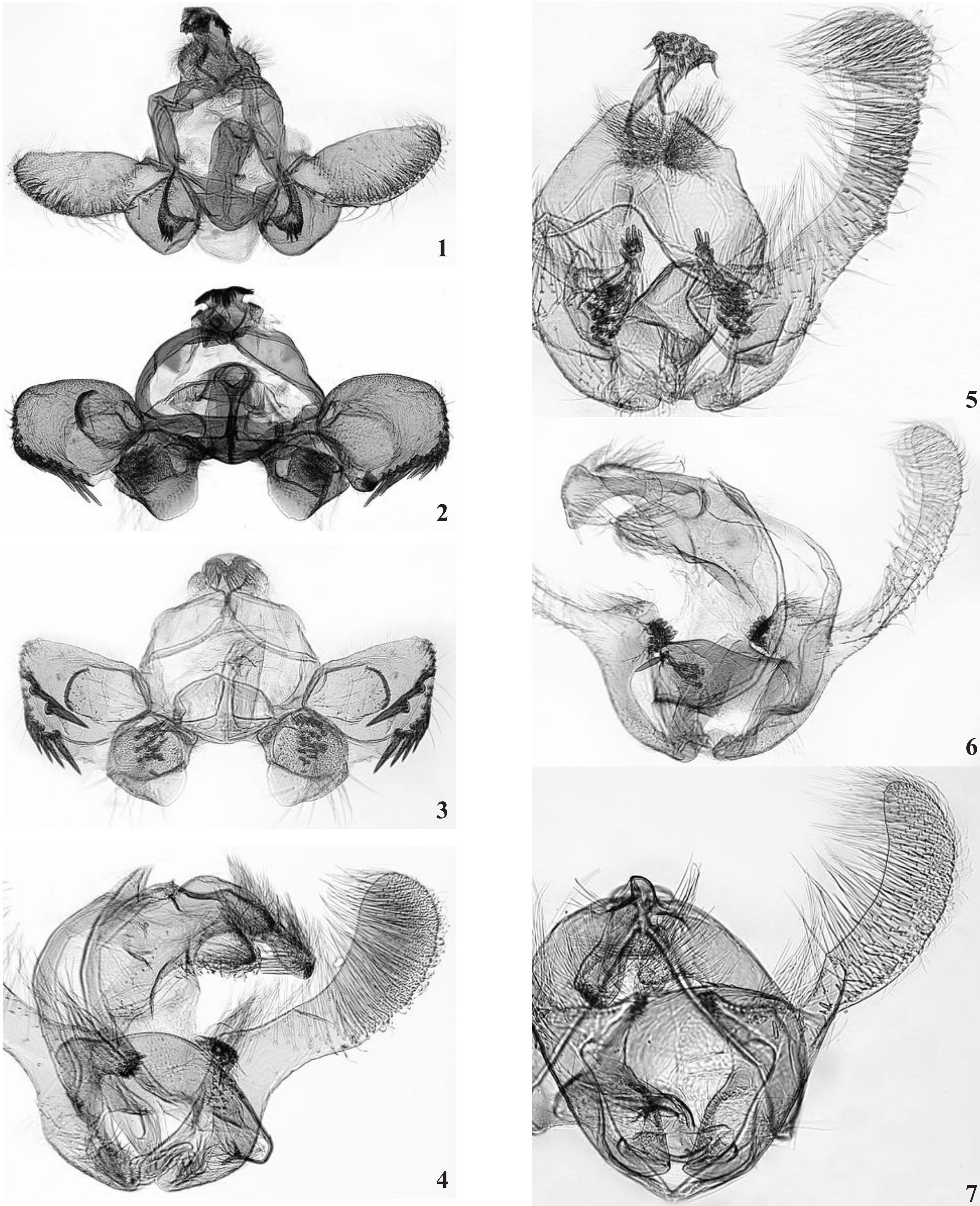


Plate 1

1. *Bactra furfurana* (Haworth); **2.** *Bactra maiorina* Heinrich; **3.** *Bactra verutana* Zeller; **4.** *Endothenia heinrichi* McDunnough; **5.** *Endothenia hebesana* (Walker); **6.** *Endothenia nubilana* (Clemens); **7.** *Endothenia montanana* (Kearfott).

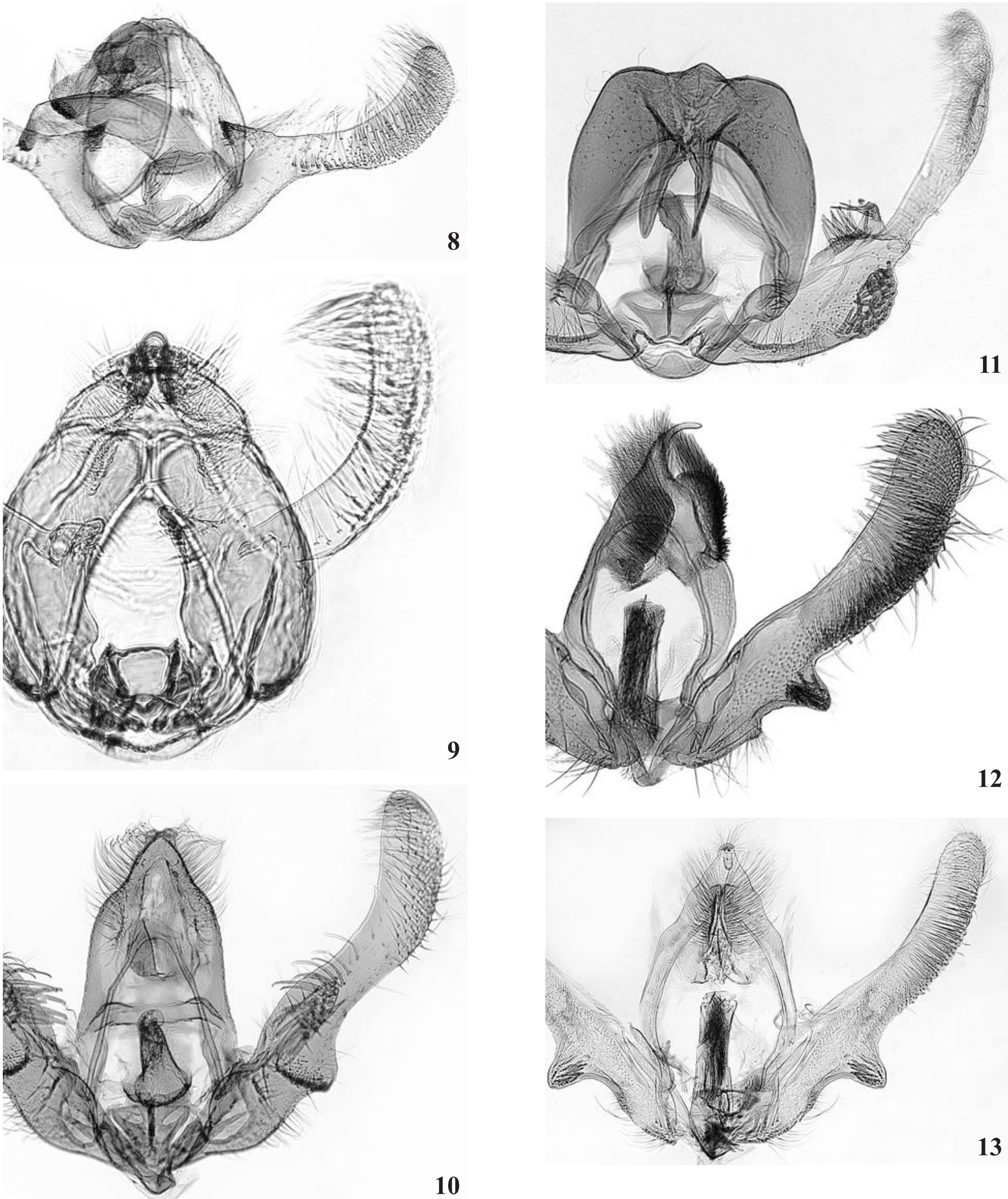


Plate 2
8. *Endothenia infuscata* Heinrich; **9.** *Endothenia microptera* Clarke; **10.** *Taniva albolineana* (Kearfott); **11.** *Hulda impudens* (Walsingham); **12.** *Episimus argutanus* (Clemens); **13.** *Episimus tyrius* Heinrich.

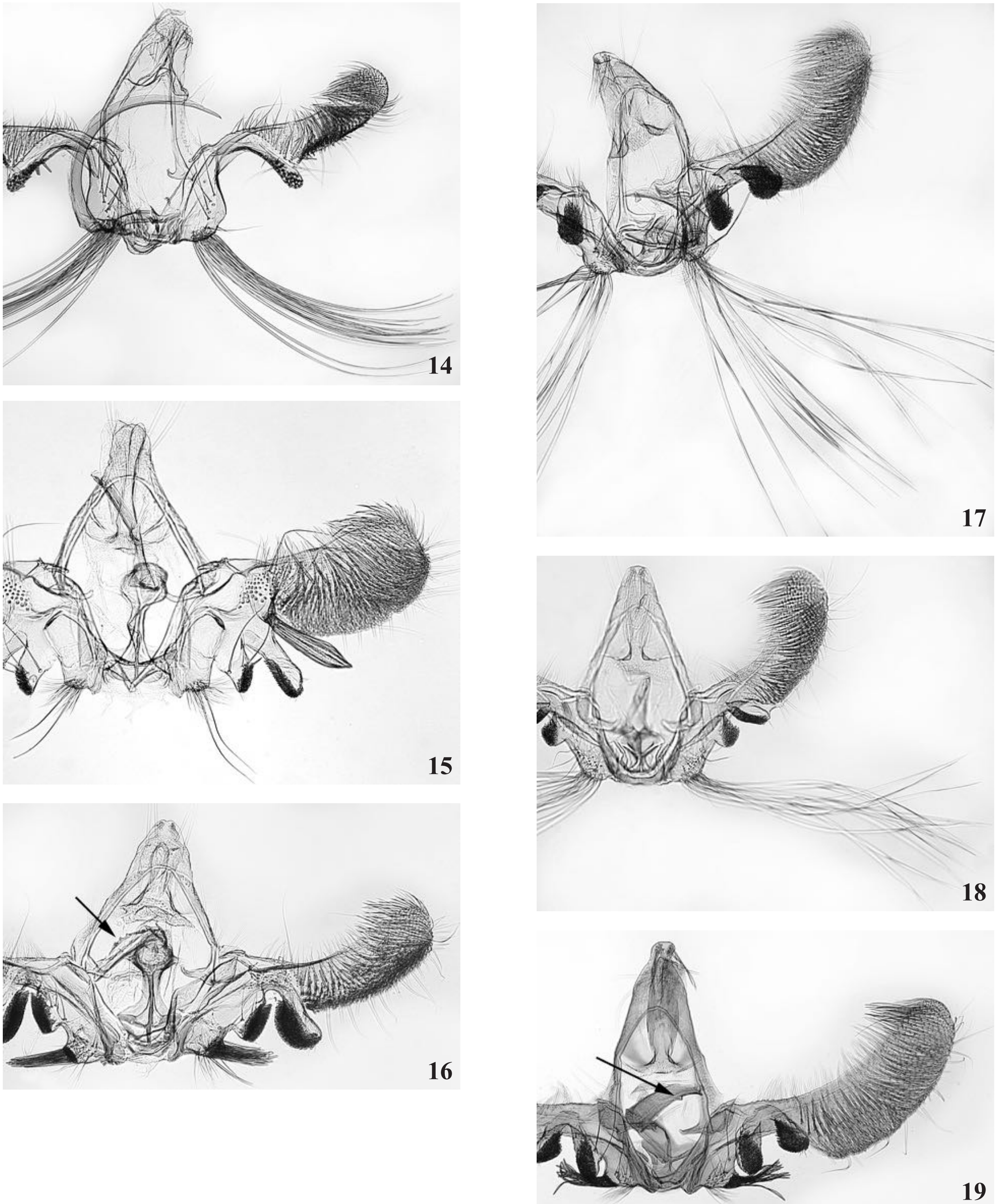


Plate 3

14. *Paralobesia liriodendrana* (Kearfott); **15.** *Paralobesia viteana* (Clemens); **16.** *Paralobesia monotropana* (Heinrich), arrow indicates teeth on aedeagus; **17.** *Paralobesia rhoifructana* (Kearfott); **18.** *Paralobesia yaracana* (Kearfott); **19.** *Paralobesia sambuci* (Clarke), arrow indicates tooth on aedeagus.

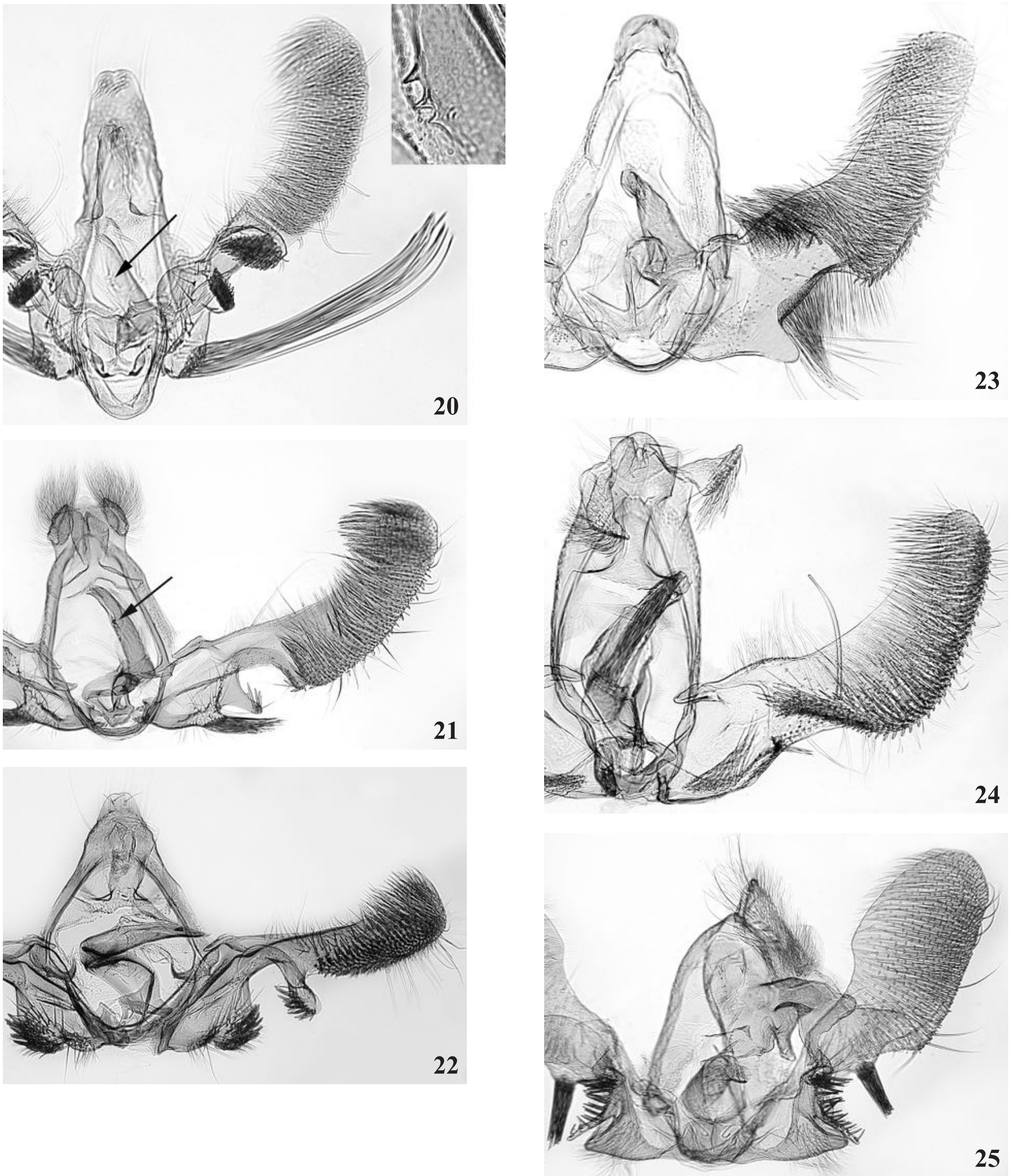


Plate 4

20. *Paralobesia spiraeifoliana* (Heinrich), arrow and inset indicates teeth on aedeagus; **21.** *Paralobesia cyclopiana* (Heinrich), arrow indicates tooth on aedeagus; **22.** *Lobesia carduana* (Busck); **23.** *Aterpia approximana* (Heinrich); **24.** *Eumarozia malachitana* (Zeller); **25.** *Zomaria interruptolineana* (Fernald).

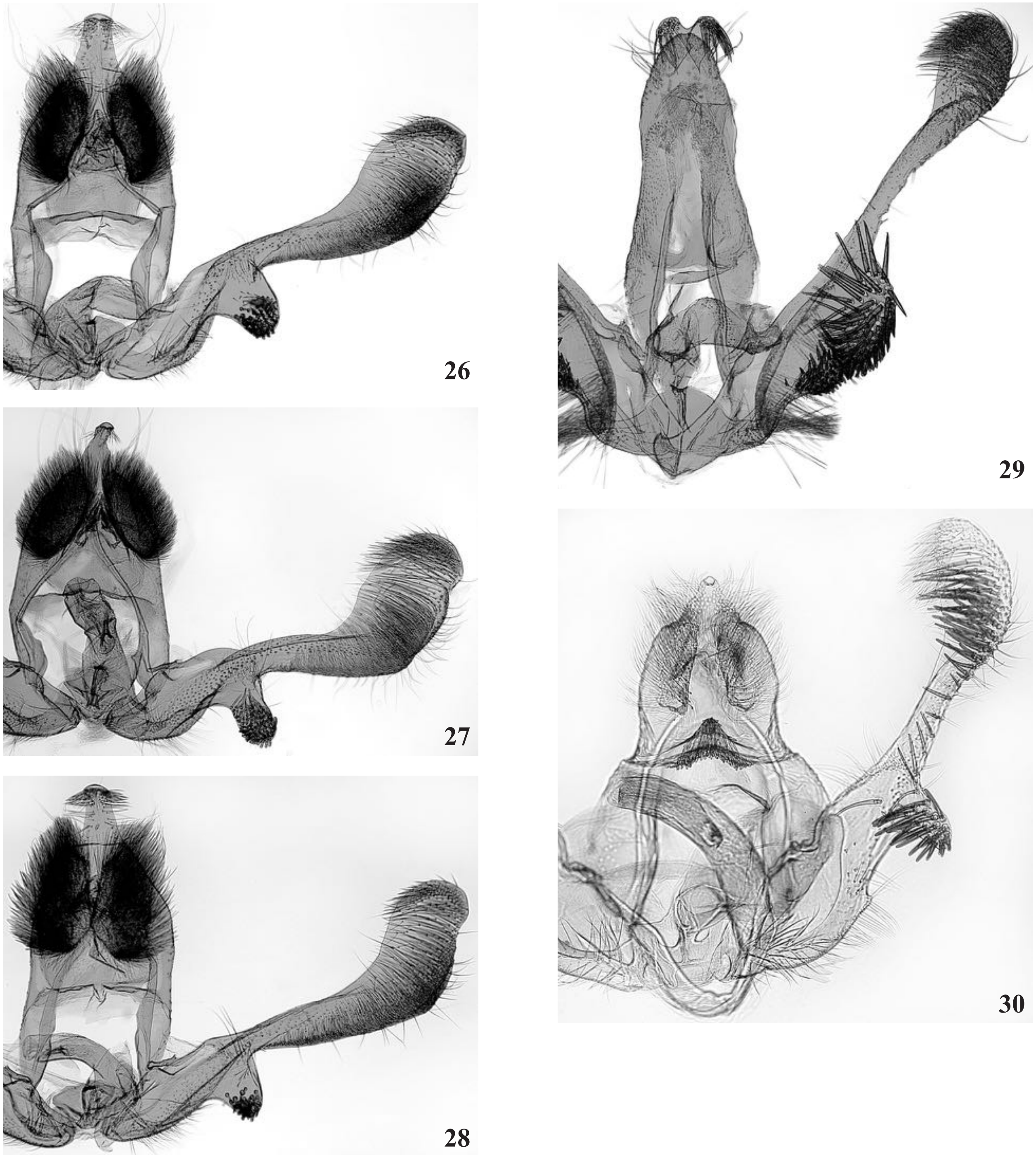


Plate 5

26. *Apotomis capreana* (Hübner); **27.** *Apotomis deceptana* (Kearfott); **28.** *Apotomis removana* (Kearfott); **29.** *Pseudosciaphila duplex* (Walsingham); **30.** *Orthotaenia undulana* (Denis & Schiffermüller).

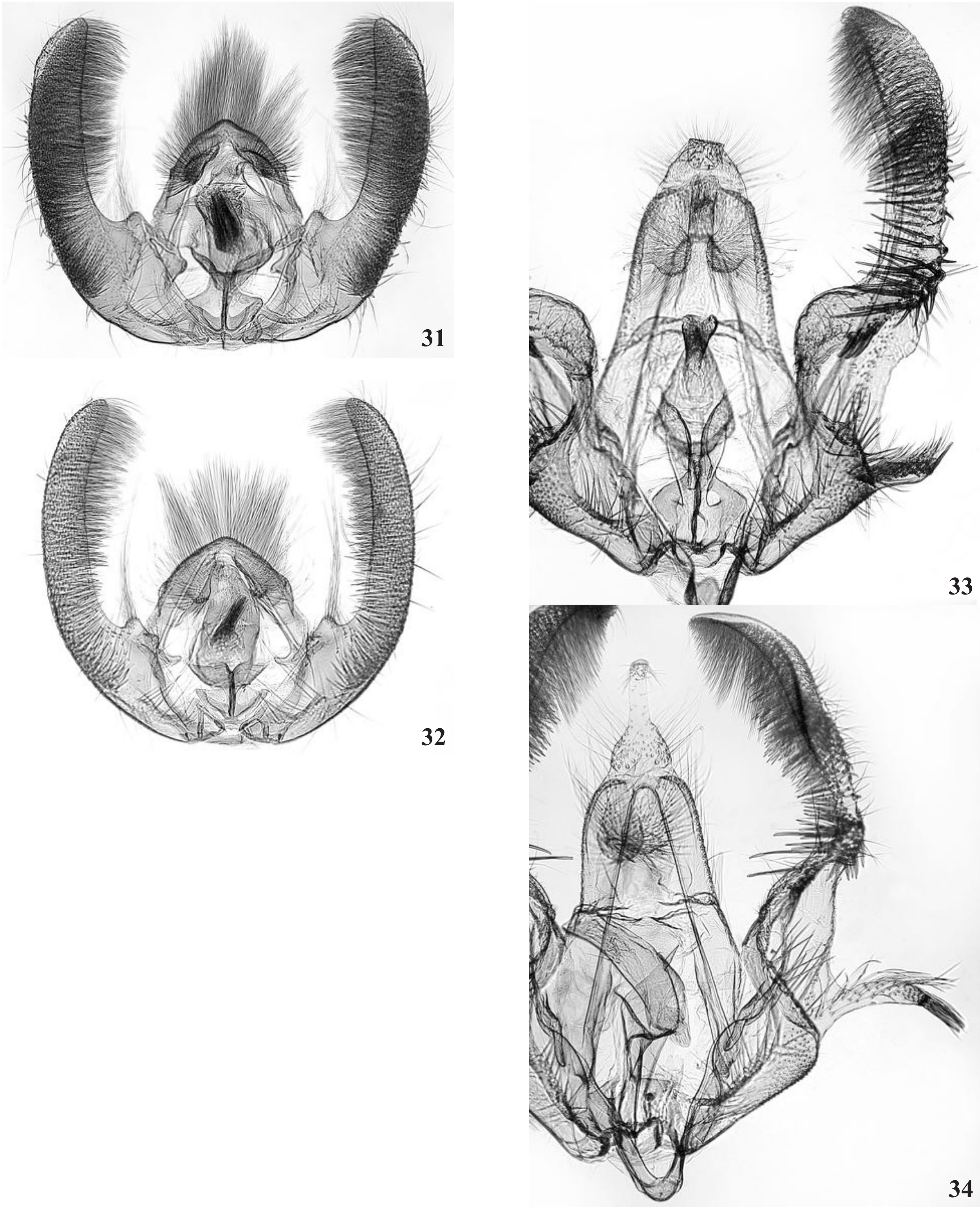


Plate 6

31. *Phaecasiophora confixana* (Walker); **32.** *Phaecasiophora niveiguttana* Grote; **33.** *Olethreutes monetiferana* (Riley); **34.** *Olethreutes nitidana* (Clemens).

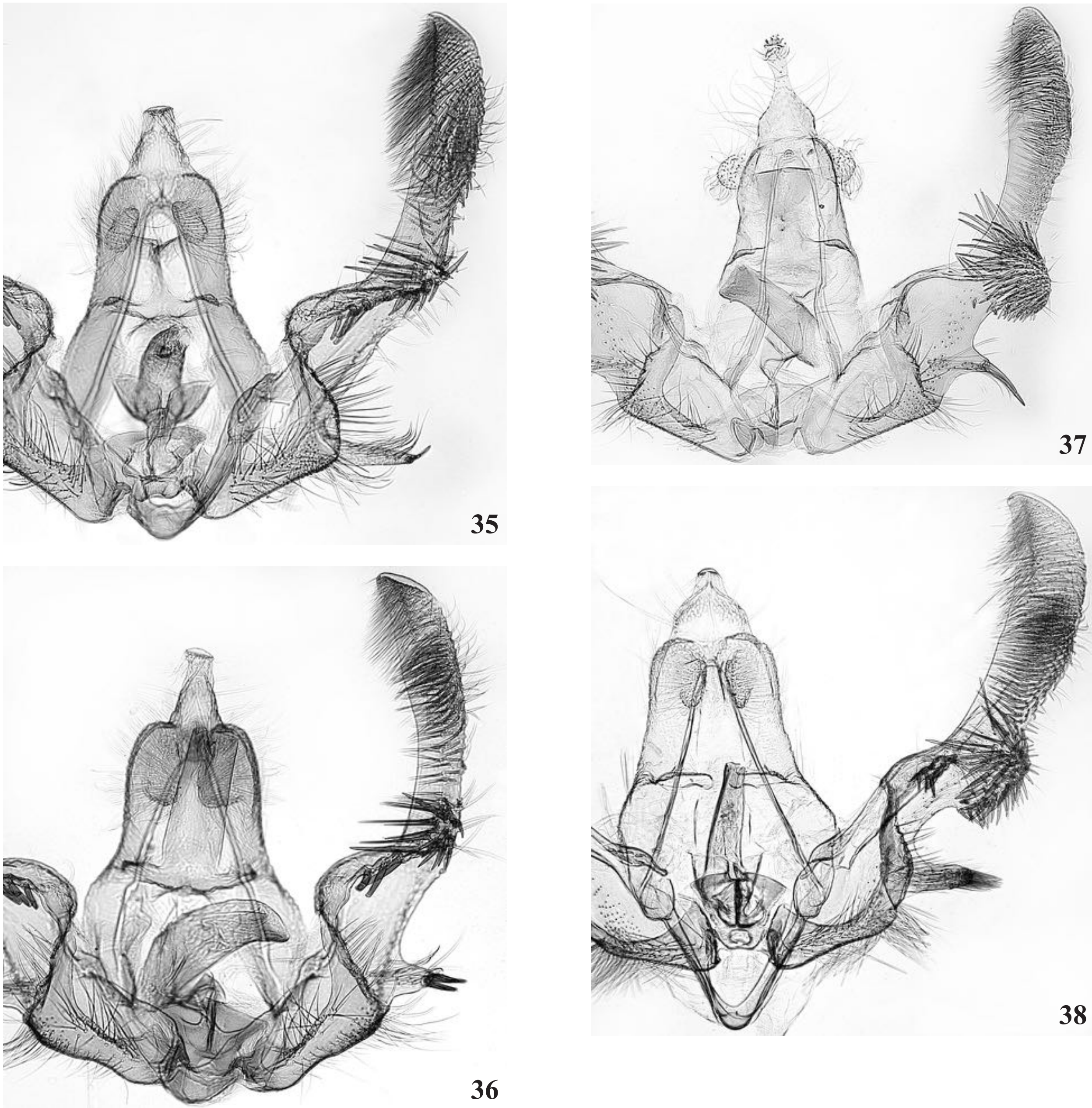


Plate 7
35. *Olethreutes furfurana* (McDunnough); **36.** *Olethreutes comandrana* (Clarke); **37.** *Olethreutes olivaceana* (Fernald); **38.** *Olethreutes subnubilus* (Heinrich).

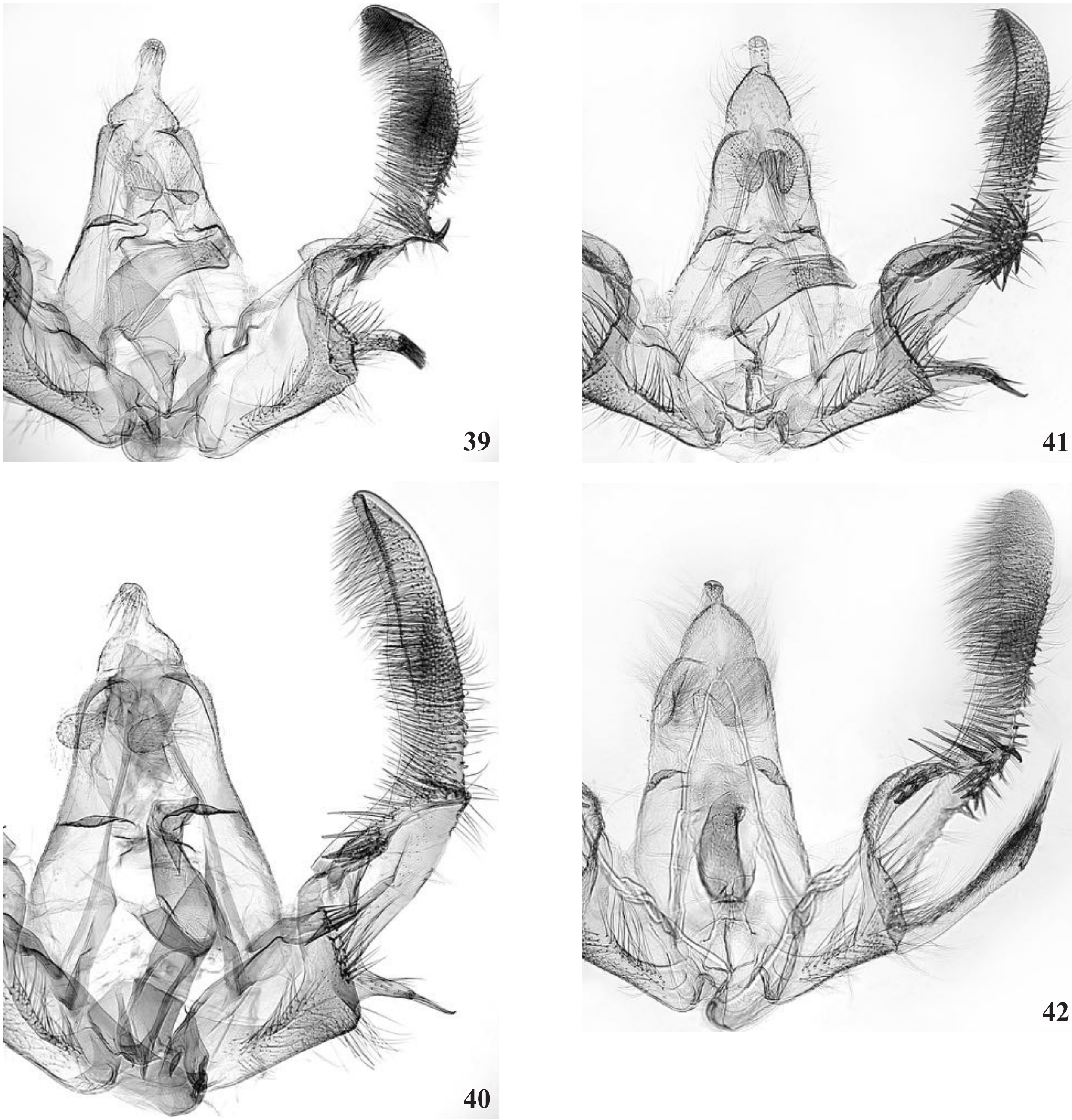


Plate 8
39. *Olethreutes footiana* (Fernald); **40.** *Olethreutes atrodentana* (Fernald); **41.** *Olethreutes punctana* (Walsingham); **42.** *Olethreutes connectus* (McDunnough).

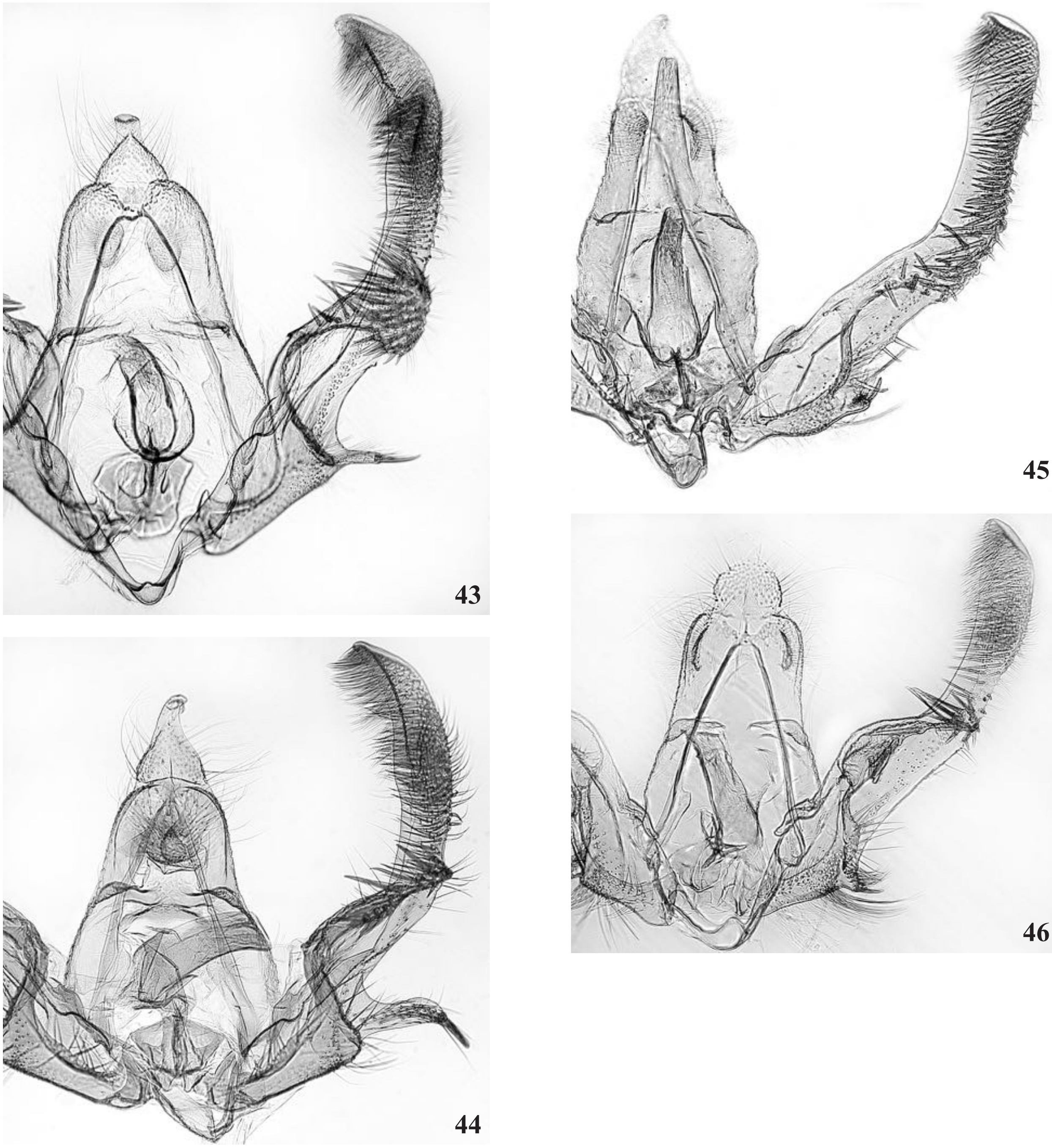
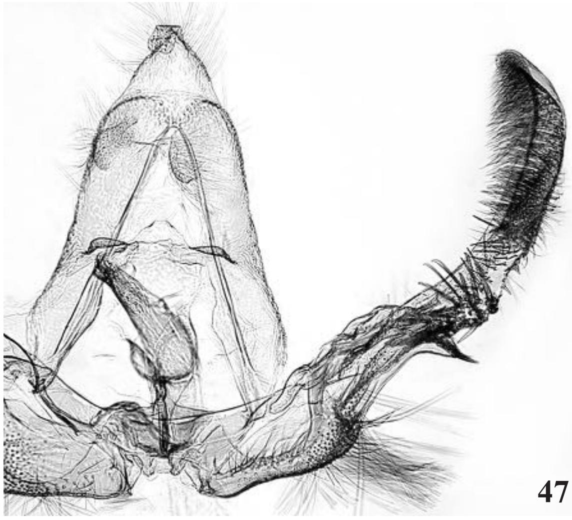


Plate 9

43. *Olethreutes inornatana* (Clemens); **44.** *Olethreutes mysteriana* Miller; **45.** *Olethreutes mediopartitus* (Heinrich); **46.** *Olethreutes exoletus* (Zeller).



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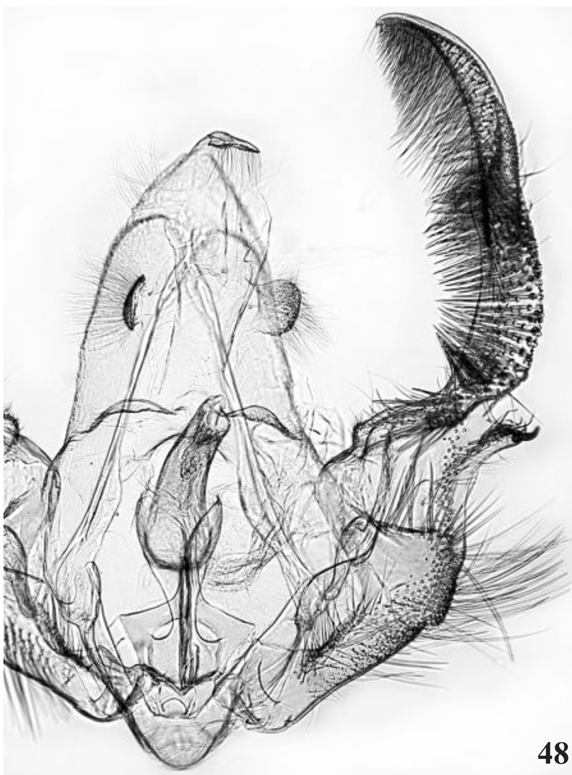

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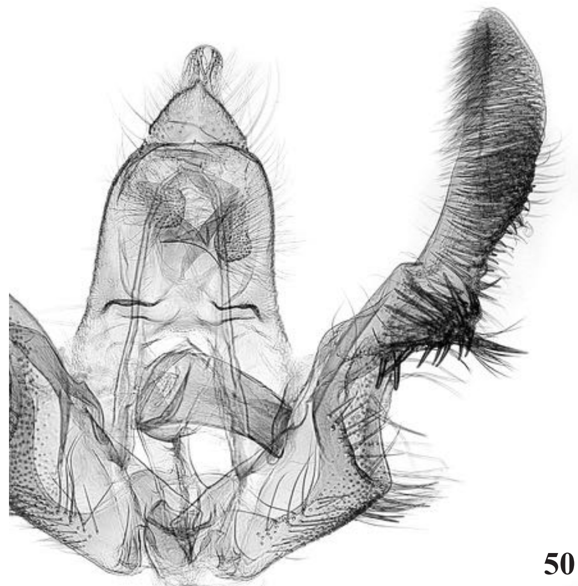

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Plate 10

47. *Olethreutes quadrifidus* (Zeller); **48.** *Olethreutes tiliana* (Heinrich); **49.** *Olethreutes sciotana* (Heinrich); **50.** *Olethreutes appalachiana* (Braun).

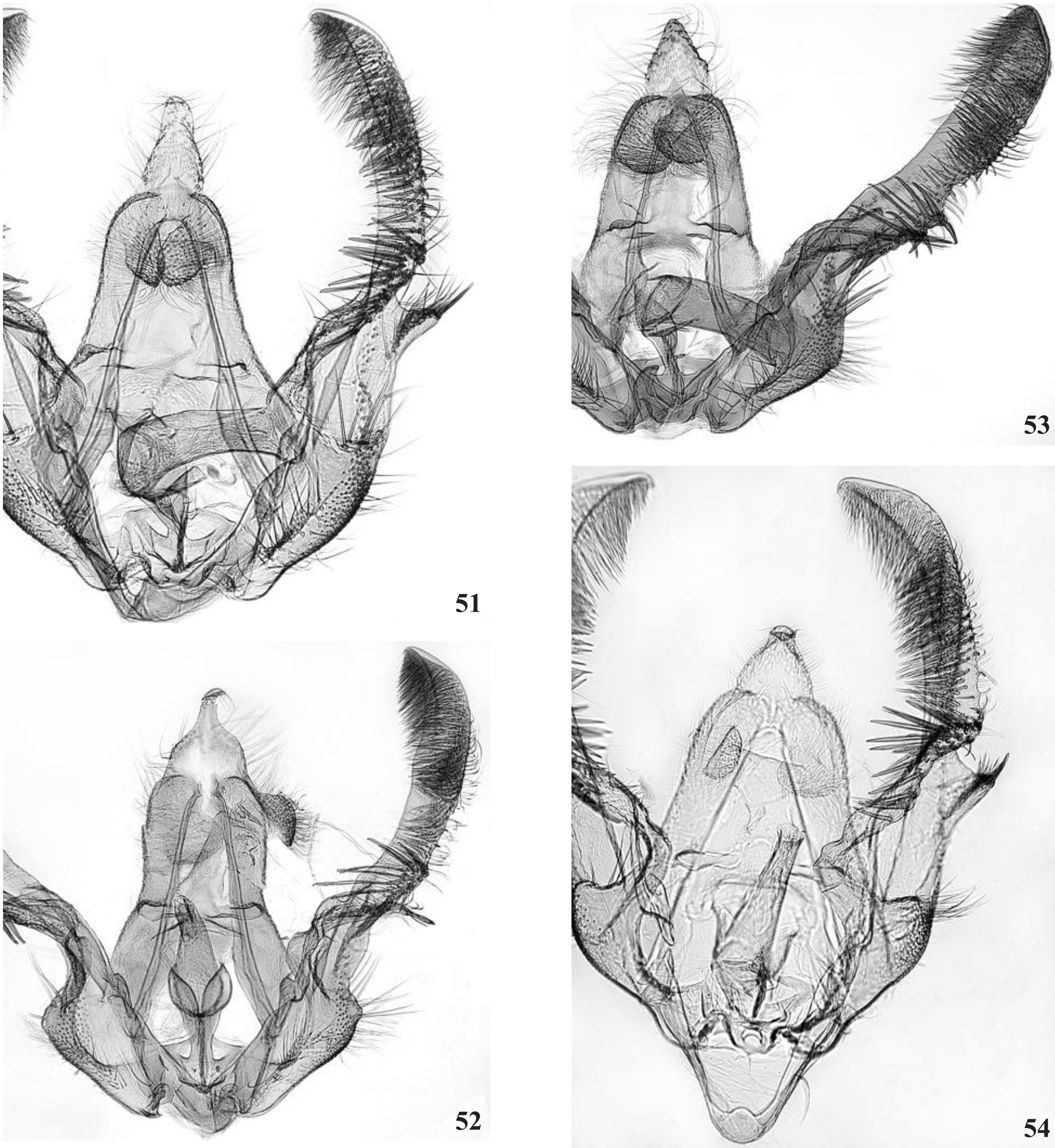


Plate 11
51. *Olethreutes clavana* (Walker); **52.** *Olethreutes nigrana* (Heinrich); **53.** *Olethreutes viburnana* (McDunnough); **54.** *Olethreutes merrickana* (Kearfott).

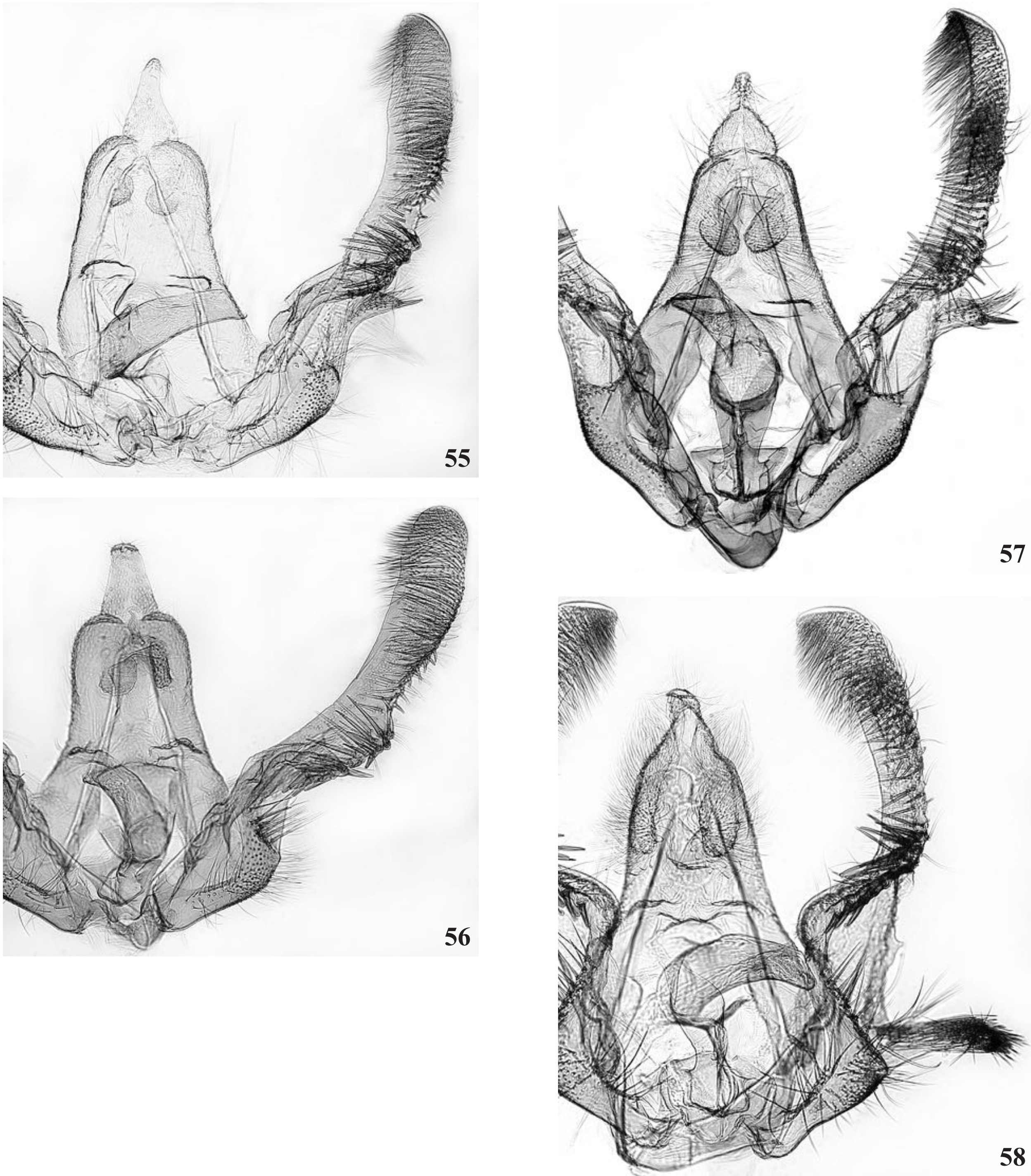


Plate 12
55. *Olethreutes hamameliana* (McDunnough); **56.** *Olethreutes corylana* (Fernald); **57.** *Olethreutes ochrosuffusana* (Heinrich); **58.** *Olethreutes brunneopurpuratus* (Heinrich).

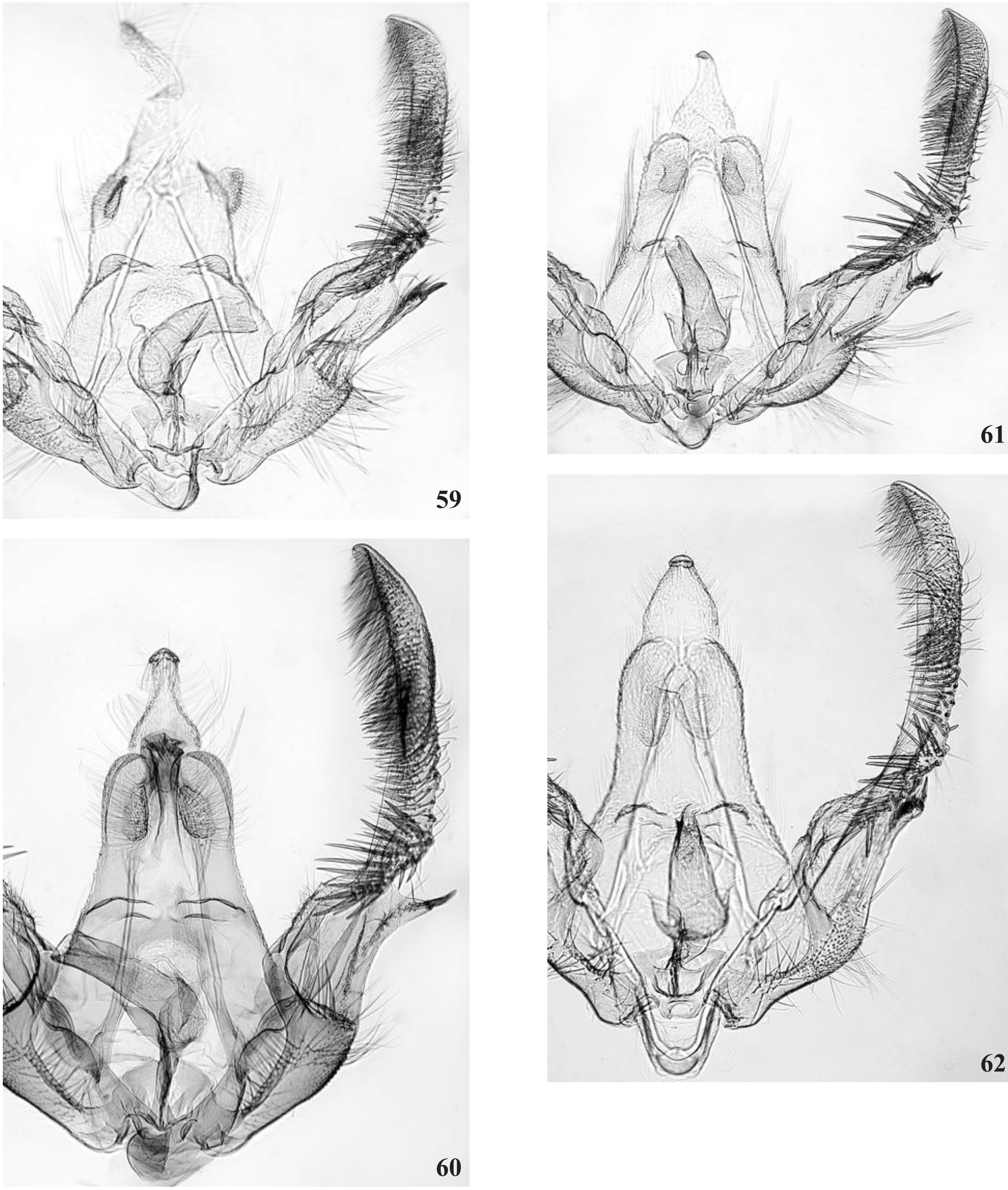
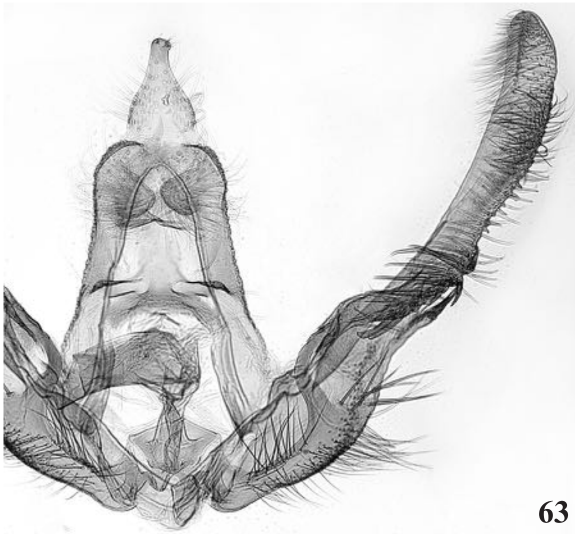


Plate 13

59. *Olethreutes ferrugineana* (Riley); **60.** *Olethreutes fagigemmeana* (Chambers); **61.** *Olethreutes sericorana* (Walsingham); **62.** *Olethreutes melanomesa* (Heinrich).



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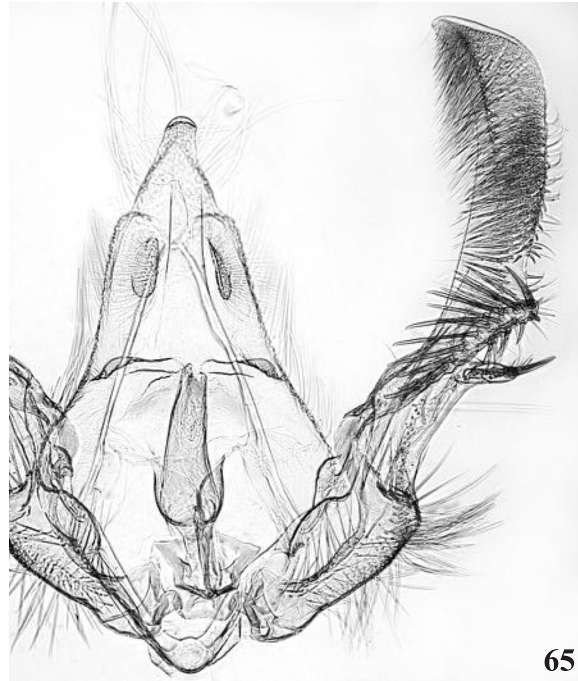

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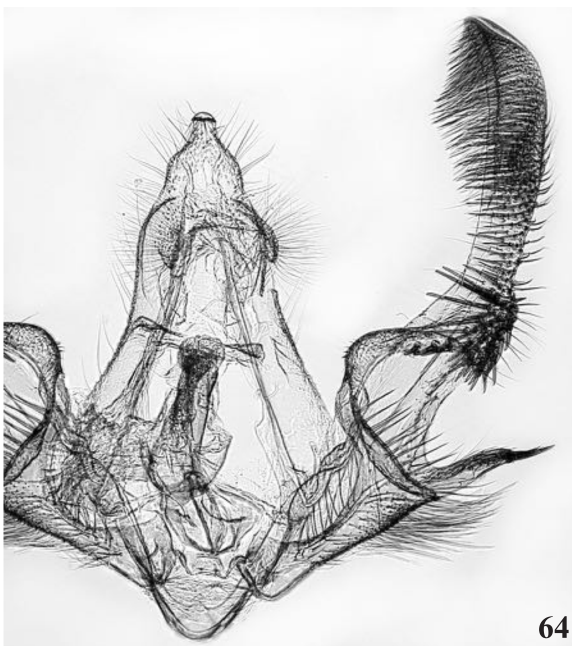

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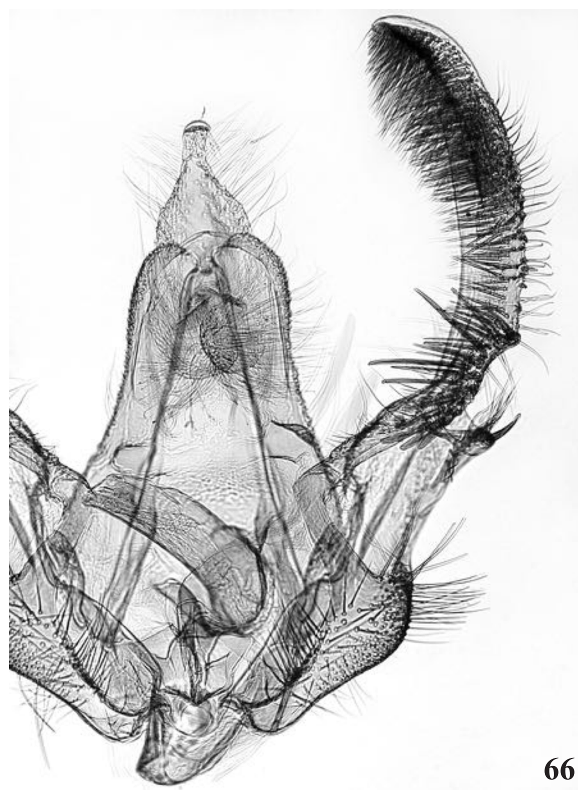

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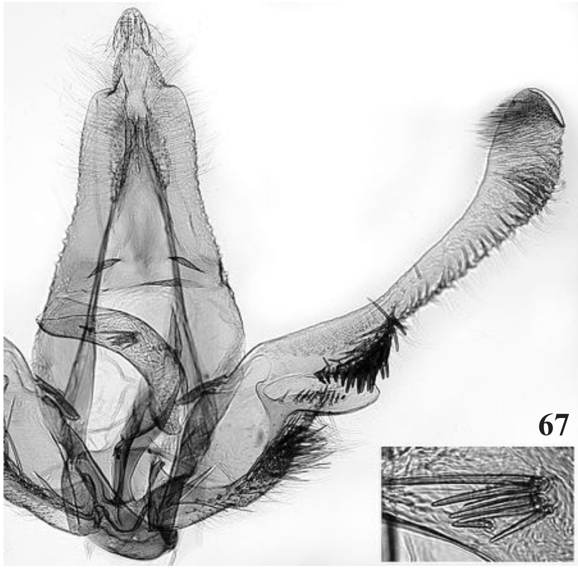
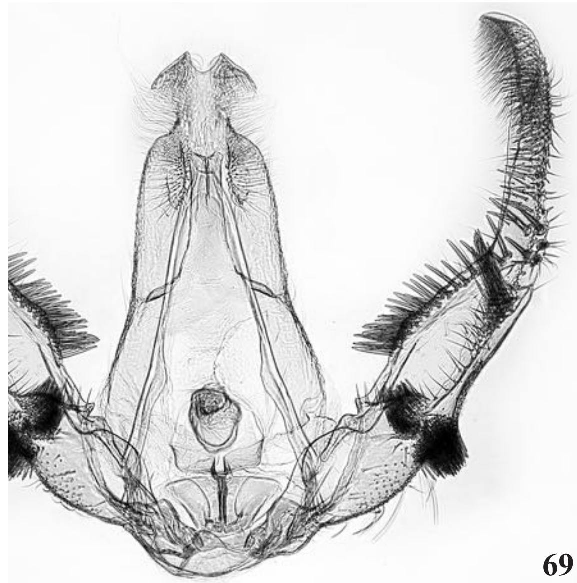
Plate 14

63. *Olethreutes valdana* (McDunnough); **64.** *Olethreutes versicolorana* (Clemens); **65.** *Olethreutes permundana* (Clemens); **66.** *Olethreutes malana* (Fernald).





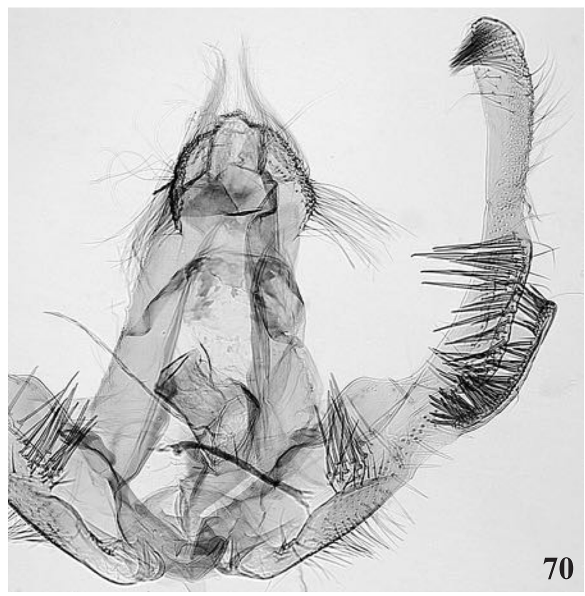
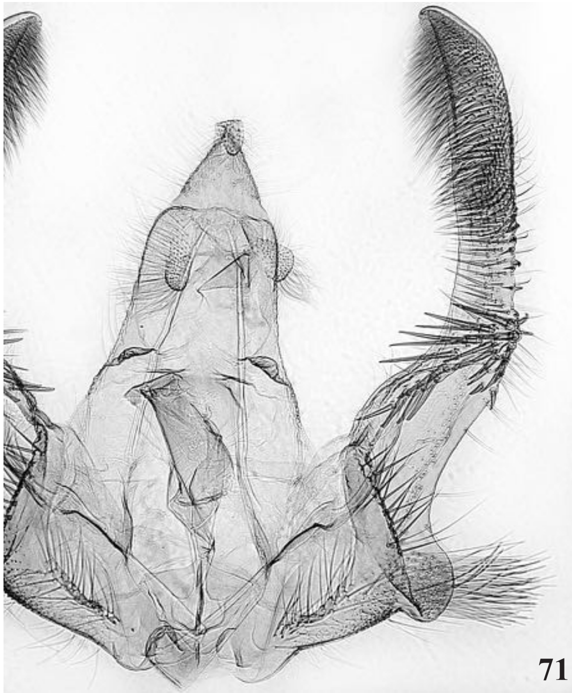


Plate 15

67. *Olethreutes appendicea* (Zeller), inset indicates multiple cornuti; **68.** *Olethreutes concinnana* (Clemens); **69.** *Olethreutes fasciatana* (Clemens); **70.** *Olethreutes troglodana* (McDunnough).



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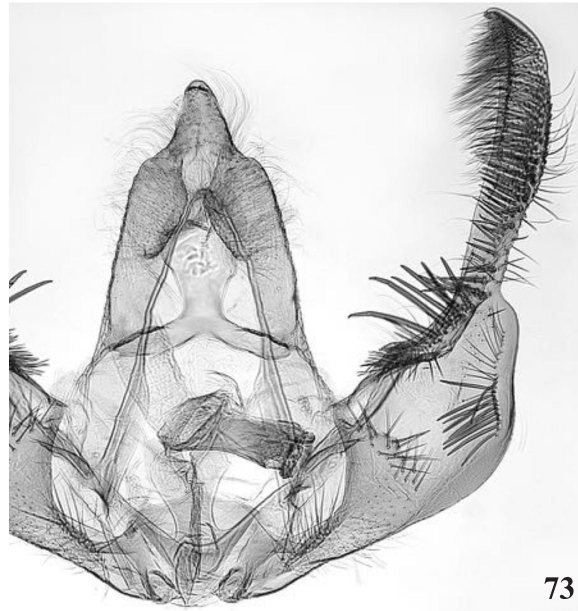

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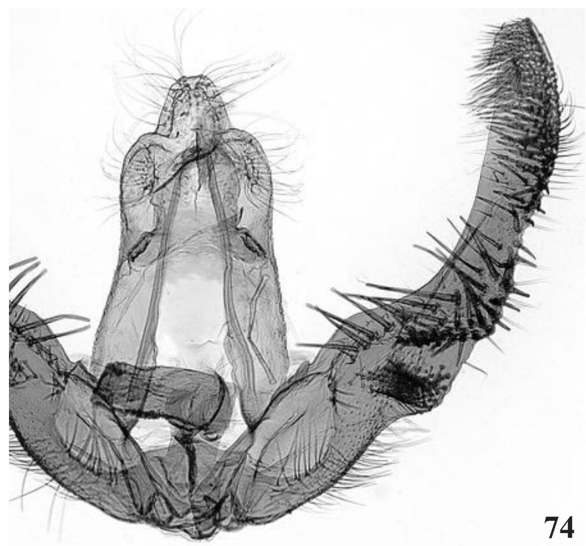

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Plate 16

71. *Olethreutes exaeresima* (Heinrich); **72.** *Olethreutes lacunana* (Freeman); **73.** *Olethreutes ferriferana* (Walker); **74.** *Olethreutes auricapitana* (Walsingham).

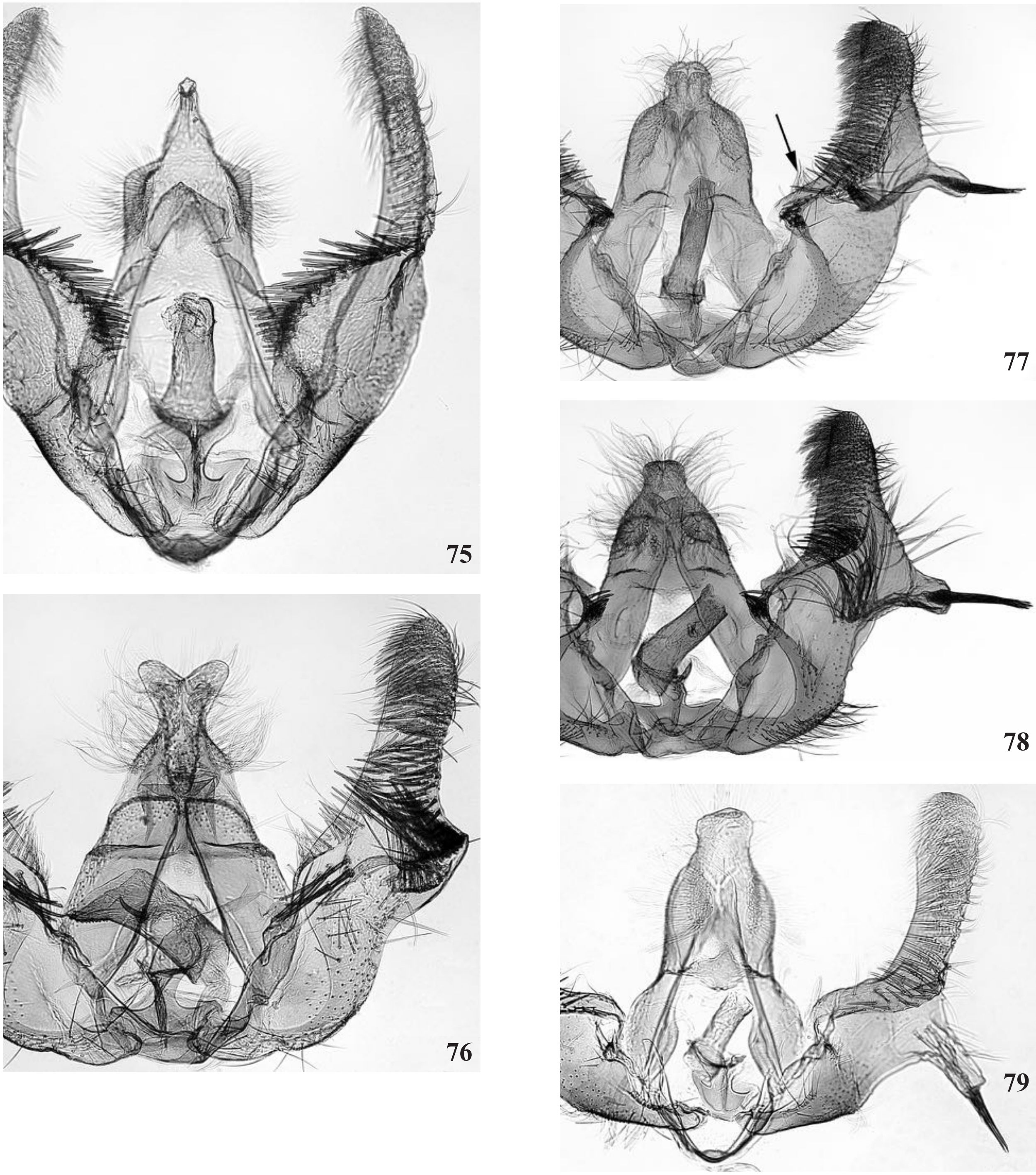

Plate 17

75. *Olethreutes albiciliana* (Fernald); **76.** *Olethreutes astrologana* (Zeller); **77.** *Olethreutes coruscana* (Clemens), arrow indicates row of spines; **78.** *Olethreutes ferrolineana* (Walker); **79.** *Olethreutes glaciana* (Möschler).

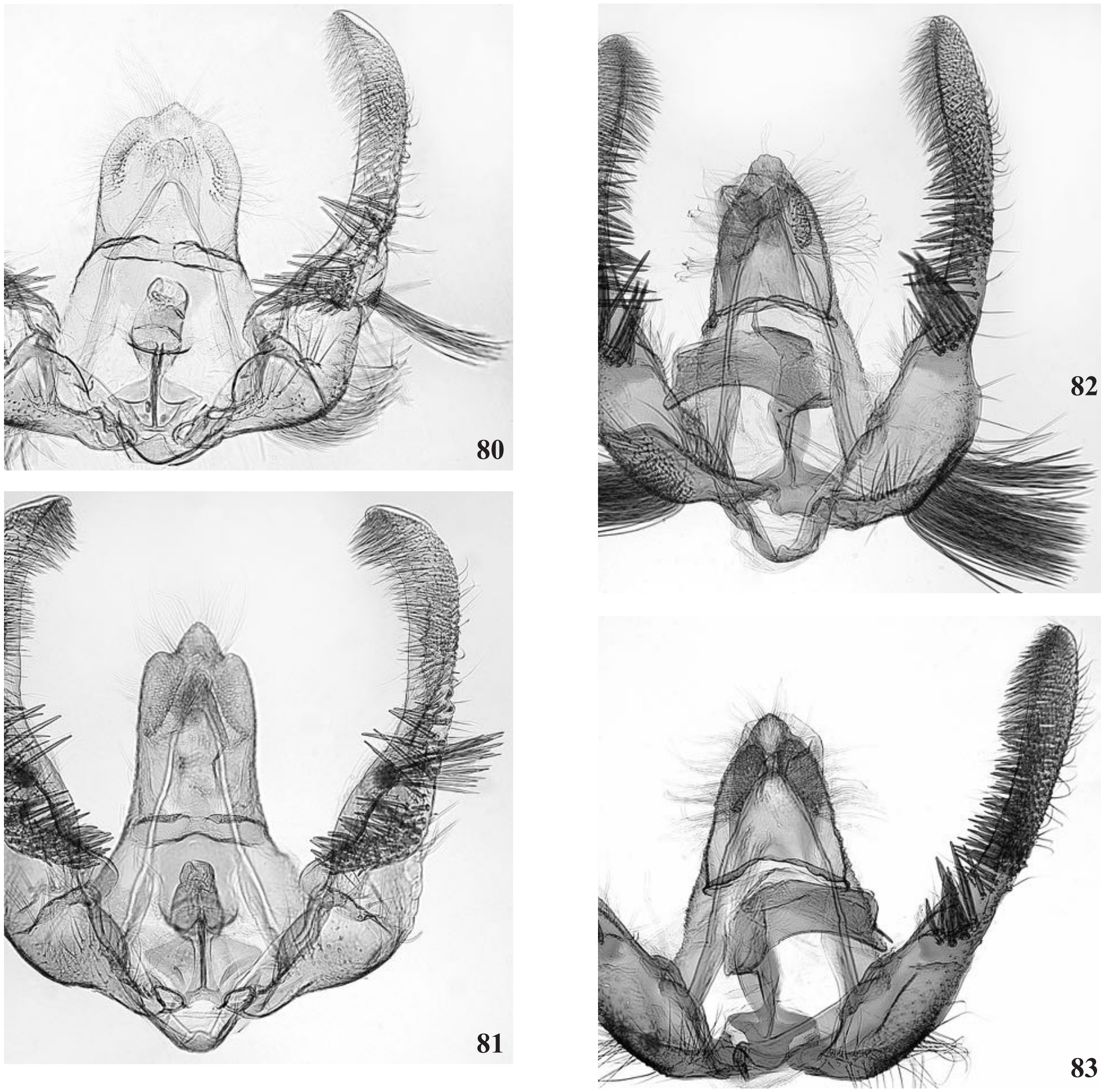

Plate 18
80. *Olethreutes bipartitana* (Clemens); **81.** *Olethreutes trinitana* (McDunnough); **82.** *Olethreutes griseoalbana* (Walsingham); **83.** *Olethreutes osmundana* (Fernald).

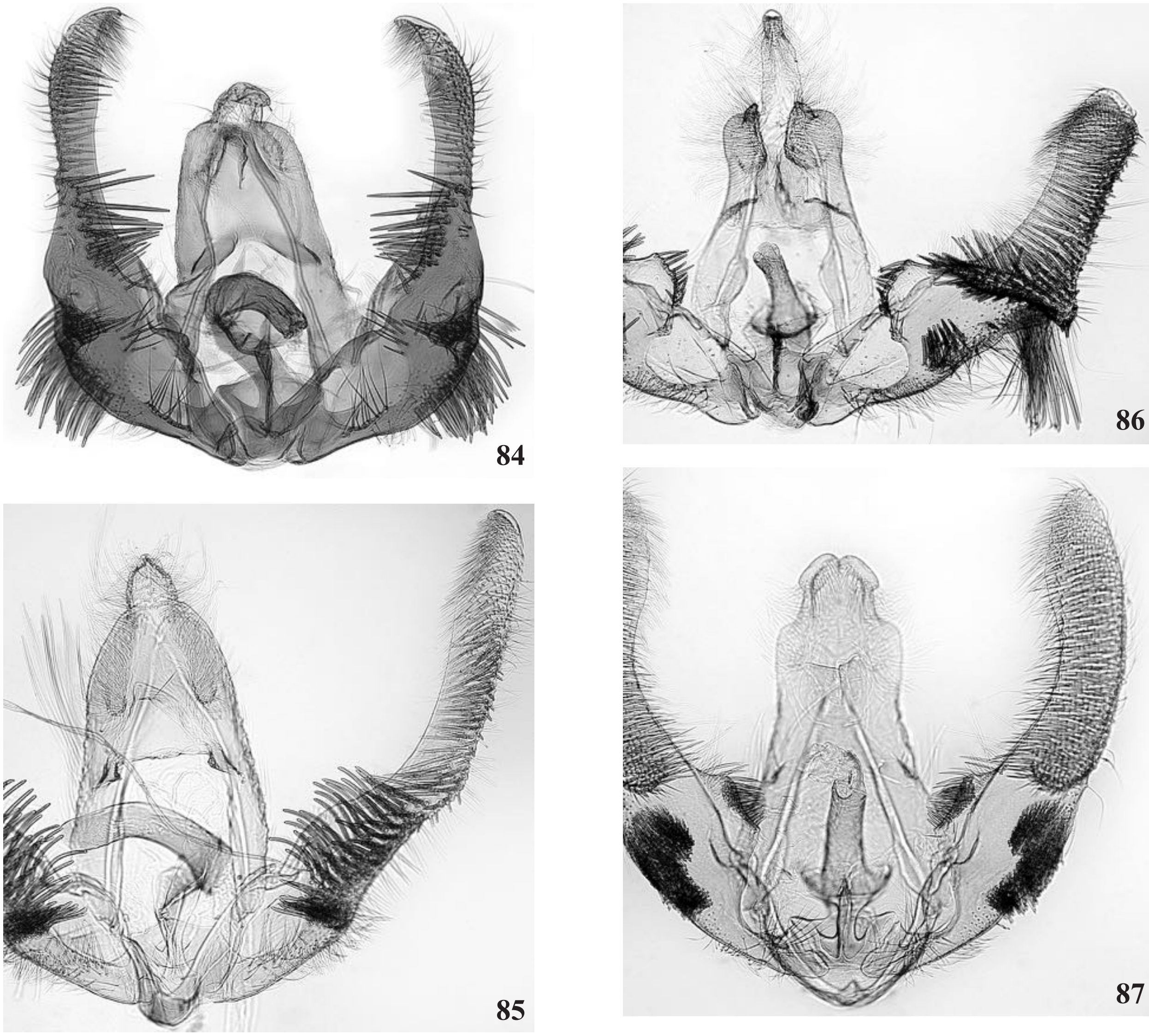

Plate 19
84. *Celypha cespitana* (Hübner); **85.** *Pristerognatha agilana* (Clemens); **86.** *Metendothenia separatana* (Kearfott); **87.** *Hedya ochroleucana* (Frölich).

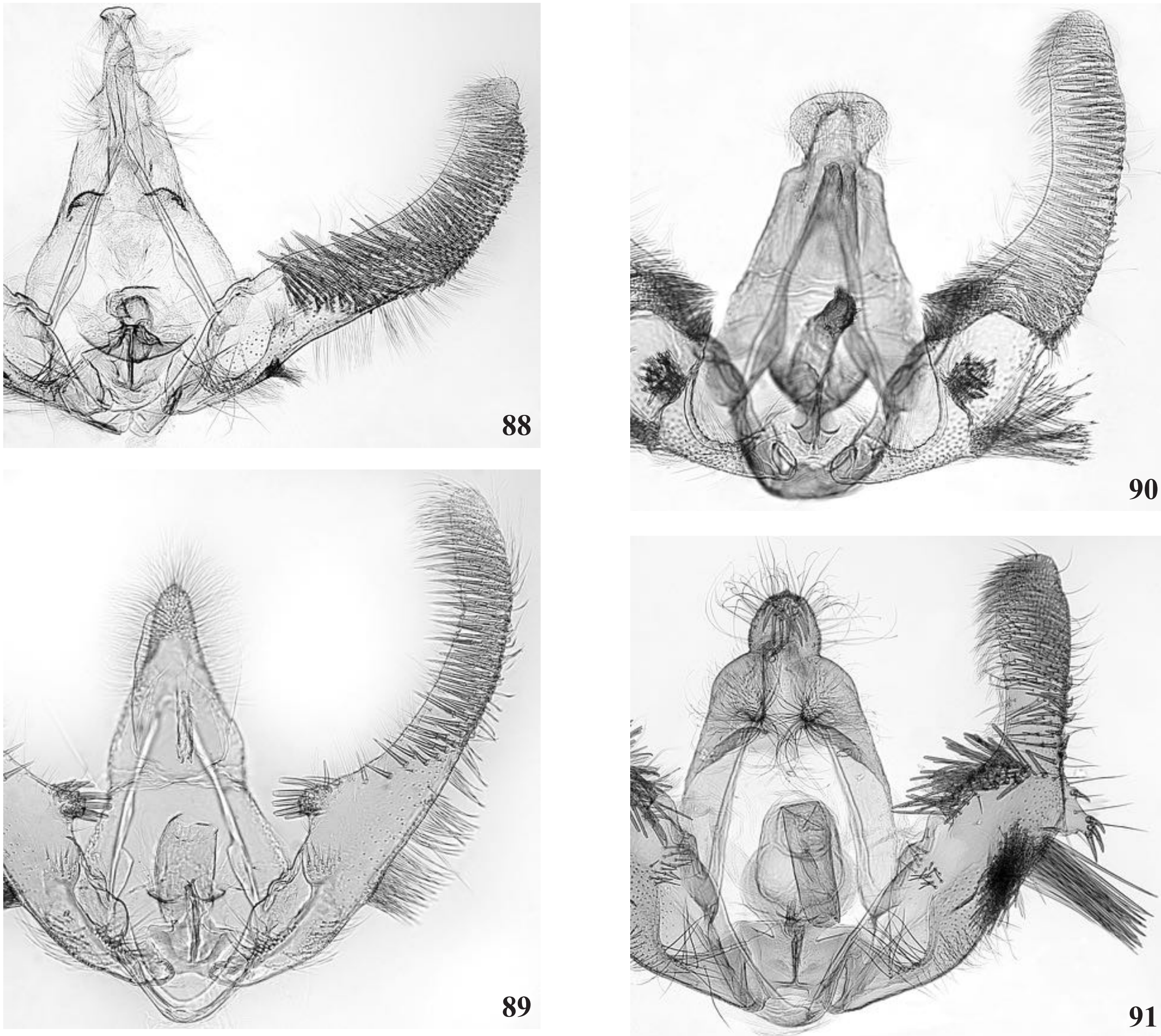

Plate 20
88. *Hedya nubiferana* (Haworth); **89.** *Hedya chionosema* (Zeller); **90.** *Hedya cyanana* (Murtfeldt); **91.** *Evora hemidesma* (Zeller).

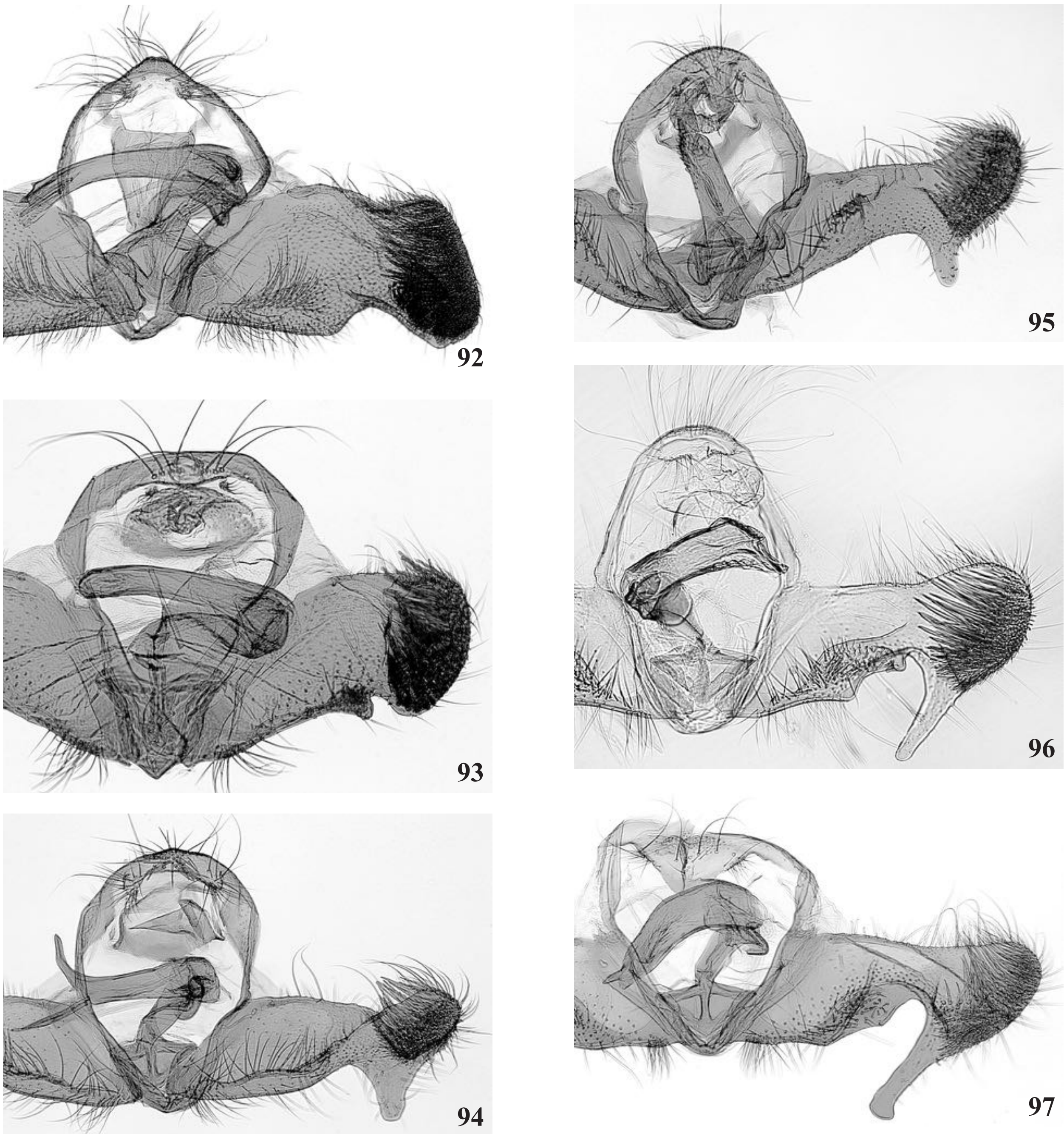

Plate 21

92. *Rhyacionia buoliana* (Denis & Schiffermüller); **93.** *Rhyacionia rigidana* (Fernald); **94.** *Rhyacionia adana* Heinrich; **95.** *Rhyacionia busckana* Heinrich; **96.** *Rhyacionia frustrana* (Scudder); **97.** *Rhyacionia aktita* Miller.

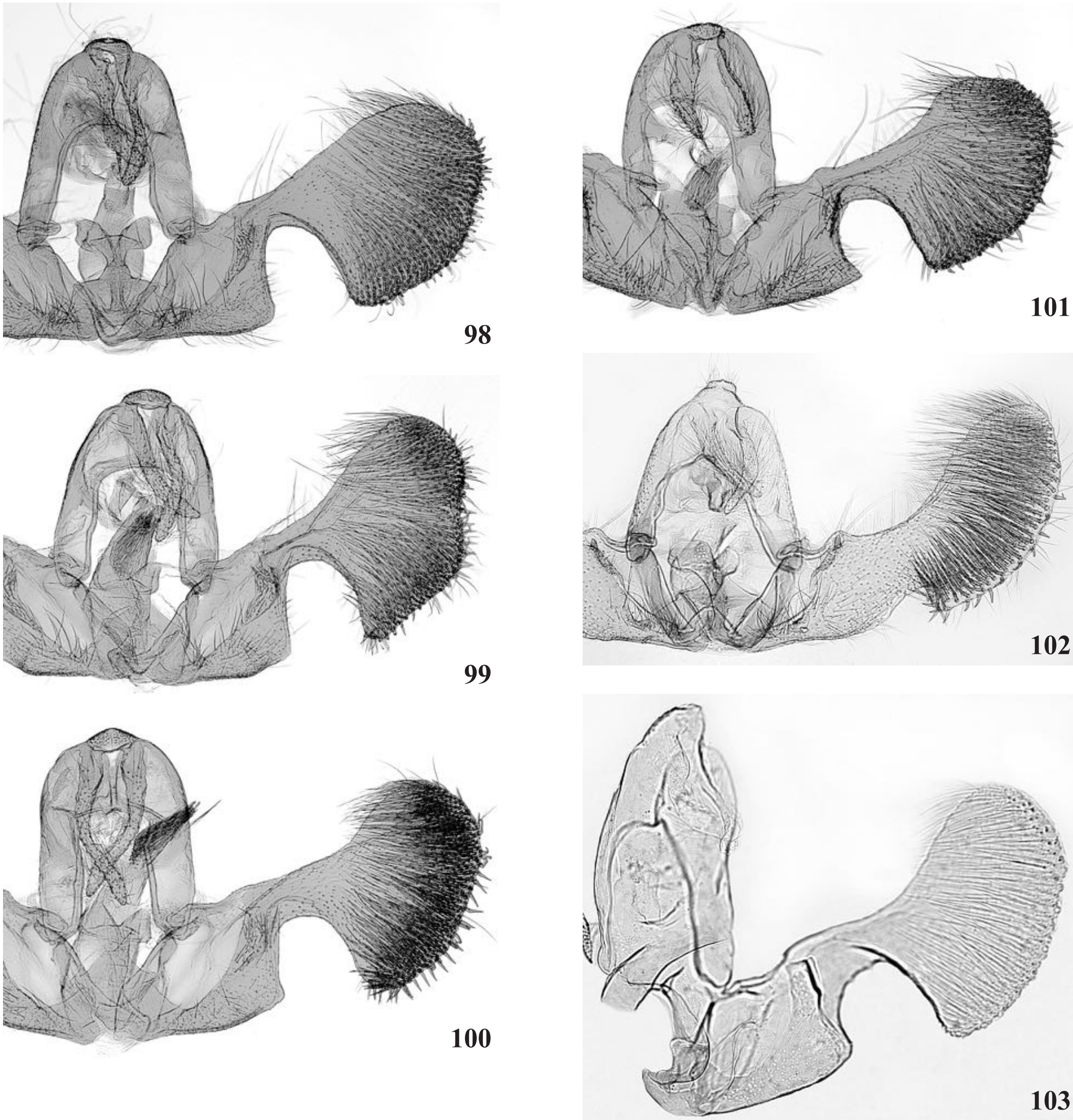

Plate 22
98. *Retinia comstockiana* Fernald; **99.** *Retinia virginiana* (Busck); **100.** *Retinia albicapitana* (Busck); **101.** *Retinia metallica* (Busck); **102.** *Retinia gemistrigulana* (Kearfott); **103.** *Retinia houseri* (Miller).

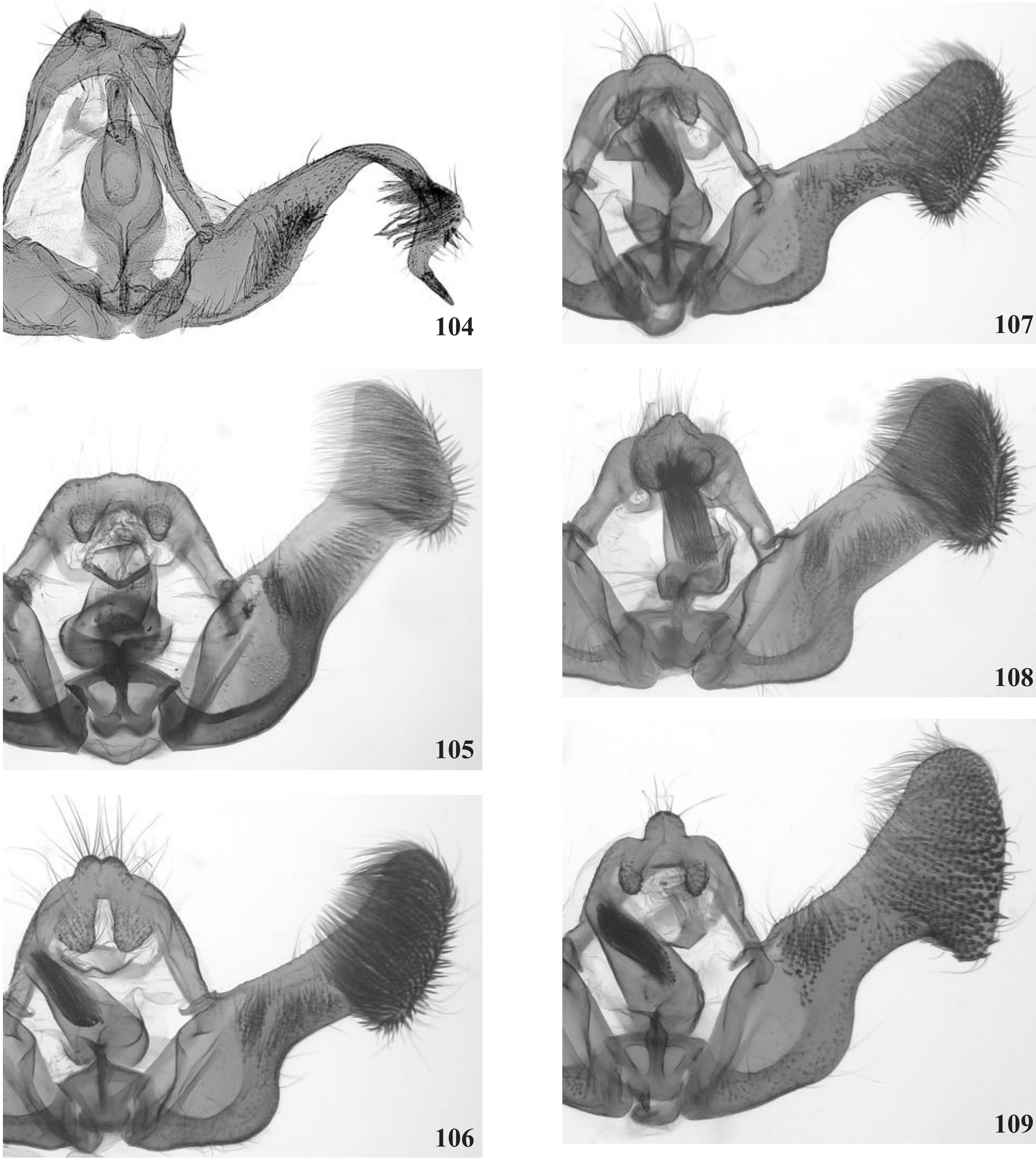

Plate 23

104. *Spilonota ocellana* (Denis & Schiffermüller); **105.** *Phaneta formosana* (Clemens); **106.** *Phaneta essexana* (Kearfott); **107.** *Phaneta awemeana* (Kearfott); **108.** *Phaneta umbrastriana* (Kearfott); **109.** *Phaneta annetteana* (Kearfott).


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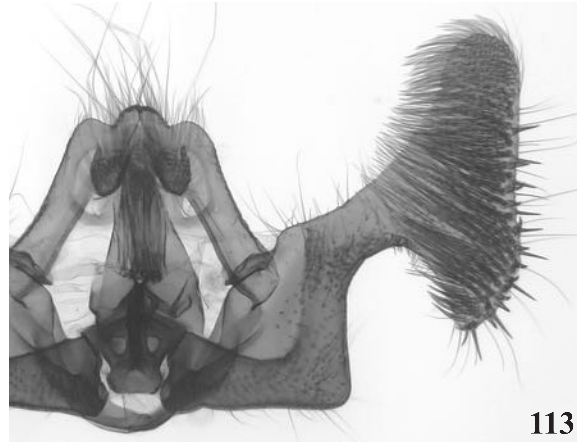
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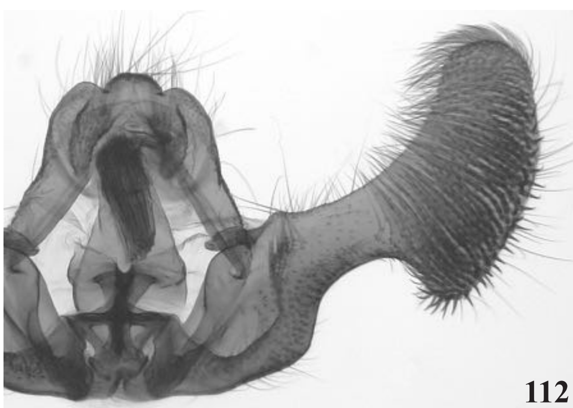
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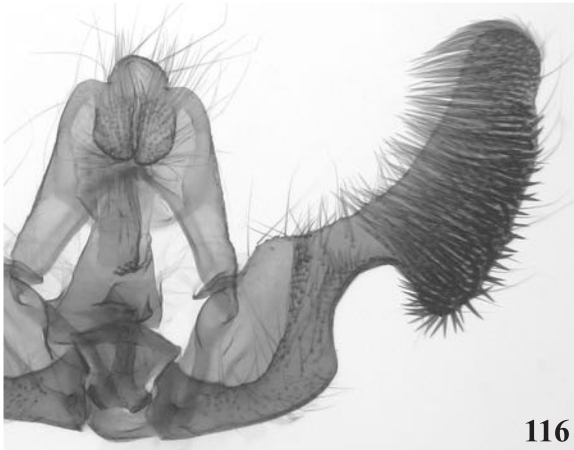
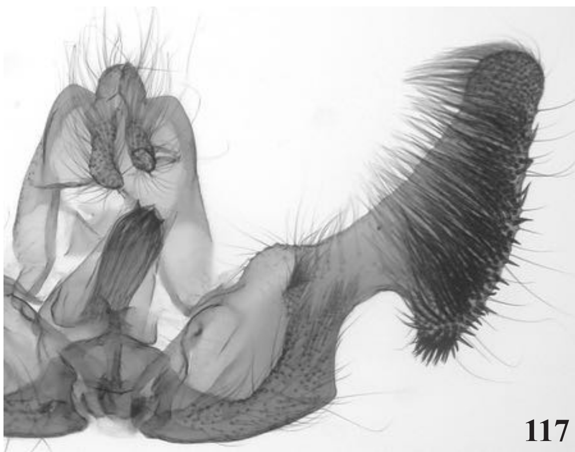
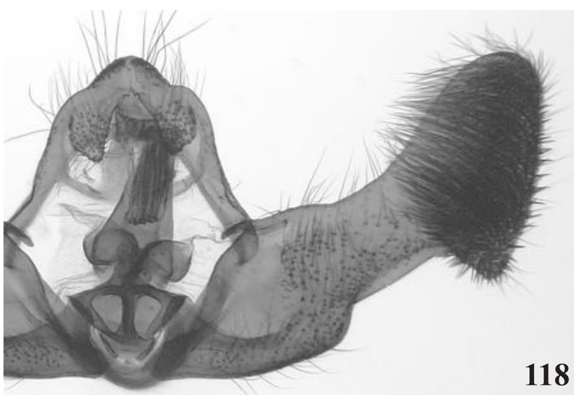
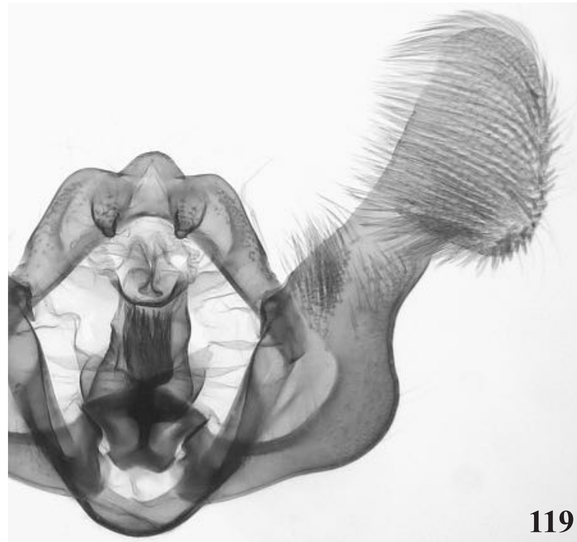
Plate 24

110. *Phaneta autumnana* (McDunnough); **111.** *Phaneta verna* Miller; **112.** *Phaneta ochrocephala* (Walsingham); **113.** *Phaneta raracana* (Kearfott); **114.** *Phaneta ochroterminana* (Kearfott); **115.** *Phaneta marmontana* (Kearfott).









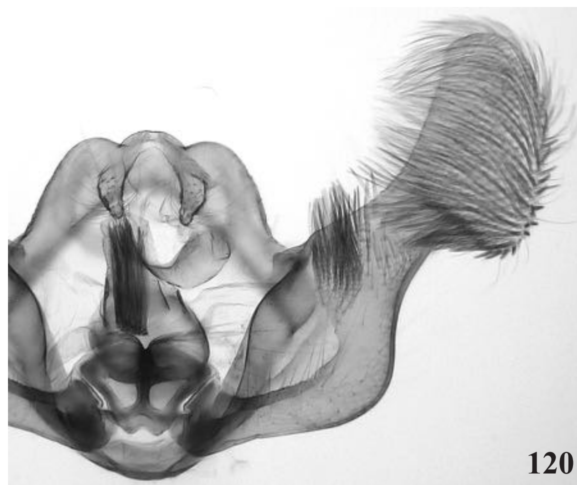


Plate 25

116. *Phaneta tomonana* (Kearfott); **117.** *Phaneta parmatana* (Clemens); **118.** *Phaneta convergana* (McDunnough); **119.** *Phaneta kokana* (Kearfott); **120.** *Phaneta canusana* Wright.

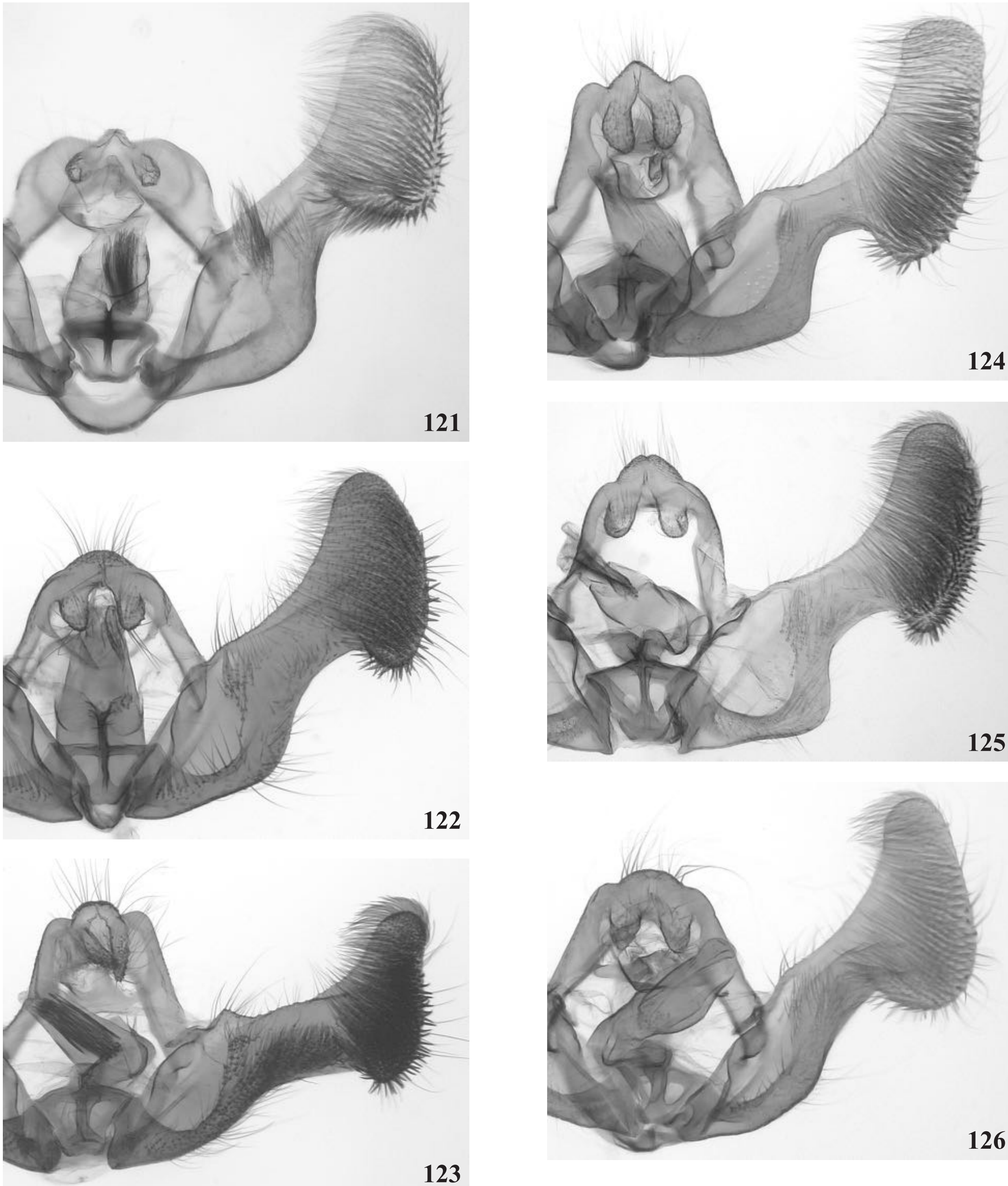
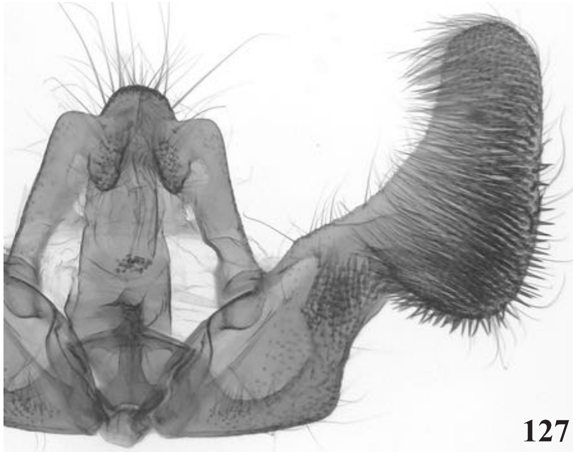


Plate 26
121. *Phaneta ambodaidaleia* Miller; **122.** *Phaneta influana* (Heinrich); **123.** *Phaneta ornatula* (Heinrich); **124.** *Phaneta clavana* (Fernald); **125.** *Phaneta argenticostana* (Walsingham); **126.** *Phaneta striatana* (Clemens).



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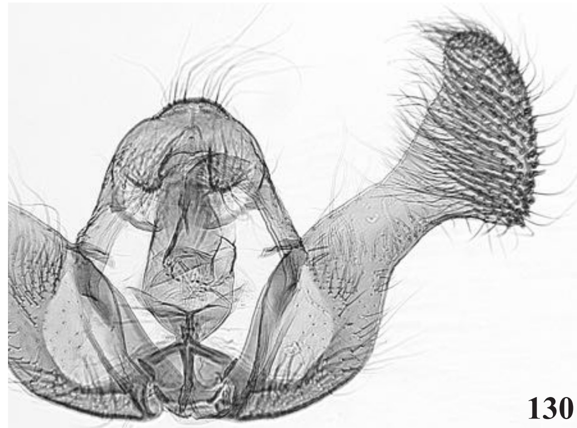

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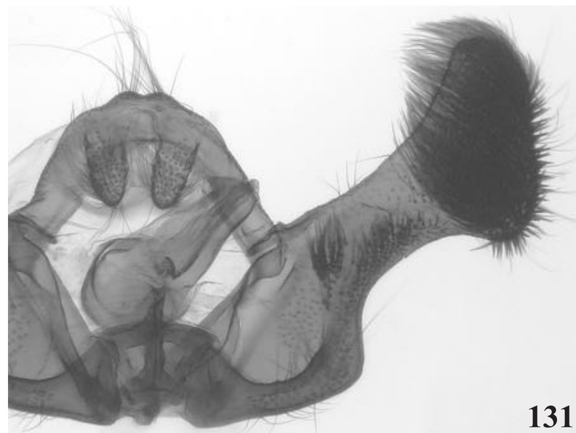

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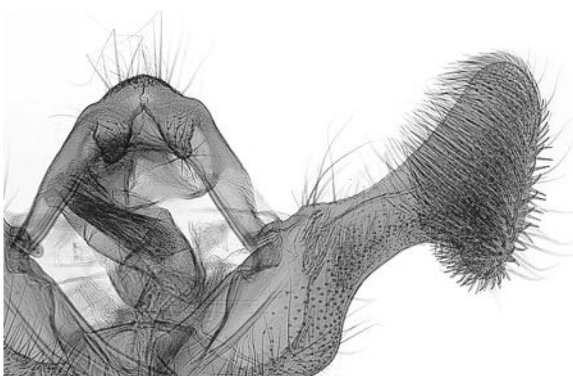

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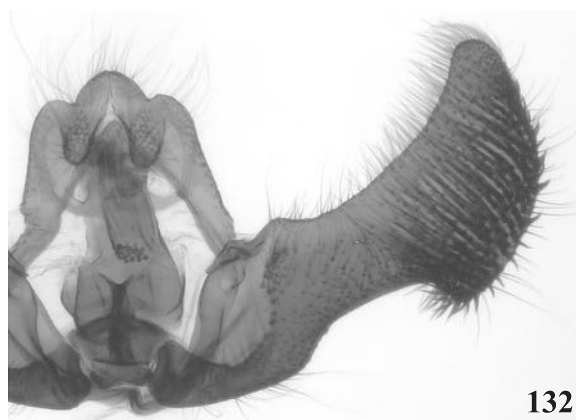

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Plate 27
127. *Phaneta pallidicostana* (Walsingham); **128.** *Phaneta kiscana* (Kearfott); **129.** *Phaneta montanana* (Walsingham); **130.** *Phaneta stramineana* (Walsingham); **131.** *Phaneta olivaceana* (Riley); **132.** *Phaneta argutipunctana* Blanchard & Knudson.

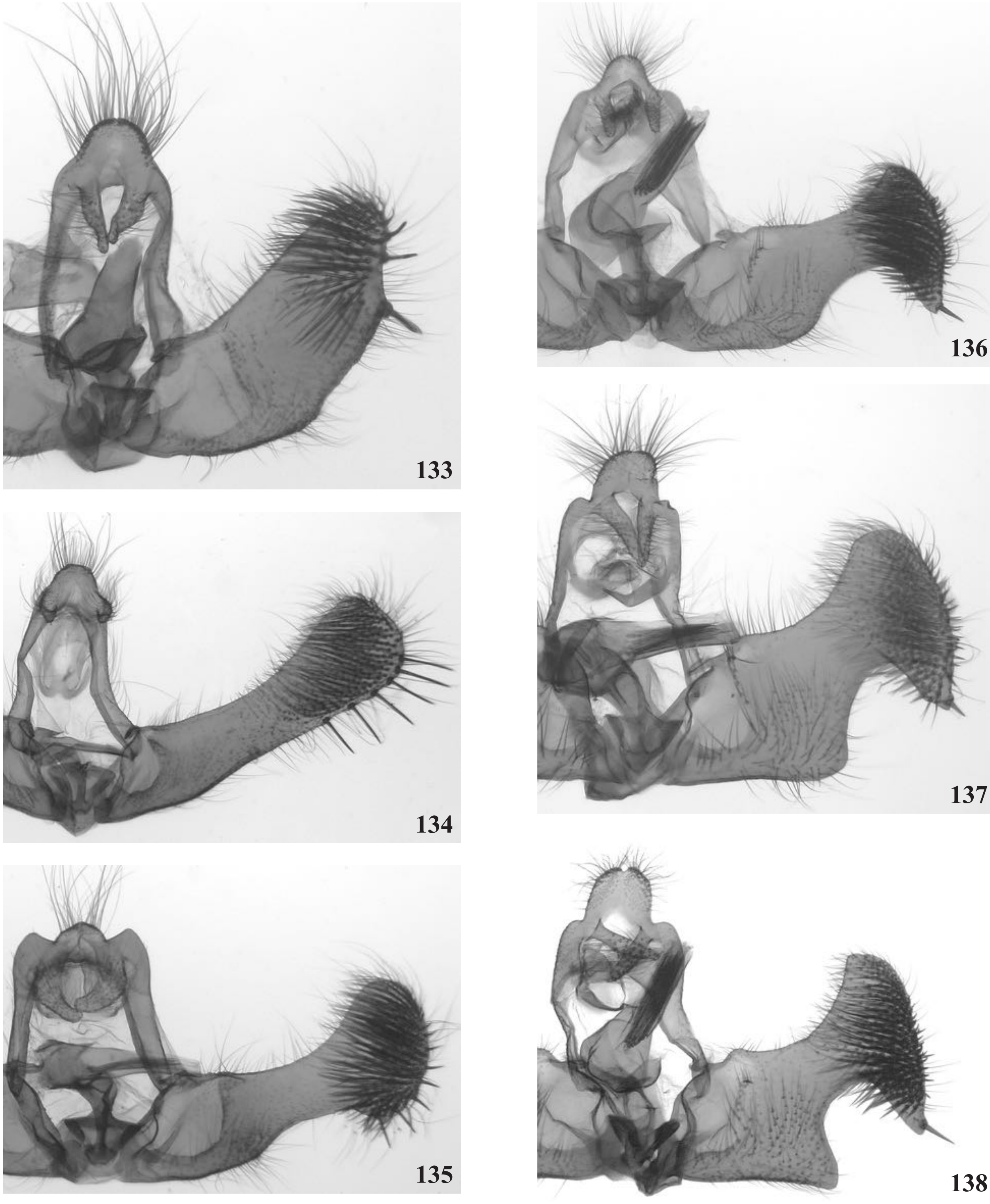

Plate 28

133. *Eucosma quinquemaculana* (Robinson); **134.** *Eucosma robinsonana* (Grote); **135.** *Eucosma ridingsana* (Robinson); **136.** *Eucosma heathiana* Kearfott; **137.** *Eucosma morrisoni* (Walsingham); **138.** *Eucosma agricolana* (Walsingham).

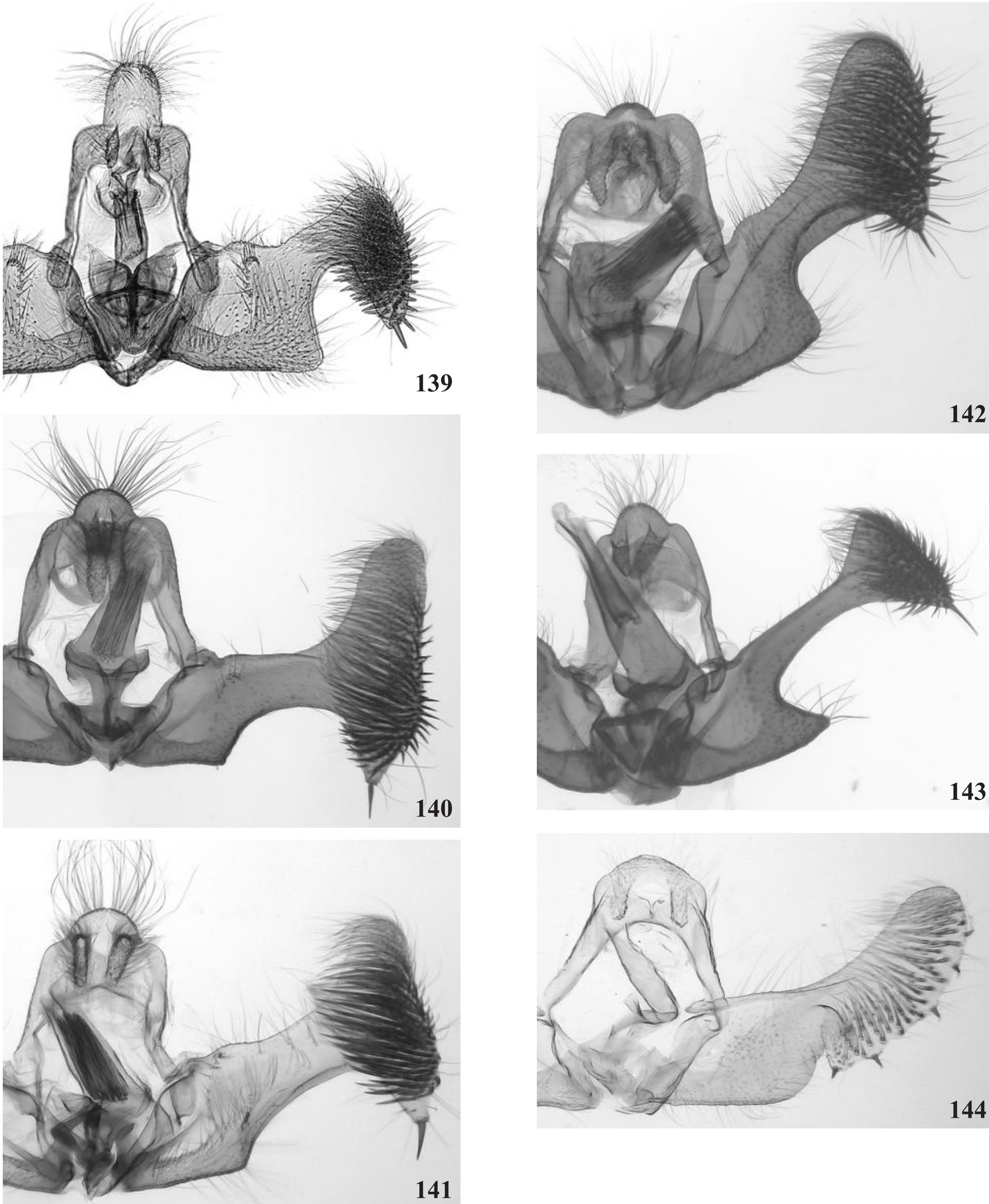

Plate 29
139. *Eucosma smithiana* (Walsingham); **140.** *Eucosma comatulana* (Zeller); **141.** *Eucosma vagana* McDunnough; **142.** *Eucosma glomerana* (Walsingham); **143.** *Eucosma albiguttana* (Zeller); **144.** *Eucosma gloriola* Heinrich.

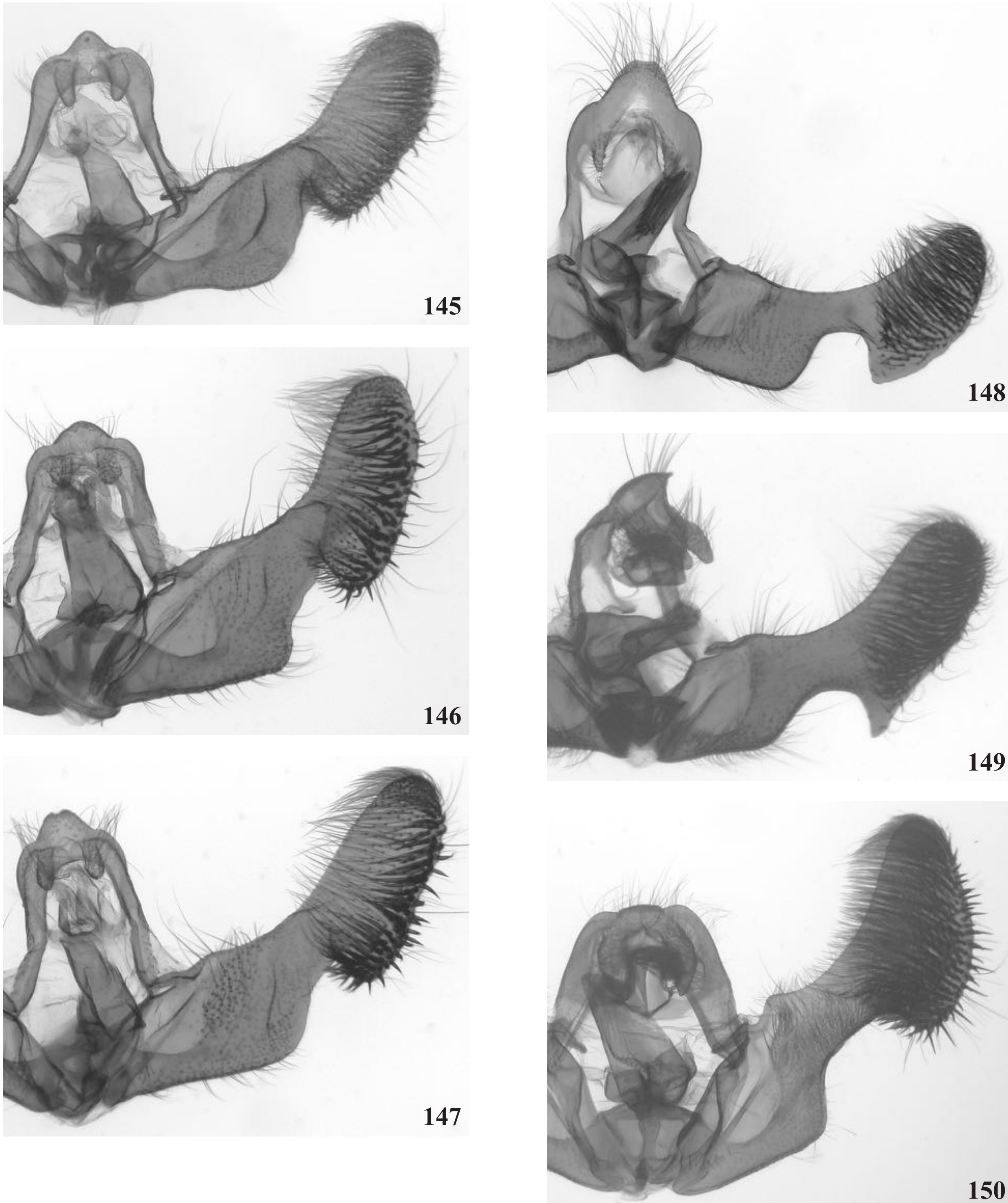

Plate 30
145. *Eucosma cocana* Kearfott; **146.** *Eucosma monitorana* Heinrich; **147.** *Eucosma tocullionana* Heinrich; **148.** *Eucosma palabundana* Heinrich; **149.** *Eucosma matutina* (Grote); **150.** *Eucosma giganteana* (Riley).

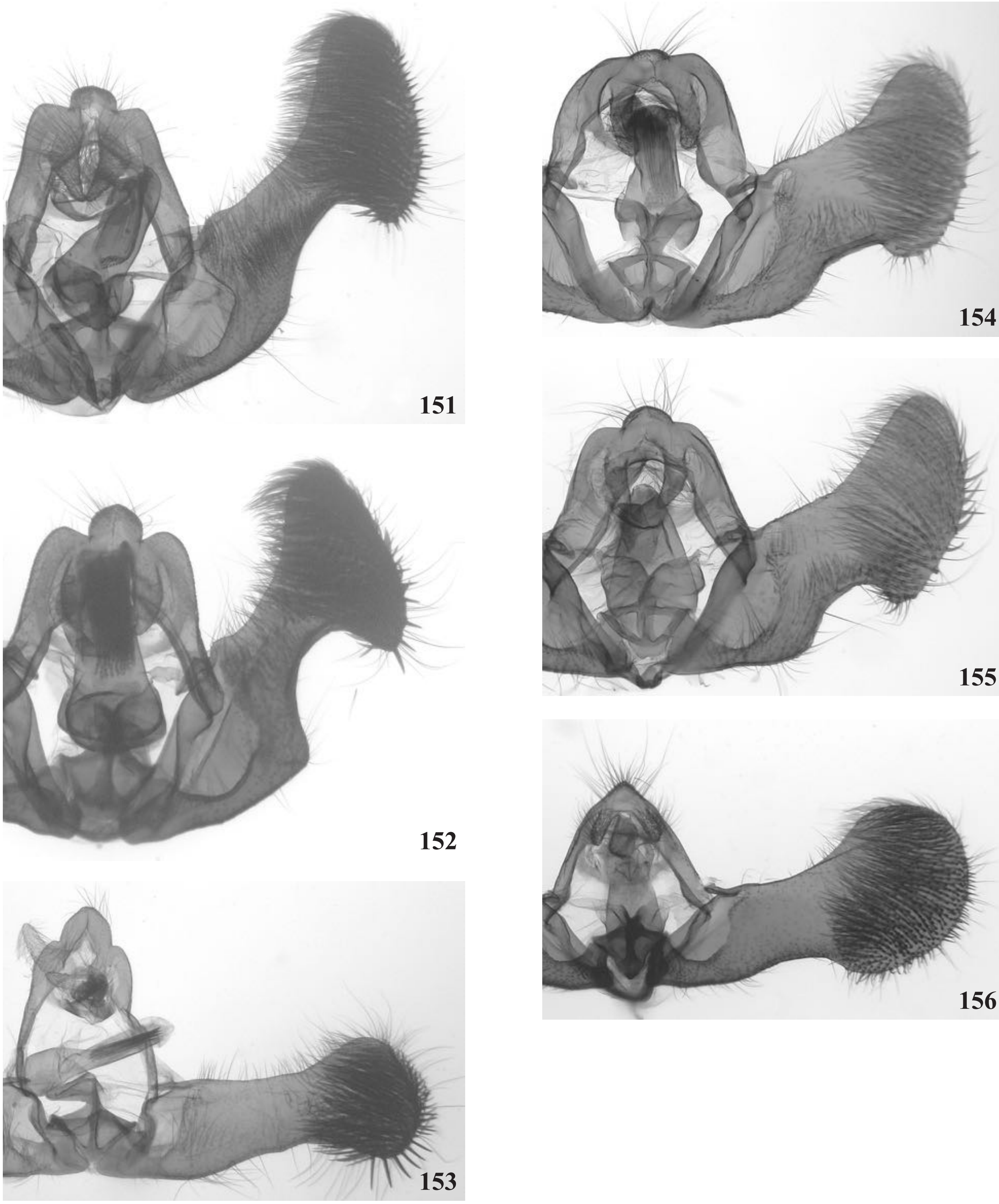

Plate 31

151. *Eucosma bipunctella* (Walker); **152.** *Eucosma bilineana* Kearfott; **153.** *Eucosma nandana* Kearfott; **154.** *Eucosma landana* Kearfott; **155.** *Eucosma simplex* McDunnough; **156.** *Eucosma dosisignatana* (Clemens).


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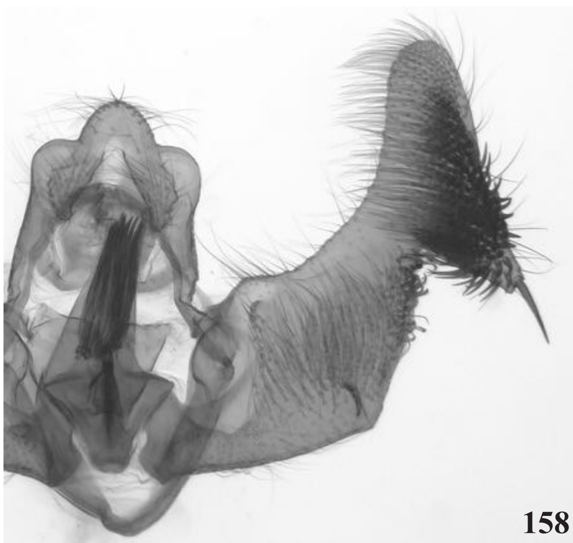
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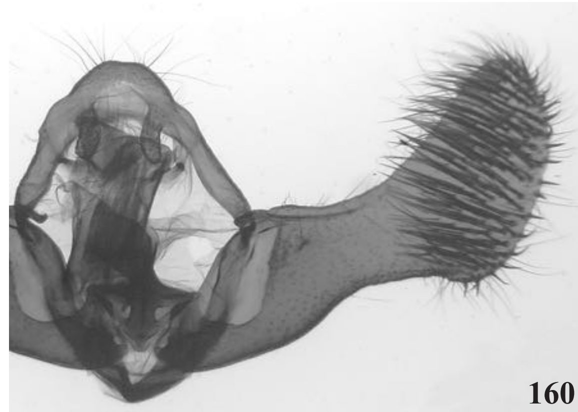
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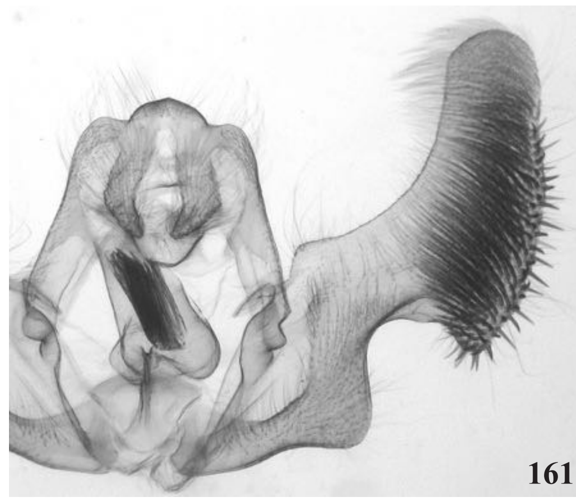
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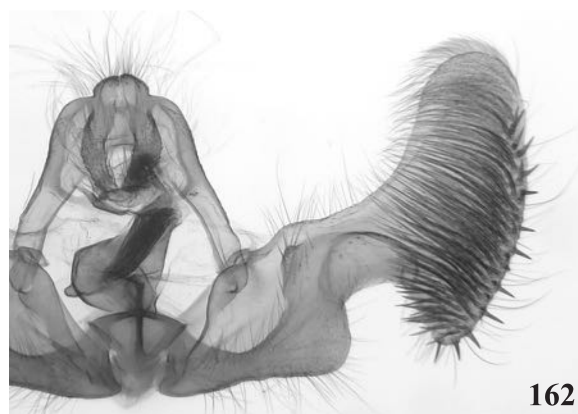
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Plate 32

157. *Eucosma similiana* Clemens; **158.** *Eucosma derelicta* Heinrich; **159.** *Eucosma wandana* Kearfott; **160.** *Eucosma fulminana* (Walsingham); **161.** *Eucosma rusticana* Kearfott; **162.** *Eucosma haydenae* Wright.

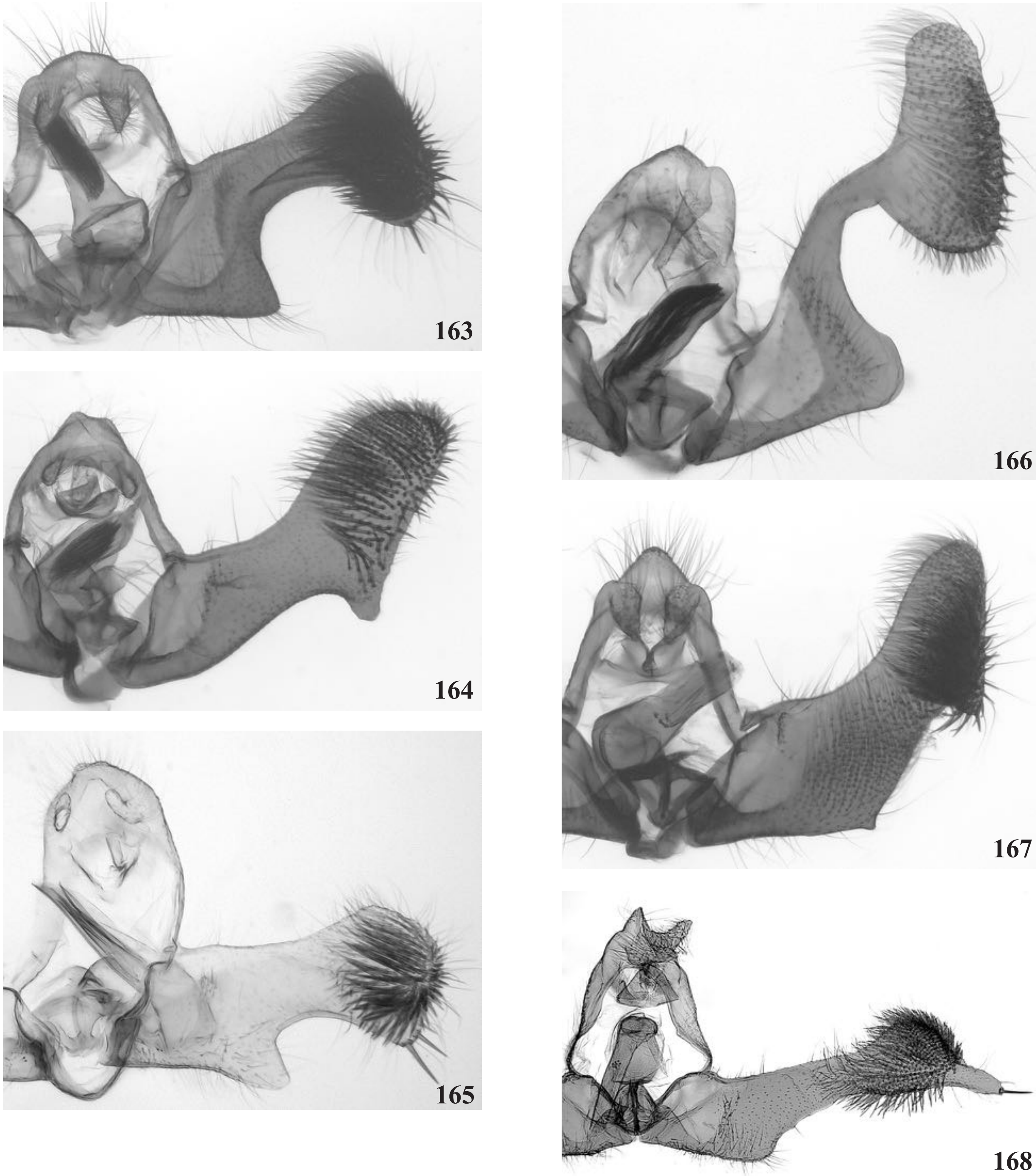


Plate 33

163. *Eucosma sombreana* Kearfott; **164.** *Eucosma fiskeana* Kearfott; **165.** *Eucosma consobrinana* Heinrich; **166.** *Eucosma gomonana* Kearfott; **167.** *Eucosma cataclystiana* (Walker); **168.** *Pelochrista argenteana* (Walsingham).

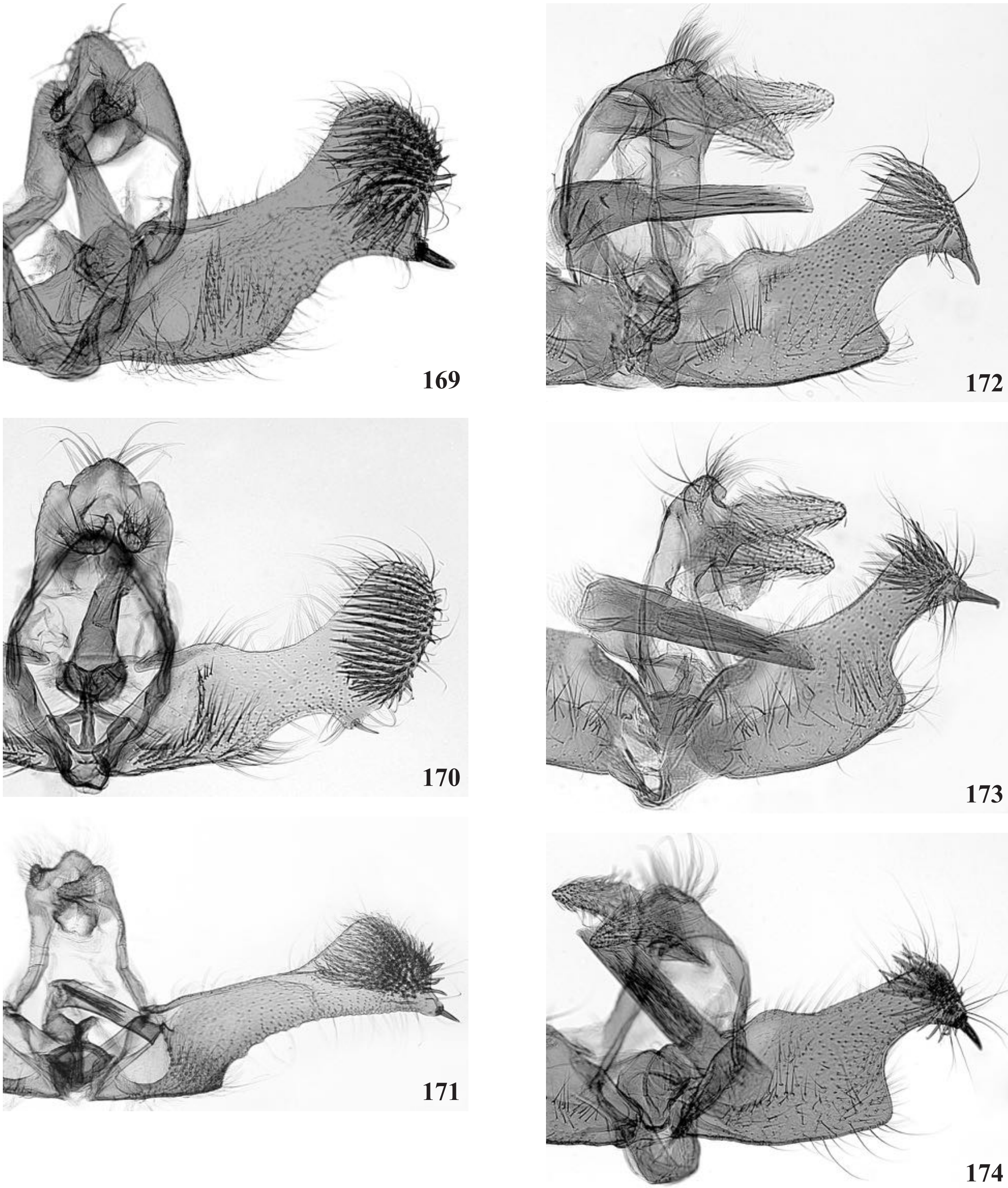


Plate 34
169. *Pelochrista scintillana* (Clemens); **170.** *Pelochrista pallidipalpana* (Kearfott); **171.** *Pelochrista corosana* (Walsingham); **172.** *Pelochrista rorana* (Kearfott); **173.** *Pelochrista zomonana* (Kearfott); **174.** *Pelochrista womonana* (Kearfott).

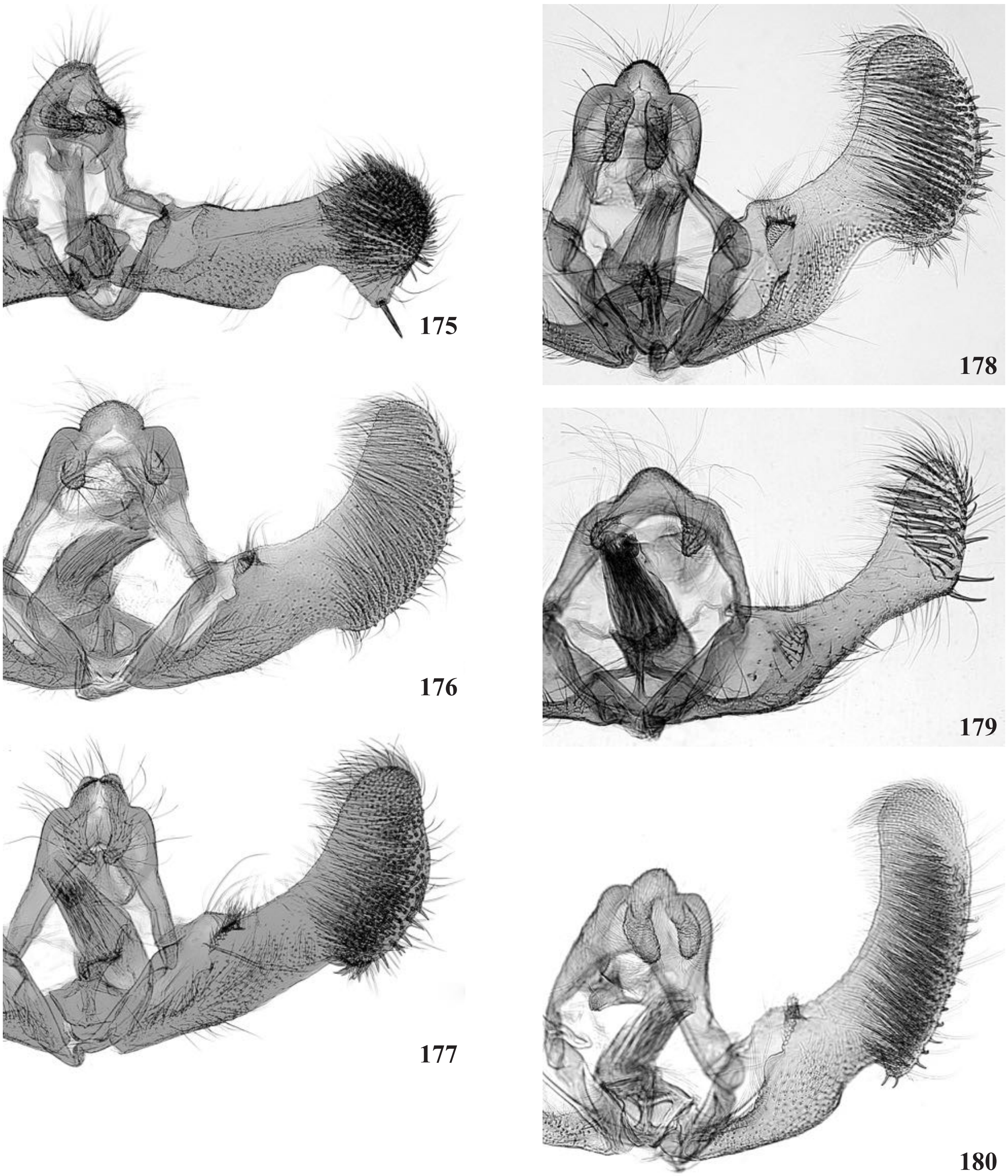


Plate 35

175. *Pelochrista milleri* Wright; **176.** *Epiblema luctuosissima* Blanchard; **177.** *Epiblema boxcana* (Kearfott); **178.** *Epiblema strenuana* complex; **179.** *Epiblema abruptana* (Walsingham); **180.** *Epiblema tripartitana* (Zeller).

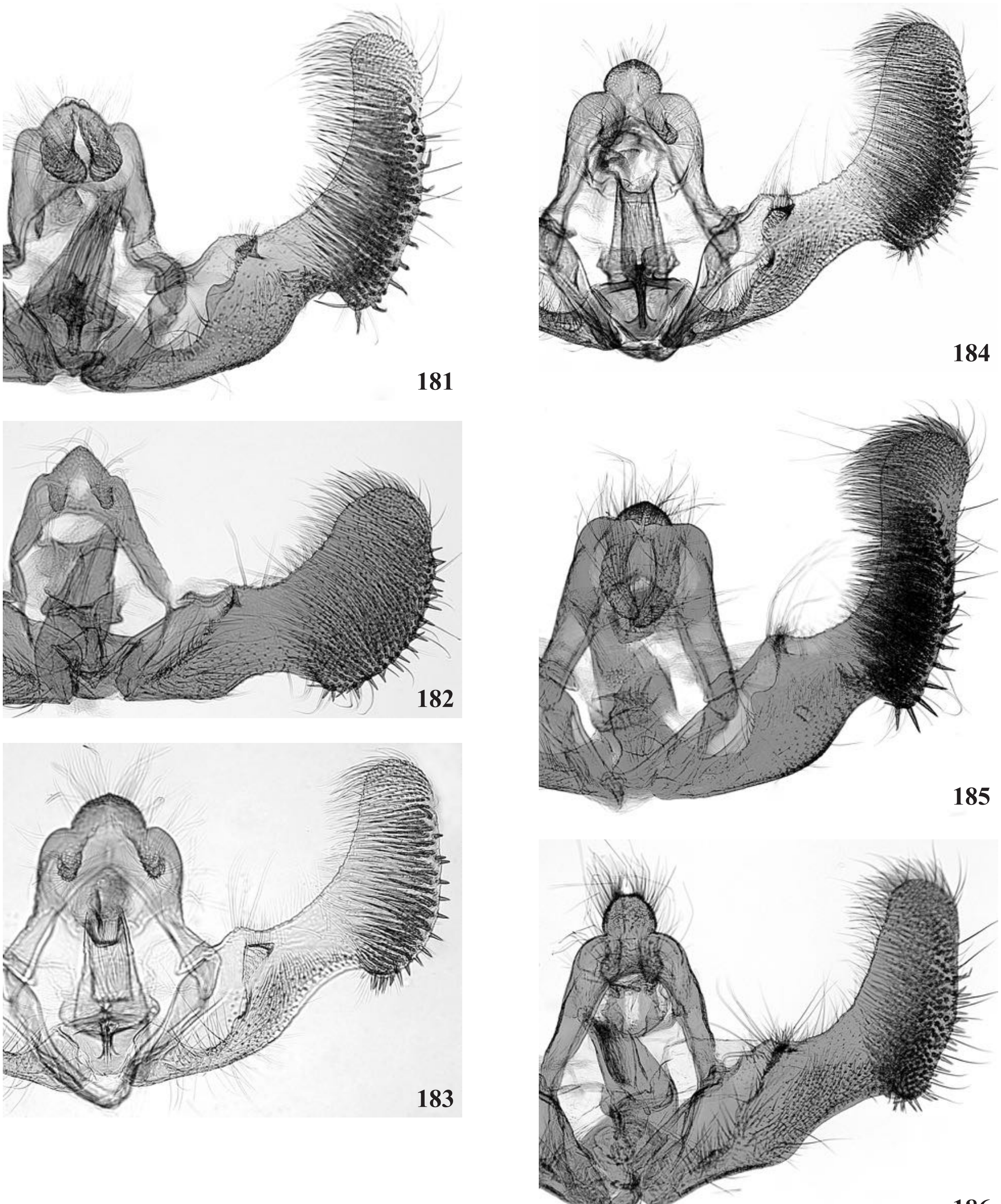
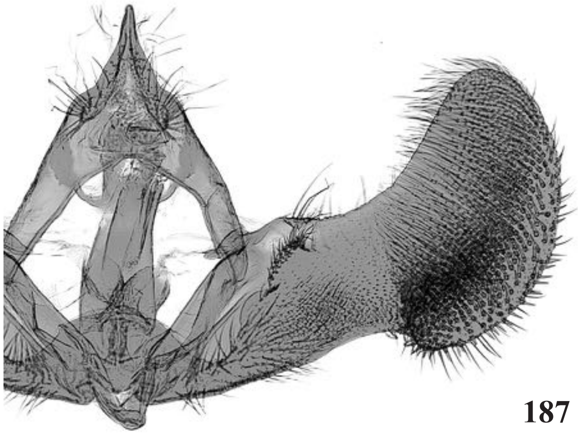


Plate 36

181. *Epiblema glenni* Wright; **182.** *Epiblema resumptana* (Walker); **183.** *Epiblema benignatum* McDunnough; **184.** *Epiblema scudderiana* (Clemens); **185.** *Epiblema carolinana* (Walsingham); **186.** *Epiblema obfuscana* (Dyar).



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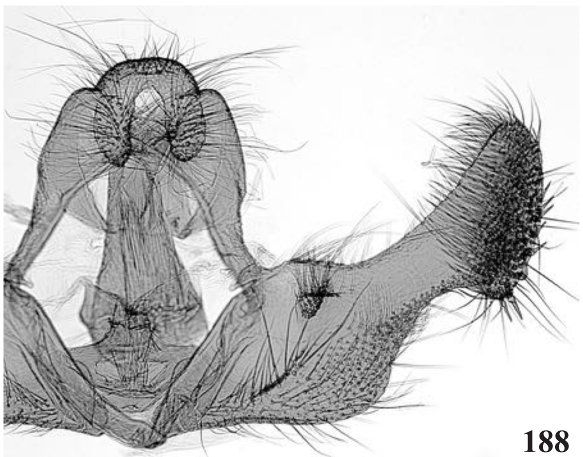

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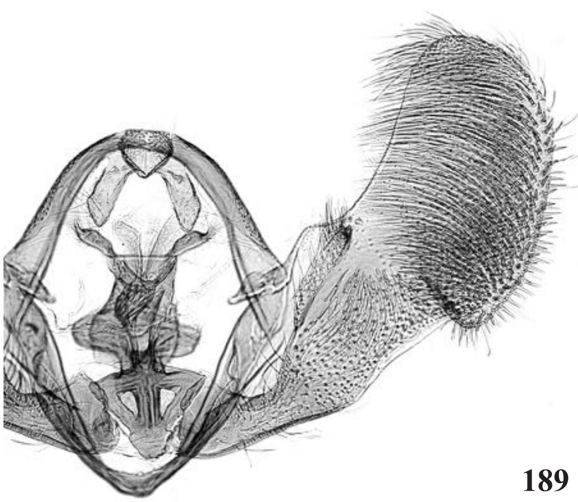

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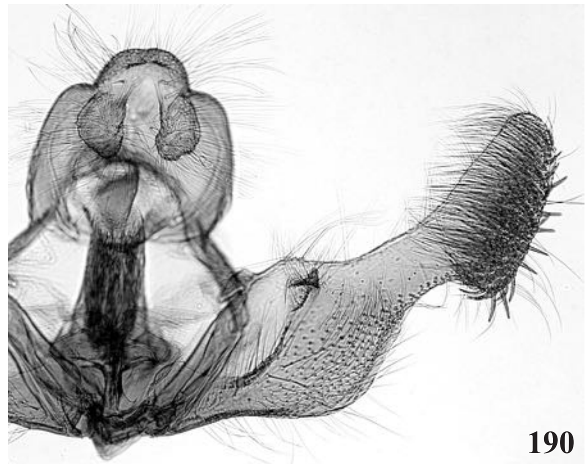

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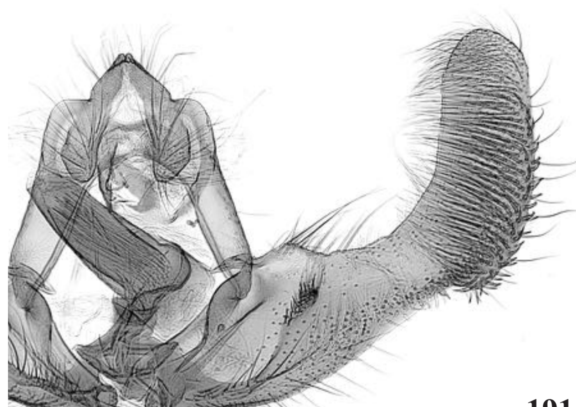

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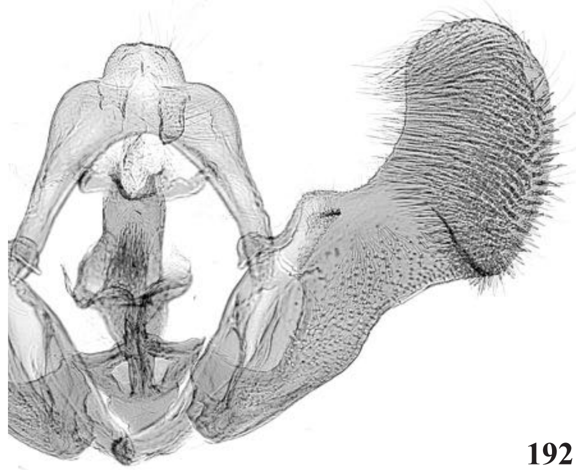

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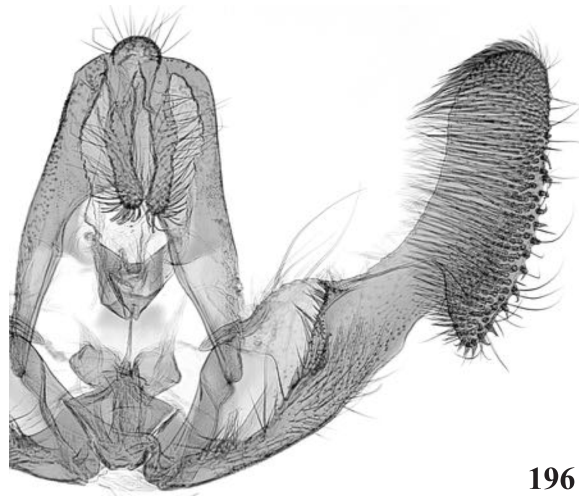
Plate 37

187. *Epiblema desertana* (Zeller); **188.** *Epiblema dorsisuffusana* (Kearfott); **189.** *Epiblema iowana* McDunnough; **190.** *Epiblema otiosana* (Clemens); **191.** *Epiblema infelix* Heinrich; **192.** *Epiblema walsinghami* (Kearfott).

193



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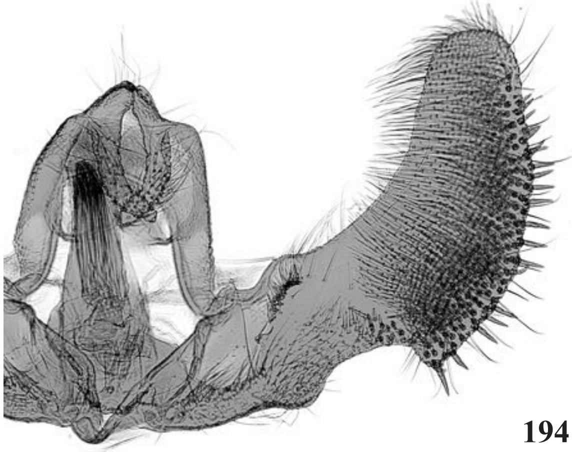

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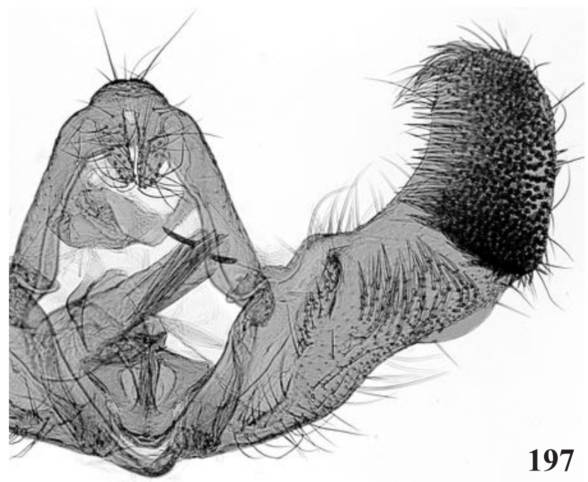

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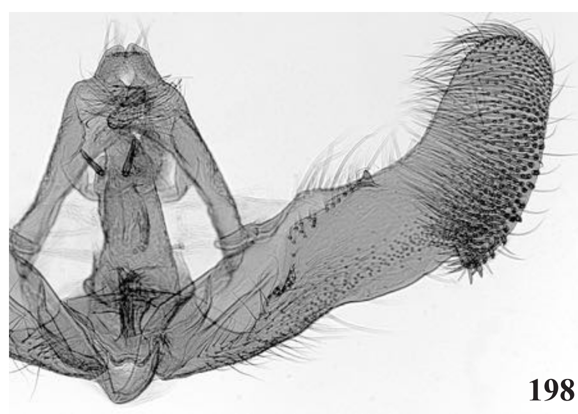

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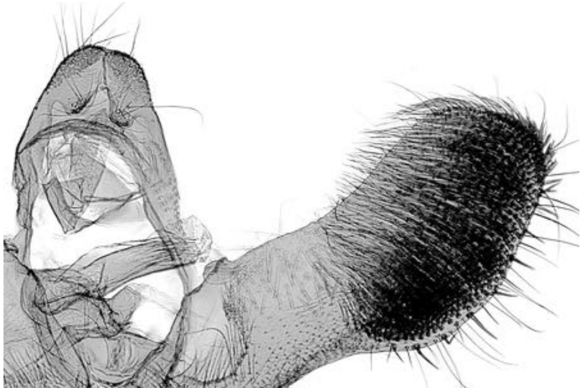
Plate 38

193. *Epiblema gibsoni* Wright & Covell; **194.** *Epiblema brightonana* (Kearfott); **195.** *Epiblema tandana* (Kearfott); **196.** *Notocelia rosaecolana* (Doubleday) (fixed cornuti are not visible in photo); **197.** *Notocelia illotana* (Walsingham); **198.** *Notocelia culminana* (Walsingham).



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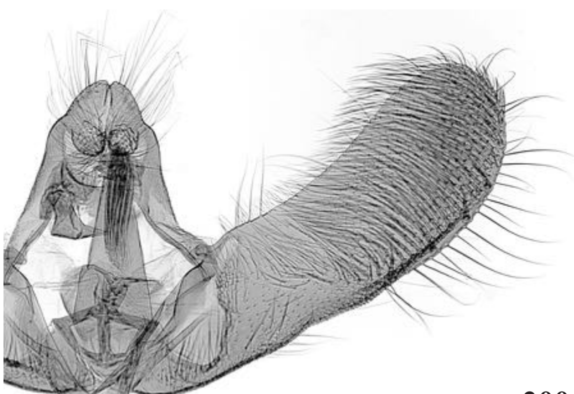

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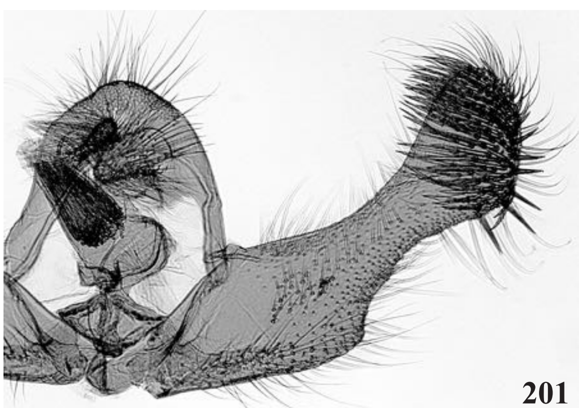

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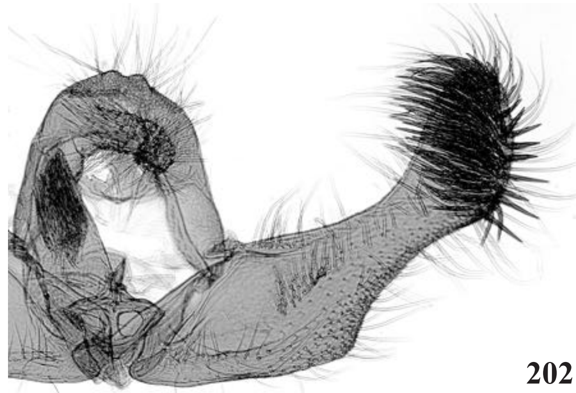

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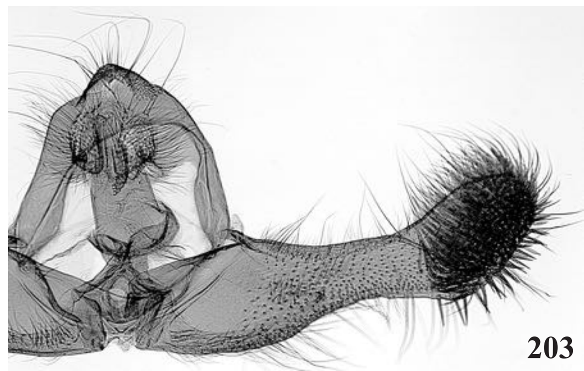

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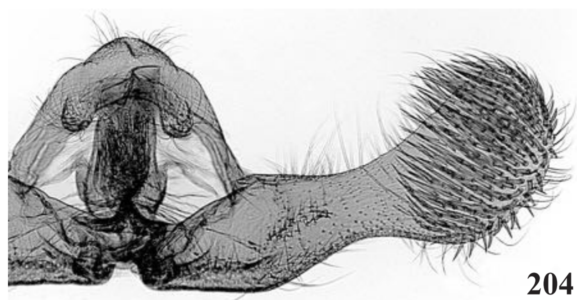

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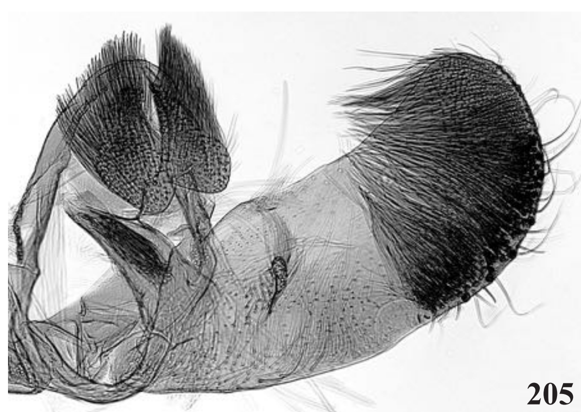

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Plate 39

199. *Suleima helianthana* (Riley); **200.** *Suleima cinerodorsana* Heinrich; **201.** *Sonia paraplesiana* Blanchard; **202.** *Sonia canadana* McDunnough; **203.** *Sonia vovana* (Kearfott); **204.** *Sonia divaricata* Miller; **205.** *Gypsonoma haimbachiana* (Kearfott).

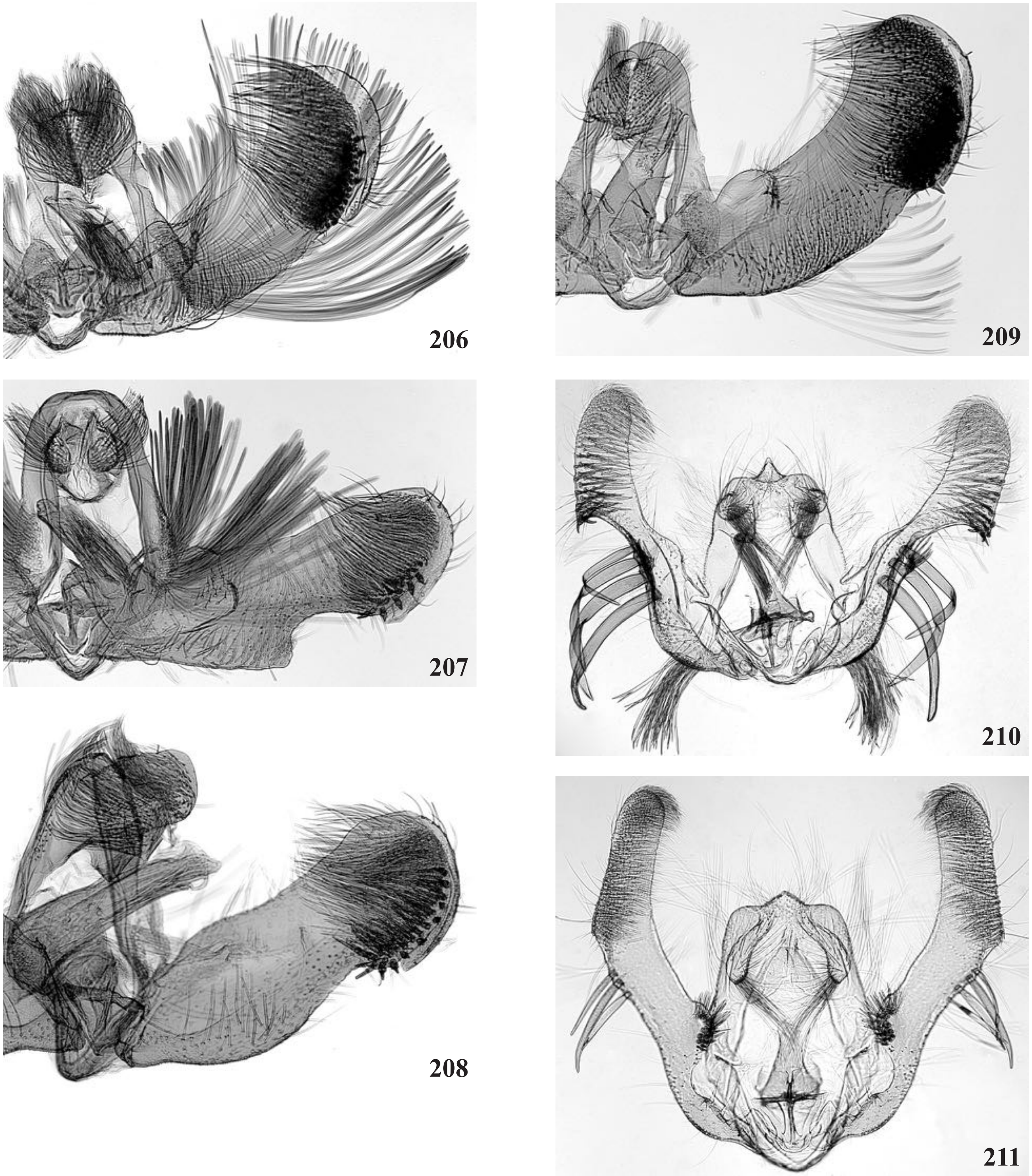
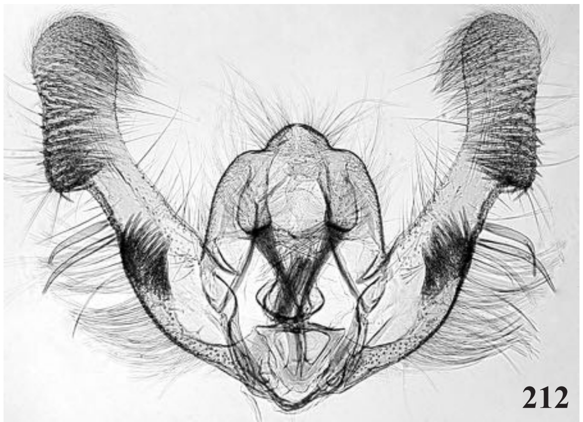
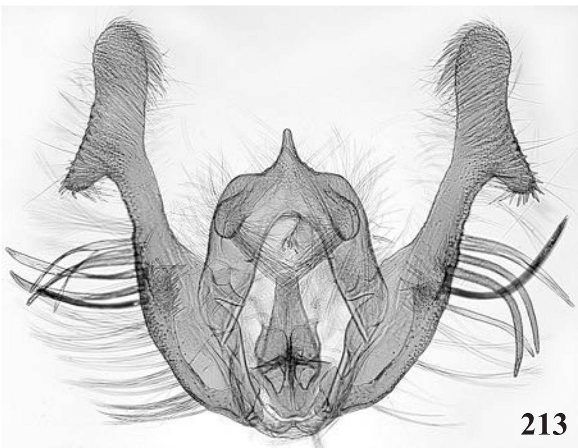
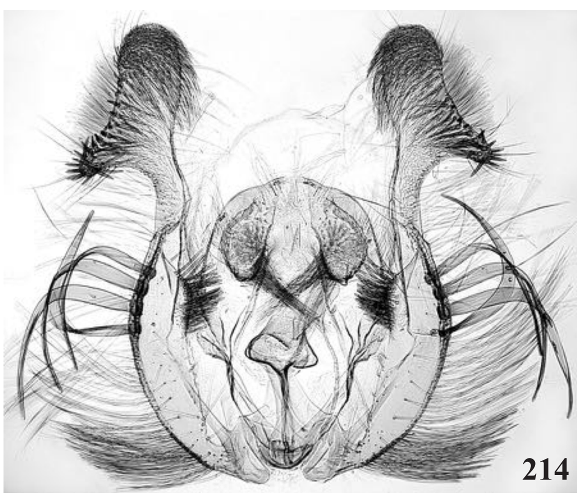


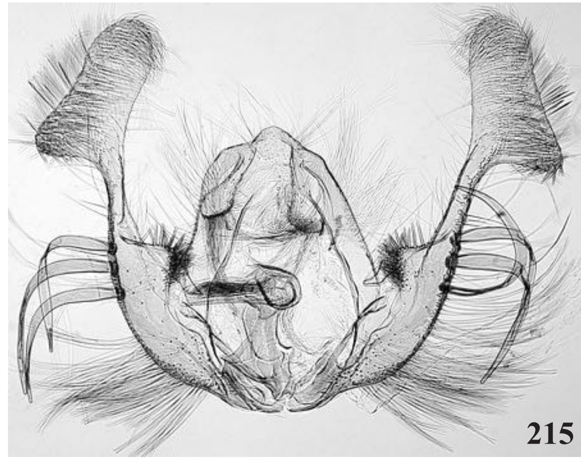
Plate 40

206. *Gypsonoma salicicolana* (Clemens); **207.** *Gypsonoma adjuncta* Heinrich; **208.** *Gypsonoma fasciolana* (Clemens); **209.** *Gypsonoma substitutionis* Heinrich; **210.** *Proteoteras aesculana* Riley; **211.** *Proteoteras willingana* (Kearfott).









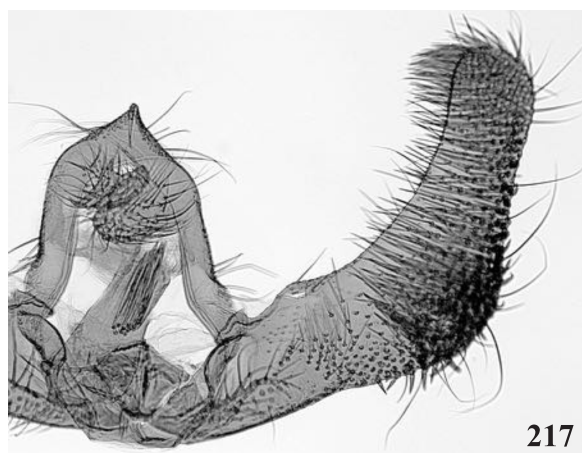


Plate 41

212. *Proteoteras crescentana* Kearfott; **213.** *Proteoteras naracana* Kearfott; **214.** *Proteoteras moffatiana* Fernald; **215.** *Proteoteras obnigrana* Heinrich; **216.** *Zeiraphera claypoleana* (Riley); **217.** *Zeiraphera canadensis* Mutuura & Freeman.

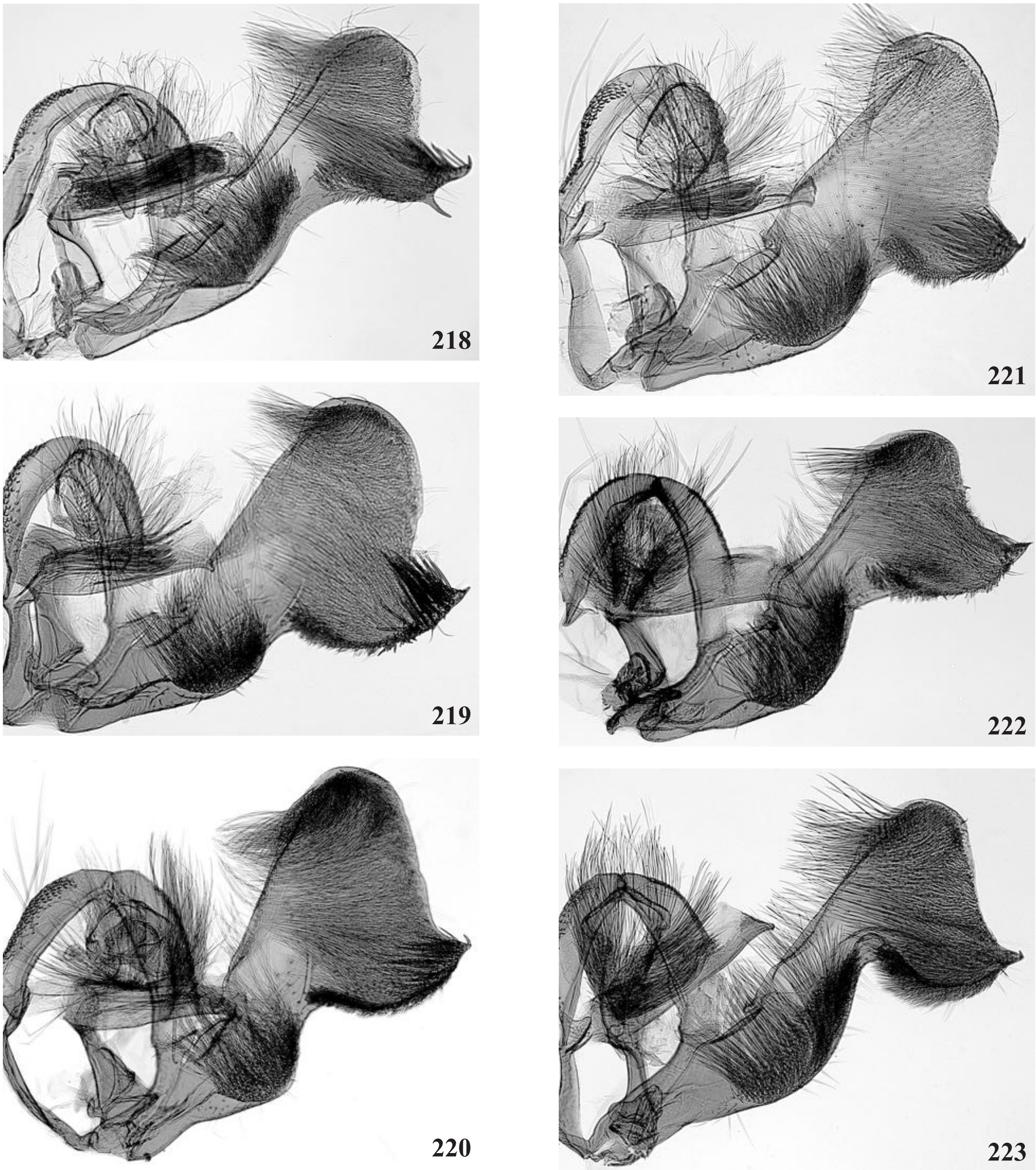


Plate 42
218. *Pseudexentera cressoniana* (Clemens); **219.** *Pseudexentera mali* Freeman; **220.** *Pseudexentera oregonana* (Walsingham); **221.** *Pseudexentera spoliana* (Clemens); **222.** *Pseudexentera haracana* (Kearfott); **223.** *Pseudexentera faracana* (Kearfott).

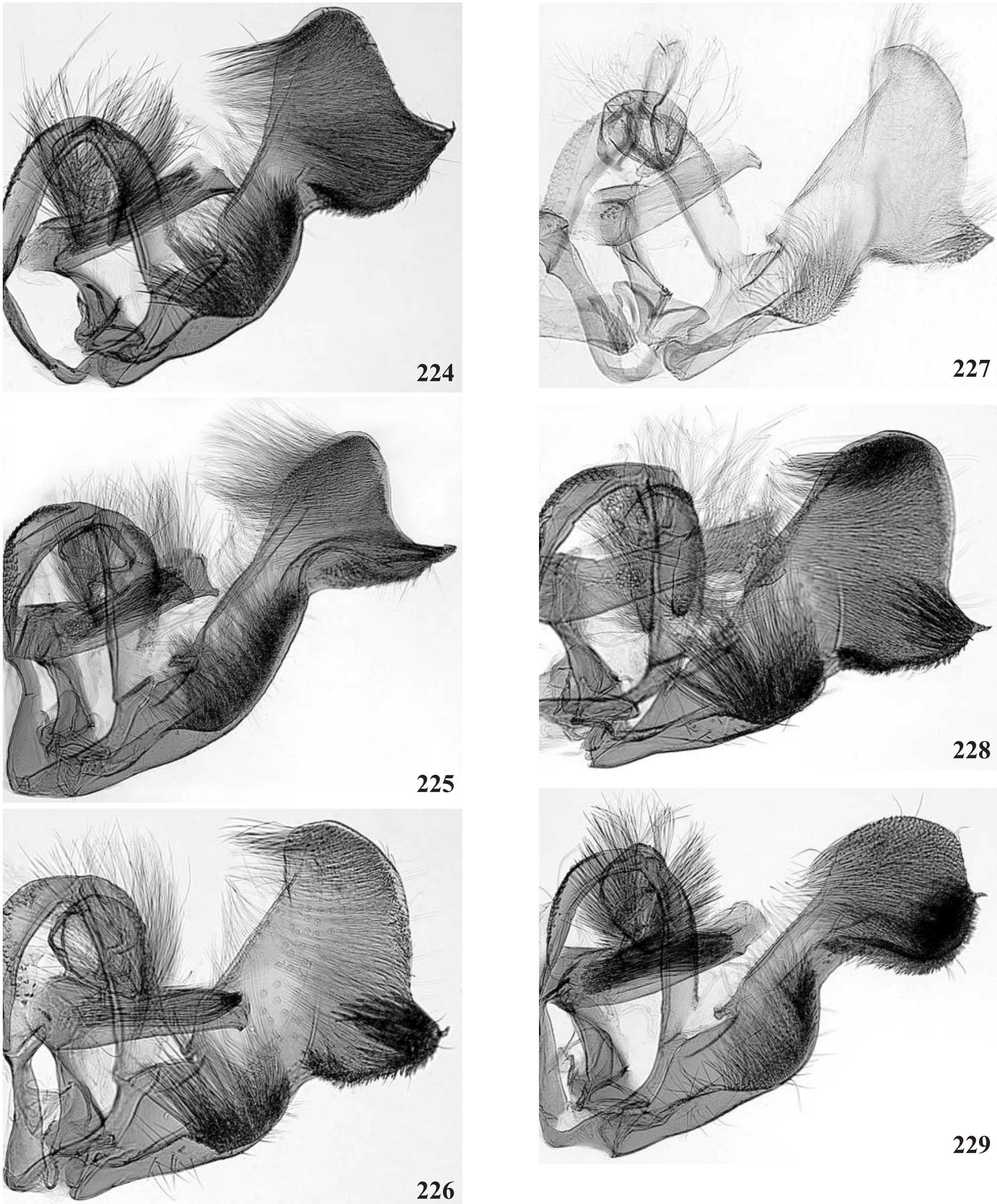
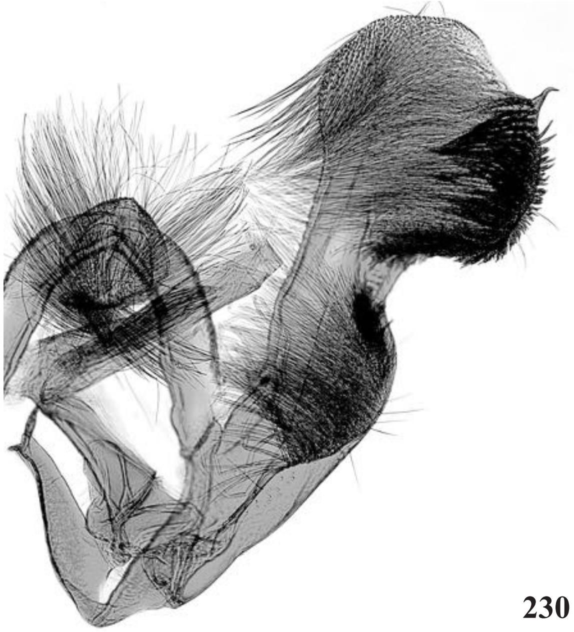


Plate 43

224. *Pseudexentera sepia* Miller; **225.** *Pseudexentera hodsoni* Miller; **226.** *Pseudexentera maracana* (Kearfott); **227.** *Pseudexentera kalmiana* McDunnough; **228.** *Pseudexentera vaccinii* Miller; **229.** *Pseudexentera costomaculana* (Clemens).



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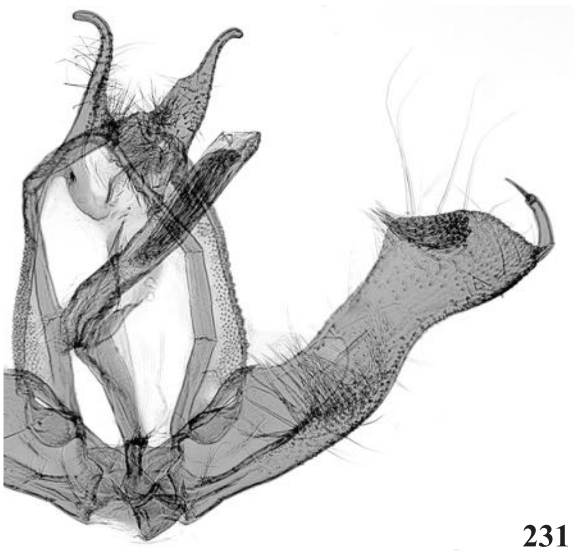

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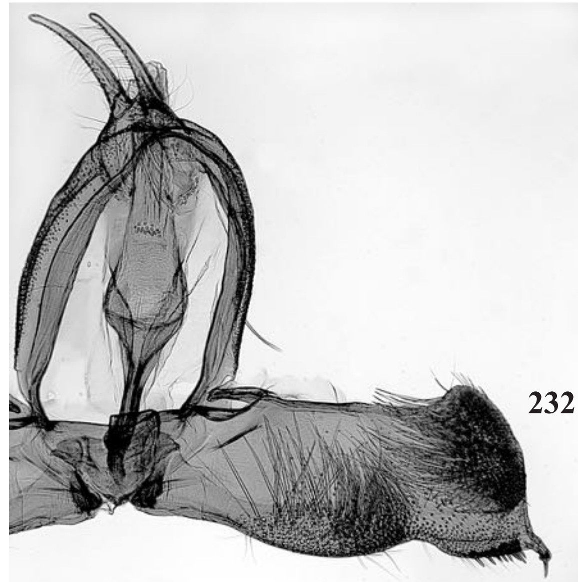

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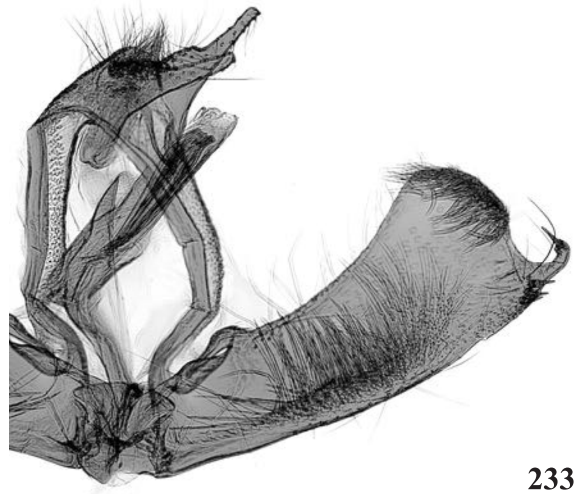

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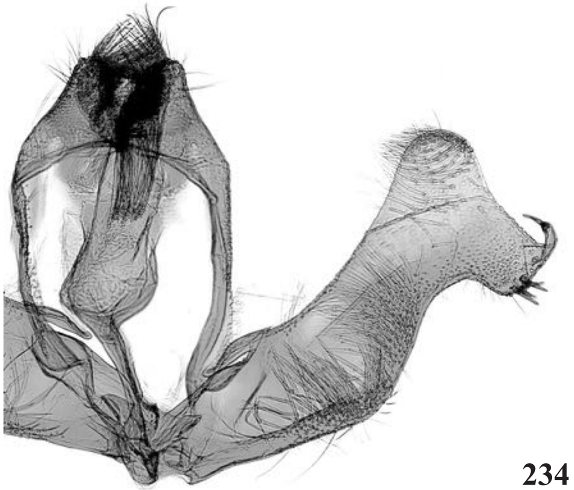
Plate 44

230. *Pseudexentera virginiana* (Clemens); **231.** *Gretchena deludana* (Clemens); **232.** *Gretchena concubitana* Heinrich; **233.** *Gretchena watchungana* (Kearfott).



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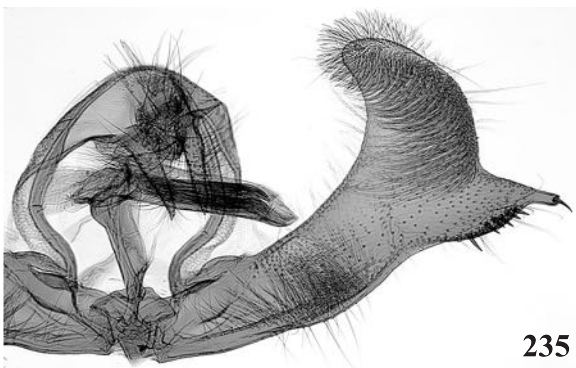

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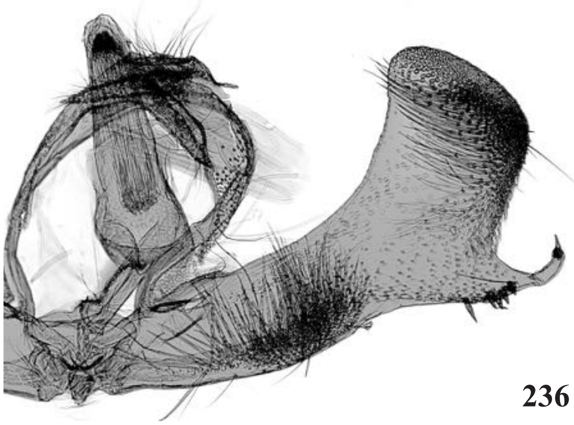

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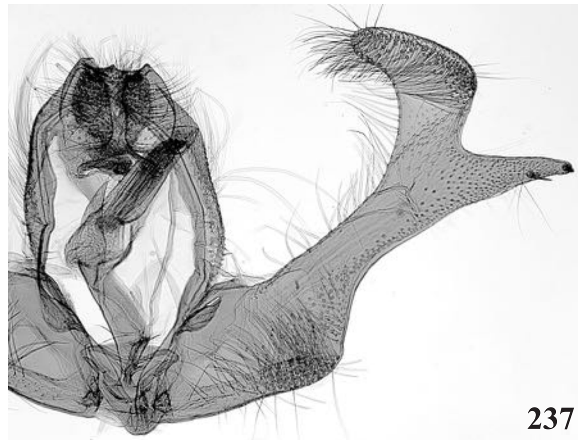

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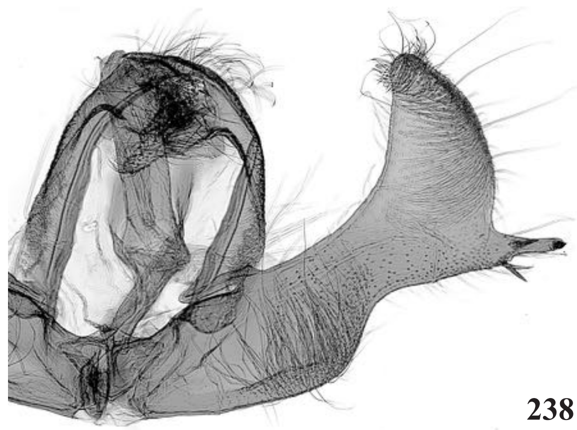

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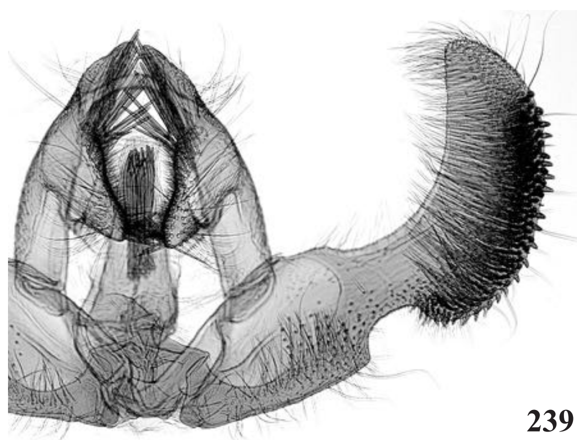

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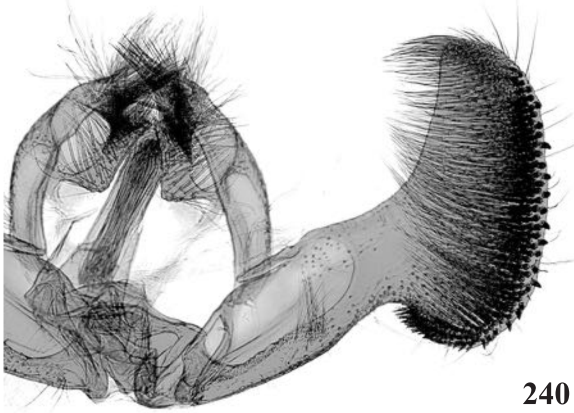
Plate 45

234. *Gretchena bolliana* (Slingerland); **235.** *Gretchena amatana* Heinrich; **236.** *Gretchena delicatana* Heinrich; **237.** *Gretchena concitatricana* (Heinrich); **238.** *Gretchena nymphana* Blanchard & Knudson; **239.** *Chimoptesis gerulae* (Heinrich).



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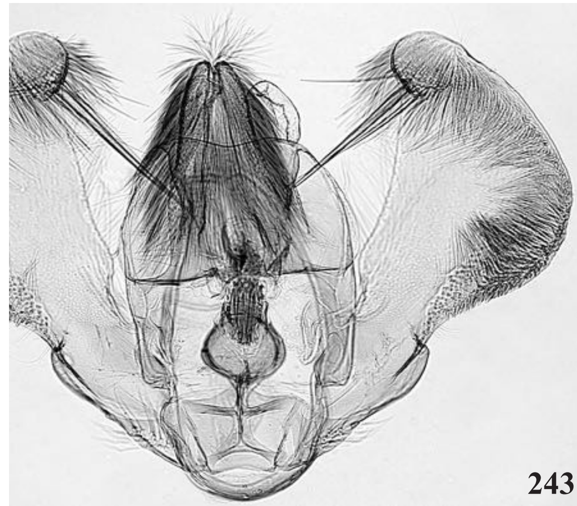

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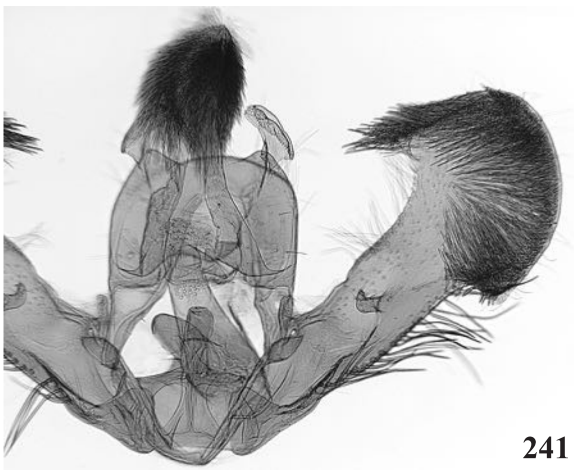

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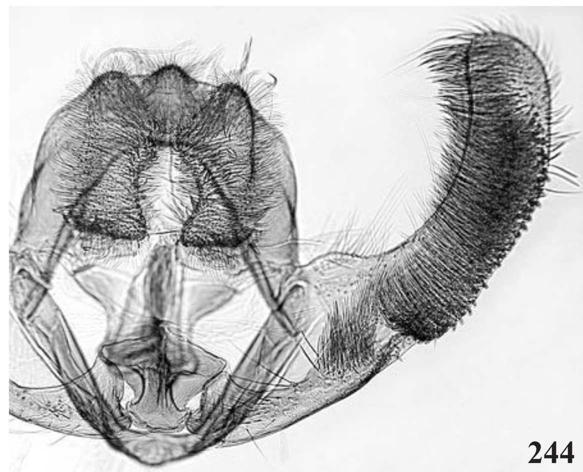

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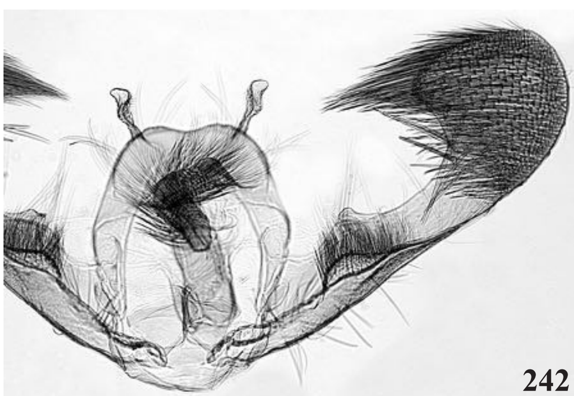

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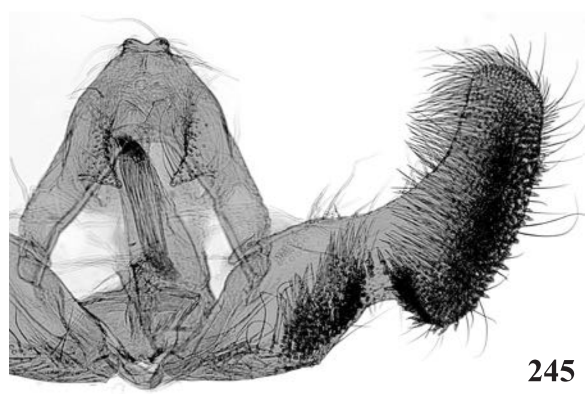

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Plate 46

240. *Chimoptesis pennsylvaniana* (Kearfott); **241.** *Rhopobota naevana* (Hübner); **242.** *Rhopobota dietziana* (Kearfott); **243.** *Rhopobota finitimana* (Heinrich); **244.** *Epinotia medioviridana* (Kearfott); **245.** *Epinotia madderana* (Kearfott).

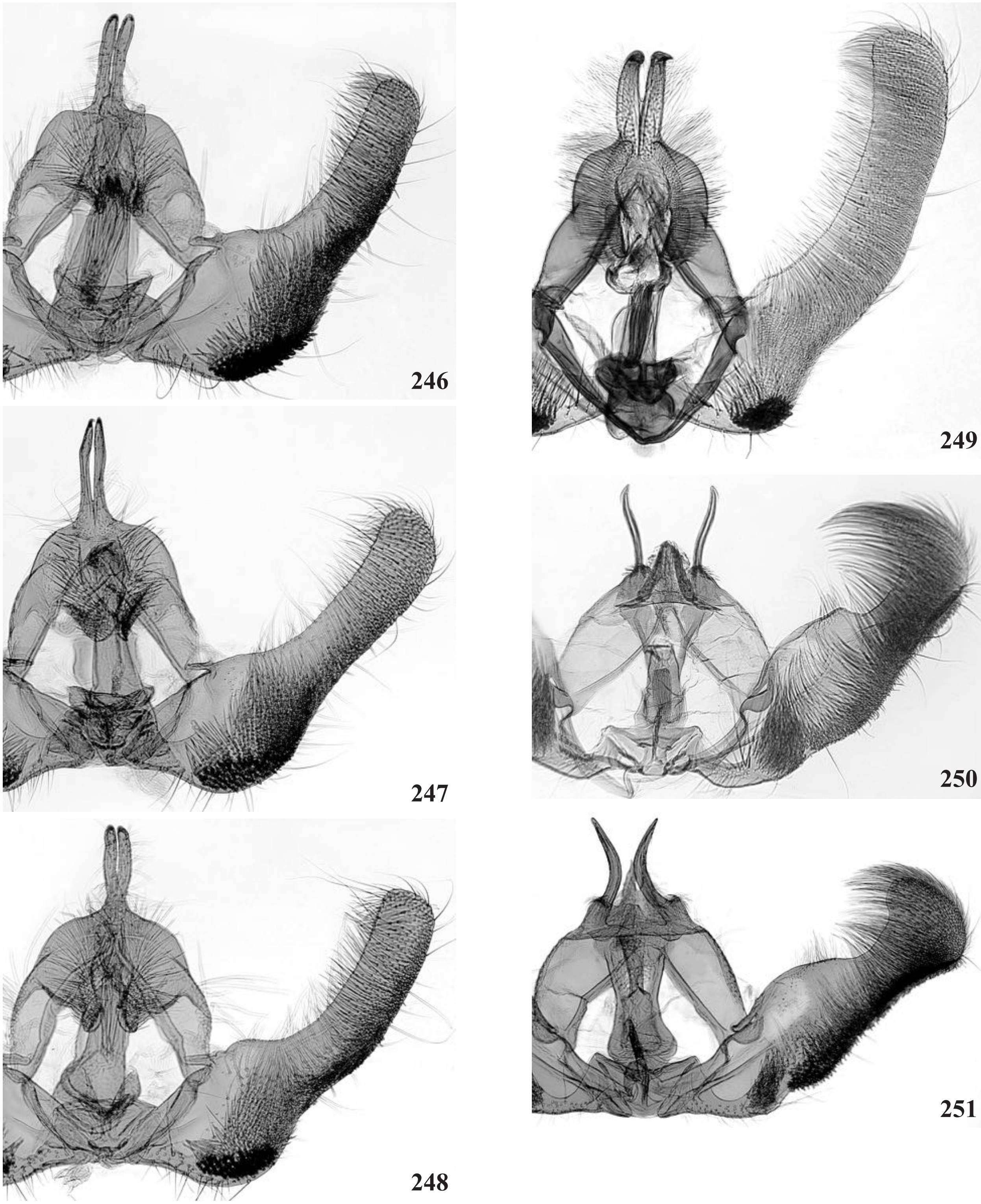


Plate 47

246. *Epinotia celtisana* (Riley); **247.** *Epinotia sotipena* Brown; **248.** *Epinotia vertumnana* (Zeller); **249.** *Epinotia zandana* (Kearfott); **250.** *Epinotia nisella* (Clerck); **251.** *Epinotia criddleana* (Kearfott).

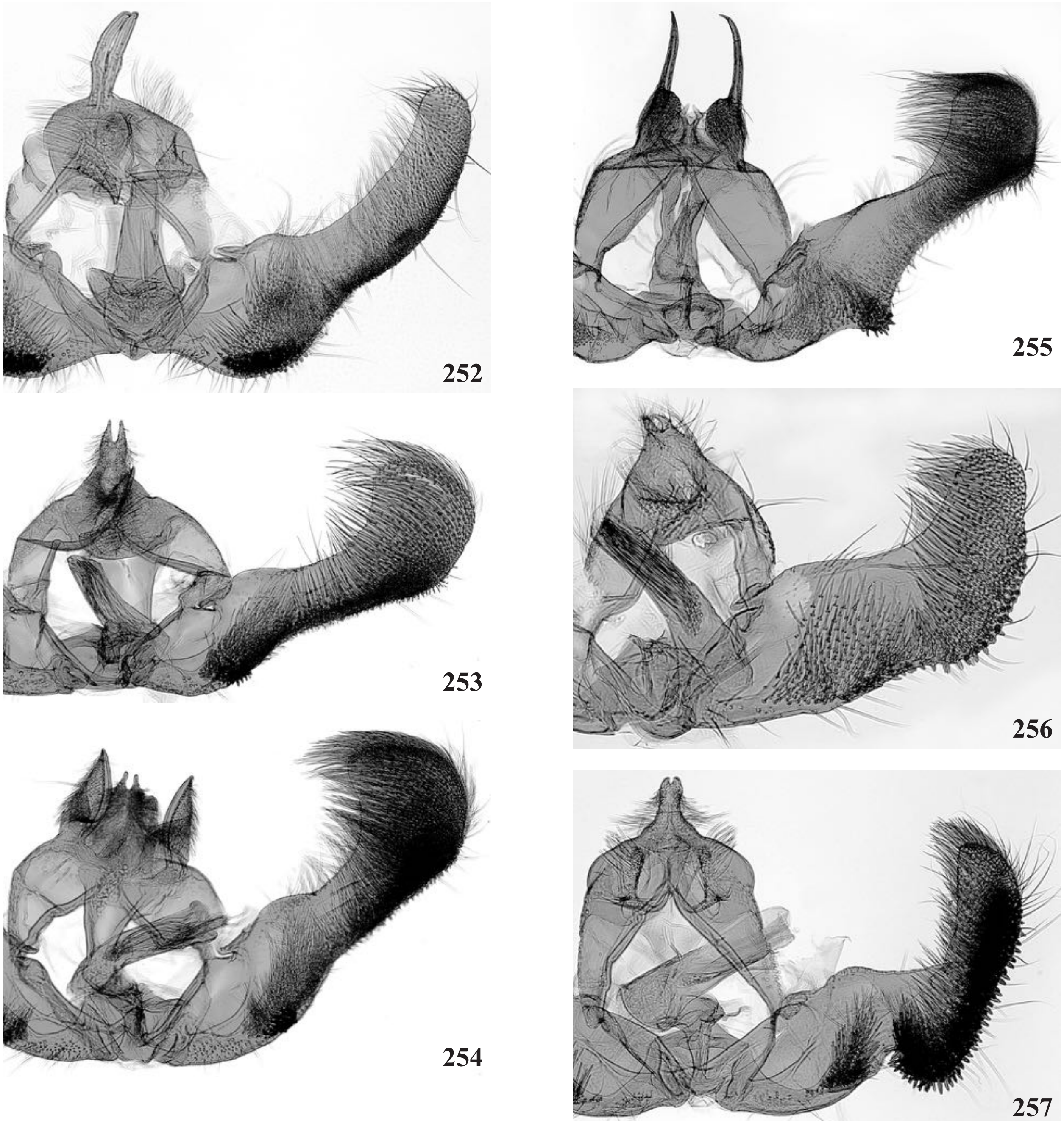
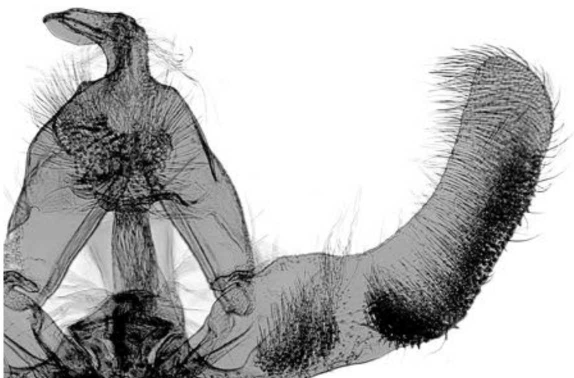


Plate 48

252. *Epinotia xandana* (Kearfott); **253.** *Epinotia walkerana* (Kearfott); **254.** *Epinotia transmissana* (Walker); **255.** *Epinotia nonana* (Kearfott); **256.** *Epinotia nanana* (Treitschke); **257.** *Epinotia septemberana* (Kearfott).



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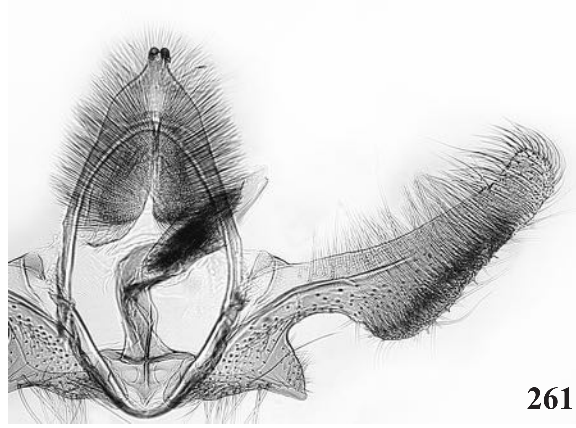

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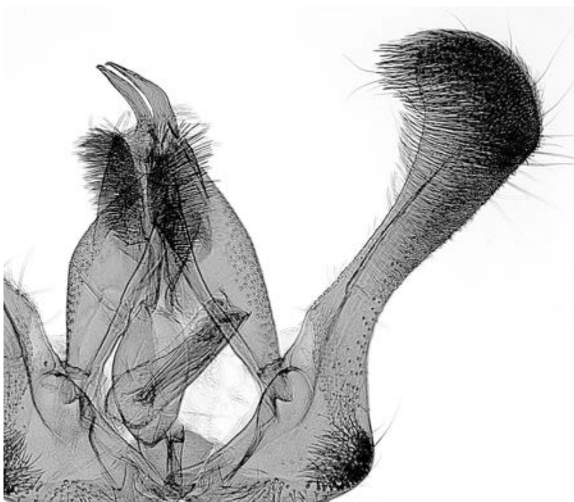

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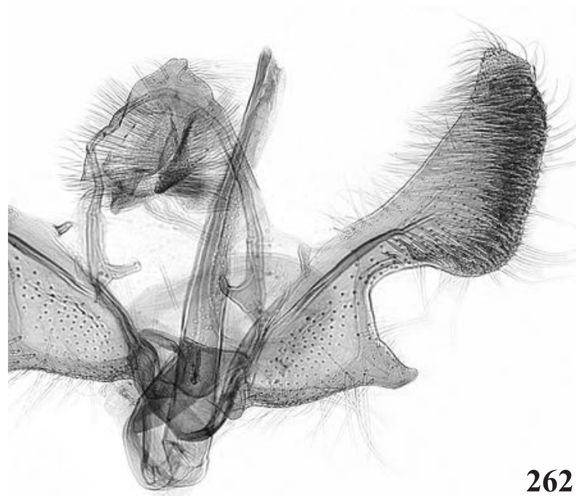

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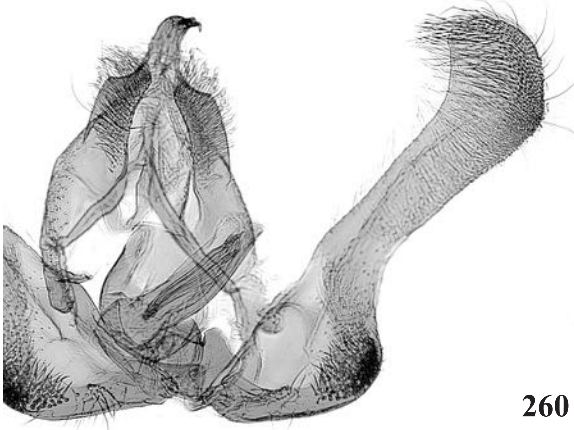

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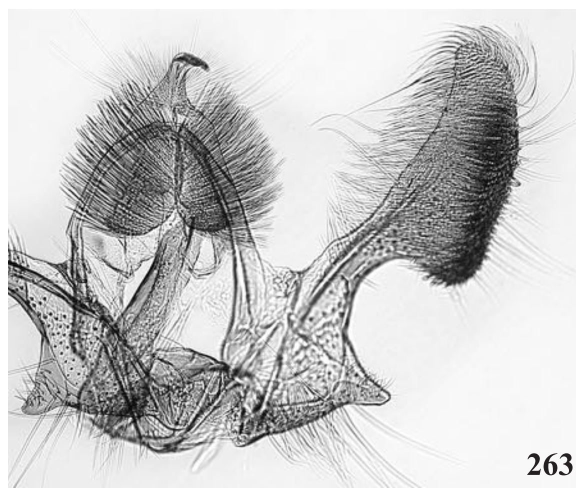

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Plate 49

258. *Epinotia lindana* (Fernald); **259.** *Catastega timidella* Clemens; **260.** *Catastega aceriella* Clemens; **261.** *Ancylis nubeculana* (Clemens); **262.** *Ancylis subaequana* complex; **263.** *Ancylis semiovana* (Zeller).

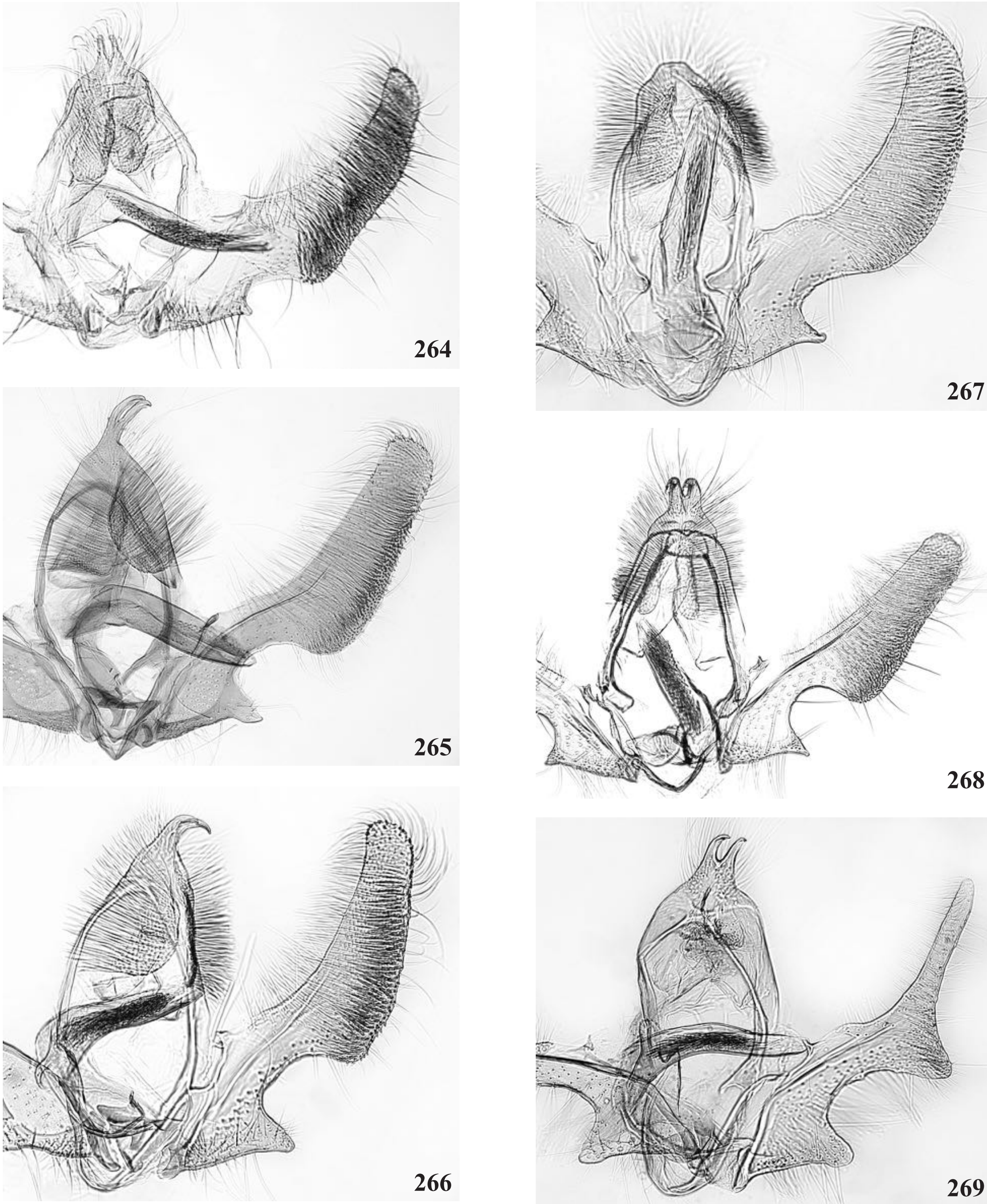


Plate 50

264. *Ancylis brauni* (Heinrich); **265.** *Ancylis spiraeifoliana* complex; **266.** *Ancylis platanana* (Clemens); **267.** *Ancylis metamelana* (Walker); **268.** *Ancylis comptana* (Frölich); **269.** *Ancylis divisana* (Walker).

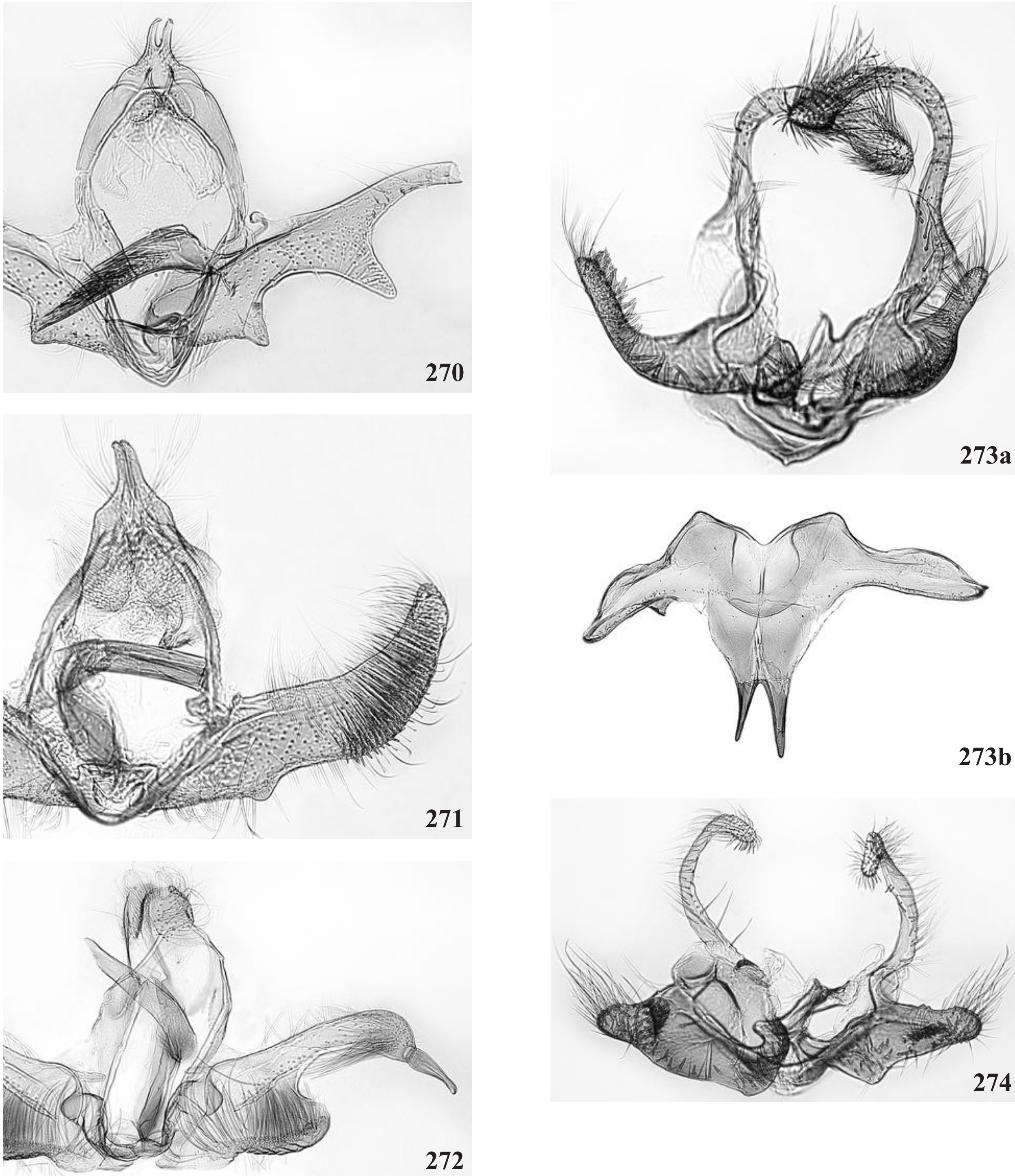
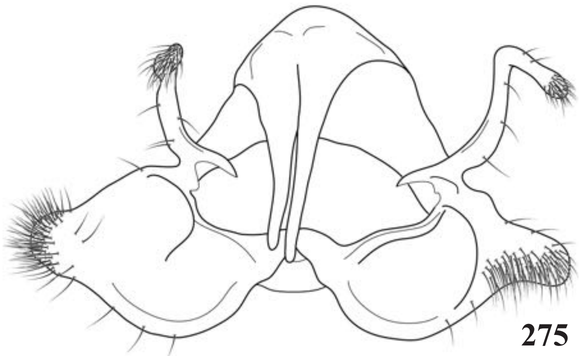


Plate 51

270. *Ancylis muricana* (Walsingham); **271.** *Ancylis diminutana* (Haworth); **272.** *Eucosmomorpha nearctica* Miller; **273.** *Hystrichophora taleana* (Grote), **a.** valvae, **b.** tegumen and uncus; **274.** *Hystrichophora ochreicostana* (Walsingham), valvae only.



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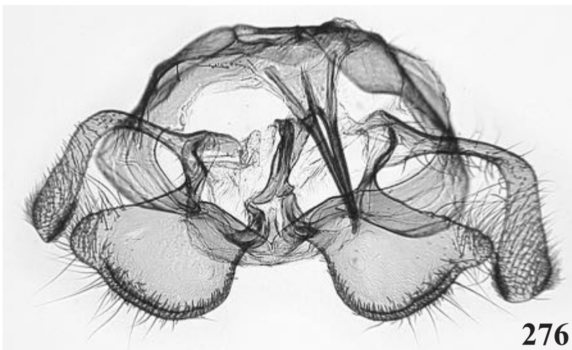

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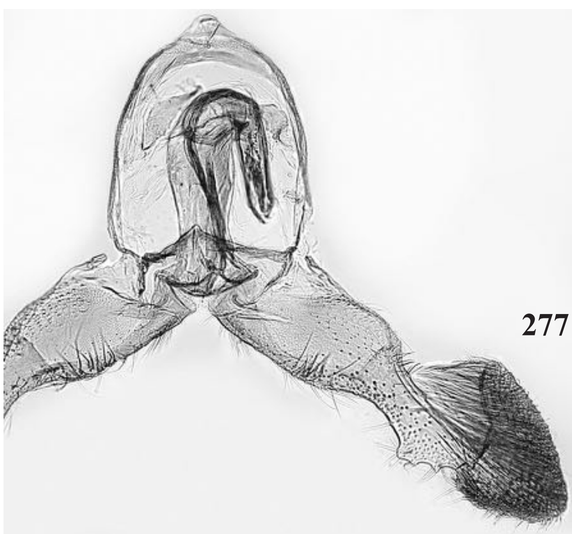

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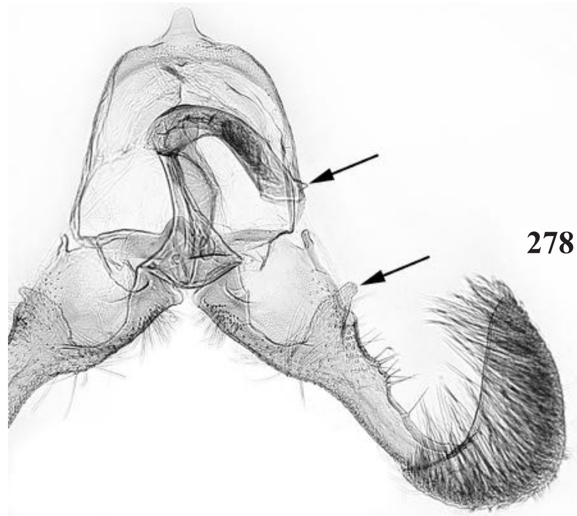

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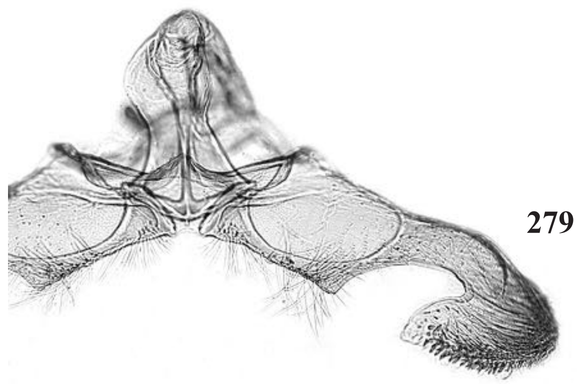

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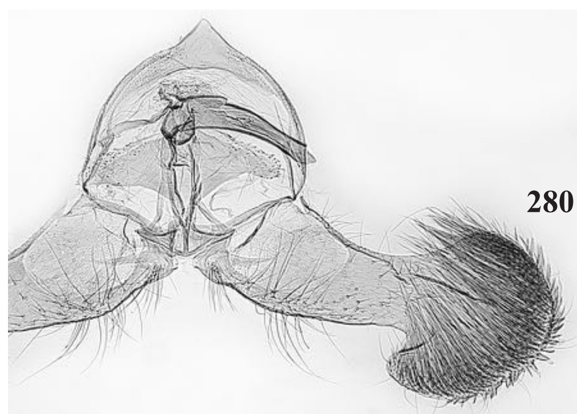

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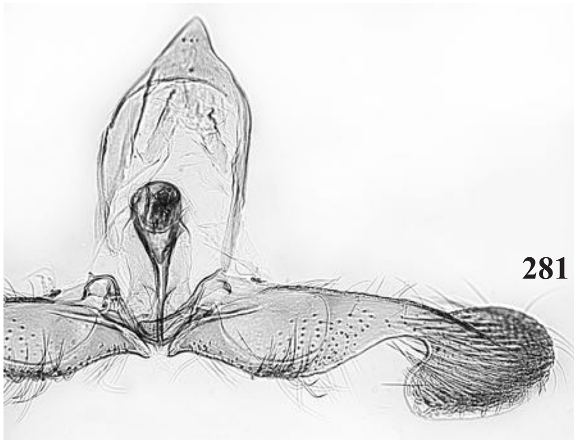
Plate 52

275. *Hystrichophora loricana* (Grote), drawing from holotype; **276.** *Hystrichophora vestaliana* (Zeller), valvae only; **277.** *Dichrorampha simulana* (Clemens); **278.** *Dichrorampha bittana* (Busck), arrows indicate preapical spur on aedeagus and tonguelike projection off valva; **279.** *Dichrorampha incanana* (Clemens); **280.** *Dichrorampha sedatana* (Busck).



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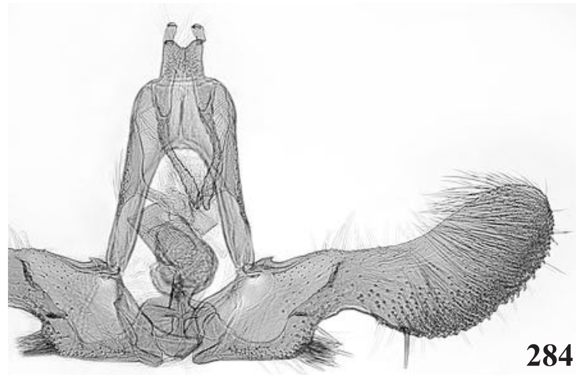

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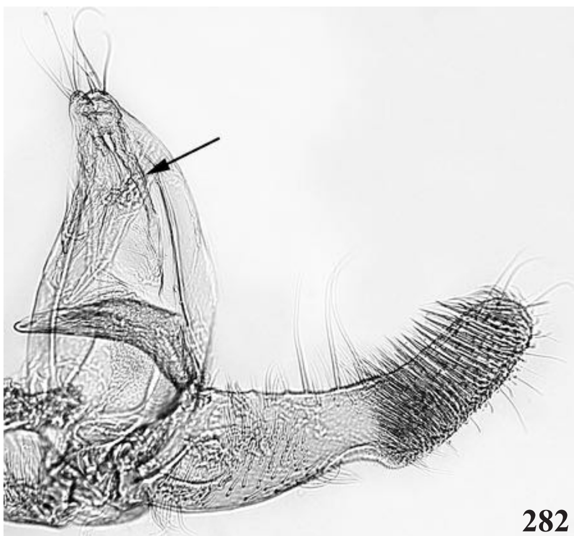

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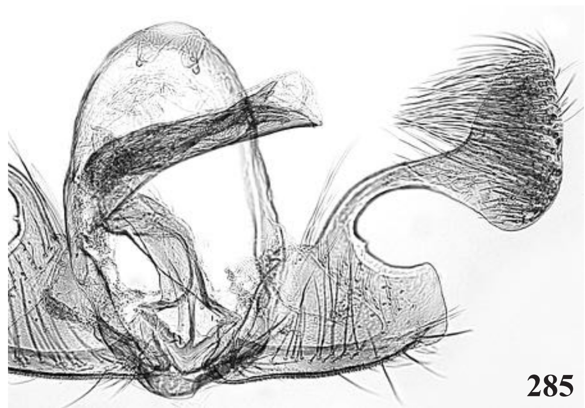

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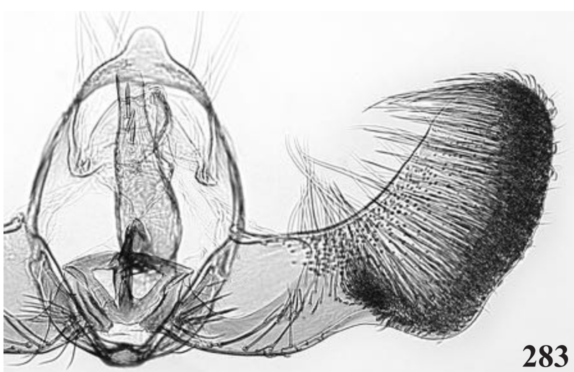

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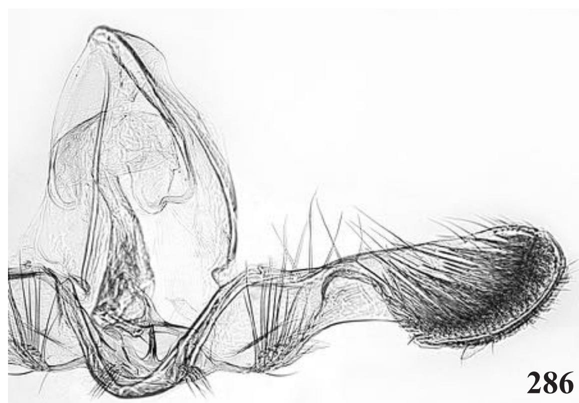

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Plate 53

281. *Dichrorampha leopardana* (Busck); **282.** *Talponia plummeriana* (Busck), arrow indicates socii; **283.** *Pammene felicitana* Heinrich; **284.** *Larisa subsolana* Miller; **285.** *Sereda tautana* (Clemens); **286.** *Grapholita molesta* (Busck).

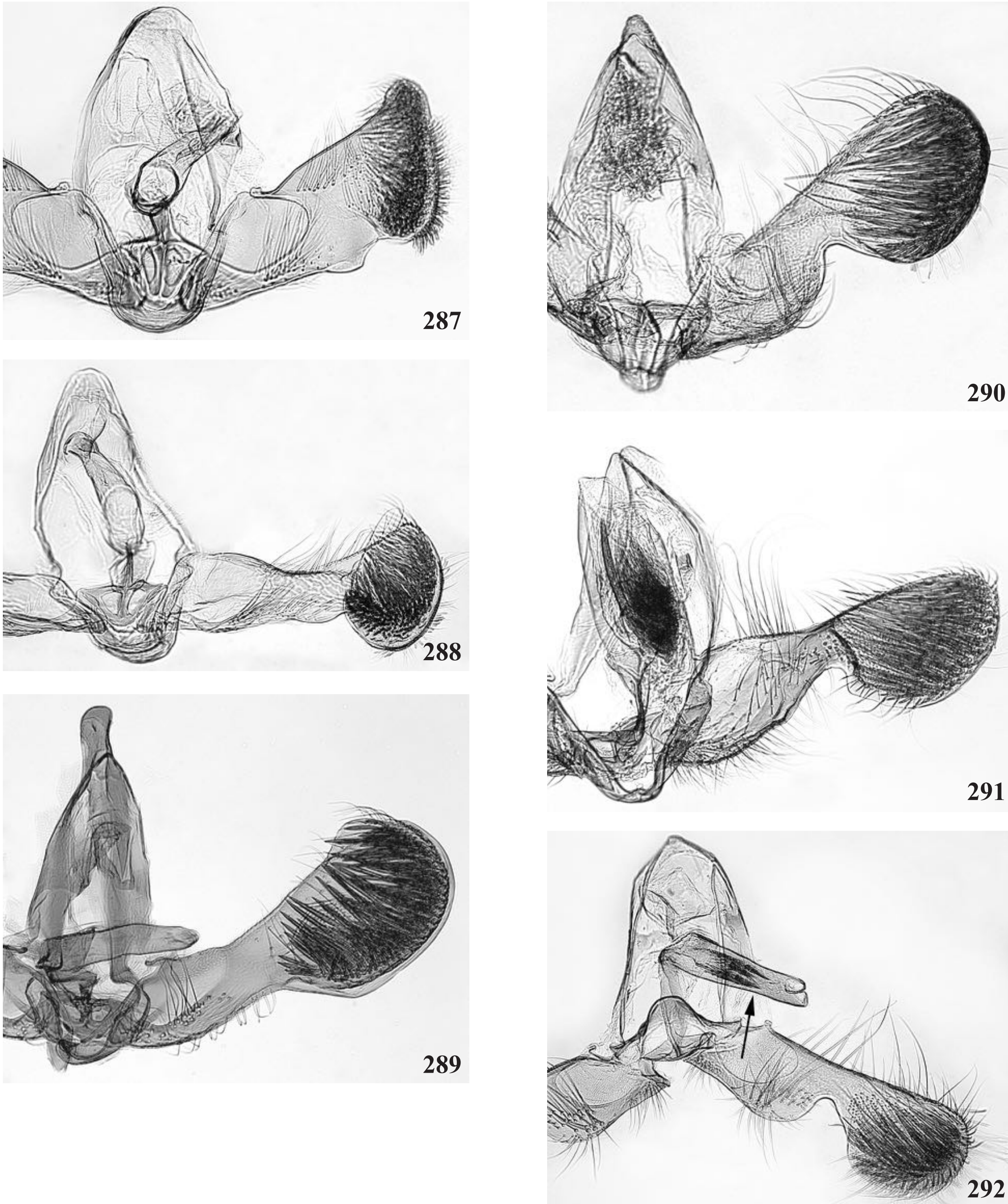


Plate 54

287. *Grapholita packardi* Zeller; **288.** *Grapholita prunivora* (Walsh); **289.** *Grapholita fana* (Kearfott); **290.** *Grapholita interstinctana* (Clemens); **291.** *Grapholita eclipsana* Zeller; **292.** *Grapholita tristrigana* (Clemens), arrow indicates evenly tapered aedeagus.

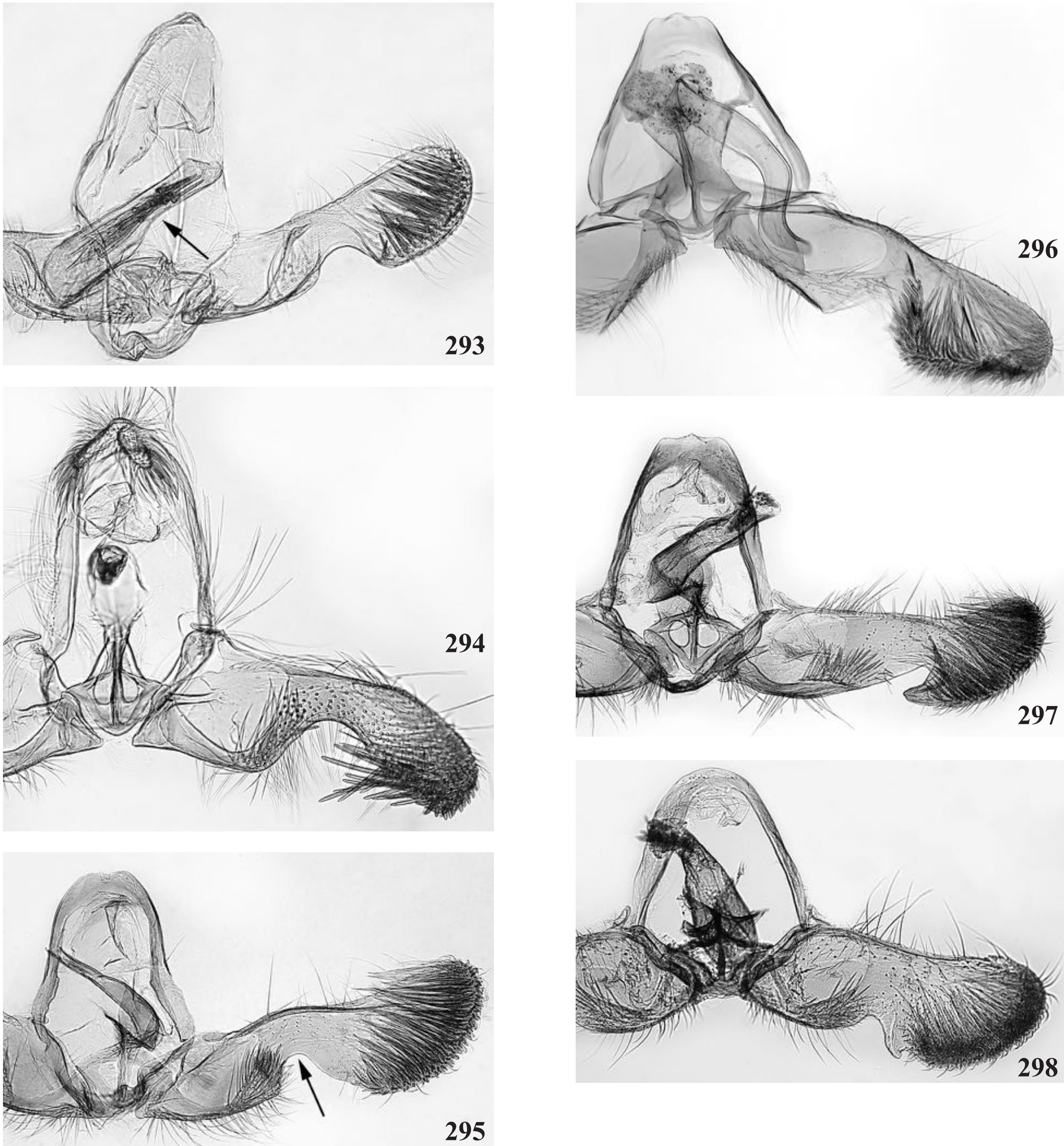


Plate 55

293. *Grapholita delineana* (Walker), arrow indicates unevenly tapered aedeagus; **294.** *Corticivora clarki* Clarke; **295.** *Cydia garacana* (Kearfott), arrow indicates constricted valval neck; **296.** *Cydia albimaculana* (Fernald); **297.** *Cydia lacustrina* (Miller); **298.** *Cydia candana* (Forbes).

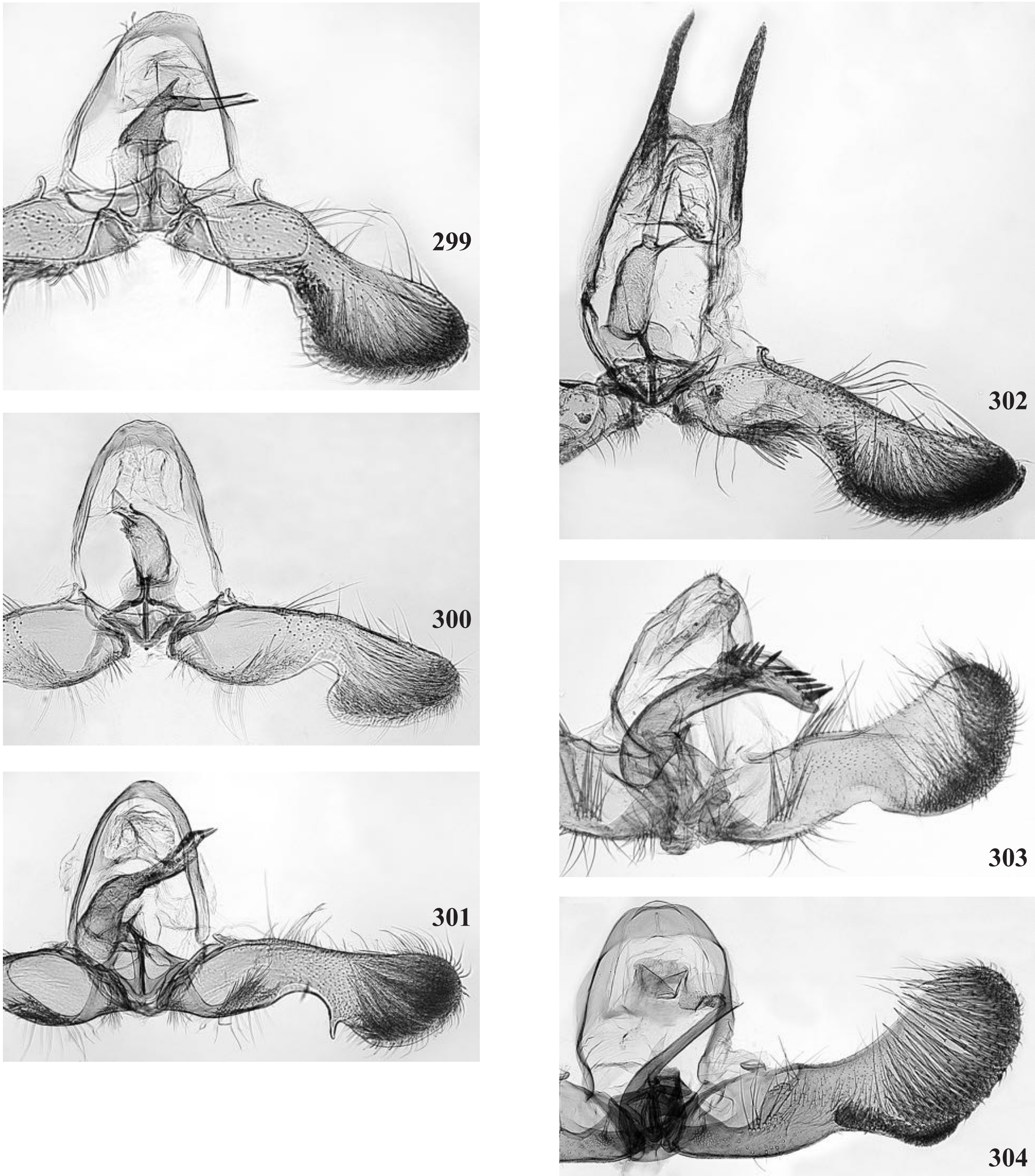
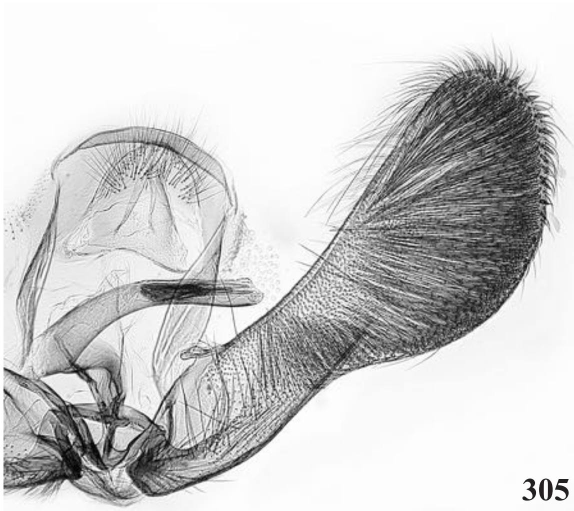


Plate 56
299. *Cydia caryana* (Fitch); **300.** *Cydia gallaesaliciana* (Riley); **301.** *Cydia pomonella* (Linnaeus); **302.** *Cydia latiferreana* complex (type F); **303.** *Cydia toreuta* complex; **304.** *Gymnandrosoma punctidiscanum* Dyar.



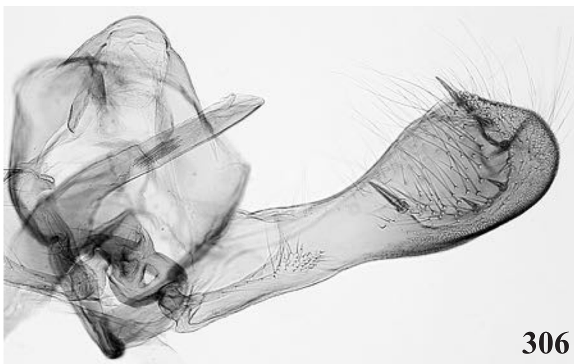


Plate 57
305. *Ecdytolopha insiticiana* Zeller; **306.** *Pseudogalleria inimicella* (Zeller).

Female Genitalia

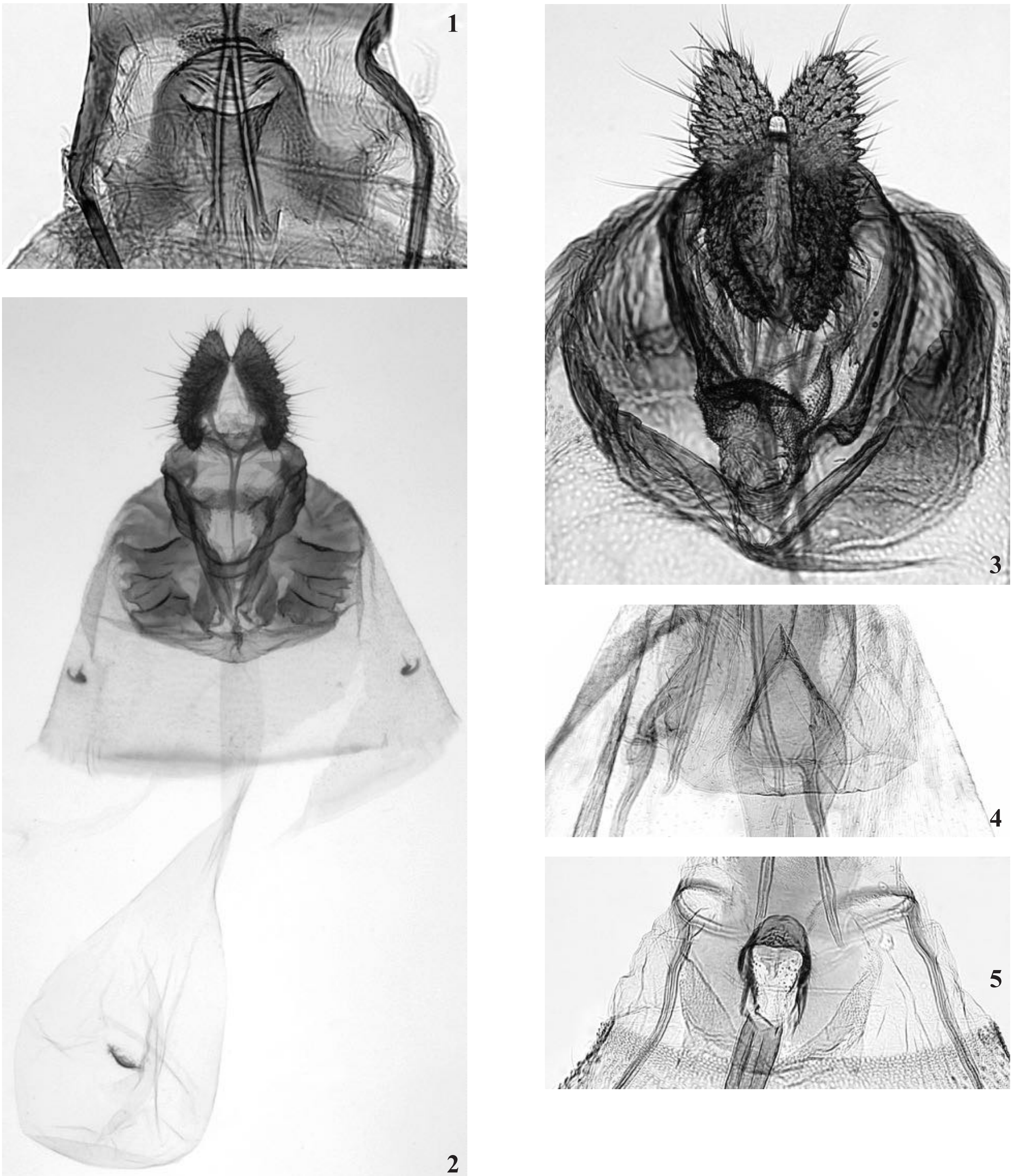


Plate 58

1. *Bactra furfurana* (Haworth); **2.** *Bactra maiorina* Heinrich; **3.** *Bactra verutana* Zeller; **4.** *Endothenia heinrichi* McDunnough; **5.** *Endothenia hebesana* (Walker).

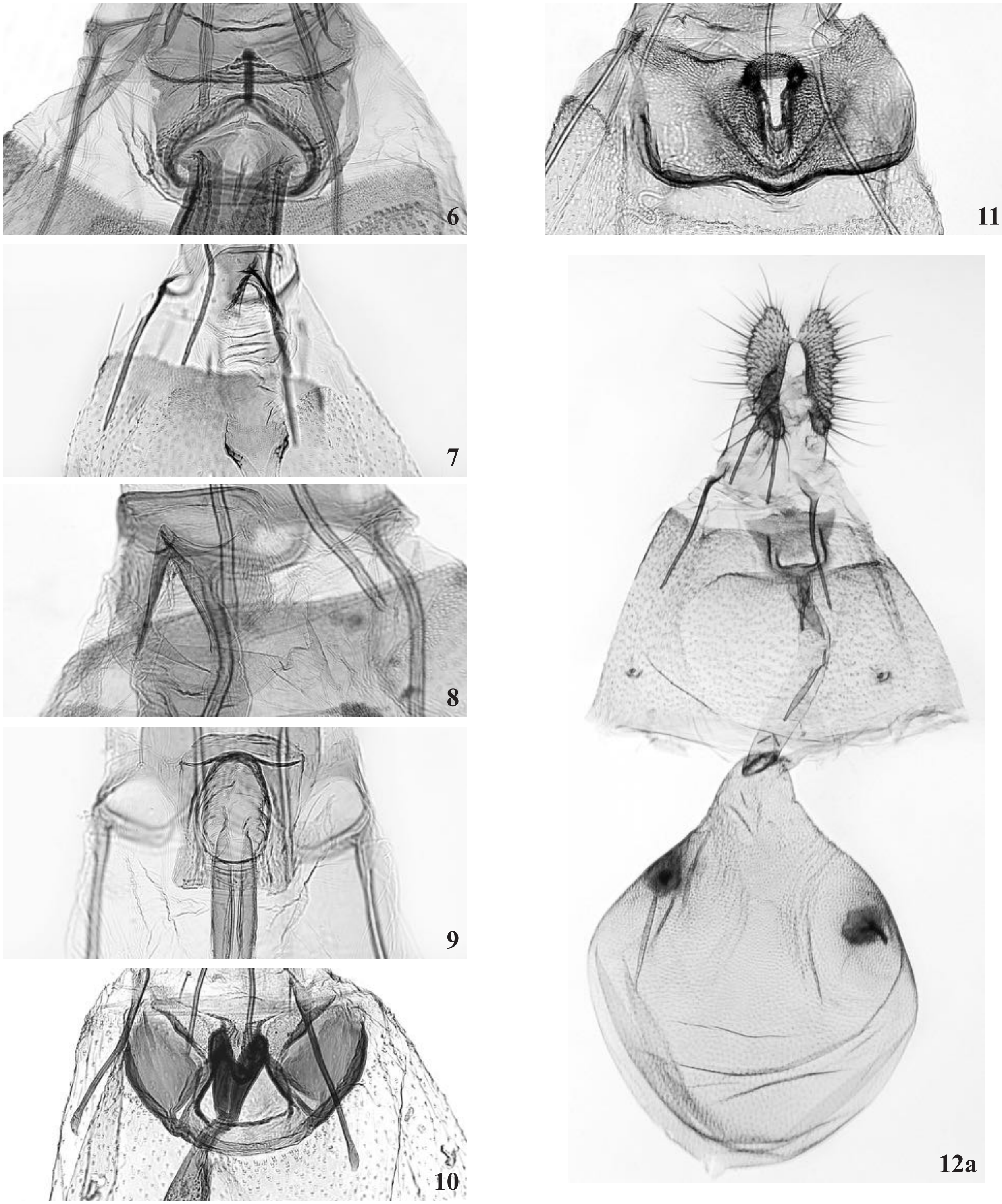


Plate 59

6. *Endothenia nubilana* (Clemens); **7.** *Endothenia montanana* (Kearfott); **8.** *Endothenia infuscata* Heinrich; **9.** *Endothenia microptera* Clarke; **10.** *Taniva albolineana* (Kearfott); **11.** *Hulda impudens* (Walsingham); **12a.** *Episimus argutanus* (Clemens).

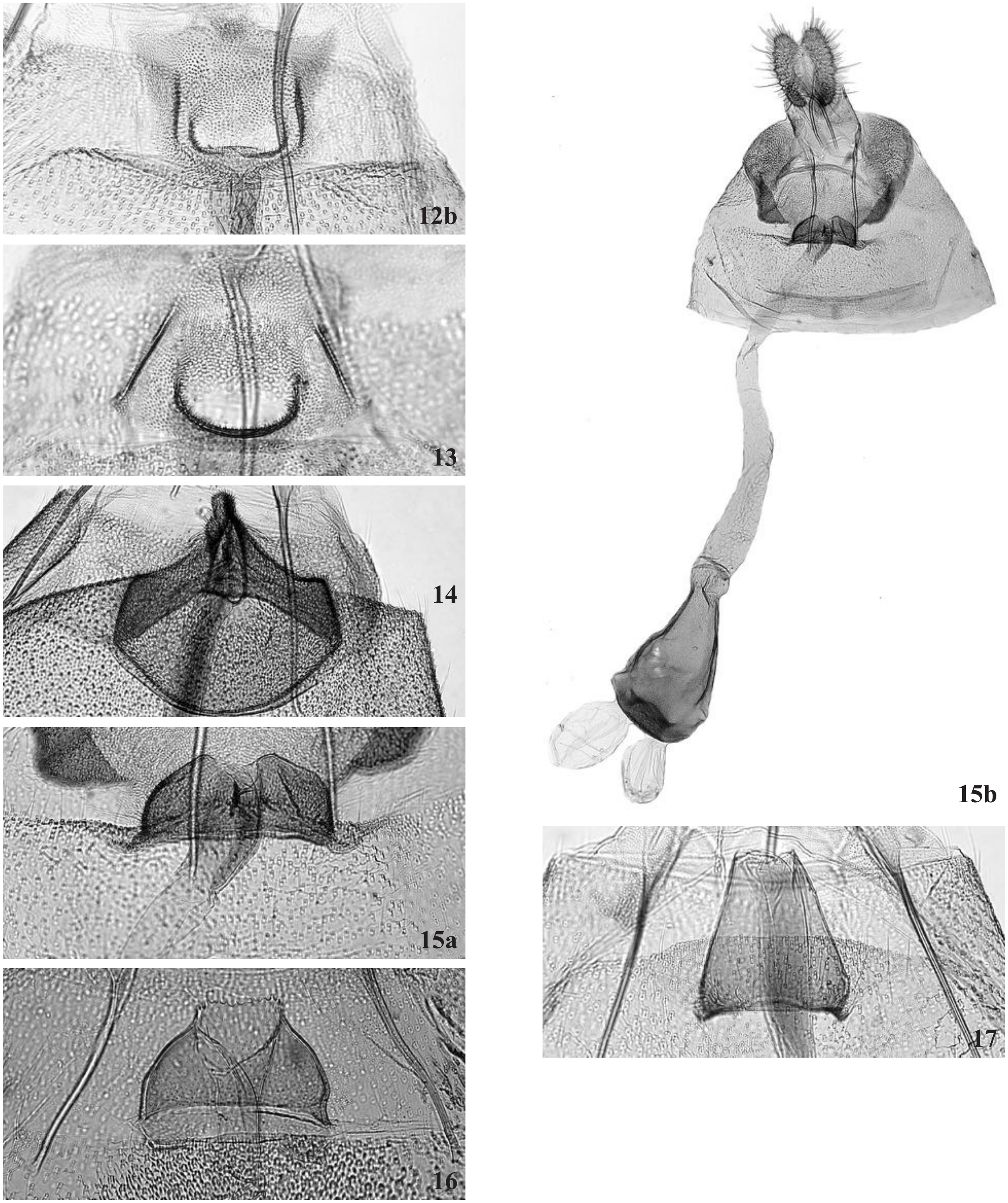


Plate 60

12b. *Episimus argutanus* (Clemens); **13.** *Episimus tyrius* Heinrich; **14.** *Paralobesia liriodendrana* (Kearfott); **15a, b.** *Paralobesia viteana* (Clemens); **16.** *Paralobesia monotropana* (Heinrich); **17.** *Paralobesia rhoifructana* (Kearfott).

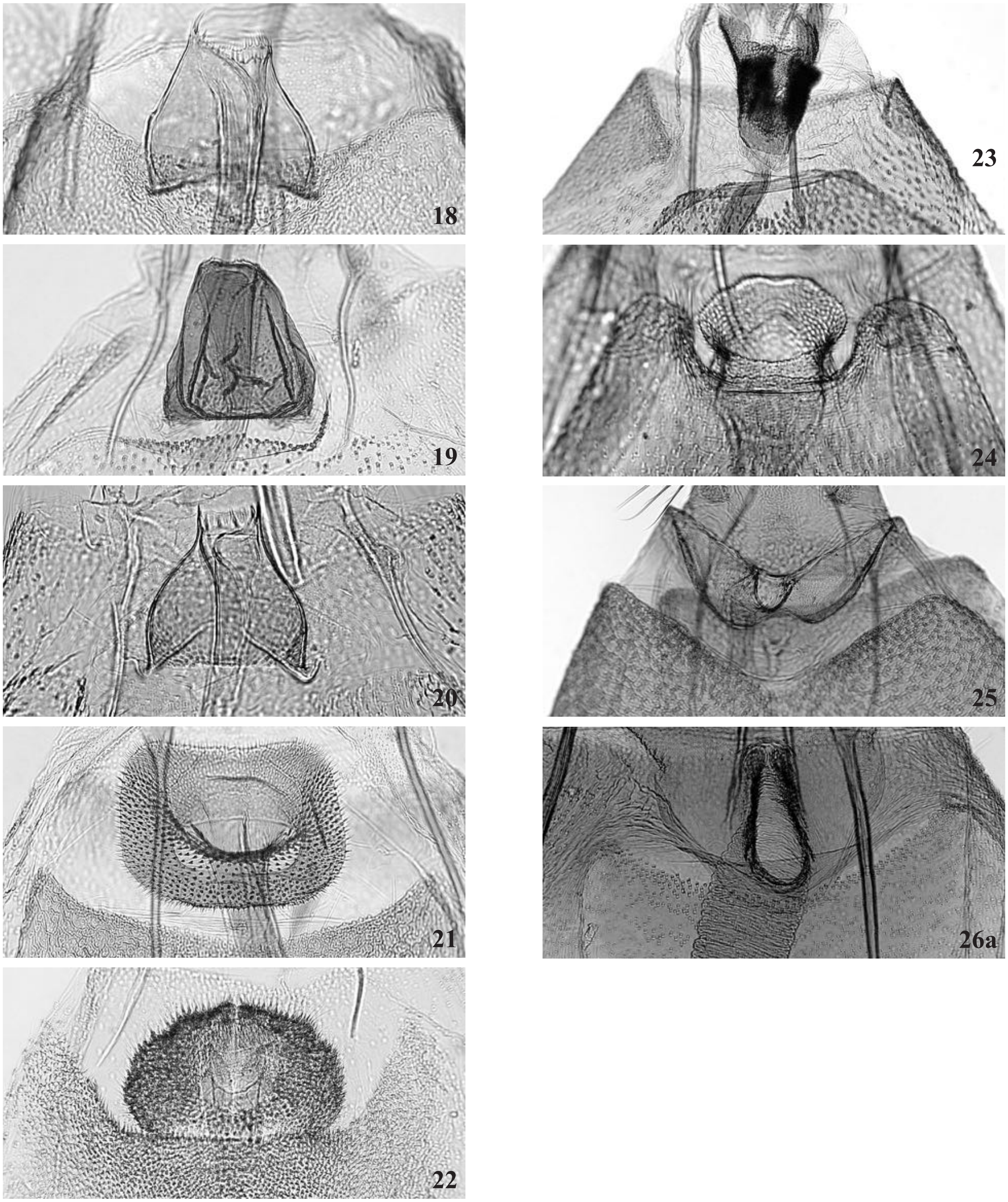


Plate 61

18. *Paralobesia yaracana* (Kearfott); **19.** *Paralobesia sambuci* (Clarke); **20.** *Paralobesia spiraeifoliana* (Heinrich); **21.** *Paralobesia cyclopiana* (Heinrich); **22.** *Lobesia carduana* (Busck); **23.** *Aterpia approximana* (Heinrich); **24.** *Eumarozia malachitana* (Zeller); **25.** *Zomaria interruptolineana* (Fernald); **26a.** *Apotomis capreana* (Hübner).

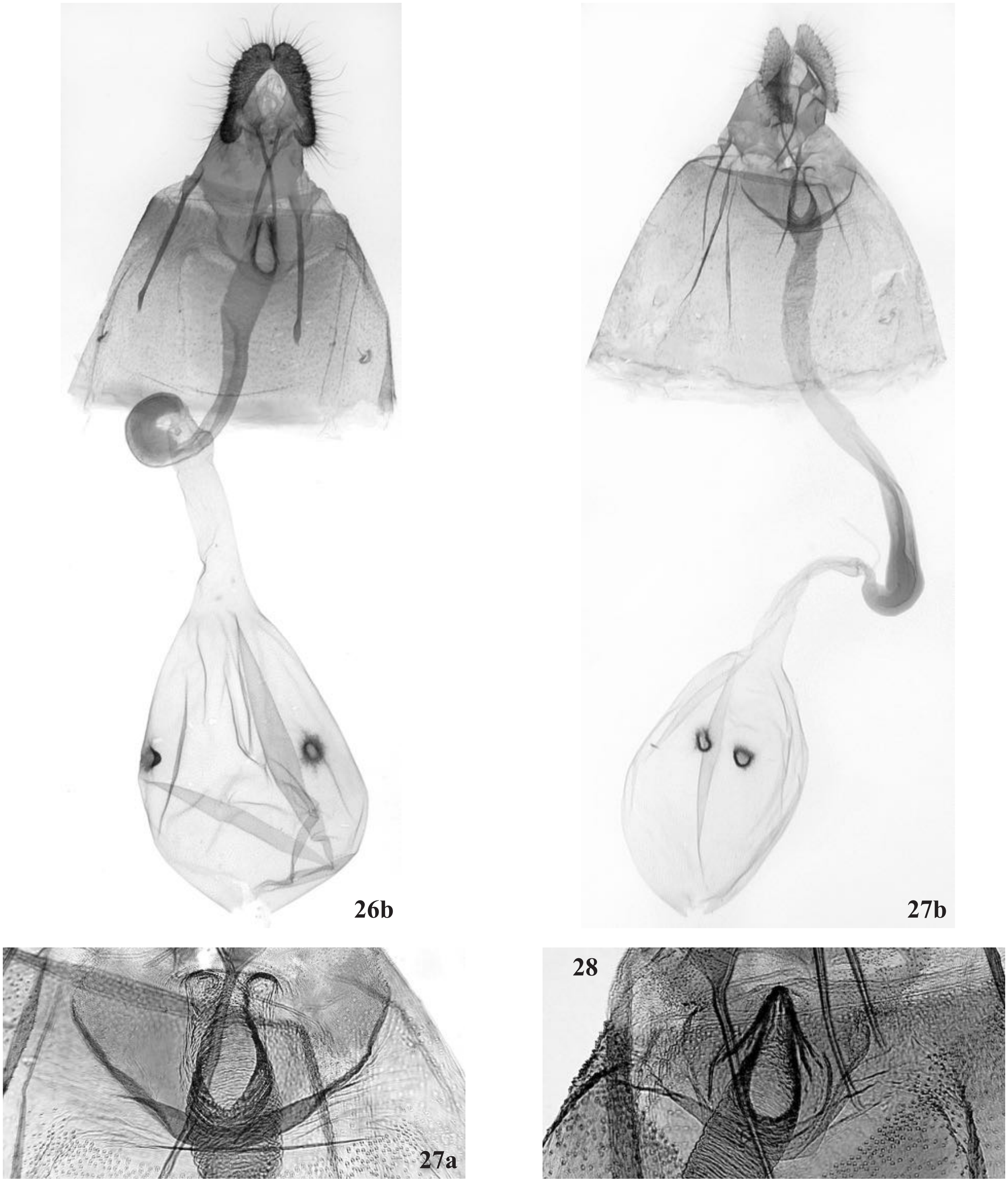


Plate 62
26b. *Apotomis capreana* (Hübner); **27a, b.** *Apotomis deceptana* (Kearfott); **28.** *Apotomis removana* (Kearfott).

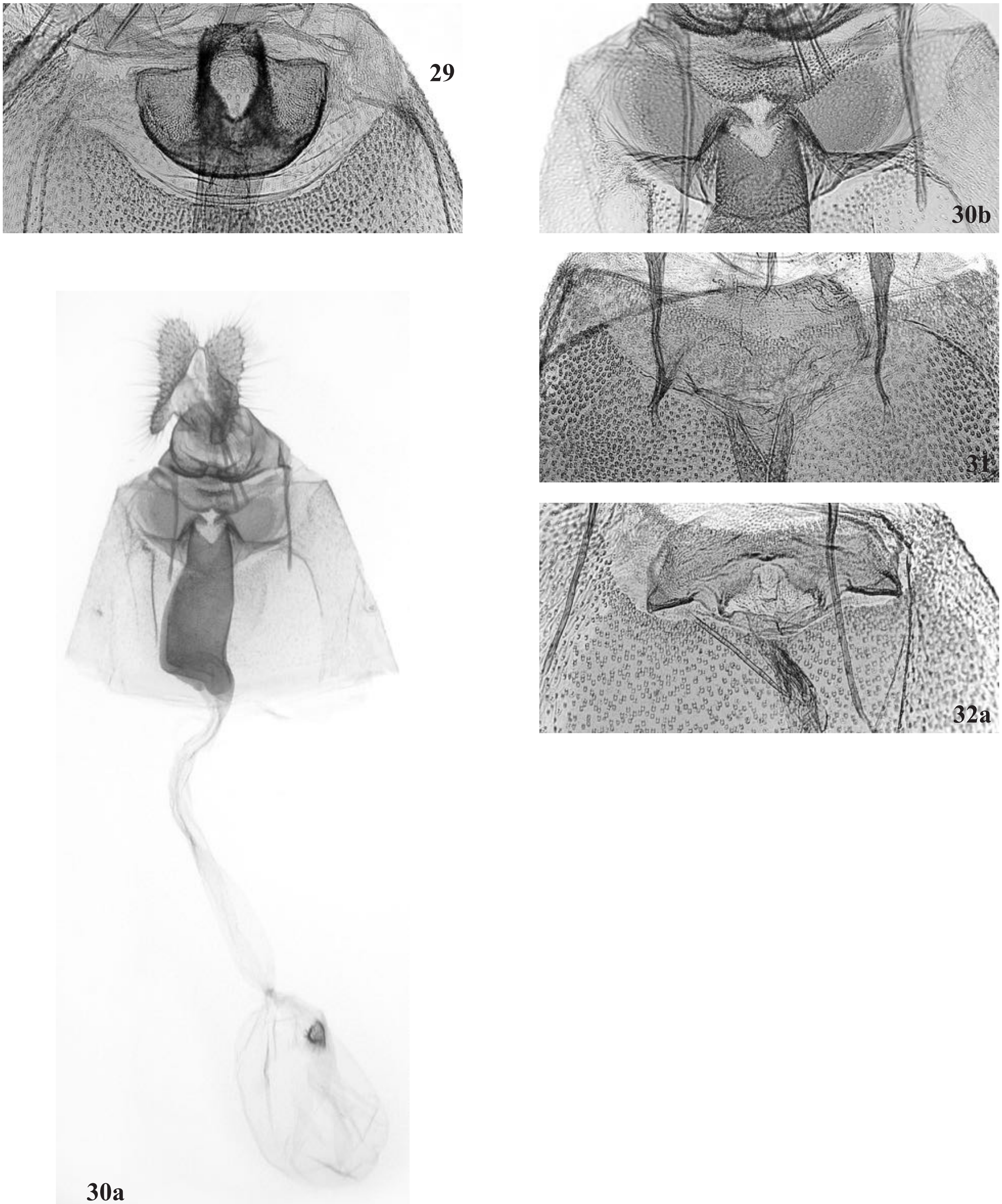
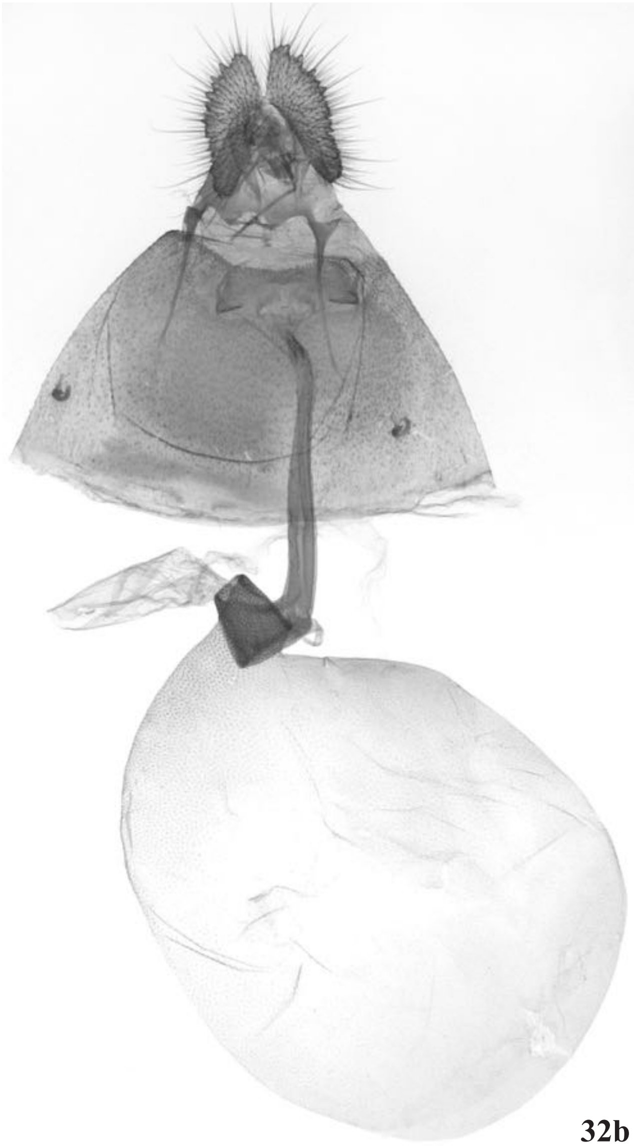
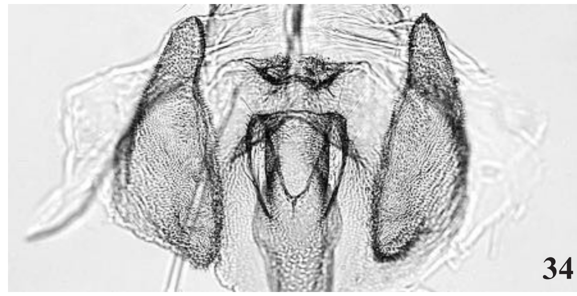


Plate 63

29. *Pseudosciaphila duplex* (Walsingham); **30a, b.** *Orthotaenia undulana* (Denis & Schiffermüller); **31.** *Phaecasiophora confixana* (Walker); **32a.** *Phaecasiophora niveiguttana* Grote.



32b



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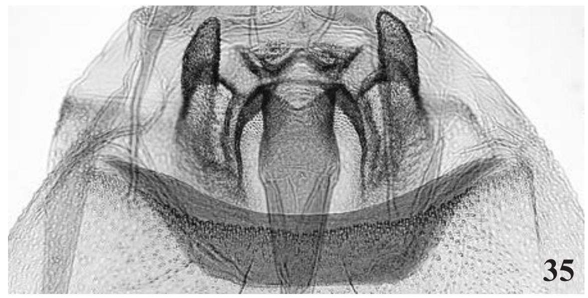

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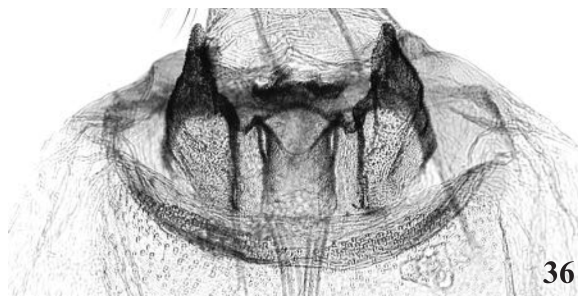

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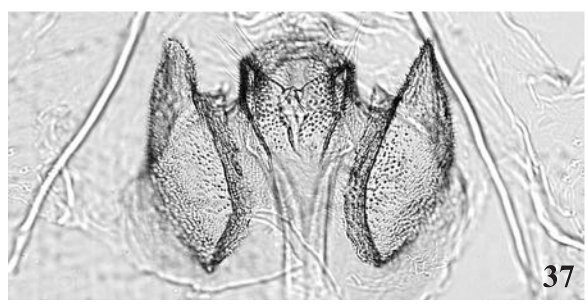

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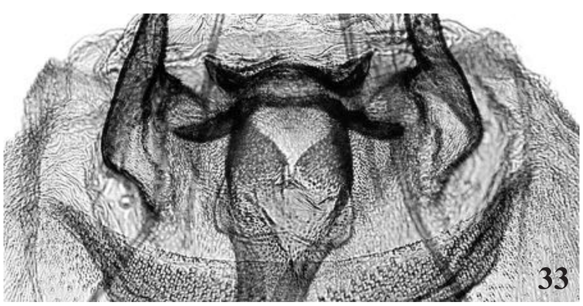

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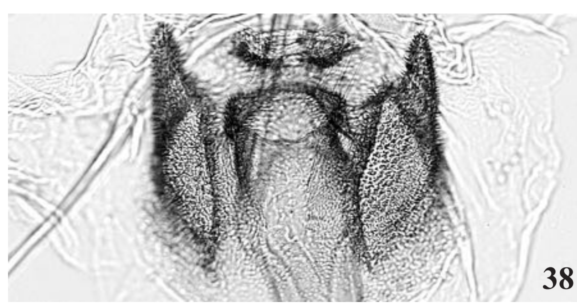

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Plate 64

32b. *Phaecasiophora niveiguttana* Grote; **33.** *Olethreutes monetiferana* (Riley); **34.** *Olethreutes nitidana* (Clemens); **35.** *Olethreutes furfurana* (McDunnough); **36.** *Olethreutes comandrana* (Clarke); **37.** *Olethreutes olivaceana* (Fernald); **38.** *Olethreutes subnubilus* (Heinrich).

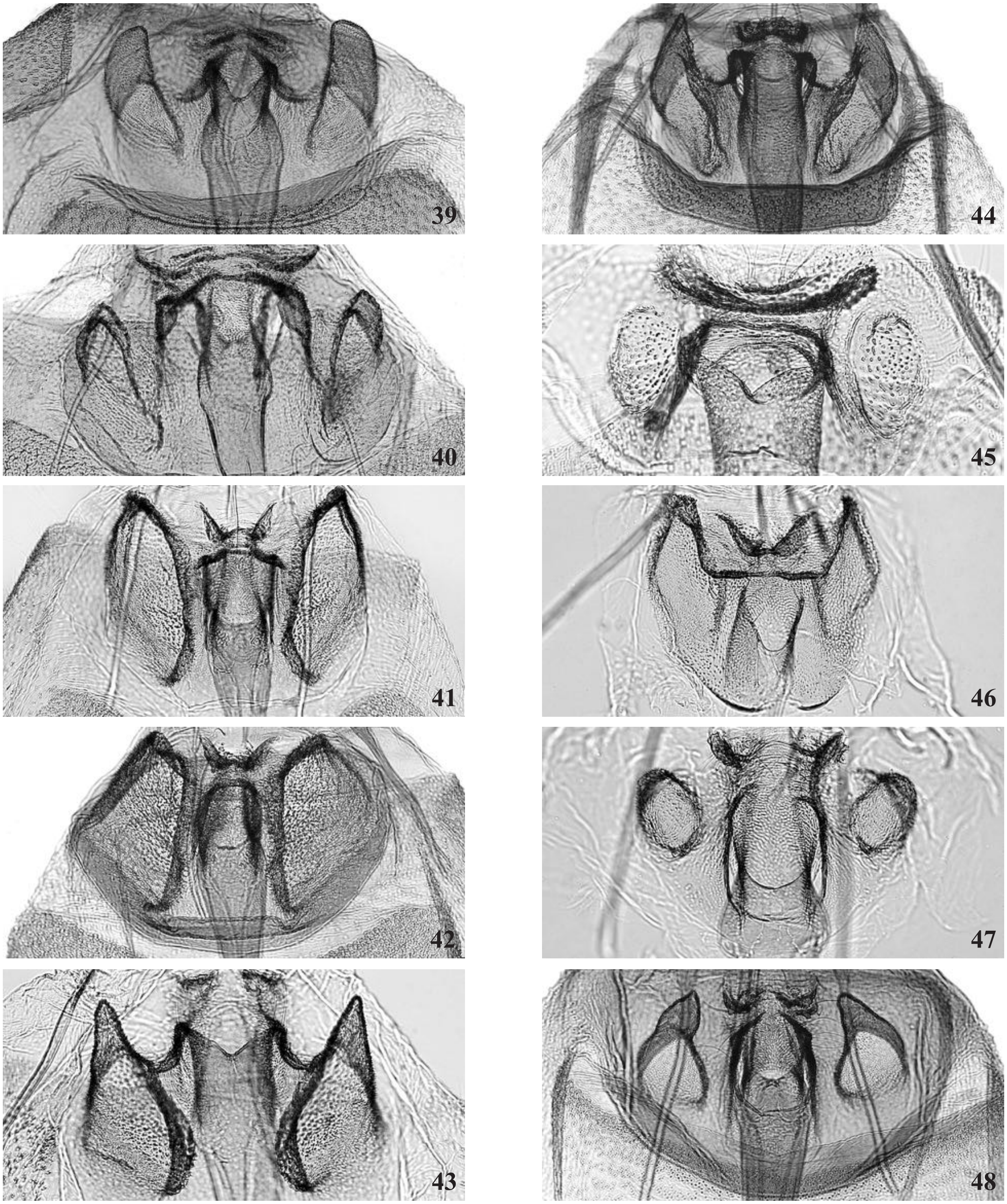


Plate 65

39. *Olethreutes footiana* (Fernald); **40.** *Olethreutes atrodentana* (Fernald); **41.** *Olethreutes punctana* (Walsingham); **42.** *Olethreutes connectus* (McDunnough); **43.** *Olethreutes inornatana* (Clemens); **44.** *Olethreutes mysteriana* Miller; **45.** *Olethreutes mediopartitus* (Heinrich); **46.** *Olethreutes exoletus* (Zeller); **47.** *Olethreutes quadrifidus* (Zeller); **48.** *Olethreutes tiliana* (Heinrich).

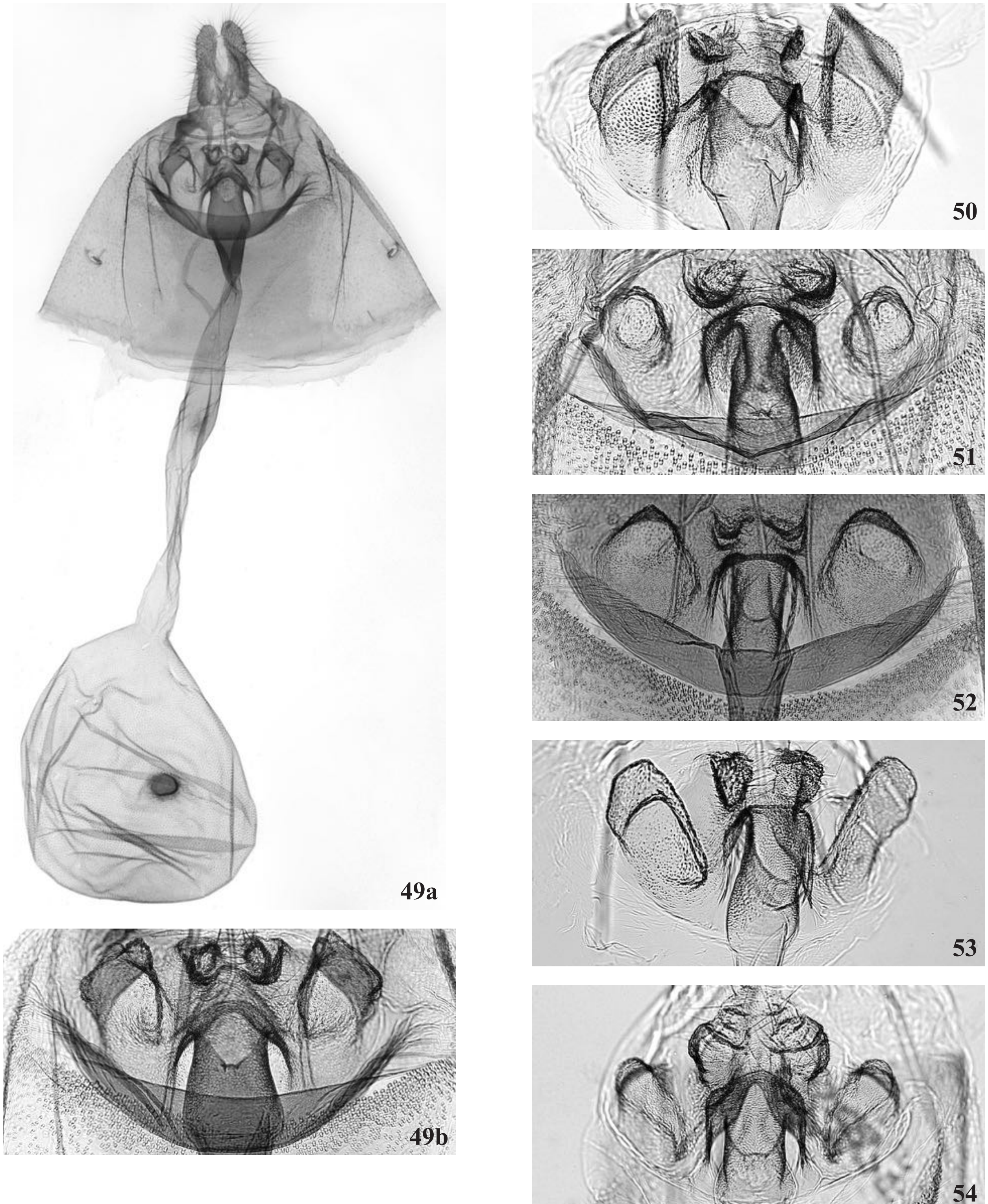


Plate 66

49a, b. *Olethreutes sciotana* (Heinrich); **50.** *Olethreutes appalachiana* (Braun); **51.** *Olethreutes clavana* (Walker); **52.** *Olethreutes nigrana* (Heinrich); **53.** *Olethreutes viburnana* (McDunnough); **54.** *Olethreutes merrickana* (Kearfott).

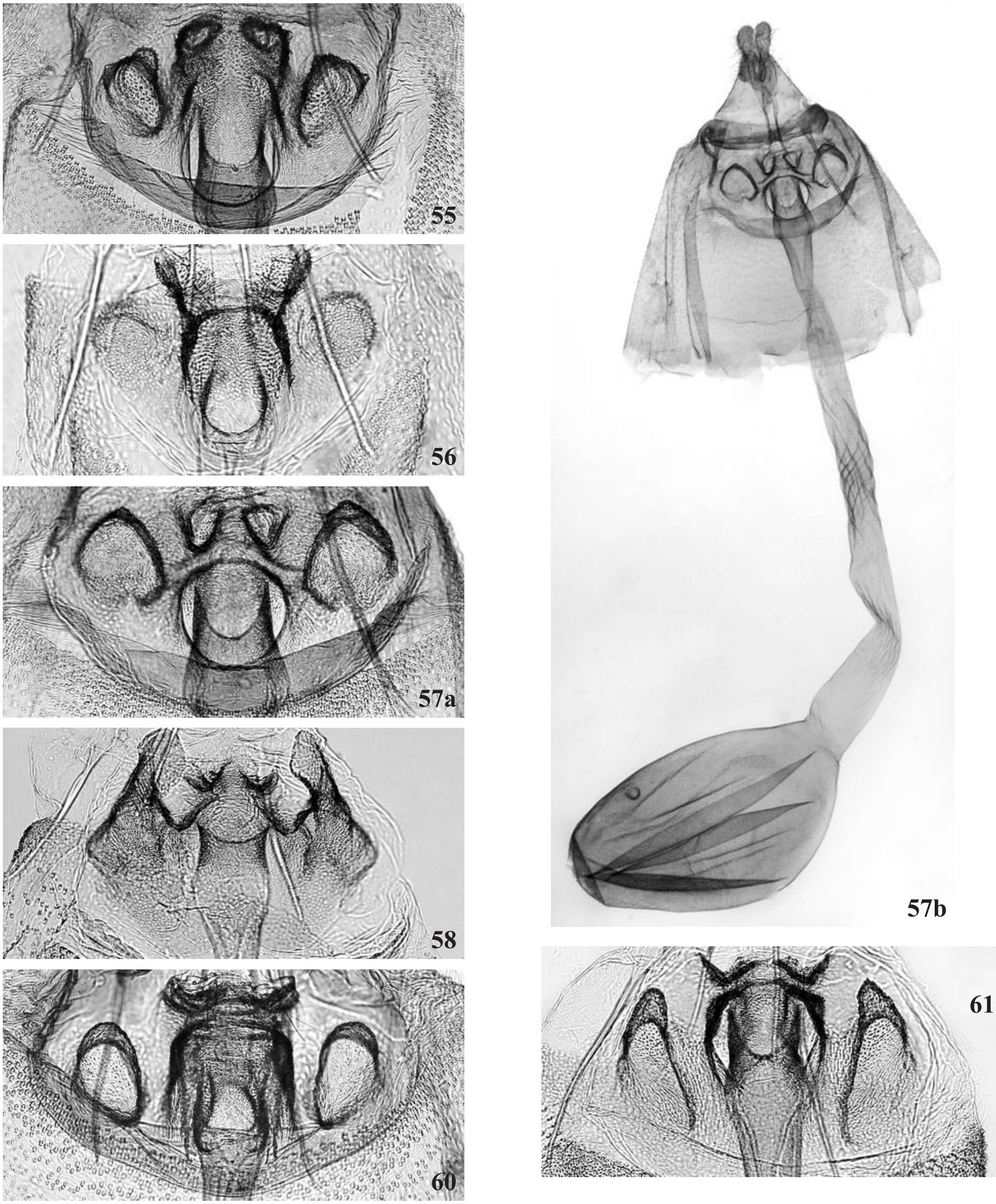


Plate 67

55. *Olethreutes hamameliana* (McDunnough); **56.** *Olethreutes corylana* (Fernald); **57a, b.** *Olethreutes ochrosuffusana* (Heinrich); **58.** *Olethreutes brunneopurpuratus* (Heinrich); **59. (not shown)** *Olethreutes ferrugineana* (Riley) [female unknown]; **60.** *Olethreutes fagigemmeana* (Chambers); **61.** *Olethreutes sericorana* (Walsingham).

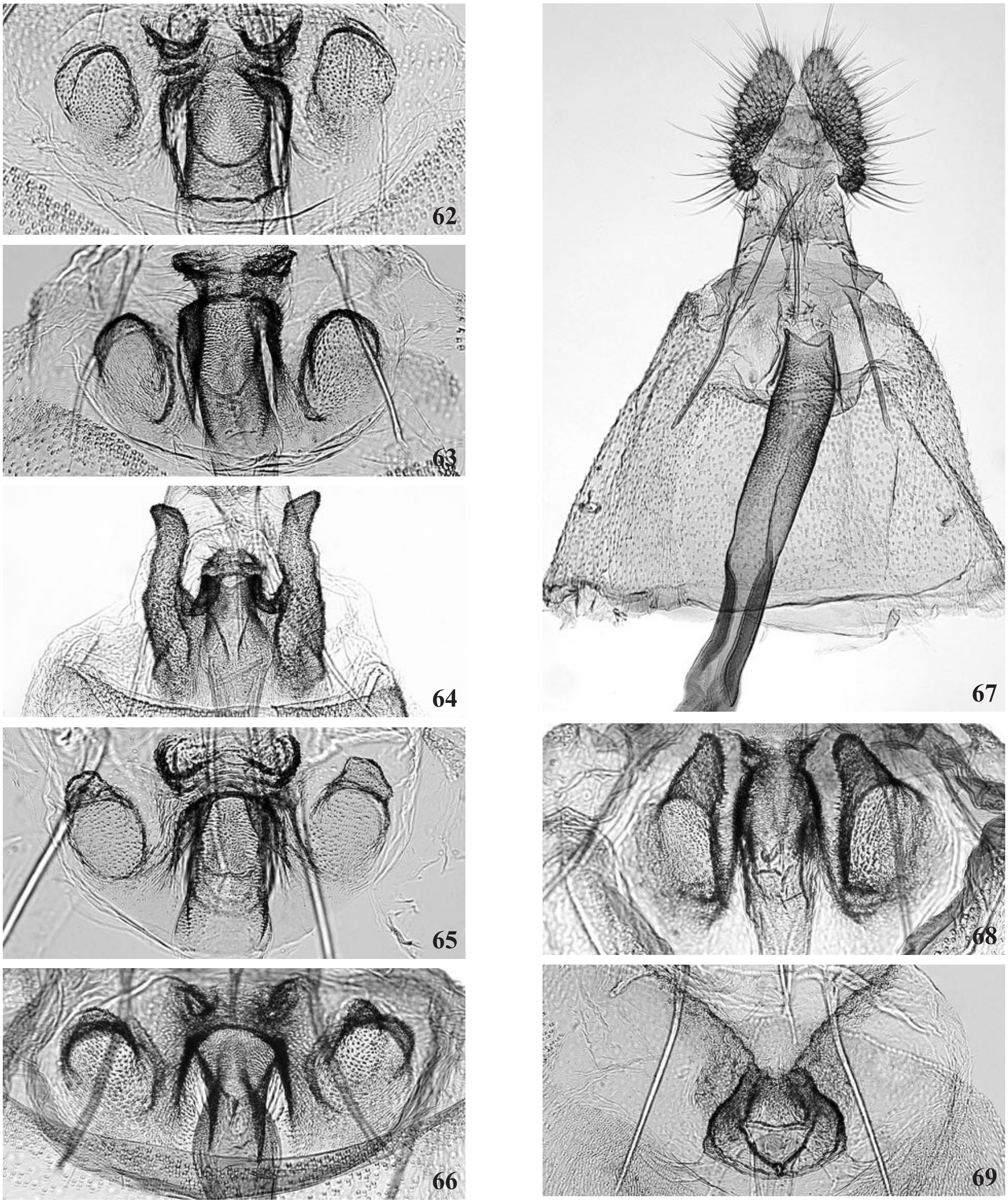


Plate 68

62. *Olethreutes melanomesa* (Heinrich); **63.** *Olethreutes valdana* (McDunnough); **64.** *Olethreutes versicolorana* (Clemens); **65.** *Olethreutes permundana* (Clemens); **66.** *Olethreutes malana* (Fernald); **67.** *Olethreutes appendicea* (Zeller); **68.** *Olethreutes concinnana* (Clemens); **69.** *Olethreutes fasciatana* (Clemens).

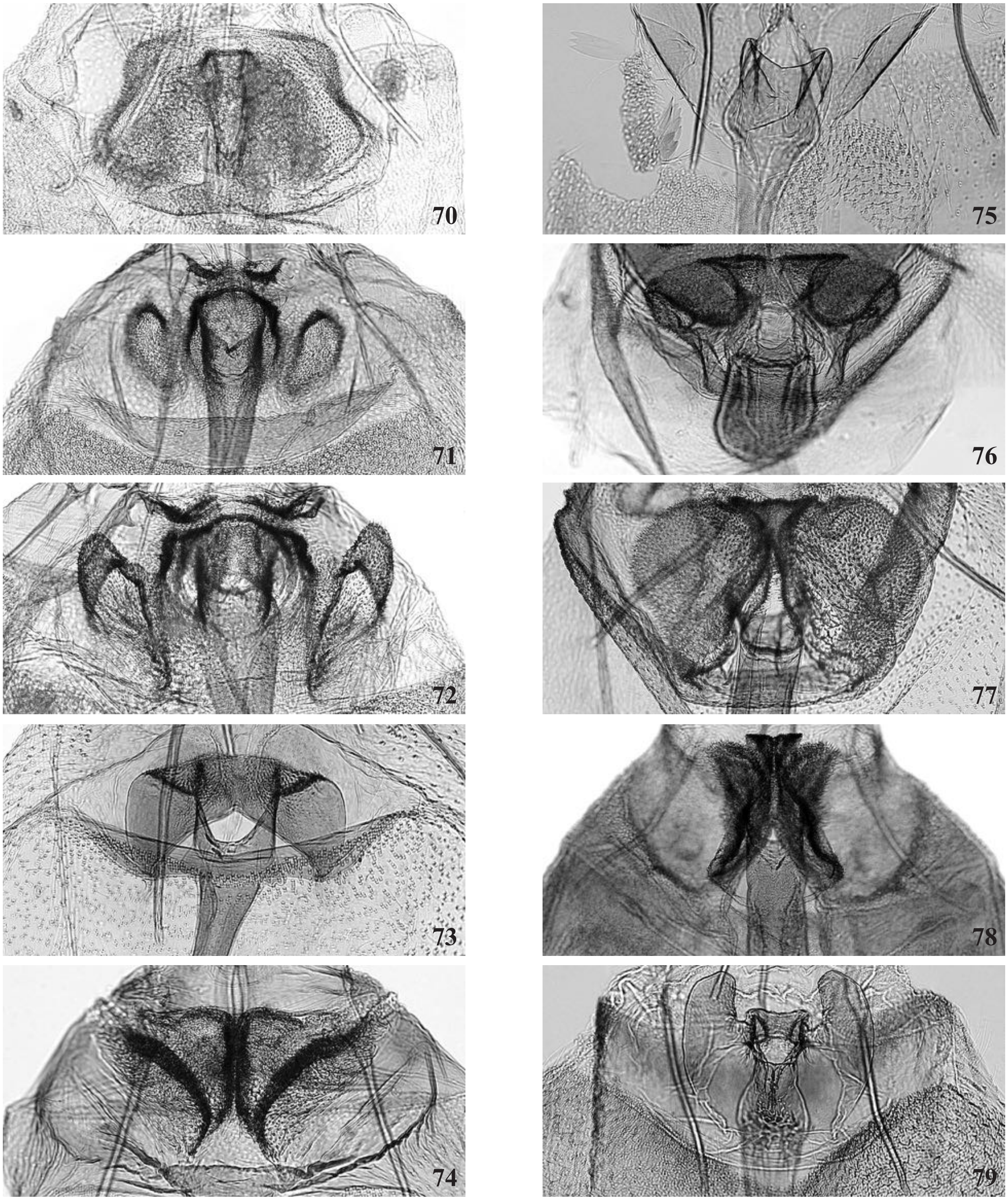


Plate 69

70. *Olethreutes troglodana* (McDunnough); **71.** *Olethreutes exaeresima* (Heinrich); **72.** *Olethreutes lacunana* (Freeman); **73.** *Olethreutes ferriferana* (Walker); **74.** *Olethreutes auricapitana* (Walsingham); **75.** *Olethreutes albiciliana* (Fernald); **76.** *Olethreutes astrologana* (Zeller); **77.** *Olethreutes coruscana* (Clemens); **78.** *Olethreutes ferrolineana* (Walker); **79.** *Olethreutes glaciana* (Möschler).

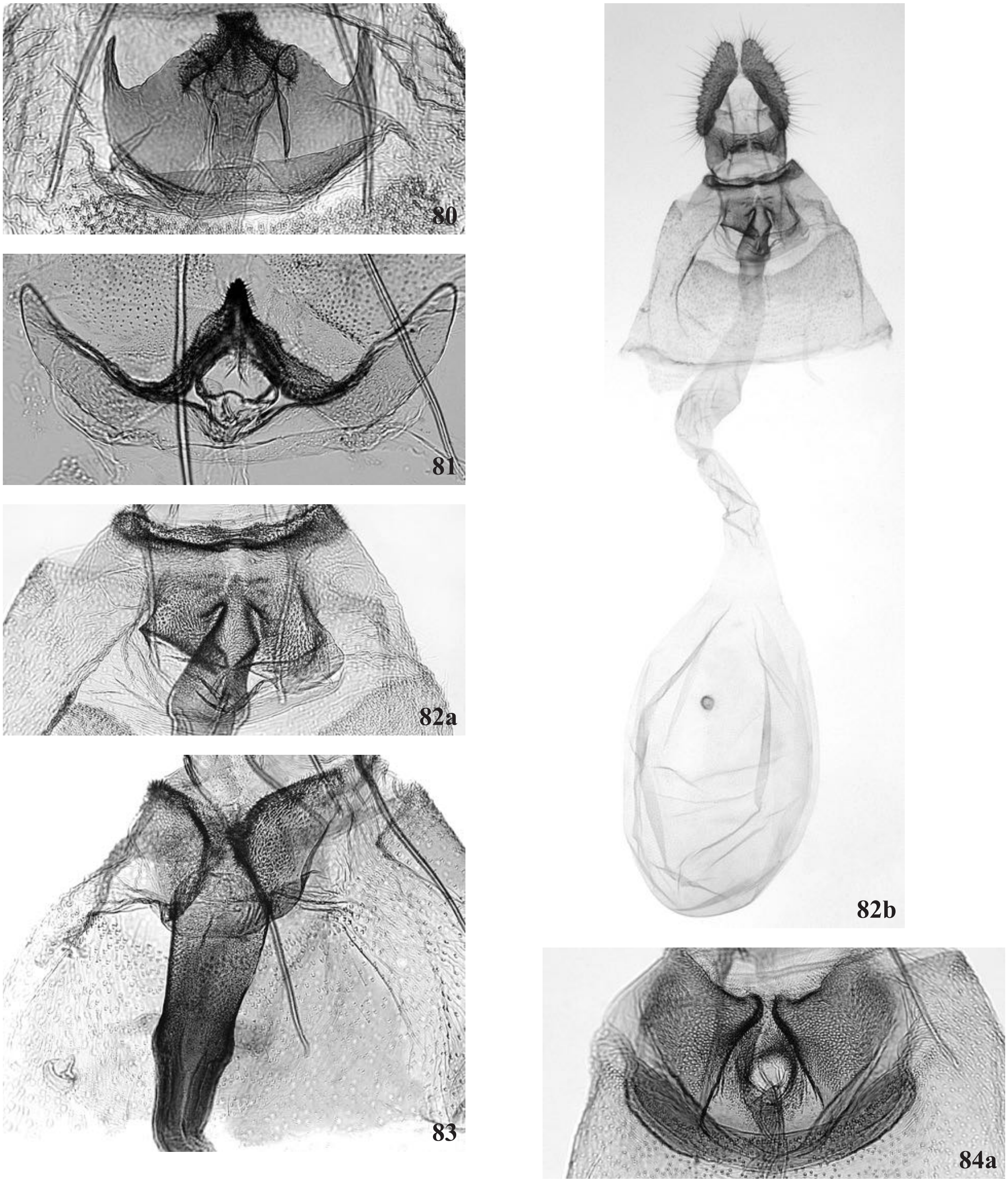


Plate 70

80. *Olethreutes bipartitana* (Clemens); **81.** *Olethreutes trinitana* (McDunnough); **82a, b.** *Olethreutes griseoalbana* (Walsingham); **83.** *Olethreutes osmundana* (Fernald); **84a.** *Celypha cespitana* (Hübner).

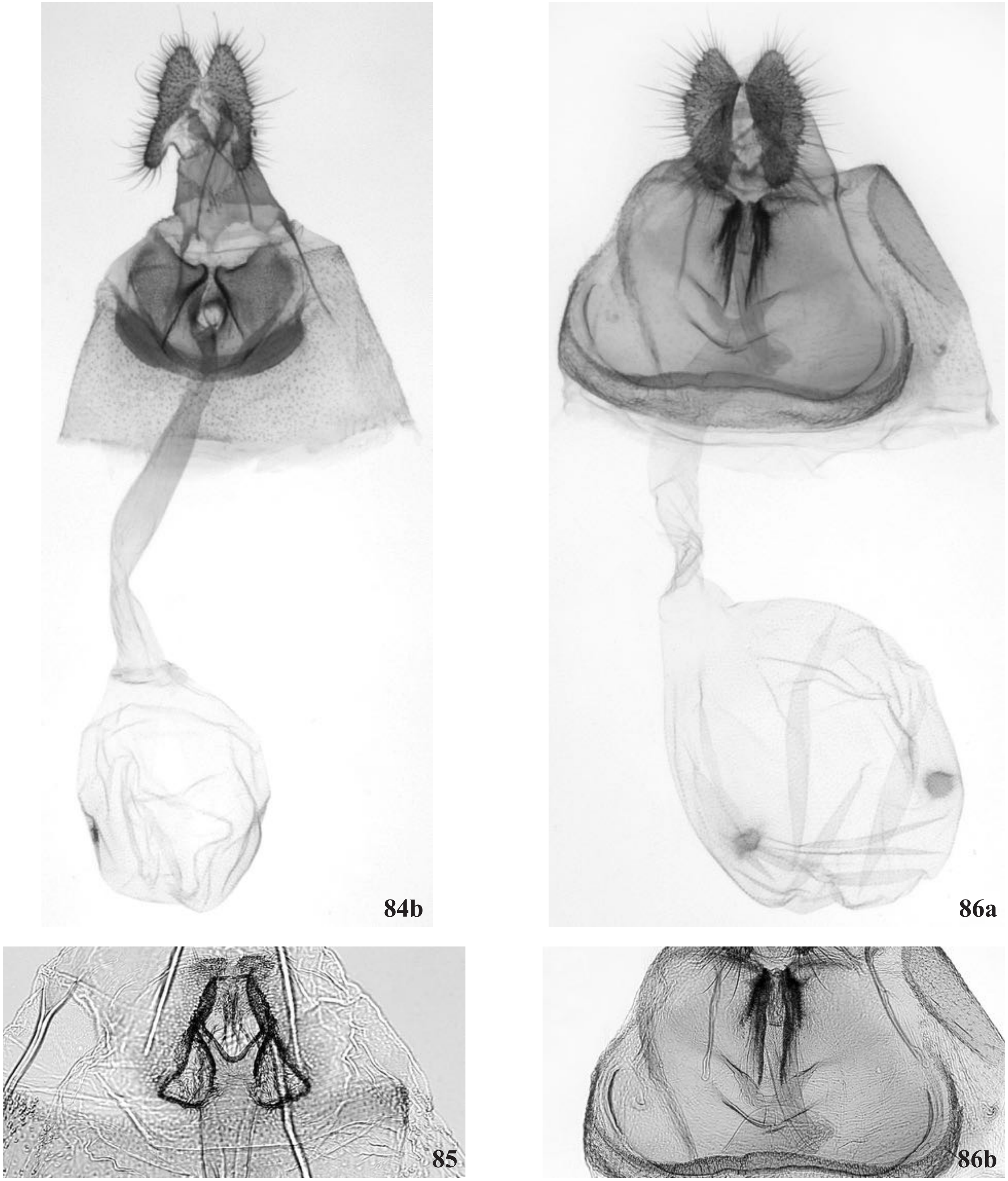


Plate 71

84b. *Celypha cespitana* (Hübner); **85.** *Pristerognatha agilana* (Clemens); **86a, b.** *Metendothenia separatana* (Kearfott).

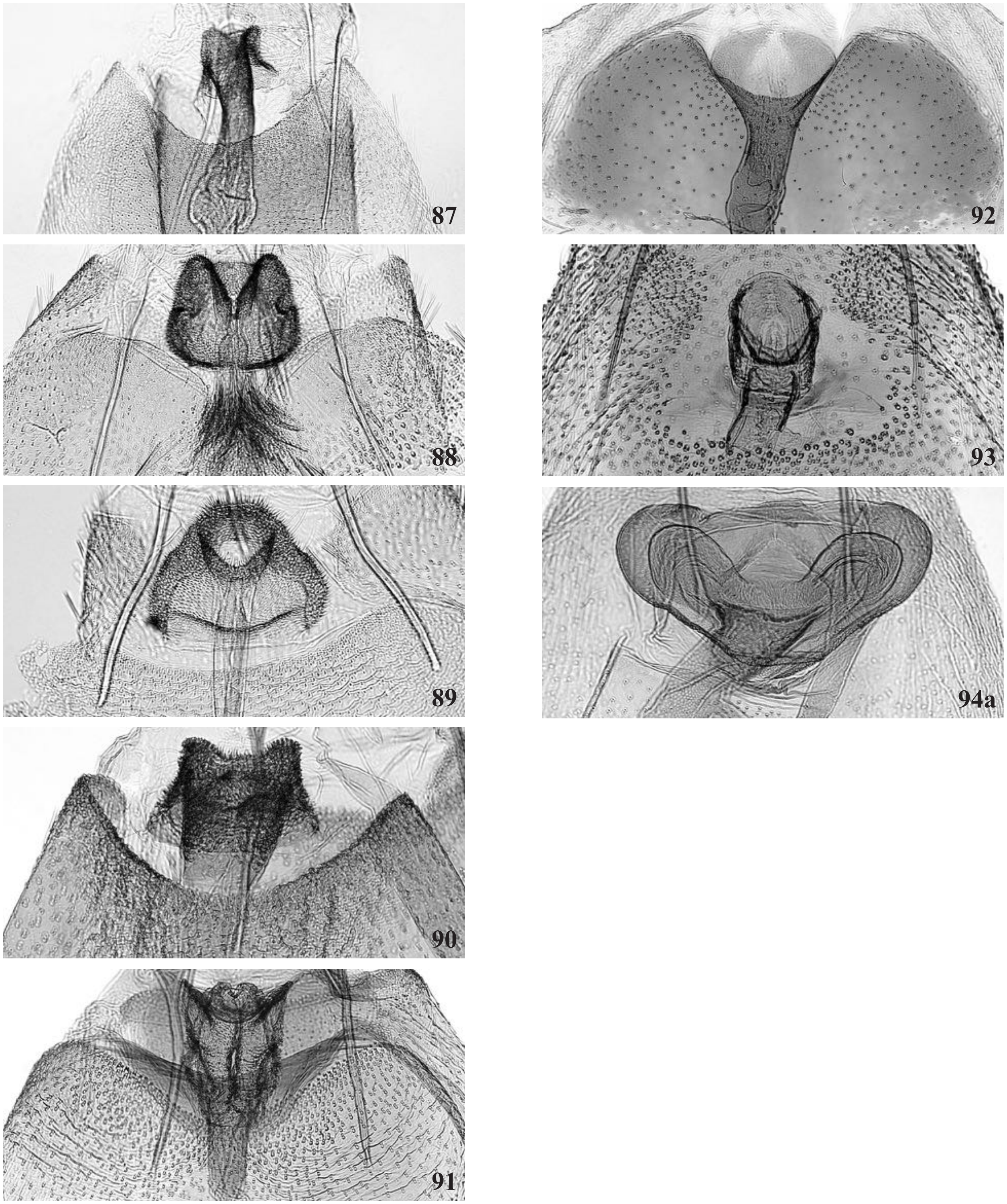


Plate 72

87. *Hedya ochroleucana* (Frölich); **88.** *Hedya nubiferana* (Haworth); **89.** *Hedya chionosema* (Zeller); **90.** *Hedya cyanana* (Murtfeldt); **91.** *Evora hemidesma* (Zeller); **92.** *Rhyacionia buoliana* (Denis & Schiffermüller); **93.** *Rhyacionia rigidana* (Fernald); **94a.** *Rhyacionia adana* Heinrich.

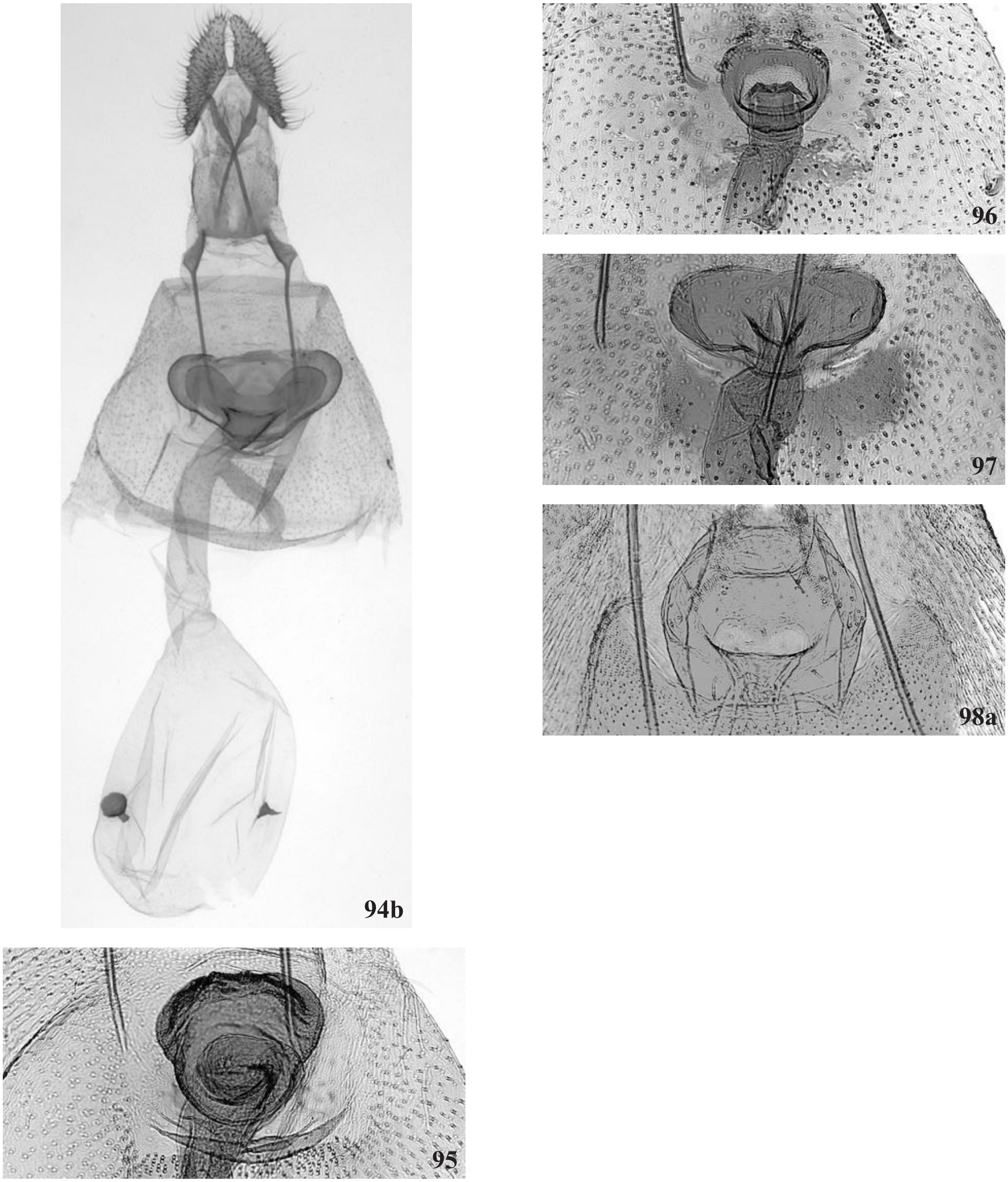


Plate 73

94b. *Rhyacionia adana* Heinrich; **95.** *Rhyacionia busckana* Heinrich; **96.** *Rhyacionia frustrana* (Scudder); **97.** *Rhyacionia aktita* Miller; **98a.** *Retinia comstockiana* Fernald.

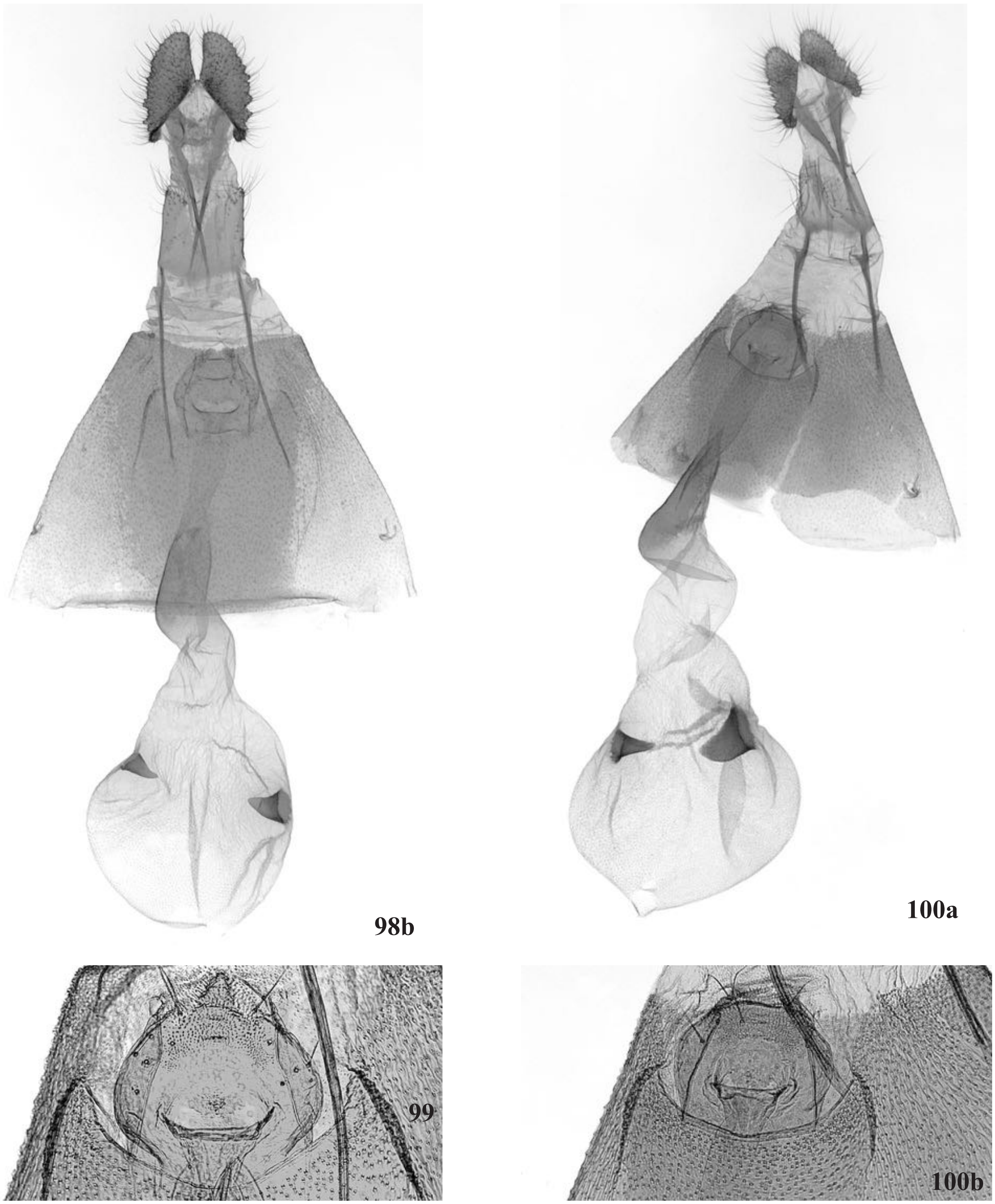


Plate 74
98b. *Retinia comstockiana* Fernald; **99.** *Retinia virginiana* (Busck); **100a, b.** *Retinia albicapitana* (Busck).

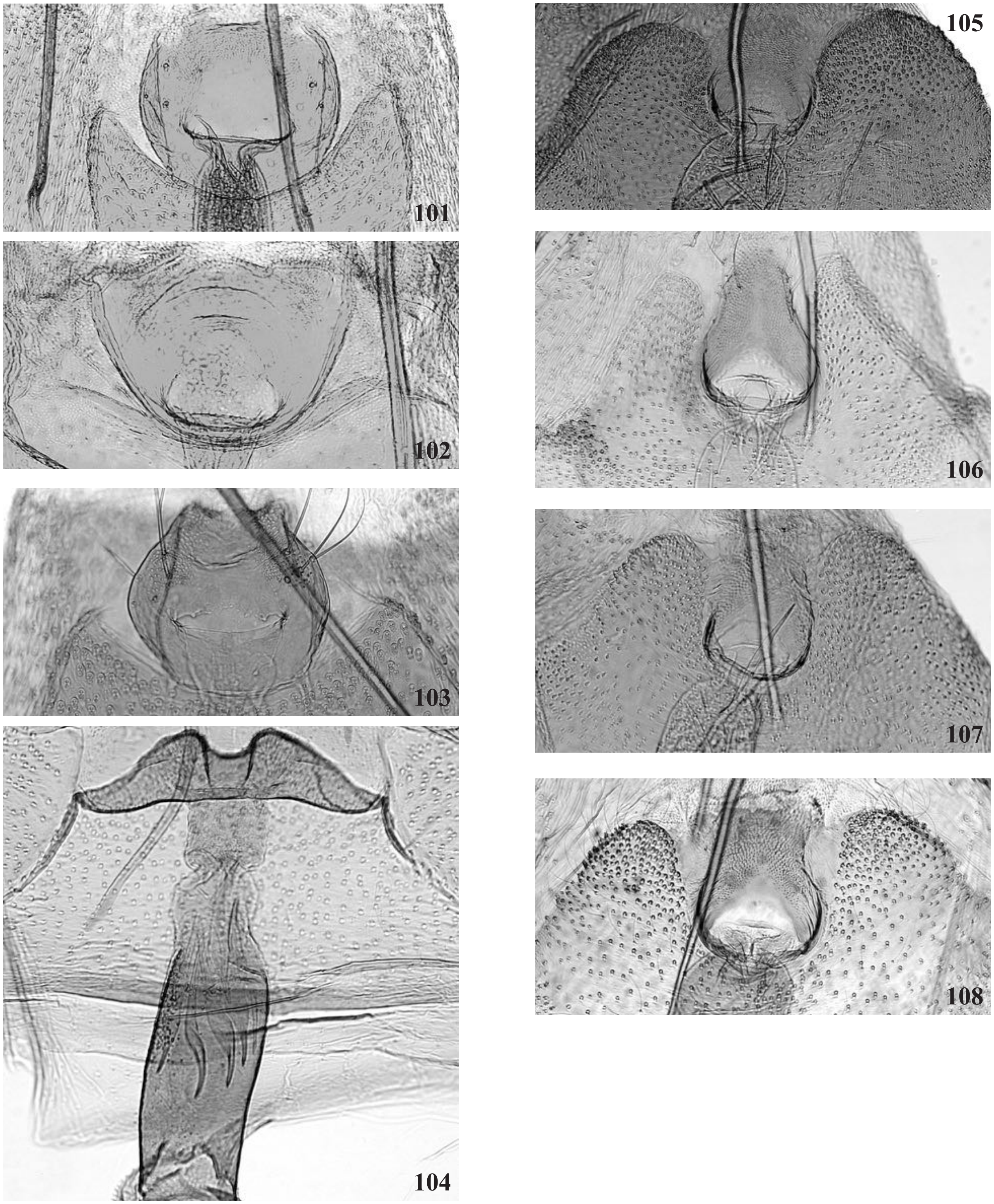


Plate 75

101. *Retinia metallica* (Busck); **102.** *Retinia gemistrigulana* (Kearfott); **103.** *Retinia houseri* (Miller); **104.** *Spilonota ocellana* (Denis & Schiffermüller); **105.** *Phaneta formosana* (Clemens); **106.** *Phaneta essexana* (Kearfott); **107.** *Phaneta awemeana* (Kearfott); **108.** *Phaneta umbrastriana* (Kearfott).

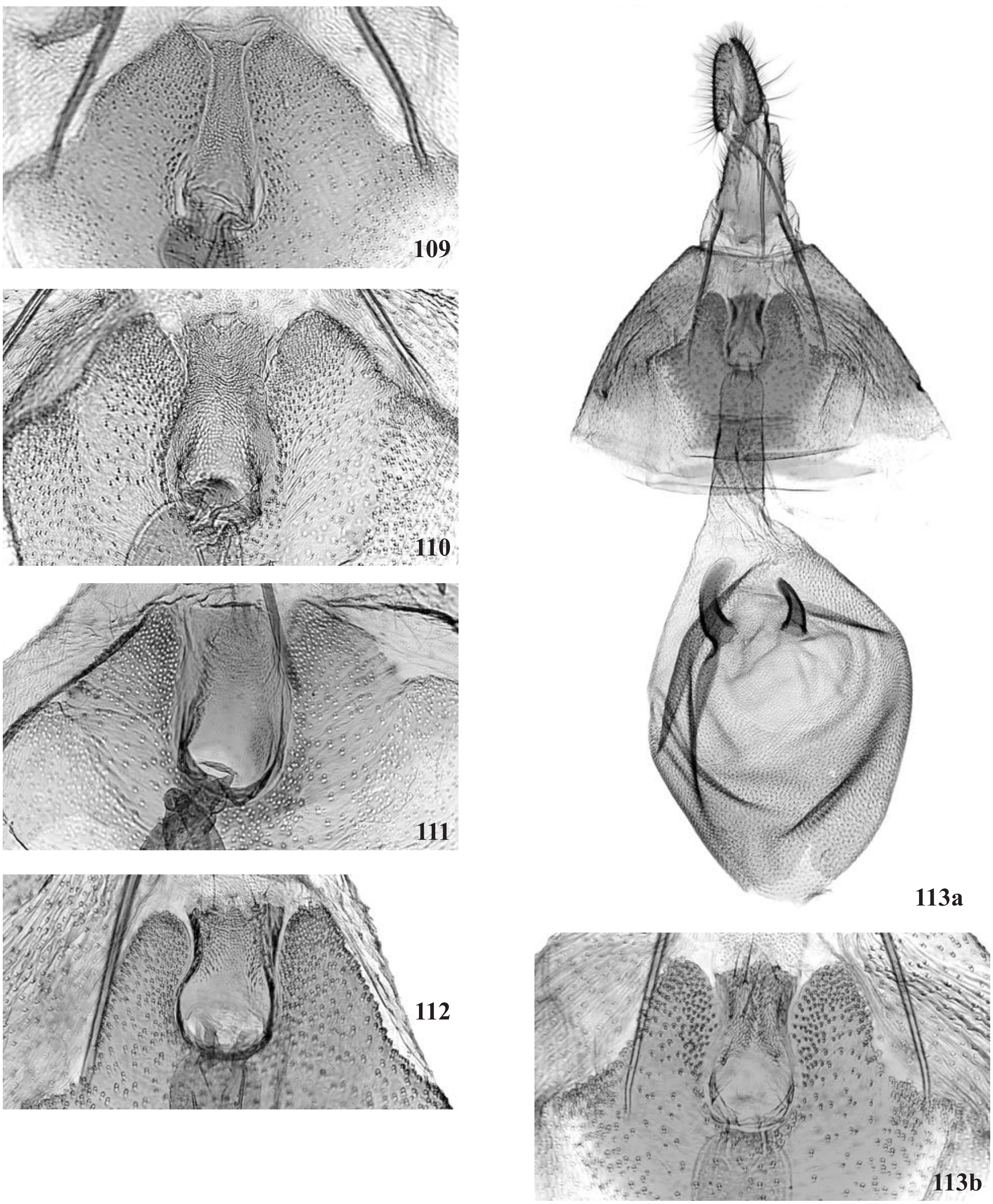


Plate 76
109. *Phaneta annetteana* (Kearfott); **110.** *Phaneta autumnana* (McDunnough); **111.** *Phaneta verna* Miller; **112.** *Phaneta ochrocephala* (Walsingham); **113a, b.** *Phaneta raracana* (Kearfott).

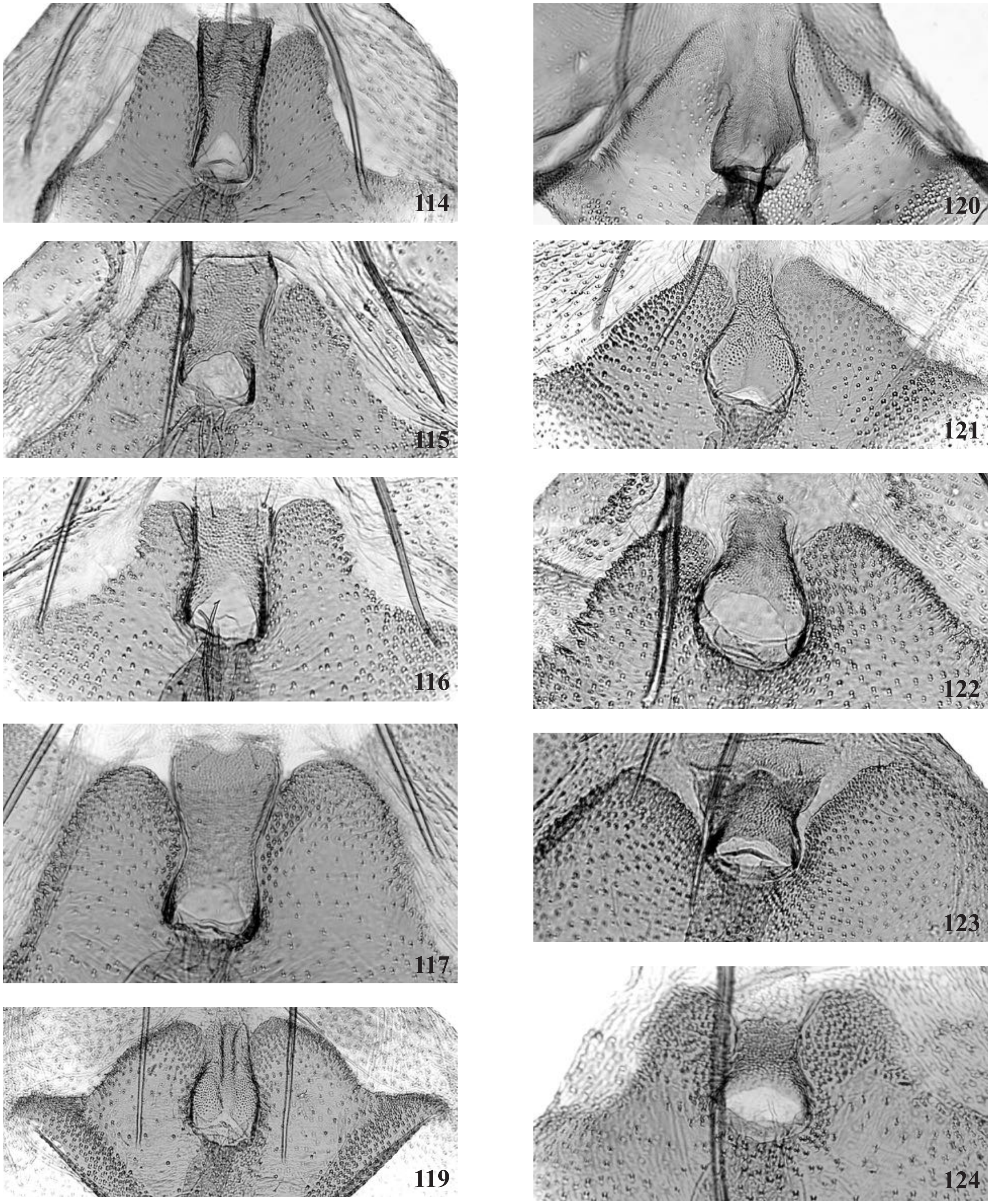


Plate 77

114. *Phaneta ochroterminana* (Kearfott); **115.** *Phaneta marmontana* (Kearfott); **116.** *Phaneta tomonana* (Kearfott); **117.** *Phaneta parmatana* (Clemens); **118. (not shown)** *Phaneta convergana* (McDunnough) [female unknown]; **119.** *Phaneta kokana* (Kearfott); **120.** *Phaneta canusana* Wright; **121.** *Phaneta ambodaidaleia* Miller; **122.** *Phaneta influana* (Heinrich); **123.** *Phaneta ornatula* (Heinrich); **124.** *Phaneta clavana* (Fernald).

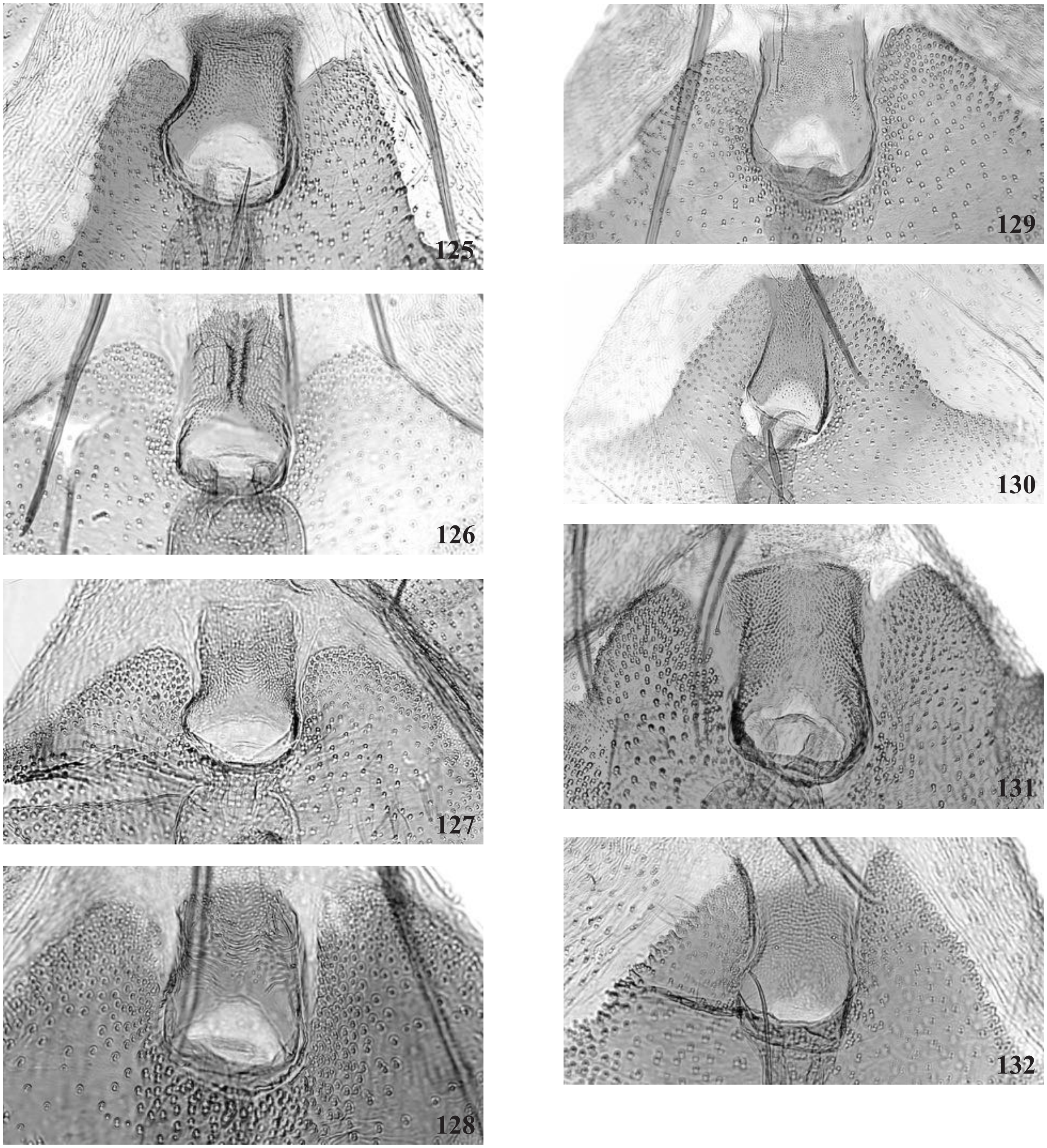
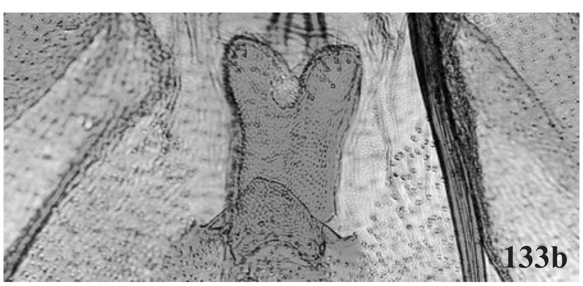


Plate 78

125. *Phaneta argenticostana* (Walsingham); **126.** *Phaneta striatana* (Clemens); **127.** *Phaneta pallidicostana* (Walsingham); **128.** *Phaneta kiscana* (Kearfott); **129.** *Phaneta montanana* (Walsingham); **130.** *Phaneta stramineana* (Walsingham); **131.** *Phaneta olivaceana* (Riley); **132.** *Phaneta argutipunctana* Blanchard & Knudson.



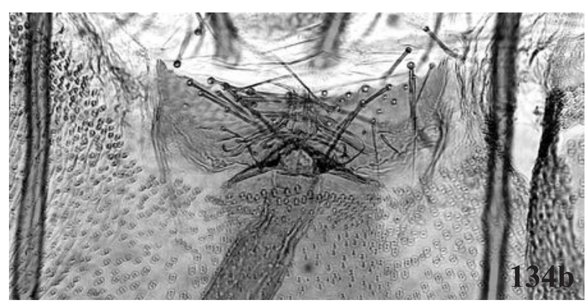


Plate 79
133a, b. *Eucosma quinquemaculana* (Robinson); **134a, b.** *Eucosma robinsonana* (Grote).

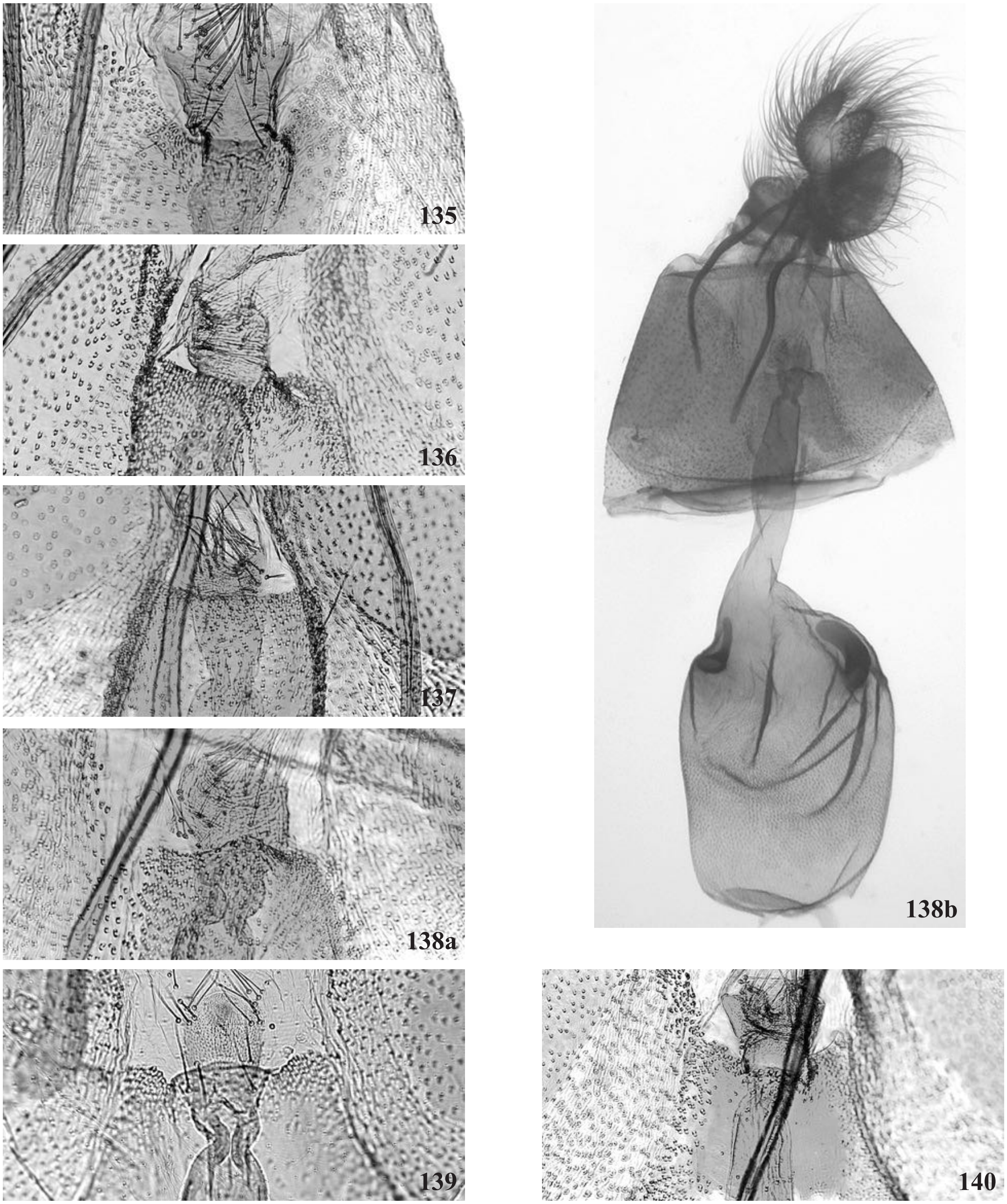


Plate 80

135. *Eucosma ridingsana* (Robinson); **136.** *Eucosma heathiana* Kearfott; **137.** *Eucosma morrisoni* (Walsingham); **138a, b.** *Eucosma agricolana* (Walsingham); **139.** *Eucosma smithiana* (Walsingham); **140.** *Eucosma comatulana* (Zeller).

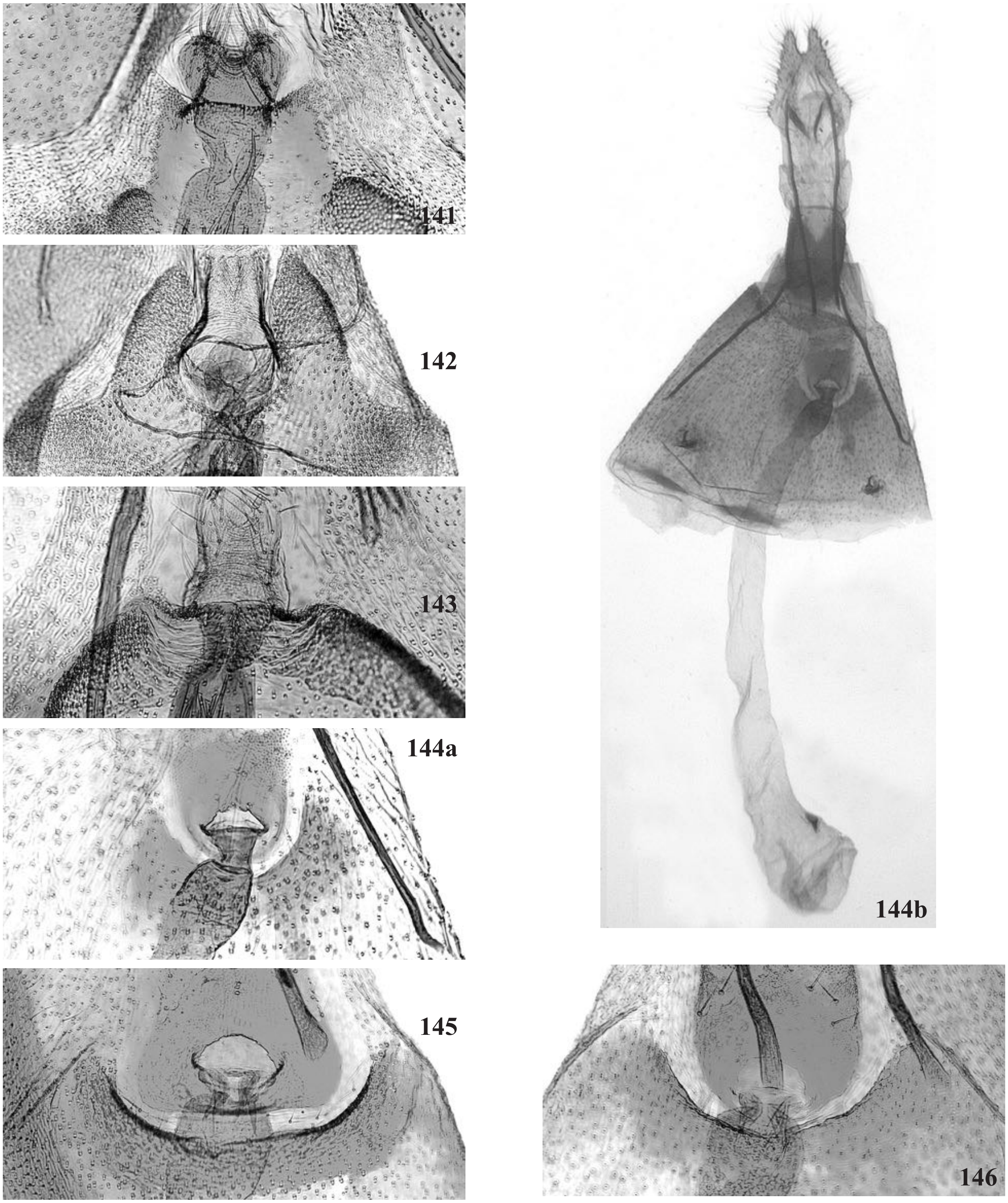


Plate 81

141. *Eucosma vagana* McDunnough; **142.** *Eucosma glomerana* (Walsingham); **143.** *Eucosma albiguttana* (Zeller); **144a, b.** *Eucosma gloriola* Heinrich; **145.** *Eucosma cocana* Kearfott; **146.** *Eucosma monitorana* Heinrich.

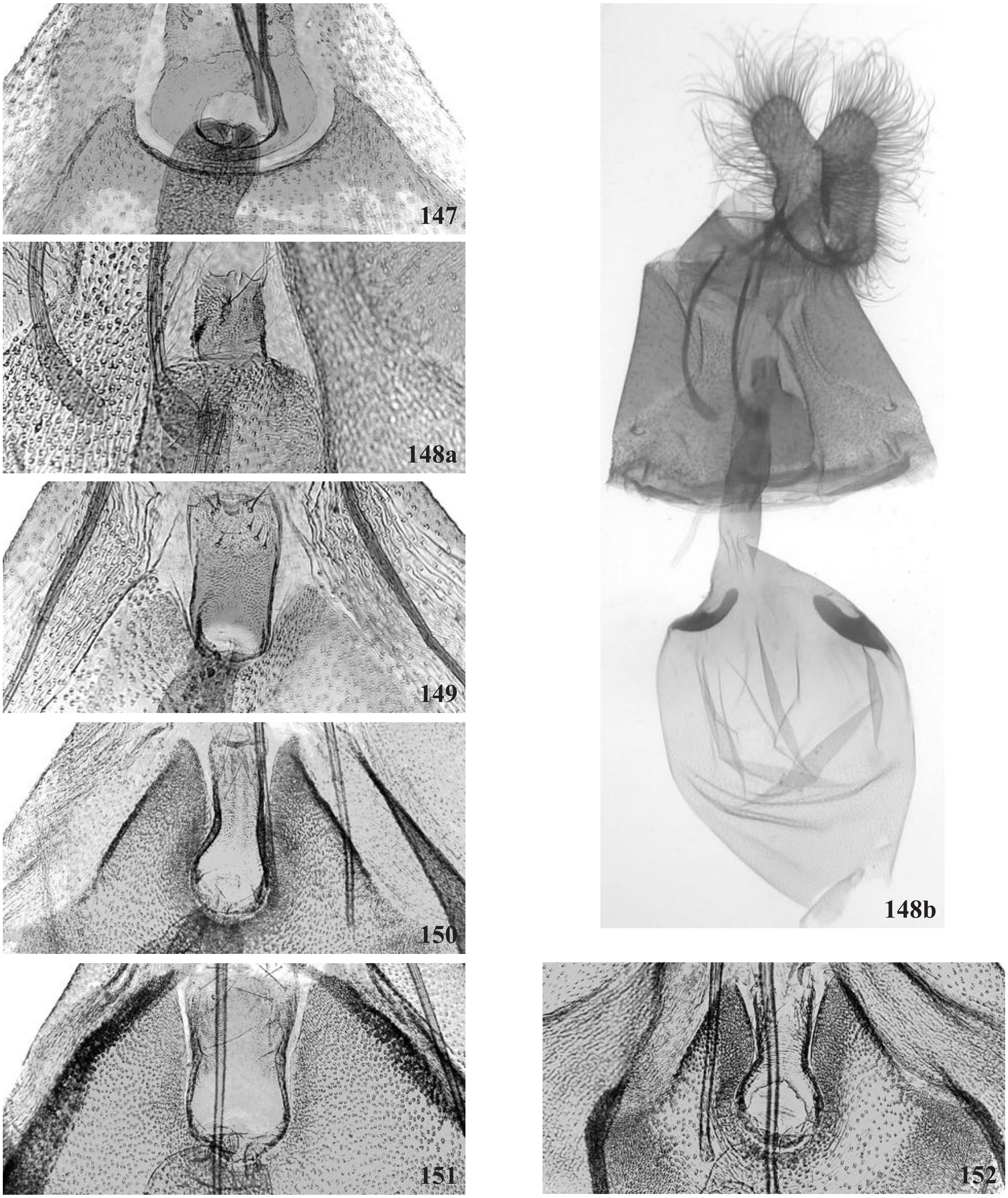


Plate 82

147. *Eucosma tocullionana* Heinrich; **148a, b.** *Eucosma palabundana* Heinrich; **149.** *Eucosma matutina* (Grote); **150.** *Eucosma giganteana* (Riley); **151.** *Eucosma bipunctella* (Walker); **152.** *Eucosma bilineana* Kearfott.

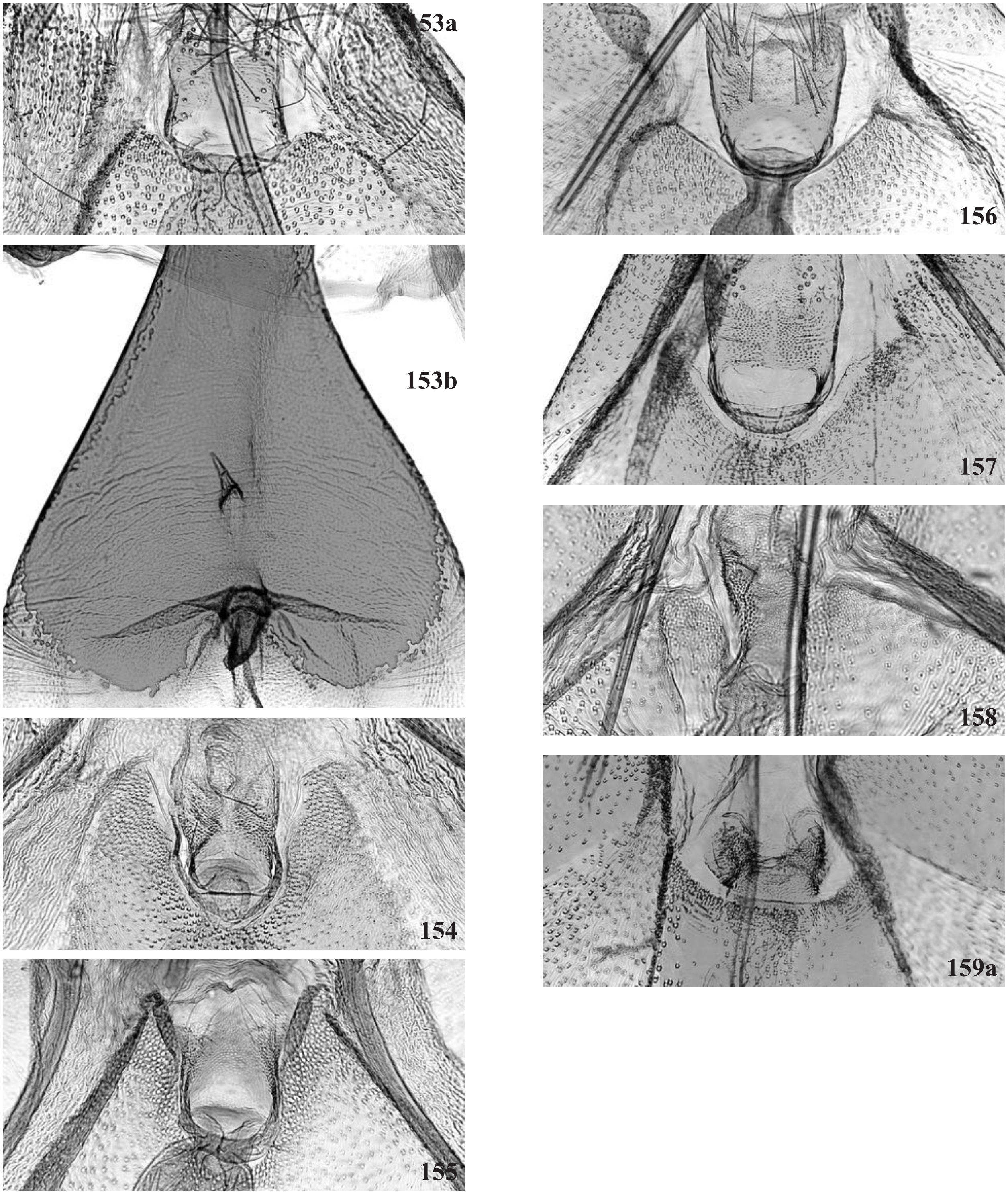
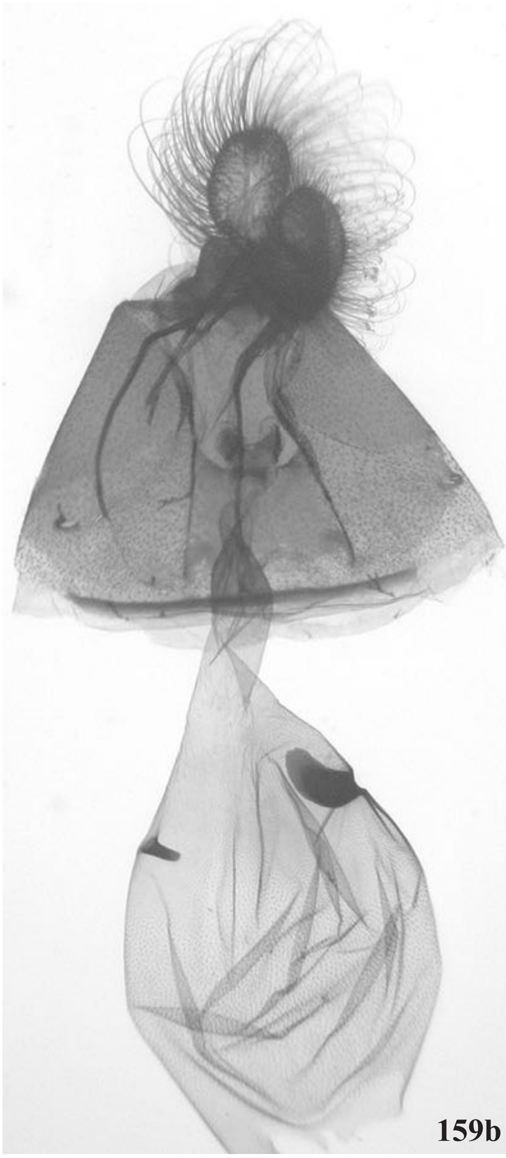
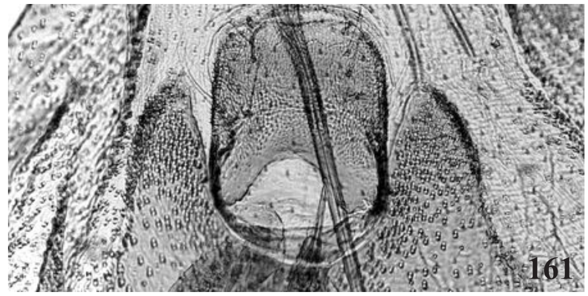
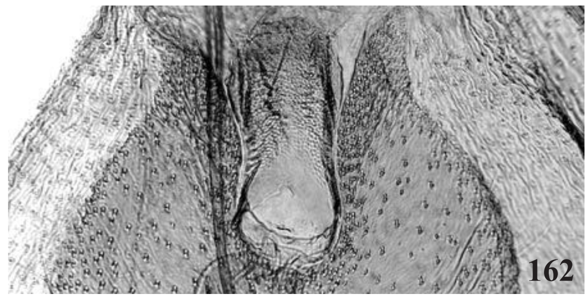


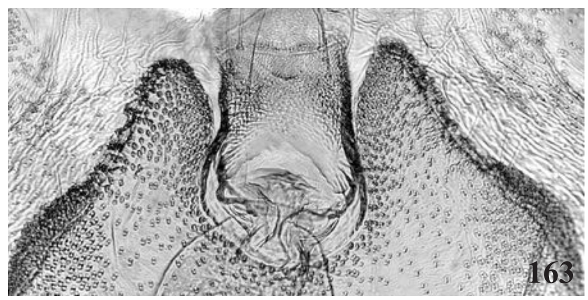
Plate 83

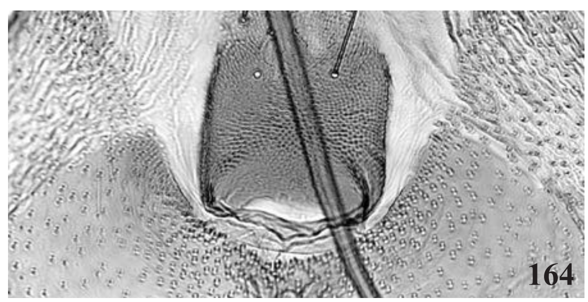
153a, b. *Eucosma nandana* Kearfott; **154.** *Eucosma landana* Kearfott; **155.** *Eucosma simplex* McDunnough; **156.** *Eucosma dosisignatana* (Clemens); **157.** *Eucosma similiana* Clemens; **158.** *Eucosma derelicta* Heinrich; **159a.** *Eucosma wandana* Kearfott.

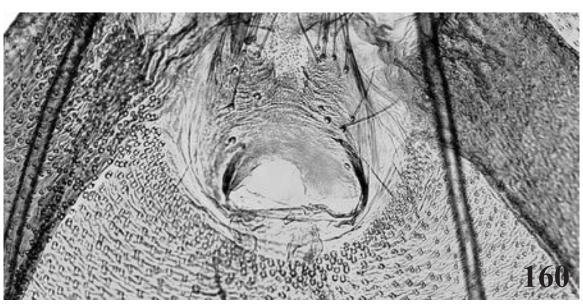












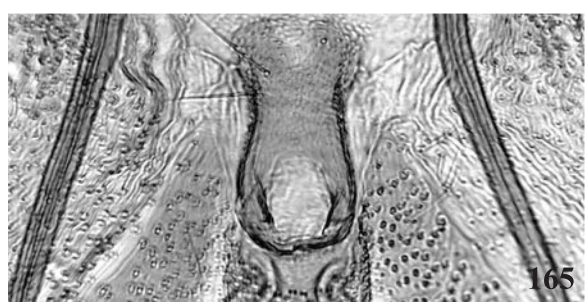


Plate 84

159b. *Eucosma wandana* Kearfott; **160.** *Eucosma fulminana* (Walsingham); **161.** *Eucosma rusticana* Kearfott; **162.** *Eucosma haydenae* Wright; **163.** *Eucosma sombreana* Kearfott; **164.** *Eucosma fiskeana* Kearfott; **165.** *Eucosma consobrinana* Heinrich.

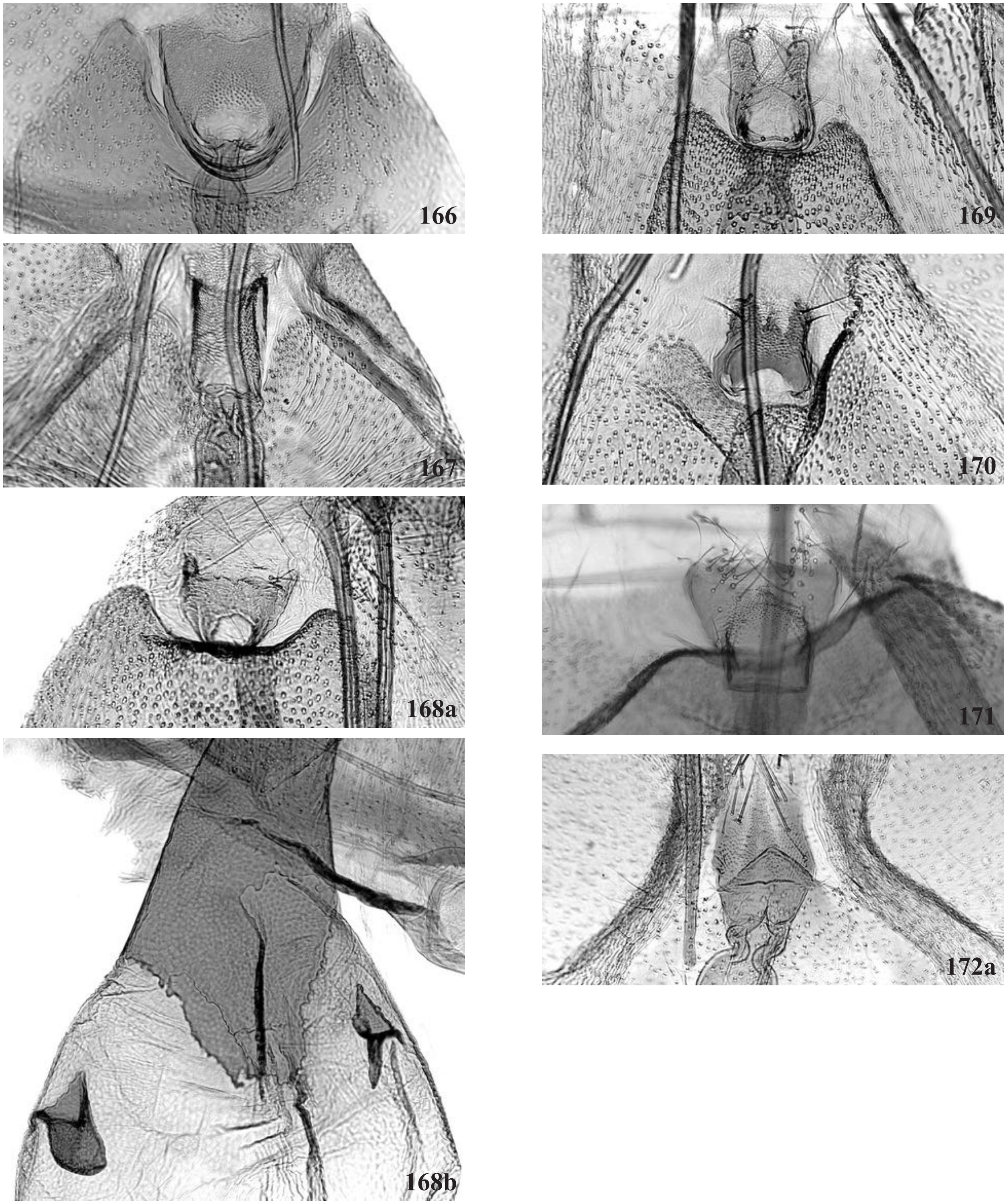
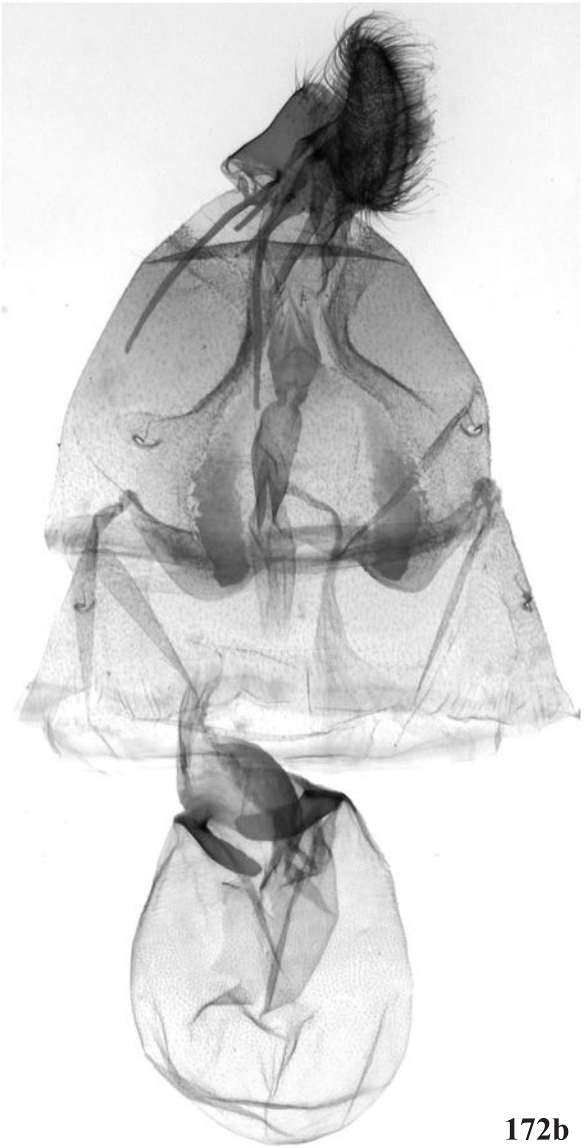
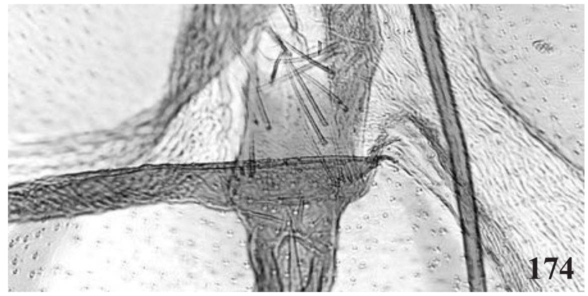
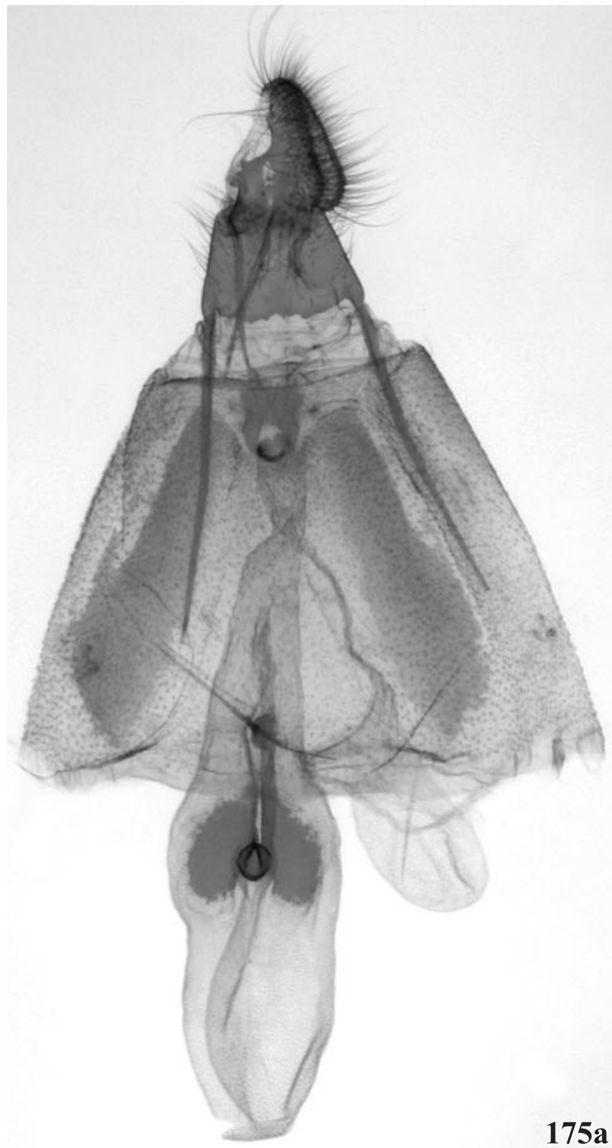


Plate 85

166. *Eucosma gomonana* Kearfott; **167.** *Eucosma cataclystiana* (Walker); **168.** *Pelochrista argenteana* (Walsingham), **a.** sterigma, **b.** corpus bursae; **169.** *Pelochrista scintillana* (Clemens); **170.** *Pelochrista pallidipalpana* (Kearfott); **171.** *Pelochrista corosana* (Walsingham); **172a.** *Pelochrista rorana* (Kearfott).







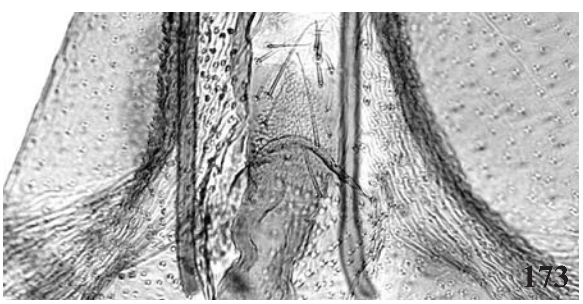


Plate 86

172b. *Pelochrista rorana* (Kearfott); **173.** *Pelochrista zomonana* (Kearfott); **174.** *Pelochrista womonana* (Kearfott); **175a.** *Pelochrista milleri* Wright.

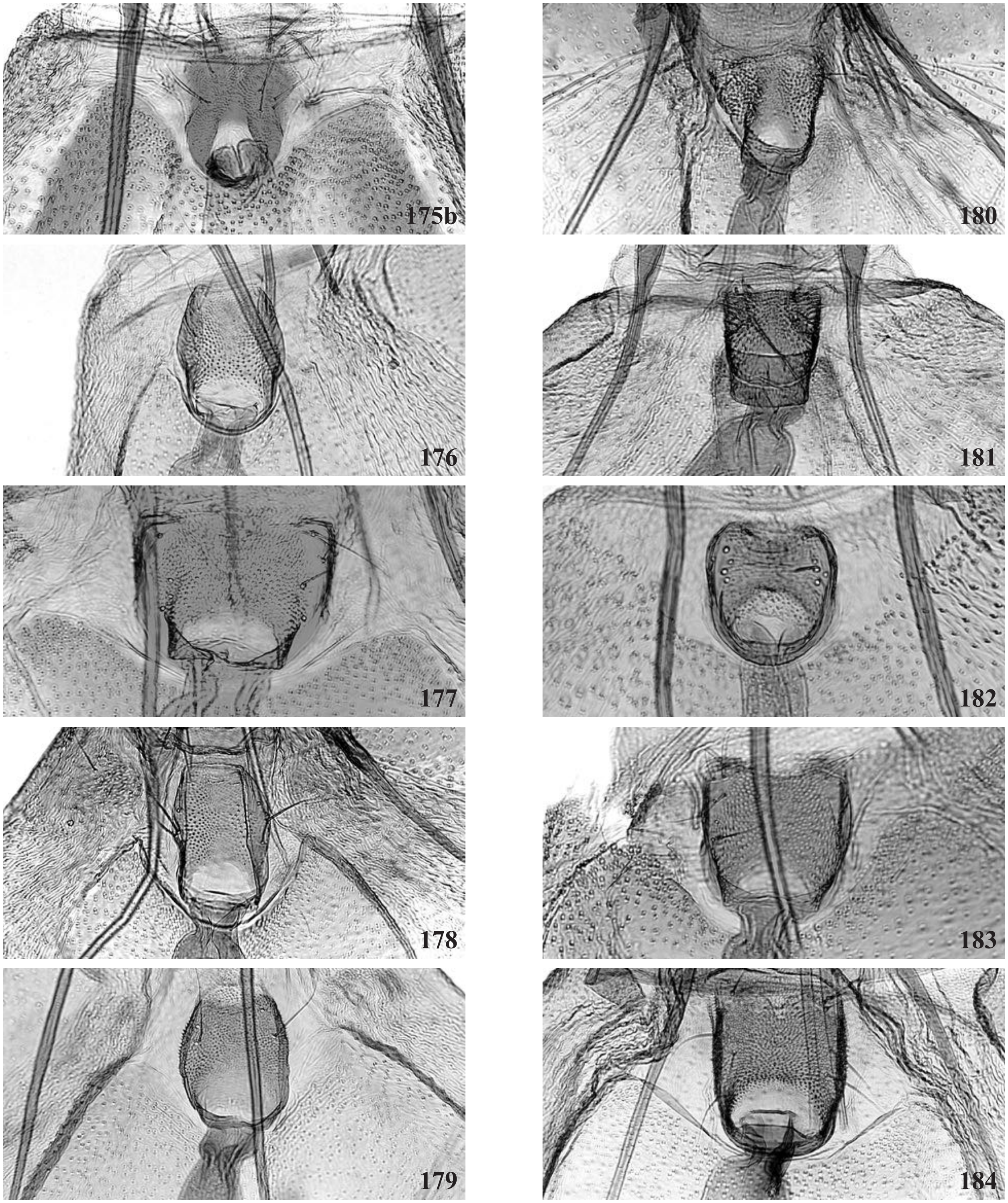


Plate 87

175b. *Pelochrista milleri* Wright; **176.** *Epiblema luctuosissima* Blanchard; **177.** *Epiblema boxcana* (Kearfott); **178.** *Epiblema strenuana* complex; **179.** *Epiblema abruptana* (Walsingham); **180.** *Epiblema tripartitana* (Zeller); **181.** *Epiblema glenni* Wright; **182.** *Epiblema resumptana* (Walker); **183.** *Epiblema benignatum* McDunnough; **184.** *Epiblema scudderiana* (Clemens).

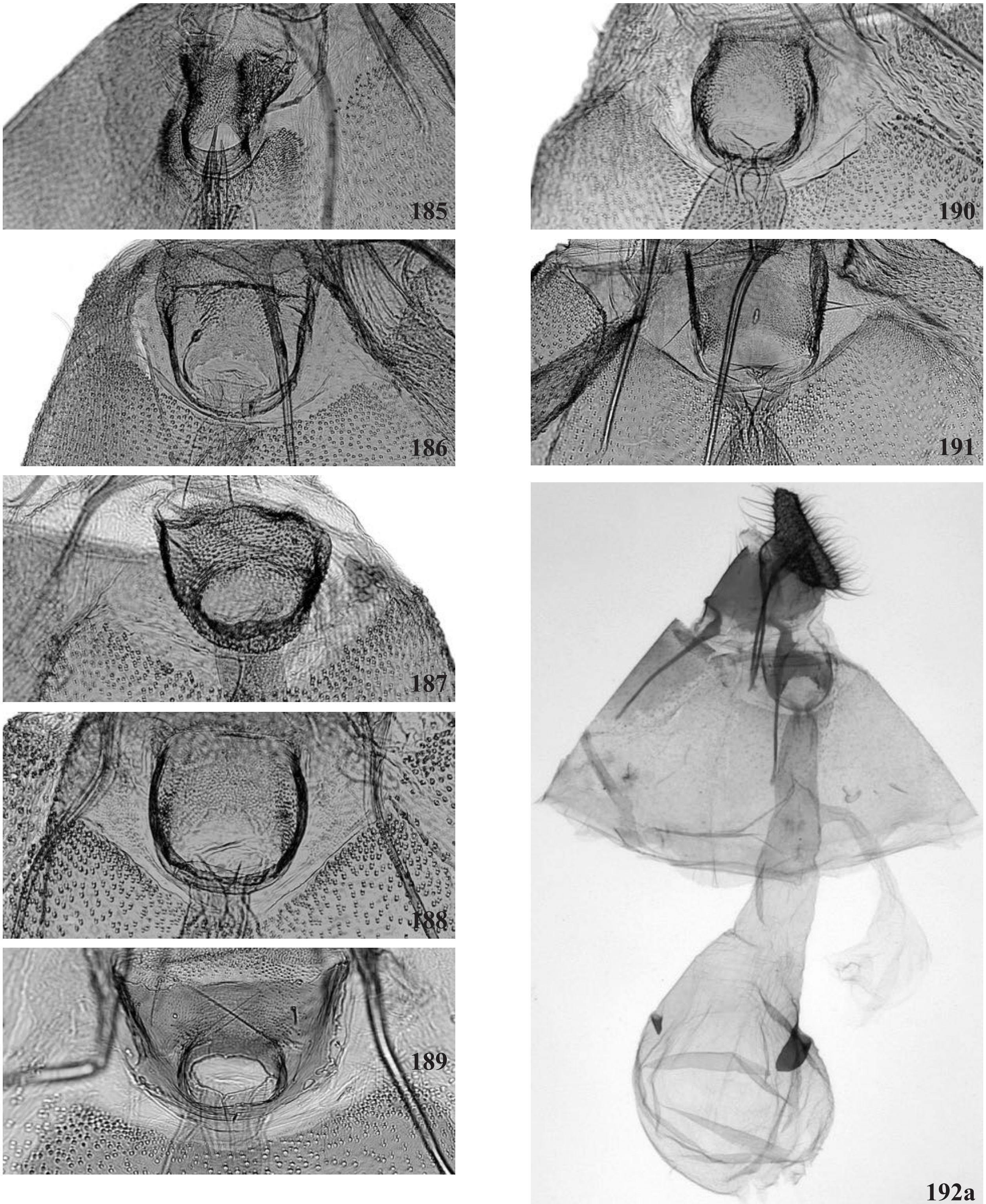


Plate 88

185. *Epiblema carolinana* (Walsingham); **186.** *Epiblema obfuscana* (Dyar); **187.** *Epiblema desertana* (Zeller); **188.** *Epiblema dorsisuffusana* (Kearfott); **189.** *Epiblema iowana* McDunnough; **190.** *Epiblema otiosana* (Clemens); **191.** *Epiblema infelix* Heinrich; **192a.** *Epiblema walsinghami* (Kearfott).

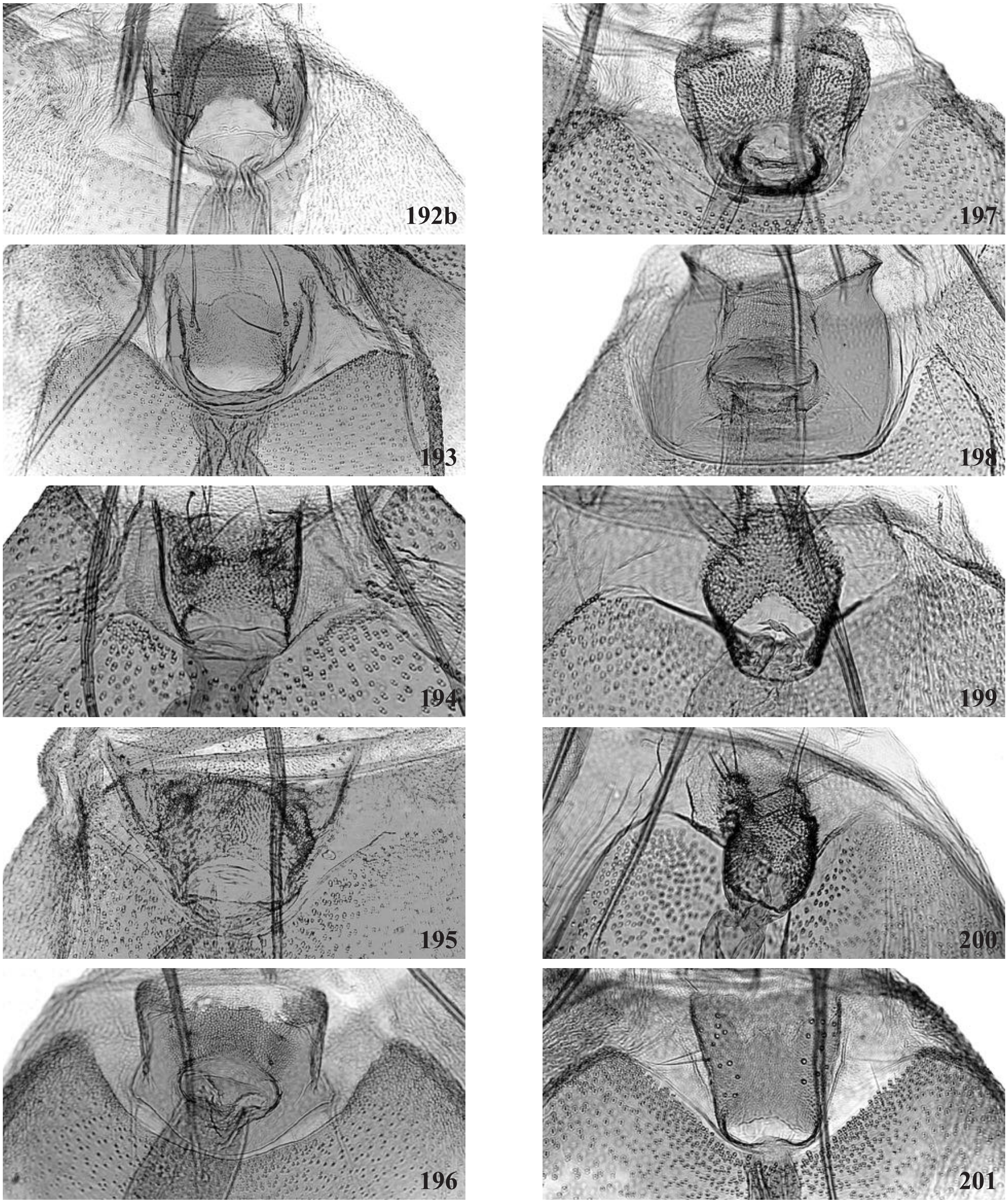


Plate 89

192b. *Epiblema walsinghami* (Kearfott); **193.** *Epiblema gibsoni* Wright & Covell; **194.** *Epiblema brightonana* (Kearfott); **195.** *Epiblema tandana* (Kearfott); **196.** *Notocelia rosaecolana* (Doubleday); **197.** *Notocelia illotana* (Walsingham); **198.** *Notocelia culminana* (Walsingham); **199.** *Suleima helianthana* (Riley); **200.** *Suleima cinerodorsana* Heinrich; **201.** *Sonia paraplesiana* Blanchard.

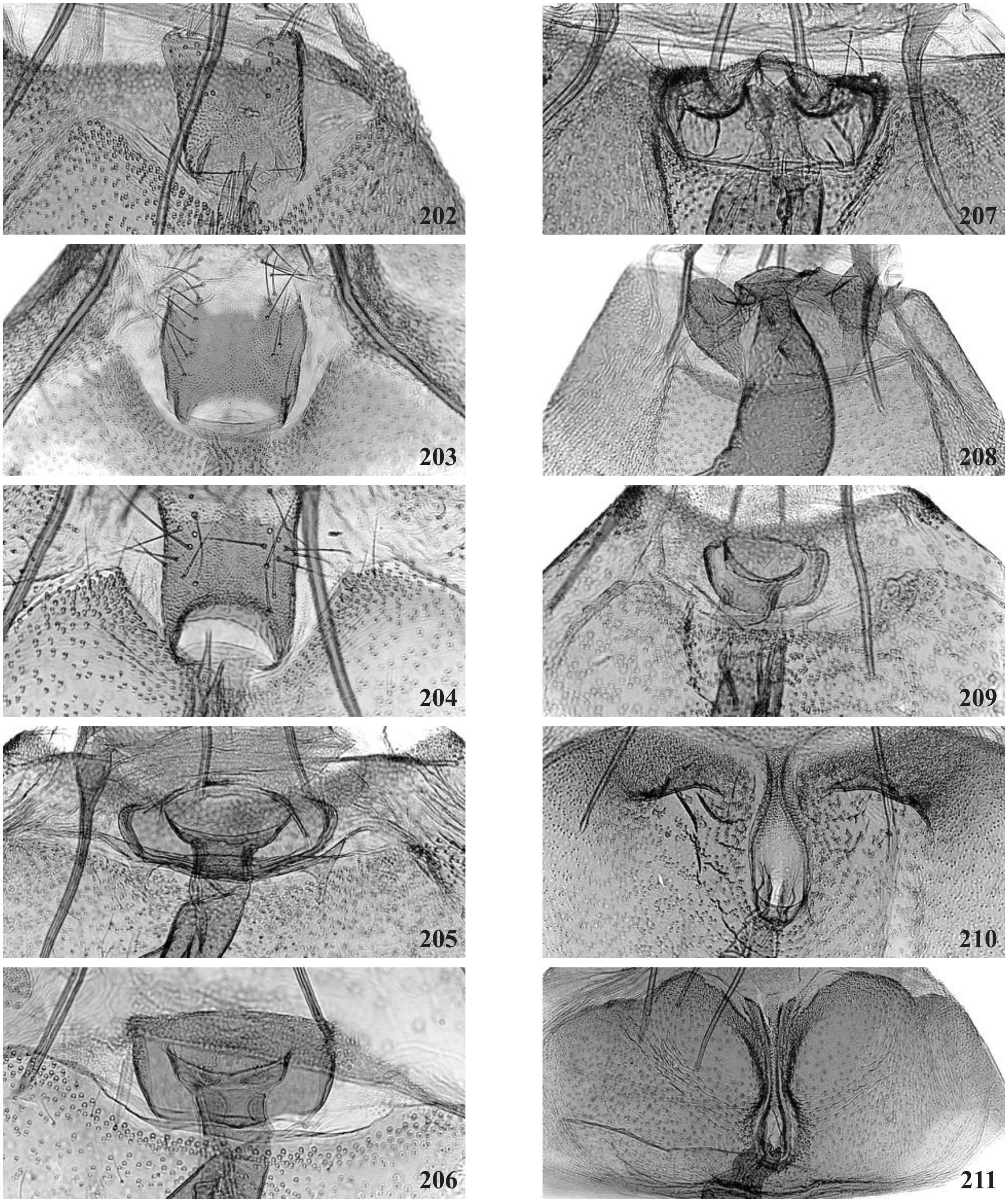


Plate 90

202. *Sonia canadana* McDunnough; **203.** *Sonia vovana* (Kearfott); **204.** *Sonia divaricata* Miller; **205.** *Gypsonoma haimbachiana* (Kearfott); **206.** *Gypsonoma salicicolana* (Clemens); **207.** *Gypsonoma adjuncta* Heinrich; **208.** *Gypsonoma fasciolana* (Clemens); **209.** *Gypsonoma substitutionis* Heinrich; **210.** *Proteoteras aesculana* Riley; **211.** *Proteoteras willingana* (Kearfott).

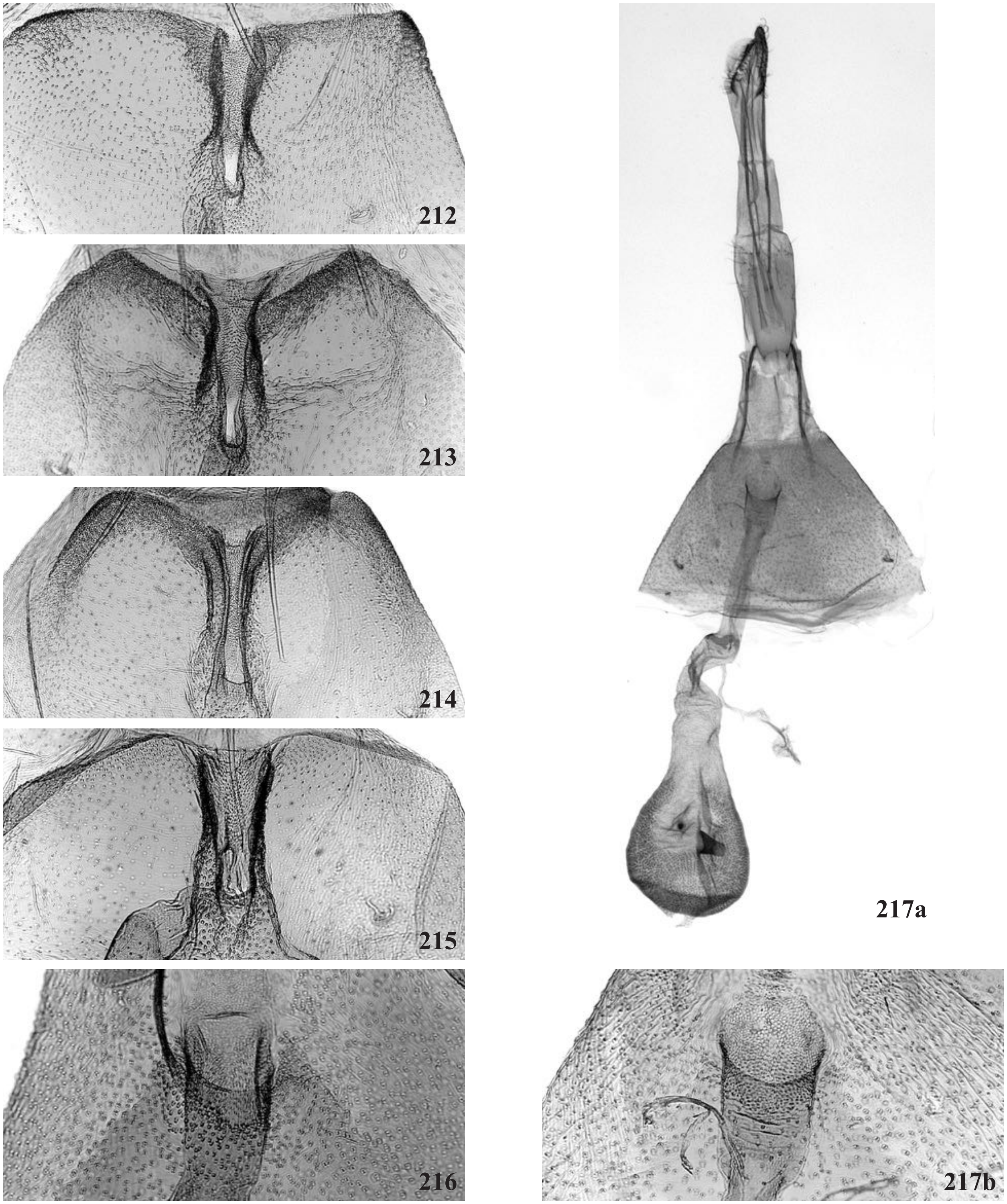


Plate 91

212. *Proteoteras crescentana* Kearfott; **213.** *Proteoteras naracana* Kearfott; **214.** *Proteoteras moffatiana* Fernald; **215.** *Proteoteras obnigrana* Heinrich; **216.** *Zeiraphera claypoleana* (Riley); **217a, b.** *Zeiraphera canadensis* Mutuura & Freeman.

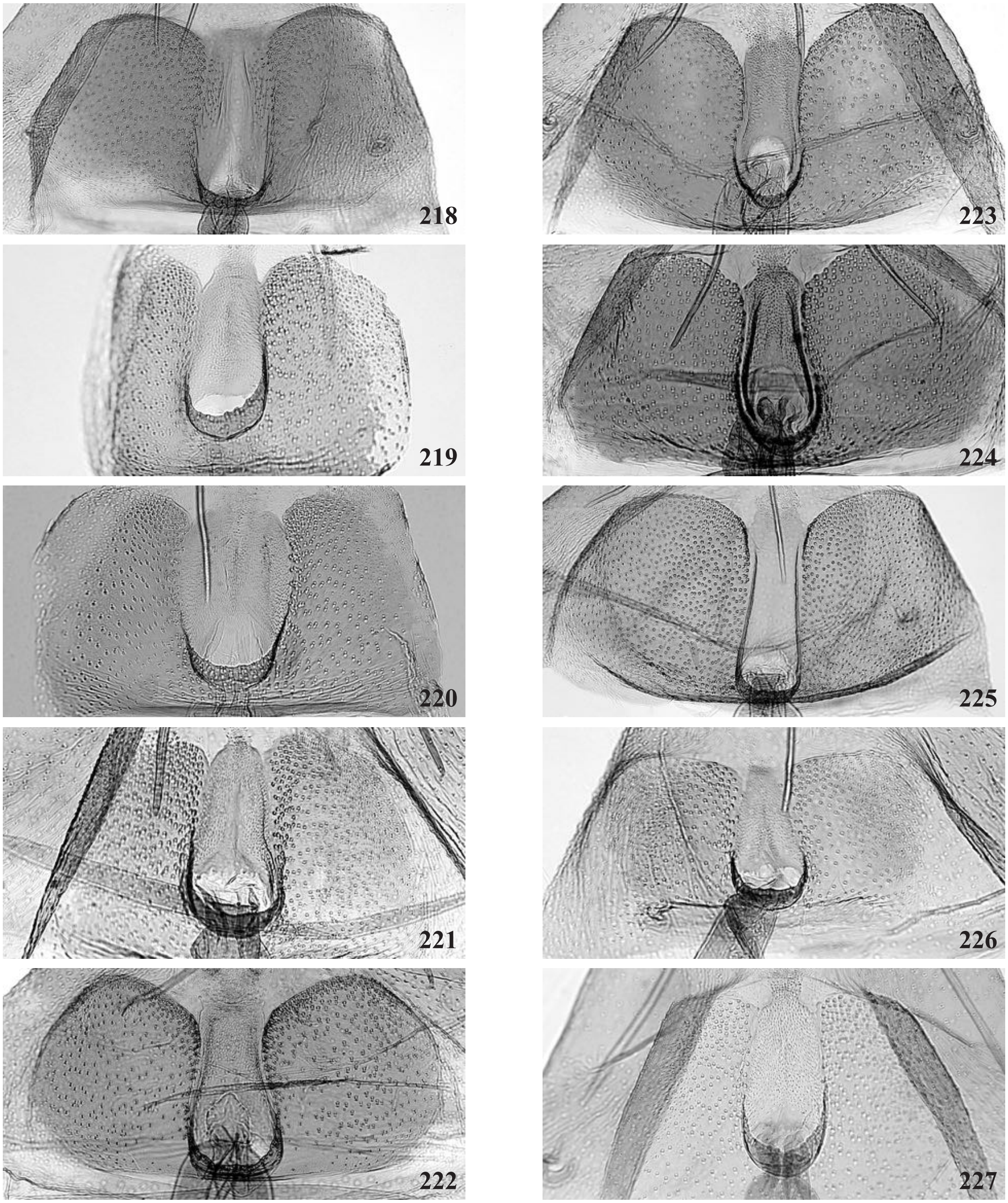


Plate 92

218. *Pseudexentera cressoniana* (Clemens); **219.** *Pseudexentera mali* Freeman; **220.** *Pseudexentera oregonana* (Walsingham); **221.** *Pseudexentera spoliana* (Clemens); **222.** *Pseudexentera haracana* (Kearfott); **223.** *Pseudexentera faracana* (Kearfott); **224.** *Pseudexentera sepia* Miller; **225.** *Pseudexentera hodsoni* Miller; **226.** *Pseudexentera maracana* (Kearfott); **227.** *Pseudexentera kalmiana* McDunnough.

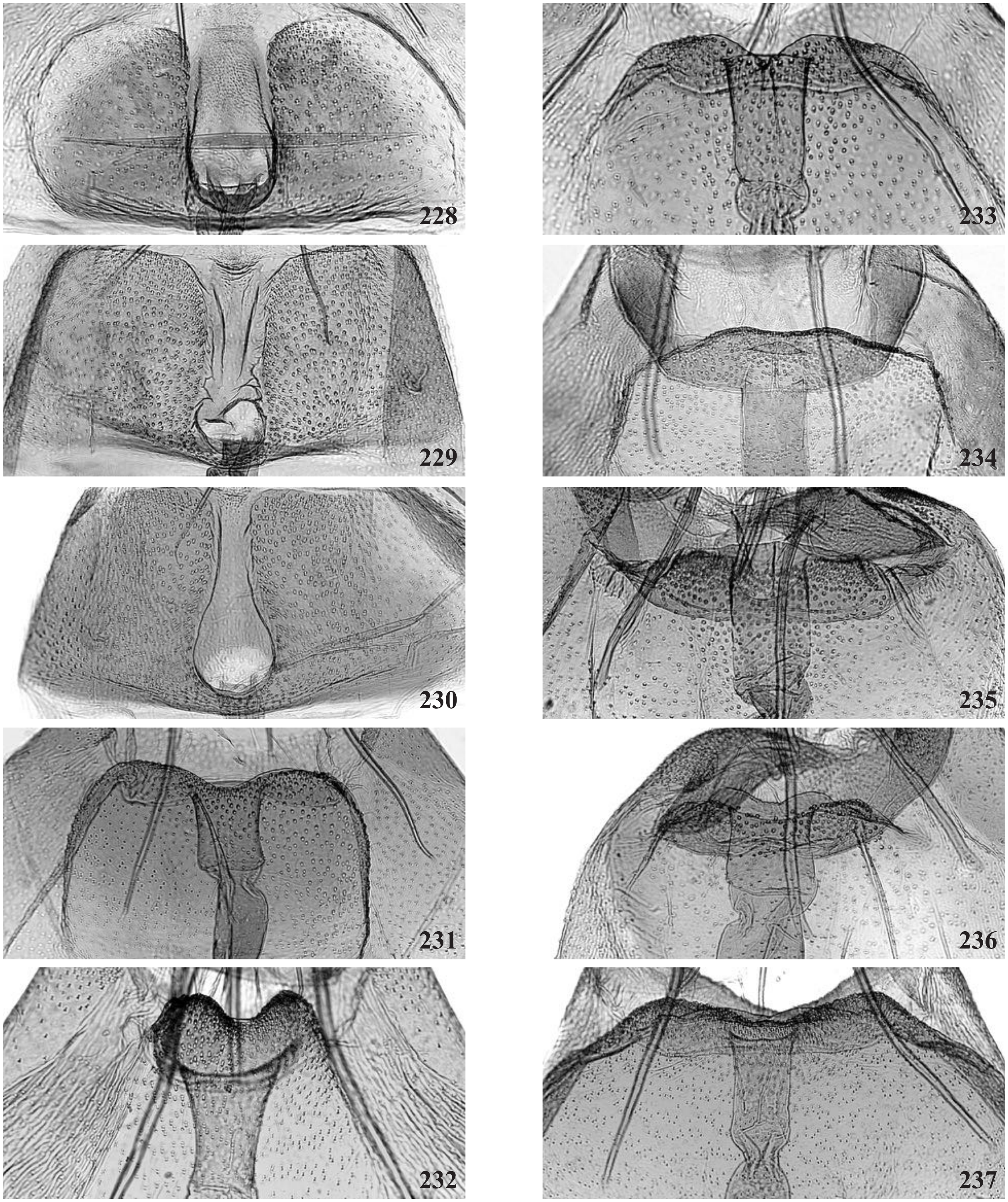


Plate 93

228. *Pseudexentera vaccinii* Miller; **229.** *Pseudexentera costomaculana* (Clemens); **230.** *Pseudexentera virginiana* (Clemens); **231.** *Gretchena deludana* (Clemens); **232.** *Gretchena concubitana* Heinrich; **233.** *Gretchena watchungana* (Kearfott); **234.** *Gretchena bolliana* (Slingerland); **235.** *Gretchena amatana* Heinrich; **236.** *Gretchena delicatana* Heinrich; **237.** *Gretchena concitatricana* (Heinrich).

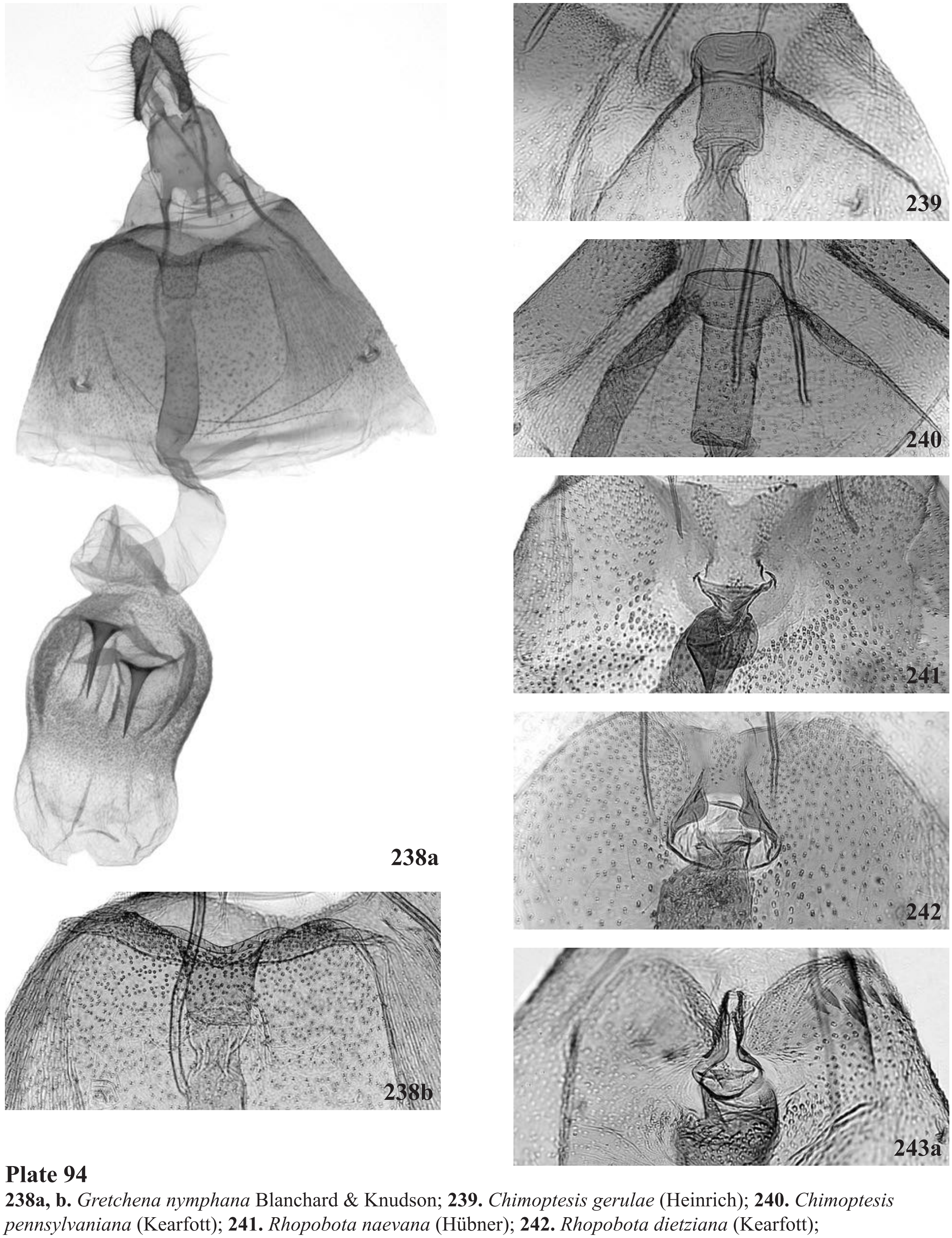


Plate 94

238a, b. *Gretchena nymphana* Blanchard & Knudson; **239.** *Chimoptesis gerulae* (Heinrich); **240.** *Chimoptesis pennsylvaniana* (Kearfott); **241.** *Rhopobota naevana* (Hübner); **242.** *Rhopobota dietziana* (Kearfott); **243a.** *Rhopobota finitimana* (Heinrich).

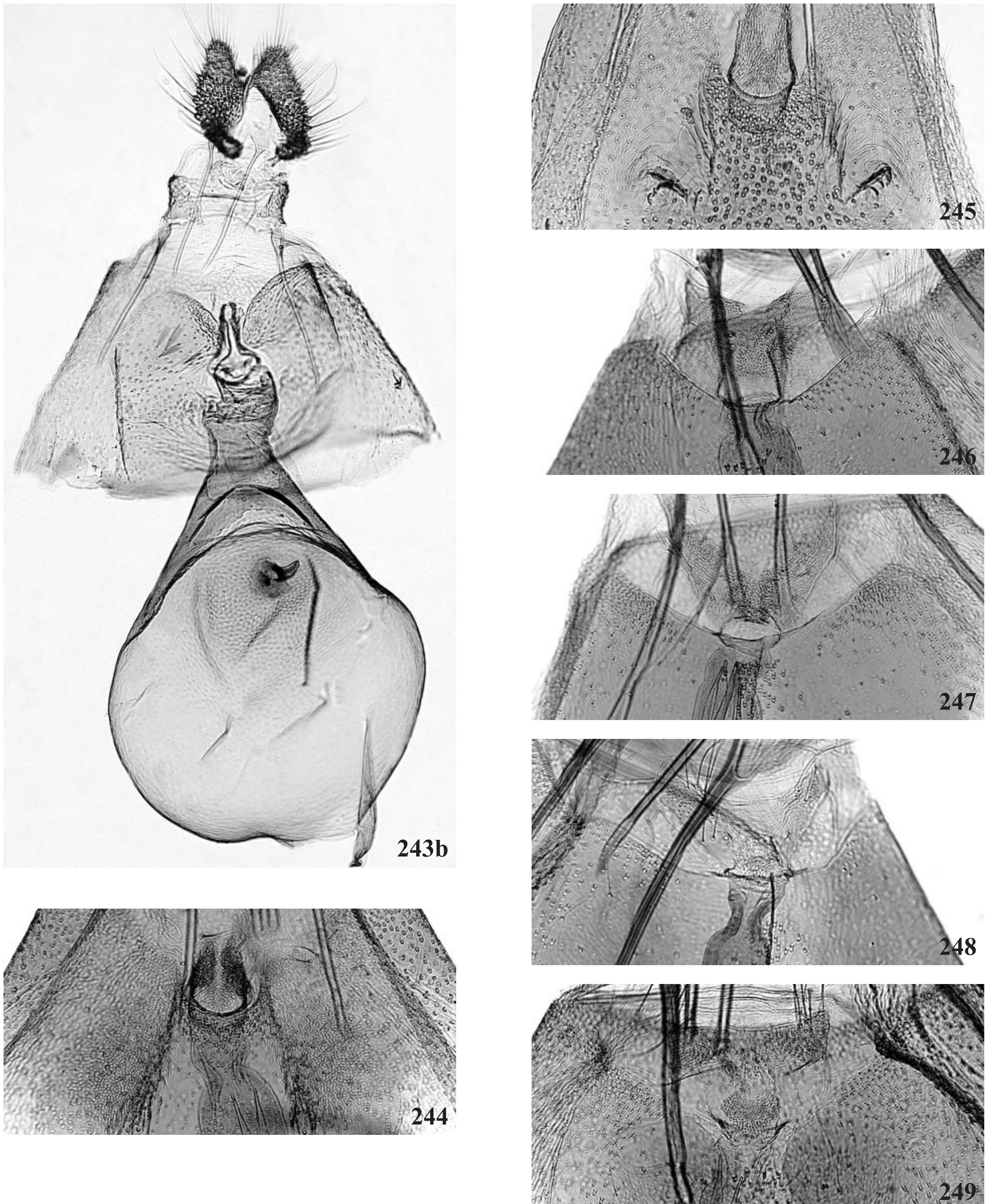


Plate 95

243b. *Rhopobota finitimana* (Heinrich); **244.** *Epinotia medioviridana* (Kearfott); **245.** *Epinotia madderana* (Kearfott); **246.** *Epinotia celtisana* (Riley); **247.** *Epinotia sotipena* Brown; **248.** *Epinotia vertumnana* (Zeller); **249.** *Epinotia zandana* (Kearfott).

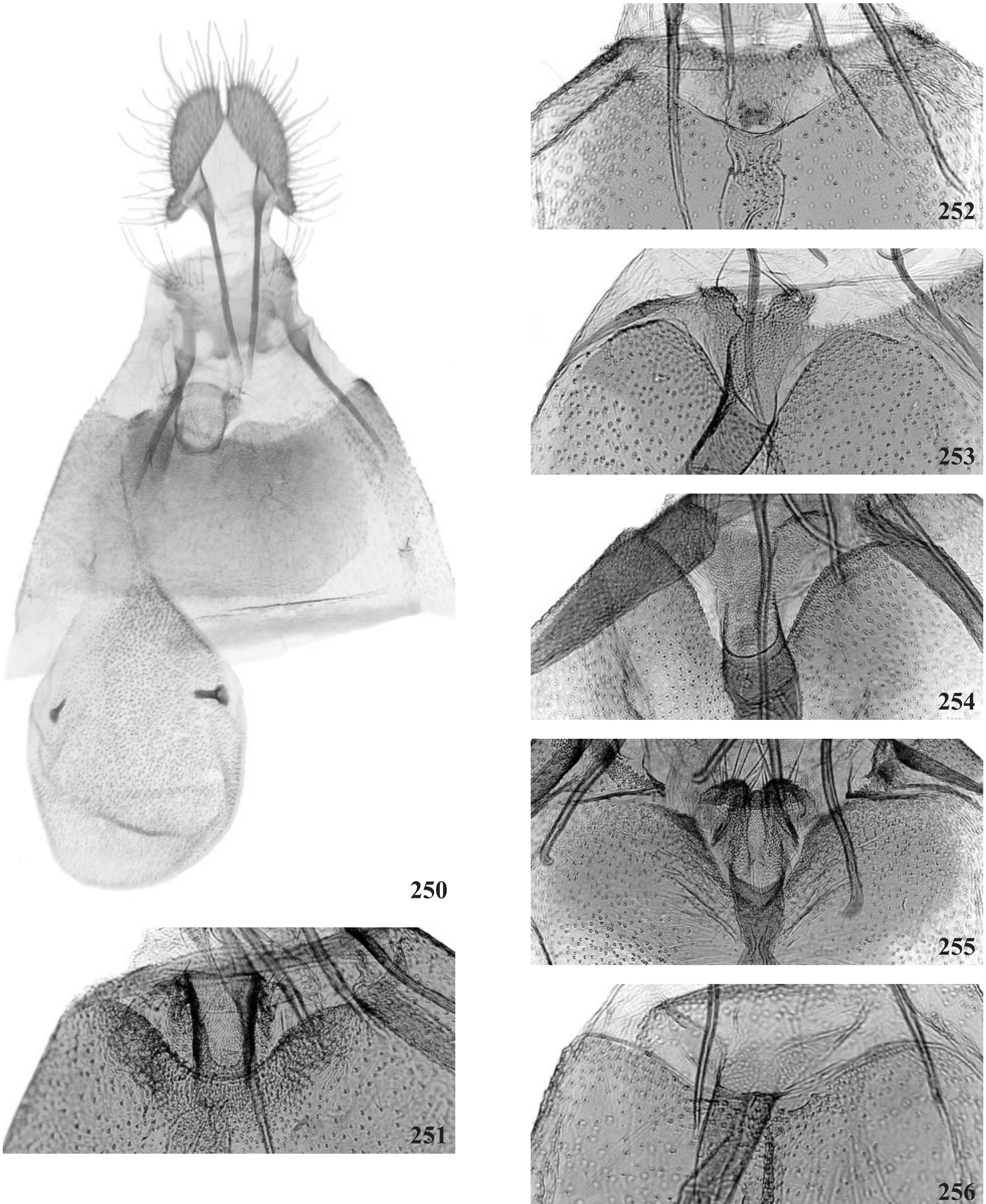


Plate 96

250. *Epinotia nisella* (Clerck); **251.** *Epinotia criddleana* (Kearfott); **252.** *Epinotia xandana* (Kearfott); **253.** *Epinotia walkerana* (Kearfott); **254.** *Epinotia transmissana* (Walker); **255.** *Epinotia nonana* (Kearfott); **256.** *Epinotia nanana* (Treitschke).

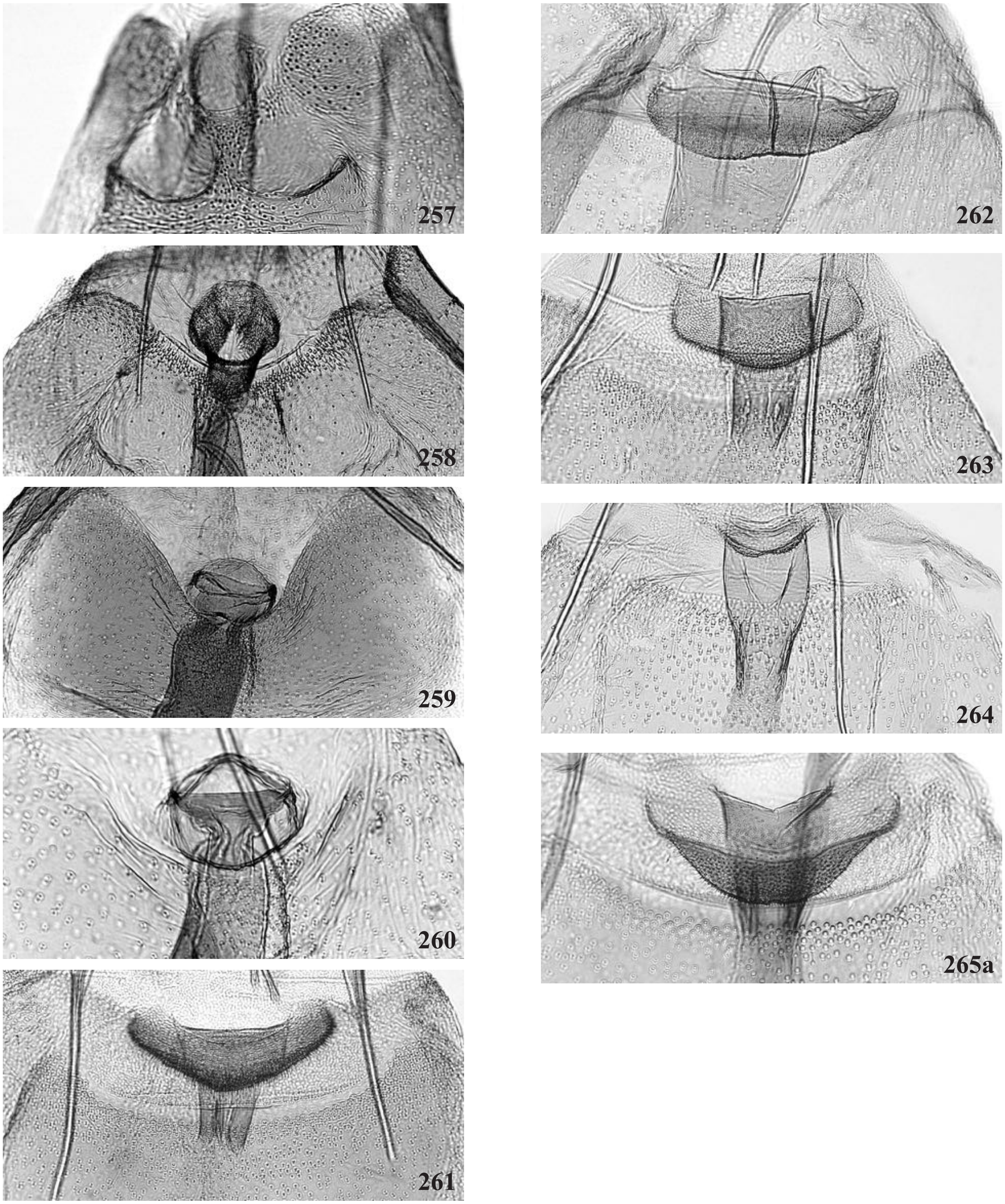


Plate 97

257. *Epinotia septemberana* (Kearfott); **258.** *Epinotia lindana* (Fernald); **259.** *Catastega timidella* Clemens; **260.** *Catastega aceriella* Clemens; **261.** *Ancylis nubeculana* (Clemens); **262.** *Ancylis subaequana* complex; **263.** *Ancylis semiovana* (Zeller); **264.** *Ancylis brauni* (Heinrich); **265a.** *Ancylis spiraeifoliana* complex.

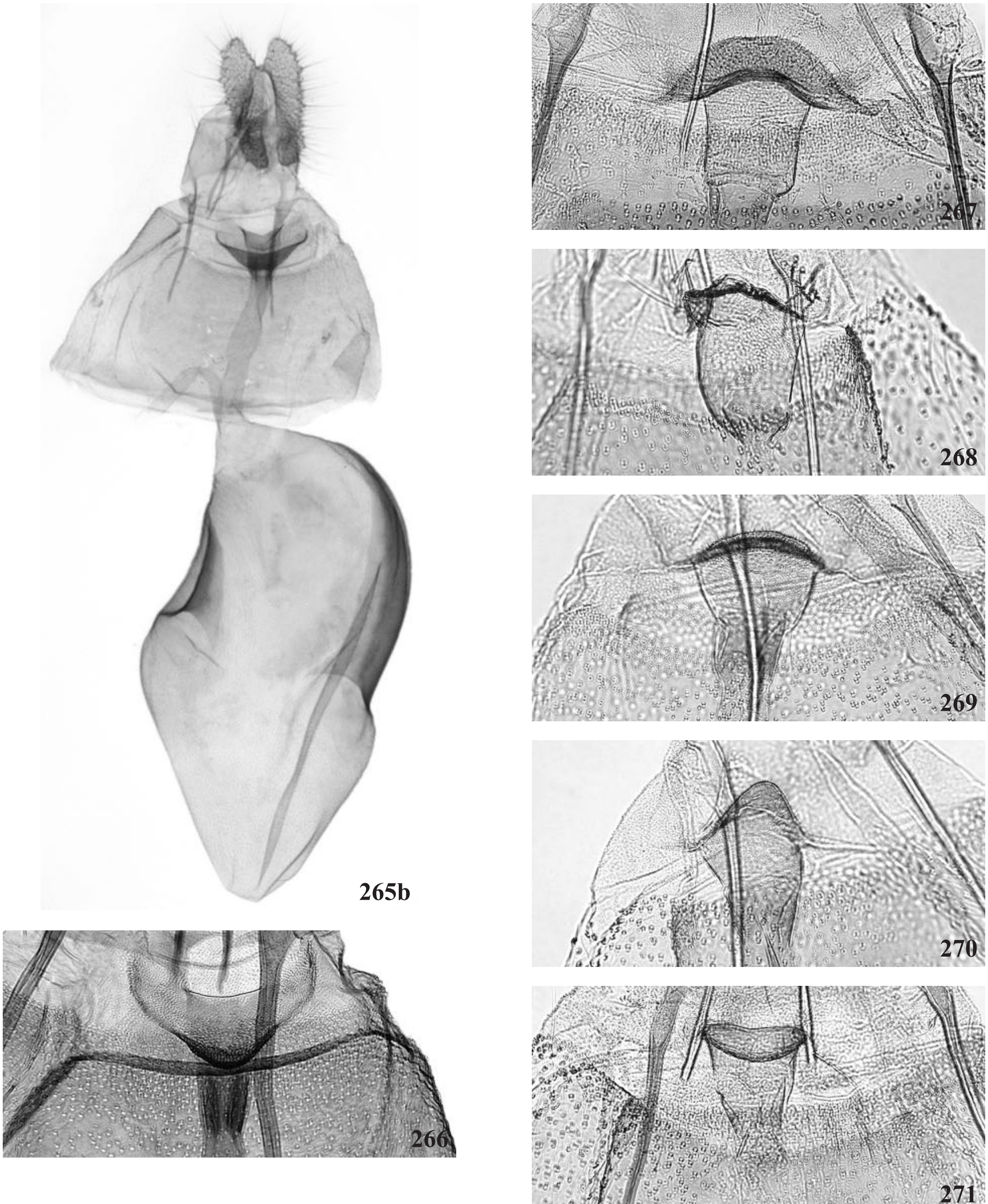


Plate 98

265b. *Ancylis spiraeifoliana* complex; **266.** *Ancylis platanana* (Clemens); **267.** *Ancylis metamelana* (Walker); **268.** *Ancylis comptana* (Frölich); **269.** *Ancylis divisana* (Walker); **270.** *Ancylis muricana* (Walsingham); **271.** *Ancylis diminutana* (Haworth).

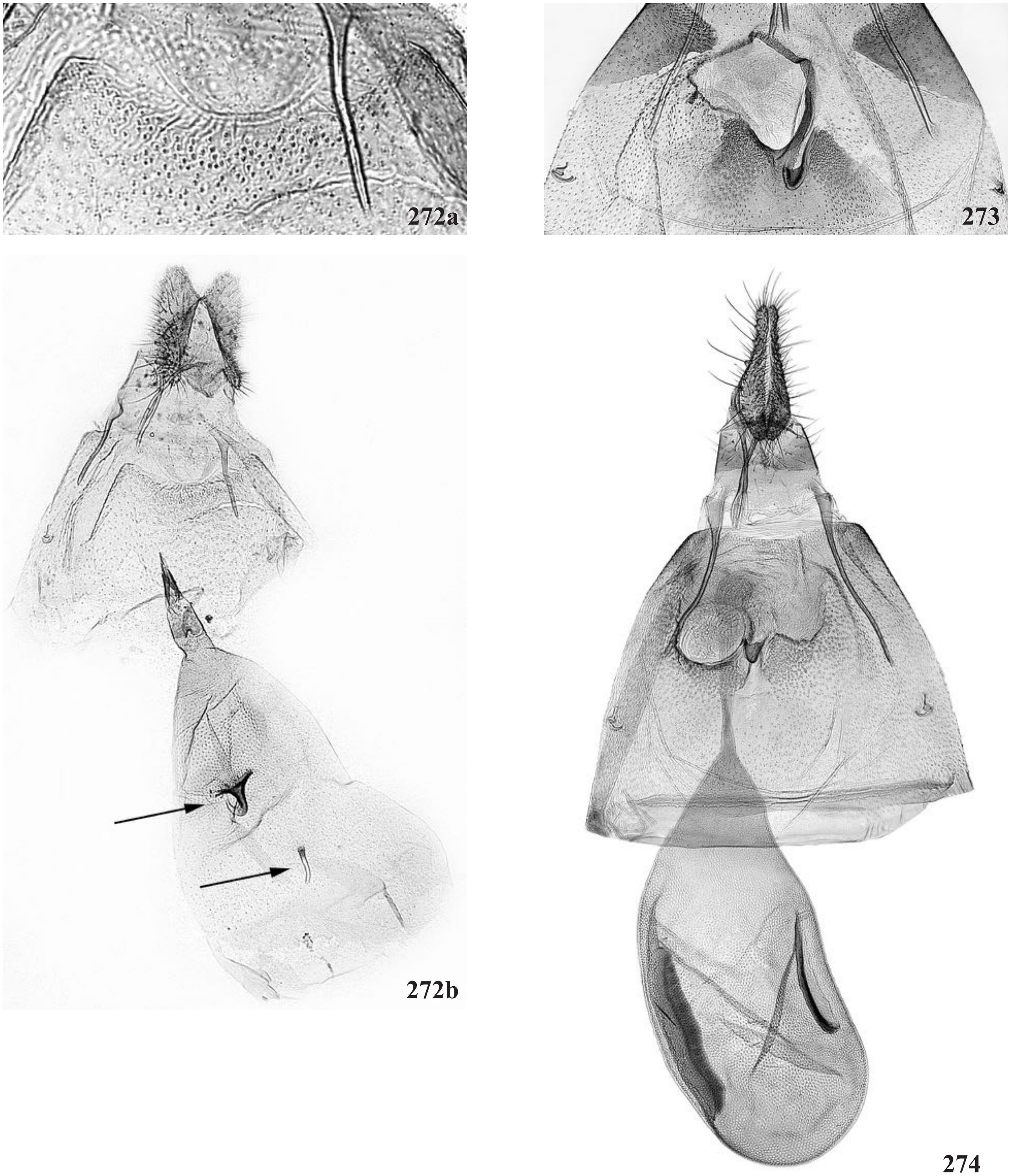
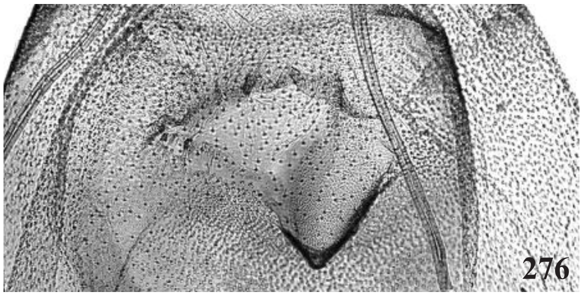
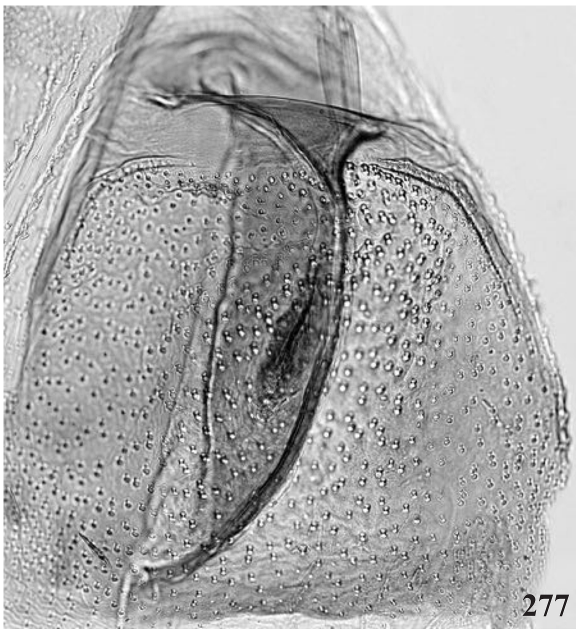


Plate 99

272a, b. *Eucosmomorpha nearctica* Miller, arrows indicate signa; **273.** *Hystrichophora taleana* (Grote); **274.** *Hystrichophora ochreicostana* (Walsingham); **275. (not shown)** *Hystrichophora loricana* (Grote) [female unknown].





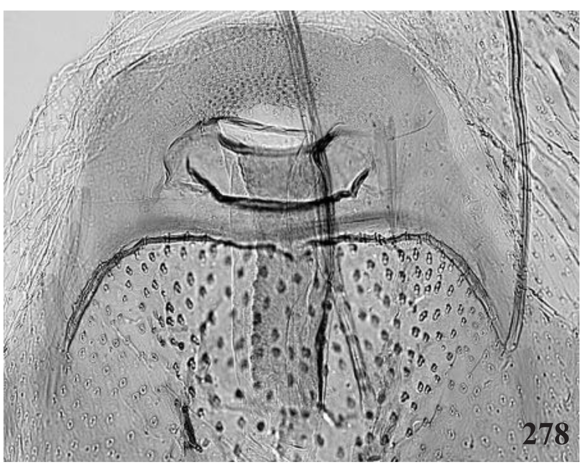


Plate 100

276. *Hystrichophora vestaliana* (Zeller); **277.** *Dichrorampha simulana* (Clemens); **278.** *Dichrorampha bittana* (Busck); **279a.** *Dichrorampha incanana* (Clemens).

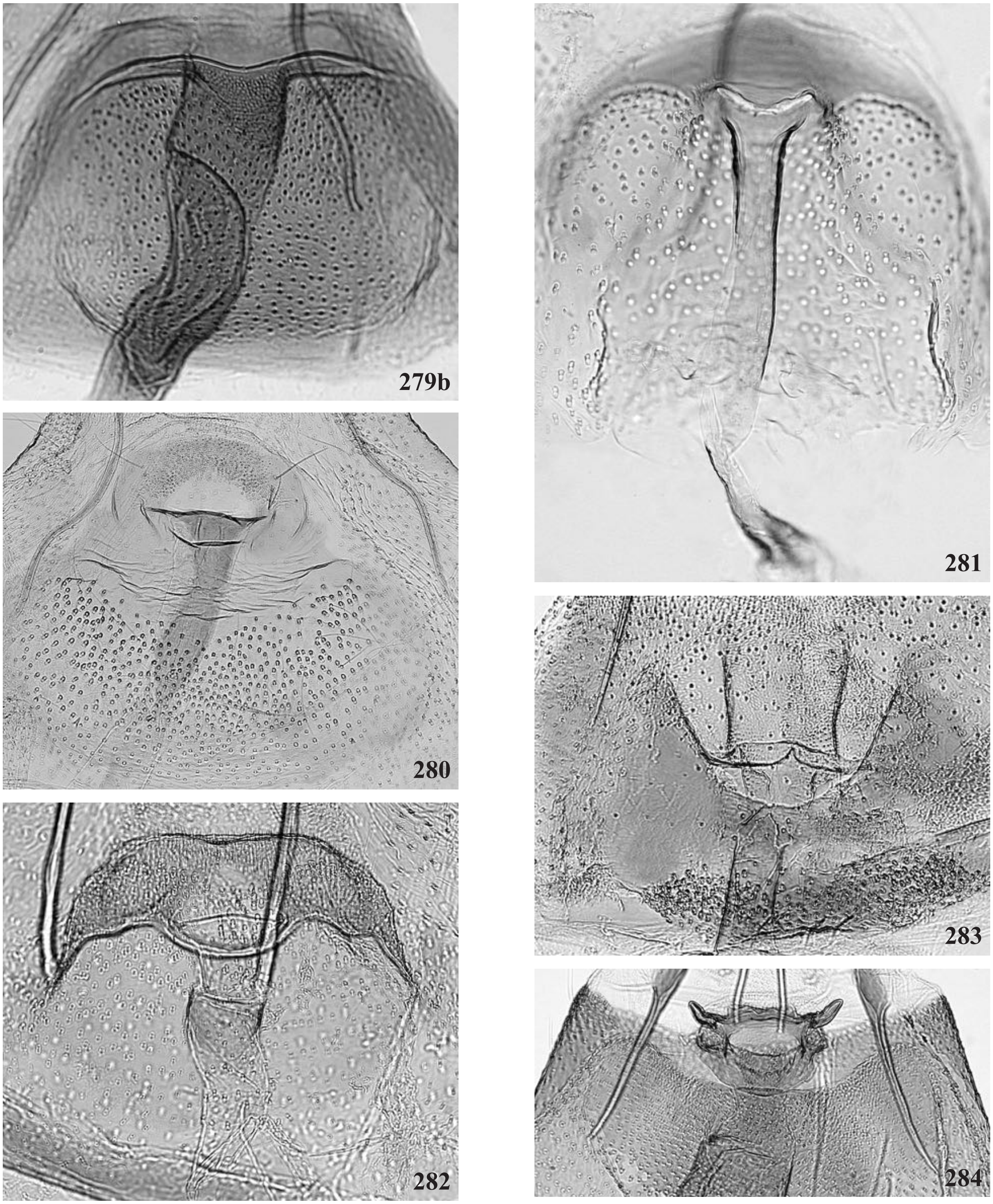
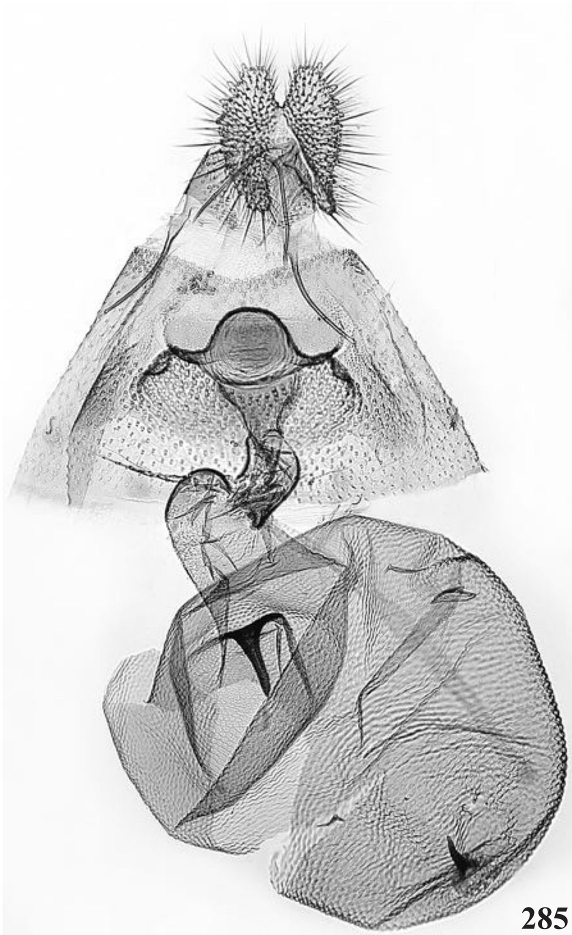


Plate 101

279b. *Dichrorampha incanana* (Clemens); **280.** *Dichrorampha sedatana* (Busck); **281.** *Dichrorampha leopardana* (Busck); **282.** *Talponia plummeriana* (Busck); **283.** *Pammene felicitana* Heinrich; **284.** *Larisa subsolana* Miller.



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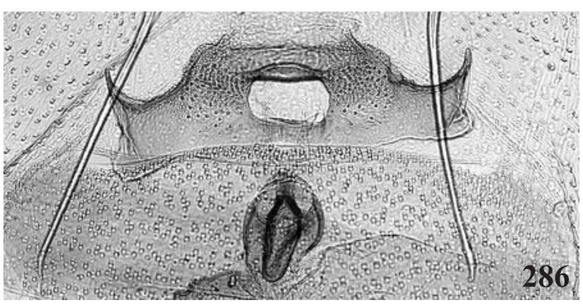

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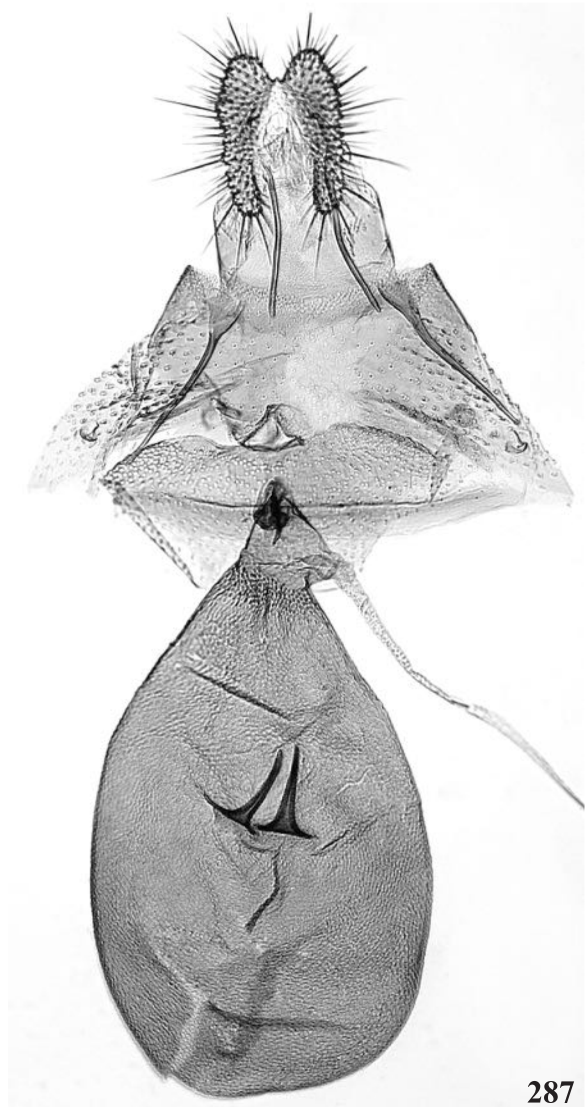

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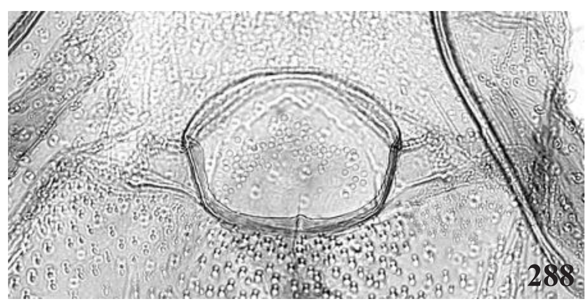

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Plate 102

285. *Sereda tautana* (Clemens); **286.** *Grapholita molesta* (Busck); **287.** *Grapholita packardi* Zeller; **288.** *Grapholita prunivora* (Walsh).

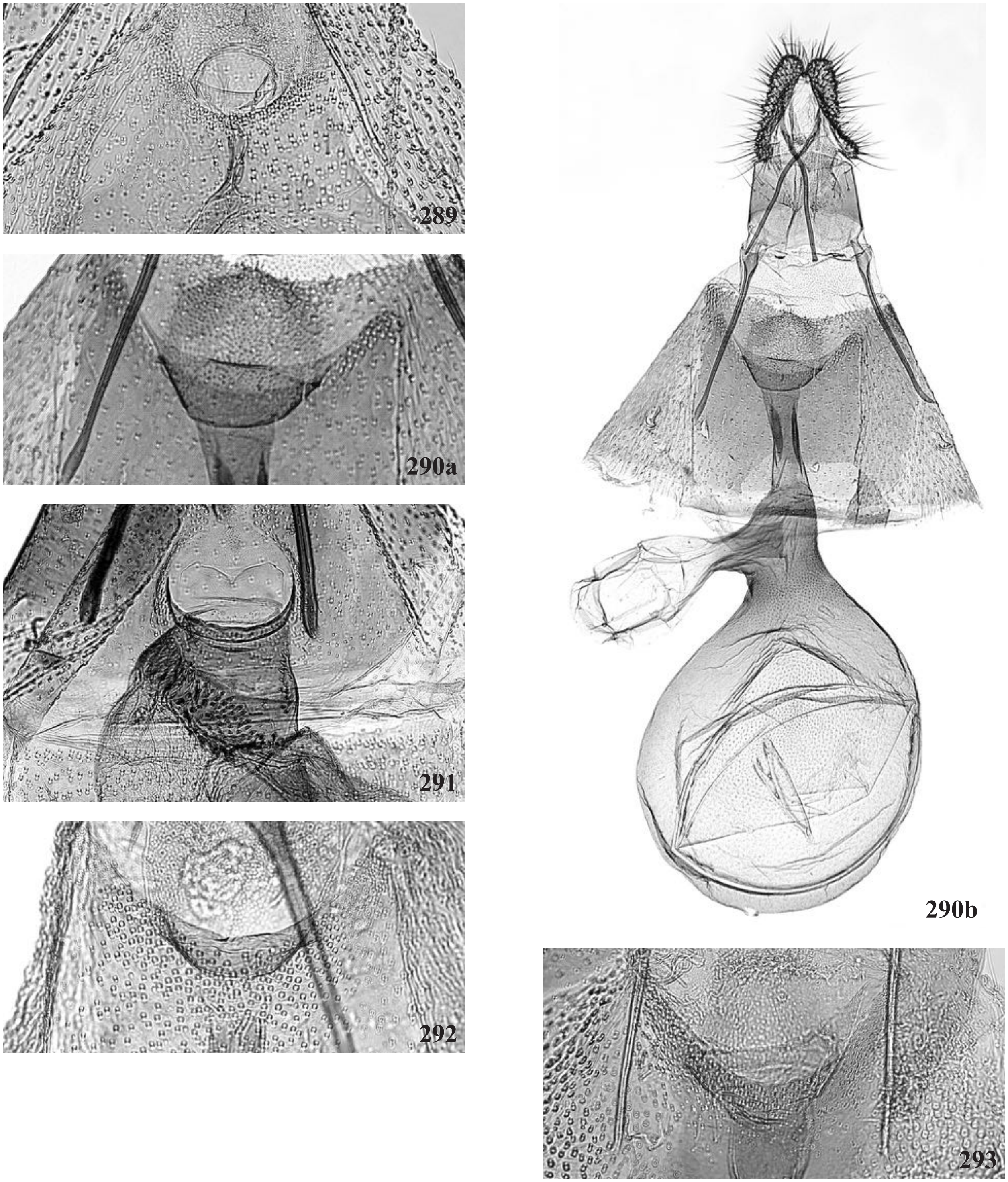


Plate 103

289. *Grapholita fana* (Kearfott); **290a, b.** *Grapholita interstinctana* (Clemens); **291.** *Grapholita eclipsana* Zeller; **292.** *Grapholita tristrigana* (Clemens); **293.** *Grapholita delineana* (Walker).

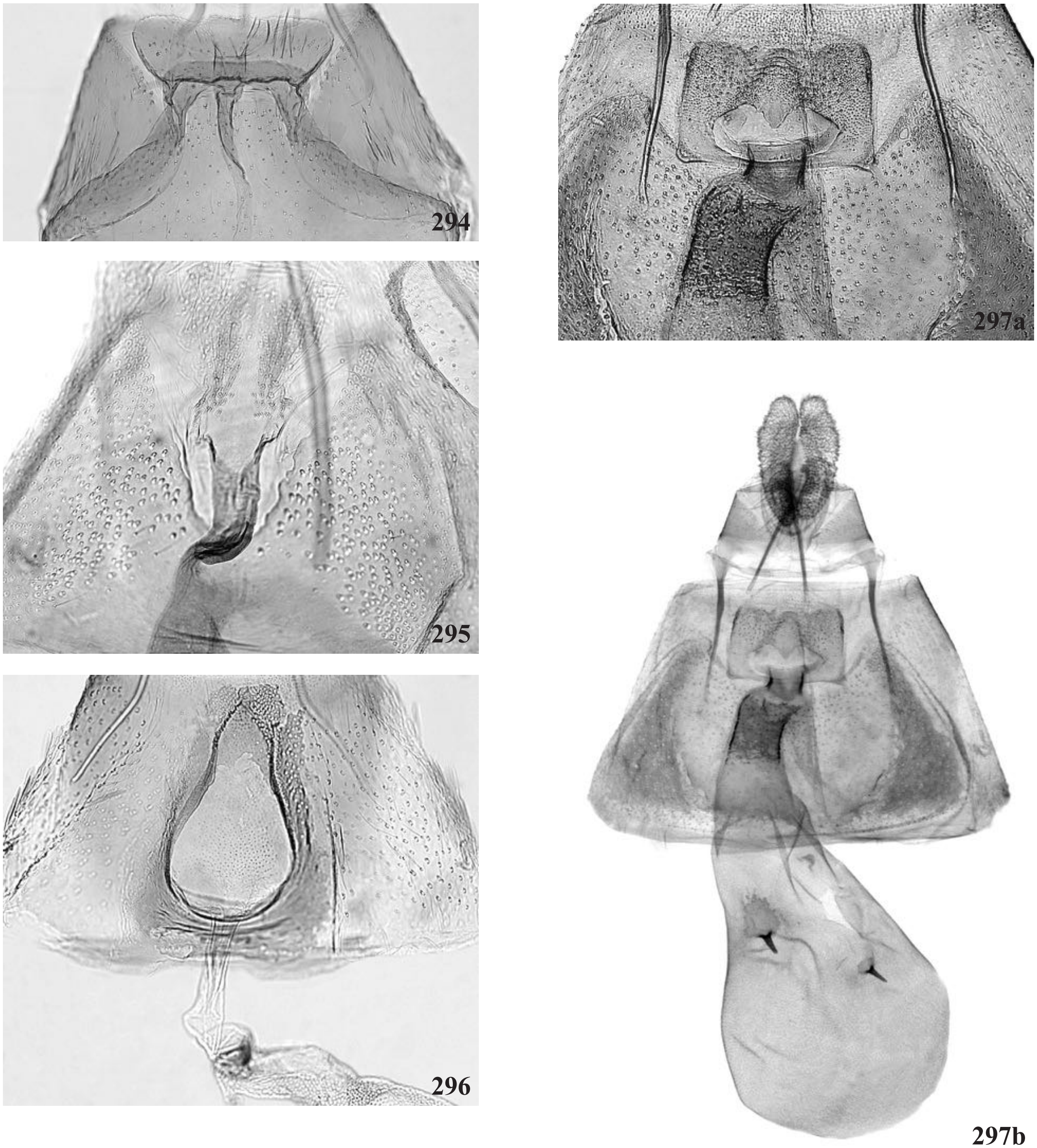


Plate 104
294. *Corticivora clarki* Clarke; **295.** *Cydia garacana* (Kearfott); **296.** *Cydia albimaculana* (Fernald);
297a, b. *Cydia lacustrina* (Miller).

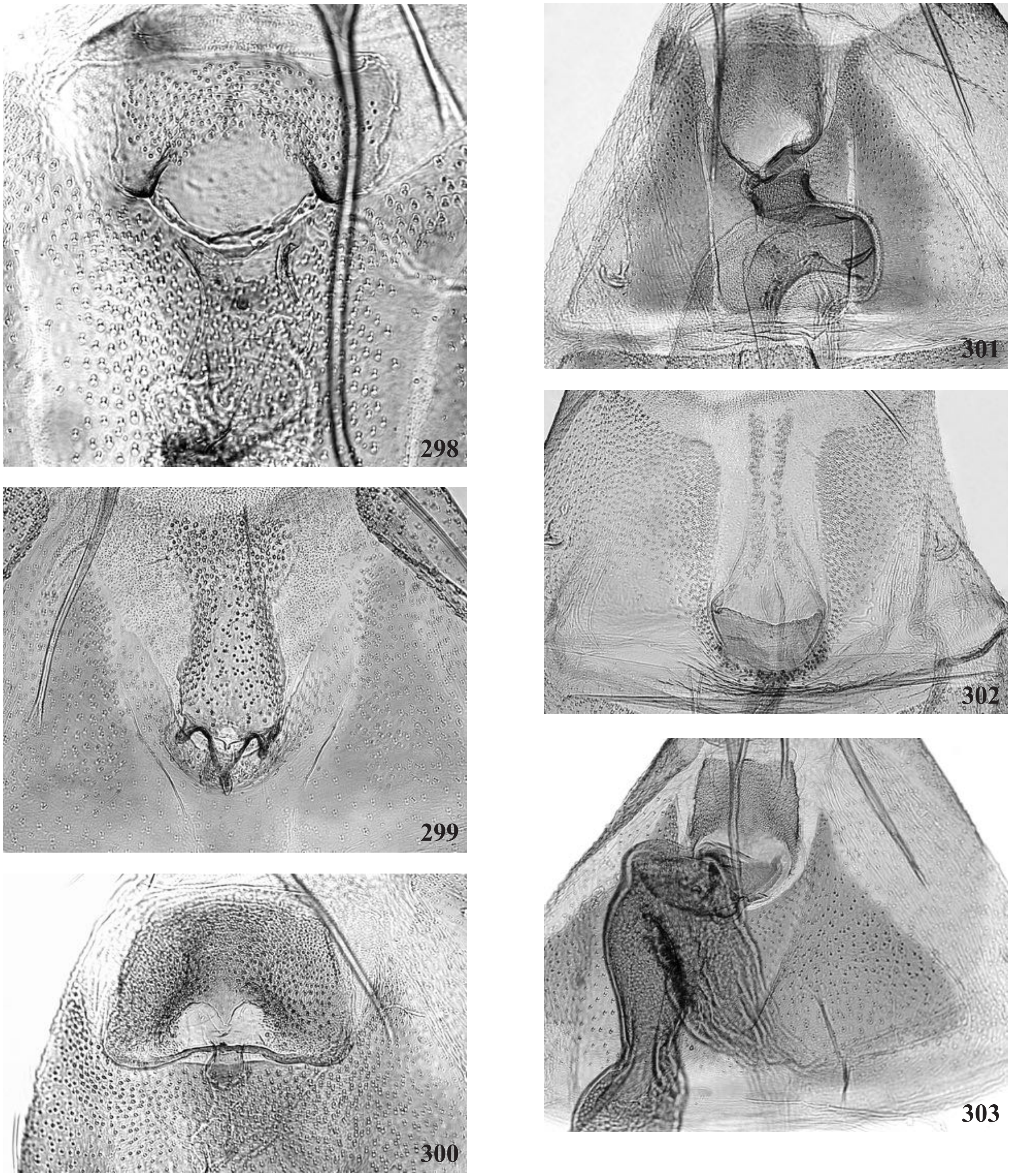
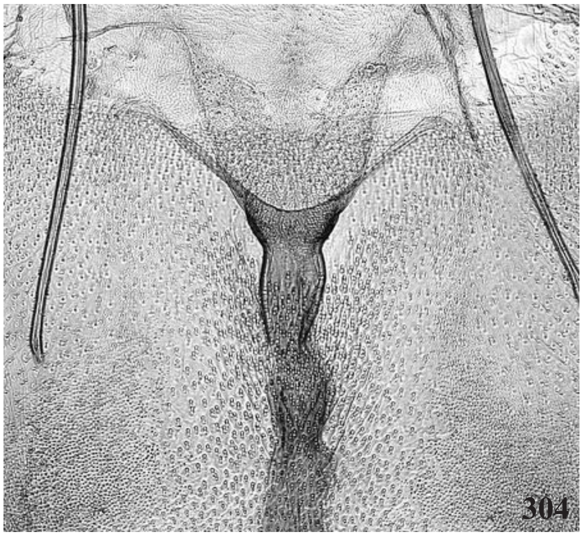
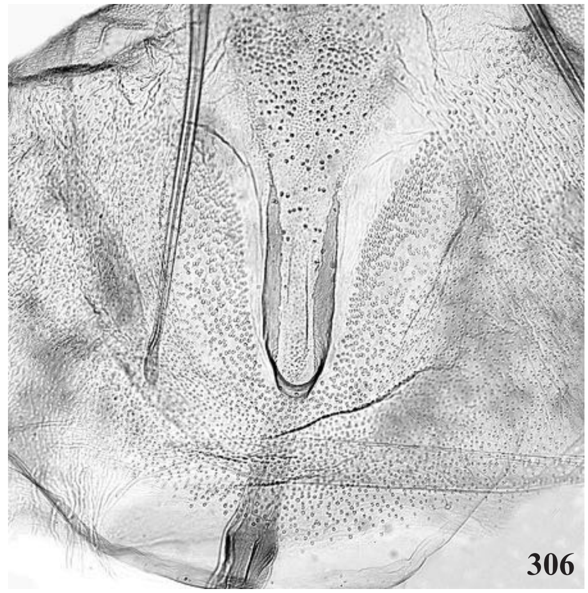


Plate 105
298. *Cydia candana* (Forbes); **299.** *Cydia caryana* (Fitch); **300.** *Cydia gallaesaliciana* (Riley); **301.** *Cydia pomonella* (Linnaeus); **302.** *Cydia latiferreana* complex; **303.** *Cydia toreuta* complex.





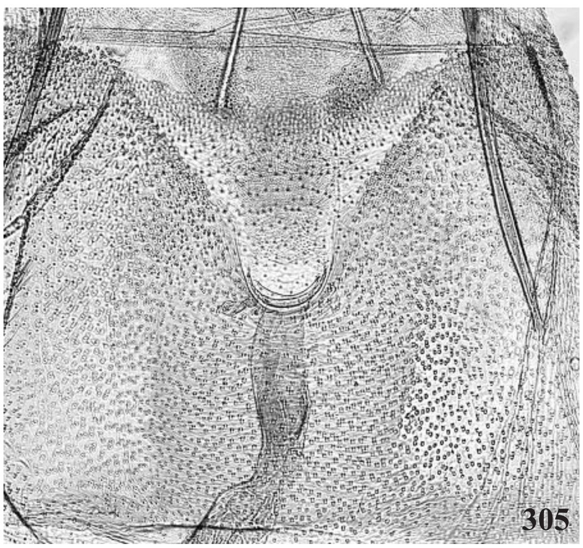


Plate 106

304. *Gymnandrosoma punctidiscanum* Dyar; **305.** *Ecdytolopha insiticiana* Zeller; **306.** *Pseudogalleria inimicella* (Zeller).

Part III:

Immature Stages

by Steven Passoa

Introduction

Most olethreutines, like other Lepidoptera, spend the majority of their lives as immatures (eggs, larvae, pupae), yet to a large extent these stages are rarely studied. Beyond the work of Peterson (1965), little has been written on olethreutine eggs. The only general treatment of Nearctic olethreutine larvae is the monograph by MacKay (1959), but her key is notoriously complicated. Less comprehensive identification guides to larvae and pupae, mostly focused on economically important species, include Chapman & Lienk (1971), Brown (1987), and Adler (1991).

Knowledge of immatures is important for a number of reasons. Nearly all economic injury or ecological impact caused by olethreutines occurs during the larval stage. Integrated pest management programs depend on detailed life-cycle information to develop effective control measures (MacKay, 1964). Agricultural inspectors require accurate identification of immatures to prevent the introduction of exotic pest species, and familiarity with pupal morphology is needed for host identification in parasitism studies. Knowledge of the immatures also contributes to lepidopteran classification (Mosher, 1916; MacKay, 1968; Stehr, 1987; Adamski & Brown, 2001; Kristensen, 2003). Larval morphology has been used to corroborate or question phylogenetic relationships deduced from studies of adults (Swatschek, 1958; MacKay, 1963c).

Unfortunately, for a large number of midwestern Olethreutinae, life history details are still unknown. This lack of information is probably the biggest obstacle to resolving taxonomic problems presented by various confusing species groups in *Paralobesia*, *Endothenia*, *Olethreutes*, *Ancylis*, *Cydia*, and other genera. Host associations tend to be discovered serendipitously, often by amateur enthusiasts. MacKay (1968) noted that amateur entomologists can “perhaps make no greater contribution to their science than to develop reference collections of immatures and associated adults for future use.”

In spite of their importance, little practical information is available on techniques for studying the immature stages of Olethreutinae. The literature is aimed mostly at specialists and often is intimidating to the amateur. This chapter provides a brief overview of olethreutine egg, larval, and pupal morphology. Procedures for studying, collecting, mounting, and preserving these stages are discussed, and representative illustrations of each stage are provided. Additional taxonomic references regarding the immature stages of Olethreutinae can be found in Brown (1987) and Horak (1991, 1998). Early literature on life histories and host records is summarized in Fernald [1903] and Robinson et al. (2002), respectively.

Eggs

Eggs of Olethreutinae are wider than high and traditionally are considered to be of the flat type (Horak, 1991, 1998). Although this term is descriptive of the egg appearance, there is no generally accepted definition of "flat egg" (see Fehrenbach, 2003), and the concept may be difficult to apply in nature (Hinton, 1981). The cuticle or "skin" of the egg is called the chorion. The chorion has openings for air exchange (called the aeropyle) and for sperm entry (called the micropyle). The orientation of the micropyle (parallel or perpendicular) relative to the substrate is the most common criterion used to classify lepidopteran eggs (Scoble, 1992). Taxonomically useful characters include the shape and number of cells in the micropyle, presence or absence and number of ridges on the chorion, presence or absence of adhesives and/or scales from the female's body, and the mode of oviposition (how the eggs are grouped) (Syme, 1962; Powell & Common, 1985). In North American Olethreutinae studied by Peterson (1965), the chorion is granulated, reticulated, ridged, dimpled, or smooth, and the egg color is translucent, milky white, or light green to yellow (Figs. 16a-k). Eggs of North American olethreutines are deposited singly or in small clusters (Peterson, 1965; Brown, 1987; Horak, 1998). The clusters may overlap (Figs. 16b, c, d, e, g, j), but they do not form a large mass as seen in many Tortricinae (Fig. 16l).

Basic egg morphology can be studied by preparing whole mounts for use with a light microscope. To make the micropyle and chorion clearly visible, the egg is split in several places and the developing larva is removed. Staining and mounting can be accomplished with the methods used for moth genitalia (see Syme, 1962). McFarland (1972) listed several characteristics that should be noted when lepidopteran eggs are described. These include oviposition sites, coverings on the egg (if any), the general appearance, several kinds of measurements, and the conditions of the study (rearing temperature, lighting, etc.). Detailed studies of egg morphology usually require a scanning electron microscope (SEM) to study surface texture of the chorion, or a transmission electron microscope (TEM) if the chorion needs to be sectioned. Good examples of the use of the SEM and TEM for egg morphology are the description of *Cydia pomonella* by Fehrenbach et al. (1987) and the monograph by Hinton (1981). Powell and Common (1985) described a useful technique for making a cast of the chorion using dental material so that fine details of the egg could be preserved for later examination.

Olethreutine eggs are obtained most easily by confining a female moth in the laboratory with several possible oviposition substrates. Peterson (1965) used plastic bags or screw-top vials containing leaves of the hostplant, bark, and a piece of rough paper. If nothing is known of the biology of the species, all parts of likely hostplants (leaves, buds, stems, bark, flowers, fruit) should be placed in the oviposition chamber. This list can be narrowed by reviewing the habits of related taxa. Allow for oviposition on a wide range of artificial surfaces (shiny, hard, soft, smooth, rough) by including pieces of crumpled aluminum foil, paper towel, Velcro, and Parafilm. Powell and Common (1985) noted that tortricid females collected at lights often are mated, which may eliminate the need to introduce live males to the oviposition chamber. A water source usually is essential; adding a food source may also encourage oviposition.

Eggs usually are preserved in alcohol (Syme, 1962; McFarland, 1972). The first-instar may eat the egg upon hatching, but it is often worthwhile to save the partially destroyed eggshell. Empty eggshells tend to be transparent and relatively clean, making them ideal for whole mounts. In addition, they do not swell like eggs preserved in alcohol, so measurements may be more accurate (McFarland, 1972). Dry eggs can be stored in gelatin capsules underneath the pinned female or in small vials numbered to associate them with the adult.

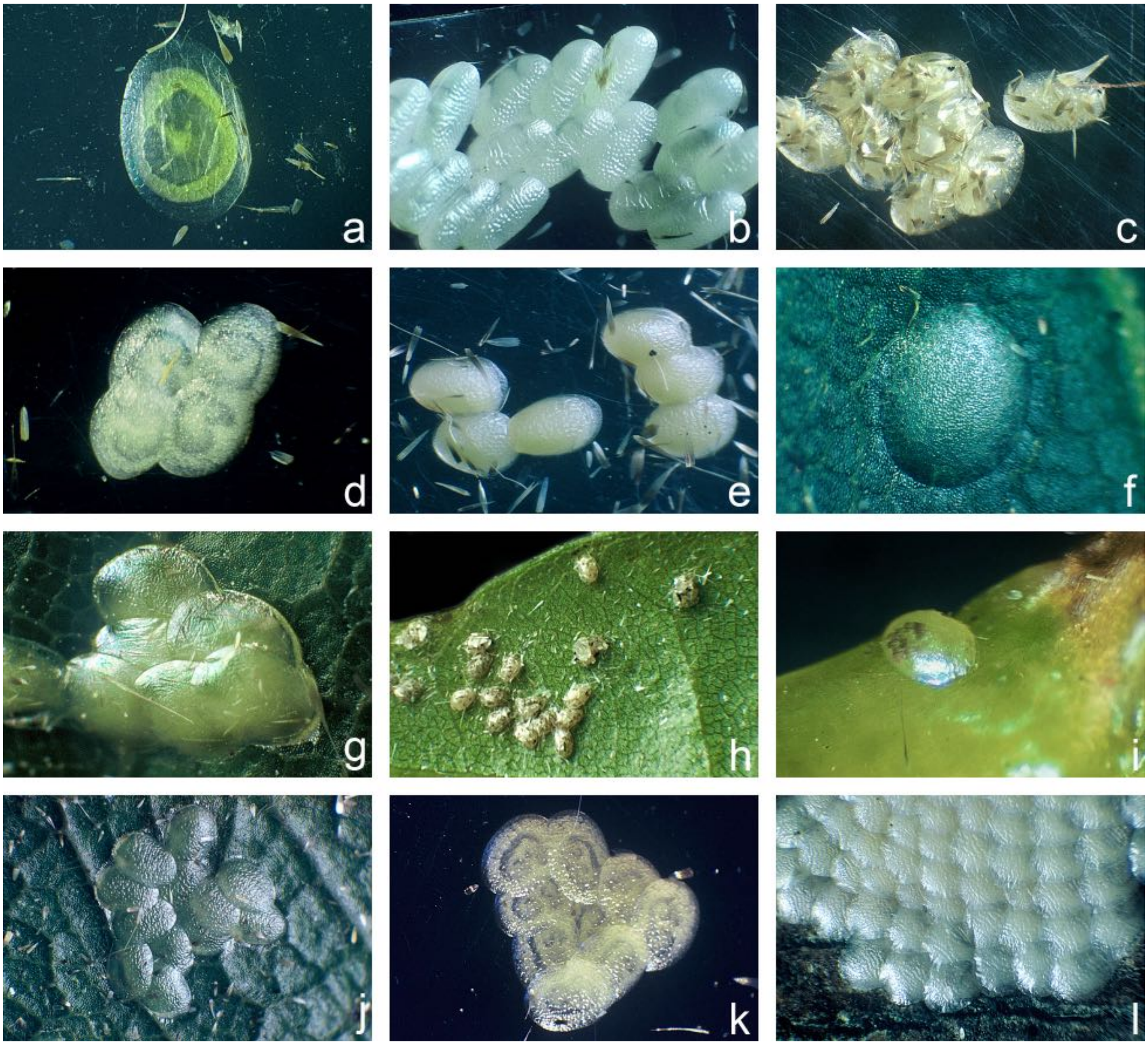


Figure 16: Olethreutine eggs; **a:** *Paralobesia liriodendrana*; **b:** *Phaneta* sp.; **c:** *Phaneta ochrocephala*; **d:** *Endothenia hebesana*; **e:** *Eucosma dosisignatana*; **f:** *Cydia pomonella*; **g:** *Bactra verutana*; **h:** *Eucosma robinsonana*; **i:** *Rhyacionia rigidana*; **j:** *Epiblema strenuana*; **k:** *Epiblema strenuana*; **l:** Tortricinae egg mass. Figures reproduced from scans of original slides by A. Peterson, courtesy of The Ohio State University.

Larvae

Larval morphology

The olethreutine larval structure is similar to that of most other Lepidoptera. A summary of basic external larval morphology, modified from Stehr (1987), is included below to introduce the beginner to taxonomically important parts of the caterpillar body used in the identification key. Internal anatomy is not covered here; consult Eaton (1988) and Lopez (1929) for descriptions of the nervous system, silk gland, etc.

The general body plan consists of three sections: head, thorax, and abdomen. The head has "eyes", a spinneret, and mouthparts; the thorax is divided into three segments, each with a pair of true legs; and the abdomen is composed of 10 segments: A1-2 with spiracles but no prolegs, A3-6 with both spiracles and prolegs, A7-8 with spiracles but no prolegs, A9 with neither spiracles nor prolegs, and A10 with an anal shield and anal prolegs. Details regarding the three body sections follow.

Taxonomically important features of the head (Fig. 17) include the frontal area, the stemmata (formerly called ocelli), the labrum, a hypopharyngeal complex with spinneret, and a pair each of antennae, maxillae and mandibles. The frontal area is bounded by the adfrontal sutures, structures found only in Lepidoptera, thus distinguishing them from larvae of other insect orders. Olethreutinae have six stemmata on each side of the head; the number may be reduced in other moth families. The flaplike labrum serves to taste and manipulate food as well as close the oral cavity. The hypopharyngeal complex (Fig. 18b) contains the labial palpi and spinneret (Fig. 18c). In Olethreutinae, the form of the spinneret determines the characteristics of the silk produced by each species (MacKay, 1964). Taxonomic characters have been found on the hypopharyngeal complex in Noctuidae (Godfrey, 1972), but these structures remain unexplored in tortricid larvae (MacKay, 1964). The maxillae are not known to be taxonomically significant in olethreutines, but the antennal morphology is more diverse (see examples in Dethier, 1941). For identification purposes the mandible is probably the most important mouthpart. A typical mandible has teeth, ribs, two mandibular setae and sometimes a plate or ridge on the oral surface called the retinaculum. Mandibular morphology is useful for identifying olethreutine larvae in North America (Peterson, 1962) and New Zealand (Dugdale et al., 2005).

The thorax is divided into the prothorax, mesothorax, and metathorax (abbreviated T1-3). Each thoracic segment has a pair of legs, called "true legs"

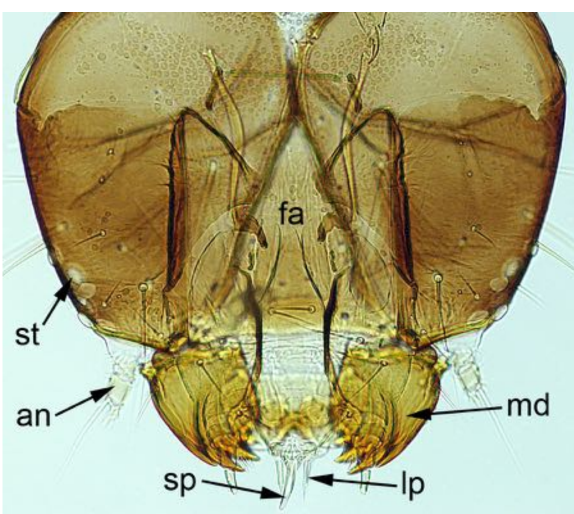


Figure 17: Ventral view of a typical olethreutine larva head capsule (an, antenna; fa, frontal area; lp, labial palpus; md, mandible; sp, spinneret; st, stemma).

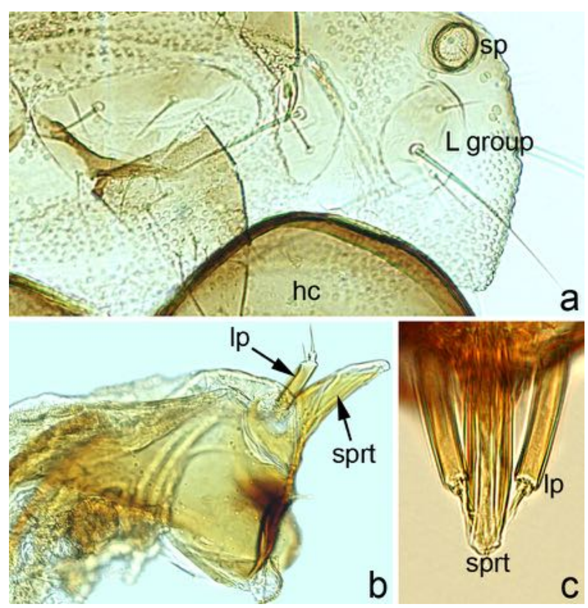


Figure 18: Details of larval morphology (hc, head capsule; lp, labial palpus; sp, spiracle; sprt, spinneret); **a:** prothorax (T1) with trisetose prespiracular pinaculum (L group); **b:** hypopharyngeal complex (lateral view); **c:** spinneret (dorsal view).

because they are segmented and end in a claw. The prothorax has a dorsal plate, termed the prothoracic shield, and a pair of lateral respiratory openings, called spiracles. Body setae on both the thorax and abdomen arise from sclerotized plates called pinacula (singular, pinaculum). Because of the taxonomic significance of the prothoracic lateral setae (L group), the plate supporting those setae has acquired a specialized name, the prespiracular pinaculum.

The abdomen has ten segments (abbreviated A1-10). There are spiracles on A1-8. Fleshy unsegmented protrusions of the body wall, known as prolegs, are present on A3-6 (ventral prolegs) and A10 (anal prolegs). Crochets (small hooks) are located at the apex of each proleg. In olethreutines, the crochets on the ventral prolegs are arranged in a circle (Brown, 1987). The anal segment (A10) has a sclerotized plate, called the anal shield and, in many species, an anal comb (also known as the anal fork) that serves to eject frass away from the feeding larva. The tortricid anal comb has straight prongs (Horak, 1998) and is similar to that of some gelechiids (e.g., *Dichomeris*). Rings & Neiswander (1966) used the shape and number of the prongs on the anal comb to distinguish between different species of olethreutines on strawberries.

The number and arrangement of the body setae, together with the size and shape of their pinacula, are important for identification. Following Hinton (1946), the setae are named according to their body position. Dorsal setae (D) are located on the dorsal surface, subdorsal (SD) setae are below them and above the spiracle (if present), lateral (L) setae are on the side of the body, subventral (SV) setae are below the lateral setae, and ventral (V) setae are located on the underside. The prothoracic shield has extra setae, with abbreviations preceded by an X (XD1, XD2).

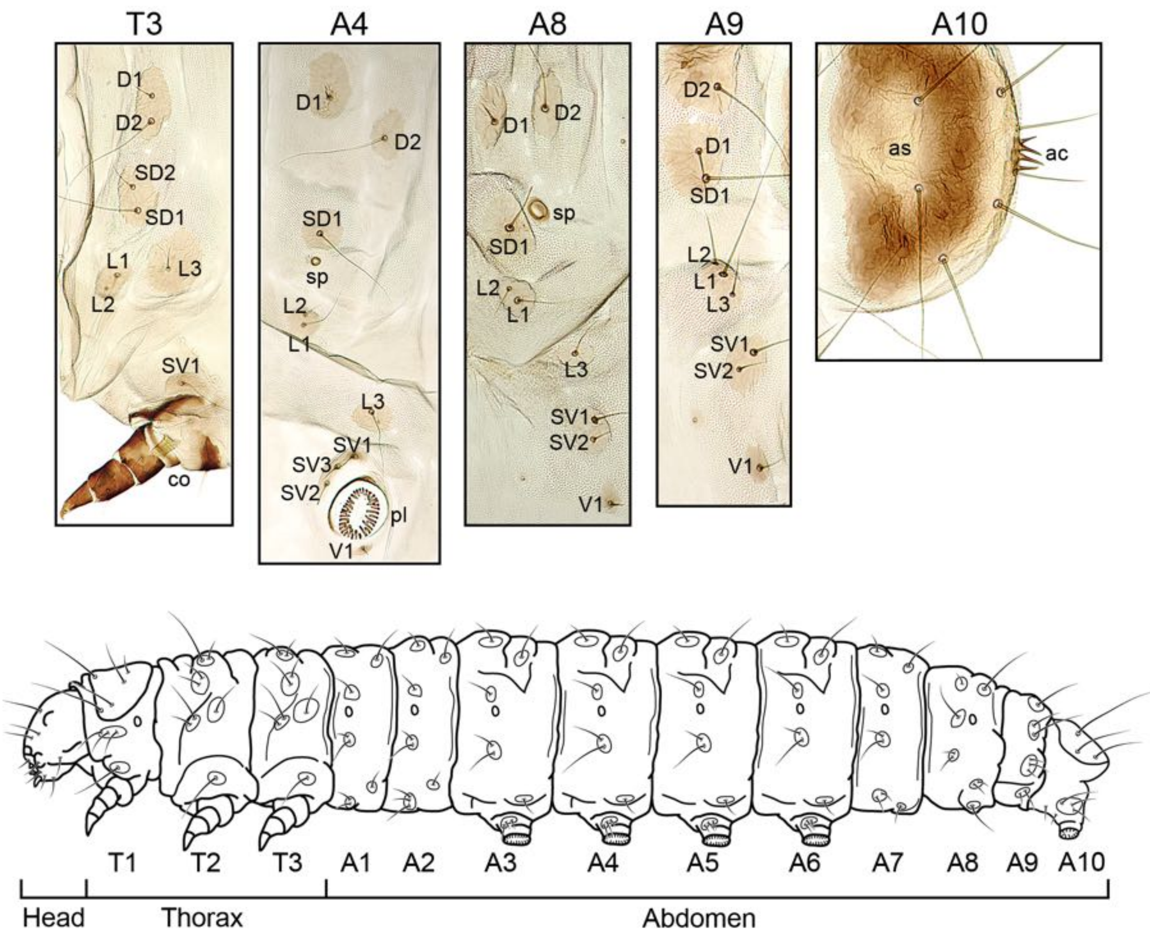


Figure 19: Body plan of a typical olethreutine larva with body sections and segments labeled. Photos of T3, A4, A8-10 show a labeled setal map for those segments in *Spilonota ocellana* (ac, anal comb; as, anal shield; co, coxa; pl, proleg).

Chaetotaxy, the arrangement and naming of setae, is often represented by a setal map. Figure 19 shows a typical olethreutine larva, with photos of the major setae on various segments. A complete tortricid setal map has been illustrated by numerous authors (e.g., MacKay, 1959; Stehr, 1987; Horak, 1991).

Olethreutine larvae exhibit a wide range of morphological specializations at both the genus and species levels. Every body structure is subject to modification, as shown by the works of MacKay (1959, 1963c, 1964), Swatschek (1958), and Dugdale et al. (2005) on the faunas of North America, Europe, and New Zealand, respectively. The head and prothoracic shield are colored black, red, tan, or light green, sometimes with maculation (dashes or spots). This coloration usually contrasts with the unmarked body, which is some shade of white or green (e.g., Figs. 20a-c, 23g, i) or, more rarely, red or dark brown (e.g., Figs. 25j-l). Pinacula may be pigmented or pale, and pinaculum size varies from large to minute. Head shape, seta P1 position, and characters of the stemmata are variable and taxonomically useful. The spinneret may be pointed, spatulate, or bifurcate. Pinaculum size and position of V setae are important thoracic features. Taxonomically informative characters of the abdomen include spiracle shape and position as well as whether or not pinaculum SD1 is fused to the spiracle. An extra seta may be present near the spiracle on A1-8 or in the SV group of A3-6. Unlike other microlepidoptera, the number of SV setae on A9 is more important than the SV group of A1. The anal shield may be rounded or pointed, and the anal comb may be present or absent. Not all authors agree on the taxonomic significance of various larval structures, but the characters mentioned here may be phylogenetically significant at some level and merit inclusion in a total evidence matrix of Olethreutinae phylogeny. MacKay (1959, 1963c) and Dugdale et al. (2005) provide a more extensive list of useful characters in Olethreutinae and their probable ancestral states.

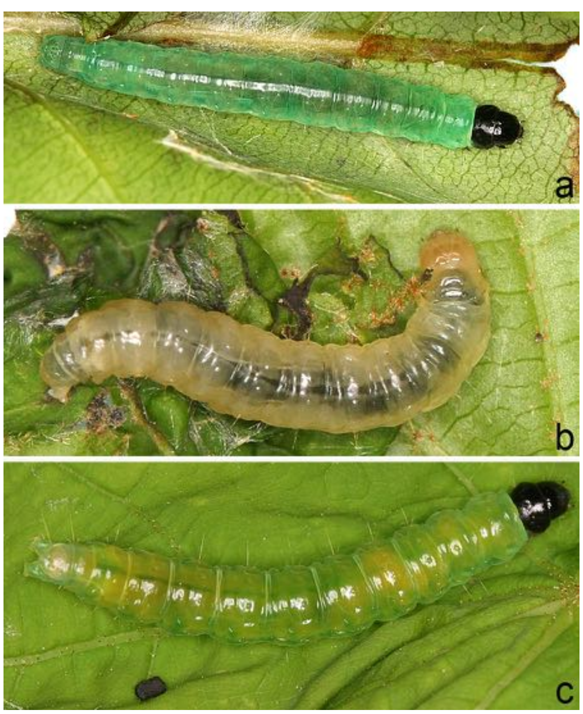


Figure 20: Examples of typical olethreutine larvae; **a:** *Olethreutes appalachiana*; **b:** *O.hamameliana*; **c:** *O. nigrana*.

Larval habits and biology

Nearly all midwestern Olethreutinae can be described as concealed feeders on trees, shrubs, and herbaceous plants (MacKay, 1963c). Some construct shelters from silk and plant material, particularly leaves; others bore in stems, roots, seeds or fruit. Representative feeding behaviors are illustrated in Figures 23-25.

In genera such as *Apotomis*, *Olethreutes*, *Hedya*, and others, the larvae tend to tie or fold leaves. Construction techniques include rolling leaves into tubes (Fig. 23j), sewing the margins of opposite leaves (Fig. 23b), tying adjacent leaves or leaflets (Figs. 23c, e), and generally webbing contiguous leaves into amorphous nests (Figs. 23d, f, h). These habits often are associated with species that feed on newly emerging spring foliage. Pupation usually occurs in the nest or on the ground, and the adults fly in spring or early summer. Most of these species are univoltine, and little to nothing is known about their modes of overwintering. Some species that fly later in the year (e.g., *Epinotia lindana*) complete their development in the spring and then spend several weeks in a state of dormancy before emerging in late summer or early autumn. This behavior could explain the lack of life history information for so many of the late flying species.

Twig boring larvae are found in genera such as *Proteoteras*, *Gypsonoma*, *Retinia*, *Rhyacionia*, and *Ecdytolopha*. The newly emerged caterpillars usually feed on buds and foliage, but later instars tunnel into developing shoots. The larval presence of *Proteoteras*, *Gypsonoma*, and *Ecdytolopha* is revealed by swelling of the infested shoot together with bundles of expelled frass (Figs. 25d, e, l). The pine feeding species of *Ryacionia* and *Retinia* produce twig or crotch nodules consisting of frass and exuded resin (Figs. 24a-f). *Epiblema* larvae bore in the stems of species of Asteraceae. The induced elongate galls (Figs. 21, 23k, l) serve as shelters for feeding, overwintering, and pupation.

Figure 21: Split *Solidago* gall showing larva of *Epiblema scudderiana* (photo: J. M. Storey, Carleton University).

Most larvae of *Phaneta*, *Eucosma*, *Pelochrista*, and *Sonia* are root borers in species of Asteraceae. One group of *Eucosma* species is associated with pines: *E. gloriola* is a twig-borer, others in the group bore into the cones and eat the seeds (Fig. 24i). *Grapholita* and *Cydia* are genera known for their pest species, with larvae that attack the fruit and seeds of their hosts (Figs. 24j, 25j-k). Life histories of such species are well documented in the economic entomology literature (e.g., Wearing et al. 2001). A few midwestern olethreutines have rather specialized larval habits: the two *Catastega* species live in serpentine feeding tubes on the underside of the leaf (Fig. 25a-c); the larva of *Corticivora clarki* feeds on the bark of the host tree.

Collecting and rearing

There are a number of references (e.g., Emmet, 1986; Stehr, 1987; Winter, 2000; Wagner, 2005) that discuss methods for collecting immature lepidopterans, rearing them to adulthood, and maintaining appropriate records. The comments that follow reflect the authors' experiences with olethreutines.

Olethreutine larvae usually are found in the field by recognizing their feeding shelters. The crumpled, rolled or wilted leaves forming the nest are often conspicuous, especially in early spring before the foliage is fully developed. Adults can be obtained by maintaining the nest in a rearing container (zip-lock plastic bags or small plastic cups work well) until pupation. This process is remarkably easy for leaf-tying larvae that do not diapause prior to pupation. Maintenance of the rearing container consists of frass removal, moisture control, and the occasional resupply of fresh food. The main challenge is to monitor the humidity level to keep the food fresh without encouraging mold growth. Pieces of paper towel can be inserted to absorb excess moisture but must be removed when they get wet or moldy. The fully developed larva constructs a pupation chamber, either within the leaves or on the surface of the rearing container. Pupation chambers should be placed singly in vials or plastic cups for adult emergence. This might require cutting out a section of the plastic bag if the chamber is attached to the container. Excess rotting plant material should be trimmed away to prevent mold development. An acceptable humidity level in the pupation container can be maintained by occasionally inserting a piece of fresh leaf from the host plant. Fully developed larvae that postpone pupation for a period of time often sequester themselves in silken chambers on the surface of the container or between layers of paper towel. Carrying these larvae through to eclosion requires continuous vigilance during the dormancy period to prevent desiccation without inducing mold growth.

Twig borers are often easier to manage because the larvae have entered later instars by the time the feeding shelter is discovered. As long as the twig is not trimmed too short, there likely will be enough food to sustain the larva until fully developed. Monitoring humidity levels and frass accumulation is usually all that is required. Paper towel on the bottom of the container might be useful if the larva leaves the feeding shelter to pupate. Some borers (e.g., *Epiblema*) overwinter in stem galls, so collection of the galls should probably be postponed until the end of the growing season, and the stems should be kept outdoors under natural conditions through the winter.

Root borers present a special challenge. There are very few cases in which the full life cycle has been observed. Powell & Opler (2006) described the method they utilized in documenting host associations for several western species of *Phaneta*, *Eucosma*, *Pelochrista* and *Sonia*. They visited locations where adults of the target species had previously been collected, dug up roots of likely hosts shortly before the expected flight period, trimmed off the extraneous portions of the plant, and placed the roots in plastic bags for observation in the laboratory.

Preservation techniques

Methods of preserving larvae are discussed by Winter (2000), Wagner (2005), Dugdale et al. (2005), and in detail by Stehr (1987). The objective is to fix the tissues to prevent discoloration or rotting of samples. This can be accomplished with heat or with chemical fixing agents.

For the amateur collector, the simplest method for killing larvae is to drop them in household vinegar (5% acetic acid) for 24 hours. Specimens are then transferred to rubbing alcohol for permanent preservation. Although the results are far from ideal, this method has the advantages that vinegar is cheap, nonflammable, relatively nontoxic, and may be readily available in remote locations. The remainder of this section discusses techniques appropriate for research purposes.

Larvae can be killed and heat-fixed by dropping them in very hot or gently boiling water, a process that causes the body to expand and become rigid. The resulting body distention makes the crochets easy to see and prevents folds of cuticle from obscuring body setae. However, bloated larvae are difficult to manipulate and can be punctured by forceps. Light colors tend to be poorly preserved; the process causes most individuals to bleach bright white. Dark markings are unaffected.

Chemical killing agents and fixatives usually involve a mixture of alcohol and some organic solvent or acid. This approach allows the larva to be slightly bent or twisted without repositioning the sample. Color preservation tends to be better than with boiling, but crochet patterns are often difficult to see unless the larva is inflated. Perhaps the biggest disadvantage of this method is that toxic acids and organic solvents require a fume hood for use and storage. Godfrey (1972) used a mixture of nine parts 70% ethanol and one part glacial acetic acid by volume. The specimen can be injected through the mouth or anus using a diabetes syringe to inflate the larva as needed. In this process, use of protective eyewear is essential as specimens can burst, squirting the acid alcohol mixture in all directions. Dugdale et al. (2005) mentions an alternative chemical fixative called Carnoy's solution, which contains chloroform as well as the alcohol-acetic acid mixture.

After killing and fixing, the larvae should be transferred into vials containing 75-80% ethanol for storage. Proper labeling is important: place the label inside the vial to avoid loss; use only 100% rag, acid-free paper; and write the label in pencil to avoid smearing of ink. Figure 22 shows a rack of properly prepared, wide-mouth, screw-top vials, which are appropriate for frequently consulted specimens. Rubber stoppered vials are preferred for long-term storage. In either case, periodic inspection is needed to check for alcohol evaporation. Institutional collections usually place the vials in mason jars that are themselves filled with alcohol. Adding a few drops of glycerine per vial provides some protection to the specimen should the alcohol completely evaporate.

MacKay (1963b) warned that larvae stored in ethanol may darken to the point that lighter colored species could be unrecognizable, but some morphological features are easier to see in these specimens. H. W. Capps, in a 1963 unpublished training aid used at the National Museum of Natural History, actually recommended killing tortricid larvae directly in 80% ethanol for this reason.

Before alcohol collections became popular, most larvae were dried, mounted on pins, and stored with the associated adults. The technique involved rolling out the body contents with a tube and then inflating and drying the cuticle under low constant heat. Details are given by Hammond (1960) and Stehr (1987). Numerous examples of these "inflated larvae" still exist in collections, but the method is used rarely today because of the time and effort required to prepare the specimens and the damage that results to the terminal abdominal segments. Chemical dehydration and freeze-drying alternatives are discussed by Stehr (1987). Dried specimens have the advantage that they are easily manipulated on the pin to observe gross morphological characters, and they often show cuticle texture better than alcohol preserved material. Dry preservation also eliminates the maintenance issues associated with alcohol collections.

Serious morphological studies of larvae require that specimens be cleared for examination under a microscope. Dugdale et al. (2005) recommends macerating the larva in a 10% potassium hydroxide solution and then making two transverse slits to expel the body contents. One slit cuts the membrane that attaches the head to the prothorax; the other is made between the fifth and sixth abdominal segments. The cuticle can then be stained with Chlorazol Black E or acetocarmine (Komai, 1999) and examined under high

Figure 22: An example of a larval collection with specimens stored in 80% ethanol.

magnification. If a slide mount is desired, longitudinal slits are made instead of two transverse ones. The cuticle is stained and then slide mounted using typical genitalia techniques (see Robinson, 1976).

The following modification of the above procedure has been used by S. Passoa for many years. Maceration, staining and separation of the head follow Dugdale et al. (2005), but the larval cuticle is prepared by making a longitudinal slit in the subdorsal region between the D and SD setae. This allows better observation of the spacing of the V setae, an important character in Olethreutinae (MacKay, 1959). The mouthparts are dissected and mounted separately following Godfrey (1972), thus avoiding the problems mentioned by Dugdale et al. (2005) in trying to position the mandible. The spinneret can be mounted laterally or ventrally depending on the desired view.

Introduction to the simplified larval key

MacKay's (1959) treatment of the North American olethreutines contains the most comprehensive and accurate larval identification keys for this group. However, use of these keys is difficult and time consuming because of the morphological diversity and size of the subfamily. Brown (1987) partially summarized MacKay's keys by dividing the Olethreutinae into pest guilds sorted by commodity groups (e.g., common tortricid larvae on pines). These simplified keys have proven useful to economic entomologists needing identifications of larvae on a particular host. The concept of a simplified larval key is equally valuable when applied to a particular faunal region.

The purpose of the following key is to provide a quick and simple method for identifying olethreutine larvae that may be commonly encountered in the Midwestern United States. This key is greatly simplified from MacKay (1959) with several minor modifications. All couplets have been rewritten to be contrasting, and the nomenclature follows Brown (2005). Morphological terms have been updated when required; for instance, stemma is currently used in place of ocellus (Stehr, 1987). All terminology used in the key is explained in this chapter or figured in MacKay (1959, 1963a). The key resolves to the lowest possible taxonomic level that can be distinguished easily. In some cases this is the species level; in others it may be a genus or a group of species. Knowledge of the larval host is helpful and may be required by some couplets. Setal variation is common in tortricid larvae; it is important to check both sides of a specimen and to look for empty setal bases that indicate setae have fallen out.

Several works discuss the recognition of tortricid larvae at the family level (Brown, 1987; Dugdale et al., 2005). All of the species treated in this work have the following characters: a trisetose prespiracular group; L1 and L2 closely associated on A1-8; and the D2 setae of A9 joined on a single pinaculum. No set of larval characters has been discovered that will completely separate the subfamilies Olethreutinae and Tortricinae, but there are some useful partial results. Weisman (1986) characterized Olethreutinae as having D1 and SD1 of A9 on the same pinaculum. Though useful in recognizing the majority of species in the subfamily, this character is lacking in some olethreutines (MacKay, 1962a; Brown & Nishida, 2003) and is present in some Tortricinae (MacKay, 1962a) and Cochylini (MacKay, 1959). MacKay (1962a) pointed out that mature larvae of true borers are likely to be olethreutines if the tip of the spinneret is spatulate, tapered, or bifurcate. Leaf-rolling larvae with a rounded spinneret tip are likely to be tortricines.

Simplified Key to some Common Olethreutinae Larvae found in the Midwestern United States

(modified from MacKay, 1959, 1962b)

1. SV group on A3-6 always with 4, and sometimes 5 setae; spinneret with distal end distinctly bifurcated ____ *Retinia*

1'. SV group on A3-6 never with more than 3 setae; spinneret with distal end not distinctly bifurcated ____ 2

2. Extra seta present posterodorsad of spiracle on A1-7 and posteroventrad of spiracle on A8 ____ 3

2'. Extra seta not present on either A1-7 or A8 ____ 4

3. Spinneret broadened at distal end so that it is almost spatulate; a borer in buds and new growth of pines, but never causing formation of pitch nodules on stems ____ *Rhyacionia*

3'. Spinneret tapered at distal end; a borer in roots and stems of *Helianthus* or *Silphium* ____ *Eucosma giganteana*, *E. bipunctella*, *or E. sombreana*

4. Spinneret 6-15x as long as wide; anal comb absent; larva in *Solidago* or Rosaceae as a borer or sometimes a webber, but never a leaf-roller ____ 5

4'. Spinneret not 6-15x as long as wide; anal comb present or absent; habits and hosts vary ____ 6

5. Setal pinacula minute; feeds in flower heads of *Solidago* ____ *Phaneta ochroterminana*

5'. Setal pinacula moderately large; usually feeds in fruits of Rosaceae ____ *Cydia pomonella*

6. Distance between the D2 pinacula of A8 always less than the diameter of the D2 pinaculum of A8; anal comb absent; borers and gall makers in *Solidago*, *Ambrosia*, *Rudbeckia* and other herbaceous plants ____ *Epiblema*

6'. Distance between the D2 pinacula of A8 usually more than the diameter of the D2 pinaculum on A8; anal comb present or absent; not a borer or gall maker in *Solidago*, *Ambrosia*, *Rudbeckia* and other herbaceous plants ____ 7

7. SD1 pinacula of A1-8 usually fused with rim of the spiracle; prothoracic L setae nearly form an equilateral triangle; bores in cones, needles or stems of conifers ____ *Eucosma*

7'. SD1 pinacula of A1-8 separated from rim of the spiracle; L setae do not form an equilateral triangle; not borers in cones, needles or stems of conifers ____ 8

8. Lower one-half of prothoracic shield with a contrasting dark patch ____ 9

8'. Lower one-half of prothoracic shield without a contrasting dark patch ____ 11

9. Prespiracular group and prothoracic shield with dark spot ____ *Hedya chionosema*

9'. Prespiracular group and prothoracic shield without a dark spot ____ 10

10. Stemma 1 often shaped like a half-moon; anal shield tapers to a blunt point; larva webs leaves and flower heads of *Spiraea* ____ *Evora hemidesma*

10'. Stemma 1 not half-moon shaped; anal shield rounded; leaf folder on deciduous plants (including *Spiraea*) ____ *Ancylis*

11. SV group on A1, 2, 7, 8, and 9 consistently 3:3:3:2:2 ______ 12

11'. SV group on A1, 2, 7, 8, and 9 consistently 3:3:2:2:2 or less ______ 16

12. Cuticular spinules inconspicuous except on prothorax; prothoracic legs darkly pigmented in contrast to meso- and metathoracic legs, which are concolorous with the body; leaf-rollers on deciduous hosts ______ *Olethreutes*

12'. Cuticular spinules of prothorax similar to those of the body; prothoracic legs concolorous with the meso- and metathoracic legs; habits and hosts vary ______ 13

13. Head with dorsal surface flattened; setae A2, A3 and L1 usually approximate a straight line ______ 14

13'. Head with dorsal surface convex; setae A2, A3 and L1 never form a straight line ______ *Endothenia*, *Paralobesia*, or *Lobesia*

14. Anal comb present, but poorly developed; on terminal buds and folded leaves of *Rhus* or *Acer* ______ *Episimus*

14'. Anal comb absent; on *Impatiens* or *Hydrangea* ______ 15

15. Prothoracic spiracle oval; a borer in stems of *Impatiens* ______ *Pristerognatha agilana*

15'. Prothoracic spiracle circular, larva makes a nest in folded leaves of *Hydrangea* ______ *Olethreutes ferriferana*

16. SV group on segment 9 usually a single seta ______ 17

16'. SV group on segment 9 usually with two setae ______ 19

17. L3 pinaculum on the meso- and metathorax as large, or larger than, the corresponding L1 and L2 pinaculum; all pinacula usually darker than the body especially on the thoracic segments; spinules sparse and dark, their bases enlarged, dark, and distinct; gall maker in stems, petioles of leaves, and terminal twigs of deciduous hosts ______ *Proteoteras*

17'. L3 pinaculum on the meso- and metathorax smaller than the corresponding L1 and L2 pinaculum; thoracic pinacula not especially darker than the body color; spinules without enlarged bases ______ 18

18. Distance between the metathoracic coxae equal to 1½ times or more the diameter of the metathoracic coxa; thoracic V1 pinacula not fused to the coxae; larva feeds in acorns or beech nuts ______ *Cydia latiferreana*

18'. Distance between the metathoracic coxae equal to approximately the diameter of the metathoracic coxa; V1 pinacula very close to coxae or fused with coxae; larva does not feed in acorns or beech nuts ______ *Grapholita* or *Cydia*

19. Anal comb absent; larva skeletonizes maple leaves from a frass tube within crumpled leaf ______ *Catastega aceriella*

19'. Anal comb present; larva feeds in flowers, buds, and leaves of *Pyrus*, *Prunus*, *Rubus*, and others ______ *Spilonota ocellana*

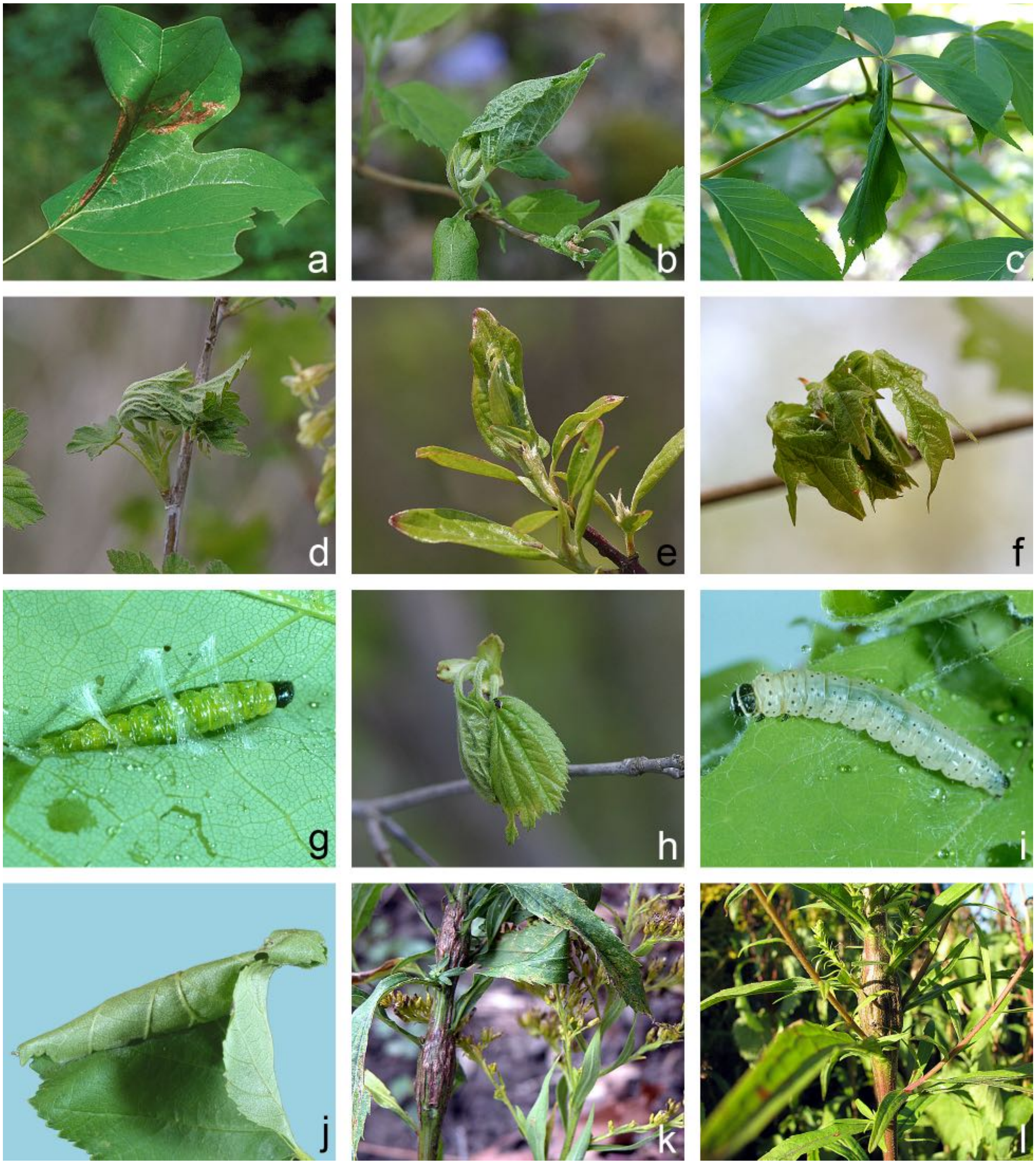


Figure 23: Examples of larval damage; **a:** *Paralobesia liriodendrana* on *Liriodendron tulipifera*; **b:** *Olethreutes ferriferana* on *Hydrangea arborescens*; **c:** *Olethreutes appalachiana* on *Aesculus flava*; **d:** *Olethreutes exoletus* on *Ribes*; **e:** *Olethreutes furfurana* on *Cornus*; **f:** *Olethreutes nigrana* on *Acer*; **g:** *Olethreutes nigrana* on *Acer saccharum*; **h:** *Hedya chionosema* on *Crataegus*; **i:** *Pseudosciaphila duplex* on *Populus*; **j:** *Epinotia* leaf roll on *Betula*; **k:** *Epiblema scudderiana* double gall on *Solidago*; **l:** *Epiblema scudderiana* gall on *Solidago*. Photo credits; a: L. S. Risley, William Paterson University; g, i, j: Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada; k, l: J. M. Storey, Carleton University.

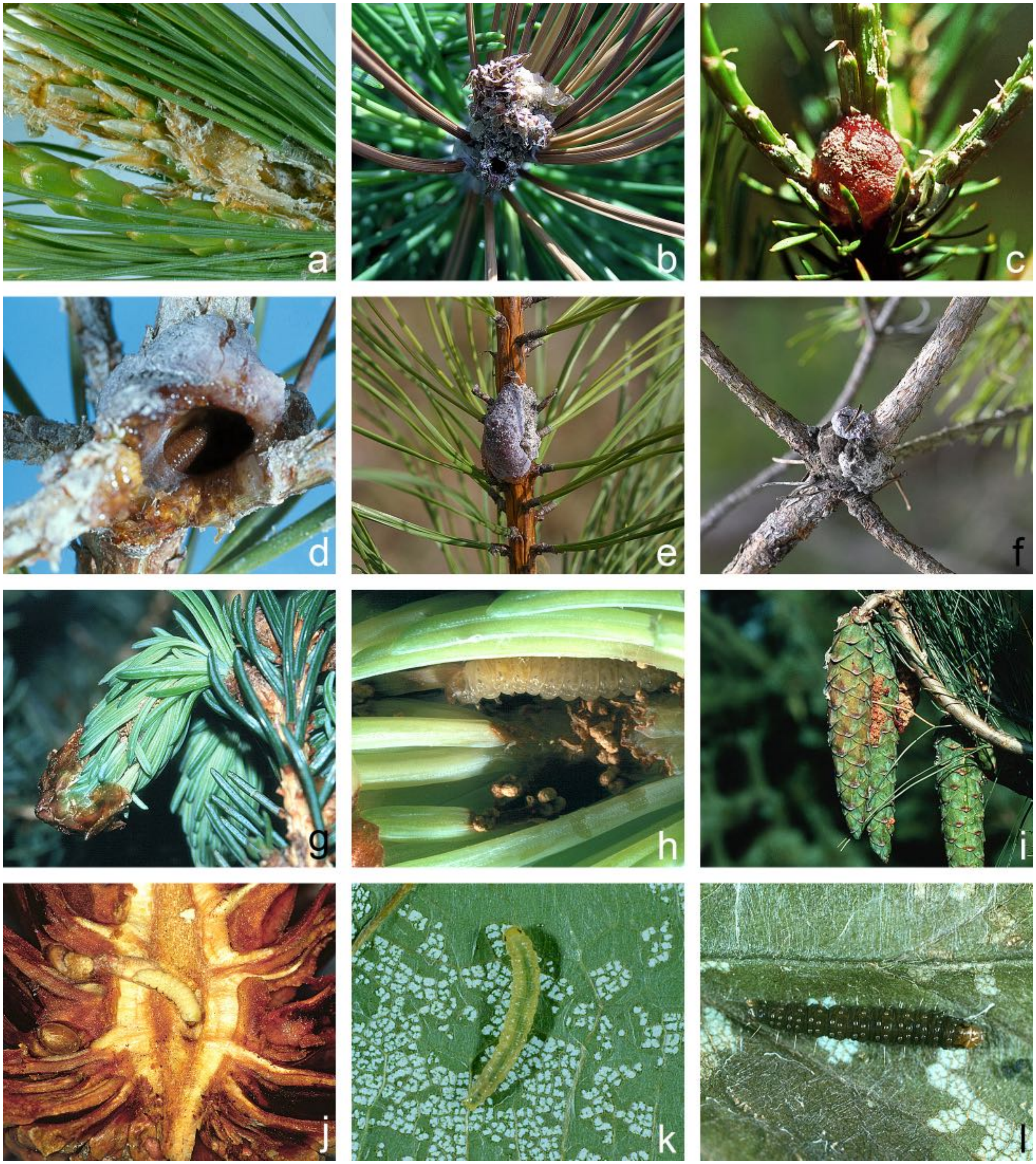


Figure 24: Examples of larval damage (cont'd); **a:** *Rhyacionia buoliana* on *Pinus resinosa*; **b:** *Rhyacionia buoliana* exit hole on *Pinus sylvestris*; **c, d:** *Retinia albicapitana* pitch nodule on *Pinus banksiana*; **e:** *Retinia* sp. pitch nodule; **f:** *Retinia virginiana* pitch nodule; **g, h:** *Zeiraphera canadensis* damage to *Picea*; **i:** *Eucosma tocullionana* damage to cones of *Pinus strobus*; **j:** *Cydia toreuta* overwintering in cone of *Pinus resinosa*; **k:** *Ancylis burgessiana* on *Quercus rubra*; **l:** *Ancylis nubeculana* on *Crataegus*. Photo credits; a, d, k, l: Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada; b: M. Zubrick, Forest Research Institute - Slovakia; c: USDA Forest Service - Northeastern Area Archive; g, h: Connecticut Agricultural Experiment Station Archive; i, j: S. Katovich, USDA Forest Service.

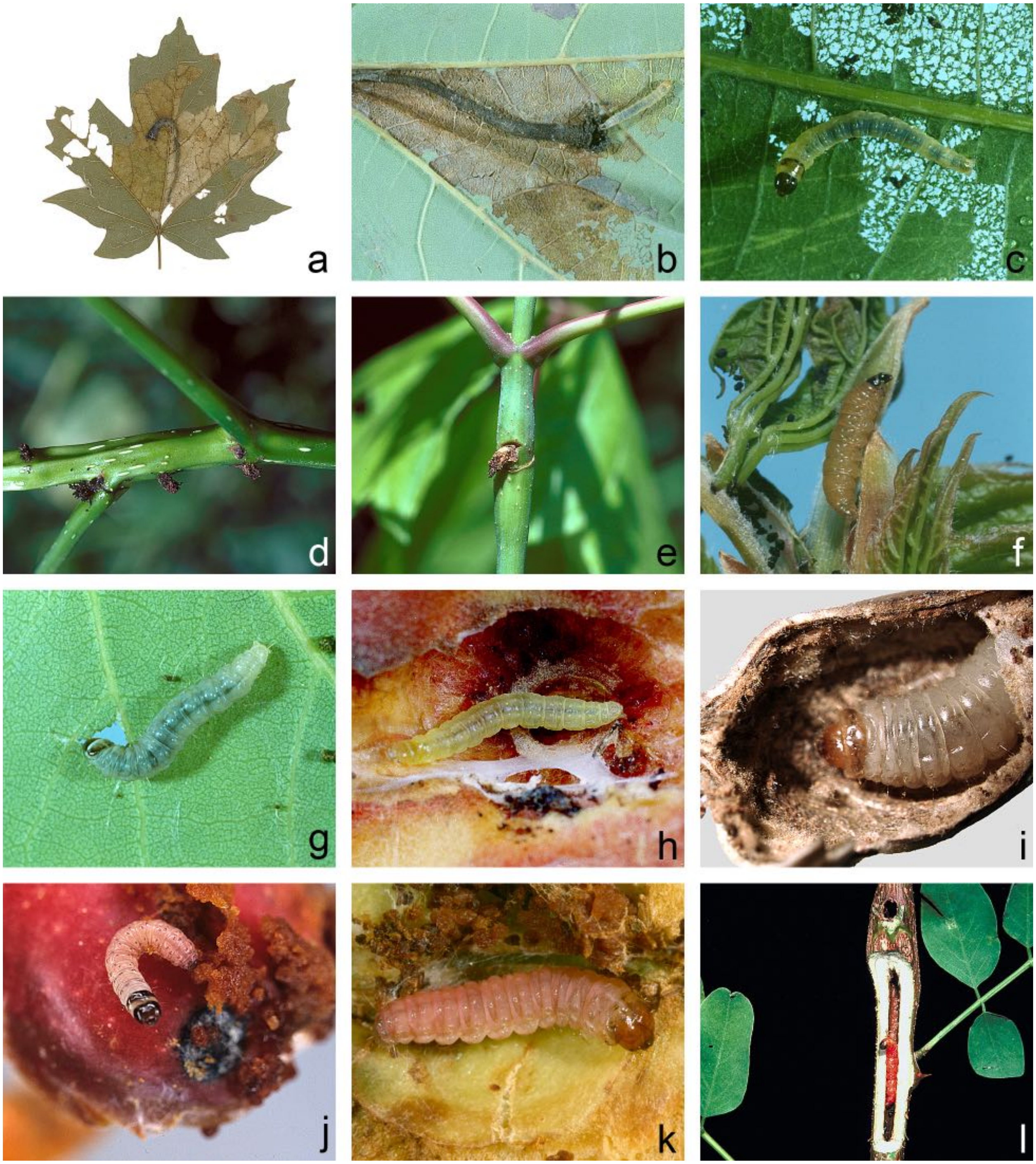


Figure 25: Examples of larval damage (cont'd); **a, b:** *Catastega aceriella* larval shelter on *Acer*; **c:** *Catastega timidella* on *Quercus rubra*; **d:** *Gypsonoma haimbachiana* frass tubes on *Populus deltoides*; **e:** *Proteoteras willingana* in stem of *Acer negundo* with frass tube at entrance hole; **f:** *Proteoteras moffatiana* on *Acer saccharum*; **g:** *Pseudexentera oregonana* on *Populus tremuloides*; **h:** *Grapholita* sp.; **i:** *Cydia latiferreana* in acorn of *Quercus*; **j, k:** *Cydia pomonella* on *Malus*; **l:** *Ecdytolopha insiticiana* in stem of *Robinia pseudoacacia*. Photo credits; b, c, f, g, k: Canadian National Collection of Insects, Arachnids and Nematodes, Agriculture and Agri-Food Canada; d, e, l: J. Solomon, USDA Forest Service.

Pupae

The following is a brief introduction to basic olethreutine pupal morphology, with emphasis on family identification. Additional information is given by Mosher (1916), Adler (1991), Horak (1991), Horak and Brown (1991), and, for European species, Patočka and Turčáni (2005).

The morphology of a typical pupa includes larval remnants (setae, proleg scars), features of the pupa that aid in eclosion (dorsal spines, cremaster), and characteristics of the developing adult (legs, wings) (Horak, 1991; Patočka & Turčáni, 2005). The derivation of the pupal structure may not be apparent until the adult is almost developed under the clear cuticle; this is especially true with regard to the mouthparts, legs, and wings (Fig. 27). Dissection of pupae containing an adult close to emergence, termed a pharate adult, was used by Mosher (1916) to homologize pupal characters.

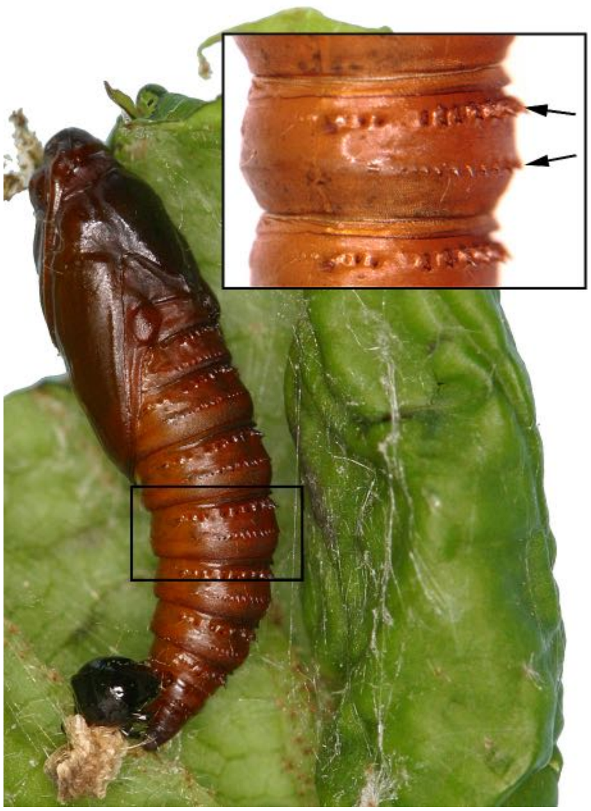


Figure 26: Two rows of dorsal spines per abdominal segment on an *Olethreutes* pupa. Note larval exuvium at end of pupal abdomen.

Like other Lepidoptera, the olethreutine pupa is divided into three sections: head, thorax, and abdomen. Appendages (wings, legs, etc.) are immobile and tightly fused with the rest of the body, a condition referred to as obtect (Scoble, 1992). The head contains the eyes, labrum, labial palpi, mandible remnants, maxillary palpi, and maxillae. On the thorax, the dorsal sclerites and forewings are clearly visible, as are the prothoracic and mesothoracic legs. The hindwings are partially visible, and only the tips of the metathoracic legs are exposed. The abdomen consists of ten segments (A1-10); some are capable of movement (A4-7 in males, A4-6 in females), others are fused and immobile (A8-10 in males, A7-10 in females). Both the genital pore and the anal opening are located ventrally on the fused terminal segments. Pupae are sexed by the position of the genital pore: on segment A8 in females, on segment A9 in males (Fig. 28). The anal opening is located on A10 in both sexes. It is often flanked laterally by small hooked setae (termed perianal setae in Patočka & Turčáni 2005) on a structure called the anal rise (Fig. 27). The tip of the abdomen, or cauda, usually forms a cremaster to anchor the pupa in its shelter.

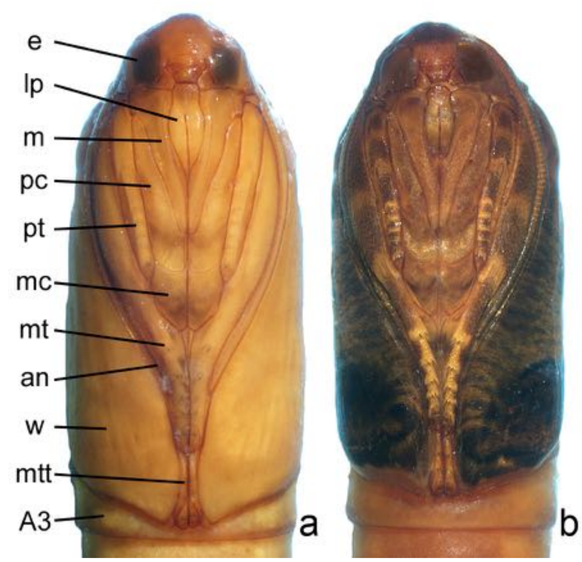


Figure 27: Pupae of *Cydia pomonella* showing development of appendages (A3, abdominal segment 3; an, antenna; e, eye; lp, labial palpus; m, maxilla; mc, mesocoxa; mt, mesotarsus; mtt, metatarsus; pc, procoxa; pt, protarsus; w, wing); **a:** newly formed pupa; **b:** fully developed pupa ready for eclosion.

North American tortricid pupae are distinguished by the following combination of characters (modified from Mosher, 1916; Heinrich, 1923a; Adler, 1991; Komai, 1999; Horak, 1991, Patočka & Turčáni 2005): antennae moderately long, extending nearly to the wing tip; maxillae well developed but short; maxillary palpi variable in size and usually visible as sclerites below the eyes; wings broad and not extending beyond segment A3; segments A3-7 with two transverse rows of dorsal spines and additional rows of spines variably developed on A2 and A8-10 (Figs. 26-27). The cremaster, if present, usually has four to eight hooked setae and is either elongate or broad and flattened, often with spines or lobes. There is no single pupal character to separate Olethreutinae from Tortricinae. Mosher's (1916) key is still the best resource for identifying North American species, although it does not include Cochylini. Pupae of Cochylini are most similar to some Olethreutinae because both groups lack a cremaster (Horak, 1998).

Oletheutine pupae exhibit a diverse array of morphological specializations. The head is usually smooth but may have dorsal ridges or horns (Komai, 1999; Patočka & Turčáni, 2005). Appendage length is variable, and several authors have separated taxa based on relative lengths of the maxillae and legs (Adler, 1991; Mosher, 1916; Patočka & Turčáni, 2005). Abdominal spiracles can be round, oval, or tubular (Mosher, 1916). In the Olethreutinae, unlike other Lepidoptera, the mesothoracic spiracle is not taxonomically significant. The dorsal abdominal spines are variable in arrangement and size. They may be aligned in a single transverse row (uniserial) or arranged in a transverse row of two or more lines of irregularly spaced spines (multiserial) (see illustrations in Komai, 1999). In midwestern species, the anterior row usually has larger spines than the posterior row. The anal rise may have zero to four pairs of setae (Horak & Brown, 1991). Adler (1991) illustrated some typical olethreutine cremasters and noted, in agreement with Komai (1999), that a cremaster is lacking in all Grapholitini and some Eucosmini. Some of the variation in olethreutine pupae is due to sexual dimorphism; males tend to have an extra row of dorsal spines on A8 or A9 (Mosher, 1916), and a metathoracic swelling has been observed in males of some *Olethreutes* species (Adler, 1991; Fig. 26).

Pupae are most often acquired by rearing larvae or by accidental discovery in the field. If still alive, every attempt should be made to rear the specimens, since the adult stage offers the best opportunity for identification. If a pupa fails to eclose, dissection of the genitalia of the pharate adult or slide preparation of the larval exuvium might yield a determination. If a parasitoid emerges, the pupal and larval exuviae of the moth may be the only clues to the identity of the host, and the host information may be necessary to identify the parasitoid.

The pupal exuvium should be stored under the reared adult, either in a gelatin capsule or by careful pinning through the wings. Intact pupae are usually preserved in alcohol to prevent rotting of the internal organs. Since some head sutures and appendages are damaged when the adult emerges, it is best to study these characters on intact pupae. For examination of the taxonomically important cremaster, the pupal exuvium is preferred, because alcohol storage can result in breakage due to occasional contact with wall of the vial. The larval exuvium should be retained and stored in a gelatin capsule.

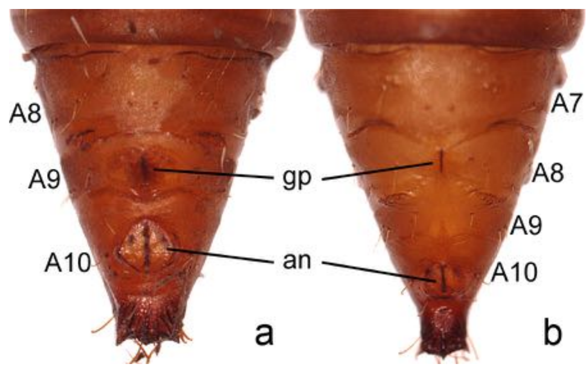


Figure 28: Details of the terminal segments on typical Olethreutinae pupae (A7-10, abdominal segments 7-10; an, anus; gp, genital pore); **a:** male with the genital pore on A9; **b:** female with the genital pore on A8.

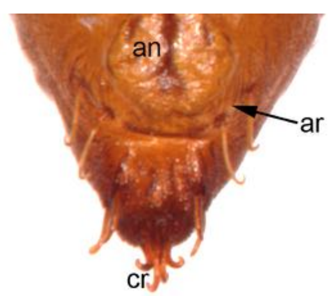


Figure 29: Terminal abdominal segments in pupa of *Hedya* with two hooked setae on each side of the anal rise (an, anus; ar, anal rise; cr, cremaster).

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* Journal abbreviations follow Brown, 2005. A list of journals and their abbreviations can be found on the following web page: http://www.tortricid.net/olethreutinebook.asp.

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Glossary of Descriptive Terms

Some descriptive terms (e.g., upper, lower, front, rear) are meaningful only in reference to some assumed orientation of the described object. We apply them to specimens that are pinned and spread in the standard manner, in which case upper refers to the direction of the pin head, front to the direction of the insect head, etc.

Acute Sharp, pointed, referring to an angle of less than 90°.

Anterior Before, to the front, toward the head.

Bifid Cleft, forked, divided into two parts.

Distal Farthest from body, distant from point of attachment.

Dorsal Upper, to the top, on the back.

Emarginate Indented, notched, or cut out at the margin.

Falcate Narrow, curved and pointed, sickle-shaped.

Filiform Threadlike, long and slender with uniform cross section.

Invaginated Inwardly folded, pocketlike, scooped out.

Irrorated Minutely spotted, sprinkled with minute marks.

Lateral To the side.

Lustrous Bright, shining, metallic.

Maculation Markings, pattern of spots, bands, blotches, streaks, etc.

Medial To the middle, central, toward center line.

Melanic Darkened, blackened.

Posterior After, to the rear, toward anal end.

Produced Enlarged, extended, drawn out.

Proximal Toward the base, nearest the body or point of attachment.

Reticulate Covered with network of fine lines.

Sclerotized Hardened.

Scobinate Rasplike.

Setose Covered with setae.

Spatulate Spoonlike, narrow basally and enlarged and rounded apically.

Spinulate Covered with spinules.

Striate Finely lined.

Suffused Spread throughout, obscured.

Ventral Lower, to the bottom, on the under side.

Host Plant Index*

* Numbers in **bold** refer to species number (not page number). Nomenclature follows the USDA PLANTS Database (http://plants.usda.gov).

Q

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General Index*

* Numbers in **bold** refer to species number; all other numbers refer to page number.

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