# *Eucosma* Hübner of the Contiguous United States and Canada (Lepidoptera: Tortricidae: Eucosmini)

Donald J. Wright Todd M. Gilligan

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# Abstract

We review 133 species of Eucosma from the contiguous United States and Canada, emphasizing diagnostic morphological features useful in species identification. Nine new species are described: E. calderana Wright and Gilligan, sp.n.; E. fulvofasciata Wright and Gilligan, sp.n.; E. robertsoni Wright and Gilligan, sp.n.; E. alabamae Wright and Gilligan, sp.n.; E. salidana Wright and Gilligan, sp.n.; E. fulvotegulana Wright and Gilligan, sp.n.; E. pecosana Wright and Gilligan, sp.n.; E. sableana Wright and Gilligan, sp.n.; and E. knudsoni Wright and Gilligan, sp.n. In addition, *E. occidentalis* (Heinrich), stat.rev., formerly a subspecies of *E.* striatana (Clemens), is elevated to species status; 21 lectotypes are designated; and nine new synonymies are proposed: E. infimbriana candidula (Heinrich), syn.n., with E. infimbriana (Dyar); E. castrensis (McDunnough), syn.n., with E. segregata (Heinrich); E. argenticostana (Walsingham), syn.n., with E. spiculana (Zeller); E. triangulana (Kearfott), syn.n., with E. tarandana (Möschler); E. clarkei (Blanchard and Knudson), syn.n., with E. montanana (Walsingham); E. vernalana (McDunnough), syn.n., with E. rupestrana (McDunnough); E. marmontana (Kearfott), syn.n., with E. parmatana (Clemens); E. musetta (Blanchard and Knudson), syn.n., with E. influana (Heinrich); and E. urnigera Meyrick, syn.n., with E. southamptonensis (Heinrich). Included are 450 adult images, 629 genitalia drawings, and several discussions of unresolved species complexes.

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# Introduction

*Eucosma* Hübner is one of the largest genera in the Tortricidae, with 231 species recognized in the most recent world catalogue (Gilligan and Wright 2013b). It is Holarctic in distribution but achieves its greatest species richness in the Nearctic, where members of the genus can be found in nearly every habitat, ranging from the dunes of the Gulf Coast to the barren summits of the Rocky Mountains. For the past 60 years, a large number of the North American species (89%) were incorrectly placed in *Phaneta* Stephens due to a misinterpretation of that genus by Obraztsov (1952). That situation was recently rectified by Gilligan et al. (2014), whose phylogenetic analysis of *Eucosma* and related genera resolved the long standing difference between the Nearctic and Palearctic interpretations of *Eucosma* and resulted in the present species arrangement (Gilligan and Wright 2013b). This volume is, in part, a culmination of that study. It is the first comprehensive treatment of North American *Eucosma* since Heinrich's (1923) revision of the then recognized subfamily Eucosminae.

Very little detailed information is available on the life histories of North American Eucosma. Larval hosts have been reported for only about 20% of the species, and none are of significant agricultural importance. Recorded hosts are exclusively Asteraceae, the largest plant family in North America (Barkley et al. 2006), and the preference for these ubiquitous hosts could explain the extensive species diversity found within the genus. The primary sources of life history information are Heinrich (1923), who reported hosts for reared specimens deposited in the USNM, Putman (1942), who reared a number of eastern eucosmines in Ontario as part of a study of native hosts of parasites of Grapholita molesta (Busck), and Powell and Opler (2006, 2009), who conducted an extensive survey of Tortricidae that bore in roots of woody Asteraceae in California and neighboring states. Many host associations appear to have been serendipitous discoveries that were reported as short notes, often only on specimen labels, stating the name of the host and sometimes the part of the plant in which a larva was collected. Historical records can be difficult to evaluate due to uncertainty as to the accuracy of the species determinations (moths and/or plants). Most accounts of larval feeding behaviors describe webbing of flowers and/or terminal leaves, with the larva leaving the host to overwinter in a cocoon spun in the soil or leaf litter (Putman 1942), or boring into stems and roots, with construction of an emergence path for the pupa leading to or above ground level (Powell and Opler 2006). Prior to Gilligan et al. (2014), Eucosma included a number of species known to be pests on conifers, the larvae boring into cones and feeding on the seeds, but those taxa are now placed in the recently described genus Eucopina Gilligan and Wright. Adult collection data suggest that most Nearctic *Eucosma* are univoltine, with local flight periods lasting about 3–6 weeks, but there are examples of bimodal emergence patterns in southern and southwestern United States that indicate fairly well-defined spring and fall broods. In some instances, such as E. circulana in western Kentucky and E. amphorana in California, adults fly throughout the summer.

Nearctic *Eucosma* exhibit considerable intraspecific variation in size and forewing appearance and, to a lesser extent, in aspects of the genitalia. Forewing length, a reliable indicator of specimen size (Miller 1977), often varies within species by 3–5 mm and sometimes by as much as 10 mm (e.g., *E. giganteana*), this within a group of species with an overall average forewing length of 8.1 mm. Forewing color and maculation can vary substantially within local populations and from one population to another in geographically widespread species. Intraspecific variation in genitalia usually takes the form of subtle differences in uncus, valva, and/or sterigma shape and can be sufficient to render species determinations based on genitalic characters unreliable. Under these circumstances, species circumscription based on classical morphology often has been uncertain, and numerous names that were once proposed on the basis of only a few

specimens are now relegated to synonymy. We have taken what we consider to be a conservative point of view with respect to these matters by recognizing, as much as possible, only those species that can be defined by discrete morphological characters states. Nevertheless, there remain a number of historically difficult species complexes that have not been satisfactorily resolved into well-diagnosed species. In those cases, we discuss the pertinent taxonomic issues and propose very few taxonomic changes.

## **Taxonomic History**

Hübner (1823) introduced *Eucosma*, with type species *E. circulana* Hübner, in the second volume of his *Zuträge zur Sammlung exotischer Schmettlinge* [sic.]. His description of *E. circulana* consisted of a few lines of text and two hand-painted illustrations of a female from Pennsylvania, a specimen that is now presumed lost or destroyed (Gilligan and Wright 2013a). The lack of a type specimen and of a detailed description for *E. circulana* resulted in uncertainty for nearly 100 years as to the true identity of the species and, in turn, of *Eucosma* and several related genera.

*Eucosma* was essentially a monotypic genus until late in the 19th century when Fernald (1882a) transferred *E. circulana* to *Paedisca* Treitschke. *Eucosma* remained a junior synonym of *Paedisca* until Walsingham (1897), in his second monograph on microlepidoptera of the West Indies, began consolidating genera as junior synonyms of *Eucosma*, starting with *Callimosema* Clemens, *Epiblema* Hübner, and *Paedisca*. This trend continued with Fernald (1908), who listed 26 generic names under *Eucosma*, and Walsingham (1914), who expanded the list to a total of 38 generic synonyms, effectively combining under *Eucosma* all of the early 20th century genera that today comprise Eucosmini.

Heinrich was the first taxonomist to attempt to characterize the Nearctic olethreutine genera using characters of the male genitalia. His *Revision of the North American moths of the subfamily Eucosminae of the family Olethreutidae*, published in 1923, resurrected many of the generic names synonymized by previous authors under *Eucosma*, thereby providing a framework for much of the current generic arrangement within Eucosmini. Heinrich (1923) proposed an interpretation of *E. circulana* that was widely accepted, but he did not address the lack of a formally recognized name-bearing specimen. He divided Nearctic *Eucosma* into two genera, assigning those species with a costal fold on the male forewing to *Eucosma* and resurrecting *Thiodia* Hübner for those that lack the costal fold, this despite clear differences in the male genitalia between the type species of *Thiodia* and the North American species he assigned to that genus.

Realizing that the Palearctic species of *Thiodia* were not congeneric with those from the Nearctic (sensu Heinrich), Obraztsov (1952) transferred the North American *Thiodia* to *Phaneta* Stephens and thereby introduced a discrepancy between the North American and European concepts of *Phaneta* and *Eucosma*. Palearctic *Phaneta* remained monotypic, with type species *Cochylis pauperana* Duponchel, while the Nearctic interpretation of the genus expanded to include nearly 100 species that would have been placed in *Eucosma* (or *Pelochrista* Lederer) if described from Europe. Subsequent North American authors (e.g., Miller 1987; Gilligan et al. 2008) followed Obraztsov, while European authors (e.g., Razowski 2003) continued to restrict *Phaneta* to one or two species. In two posthumous publications, Obraztsov (1967, 1968) separated *Pelochrista* from *Eucosma* based primarily on differences in the male genitalia, but for the next 45 years the assignment of Nearctic species to *Eucosma* or *Pelochrista* remained problematic due to frequent reduction or loss of the supposed diagnostic structures.

We addressed these problems in three publications (Gilligan and Wright 2013a, b; Gilligan et al. 2014) by providing revised circumscriptions of *Eucosma*, *Pelochrista*, and related genera based on morphological and molecular evidence. Gilligan and Wright (2013a) evaluated several species that are similar in appearance to Hübner's illustration of *E. circulana* and designated a neotype for that species, thus establishing a basis for rigorous assessment of *Eucosma*. Gilligan et al. (2014) tested the monophyly of *Eucosma* and related

genera though a combined phylogenetic analysis of morphological characters and a molecular data set consisting of three nuclear and one mitochondrial gene. That study produced revised definitions of *Eucosma* and *Pelochrista* based on female genital morphology, concluded that nearly all North American *Phaneta* belong in the redefined *Eucosma*, and differentiated *Eucopina* as a new genus of Pinaceae-feeding species that previously had been placed in *Eucosma*. Finally, Gilligan and Wright (2013b) provided a revised world catalogue of *Eucopina*, *Eucosma*, *Pelochrista*, and *Phaneta* consisting of 521 species or subspecies assigned to genus based on the generic concepts of Gilligan et al. (2014).

*Eucosma* and *Pelochrista* are currently distinguished by the sterigma-sternum 7 structure in the female. Three forms of this structure (referred to as Types I–III) were identified by Gilligan et al. (2014). Type I is found in *Eucosma*, Types II and III in *Pelochrista*. In the Type I arrangement, the posterior margin of sternum 7 is deeply invaginated, usually to the full length of the sterigma, the posterior lobes of that sternite are fused with or approximate to the lateral margins of the lamella postvaginalis, and the sterigma has a ringlike lamella antevaginalis. Type II differs from Type I in that the invagination of the posterior margin of sternum 7 is reduced, and the posterior lobes of sternum 7 diverge laterally from the sterigma. In Type III, the lamella antevaginalis is absent and the anterior margin of the ostium is fused with sternum 7.

Here we provide a review of the 133 species of *Eucosma* present in the contiguous United States and Canada. We describe nine new species, elevate to species status a former subspecies, and propose nine new synonymies. The species accounts are accompanied by 450 adult images, 629 genitalia drawings, and several discussions of unresolved species complexes.

# Materials and Methods

We examined approximately 5,600 adult specimens and 1,400 genitalia preparations. The following abbreviations are used for institutional and private collections:

ADW	= Andrew D. Warren collection, Gainesville, Florida, USA
AMNH	= American Museum of Natural History, New York, New York, USA
BMNH	= The Natural History Museum, London, United Kingdom
CFSE	= Canadian Forest Service, Edmonton, Alberta, Canada
CMNH	= Carnegie Museum of Natural History, Pittsburg, Pennsylvania, USA
CSU	= Colorado State University, Fort Collins, Colorado, USA
CNC	= Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa,
	Ontario, Canada
DJW	= Donald J. Wright collection, Cincinnati, Ohio, USA
ECK	= Edward C. Knudson collection, Houston, Texas, USA
EME	= Essig Museum of Entomology, University of California, Berkeley, USA
ESUW	= University of Wyoming, Laramie, Wyoming, USA
FSCA	= Florida State Collection of Arthropods, Gainesville, Florida, USA
INHS	= Illinois Natural History Survey, Champaign, Illinois, USA
LACM	= Natural History Museum of Los Angeles County, Los Angeles, California, USA
LDG	= Loran D. Gibson collection, Florence, Kentucky, USA
MCZ	= Museum of Comparative Zoology, Harvard University, Cambridge,
	Massachusetts, USA
MEM	= Mississippi Entomological Museum, Mississippi State University, Starkville,
	Mississippi, USA

- MSU = Michigan State University, East Lansing, Michigan, USA
- TMG = Todd M. Gilligan collection, Loveland, Colorado, USA
- UASM = Strickland Museum, University of Alberta, Edmonton, Alberta, Canada
- UCMS = University of Connecticut, Storrs, Connecticut, USA
- UMSP = University of Minnesota Insect Collection, St. Paul, Minnesota, USA
- USNM = National Museum of Natural History, Smithsonian Institution, Washington, D.C., USA

General morphological terminology follows Gilligan et al. (2008), with descriptions of forewing pattern elements based on the system proposed by Brown and Powell (1991) and modified by Baixeras (2002). Forewing length is used as an indication of specimen size. Terms used to describe the geometry of the forewing, valva, and sterigma are defined and abbreviated as follows (see Figs. A–D):

- AR = forewing aspect ratio = forewing length divided by medial forewing width (Fig. A)
- BVW = basal valva width = perpendicular distance from the base of the costa to the ventral margin of the sacculus, taken near the distal margin of the basal excavation (Fig. B)
- FWL = forewing length = distance from base to apex including fringe (Fig. A)
- MW = medial forewing width, measured perpendicular to the inner margin (Fig. A)
- NR = neck ratio = neck width divided by basal valva width (Fig. B)
- NW = neck width = width of the valva at the narrowest point of the neck (Fig. B)
- SA = saccular angle = angle formed at the distal end of the sacculus by linear approximations to the ventral margins of the sacculus and the base of the neck (Fig. B)
- SL = sterigma length (Fig. C)
- SR = sterigma aspect ratio = sterigma length divided by sterigma width (Fig. C)
- SW = sterigma width measured at mid-ostium (Fig. C)

Adults were examined with a Leica MZ95 stereomicroscope equipped with an ocular micrometer, and forewing measurements were estimated to the nearest 0.1 of a millimeter. Genitalia were examined with a Leica DME compound microscope. Associated measurements were taken on projected images of the genitalia generated by a Ken-A-Vision X1000-1 microprojector and were recorded to the nearest degree (SA) or nearest 0.5 millimeter (NW, BVW, SL, SW). The SA and NR for an individual specimen were recorded as averages of those quantities obtained from the two valvae, and the values assigned to a particular species were then calculated as the average of the specimen values associated with several representative specimens. All the dimensionless statistics (AR, NR, SR) were rounded to two decimal places. The numerical data are tabulated in Appendix A. The data for the specimens used for the genitalia drawings are provided in Appendix B.

Usually there is considerable intraspecific variation in the quantities defined above. SA and NR often vary from specimen to specimen in a given species and from one valva to the other in a given specimen. Moreover, these quantities do not lend themselves to precise measurement. In the case of the SA, there is often inherent ambiguity in the determination of the angle sides due to irregularities in the shapes of the sacculus and neck, and the actual measurement is dependent on the inclination of the valva in the slide-mounted preparation of the genitalia. These ambiguities also affect the calculation of NR, since BVW depends upon one side of the SA. For a particular species, the average values of such quantities provide a moderately useful quantitative characterization of valva geometry, but these statistics are usually not reliable in distinguishing between two species unless the differences are relatively large.

We restrict our coverage to the contiguous United States and Canada, which includes all of continental North America north of Mexico except Alaska. Ferris et al. (2012) published a list of the Lepidoptera of



Figures A–D. Morphological terms used to describe the geometry of the forewing, valva, and sterigma; abbreviations and ratios are explained in the text. A, adult wing pattern and venation. B, male genitalia. C, female sterigma. D, female genitalia.

Alaska which included five described species of *Eucosma*, four of which are treated here because their ranges extend into Canada and western United States. The fifth, *E. hohenwartiana* ([Denis and Schiffermüller]), is Holarctic and was reviewed by Razowski (2003). Most of the North American *Eucosma* have not been sufficiently sampled to yield accurate determinations of their geographic distributions. Our comments on the range of a particular species are based on selected specimens from institutional collections, specimens from various private collectors, and our own field experience. We excluded literature records that we consider unreliable and museum records that we could not verify. The result is at best a crude approximation to the actual range of the insect.

Approximately 40% of the recognized North American species of *Eucosma* were described prior to 1910 and, therefore, before the development of the concept of a unique name-bearing specimen for each taxon. Consequently, many of the species described by early authors such as Walsingham and Kearfott were based on series of syntypes, some of which have proved to be comprised of more than one species. Most of the Kearfott type material is located in the AMNH. Heinrich (1923) examined it while preparing his revision of North American Eucosmini and partially singled out name-bearing specimens with comments such as "Type – in American Museum," "Type locality – \_\_\_\_." In many cases, however, there are two or more specimens that meet his stated requirements. Nevertheless, Klots (1942) reported and labeled lectotypes in the AMNH for many of the Kearfott names, attributing the designations to Heinrich (1923). The Walsingham material, which resides in the BMNH, was not examined by Heinrich, and the comments in Heinrich (1923) regarding those "Types" were based on Walsingham's descriptions, which only mention the number of syntypes and the collection locality. In the 1960s, in preparation for a revisionary study of Nearctic Olethreutinae, Obraztsov examined the Walsingham syntypes and selected specimens to serve as lectotypes, but he died without publishing the designations. His photographs (35 mm slides) of the selected specimens and their genitalia were deposited in the AMNH and are now on long term loan to the MEM. Over the last fifty years, many of these type fixation issues have been resolved by authors such as Darlington, Miller, and Wright, who designated lectotypes as needed in their taxonomic studies. Today there remain 21 names (5 of which are synonyms) that have not been addressed. For the sake of nomenclatorial stability, we have included a lectotype designation for each of those names, using when possible the specimens selected by Klots or Obraztsov.

Photographs of adults were taken with a Canon EOS digital SLR and edited using Adobe Photoshop CS5/6 Extended. In most cases, lighting was provided by an Aristo DA-10 light box with a T55 (5500K) "daylight" bulb to maintain color correctness. For some specimens, lighting was provided using a Canon 430EX II or MR-14EX flash, and color was manually adjusted in Adobe Photoshop. Some photos are combinations of several images stacked with Zerene Stacker. Several photographs are provided for most species to illustrate multiple phenotypes. Genitalia drawings were based on pencil tracings of projected images produced with a Ken-A-Vision X1000-1 microprojector. The tracings were refined during examination of the genitalia with a Leica DME compound microscope and inked with KOH-I-NOOR Rapidograph pens using 4×0 and 3×0 nibs. Genitalia drawings were scanned with an Epson Perfection 2400 Photo scanner and compiled into plates using Adobe Photoshop. Multiple drawings are provided for most species to illustrate intraspecific variation in features such as valva and sterigma shape. Plant names follow the most recent taxonomy listed in the USDA, ARS, National Genetic Resources Program Germplasm Resources Information Network (GRIN) online database (www.ars-grin.gov, accessed September, 2014). Type abbreviations are as follows: HTP = holotype; PTP = paratype; LTP = lectotype; NTP = neotype; PLTP = paralectotype. Paratypes for some of the new species (e.g., *E. salidana*) will be distributed after the printing of this volume, and in these instances the depositories are given at the end of the paratype specimen lists.

# **Species Accounts**

Species 1–102 are organized in groups based on similarities in forewing appearance and/or genitalia, with the name of the earliest described group member serving as the group title. Species 102–133 are treated individually for lack of conspicuous affinities with other members of the genus.

The table of contents lists the species covered in this monograph in the order of their appearance in the species accounts. The number assigned to a particular species also identifies the adult images and genitalia illustrations associated with that taxon. Recognized valid names are numbered; synonyms are indented and not numbered. The Animal Name Index lists the species covered in this monograph in alphabetical order.

## *Eucosma* Hübner

Eucosma Hübner, 1823, Zuträge zur Sammlung exotischer Schmettlinge [sic] 2: 28. Type species: Tortrix circulana Hübner, 1823.

Affa Walker, 1863, List of specimens of lepidopterous insects in the collection of the British Museum 27: 202. Type species: Affa bipunctella Walker, 1863.

Ascelodes Fletcher, 1929, Memoirs of the Department of Agriculture in India (Entomological Series) 11: 25; nomen nudum.

Calosetia Stainton, 1859, A Manual of British Butterflies and Moths 2: 271. Type species: Tortrix nigromaculana Haworth, [1811].

*Catoptria* Guenée, 1845, Annales de la Société Entomologique de France (2) 3: 187; preoccupied by *Catoptria* Hübner [1825], Pyralidae. Type species: *Tortrix cana* Haworth, [1811].

Exentera Grote, 1877, The Canadian Entomologist 9: 227. Type species: Exentera apriliana Grote, 1877.

Exenterella Grote, 1883, The Canadian Entomologist 15: 23; unnecessary replacement name for Exentera.

Ioplocama Clemens, 1860, Proceeding of the Academy of Natural Sciences, Philadelphia 12: 360. Type species: Ioplocama formosana Clemens, 1860.

Palpocrinia Kennel, 1919, Mitteilungen der Münchner Entomologischen Gesellschaft 8: 66. Type species: Palpocrinia ottoniana Kennel, 1919.

**Diagnosis and description**. *Eucosma* is separated from similar genera (such as *Epiblema*, *Eucopina*, and *Pelochrista*) by the following combination of female character states: lamella antevaginalis ringlike, posterior margin of sternum 7 deeply invaginated, usually to the full length of the sterigma, with the resulting posterior lobes approximate to or fused with the lateral margins of the lamella postvaginalis. *Eucosma* females have laterally facing papillae anales that lack hook-tipped setae and two signa in the corpus bursae that usually are nearly equal in size. Male character states do not reliably diagnose *Eucosma*, but most males lack large solitary spiniform setae on the anal angle of the cucullus (present in many *Pelochrista*) and a clasper on the distal margin of the basal excavation (present in most *Epiblema*).

*Wings* (Fig. A). Forewing with  $R_4$  and  $R_5$  separate,  $M_2$  and  $M_3$  separate, chorda weak; males with costal fold present (11%) or absent (89%); mean FWL: 5.2–17.5 mm; AR: 2.36–3.66; maculation variable, often with subbasal and median fasciae at least partially expressed, usually including a conspicuous ocellus delimited proximally and distally by metallic gray bars. Hindwing with Rs and  $M_1$  approximate,  $M_2$  and  $M_3$  approximate,  $M_3$  and CuA<sub>1</sub> stalked or united.

*Male genitalia* (Fig. B). Uncus weakly to moderately developed, usually well differentiated from dorsolateral shoulders of tegumen, with apical margin rounded or medially indented; socii fingerlike and setose; phallus stout, tapering distally, with base closely surrounded by anellus; caulis short; vesica with sheaf of deciduous cornuti; valva with costal margin moderately concave to nearly straight, neck well defined, ventral margin broadly to deeply emarginate, distal margin of basal excavation sometimes with weakly developed basal process, saccular corner angulate to broadly rounded; cucullus with dorsal and ventral lobes weakly to moderately developed, often with basoventral margin overlapping or projecting in ridgelike manner onto medial surface of neck.

*Female genitalia* (Figs. C, D). Papillae anales laterally facing, usually flat, sparsely to moderately setose, usually microtrichiate, without ventral extensions; lamella postvaginalis usually well developed, often rectangular; lamella antevaginalis ringlike; posterior margin of sternum 7 deeply emarginated (usually to full length of sterigma) and approximate to or fused with lateral margins of lamella postvaginalis; ductus bursae usually with sclerotized band or patch at juncture with ductus seminalis; corpus bursae with two signa, usually well developed and nearly equal in size.

**Immature stages**. The immature stages of most North American *Eucosma* have not been documented. Eggs and pupae for those that have been described are typical of Eucosmini. *Eucosma* larvae lack an anal comb, as in other recently derived internal feeding Eucosmini such as *Epiblema* and *Rhyacionia* (Brown 1987; Horak 1998; MacKay 1959). Within Eucomini, this character separates internal feeders, such as *Eucosma*, from external feeders, such as most *Epinotia* and *Pseudexentera*.

The morphological information that follows is summarized from the descriptions and illustrations in: Peterson (1965) and Passoa (2008)—eggs of *Thiodia* (= *Eucosma* in North America); Brown (1987) and Horak (1998)—Eucosmini larvae; MacKay (1959), Passoa (2008), and Swatschek (1958)—*Eucosma* larvae; and Moscher (1916) and Horak (1998)—Eucosmini pupae.

*Egg.* Oval, scalelike ("flat"), watery white, and variably translucent; chorion bright, with a rough irregular surface.

*Larva*. Head hypgnathous; L-group on T1 trisetose, never enlarged or extending under the spiracle; L1 and L2 setae adjacent on A1–8; SV-group setal counts on A1, 2, 7, 8, 9 are 3(2):3(2):3(2):2:2(1); SD1 seta on A8 is anterior, anterodorsal, or anteroventral, but never directly dorsal, to the spiracle; D2 setae on A9 usually located on the same joined "saddle" pinaculum on A9; D1 and SD1 setae located on the same pinaculum on A9; L-group on A9 bi- or trisetose; V1 setae on A9 the same or farther apart than those on A8; crochets uniordinal, arranged in a circle or oval; anal comb absent. In some species in the *circulana* group, an extra seta is present dorsocaudal to the spiracle on A1–7 and ventrocaudal to the spiracle on A8; similar extra setae are present in other Eucosmini, such as *Rhyacionia*. Larvae of *E. alterana* (= *parmatana*) have the D1, D2, and SD1 setae located on a single enlarged pinaculum on A9, an arrangement that is unusual in *Eucosma* but also found in other internal feeders such as *Cryptaspasma* (Microcorsini) and *Talponia* (Grapholitini).

*Pupa*. Dorsum of A2–7 with two rows of spines; A8–10 usually with one row of spines; maxillary palpi extending into the proximolateral angles of the maxillae; maxillae about  $0.4 \times FWL$ ; labial palpi usually  $0.5 \times length$  of the maxillae; cauda with 4–8 flat hooked setae; anal rise with 1–2 or rarely 3 setae on each side; cremaster absent.

**Biology**. The following life history information is summarized from Brown et al. (1983), Hare (1977), Heinrich (1923), MacKay (1959), Powell and Opler (2006, 2009), and Putman (1942). Bradley et al. (1979) and Bland (2014) provide detailed life histories for several European species.

Recorded larval hosts are, without exception, Asteraceae. Females lay eggs on flower heads, seeds, or smooth surfaces, singly or in small clusters with some eggs overlapping. Early instars feed in flower heads, burrow into seeds, or mine under the bark of woody hosts. Later instars burrow into stems or roots. Last instars usually exit the host and construct a silk cocoon in the soil where they overwinter, although some species may remain in hollow stems or roots of the host. Pupation occurs the following year in late spring or early summer, and adults emerge in approximately one month. The following life cycle for the European *E. conterminana* feeding on *Lactuca* is described by Bradley et al. (1979). Females deposit 70–80 eggs singly or in clusters of 2–6 on the bracts of a flower head. Eggs turn red 2–3 days after oviposition, and larvae hatch within 8–10 days. Early instars feed in the flower heads, sometimes partially exposed, while later instars burrow into developing seed heads and feed on the ovaries. Larval development occurs in August–September. Last instars descend to the ground and overwinter in a dense cocoon constructed in soil or under leaf litter. Pupation occurs the following June, and adults emerge July–August.

# The circulana group (species 1-15)

Nearctic *Eucosma*, as defined by Gilligan et al. (2014), includes fifteen species previously assigned to the genus by Heinrich (1923) due to the presence of a costal fold at the base of the male forewing. We treat these taxa as a loosely defined group based on that single forewing character and on overall similarity in genitalia. Most members of the group can be identified by forewing appearance. Shared genitalic characters include:

*Male genitalia*. Uncus weakly to moderately developed; valva with ventral emargination moderate to deep, ventral margin of neck narrowly flattened to deeply scooped-out, saccular corner angulate; cucullus with dorsal and ventral lobes moderately to well developed, the ventral margin of the ventral lobe sometimes with one or more spiniform setae.

*Female genitalia*. Papillae anales moderately setose and, with the exception of *E. bilineana*, microtrichiate; lamella postvaginalis semi-rectangular in all but *E. paregoria* and microtrichiate in all but *E. bilineana*; sternum 7 with narrowly rounded posterior lobes and concavely inflected posterolateral margins; scaling of sternum 7 dense on posterior lobes and often on lateral extremities; ductus bursae encircled and usually contorted by sclerotized band/patch at juncture with ductus seminalis.

The *circulana-gemellana-paragemellana* subgroup (species 1–3). These three species were reviewed by Gilligan and Wright (2013a). They are strikingly similar in forewing appearance and occur primarily on the Gulf and Atlantic coasts from east Texas to North Carolina. Subgroup characteristics include:

*Forewing*. Mean FWL: 6.4–9.3 mm, AR: 2.66–2.78; distal one-half of dorsal surface golden yellow, with large circular ocelloid region edged by arclike segments of metallic-gray striae; ocellus with two longitudinal rows (often partially confluent) of black dots, the dots separated by metallic-gray bars; proximal one-half of dorsal surface yellow brown to gray brown, sometimes with grayish or clay-colored longitudinal streaking.

*Male genitalia*. Valva with costal margin weakly concave to nearly straight, ventral emargination deep to moderate (NR: 0.19–0.42), ventrolateral margin of neck weakly to moderately scooped-out; anal angle with course setae on medial surface and one or more spiniform setae near apex.

#### 1. Eucosma circulana Hübner, 1823

(Plate A, 1a–b; Plate 1, 1a–e)

Eucosma circulana Hübner 1823:28, figs. 363–364; Fernald 1903:455; Fernald 1908:4; Barnes and McDunnough 1917:169; Heinrich 1923:95; McDunnough 1939:46; Obraztsov 1968:1; Powell 1983:34; Razowski 1989:175; Brown 2005:317; Gilligan and Wright 2013a:494; Gilligan and Wright 2013b:306.
 Paedisca circulana: Fernald 1882a:36.

**Neotype** (designated by Gilligan and Wright 2013a; Plate A:1a).  $\mathcal{J}$ , Kentucky, McCracken County, Paducah, <sup>1</sup>/<sub>4</sub> mi WNW Route 60 and Broad Street, 37.0619° N, 88.5989° W, D. J. Wright, 12 August 2008, USNM.

The proximal one-half of the forewing is uniformly yellowish brown to dark gray brown and lacks the pale clay-colored costal streak present in *E. gemellana* and *E. paragemellana*. Genitalic differences from the latter two species include: the ventrolateral margin of the valval neck is more strongly scooped-out; the dorsal lobe of the cucullus is more strongly produced; the ventral lobe of the cucullus is moderately produced but not elongate; the deepest points of inflection in the posterolateral margins of sternum 7 are

aligned with the lamella antevaginalis instead of the midpoint (in *E. gemellana*) or the posterior margin (in *E. paragemellana*) of the lamella postvaginalis (Plate 1:1e, 2d, 3d); and the posterior lobes of sternum 7 do not extend beyond the posterior margin of the lamella postvaginalis.

*Eucosma circulana* is known from east Texas, Louisiana, Mississippi, northern Florida, and western Kentucky. Capture dates range from late February to early September, but most records are from June, July, and August. Hübner (1823) described and illustrated this species based on a female from Pennsylvania, but we were unable to confirm the presence of *E. circulana* in that state.

#### 2. Eucosma gemellana Heinrich, 1923

(Plate A, 2a–b; Plate 1, 2a–d)

*Eucosma circulana gemellana* Heinrich 1923:96; McDunnough 1939:46; Powell 1983:34; Brown 2005:317. *Eucosma gemellana*: Gilligan and Wright 2013a:497; Gilligan and Wright 2013b:308.

Holotype. (7, Florida, [Pinellas County], St. Petersburg, May, slide 72903, USNM.

Heinrich (1923) proposed the name *gemellana* for what he considered to be a "variety" of *E. circulana*, but the two taxa differ sufficiently in genitalia to warrant species status (Gilligan and Wright 2013a).

Unlike *E. circulana*, the forewing in most specimens of *E. gemellana* has a clay-colored streak along the costa and similarly colored streaks emanating from the base, usually in the cell, on CuP, and on  $A_{1+2}$ . Males of the two species differ in valval shape. In *E. gemellana* the costal margin is straighter, the neck is narrower (NR = 0.28 vs. 0.42), and the ventral lobe of the cucullus is much more elongate. Females differ in the position of the deepest points of inflection of the posterolateral margins of sternum 7: aligned with the midpoint of the lamella postvaginalis in *E. gemellana* and with the lamella antevaginalis in *E. circulana*. *Eucosma gemellana* is most similar to *E. paragemellana* (species 3); differences are discussed under the latter taxon.

The specimens we examined were collected in Florida, most from the central part of the state, some from the western end of the panhandle. Capture dates range from February to November.

#### 3. Eucosma paragemellana Gilligan and Wright, 2013

(Plate A, 3a–b; Plate 1, 3a–d)

Eucosma paragemellana Gilligan and Wright 2013a:498; Gilligan and Wright 2013b:313.

**Holotype** (Plate A:3a). (), Alabama, Baldwin County, Weeks Bay Estuarine Reserve, D. J. Wright, 22 June 2008, USNM.

*Eucosma paragemellana* resembles *E. gemellana* in forewing appearance but is smaller (mean FWL = 6.4 vs. 9.3 mm) and has a shorter costal fold (costal fold length/FWL = 0.23 vs. 0.38). In males, the socii are shorter, the neck is narrower (NR = 0.19 vs. 0.28), the neck-cucullus shape is more sicklelike, and the coarse setae on the medial surface of the anal angle extend nearly to the spiniform setae at the apex. In females, the deepest points of inflection of the posterolateral margins of sternum 7 are aligned with the posterior margin instead of the mid-point of the lamella postvaginalis.

This species is currently known from two disjunct populations, one along the Gulf Coast from Mississippi to the western end of the Florida panhandle, the other in southern coastal North Carolina. Adults have been collected from April to early September.

#### 4. Eucosma glomerana (Walsingham, 1879)

(Plate A, 4a–i; Plate 2, 4a–g)

Paedisca glomerana Walsingham 1879:49.

Eucosma glomarana; Fernald 1903:457, misspelling of glomerana.

*Eucosma glomerana*: Barnes and McDunnough 1917:170; Heinrich 1923:95; McDunnough 1939:46; Powell 1983:34; Brown 2005:320; Gilligan et al. 2008:105; Gilligan and Wright 2013b:308.

Eucosma sandana Kearfott 1907b:22; Heinrich 1923:95; McDunnough 1939:46; synonymy by Powell 1983:34.

Eucosma griphodes Meyrick 1912:34, unnecessary replacement name for sandana.

**Types**. *Paedisca glomerana*. Holotype. ∂, Texas, Bosque County, Belfrage, 4 October 1879, slide 11510, BMNH. *Eucosma sandana*. Lectotype (designated by Heinrich 1923). ∂, Colorado, Golden, Chimney Gulch, E. J. Oslar, 3 September 1904, AMNH.

Walsingham (1879) described *P. glomerana* from a single male collected in Texas by G. W. Belfrage. Kearfott (1907b) based *E. sandana* on three syntypes collected at two localities, Volga, South Dakota by W. E. Dietz and Golden, Colorado by E. J. Oslar. The AMNH has two of these specimens, one from Colorado and one from South Dakota, so Heinrich's (1923) comments indicating type locality and specimen depository constitute a valid lectotype designation. The Colorado specimen bears a green "LECTOTYPE" label attached by Klots.

*Eucosma glomerana*, as currently interpreted, exhibits considerable variation in color and male valva shape. There are two primary color forms, orange brown and gray, but many specimens present at least some indication of both colors, with one being strongly dominant. Members of local populations tend to be of the same color, but there are exceptions (e.g., Plate A:4e, f; Brisco County, Texas). Illinois, Iowa, Kentucky, and Ohio have populations of both phenotypes; brown specimens have been collected in Kansas, Louisiana, Montana, Texas, Wisconsin, and Wyoming; and gray populations are known from Mississippi. The holotype is brown, much like the specimen figured in Plate A:4a, as is the lectotype of *E. sandana*. Mean FWL = 10.2 mm.

The male genitalia resemble those of *E. circulana*, but the cucullus shape is more variable (Plate 2:4a–e) (and appears not to be linked to color), the neck is slightly narrower (NR = 0.37 vs. 0.42), and the distal margin of the cucullus has five or six spiniform setae evenly distributed from the anal angle to two-thirds the distance to the apex. There are no substantial genitalic differences between females of the two species.

The range of *E. glomerana* extends from the high plains east of the Rocky Mountains to the western edge of the Appalacian Mountains, and from Montana, North Dakota, and Wisconsin south to the Gulf of Mexico. Nearly all of the specimens we examined were associated with prairie habitat. Adults fly from late June through September.

### 5. Eucosma bilineana Kearfott, 1907

(Plate B, 5a–f; Plate 2, 5a–d)

*Eucosma bilineana* Kearfott 1907a:54; Barnes and McDunnough 1917:171; Heinrich 1923:115; McDunnough 1939:47; Powell 1983:34; Miller 1987:52; Metzler et al. 2005:49; Brown 2005:316; Gilligan et al. 2008:109; Gilligan and Wright 2013b:305.

**Lectotype** (here designated). ♀, Illinois, Fernald, AMNH.

Kearfott (1907a) described *E. bilineana* from eight syntypes  $(7 \ 3, 1 \ 2)$  collected in West Manitoba, Illinois, and Iowa. Heinrich (1923) indicated that the "type" was from Illinois and was deposited in the AMNH, but he did not mention the sex of that specimen. Klots (1942) reported two syntypes in the

AMNH, a female lectotype from Illinois and a female paralectotype, attributing the lectotype designation to Heinrich (1923). Kearfott (1907a) clearly stated that there was only one female syntype, so Klots may have mistaken either the identity or the sex of the paralectotype. In any event, we designate here as lectotype the Illinois female as interpreted by Klots.

*Eucosma bilineana* is sexually dimorphic: males (Plate B:5a–d) are white to tan with one prominent black streak on the cubitus from the base to mid-wing and another in the distal one-half of the cell; females (Plate B:5e–f) are dark brownish gray with streaks inconspicuous to absent. We examined one exceptional male from Iowa with typical female coloration. Mean FWL = 13.0 mm.

The valval neck is of medium width (NR = 0.43), with the ventrolateral margin weakly scooped-out. The distal margin of the cucullus has a series of spiniform setae from the anal angle to one-half the distance to the apex. The female genitalia are similar to those of *E. glomerana*, but the papillae anales and the lamella postvaginalis lack microtrichia, and the sterigma is more strongly constricted at the posterior margin of the ostium.

This species has been collected in Alberta, Manitoba, Colorado, Illinois, Iowa, Missouri, Ohio, and Wyoming. It appears to be associated with prairie habitat and has been reared in DuPage County, Illinois from *Helianthus tuberosus* L. (Jerusalem-artichoke) (Brown et al. 1983).

#### 6. Eucosma floridana Kearfott, 1907

(Plate B, 6a-c; Plate 2, 6a-d)

*Eucosma floridana* Kearfott 1907b:21; Barnes and McDunnough 1917:169; Heinrich 1923:136; McDunnough 1939:48; Powell 1983:35; Brown 2005:319; Gilligan and Wright 2013b:308.

Lectotype (designated by Klots 1942).  $\vec{O}$ , Florida, Hastings, [A. J. Brown], 6 October, AMNH.

Kearfott (1907b) mentioned seven syntypes from Hastings, Florida, and Klots (1942) reported three of those specimens in the AMNH, including a lectotype (designation attributed to Heinrich 1923) that was collected on 6 October. The other two specimens in the AMNH have a collection date of 7 October, so we credit Klots with the selection of a unique specimen and, therefore, with the designation of the lectotype.

This species is recognized by its white head, white-speckled orange-brown forewing, and thin black longitudinal streaks in the ocelloid region. Mean FWL = 8.5 mm.

The male genitalia are similar to those of *E. bilineana*, but the ventral margin of the valval neck is not scooped-out, and the margin of the cucullus has only one spiniform seta (at the apex of the anal angle). In females, the width of the lamella postvaginalis is uniform and approximately equal to the ostium diameter.

*Euosma floridana* is a resident of the southeasthern coastal states, from Texas to North Carolina. Adults fly from August to November.

#### 7. Eucosma monogrammana (Zeller, 1875)

(Plate B, 7a–b; Plate 3, 7a–d)

Paedisca monogrammana Zeller 1875:313.

*Eucosma monogrammana*: Fernald 1903:456; Barnes and McDunnough 1917:169; Heinrich 1923:94; McDunnough 1939:46; Powell 1983:34; Brown 2005:324; Gilligan and Wright 2013b:311.

**Holotype** (Plate B:7a).  $\mathcal{E}$ , Texas, Dallas, Boll, slide 11501, BMNH.

At some time between 1869 and 1871, while employed by Louis Agassiz at the MCZ, Jacob Boll collected five specimens of *E. monogrammana* in Dallas, Texas. One was sent for examination to P. C. Zeller, who decided that it represented a new species, publishing the description in 1875. Zeller retained the holotype, which eventually made its way to the BMNH by way of the Walsingham Collection. The other four specimens (3  $\Im$ , slide DJW 727; 1  $\bigcirc$ , slide DJW 728) are at the MCZ. We have seen only five other individuals of this species: three males from Hempstead County, Arkansas (DJW Collection), one female from Lincoln County, Oklahoma (EME), and one female from Bossier Parish, Louisiana (MEM). Mean FWL = 11.9 mm. The Boll specimens do not have capture dates; the others were collected in May.

*Eucosma monogrammana* resembles *Pelochrista galenapunctana* (Kearfott) in forewing appearance (tan with gray speckling) but lacks the well-defined ocellus, the costal striae, and the salt-and-pepper terminal band found in the latter species. Males of the two taxa differ in valva shape (Plate 3:7a vs. Heinrich 1923, Fig. 166), females in sterigma type (Type 1 vs. Type 3) and in the structure of the papillae anales (laterally facing in *E. monogrammana*, ventrally facing with well-developed ventral extensions in *P. galenapunctana*).

#### 8. Eucosma giganteana (Riley, 1881)

(Plate B, 8a–b; Plate 3, 8a–d)

#### Paedisca giganteana Riley 1881:318.

Eucosma giganteana: Fernald 1903:456; Barnes and McDunnough 1917:171; Heinrich 1923:114; McDunnough 1939:47; Powell

1983:34; Miller 1987:52; Metzler et al. 2005:50; Brown 2005:320; Gilligan et al. 2008:108; Gilligan and Wright 2013b:308.

**Types**. *Eucosma giganteana*. Syntypes. 2  $\stackrel{\bigcirc}{\downarrow}$ , lost (Brown 2005). *Eucosma giganteana minorata*. Holotype.  $\stackrel{\bigcirc}{\Diamond}$ , Texas, Liberty, USNM.

The description of *E. giganteana* was based on two females from Kansas and Iowa that, according to Heinrich (1923), were deposited in the USNM along with a third female from Wisconsin labeled "*Paedisca giganteana* Riley, Type" in Riley's handwriting. This material has been reported lost (Brown 2005).

*Eucosma giganteana* was reared by A. K. Wyatt at Chicago, Illinois from larvae feeding in roots of *Silphium perfoliatum* L. (cup-plant) (Heinrich 1923). In 1924, Heinrich proposed the name *E. g. minorata* for several small specimens with the same forewing appearance and genitalia as *E. giganteana* that were reared in Texas from larvae feeding in the flower heads of *Silphium radula* Nutt. var. *gracile* (A. Gray) Clevinger (slender rosinweed). Heitzman and Heitzman (1996) reported larvae of *E. giganteana* boring in roots of *Silphium terebinthinaceum* Jacq. (prairie-dock) in Missouri. Moths with the *E. giganteana* forewing pattern and coloration are widespread in the Midwest (Metzler et al. 2005) and vary considerably in size. At one location in Adams County, Ohio (well outside the range of *S. radula* var. *gracile*) we collected a series of specimens with FWL ranging from 8.6 to 16.2 mm. These observations suggest that the size and food plant differences noted by Heinrich are not sufficient to maintain *E. g. minorata* as a separate taxon. Mean FWL = 12.8 mm.

This species is easily recognized by its distinctive forewing appearance, which is unlike that of any other Nearctic *Eucosma*. It ranges through much of eastern North America and occurs as far west as Kansas and southeastern Colorado. It is most common in the tall grass prairie region of the Midwest, where it flies in July and August. In Florida it is collected from April through June.

Eucosma giganteana minorata Heinrich 1924:388; new synonymy.

#### 9. Eucosma bipunctella (Walker, 1863)

(Plate B, 9a–b; Plate 3, 9a–d)

#### Affa bipunctella Walker 1863a:202.

Eucosma bipunctella: Fernald 1903:457; Barnes and McDunnough 1917:171; Heinrich 1923:115; McDunnough 1939:47; Powell 1983:34; Miller 1987:52; Metzler et al. 2005:49; Brown 2005:316; Gilligan et al. 2008:109; Gilligan and Wright 2013b:305.
 Paedisca worthingtoniana Fernald 1878:83; synonymy by Fernald 1882a:39.

**Types**. *Affa bipunctella*. Holotype. ∂, North America, BMNH. *Paedisca worthingtoniana*. Lectotype (designated by Miller 1970). ∂, Northern Illinois, C. E. Worthington, USNM.

*Eucosma bipunctella* is the largest Nearctic *Eucosma* (mean FWL = 17.5 mm). Forewing color varies from yellow to dark yellow brown; forewing maculation consists of a single dark spot at the distal end of the cell, which is sometimes difficult to detect in brown specimens. The holotype is yellow (as in Plate B:9a). The genitalia are similar to those of *E. giganteana*, but in females the sterigma is less elongate (SR = 1.73 vs. 2.48), and the posterior lobes of sternum 7 are not as slender.

This species is a resident of the tall grass prairie region of the central Midwest (Metzler et al. 2005). The host is *Silphium laciniatum* L. (compass plant), the larva boring in roots (Heinrich 1923, Heitzman and Heitzman 1996). Adults fly from June through August.

### 10. Eucosma landana Kearfott, 1907

(Plate C, 10; Plate 3, 10a-d)

 Eucosma landana Kearfott 1907b:18; Barnes and McDunnough 1917:171; Heinrich 1923:120; McDunnough 1939:47; Powell 1983:34; Metzler et al. 2005:50; Brown 2005:322; Gilligan et al. 2008:110; Gilligan and Wright 2013b:310.
 Eucosma isospora Meyrick 1912:34, unnecessary replacement name for landana.

**Lectotype** (designated by Heinrich 1923).  $\mathcal{Q}$ , Manitoba, Rounthwaite, L. E. Marmont, 25 April, AMNH.

Kearfott (1907b) mentioned four syntypes from Rounthwaite and Aweme, Manitoba. They are all females, three in the AMNH, one in the USNM. Only one is from Rounthwaite, so the lectotype designation attributed to Heinrich (1923) by Klots (1942) is valid.

The forewing appearance is distinctive: charcoal gray, lacking the usual maculational elements, but uniformly speckled with small whitish dots. The male genitalia resemble those of *E. simplex* (species 11) but differ from the latter in having a distinctive ridgelike development along the ventral margin of the neck (Plate 3:10c). In females, the sclerotization of the ductus bursae is reduced to a small patch that does not encircle or distort the ductus bursae. Mean FWL = 10.9 mm.

This species ranges from southern Saskatchewan and Manitoba to Oklahoma (Metzler et al. 2005). It is poorly represented in collections, but available records indicate an adult flight period from late April to mid-June.

# 11. Eucosma simplex McDunnough, 1925 (Plate C, 11; Plate 4, 11a–d)

*Eucosma simplex* McDunnough 1925:21; McDunnough 1939:47; Powell 1983:34; Metzler et al. 2005:51; Brown 2005:327; Gilligan et al. 2008:110; Gilligan and Wright 2013b:314.

#### Holotype. Alberta, Calgary, F. H. Wolley-Dod, 30 April 1905, slide 112, CNC.

*Eucosma simplex* was described from two specimens, the male holotype from Calgary, Alberta and a female paratype from Sioux City, Iowa. It is a nondescript brown moth with charcoal-gray hindwings. The forewings are marked with a network of thin longitudinal charcoal-gray streaks that tend to follow the veins. Mean FWL = 10.9 mm.

The genitalia are similar to those of *E. landana*, but males lack the ridge along the ventral margin of the valval neck, and the female sterigma tapers somewhat posteriorly and extends slightly beyond the posterior extremities of sternum 7.

We examined 6 specimens  $(4 \Diamond, 2 \bigcirc)$ , three collected by R. Panzer in conjunction with a restoration project at a remnant prairie near Chicago, Illinois, and the others from Iowa, Kansas, and Michigan. Metzler et al. (2005) reported a specimen from northwestern Wisconsin. Specimens with capture dates were collected in May.

#### 12. Eucosma rusticana Kearfott, 1905

(Plate C, 12a–b; Plate 4, 12a–d)

*Eucosma rusticana* Kearfott 1905b:358; Barnes and McDunnough 1917:170; Heinrich 1923:125; McDunnough 1939:47; Powell 1983:35; Brown 2005:326; Wright 2006:162; Gilligan et al. 2008:113; Gilligan and Wright 2013b:314.

**Lectotype** (designated by Heinrich 1923).  $\mathcal{E}$ , Texas, Kerrville, AMNH.

Kearfott (1905b) based the description on six syntypes, only one of which was from Texas, so Heinrich's (1923) comments constitute a valid lectotype designation.

*Eucosma rusticana* can usually be recognized by its two-toned forewing coloration (Plate C:12a), which is blackish brown anterior to the cubitus and tan on the inner margin, ocellus, and termen. Specimens from the Chicago area tend to be suffused with black (Plate C:12b). The valva is similar in shape to that of *E. paregoria* (species 14), but the ventral margin of the neck is only moderately scooped-out (on the lateral edge) vs. strongly scooped-out (on the medial edge). Females of the two species differ in sterigma shape (Plate 4:12d; Plate 5:14e). Mean FWL = 10.5 mm.

Most records of *E. rusticana* are from the eastern one-half of the Midwest (Ohio and Wisconsin, south to Mississippi and Texas), but four of the syntypes were collected east of the Appalachian Mountains in Polk County, North Carolina. Adults fly in April and May in the South and from June through mid-August in the upper Midwest.

The *haydenae-paregoria-sombreana* subgroup (species 13–15). In the next three species the ventral margin of the valval neck is more deeply scooped-out than in any other Nearctic *Eucosma*.

## 13. Eucosma haydenae Wright, 2006

(Plate C, 13a–b; Plate 4, 13a–f)

Eucosma haydenae Wright 2006:162; Gilligan et al. 2008:113; Gilligan and Wright 2013b:309.

**Holotype**. ♂, Iowa, Howard County, Hayden Prairie, D. J. Wright, 23 June 1997, 43.4431° N, 92.3828° W, USNM.

*Eucosma haydenae* in known from four tall grass prairie preserves, one in northeast Iowa and three near Chicago, Illinois. It is somewhat similar in forewing appearance to *E. rusticana* but is smaller (mean FWL = 7.3 vs. 10.5 mm), and has conspicuous costal strigulae and a well-defined ocellus. As in *E. rusticana*, the specimens from the Chicago area are often suffused with black. Adults fly from late May to early July.

This species shares some distinctive genitalia features with *E. paregoria* (species 14): the medioventral margin of the valval neck is deeply scooped-out; the extremities of the posterior lobes of sternum 7 are flared laterally; and the margins of the papillae anales that flank the anal opening face ventrally.

#### 14. Eucosma paregoria Brown, 2014

(Plate C, 14a–c; Plate 5, 14a–f)

Eucosma paregoria Brown 2014:227.

**Holotype** (Plate C:14a). ♂, Iowa, Howard County, Hayden Prairie, D. J. Wright, 23 June 1997, 43.4431° N, 92.3828° W, USNM.

*Eucosma paregoria* is similar to *E. sombreana* (species 15) in size (mean FWL = 9.5 vs. 9.9 mm) and forewing maculation (fasciate markings represented by obscure dark shades), but the ocellus is conspicuous, and the overall coloration nearly always includes some orange tints, especially in the subcostal area from the median fascia to the apex. Some specimens are uniformly orange brown (Plate C:14a, c), but in many the proximal one-half of the forewing is grayish brown and overlaid with some orange-brown scales (Plate C:14b). Specimens from the Chicago area tend to be suffused with black, as in *E. rusticana* and *E. haydenae*.

The genitalia most closely resemble those of *E. haydenae*, as discussed under the latter species. Differences include: the distal margin of the cucullus is nearly straight in *E. paregoria* vs. convex in *E. haydenae*; the lamella postvaginalis broadens posteriorly in *E. paregoria*, with the length of the posterior margin approximately twice that of the ostium diameter vs. rectangular and of uniform width in *E. haydenae*.

This species has been collected in Arkansas, Illinois, Indiana, Iowa, Louisiana, Missouri, and North Carolina from late June through August. It usually is associated with tall grass prairie remnants.

## 15. Eucosma sombreana Kearfott, 1905

(Plate C, 15a–c; Plate 5, 15a–e)

*Eucosma sombreana* Kearfott 1905b:357; Barnes and McDunnough 1917:171; Heinrich 1923:126; McDunnough 1939:47; Powell 1983:35; Miller 1987:54; Brown 2005:327; Gilligan et al. 2008:114; Gilligan and Wright 2013b:314.

*Eucosma phaeodes* Meyrick 1920:344, unnecessary replacement name for *sombreana*. *Eucosma phlaeodes*; Heinrich 1923:126, misspelling of *phaeodes*.

**Lectotype** (designated by Heinrich 1923).  $\mathcal{E}$ , North Carolina, Tryon, Fiske, 14 July, AMNH.

Of the twelve syntypes mentioned by Kearfott (1905b), the AMNH has only one from Tryon, North Carolina, so Heinrich's (1923) comments constitute a valid lectotype designation.

Forewing color varies from dark brown to dark gray, usually with the interfascial areas grayish and the subbasal and median fasciae obscurely represented by brownish shades. The ocellus is weakly expressed but usually discernable. This is a medium sized species (mean FWL = 9.9 mm) that usually can be recognized by its drab coloration and somewhat broad forewing (AR = 2.36).

The male genitalia are distinctive and unlikely to be confused with those of any other Nearctic *Eucosma*: the costal margin of the valva is nearly straight, and the ventral emargination is deep and U-shaped; the ventral margin of the neck is deeply scooped-out; and the ventral lobe of the cucullus is well developed, with three spiniform setae on the broad semicircular margin of the anal angle.

This moth is common in prairie and old field habitat in eastern North America. The larva bores in roots of *Helianthus* L.; reported hosts include *H. giganteus* L. (giant sunflower), *H. tuberosus* L. (Jerusalemartichoke), and *H. decapetalus* L. (thin-leaf sunflower) (Heinrich 1923, MacKay 1959).

# The *refusana* group (species 16–24)

The following nine species were reviewed by Wright and Brown (2014). Group characters include:

*Forewing.* Mean FWL: 5.8–9.0 mm; AR: 2.71–3.29; dorsal surface divided into a proximal section (the basal two-thirds) of relatively uniform color (gray, brown, yellow, or combinations thereof) and a distal section containing a large circular ocelloid region reminiscent of that in *E. circulana*. About one-half of the species have a narrow but well-defined medial band separating the two regions.

*Male genitalia*. Uncus moderately developed and clearly differentiated from dorsolateral shoulders of tegumen; valva with costal margin weakly concave to nearly straight, ventral emargination deep to shallow (NR: 0.32–0.74), saccular corner angulate to broadly rounded (SA: 88–143°); cucullus with dorsal and ventral lobes weakly to moderately developed, apex broadly rounded, distal margin straight to weakly convex, anal angle narrowly rounded, basoventral margin sometimes projecting in ridgelike manner onto medial surface of neck.

*Female genitalia*. Papillae anales moderately setose and microtrichiate; lamella postvaginalis elongate (SR: 1.59–3.12), microtrichiate, and semi-rectangular to moderately tapering posteriorly; sternum 7 with posterior lobes joined to lateral margins of lamella postvaginalis by band of sclerotized membrane, the width of which has taxonomic significance; scaling of sternum 7 usually dense on posterior lobes and lateral extremities; ductus bursae encircled and often contorted by sclerotized band at juncture with ductus seminalis; corpus bursae with signa nearly equal in size.

# 16. Eucosma decempunctana (Walsingham, 1879)

(Plate C, 16a–b; Plate 6, 16a–e)

Semasia decempunctana Walsingham 1879:58.

Thiodia decempunctana: Fernald 1903:462; Heinrich 1923:44; McDunnough 1939:44.

*Eucosma decempunctana*: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:307; Wright and Brown 2014:87. *Phaneta decempunctana*: Powell 1983:33; Brown 2005:493.

**Lectotype** (designated by Wright and Brown 2014; Plate C:16a; Plate 6:16c).  $\mathcal{E}$ , Oregon, Wasco County, to Fort Dalles, Walsingham, 15–22 April 1872, BMNH(E) #819891, slide 11589, BMNH.

Walsingham (1879) described *E. decempunctana* from four male syntypes, all deposited in the BMNH. We examined the lectotype, one paralectotype, one male in the AMNH labeled "CAL," and three specimens in the USNM (2  $\Im$  without data, 1  $\Im$  from Oregon). Specimens with capture dates were collected in April.

This poorly understood species is readily distinguished from other members of the group by its pale gray forewing and rusty brown maculation. Mean FWL = 7.7 mm. Genitalia characteristics include: ventral emargination of the valva moderate and U-shaped; NR = 0.44; basoventral margin of the cucullus extending weakly onto the medial surface of the neck; and lamella postvaginalis tapering slightly posteriorly.

#### 17. Eucosma amphorana (Walsingham, 1879)

(Plates C–D, 17a–d; Plate 6, 17a–e)

Semasia amphorana Walsingham 1879:63.

Thiodia amphorana: Fernald 1903:462; Heinrich 1923:42; McDunnough 1939:44.

Eucosma amphorana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:304; Wright and Brown 2014:96.

Phaneta amphorana: Powell 1983:33; Brown 2005:492; Powell and Opler 2009:132.

**Lectotype** (designated by Wright and Brown 2014; Plate C:17a).  $\mathcal{E}$ , Oregon, Grant County, Camp Watson, Walsingham, March–April 1872, BMNH(E) #819905, slide 11588, BMNH.

Walsingham (1879) mentioned eight syntypes (7 3, 1 9) that he collected while camped on the John Day River in eastern Oregon. The lectotype was selected by Obraztsov. Most specimens in collections are from the Pacific Coast, the range extending from northern Washington to southern California.

Forewing color varies from gray (Plate C:17a) to yellow (Plate D:17d) with numerous intermediate forms, some featuring both yellow and gray in the interfascial areas and variable hoary white overscaling. The gray form of *E. amphorana* might be confused with *E. decempuntana* based on forewing appearance, but the two species are separated readily by male genitalia. Mean FWL = 8.3 mm.

The male genitalia of *E. amphorana* resemble those of *E. refusana* and *E. litorea* in that the ventral emargination of the neck is especially long and shallow (NR = 0.71, 0.74, and 0.69, respectively). Present data indicates that these three species are allopatric. They are also separated readily by forewing appearance.

Powell and Opler (2009) discuss the life history of this species, with observations regarding color forms, larval hosts, and geographic distribution in California. Clarke reared *E. amphorana* from *Grindelia* Willd. in Whatcom County, Washington (Brown et al. 1983). Powell reared it from *Grindelia camporum* Greene (Great Valley gumweed) and *Isocoma menziesii* (Hook. & Arn.) G. L. Nesom (Menzies' goldenbush) in Contra Costa and Santa Barbara counties, California, respectively (Powell and Opler 2009). The life cycle includes several generations, from February to November, with most adults flying in the spring or fall.

The *refusana-verna-autumana-citricolorana* **subgroup**. Species 18–21 are similar in size (mean FWL: 7.7–9.0 mm) and forewing appearance and often require examination of the genitalia for a reliable determination. Males of *E. verna*, *E. refusana*, and *E. autumnana* are diagnosed by the depth of the ventral emargination of the valval neck: moderate (NR = 0.48), shallow (NR = 0.74), and deep (NR = 0.32), respectively. All three lack the bluntly pointed anal angle of *E. citricolorana*. Genitalia differences between females of the four species include: sclerotized band joining sternum 7 to the lamella postvaginalis broad in *E. refusana*, very narrow in *E. citricolorana*, and of intermediate width in the other two species; lamella postvaginalis tapering posteriorly in *E. refusana*, *E. verna*, and *E. autumnana*, rectangular in *E. citricolorana*; lateral extremities of sternum 7 pointed in *E. verna*, less strongly produced in the other three species.

18. Eucosma refusana (Walker, 1863)

(Plate D, 18a–c; Plate 7, 18a–d)

Grapholita refusana Walker 1863b:382.

Semasia refusana: Walsingham 1879:63.

Thiodia refusana: Fernald 1903:463.

Eucosma refusana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:314; Wright and Brown 2014:89.

Phaneta refusana: Miller 1971:284; Powell 1983:33; Brown 2005:495; Pohl et al. 2010.

**Holotype** (Plate D:18a). ♂, Canada, [Ontario], St. Martin's Falls, Albany River, Hudson Bay, G. Barnston, 1844–17, BMNH(E) #819892, slide 4891, BMNH.

*Eucosma refusana* differs from *E. verna* in valval neck width (NR = 0.74 vs. 0.48), a distinction that went unnoticed by North American taxonomists for nearly a century until Miller (1971) examined the holotype of *E. refusana* and diagnosed the two species. Heinrich (1923) contributed to the confusion regarding these two taxa by mistakenly illustrating under *E. refusana* (Fig. 119) the male genitalia of a specimen of *E. verna*, and consequently most literature records of *E. refusana* prior to 1971 refer to *E. verna*. Females of *E. refusana* differ from the other members of the subgroup by having an especially wide band of sclerotized membrane connecting the posterior lobes of sternum 7 to the lamella postvaginalis (Plate E:18d).

The range of *E. refusana* is not well documented, the holotype being the only specimen reliably identified prior to 1971. Recent determinations suggest that this species is primarily a resident of the northern Great Plains. We examined specimens from Alberta, Manitoba, Ontario, Saskatchewan, and Minnesota. Those with capture dates were collected in May or the first half of June.

#### 19. Eucosma verna (Miller, 1971)

(Plate D, 19a–c; Plate 7, 19a–d)

*Phaneta verna* Miller 1971:286; Powell 1983:33; Miller 1987:43; Brown 2005:497; Gilligan et al. 2008:94. *Thiodia refusana*: Heinrich (not Walker 1863) 1923:43; McDunnough 1939:44. *Eucosma verna*: Gilligan and Wright 2013b:316; Wright and Brown 2014:91.

**Holotype**. *A*, Manitoba, Aweme, N. Criddle, 21 May 1904, slide 85, AMNH.

Specimens now known as *E. verna* were misidentified as *E. refusana* until Miller (1971) recognized the distinction between the two species (see discussion under *E. refusana*). Miller (1971) designated the holotype of *E. verna* but did not refer to the other 17 specimens he examined as paratypes.

Most specimens of *E. verna* have a conspicuous white costal streak on the forewing and some thin white streaking in the cell. These features are present but obscure in *E. refusana* and usually absent in *E. autumnana*. Pale specimens of *E. verna* (Plate D:19c) and *E. citricolorana* (Plate D:21a) are similar in appearance, but most specimens of *E. citricolorana* that we examined had considerable gray suffusion in the forewing (Plate D:21c).

*Eucosma verna* ranges from Nova Scotia to British Columbia, south to Florida, Mississippi, and New Mexico. Adults fly from early March (in the South) to early July.

#### 20. Eucosma autumnana (McDunnough, 1942)

(Plate D, 20a–c; Plate 7, 20a–d)

Thiodia autumnana McDunnough 1942:66.

*Phaneta autumnana*: Miller 1971:287; Powell 1983:33; Miller 1987:43; Brown 2005:492; Gilligan et al. 2008:94. *Eucosma autumnana*: Gilligan and Wright 2013b:305; Wright and Brown 2014:91.

**Holotype** (Plate D:20a).  $\Diamond$ , Quebec, Lac Ste. Marie, T. N. Freeman, 7 September 1935, slide TOR-1064, CNC.

McDunnough (1942) described *E. autumnana* from four specimens  $(2 \ 3, 2 \ 2)$  collected in Ontario and Quebec. He distinguished it from what he interpreted as *E. refusana* (likely *E. verna*) by the deep ventral emargination of the male valva, and he noted that these two species also are separated by flight period (fall for *E. autumnana*, spring for *E. refusana* (or *E. verna*)). The first distinction is diagnostic; the latter is reliable in the northern part of the range but not in the South, where *E. autumnana* flies only in the spring.

Northern specimens of *E. autumnana* are separated from the other members of the subgroup by their two-toned forewing color (proximal two-thirds gray brown, distal one-third golden yellow); southern specimens tend to be uniformly gray brown.

The range of *E. autumnana* extends from Maine to North Dakota, south to North Carolina and Mississippi. Adults fly from late August to mid-October in the North, in March and April in Mississippi.

# 21. *Eucosma citricolorana* (McDunnough, 1942)

(Plate D, 21a–c; Plate 7, 21a–d)

*Thiodia citricolorana* McDunnough 1942:66. *Phaneta citricolorana*: Powell 1983:33; Brown 2005:492. *Eucosma citricolorana*: Gilligan and Wright 2013b:306; Wright and Brown 2014:91.

Holotype (Plate 7:21b). *A*, Saskatchewan, Saskatoon, K. M. King, 4 July 1924, slide TOR-981, CNC.

For 70 years, this species was known only from two male specimens whose distinctive genitalia clearly separate them from the other members of the subgroup. In 2013, males and females were collected together by J. Nordin near Laramie, Wyoming, establishing for the first time an association of the sexes. In the Wyoming material, the forewing is strongly suffused with gray (Plate D:21c), producing a slightly different appearance than that of typical *E. refusana*, *E. verna*, or *E. autumnana*.

Current distributional data consists of one specimen from Alberta, two from Saskatchewan, and 29 from southeastern Wyoming. Capture dates range from June to early July.

The *annetteana-millerana* subgroup. *Eucosma annetteana* has been a confusing taxon for more than a century. The name was applied to numerous specimens collected more than 65 years ago in the Midwest (mostly Ohio) and in coastal New England (mostly in the vicinity of Cape Cod), that vary in size (FWL: 5.3–8.1 mm) but are indistinguishable in forewing pattern and genitalia. In 1958, McDunnough proposed the name *E. scotiana* for a population of such moths from Nova Scotia but failed to distinguish that taxon satisfactorily from *E. annetteana*. More recently (1990), *annetteana*-like specimens were collected in Mississippi, and during the past decade populations of moths with similar forewing pattern and genitalia but somewhat different coloration were discovered in both Mississippi and Minnesota. Wright and Brown (2014) addressed this situation by treating *E. scotiana* as a synonym of *E. annetteana* and proposing the name *E. millerana* for the more brightly colored specimens from Mississippi and Minnesota.

#### 22. Eucosma annetteana (Kearfott, 1907)

(Plate E, 22a–c; Plate 8, 22a–d)

*Thiodia annetteana* Kearfott 1907b:42; Heinrich 1923:43; McDunnough 1939:43. *Eucosma annetteana*: Barnes and McDunnough 1917:171; Gilligan and Wright 2013b:304; Wright and Brown 2014:94. *Phaneta annetteana*: Powell 1983:33; Brown 2005:492; Gilligan et al. 2008:93. *Thiodia scotiana* McDunnough 1958:7; synonymy by Wright and Brown 2014:94. *Phaneta scotiana*: Powell 1983:33; Brown 2005:496. *Eucosma scotiana*: Gilligan and Wright 2013b:314.

**Lectotype** (designated by Wright and Brown 2014; Plate E:22a). ♂ Ohio, [Hamilton County], Cincinnati, Annette F. Braun, 13 April 1905, AMNH.

Kearfott described *E. annetteana* from material collected by Annette F. Braun in southwestern Ohio between 1903 and 1906 (Plate E:22a–b). In 1939, M. O. Glenn collected several similar specimens in central Illinois. We have seen no modern records of this insect from the central Midwest, but there have been relatively recent captures (1990) in a prairie remnant in Mississippi (Plate E:22c). The rest of the material interpreted by Wright and Brown (2014) as *E. annetteana* comes from the Atlantic seaboard (Nova Scotia to South Carolina), with a few 19th century records from east Texas. The Midwest specimens were collected in March and April, those from the East Coast mostly from July through September, with a few April records from Massachusetts.

The forewing is rather dull, the yellowish proximal portion being generously suffused with gray brown. In males, the ventral emargination of the neck is moderate (NR = 0.56), and the basoventral margin of the cucullus sometimes extends weakly onto the medial surface of the neck. In females, the lamella postvaginalis tapers posteriorly (the width of the posterior margin is approximately  $0.33 \times \text{ostium diameter}$ ).

*Eucosma annetteana* is similar in forewing appearance and genitalia to *E. millerana* (species 23). Differences between the two are discussed under the latter taxon.

# 23. Eucosma millerana Wright and Brown, 2014

(Plate E, 23a; Plate 8, 23a–d)

Eucosma millerana Wright and Brown 2014:95.

**Holotype** (Plate 8:23a). (3), Minnesota, Clay County, Blanket Flower Scientific and Natural Area, 46.6820° N, 96.2022° W, R. P. Dana, 23–24 August 2012, slide 145170, USNM.

*Eucosma millerana* is a midwestern species that is similar to *E. annetteana* in genitalia and forewing maculation. It is distinguished from the latter species by its brighter coloration: the head, thorax, and proximal section of the forewing are bright lemon yellow, and the distal forewing markings are blackish and strongly contrast with the pale background. Wright and Brown (2014) found no genitalia characteristics that reliably separate the two taxa, but their flight periods (in the Midwest) appear to be allochronic.

*Eucosma millerana* is known only from prairie remnants in Minnesota and Mississippi, where adults fly from late August to late September; midwestern specimens of *E. annetteana* have been collected only in March and April.

#### 24. Eucosma litorea Wright and Brown, 2014

(Plate E, 24a–b; Plate 8, 24a–e)

Eucosma litorea Wright and Brown 2014:96.

**Holotype** (Plate E:24a). ♂, Alabama, Baldwin County, Bon Secour NWR, 30.2286° N, 87.8308° W, R. L. Brown and D. Pollock, 8–9 August 1994, USNM.

*Eucosma litorea* is recognized easily by the bright yellow proximal portion of the forewing and the saltand-pepper appearance of its relatively large ocelloid region. The genitalia are most similar to those of *E. amphorana* but differ from that species in the lack of a ridgelike extension of the basoventral margin of the cucullus onto the medial surface of the valval neck. In both species the sterigma is somewhat abruptly constricted at the posterior margin of the ostium, and the lamella postvaginalis is nearly uniform in width.

This species is known from dune habitat along the Gulf Coast: from Baldwin County, Alabama to Gulf County, Florida; and from the Ohoopee dunes in Emanuel County, Georgia. Adults have been collected from mid-April through June and again in August and October.

The specimen illustrated in Plate E:24b is typical of six males collected in mid-March from dune habitat near Oyster Bay, Baldwin County, Alabama. Aside from the olive-brown coloration of the head, thorax, and proximal portion of the forewing, they agree with typical *E. litorea*. They are tentatively treated here as a dark form of *E. litorea* pending availability of addition material (particularly females) for a more thorough comparison.

### The *radiatana* group (species 25–33)

The next nine accounts deal with an aggregation of species with similar genitalia and forewing pattern that has never been resolved satisfactorily into well-diagnosed taxa. Thirteen names have been associated with the group, four of which are currently relegated to synonymy. Several attempts have been made to clarify the application of these names (Kearfott 1907b; Heinrich 1923; McDunnough 1925; Miller 1983), but prevailing usage is still not uniform due to uncertainty as to which character states signify interspecific differences and which are attributable to intraspecific variation. Some species are sexually dimorphic in color and/or size, but only a few well-documented male-female associations are available to provide guidance in this regard. Current species concepts are based, for the most part, on forewing appearance. The male genitalia provide a few diagnostic characters, most importantly the degree of lateral arching in the valvae, but no substantial interspecific differences have been reported in the female genitalia. Our treatment is based on the types of the nine names currently in use. We discuss and illustrate several phenotypes of uncertain affiliation but do not propose any changes in the current taxonomy.

*Forewing*. Mean FWL: 6.6–10.3 mm; AR: 2.52–2.96; dorsal surface usually two-toned, with proximal two-thirds pale, distal one-third from inner margin to  $R_4$  contrastingly darker, markings concolorous with distal portion; ocelloid region often with alternating dark and light streaks accentuating the median branches; costal strigulae and associated striae variable in expression; maculation including one or more of the following elements: a weakly expressed (and often interrupted) median fascia represented by a dark shade from mid-costa to inner margin; a diffuse diagonal streak from base of inner margin to distal end of cell, sometimes extending along anterior margin of ocellus to termen; a line along the radius from base to median fascia, a line along the inner margin from base to tornus; and a fine line along CuP from base to mid-wing.

*Male genitalia*. Uncus weakly developed, sometimes reduced to a slight bulge; valva variably arched laterally, with costal margin weakly concave, ventral emargination moderate (NR: 0.51-0.60), neck somewhat elongate (length  $1-2 \times$  width) and nearly uniform in width, saccular corner usually angulate, SA: 99–128°; cucullus with dorsal and ventral lobes moderately developed, distal margin convex to nearly straight, basoventral margin projecting in ridgelike manner onto medial surface of neck (except *E. indeterminana*).

*Female genitalia*. Papillae anales moderately setose and microtrichiate; lamella postvaginalis rectangular and microtrichiate, with central trough slightly depressed; sternum 7 with posterior lobes moderately to broadly rounded and joined to lateral margins of lamella postvaginalis by moderately broad bands of sclerotized membrane, posterolateral margins straight to weakly concave, lateral extremities triangular and well developed; scaling of sternum 7 dense on posterior lobes and lateral extremities, moderate elsewhere; ductus bursae encircled and somewhat contorted by broad sclerotized band at juncture with ductus seminalis.

#### 25. Eucosma radiatana (Walsingham, 1879)

(Plate E, 25a–f; Plate 9, 25a–d)

*Thiodia radiatana*: Fernald 1903:460; Kearfott 1907b:38; Heinrich 1923:37; McDunnough 1939:43. *Eucosma radiatana*: Barnes and McDunnough 1917:171; Gilligan and Wright 2013b:314. *Phaneta radiatana*: Powell 1983:33; Miller 1983:99; Miller 1987:42; Brown 2005:495.

**Holotype** (Plate E:25a). ♂, Eastern states of North America, 1874, BMNH(E) #819890, slide 11577, BMNH.

*Eucosma radiatana* was described from a single male (Plate E:25a) collected in eastern North America. We examined males from Nova Scotia to Manitoba south to Virginia, Ohio, and Indiana that we consider to be *E. radiatana* based on agreement with the holotype in forewing appearance and genitalia. In these specimens, the valva is strongly arched laterally, and the valval neck is elongate (length about  $1.6 \times$  width). Mean male FWL = 10.7 mm.

Miller (1983) reported pronounced sexual color dimorphism in this species, presumably based on two males and two females in the AMNH that are associated by collection site and date. The females are uniformly orange brown as in *E. umbrastriana*. We discovered that the AMNH also has two *E. umbrastriana* males with the same collection data as the two *E. radiatana* males and the two putative *E. radiatana* females, so Miller's association of the *E. radiatana* sexes may be incorrect.

We examined numerous specimens from Arkansas, Indiana, Iowa, and Mississippi with the pale yellowish-tan coloration of *E. radiatana* but with the diagonal streak, ocellus, and costal strigulae more strongly and more variably expressed (Plate E:25d–f). They agree with *E. radiatana* in male genitalia but are more similar to *E. formosana* in maculation. The male and female illustrated in Plate E:25d–e were collected on the same night at a prairie preserve in Iowa and do not differ substantially from one another in size, color, or maculation. A similar pair has been collected in Mississippi. The genitalia of the Iowa female are illustrated in Plate 9:25d. If sexual color dimorphism is confirmed in *E. radiatana*, then these specimens will need a name. In the meantime we tentatively refer them to *E. radiatana*.

Heinrich (1923) reported *Solidago* L. as the larval host but did not indicate the source of that information. Typical *E. radiatana* (Plate E:25a–c) flies in May and early June; the specimens from Arkansas, Indiana, Iowa, and Mississippi (Plate E:25d–f) were collected from mid-April (Louisiana) to early July (Iowa).

Semasia radiatana Walsingham 1879:55.
#### **26.** *Eucosma formosana* (Clemens, 1860)

(Plates E–F, 26a–f; Plate 9, 26a–e)

Grapholita sagittana Walker 1863b:386; synonymy by Fernald 1882a:42.

Grapholitha stercoreana Zeller 1875:290; synonymy by Fernald 1882a:42.

Semasia formosana: Fernald 1882a:42.

Eucosma formosana: Barnes and McDunnough 1917:171; Gilligan and Wright 2013b:308.

Thiodia formosana: Fernald 1903:461; Kearfott 1907b:38; Heinrich 1923:39; McDunnough 1939:44; Darlington 1947:94.

Phaneta formosana: Powell 1983:33; Miller 1973:214; Miller 1983:99; Miller 1987:43; Brown 2005:493; Gilligan et al. 2008:91.

**Types**. *Ioplocama formosana*. Lectotype (designated by Darlington 1947). ♀, Illinois, ANSP (abdomen missing). *Grapholita sagittana*. Holotype. [sex undetermined], Nova Scotia, BMNH(E) #819884, BMNH (abdomen missing). *Grapholitha stercoreana*. Lectotype (here designated). ♂, Maine or Massachusets, BMNH(E) #819885, slide 11578, BMNH.

Miller (1973) discussed the type fixation issues associated with *I. formosana* and attributed the lectotype designation to Darlington (1947). Walker (1863b) did not mention the sex or number of syntypes in his description of *G. sagittana*. The specimen listed here as a holotype was reported as such by Brown (2005); it is in poor condition, missing both its head and abdomen. Zeller (1875) mentioned four syntypes (3  $\Diamond$ , 1  $\bigcirc$ ) of *E. stercoreana* obtained from Dr. Packard; the lectotype designated here was selected by Obraztsov.

The forewing is tan to grayish brown, with dark brown maculation and a sharply defined ocellus. Typical specimens from the upper Midwest (Plates E, F:26a–d) have interfascial areas that are substantially paler than the markings; the grayer, more uniformly colored specimens in Plate F:26e–f are from Garrett County, Maryland. Females (Plate E:26b) have dark markings and dark brown to black hindwings but resemble the males in size and forewing pattern. The male valva is long-necked (length about 1.75 × width) and strongly arched laterally, much like that of *E. radiatana* and *E. umbrastriana*. Mean FWL = 9.1 mm.

Putman (1942) reared *E. formosana* (determinations by J. H. McDunnough or T. N. Freeman) in Ontario from *Solidago altissima* L. (late goldenrod), the larvae forming a shelter in the terminal leaves and boring in the stem. Heinrich (1923) also mentioned *Solidago* L. as the food plant but did not indicate the source of his information.

The specimens we examined, together with records reported by Heinrich (1923) and Miller (1987), indicate a geographic range that extends from Nova Scotia to Wisconsin, south to Virginia and Illinois. Adults fly from late May through June.

#### 27. Eucosma umbrastriana (Kearfott, 1907)

(Plate F, 27a–j; Plate 10, 27a–g)

Thiodia umbrastriana Kearfott 1907b:40; Heinrich 1923:39; McDunnough 1939:44.

Thiodia umbristriana; Klots 1942:411, misspelling of umbrastriana.

Eucosma umbrastriana: Barnes and McDunnough 1917:171; Gilligan and Wright 2013b:314.

Phaneta umbrastriana: Powell 1983:33; Miller 1983:98; Miller 1987:43; Brown 2005:496; Gilligan et al. 2008:93.

*Thiodia roseoterminana* Kearfott 1907b:40; Heinrich 1923:38; McDunnough 1939:44; Powell 1983:33; synonymy by Miller 1983:98; Brown 2005:496.

Thiodia formosana subcandida Heinrich 1929:1; McDunnough 1939:44; Powell 1983:33; synonymy by Miller 1983:98; Brown 2005:496.

**Types**. *Thiodia umbrastriana*. Lectotype (here designated; Plate F:27a).  $\Diamond$ , Ohio, [Hamilton County], Cincinnati, Annette F. Braun, 22 May 1904, AMNH. *Thiodia roseoterminana*. Lectotype (here designated; Plate F:27g).  $\Diamond$ , Ohio, [Hamilton County], Cincinnati, Annette F. Braun, 20 May 1904, AMNH. *Thiodia formosana subcandida*. Holotype.  $\Diamond$ , Alberta, Bilby, USNM.

Ioplocama formosana Clemens 1860:360.

Kearfott (1907b) based the description of *E. umbrastriana* on 23 specimens from Aweme, Manitoba; Cincinnati, Ohio; and New Brighton, Pennsylvania. Klots (1942) reported eight syntypes in the AMNH, one of which he interpreted as a lectotype designated by Heinrich (1923). Since Heinrich's remarks are not sufficient to identify a particular specimen, Miller (1983) described the "lectotype" as "selected by C. Heinrich, designated by Klots." The specimen in question bears a green "LECTOTYPE" label attached by Klots. To avoid possible confusion we include a designation of that specimen and, for similar reasons, a lectotype designation for *T. roseoterminana*.

Specimens illustrated in Plate F:27a and F:27d show typical male forewing coloration: proximal twothirds yellowish tan, diagonal streak and distal one-third dark orange brown. Females (Plate F:27b, e) are similar in size to males but darker in coloration, the proximal portion of the wing being strongly suffused with orange brown. Often a faint indication of a median fascia in the form of a dark shade is discernable from mid-costa to the distal end of the cell and from there along the proximal margin of the ocellus to the inner margin. The male genitalia are similar to those of *E. radiatana* and *E. formosana*, but the neck is somewhat shorter (length about  $1.4 \times$  width). We tentatively refer paler specimens such as those in Plate F:27c, f, j (from New York, Connecticut, and Ohio, respectively) to *E. umbrastriana* for lack of any substantial genitalic differences. The male-female association illustrated in Plate F:27d–e is based on a pair of specimens collected together diurnally in a *Solidago* L. patch in southern Kentucky.

Kearfott did not offer any diagnostic comments to distinguish *E. roseoterminana* (Plate F:27 g-i) from *E. umbrastriana*, but it seems safe to assume that he considered the decidedly two-toned male forewing appearance and the near obsolescence of a diagonal streak as sufficient grounds for introducing another name. The lectotypes of *E. roseoterminana* and *E. umbrastriana* were collected in Cincinnati, Ohio within two days of one another (20 and 22 May 1904). Finding no distinguishing genitalic characters, Miller (1983) treated the two names as synonyms.

The range extends from New Hampshire to Alberta, south to Maryland, Kentucky, and Colorado. Adults fly in May and early June.

# 28. Eucosma albertana (McDunnough, 1925)

(Plate F, 28a–b; Plate 10, 28a–b)

*Thiodia albertana* McDunnough 1925:12; McDunnough 1939:43. *Phaneta albertana*: Powell 1983:33; Brown 2005:492. *Eucosma albertana*: Gilligan and Wright 2013b:304.

Holotype (Plate F:28a; Plate 10:28a). Å, Alberta, Lethbridge, H. L. Seamans, 14 June 1922, slide TOR-4311, CNC.

*Eucosma albertana* was described from two males from Lethbridge, Alberta. We examined the holotype (Plate F:28a), the paratype (in the CNC), and a female (Plate F:28b) from Chin, Alberta (in the CNC), all collected in June. They resemble *E. radiatana* in size, forewing appearance, and male genitalia but exhibit no sexual dimorphism in size or coloration. If the male-female association illustrated here is correct, and Miller's report of pronounced sexual color dimorphism in *E. radiatana* is confirmed, then the two taxa can be separated on this basis. Otherwise, *E. albertana* may be conspecific with *E. radiatana*.

#### 29. Eucosma essexana (Kearfott, 1907)

(Plate G, 29a–c; Plate 11, 29a–e)

*Thiodia essexana* Kearfott 1907b:39; Heinrich 1923:38; McDunnough 1939:43. *Eucosma essexana*: Barnes and McDunnough 1917:171; Gilligan and Wright 2013b:308. *Phaneta essexana*: Powell 1983:33; Miller 1983:99; Miller 1987:42; Brown 2005:493; Gilligan et al. 2008:92.

**Lectotype** (here designated; Plate G:29a). ♂, New Jersey, [Essex County], Caldwell, W. D. Kearfott, 22 May 1904, AMNH.

The AMNH has five of Kearfott's (1907b) syntypes (4  $\Diamond$ , 1  $\bigcirc$ ) from Caldwell, New Jersey, each of which could be the "type" based on Heinrich's (1923) remarks. The specimen designated here is Klots' interpretation of Heinrich's intention. It bears a green "LECTOTYPE" label attached by Klots.

The lectotype (Plate G:29a) is a male with dark brown markings on a pale yellowish-tan forewing, the dark color in the distal portion of the wing nearly, but not quite, surrounding the pale ocellus. Females are uniformly dark orange brown (Plate G:29b). They are smaller than males (mean FWL = 8.5 vs. 10.6 mm) and have a slightly broader forewing (AR = 2.58 vs. 2.75). Midwestern males (Plate G:29c) are less strongly marked and might be confused with *E. radiatana* or *E. albertana*, but *E. essexana* lacks the lateral arching of the valva that is prominent in the other two species.

Kearfott (1907b) reared this species from larvae that overwintered in stems of *Symphyotrichum patens* (Aiton) G. L. Nesom (late purple aster). The association of the sexes is based on that type series. Putman (1942) reported larvae boring in stems of *Symphyotrichum novae-angliae* (L.) G. L. Nesom (New England aster) and overwintering in cocoons spun in the soil (determinations by J. H. McDunnough or T. N. Freeman). We examined specimens from Kentucky, New Jersey, New York, and Ohio, all collected in May; the Putman specimens were collected in Ontario.

#### **30.** *Eucosma awemeana* (Kearfott, 1907)

(Plate G, 30a–c; Plate 11, 30a–e)

*Thiodia awemeana* Kearfott 1907b:41; Heinrich 1923:38; McDunnough 1939:43. *Eucosma awemeana*: Barnes and McDunnough 1917:171; Gilligan and Wright 2013b:305. *Phaneta awemeana*: Powell 1983:33; Miller 1983:99; Miller 1987:42; Brown 2005:492; Gilligan et al. 2008:92.

Lectotype (here designated; Plate G:30a).  $\vec{\bigcirc}$ , Manitoba, Aweme, N. Criddle, 2 May 1904, AMNH.

Despite the attribution in Klots (1942), Heinrich's (1923) remarks regarding the "type" are insufficient to specify a particular syntype in the AMNH. The specimen here designated as lectotype bears a green "LECTOTYPE" label attached by Klots. The collection date was taken from the specimen label and does not agree with that reported by Kearfott (1907b).

Males of *E. awemeana* and *E. essexana* are similar in forewing appearance, but in *E. awemeana* the diagonal streak is interrupted in the median area, and the ocellus is surrounded by the dark coloration in the tornal area. As in *E. essexana*, females are somewhat smaller than males (mean FWL = 7.8 vs. 8.9 mm) and have a broader forewing (AR = 2.52 vs. 2.87). *Eucosma awemeana* is smaller than *E. essexana* (mean  $\Im$  FWL = 8.9 vs. 10.6 mm; mean  $\Im$  FWL = 7.8 vs. 8.5 mm). Males of the two species differ in the amount of lateral arching of the valva: moderate in *E. awemeana*, absent in *E. essexana*.

We examined specimens from Alberta, Manitoba, Quebec, New York, North Carolina, and Ohio. Capture dates range from 23 April to 15 June.

#### **31.** *Eucosma ferruginana* (Fernald, 1882)

(Plate G, 31a–c; Plate 12, 31a–e)

Semasia ferruginana Fernald 1882b:72. Thiodia ferruginana: Fernald 1903:461; Kearfott 1907b:38; Heinrich 1923:40; McDunnough 1939:44. Eucosma ferruginana: Barnes and McDunnough 1917:171; 308; Gilligan and Wright 2013b:308. Phaneta ferruginana: Miller 1970:291; Powell 1983:33; Miller 1983:99; Brown 2005:493.

**Lectotype** (designated by Miller 1970; Plate G:31a; Plate 12:31e).  $\bigcirc$ , Massachusetts, Goodell, slide 141804, USNM.

Fernald (1882b) mentioned three syntypes  $(1 \ 3, 2 \ 9)$  from Maine, Massachusetts, and New Hampshire. The New Hampshire male and Massachusetts female are in the USNM; the location of the third specimen is not known. Heinrich (1923) referred to the male as "type," but Miller (1970) designated the Massachusetts female as the lectotype, noting that the specimen selected by Heinrich lacked an abdomen. Sternum 7 in the lectotype is malformed (Plate 12:31e), but its right half seems to be normal.

This is the smallest member of the group (mean FWL = 6.6 mm). There is no substantial difference in size or coloration between males and females. As the name suggests, the forewing is rusty brown; the proximal portion is usually somewhat paler than the distal portion. Males have a relatively short valval neck (length about equal to width) that is mildly arched laterally. This species has been confused with females of sexually dimorphic members of the group (*E. umbrastriana*, *E. roseoterminana*, and *E. essexana*), so historical records should be treated with caution.

We examined 10 specimens from Connecticut, Delaware, Massachusetts, New Jersey, and New Hampshire, indicating a flight period from early May to early June.

#### **32.** *Eucosma indeterminana* (McDunnough, 1925)

(Plate G, 32a–c; Plate 12, 32a–b)

*Thiodia indeterminana* McDunnough 1925:13; McDunnough 1939:44. *Phaneta indeterminana*: Powell 1983:33; Brown 2005:494. *Eucosma indeterminana*: Gilligan and Wright 2013b:310.

Holotype (Plate G:32a). (7), Quebec, Aylmer, J. McDunnough, 20 May 1920, slide TOR-1014a, CNC.

*Eucosma indeterminana* is a pale brownish-gray species. The forewing is nearly uniform in color, but one can usually discern a basal patch and a median fascia, each indicated by a slightly darker shade of brown. Females appear to be a little smaller than males (mean FWL = 6.8 vs. 8.4 mm) but are not especially different in color.

In males, the valval neck is relatively short (length about equal to width) and weakly arched laterally, and the basoventral margin of the cucullus does not project onto the medial surface of the neck. Females seem to be distinguished by the tapering of the lamella postvaginalis (width of posterior margin about  $0.50-0.75 \times \text{ostium}$  diameter) and the reduced sclerotized connection between its lateral margins and sternum 7 (based on 2 preparations).

We examined 10 specimens from Alberta and Quebec. Capture dates range from 20 May to 9 June.

#### 33. Eucosma altana (McDunnough, 1927)

(Plate G, 33a–c; Plate 12, 33a–b)

*Thiodia altana* McDunnough 1927:272; McDunnough 1939:44. *Phaneta altana*: Powell 1983:33; Brown 2005:492. *Eucosma altana*: Gilligan and Wright 2013b:304.

Holotype (Plate G:33a). (7, British Columbia, Alta Lake, Mons, J. McDunnough, 11 June 1926, CNC.

*Eucosma altana* was described from four blackish-brown specimens  $(3 \ 3, 1 \ 2)$  collected in southwestern British Columbia. The forewing markings include a basal patch and median fascia that are moderately well defined, a conspicuous ocellus with up to three black dashes on a brownish central field, and prominent whitish strigulae on the distal one-half of the costa. The length of the valval neck is slightly shorter than the width (based on two preparations).

In addition to the types, we examined a male from Peachland, British Columbia; a male from Linn County, Oregon; and three specimens  $(2 \ 3, 1 \ 9)$  from Jacquet River, New Brunswick. All of these specimens were collected in June. The last three (represented by Plate G:33c) are a little paler and grayer than the types but are not different in genitalia.

# The artemisiana group (species 34–46)

These thirteen taxa are remarkably homogeneous in genitalia. The species concepts are based mostly on subtle aspects of forewing pattern and coloration. Group characteristics include:

*Forewing*. Mean FWL: 6.1–9.1 mm, AR: 2.8–3.1; subbasal and median fasciae usually clearly defined and sharply contrasting with paler interfascial areas; ocellus obscure to conspicuous, in the latter case with two longitudinal rows of black dots as in members of the *refusana* group.

*Male genitalia*. Uncus weakly developed, rounded, and moderately well differentiated from dorsolateral shoulders of tegumen; valva with costal margin weakly concave, neck narrow (NR: 0.23–0.43), saccular corner rounded, SA: 83–110°; cucullus triangular, with apex rounded, distal margin nearly straight, ventral lobe strongly produced, anal angle acute (25–40°), basoventral margin projecting onto medial surface of neck, setae on medial surface short and stubby in band along distal margin from anal angle to about 0.75 distance to apex (Plate 16:42b), otherwise relatively fine.

*Female genitalia*. Papillae anales weakly sclerotized, sparsely setose, and lacking microtrichia; sterigma ringlike, with lamella postvaginalis only slightly more developed than lamella antevaginalis; sternum 7 with strongly produced, triangular, lateral extremities; ductus bursae with irregularly shaped sclerotized band at juncture with ductus seminalis; corpus bursae with one signum larger than the other.

#### 34. Eucosma artemisiana (Walsingham, 1879)

(Plate H, 34; Plate 13, 34a–e)

Semasia artemisiana Walsingham 1879:56. Thiodia artemisiana: Fernald 1903:461; Heinrich 1923:63; McDunnough 1939:45. Eucosma artemisiana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:304.

Phaneta artemisiana: Powell 1983:34; Brown 2005:492.

**Holotype**. *(*), California, Siskiyou County, McCloud's Creek, Walsingham, 29–30 July 1871, BMNH(E) #819940, slide 11581, BMNH.

*Eucosma artemisiana* is the largest member of the group (mean FWL = 9.1 mm). The forewing is white to very pale gray, with gray outwardly-oblique subbasal and median fasciae extending from the costa to the inner margin. Reddish-brown suffusion in the fringe and usually in the central field of the ocellus distinguishes this species from *E. infimbriana*, its closest congener. Distinctive genitalic features include: costal margin of the valva strongly concave at the distal end of the neck; membrane posterior to tergum 8 with telescoping collarlike section that is densely covered with sawtoothlike michrotrichia; and apophyses stout, with length of apophyses posteriores about  $1.5 \times$  that of apophyses anteriores.

The holotype was reared by Walsingham in 1871 from a larva collected in tied terminal shoots of *Artemisia* L., and several specimens in the USNM from Pullman, Washington collected by J. F. G. Clarke are labeled "*Artemisia absintheum*" [sic.] (= *Artemisia absinthium* L.; absinthe wormwood). Powell and Opler (2009) reported rearings from *Artemisia douglasiana* Besser ex Hook. (Douglas sagewort) and *Artemisia dracunculus* L. (wild tarragon) in coastal California. The range includes Alberta, California, Idaho, Montana, Nevada, Oregon, Utah, and Washington, with adults flying from late June to early September.

# 35. Eucosma infimbriana (Dyar, 1904)

(Plate H, 35a-c; Plate 13, 35a-e)

Thiodia artemisiana infimbriana Dyar 1904:927.

*Eucosma artemisiana infimbriana*: Barnes and McDunnough 1917:172. *Thiodia infimbriana*: Heinrich 1923:64; McDunnough 1939:45. *Thiodia infimbriana candidula* Heinrich 1924:387; McDunnough 1939:45; new synonymy. *Phaneta infimbriana*: Powell 1983:34; Brown 2005:494. *Phaneta infimbriana candidula*: Powell 1983:34; Brown 2005:494.

Eucosma infimbriana: Gilligan and Wright 2013b:310.

**Types**. *Thiodia artemisiana infimbriana*. Holotype. ♀, British Columbia, Kaslo, H. G. Dyar, USNM. *Thiodia infimbriana candidula*. Holotype. ♂, Manitoba, Aweme, N. Criddle, 28 July 1921, slide TOR-1009, CNC.

Dyar (1904) described *T. a. infimbriana* as a variety of *T. artemisiana*. Heinrich (1923) elevated the taxon to species status and later (1924) proposed the name *T. i. candidula* for a white phenotype with nearly obsolete markings (Plate H:35b) that he interpreted as an eastern "race" of *E. infimbriana*. We found no substantial difference between *E. i. candidula* and *E. infimbriana*, hence the new synonymy is proposed.

This species is similar in size and maculation to *E. artemisiana*. Forewing color varies from white to gray and lacks the reddish-brown suffusion in the fringe characteristic of *E. artemisiana*. The dark form in Plate H:35c is associated with elevations of 9,000–10,500 feet. The genitalia differ from those of *E. artemisiana* in that the costal margin of the valva is nearly straight, and the apophyses are nearly equal in length.

Heinrich (1924) reported a paratype of *E. i. candidula* from St. Anthony Park, Minnesota labeled "ties leaves of *Artemesia ludovicana*" [sic.] (= *Artemisia ludoviciana* Nutt.; cudweed). The range of *E. infimbriana* includes Alberta, British Columbia, Manitoba, California, Colorado, Idaho, Minnesota, Montana, Oregon, South Dakota, Utah, and Washington. Adults fly from late June to late August.

#### 36. Eucosma segregata (Heinrich, 1924)

(Plate H, 36a–h; Plate 14, 36a–f)

Thiodia segregata Heinrich 1924:388; McDunnough 1939:45. Phaneta segregata: Powell 1983:34; Brown 2005:496. Eucosma segregata: Gilligan and Wright 2013b:314. Thiodia castrensis McDunnough 1929:271; McDunnough 1939:45; new synonymy. Phaneta castrensis: Powell 1983:34; Brown 2005:492. Eucosma castrensis: Gilligan and Wright 2013b:306.

**Types**. *Thiodia segregata*. Holotype. *C*, California, Tulare County, Monachee Meadows, 8,000 feet, 16–23 July, slide 72778, USNM. *Thiodia castrensis* (Plate H:36b). Holotype. *C*, Wyoming, Yellowstone Park, Camp Roosevelt, J. McDunnough, 25 July 1928, CNC.

Heinrich (1924) described this species from a series of 46 specimens, all from the type locality in California. McDunnough (1929) based *T. castrensis* on four specimens from Yellowstone National Park, Wyoming. The latter taxon is common in sage brush habitat from the eastern slope of the Rocky Mountains to the Sierra Nevada and Cascade Mountains, and it exhibits considerable variation in forewing color and maculation (Plate H:36b–h). We compared the *E. segregata* types with more than 100 specimens of *E. castrensis* and found no reliable basis for separating the two taxa. The types of *E. segregata* are rather dull, the color having deteriorated with age, but the two species agree in maculation and genitalia.

Forewing color varies from deep salmon to dark gray, with a thin white costal streak extending from base to apex; forewing maculation consists of salmon-colored subbasal and median fasciae that are weakly expressed to obsolete. The ocellus is absent to obscure, in the latter case often represented by a few black scales. This medium sized member of the group (mean FWL = 7.9 mm) has a particularly narrow valval neck (NR = 0.24) and apophyses posteriores and anteriores of nearly equal length.

We examined specimens from California, Colorado, Idaho, Montana, Oregon, Utah, and Wyoming. Adults fly in July and August at elevations between 4,000 and 9,000 feet.

37. Eucosma setonana (McDunnough, 1927)

(Plate H, 37a–b; Plate 14, 37a–c)

*Thiodia setonana* McDunnough 1927:273; McDunnough 1939:45. *Phaneta setonana*: Powell 1983:34; Brown 2005:496. *Eucosma setonana*: Gilligan and Wright 2013b:314.

**Holotype** (Plate H:37a).  $\mathcal{J}$ , British Columbia, Lillooet, Seton Lake, J. McDunnough, 2 June 1926, slide TOR-1059, CNC.

This species is poorly represented in collections. It is similar to but a little smaller than *E. segregata* (mean FWL = 7.0 vs. 7.9 mm) and has sharply defined orange-brown subbasal and median fasciae that contrast strongly with the gray interfascial areas. It may prove to be a well-marked phenotype of *E. segregata*, but the available material does not include intermediates that support that conclusion.

In addition to the type series, which was collected by McDunnough in June by beating *Artemisia* L., we examined four specimens collected in August at Pavilion Lake, British Columbia and Yakima, Washington.

#### 38. Eucosma octopunctana (Walsingham, 1895)

(Plate H, 38; Plate 14, 38a–c)

Semasia octopunctana Walsingham 1895:512. Thiodia octopunctana: Fernald 1903:463; Heinrich 1923:64; McDunnough 1939:45. Eucosma octopunctana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:312. Phaneta octopunctana: Powell 1983:34; Brown 2005:495.

**Holotype**. *(*), Larimer County, Colorado, 5,000 feet, W. G. Smith, May 1891, BMNH(E) #819895, slide 11586, BMNH.

*Eucosma octopunctana* is distinguished by its relatively large size (mean FWL = 8.2 mm) and its bright orange-brown markings, the latter including a full basal patch, a complete median fascia, and a band along the anterior margin of the ocellus joining the median fascia to the apex. The interfascial areas are creamy white with some pale orange suffusion.

We examined 14 specimens from British Columbia, Saskatchewan, California, Colorado, Montana, Utah, and Wyoming. The holotype was collected in May, the other specimens in June and July.

#### 39. Eucosma festivana (Heinrich, 1923)

(Plate I, 39a–b; Plate 15, 39a–c)

*Thiodia festivana* Heinrich 1923:265; McDunnough 1939:45. *Phaneta festivana*: Powell 1983:34; Brown 2005:493. *Eucosma festivana*: Gilligan and Wright 2013b:308.

Holotype.  $\mathcal{O}$ , Manitoba, Aweme, N. Criddle, 22 June 1905, slide CH 3 March 1921, AMNH.

*Eucosma festivana* is superficially similar to *E. youngi* (species 40) but differs from that taxon in size (mean FWL = 6.1 vs. 8.8 mm) and subtle aspects of forewing maculation. The fasciate markings are rusty brown; the whitish interfascial areas are strongly suffused with gray (especially between base and subbasal fascia); and the anterior margin of the ocellus is capped with a conspicuous gray band extending from the median fascia to the termen. In *E. youngi*, the rusty-brown coloration of the subbasal fascia extends to the base, forming a basal patch, and the gray arc over the ocellus is less prominent. Females of the two species are easily separated by the relative lengths of the apophyses posteriores and apophyses anteriores (approximately equal in *E. festivana*, the former nearly twice the latter in *E. youngi*).

Little is known about this species. We examined seven specimens, one from Cypress Hills, Saskatchewan, the others from the type locality, all collected from 3–12 June.

# 40. Eucosma youngi (McDunnough, 1925)

(Plate I, 40a–b; Plate 15, 40a–d)

*Thiodia youngi* McDunnough 1925:16; McDunnough 1939:45. *Phaneta youngi*: Powell 1983:34; Brown 2005:497. *Eucosma youngi*: Gilligan and Wright 2013b:316.

Holotype (Plate I:40a). *Alberta*, Waterton Lakes, C. H. Young, 10 July 1923, CNC.

*Eucosma youngi* resembles *E. festivana* in forewing appearance but is substantially larger (mean FWL = 8.8 vs. 6.1 mm) and has a complete rusty-brown basal patch. Females of the two species differ in the relative lengths of the apophyses. In *E. youngi* the apophyses posteriores are nearly twice as long as the apophyses anteriores; in *E. festivana* the two are nearly equal in length.

We examined the holotype, which was collected on a bare summit at approximately 7,000 feet elevation; 3 specimens from San Juan County, Colorado taken at 11,700 feet; 1 from Glacier National Park, Montana captured at 4,500 feet; and one each from Idaho, Washington, and Wyoming collected at unknown elevations. Capture dates range from 10 July to 12 August.

#### 41. Eucosma scalana (Walsingham, 1879)

(Plate I, 41a–b; Plate 15, 41a–b)

Semasia scalana Walsingham 1879:57.

*Thiodia scalana*: Fernald 1903:462; Heinrich 1923:65; McDunnough 1939:45. *Eucosma scalana*: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:314. *Phaneta scalana*: Powell 1983:34; Brown 2005:496.

**Lectotype** (here designated).  $\eth$ , Oregon and California, Siskiyou Mountains, 7–15 July 1872, Walsingham, BMNH(E) #819893, slide 11596, BMNH.

Walsingham (1879) described *E. scalana* from four males that he collected "on the borders of California and Oregon." Obraztsov selected the lectotype designated here.

This poorly known insect is similar to *E. festivana*, but differs from the latter species in size (mean FWL = 7.5 vs. 6.1 mm), in the more evenly curved distal margin of the subbasal fascia, and in the darker central field of the ocellus.

We examined three specimens from Alameda and Monterey counties in California and two without locality information, all in the USNM. The meager data suggest a flight period from mid-June to August.

42. Eucosma insignata (Heinrich, 1924)

(Plate I, 42a–d; Plate 16, 42a–f)

*Thiodia insignata* Heinrich 1924:386; McDunnough 1939:44. *Phaneta insignata*: Powell 1983:33; Brown 2005:494. *Eucosma insignata*: Gilligan and Wright 2013b:310.

**Holotype** (Plate I:42a; Plate 16:42a).  $\mathcal{J}$ , Colorado, [San Juan County], Silverton, 8–15 July, slide 89907, USNM.

*Eucosma insignata* has dark brown fasciae and grayish-white interfascial areas, the latter sometimes heavily suffused with dark gray. The subbasal fascia is chevron-shaped and confluent with the basal fascia, forming a conspicuous basal patch; the median fascia is often interrupted on CuA<sub>2</sub>.

In Colorado this species inhabits the alpine zone, flying diurnally in July at elevations of 11,000 to 14,000 feet. We examined a few melanic specimens from the Yukon Territory that we tentatively refer to *E. insignata* (Plate I:42d; Plate 16:42d), but we cannot confidently distinguish them from *E. camdenana* (species 43), which was described from Alaska.

# **43.** *Eucosma camdenana* (McDunnough, 1925)

(Plate I, 43a–b, Plate 16, 43a–b)

*Thiodia camdenana* McDunnough 1925:17; McDunnough 1939:44. *Phaneta camdenana*: Powell 1983:34; Brown 2005:492. *Eucosma camdenana*: Gilligan and Wright 2013b:305.

Holotype (Plate I:43a). J, Alaska, W of Kangengevik, Camden Bay, D. Jenness, July 1914, CNC.

This species was described from two males, both in poor condition. What can be discerned of the forewing pattern suggests that *E. camdenana* is similar to *E. insignata*, but the subbasal fascia appears not to be chevron-shaped as in the latter species. The male genitalia of the two species are essentially identical, and the female of *E. camdenana* is unknown. We examined three specimens in the CNC from the Yukon that may be *E. camdenana*, one of which is illustrated in Plate I:43b.

# 44. Eucosma calderana Wright and Gilligan, new species

(Plate I, 44; Plate 16, 44)

**Diagnosis**. *Eucosma calderana* is described from a single male that is similar in size to *E. festivana* and *E. fulvofasciata* (median FWL = 6.2 mm vs. 6.1 and 6.5, respectively) but differs from the latter two species in the presence of a yellowish tint to the interfascial areas and a lack of a prominent subbasal fascia. It also differs from *E. fulvofasciata* in having a strongly expressed ocellus and grayish fringe.

**Description**. *Head*. Frons white; vertex scales pale gray brown with white apices; labial palpus white with dark gray spot on lateral surface of second segment and long gray scales at distal end of second segment, the latter concealing the third segment; antenna white with pale gray streak on dorsal surface. *Thorax.* Dorsal surface pale gray brown; legs white with dark gray-brown tarsal annulations. Forewing:  $\bigcirc$  FWL 6.2 mm, AR = 2.82 (n = 1); male without costal fold, costa weakly arched; apex acute; termen nearly straight; subbasal fascia represented by obscure orange-brown spot on cubitus and pale yellow-brown bar from said spot to inner margin; median fascia orange brown, narrow, complete but nearly interrupted by yellowish-white longitudinal streak in cell; interfascial areas white at costa, shading to pale yellow brown mear cubitus, gray from cubitus to inner margin; costal strigulae white, delimited by dark gray-brown marks; ocellus with three rows of black dots on a pale field (posterior row reduced), with transverse metallic-gray bars at proximal, distal and medial positions; anterior one-half of ocelloid region gray; termen with thin orange-brown line from tornus to apex; fringe scales grayish with blackish crossmarkings. Hindwing: Dark gray brown. *Abdomen*. Male genitalia (n = 1): Typical of the group, with 11 cornuti, NR = 0.29, and SA = 84°. Female unknown.

**Holotype** (Plate I:44, Plate 16:44).  $\delta$ , New Mexico, Sandoval County, Valles Caldera National Preserve, Gate to Redondo Meadow, 32.8733° N, 106.6200° W, J. Brown and S. Monsalve, 22 June 2010, slide 144979, USNM.

**Etymology**. The specific epithet refers to the type locality, Valles Caldera National Preserve, a volcanic caldera in the Jemez Mountains of northern New Mexico.

# 45. Eucosma fulvofasciata Wright and Gilligan, new species

(Plate I, 45; Plate 16, 45a–b)

**Diagnosis**. This is the only member of the group with fully expressed subbasal and median fasciae and no rows of black dots in the ocellus. It differs from the somewhat similar *E. setonana* in that the fringe from tornus to  $R_5$  is white rather than gray, and the costa beyond the median fascia has two prominent orange-brown marks separating whitish strigulae. It is also similar to *E. octopunctana* but is smaller (mean FWL = 6.5 vs. 8.2 mm) and lacks the prominent orange-brown band along the anterior margin of the ocellus.

**Description**. *Head.* Frons, vertex and labial palpus white; antenna pale orange brown. *Thorax.* Dorsal surface white, tinted with orange brown; legs white with gray-brown tarsal annulations. Forewing:  $\bigcirc$  FWL 5.4–6.7 mm (mean = 6.3, n = 5), AR = 2.87;  $\bigcirc$  FWL 6.4–6.5 mm, (mean = 6.5, n = 2), AR = 2.93; male without costal fold, costa weakly arched near base; apex acute; termen straight; dorsal surface with bright orange-brown markings and whitish interfascial areas, the latter variably suffused with pale gray; basal and subbasal fasciae confluent, forming basal patch; median fascia clearly defined from mid-costa to cubitus, fading from there to inner margin; ocellus white, lacking rows of black dots, with pearly white transverse bars marking proximal, medial, and distal positions; fringe white from tornus to R<sub>5</sub>, bright orange brown at apex. Hindwing: Gray with contrasting white fringe. *Abdomen*. Male genitalia (n = 3): Typical of the group, with 16–20 cornuti, NR = 0.28, and SA = 87°. Female genitalia (n = 1): Typical of the group, with apophyses nearly equal in length.

**Holotype** (Plate I:45, Plate 16:45a).  $\mathcal{J}$ , Idaho, Oneida County, Curlew National Grassland, 5 mi ENE of Holbrook, 5,050 feet, D. J. Wright, 9 July 2006, slide 144980, USNM.

**Paratypes.** CALIFORNIA: Lassen County, 7 mi E of Bieber, Cary Reservoir, L. L. Crabtree, 17 August 2013, DJW. COLORADO: Mesa County, Lands End Road, 10.3 mi E of US 50, D. J. Wright, 2 September 2000 (1  $\bigcirc$ , slide DJW 2246), DJW. NEVADA: Washoe County, Verdi, A. H. Vachell, 10–20 June (1  $\bigcirc$ ), USNM. UTAH: Juab County, Eureka, T. Spalding, 16 August 1911 (1  $\bigcirc$ , slide 70102), USNM, 27 August 1911 (1  $\bigcirc$ ), USNM. WYOMING: Park County, E Entrance Yellowstone National Park, R. J. Lavigne, 12 August 1980 (1  $\bigcirc$ , slide DJW 799), ESUW.

**Etymology**. The specific epithet comes from the Latin *fulvus*, meaning reddish yellow, and refers to the orange forewing fasciae.

### 46. Eucosma robertsoni Wright and Gilligan, new species

(Plate I, 46; Plate 17, 46a–b)

**Diagnosis**. This is one of three species in the group with the apophyses posteriores distinctly longer than the apophyses anteriores (length of apophyses posteriores about 1.6, 1.5, and 1.9 × length of apophyses anteriores in *E. robertsoni*, *E. artemisiana*, and *E. youngi*, respectively). Maculational differences between *E. robertsoni* and *E. artemisiana* include: fasciae orange brown instead of gray; basal and subbasal fasciae confluent, forming basal patch vs. basal fascia absent; and median fascia fragmented vs. complete. In *E. youngi* the fasciate markings are dark rusty brown rather than orange brown, and the median fascia is complete.

**Description**. *Head*. Frons and vertex white; labial palpus white with pale gray-brown shading on lateral surface; antenna white. *Thorax*. Dorsal surface white with orange shading on metathorax; legs mostly whitish, with darker tarsal annulations. Forewing:  $\bigcirc$  FWL 10.0 mm, AR = 3.03 (n = 1); costa arched near base; apex acute; termen straight; dorsal surface creamy white with orange-brown markings; basal patch extending from inner margin to radius, fading to white at costa; median fascia represented by spot at distal end of cell and thin bar at mid-costa; interfascial area posterior to CuA, suffused with gray;

ocellus with two rows of black dots on a white ground, the dots separated by transverse metallic-gray bars at the proximal, medial, and distal positions; fringe scales white with blackish cross-marks. Hindwing: Gray brown. *Abdomen*. Female genitalia: Typical of the group, with length of apophyses posteriores about 1.6 × that of apophyses anteriores.

**Holotype** (Plate I:46, Plate 17:46b). ♀, California, Modoc County, Cedar Pass N of Alturas, R. G. Robertson, 7 August 1990, slide DJW 2937, EME.

**Etymology**. This species is named after the late R. G. Robertson, the collector of the holotype.

**Discussion**. We examined a male in poor condition that may also be this species. It is much smaller than the holotype (FWL = 5.2 vs. 10.0 mm) and was collected earlier in the year (March vs. August) by F. Hsu and J. Powell at Big Creek Reserve in Monterey County, California. The genitalia of that specimen are illustrated in Plate 17:46a.

# The *perangustana* group (species 47–48)

This group consists of two similar looking species with nearly identical genitalia. One is western in distribution, the other ranges throughout eastern North America.

*Forewing*. Forewing coloration variably two-toned, the portion anterior to the cubitus yellow brown to pale tan, that from CuA<sub>2</sub> to inner margin mostly pale gray; maculation including a thin dark line on CuP from base to mid-wing and an obscure median fascia represented by an outwardly oblique shade at mid-costa; costal strigulae prominent from median fascia to apex; inner margin with series of small black marks; ocellus well defined.

*Male genitalia*. Uncus moderately developed, with apex rounded; dorsolateral shoulders of tegumen slightly hunched; valva with costal margin concave, ventral emargination moderate (NR: 0.59–0.65), saccular corner angulate (SA: 120–123°); cucullus with dorsal lobe strongly developed, apex rounded, distal margin weakly convex of nearly uniform curvature, ventral lobe weakly developed, anal angle rounded, basoventral margin overlapping ventral one-half of medial surface of neck.

*Female genitalia*. Papillae anales moderately setose and microtrichiate; lamella postvaginalis rectangular and moderately microtrichiate, with anterior extremities of lateral margins fused with sternum 7; lateral extremities of sternum 7 strongly developed and pointed; scaling of sternum 7 dense on posterior lobes and anterolateral margins, relatively sparse elsewhere; ductus bursae with sclerotized ring at juncture with ductus seminalis; corpus bursae with one signum much smaller than the other.

#### 47. Eucosma perangustana (Walsingham, 1879)

(Plate J, 47a–c; Plate 17, 47a–e)

Semasia perangustana Walsingham 1879:58

Thiodia perangustana: Fernald 1903:462; Heinrich 1923:67; McDunnough 1939:45.

Eucosma perangustana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b: 313.

Phaneta perangustana: Powell 1983:34; Brown 2005:495.

**Lectotype** (here designated).  $\bigcirc$ , Oregon and California, Siskiyou Mountains, 7–15 June 1872, Walsingham, BMNH(E) #819904, slide 11587, BMNH.

Walsingham (1879) described this species from two males collected in the "extreme north of California." The lectotype designated here was selected by Obraztsov. In most specimens the forewing is distinctly two-toned (brown and gray), with a variably expressed black line along the termen. The lectotype is more uniformly brown than in the specimens illustrated here, with the gray reduced to a pale shade. This species differs from *E. kiscana* in size (mean FWL = 7.6 vs. 5.6 mm), forewing geometry (AR = 3.68 vs. 3.17), and geographic distribution (western vs. eastern North America). The male genitalia have the ventrolateral margin of the valval neck scooped-out but are otherwise indistinguishable from those of *E. kiscana*.

We examined specimens from British Columbia, California, Colorado, Nevada, Oregon, South Dakota, Washington, and Wyoming. Adults fly in May, June, and July.

#### 48. Eucosma kiscana (Kearfott, 1907)

(Plate J, 48a–c; Plate 17, 48a–c)

*Thiodia kiscana* Kearfott 1907b:92; Heinrich 1923:62; McDunnough 1939:45. *Thiodia speculigera* Meyrick 1912:35, unnecessary replacement name for kiscana. *Eucosma kiscana*: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:310 *Phaneta kiscana*: Powell 1983:34; Miller 1987:47; Brown 2005:494; Gilligan et al. 2008:100.

**Lectotype** (designated by Heinrich 1923). <sup>Q</sup>, New Jersey, Greenwood Lake, W. D. Kearfott, 10 June 1900, AMNH.

Of the ten syntypes mentioned by Kearfott (1907b), the lectotype is the only one in the AMNH from Greenwood Lake, New Jersey, so Heinrich's (1923) comments constitute a valid lectotype designation. That specimen is a female, but has been reported as a male (Brown 2005; Gilligan and Wright 2013b).

This species is smaller and less two-toned in forewing coloration than *E. perangustana* (see discussion under the latter species). The range includes the region from New York to Wisconsin, south to Virginia, Tennessee, and Arkansas. Adults fly in May, June, and July.

#### The *lapidana* group (species 49–52)

Three of the following four species are nearly indistinguishable, based on genitalia and forewing appearance, but they differ in geographic distribution and/or flight period. The fourth is readily separated from the others by forewing color. The group was last reviewed by Wright et al. (1997).

*Forewing*. Mean FWL: 8.0–10.3 mm; AR = 3.03–3.22; forewing gray to pale brownish yellow and speckled with black; maculation consisting of a grid of fine black longitudinal lines following the veins and a more substantial black line along the termen from tornus to apex (fragmented in *E. ambodaidaleia*); costal strigulae obscure to absent; ocellus not expressed.

*Male genitalia*. Uncus weakly developed; valva with costal margin weakly concave, ventral emargination moderate (NR: 0.36–0.51), neck narrowing somewhat distally; saccular corner angulate with rounded vertex (SA: 99–112°); cucullus with dorsal lobe strongly developed, apex rounded, distal margin convex to nearly straight, anal angle moderately developed, basoventral margin extending over ventral one-half of medial surface of neck.

*Female genitalia*. Papillae anales moderately setose and microtrichiate; lamella postvaginalis rectangular to tapering posteriorly, moderately elongate (SR: 1.5–2.1), and microtrichiate; lateral extremities of sternum 7 pointed and strongly developed; scaling of sternum 7 dense on posterior lobes and anterolateral margins; ductus bursae with sclerotized ring at juncture with ductus seminalis; corpus bursae with one signum larger than the other.

#### 49. Eucosma lapidana (Walsingham, 1879)

(Plate J, 49; Plate 18, 49a–b)

Semasia lapidana Walsingham 1879:58. Thiodia lapidana: Fernald 1903:462; Heinrich 1923:50; McDunnough 1939:44. Eucosma lapidana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:310. Phaneta lapidana: Powell 1983:33; Wright et al. 1997:120; Brown 2005:494. Thiodia lepidana; Heinrich 1929:2, misspelling of lapidana.

Lectotype (designated by Wright et al. 1997; Plate J:49; Plate 18:49a). ♂, Oregon, Jackson County, Crooked River, near Fort Klamath, Walsingham, 21–23 September 1871, BMNH(E) #819910, slide 11598, BMNH.

*Eucosma lapidana* is poorly represented in collections. We examined the lectotype, a female syntype from the type locality (both in the BMNH), and one male in the USNM from British Columbia. We found no morphological characteristics that reliably distinguish males from those of *E. canusana*. Females of *E. lapidana* differ from those of *E. canusana* in the shape of the sterigma (SR = 1.5 vs. 2.0), based on one and two preparations, respectively.

The available information indicates that *E. lapidana* flies in September in Oregon and British Columbia; *E. canusana* flies in early spring (February to early April) and is known only from eastern United States.

#### **50.** *Eucosma canusana* (Wright, 1997)

(Plate J, 50a–b; Plate 18, 50a–d)

*Phaneta canusana* Wright et al. 1997:122; Brown 2005:492; Gilligan et al. 2008:97. *Eucosma canusana*: Gilligan and Wright 2013b:306.

Holotype. ♂, Ohio, Adams County, Lynx Prairie Preserve, Station 6, D. J. Wright, 17 March 1989, USNM.

*Eucosma canusana* is separated from *E. lapidana* by flight period (spring vs. fall) and geographic distribution (eastern United States vs. Oregon and British Columbia). Males of the two species appear to be indistinguishable based on genitalia. Differences in female genitalia are discussed under *E. lapidana*.

We examined specimens from Kentucky, Mississippi, Missouri, Ohio, South Carolina, and West Virginia. Adult flight occurs in February (in Mississippi), March, and early April.

#### 51. Eucosma kokana (Kearfott, 1907)

(Plate J, 51a–c; Plate 18, 51a–c)

Eucosma kokana Kearfott 1907b:29; Gilligan and Wright 2013b:310.

Eucosma chortaea Meyrick 1912:35, unnecessary replacement name for kokana.

Hystricophora [sic] kokana: Heinrich 1923:259.

Thiodia sororiana Heinrich 1923:263; McDunnough 1939:44 (subspecies of T. kokana).

Thiodia kokana: Heinrich 1924:387; McDunnough 1939:44.

Phaneta kokana: Powell 1983:33; Wright et al. 1997:121; Brown 2005:494; Gilligan et al. 2008:97.

**Types**. *Eucosma kokana*. Lectotype (designated by Heinrich 1923). ♀, Ohio, [Hamilton County], Cincinnati, A. F. Braun, 3 November, slide CH 9 October 1923, AMNH. *Thiodia sororiana*. Holotype (designated by Heinrich 1923). ♂, Manitoba, Aweme, N. Criddle, 24 September 1921, slide TOR-1061, CNC.

Kearfott (1907b) described *E. kokana* from one female and one male collected in Cincinnati, Ohio and Scranton, Pennsylvania, respectively. Heinrich (1923) examined the female but not the male, referred to the female as the "type," and placed the taxon provisionally in *Hystricophora* [sic] Walsingham. He also described *T. sororiana* based on two males from Aweme, Manitoba, not recognizing them as conspecific with the *E. kokana* type, and identified the specimen listed above as the holotype by illustrating its genitalia and referring to it as the "type." Later, Heinrich (1924) corrected this error by transferring *H. kokana* to *Thiodia* and treating it as a senior synonym of *T. sororiana*.

Most specimens of *E. kokana* are separated readily from *E. canusana* and *E. lapidana* by forewing coloration (proximal two-thirds suffused with brown, distal one-third grayish white). The dark line on the termen is more strongly expressed in *E. kokana* than in the other two species, and the distal one-half of the costa has several black marks separating obscure pale strigulae. *Eucosma kokana* and *E. canusana* are eastern species that fly in the fall and spring, respectively; *E. lapidana* is known only from the Northwest.

We examined specimens from Manitoba, Ontario, Illinois, Kentucky, Massachusetts, Ohio, and Pennsylvania. Capture dates range from late September (Manitoba) to early November, with most collections in October.

#### 52. Eucosma ambodaidaleia (Miller, 1983)

(Plate J, 52a–c; Plate 18, 52a–d)

*Phaneta ambodaidaleia* Miller 1983:101; Miller 1987:47; Wright et al. 1997:122; Brown 2005:492; Gilligan et al. 2008:97. *Eucosma ambodaidaleia*: Gilligan and Wright 2013b:304.

**Holotype**.  $\mathcal{Q}$ , South Carolina, McClellenville, Wedge Plantation, D. C. Ferguson, 16 March 1968, slide 89902, USNM.

This is the only member of the group with a brownish-yellow cast to the forewing. In most specimens the costa is whitish, the region posterior to  $CuA_2$  is suffused with gray, and the rest of the wing is brownish yellow. The terminal line is fragmented into a series of dots positioned between the veins. Genitalia differences between *E. ambodaidaleia* and the other members of the group include: basoventral margin of cucullus convex (rather than straight), and lamella postvaginalis narrowing posteriorly (rather than rectangular).

The range includes the region from New Jersey to Michigan, south to Florida, Alabama, and Texas. Adults fly from mid-January (Alabama and Mississippi) to early April.

# The griseocapitana group (species 53-57)

The similarities in forewing appearance and genitalia among *E. granulatana*, *E. linitipunctana*, and *E. argutipunctana* were recognized by A. Blanchard and E. Knudson (1983) when they described the last two taxa. We include two more species in the group, *E. griseocapitana* and *E. alabamae*, the latter described here. Group characters include:

*Forewing.* Mean FWL: 6.1–8.0 mm; AR: 2.77–3.06; forewing with yellow-brown, rusty-brown, or blackish-gray transverse reticulations on a pale yellow-brown to white ground; fasciate markings obscure to obsolete; ocellus conspicuous; costal strigulae well defined from base to apex by series of short brown/ black dashes; termen usually with salt-and-pepper-colored band from tornus to apex; fringe scales usually white to yellowish brown from tornus to  $R_s$ , darker at apex.

*Male genitalia*. Uncus moderately developed; dorsolateral shoulders of tegumen slightly hunched; valva with costal margin concave, ventral emargination moderate (NR: 0.50–0.62), saccular corner angulate (SA: 112–130°); cucullus with dorsal lobe strongly developed, apex rounded, distal margin convex of nearly uniform curvature, anal angle weakly to moderately developed and narrowly rounded.

*Female genitalia*. Papillae anales moderately setose and microtrichiate; lamella postvaginalis rectangular and microtrichiate; lateral extremities of sternum 7 strongly developed and pointed (except in *E. linitipunctana*); scaling of sternum 7 dense on posterior lobes and lateral extremities; tergum 8 with taxonomically useful patterns of scaling and setation; ductus bursae with sclerotized ring at juncture with ductus seminalis; corpus bursae with signa nearly equal in size.

#### 53. Eucosma griseocapitana (Walsingham, 1879)

(Plate K, 53a–g; Plate 19, 53a–h)

Thiodia griseocapitana: Fernald 1903:462, Heinrich 1923:66; McDunnough 1939:45.

Eucosma griseocapitana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:309.

Phaneta griseocapitana: Powell 1983:34; Brown 2005:493.

**Lectotype** (here designated; Plate K:53a). ♀, California, Siskiyou County, Mount Shasta, Walsingham, 2 August–1 September 1871, BMNH.

Walsingham described this species from three syntypes  $(1 \Diamond, 2 \heartsuit)$ . The specimen selected by Obraztsov as lectotype is a female that lacks an abdomen, so we are designating the other female as the lectotype.

*Eucosma griseocapitana* is somewhat variable in forewing appearance and male valva shape. The specimens in Plate K:53a–e illustrate phenotypes that we consider typical of the species. Plate K:53f shows a grayer, paler phenotype from southern New Mexico that we tentatively refer to this taxon based on similarity of genitalia. The specimen in Plate K:53g comes from coastal dunes in central California. It is a blackish-brown form that we believe is associated with that habitat. Mean FWL = 8.0 mm.

This species is similar to *E. linitipunctana* in size (mean FWL = 8.0 vs. 7.8 mm) and forewing appearance. In some *E. linitipunctana* specimens (Plate K:54a, c), the proximal one-half of the forewing is more strongly reticulated than in typical *E. griseocapitana*, but this condition is variable (Plate K:54d). Variation in male valva shape in both species renders diagnosis on that basis problematic, but the female genitalia present some distinctive characteristics: in *E. griseocapitana* tergum 8 is shorter, less densely scaled, and less densely setose (Plate 19:53h vs. 54f); the sterigma is shorter (SR = 1.5 vs. 2.0); and the lateral extremities of sternum 7 are more strongly developed (Plate 19:53f vs. 54e).

We examined specimens from Arizona, California, Colorado, Idaho, New Mexico, Oregon, Utah, and Wyoming. Adults fly from mid-July to mid-September.

Semasia griseocapitana Walsingham 1879:61.

# 54. *Eucosma linitipunctana* (Blanchard and Knudson, 1983)

(Plate K, 54a–d; Plate 19, 54a–f)

*Phaneta linitipunctana* Blanchard and Knudson 1983a:140; Brown 2005:494. *Eucosma linitipunctana*: Gilligan and Wright 2013b:311.

Holotype (Plate K:54a; Plate 19:54a). &, Texas, Nueces County, North Padre Island, A. and M. E. Blanchard, 9 September 1974, slide 25224, USNM.

*Eucosma linitipunctana* is similar to *E. griseocapitana* but differs from that species in the geometry, scaling, and setation of tergum 8 and in the shape of sternum 7 (see discussion under the latter taxon). The two species are sympatric in the high plains of eastern Colorado. We examined specimens from Otero and Weld counties in Colorado and from Cameron, Hemphill, and Nueces counties in Texas. Adult capture dates range from 7 August to 13 October.

#### 55. Eucosma alabamae Wright and Gilligan, new species

(Plate K, 55a–c; Plate 20, 55a–f)

**Diagnosis**. *Eucosma alabamae* is recognized by its rusty-brown forewing and the lack of scales on the dorsal surface of tergum 8 (there sometimes are a few on the ventral extremities of that tergite). It is distinguished from other species in the group by the setation of tergum 8, which is arranged in two bands of moderately long setae, one along the posterior margin, the other midway between the posterior and anterior margins. This species is sympatric with *E. argutipunctana* in Alabama, but its range does not appear to overlap that of any other member of the group.

Description. Head. Frons and vertex white; labial palpus mostly white, scales at distal end of second segment usually with pale gray-brown cross-marks; antenna white. Thorax. Scales on dorsal surface white with gray-brown cross-marks, producing speckled effect; legs mostly white; mid-leg with two gray-brown marks on tibia; tarsi with blackish-brown annulations. Forewing: 3 FWL 6.1–7.3 mm (mean = 6.7 mm, n = 19), AR = 2.87; 9 FWL 6.0–8.1 mm (mean = 7.3 mm, n = 14), AR = 2.84; male without costal fold, costa weakly arched; apex acute; termen weakly concave; dorsal surface rusty brown with variably expressed, white, subcostal band from base to apex that is interrupted at mid-costa by brown outwardly oblique bar representing median fascia, white coloration often infiltrating proximal one-half of forewing, producing transverse reticulations; subbasal fascia sometimes discernable as slightly darker shade from inner margin to radius; ocellus conspicuous, with lustrous white bars at proximal and distal margins, pale central field marked by up to three small black dashes; costal strigulae white, delimited by series of fine black dashes; termen with salt-and-pepper-colored band from tornus to apex; fringe scales white from tornus to  $R_{s}$ , blackish gray toward apex. Hindwing: Blackish gray. *Abdomen*. Male genitalia (n = 3): Typical of the group, with 30–42 cornuti, valval neck widening slightly toward cucullus, SA = 131°, NR = 0.61; cucullus with apex slightly broader than anal angle, distal margin convex of nearly uniform curvature. Female genitalia (n = 2): Typical of the group; dorsal surface of tergum 8 scaleless, with two bands of moderately long setae, one along posterior margin, the other midway between the posterior and anterior margins; sternum 7 with well-developed triangular lateral extremities.

**Holotype** (Plate K:55a; Plate 20:55b). *(*, Alabama, Baldwin County, Bon Secour National Wildlife Refuge, R. Brown and D. Pollock, 12–16 October 1991, slide 144981, USNM.

**Paratypes**. ALABAMA. Baldwin County, Bon Secour National Wildlife Refuge, R. Brown and D. Pollock, 12–16 October 1991 (8 3, 4 2); R. Brown and D. Pollock, 13–14 October 1991 (1 2); 30.2286° N, 87.8308° W, T. L. Schiefer, 15 October 1996 (4 3; 7 2, slide DJW 2548); R. L. Brown, 17 October

1997 (2 3); 1 mi E of Oyster Bay, R. L. Brown, 13 October 1990 (4 3, slides DJW 315, 3349; 2 2, slide DJW 2547). Paratype depositories: MEM, USNM, DJW.

**Etymology**. The specific epithet refers to the state of Alabama.

**Discussion**. The type series was collected in dune habitat on the Gulf Coast south of Mobile, Alabama. The specimen in Plate K:55d is representative of a series of specimens in the USNM that were collected by J. B. Sullivan in September and October of 1996 and 1997 at Fort Macon State Park, Carteret County, North Carolina. He described the habitat at that site as maritime shrub. These specimens agree with *E. alabamae* in size and genitalia but differ somewhat in forewing appearance. Most noticeably, they are paler and lack the salt-and-pepper-colored band along the forewing termen. The USNM also has a few *alabamae*-like specimens from South Chatam, Massachusetts (Cape Cod) that were collected by E. Jäckh in September, 1982. They also lack the salt-and-pepper-colored band but otherwise agree with *E. alabamae* in forewing color and maculation. This material may represent another new species that is closely related to *E. alabamae*, but we hesitate to propose another name without further distributional information about these insects.

# 56. Eucosma granulatana (Kearfott, 1908)

(Plate L, 56a-c; Plate 20, 56a-g)

*Cydia granulatana* Kearfott 1908:173. *Thiodia granulatana*: Heinrich 1923:68; McDunnough 1939:45. *Eucosma granulatana*: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:309. *Phaneta granulatana*: Powell 1983:34; Brown 2005:493.

Lectotype (here designated). *A*, Colorado, Denver, E. J. Oslar, 4 September 1906, AMNH.

Heinrich (1923) stated that the "type" is from Denver, Colorado, that it is in the AMNH, and that he was illustrating its genitalia (Fig. 94). Klots (1932) reported three syntypes in the AMNH ( $1 \Diamond, 2 \heartsuit$ ) and placed a green "LECTOTYPE" label on the male, attributing the designation to Heinrich. We examined the labeled specimen and found that it has not been dissected, so it appears that Heinrich (1923) did not illustrate the genitalia of the specimen he considered to be the "type". We designate here as lectotype the male labeled by Klots.

*Eucosma granulatana* and *E. argutipunctana* both have creamy white forewings that are heavily speckled with black. In the latter species the black marks tend to coalesce into more clearly defined transverse reticulations. The two species have previously been separated by the presence of a black dot on the scape in *E. argutipunctana* (Plate L:57a) and the lack thereof in *E. granulatana* (Blanchard and Knudson 1983; Gilligan et al. 2008). We found that dot to be conspicuous in *E. argutipunctana* specimens from Colorado, Illinois, Kansas, North Carolina, and Texas but diminished to obsolete in specimens from Alabama.

Males of *E. granulatana* have a less sickle-shaped valva and a slightly more strongly developed anal angle than those of *E. argutipunctana*. Tergum 8 is sparsely covered with a mixture of scales and setae in *E. granulatana* (Plate 20:56g) but is scaleless and densely covered with short hairlike michrotrichia (Plate 21:57g) in *E. argutipunctana*. The latter arrangement distinguishes *E. argutipunctana* from all the other members of the group.

We examined specimens from Colorado, New Mexico, and Utah, all collected from mid-August to mid-September. This species seems to prefer habitat with sandy soil.

# **57.** *Eucosma argutipunctana* (Blanchard and Knudson, 1983) (Plate L, 57a–c; Plate 21, 57a–g)

*Phaneta argutipuctana* Blanchard and Knudson 1983a:143; Brown 2005:492. *Eucosma linitipunctana*: Gilligan and Wright 2013b:304.

**Holotype** (Plate 21:57a).  $\mathcal{J}$ , Texas, Hemphill County, Canadian, A. and M. E. Blanchard, 15 August 1971, slide 25226, USNM.

*Eucosma argutipunctana* resembles *E. granulatana* in forewing appearance. Many individuals of *E. argutipunctana* can be distinguished from *E. granulatana* by the presence of a black spot on the scape (Plate L:57a), but we found that mark to be reduced to absent in specimens from Alabama. The male genitalia of the two species are similar but exhibit some subtle differences in valval shape that are discussed under *E. granulatana*. *Eucosma argutipunctana* is the only species in the group in which tergum 8 is densely covered with short hairlike microtrichia (Plate 21:57g).

We examined specimens from coastal Alabama, southeastern Colorado, central Illinois, southwestern Kansas, North Carolina, and Texas, all collected in habitat with sandy soil. There are some Alabama records from June and July, but most specimens were collected in August, September, and early October.

# The striatana group (species 58–61)

The striatana group consists of four species that are similar in forewing appearance and genitalia. The namesake for the group, *E. striatana*, has a transcontinental distribution. *Eucosma occidentalis* and *E. implicata* are poorly represented in North American collections, but the available material suggests that they are restricted to California, Washington, Oregon, and British Columbia. *Eucosma pallidicostana* is broadly distributed west of the Mississippi River and exhibits considerable variation in the amount of grayish suffusion in the forewing, suggesting that it may be a complex of similar species.

*Forewing.* Mean FWL: 7.7–8.8 mm; AR: 2.97–3.07; dorsal surface with variably-expressed central white streak in the cell from base to ocellus (subdued in some *E. pallidicostana*) and a thin black line following the cubitus and  $CuA_2$  from base to tornus; central streak flanked anteriorly and posteriorly with brown/gray bands; costa white with brown/gray marks and striae associated with median fascia and costal strigulae; area between  $CuA_2$  and inner margin variably suffused with gray; median fascia represented by outwardly oblique bar at mid-costa, extending in some species along proximal margin of the ocellus to inner margin; ocellus conspicuous, with whitish central field crossed by two black longitudinal dashes; termen with salt-and-pepper-colored band from tornus to apex

*Male genitalia*. Uncus moderately developed, usually with rounded apex; valva with costal margin concave, ventral emargination moderate (NR: 0.50–0.62), saccular corner angulate (SA: 118–139°); cucullus with dorsal lobe strongly developed and tapering toward rounded apex, distal margin convex of nearly uniform curvature, ventral lobe moderately developed and broadly rounded, basoventral margin overlapping ventral one-half of medial surface of neck.

*Female genitalia*. Papillae anales moderately setose and microtrichiate; lamella postvaginalis rectangular and microtrichiate; sternum 7 with posterolateral margins nearly straight and lateral extremities triangular and well developed; scaling of sternum 7 dense on posterior lobes and anterolateral margins; ductus bursae with sclerotized ring at juncture with ductus seminalis; signa nearly equal in size.

#### 58. Eucosma striatana (Clemens, 1860)

(Plate L, 58a–e; Plate 21, 58a–e)

Anchylopera striatana Clemens 1860:349.
Paedisca albicepsana Walker 1863b:379; synonymy by Fernald 1882a:44.
Grapholitha trivittana Zeller 1875:287; synonymy by Fernald 1882a:44.
Semasia striatana: Fernald 1882a:44.
Thiodia striatana: Fernald 1903:462; Heinrich 1923:58; McDunnough 1939:44.
Eucosma striatana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:315.
Phaneta striatana: Miller 1973:223; Powell 1983:33; Brown 2005:496; Gilligan et al. 2008:99.

**Types**. *Anchylopera striatana*. Lectotype (designated by Miller 1973). ♂, Type 138, Baltimore, Maryland or Easton, Pennsylvania, slide 208, ANSP. *Paedisca albicepsana*. Holotype. [sex undetermined], N. America, Carter, 1862–85, BMNH(E) #819886, BMNH (abdomen missing). *Grapholitha trivittana*. Holotype. ♂, Massachusetts, Beverly, 16 June 1868, BMNH(E) #819887, slide 11583, BMNH.

The description of *E. striatana* was based on an unknown number of specimens from Baltimore, Maryland and Easton, Pennsylvania. Darlington (1947) designated a lectotype, but Miller (1973) noted that that specimen is probably not a syntype due to a discrepancy between the identification number on the specimen and the numbers in a catalogue prepared by Clemens. The lectotype reported here was selected and designated by Miller (1973).

*Eucosma striatana* differs from the other members of the group in that the labial palpus has a blackish third segment and a well-defined blackish spot on the lateral surface of the second segment (Plate L:58e). In *E. striatana* the distal end of the central white forewing streak is separated from the proximal margin of the ocellus by a thin brown line; in *E. occidentalis* and *E. implicata* that separation is more substantial due to a more strongly developed median fascia. The forewing of *E. pallidicostana* is grayer and less strongly marked than that of *E. striatana*.

The male genitalia resemble those of *E. pallidicostana*. In both species the apex and anal angle of the cucullus are semicircular, the latter being of larger diameter. The difference in diameters is noticeably more pronounced in *E. pallidicostana* than in *E. striatana*. In *E. occidentalis* and *E. implicata* the cucullus is nearly symmetric about a horizontal center line. Females of *E. striatana* differ slightly from the other members of the group in sterigma shape (SR = 1.77 vs. 1.38-1.55).

The specimens we examined document a range from Maine to Alberta and Washington, south to Virginia, Tennessee, Louisiana, Arizona, and California. Adults have been collected from April to September.

#### 59. Eucosma occidentalis (Heinrich, 1923), revised status

(Plate L, 59a-c; Plate 22, 59a-c)

*Thiodia striatana occidentalis* Heinrich 1923:58; McDunnough 1939:44. *Phaneta striatana occidentalis*: Powell 1983:33; Brown 2005:496. *Eucosma striatana occidentalis*: Gilligan and Wright 2013b:315.

Holotype (Plate 22:59a). ♂, California, Siskiyou County, Shasta Retreat, June 16–23, slide 72777, USNM.

Heinrich (1923) described *E. s. occidentalis* from six specimens  $(1 \ 3, 5 \ 9)$ , referring to the male as the "type" and the females as paratypes, hence the interpretation of the above specimen as a holotype. Heinrich viewed this taxon as a "Pacific coast race" of *E. striatana*, but we find it sufficiently distinctive to deserve species status. Differences between the two species, some of which were noted by Heinrich, are discussed under *E. striatana*. In particular, the lateral surface of the labial palpus lacks the sharply defined black spot in *E. striatana* (Plate L:59c vs. Plate L:58e).

The male genitalia are most similar to those of *E. implicata*. In both species, the cucullus is nearly symmetric about a horizontal center line, and the semicircular apex and anal angle are nearly equal in diameter. In *E. occidentalis* the ventral margin of the valval neck is moderately scooped-out, a character state shared with no other member of the group.

We examined seven specimens  $(2 \land 5 \bigcirc)$  from Siskiyou County, California and Jackson County, Oregon. They were collected in mid-May and mid-June.

# **60.** *Eucosma implicata* (Heinrich, 1931)

(Plates L–M, 60a–d; Plate 22, 60a–c)

*Thiodia implicata* Heinrich 1931:7; McDunnough 1939:44. *Phaneta implicata*: Powell 1983:34; Brown 2005:493. *Eucosma implicata*: Gilligan and Wright 2013b:309.

**Holotype** (Plate L:60a).  $\mathcal{J}$ , Washington, [Thurston County], Rochester, W. W. Baker, 13 June 1929, slide 72765, USNM.

Heinrich (1931) described *E. implicata* from nine male specimens collected at Rochester, Washington and Wellington, British Columbia. He placed a "type" label on the specimen listed above and referred to the others as paratypes, hence the interpretation of the above specimen as a holotype.

This species most closely resembles *E. occidentalis*, but the forewing is whiter and has more sharply defined markings. The holotype (Plate L:60a) appears to be stained, giving the forewing interfascial areas a pale orange tint. The paratypes (e.g., Plate M:60b) provide a better indication of the forewing color. In the paratypes the brownish bands flanking the central white streak are weakly expressed and variably interrupted in the median area, but in the specimens we examined from California (Plate M:60c) they are complete and sharply defined. Like *E. occidentalis*, this species lacks the well-defined black spot on the labial palpus (Plate M:60d) that is characteristic of *E. striatana*.

The ventral margin of the valval neck is not scooped-out as in *E. occidentalis*. The female genitalia of the two species are essential identical.

We examined seventeen specimens  $(16 \ 3, 1 \ 2)$  from Wellington, British Columbia; Thurston County, Washington; and Santa Clara County, California. Capture dates range from 13 June to 31 July.

# **61.** *Eucosma pallidicostana* (Walsingham, 1879) (Plate M, 61a–d; Plate 22, 61a–g)

Semasia pallidicostana Walsingham 1879:62.

Thiodia pallidicostana: Fernald 1903:462; Heinrich 1923:63; McDunnough 1939:45.

Eucosma pallidicostana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:313.

Phaneta pallidicostana: Powell 1983:34; Brown 2005:495; Gilligan et al. 2008:99.

**Lectotype** (here designated; Plate M:61a).  $\Im$ , California, Lake County, Scott's Valley, Walsingham, 17–19 June 1871, BMNH(E) #819889, slide 11586, BMNH.

This species was described from two syntypes  $(1 \ 3, 1 \ 2)$ . The male was selected as lectotype by Obraztsov and is so designated here.

We examined specimens from Alberta, Manitoba, Arizona, northern California, and Utah that closely resemble the lectotype (Plate M:61a) in forewing appearance. The specimens in Plate M:61c, d are representative of males from Arizona, Colorado, Iowa, and Nebraska that agree with the lectotype in forewing pattern and genitalia but differ in the amount of gray suffusion in the interfascial areas. We tentatively refer all these specimens to *E. pallidicostana* based on similarity of male genitalia features: valval neck tapering distally, dorsal lobe of cucullus tapering toward apex, and ventral lobe of cucullus much broader than dorsal lobe. Adults fly in June, July, and August.

# The *clavana* group (species 62–69)

The next eight species are grouped because of similarity in forewing pattern. We recognize two subgroups in each of which the genitalia are quite uniform, but the group as a whole is somewhat diverse in that respect, especially *E. crassana* and *E. labiata*.

*Forewing*. Mean FWL: 6.9–9.5 mm; AR = 3.13–3.46; dorsal surface with a longitudinal white streak in cell from base nearly to ocellus and an adjacent brownish/blackish line along its posterior margin from base to mid-wing; area anterior to white streak variably suffused with orange, brown, and gray from base to median fascia; median fascia usually at least partially expressed as an outwardly oblique band from mid-costa to ocellus; ocellus conspicuous, with pale central field crossed by two variably expressed black dashes; costal strigulae white and conspicuous from median fascia to apex.

*Male genitalia*. Uncus weakly to moderately developed and clearly differentiated from dorsolateral shoulders of tegumen; valva with dorsal margin concave, ventral emargination shallow to moderate, saccular corner angulate, SA obtuse; cucullus with dorsal lobe strongly developed, distal margin weakly convex to nearly straight; ventral lobe weakly to moderately developed.

*Female genitalia*. Papillae anales moderately setose, with microtrichia variable in distribution and density; lamella postvaginalis rectangular and microtrichiate, the lateral margins varying from extensively fused with to disjunct from the posterior lobes of sternum 7; sternum 7 with scaling dense on posterior lobes and lateral extremities, relatively sparse elsewhere; ductus bursae with sclerotized ring at juncture with ductus seminalis; corpus bursae sometimes with one signum slightly larger than the other.

The *clavana-indagatricana-misturana* subgroup (species 62–64). *Eucosma clavana* and *E. indagatricana* are strikingly similar species with eastern and western distributions, respectively, the Mississippi River being an approximate dividing line between their ranges. *Eucosma misturana* is common in the far West and is separated from *E. indagatricana* by forewing color and flight period. Subgroup characteristics include:

*Male genitalia*. Uncus moderately developed and semitriangular; valva with ventral emargination U-shaped, NR: 0.44–0.48, SA: 96–111°; cucullus nearly uniform in width, with apex semicircular, distal margin straight to weakly convex, ventral lobe moderately developed and rounded.

*Female genitalia*. Surface of papillae anales smooth except for narrow band of microtrichia along margins of anal opening; lamella postvaginalis relatively short (SR: 1.43–1.59), with lateral margins fused with posterior lobes of sternum 7; sternum 7 with concave posterolateral margins and strongly developed lateral extremities; signa in corpus bursae nearly equal in size.

62. Eucosma clavana (Fernald, 1882)

(Plate M, 62a–b; Plate 23, 62a–e)

*Semasia clavana* Fernald 1882b:72. *Thiodia clavana*: Fernald 1903:462; Heinrich 1923:55; McDunnough 1939:44. *Eucosma clavana*: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:306. *Phaneta clavana*: Powell 1983:33; Brown 2005:493; Gilligan et al. 2008:98.

Lectotype (designated by Miller 1970). *A*, Truro, Massachusetts, 8 August, USNM 70819.

The labial palpi are whitish and rather bushy, the vertex is pale gray brown, and the dominant forewing color is orange brown to gray brown. The central streak, the ocellus, and the distal one-half of the costa are white. Concave inflection of the termen gives the apex a weakly falcate appearance.

This poorly known species ranges from New England to the upper Midwest but seems to be localized and associated with sandy or coastal habitat. We examined 21 specimens (13 3, 8 2) from Ontario, Connecticut, Illinois, Indiana, Massachusetts, Michigan, New Hampshire, and New York. Those from Indiana and Michigan were collected in dune habitat along the shore of Lake Michigan; the New England specimens are from coastal locations (e.g., Long Island and Martha's Vineyard), and the Ontario record is from Thunder Bay, on Lake Superior. Adults have been collected from late May to early September.

#### 63. Eucosma indagatricana (Heinrich, 1923)

(Plate M, 63a–f; Plate 23, 63a–c)

*Thiodia indagatricana* Heinrich 1923:56; McDunnough 1939:44. *Phaneta indagatricana*: Powell 1983:33; Brown 2005:493; Wright 2010:120. *Eucosma indagatricana*: Gilligan and Wright 2013b:309. *Phaneta verecundana* Blanchard 1979:210; Brown 2005:496; synonymy by Wright 2010:120. *Eucosma verecundana*: Gilligan and Wright 2013b:310.

**Types**. *Thiodia indagatricana*. Holotype. *C*, Utah, [Utah County], Provo, Tom Spalding, 26 August 1908, slide 72766, USNM. *Phaneta verecundana*. Holotype. *C*, Texas, Hemphill County, Canadian, A. and M. E. Blanchard, 15 August 1971, USNM.

Dominant forewing color varies from white to gray, usually with brownish suffusion. All but the darkest specimens have a whitish costal streak from the base to the apex that is interrupted by the brown/ gray dashes associated with the costal strigulae. Most specimens have a blackish line and a narrow orange-brown band along the proximal two-thirds of the posterior margin of the central white streak. The head is predominantly white, with vertex shading to grayish white in darker specimens.

This species is widespread and common in western North America from Manitoba to British Columbia, south to Texas and southern California. There are no confirmed reports of a larval host, but collection sites frequently are dominated by *Artemisia* L. (sagebrush). Adults fly from July through early October, with most captures occurring in July and August.

#### 64. Eucosma misturana (Heinrich, 1923)

(Plate N, 64a–c; Plate 23, 64a–d)

*Thiodia misturana* Heinrich 1923:54; McDunnough 1939:44. *Phaneta misturana*: Powell 1983:33; Brown 2005:494; Wright 2010:121. *Eucosma misturana*: Gilligan and Wright 2013b:311.

Holotype. (7, Saskatchewan, Oxbow, Fred K. Knab, 9 June 1907, slide 72773, USNM.

*Eucosma misturana* looks like a blackish-gray version of *E. indagatricana*. It differs from the latter species in that the head is brownish gray, the proximal one-half of the costa is gray instead of white, and the central white streak is more strongly separated from the ocellus. The specimen in Plate N:64c is representative of four specimens from Ebbetts Pass in Alpine County, California that are slightly atypical in forewing appearance and in the sculpturing of the lamella postvaginalis. They are tentatively referred to *E. misturana* for lack of sufficient material for an adequate evaluation.

The range of *E. misturana* includes the region from southwest Manitoba to eastern Washington, south to central Utah and southern California. Adults fly from mid-March to late June. Throughout its range it is sympatric with *E. indagatricana*, whose flight period begins in July. Larval hosts include *Artemisia californica* Less. (California sagebrush) in coastal California (Powell and Opler 2009) and *Artemisia tridentata* Nutt. (big sagebrush) in southern Idaho (Brown et al. 1983).

The *dorsiatomana-salidana* subgroup (species 65 and 66). *Eucosma dorsiatomana* and *E. salidana* have often been confused with one another due to similarities in forewing appearance and genitalia. We find them sufficiently different in size, flight period, color, and maculation to warrant species status.

*Forewing*. White central streak moderately to strongly expressed; costa unmarked from base to median fascia; costal strigulae beyond median fascia conspicuous and connected by white subcostal line.

*Male genitalia*. Uncus weakly developed; socii short and stout; neck moderately wide (NR: 0.72, 0.58); saccular corner angulate (SA: 125°, 121°); cucullus with apex semicircular, distal margin weakly convex, ventral lobe weakly developed and rounded, basoventral margin projecting in ridgelike manner onto medial surface of neck.

*Female genitalia*. Papillae anales moderately setose; lamella postvaginalis with lateral margins fused with posterior lobes of sternum 7; sternum 7 with weakly concave posterolateral margins and moderately developed triangular lateral extremities; corpus bursae with one signum slightly larger than the other.

# 65. Eucosma dorsiatomana (Kearfott, 1905)

(Plate N, 65a–c; Plate 24, 65a–e)

*Thiodia dorsiatomana* Kearfott 1905a:44; Heinrich 1923:57; McDunnough 1939:44. *Eucosma dorsiatomana*: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:307. *Phaneta dorsiatomana*: Powell 1983:33; Miller 1987:46; Brown 2005:493.

**Lectotoype** (designated by Heinrich 1923).  $\bigcirc$ , Saskatchewan, Regina, 15 June 1904, AMNH.

This species was described from four syntypes  $(3 \ 3, 1 \ 2)$  collected at Regina and Macleod [sic.], Saskatchewan (Kearfott 1905a). Heinrich's (1923) comments constitute a valid lectotype designation because there is only one syntype in the AMNH from Regina. It has been reported previously as a male (Brown 2005; Gilligan and Wright 2013b). The forewing of *E. dorsiatomana* is tan to gray brown, the central white streak and the blackish-brown line on its posterior margin extend nearly to the ocellus, the median fascia is represented by an outwardly oblique bar from mid-costa to distal end of cell, and the central field of the ocellus is tan. Mean FWL = 9.3 mm. The papillae anales have a few michrotrichia distributed along their anterior margins but none elsewhere.

This species flies from April to early July. Several USNM specimens from Whitman County, Washington were reared by J. F. G. Clarke from *Artemisia vulgaris* L. (mugwort) (reported by Brown et al. 1983), the emergence dates ranging from 31 January to 17 March. We examined 16 specimens from Alberta, Colorado, Nevada, New Mexico, North Dakota, Oregon, Utah, and Washington. Miller (1987) reported this species from Minnesota.

#### 66. Eucosma salidana Wright and Gilligan, new species

(Plate N, 66a–d; Plate 24, 66a–g)

**Diagnosis**. The forewing of *E. salidana* resembles that of *E. dorsiatomana* except: the proximal one-half has a hoary appearance produced by a suffusion of whitish scales on an olive-gray background, the median fascia includes a triangular mark on the inner margin, the region between  $CuA_2$  and the inner margin is longitudinally streaked, and the dark band on the posterior margin of the central white streak terminates at the base of  $CuA_2$ . In *E. dorsiatomana* the forewing color is uniformly tan to gray, the median fascia is reduced to a bar from mid-costa to distal end of cell, the region posterior to  $CuA_2$  is not streaked, and the dark band along the central streak extends to the median fascia, attenuating distally to a fine point. The male genitalia of *E. salidana* differ from those of *E. dorsiatomana* in several subtle respects: ventral surface of uncus with pair of shallow ridgelike projections; dorsolateral shoulders of tegumen distinctly hunched; socii broad basally, tapering distally; cucullus with distal margin more strongly convex, basoventral margin toward basal emargination. Females differ in the distribution of microtrichia on the papillae anales: dense and uniform in *E. salidana*, sparse and restricted to anterior margin in *E. dorsiatomana. Eucosma salidana* is slightly smaller than *E. dorsiatomana* (mean FWL = 8.7 vs. 9.3 mm) and differs from the latter species in flight period (August through mid-September vs. April to early July).

**Description**. *Head*. Frons white with some brownish suffusion; vertex pale gray brown with whitish medial streak; labial palpus white with very pale gray-brown suffusion on lateral surface of second segment; antenna concolorous with vertex. Thorax. Dorsal surface whitish medially, shading to pale gray brown laterally; legs whitish with anterior surfaces of fore-legs pale brown; tarsi without dark annulations. Forewing:  $3^{\circ}$  FWL 7.1–9.9 mm (mean = 8.6, n = 49), AR = 3.37;  $9^{\circ}$  FWL 8.1–10.0 mm (mean = 9.1, n = 12), AR = 3.27; male without costal fold, costa straight; apex acute; termen straight; proximal one-half of dorsal surface olive gray to gray brown with diffuse whitish streak in cell from base to median fascia flanked posteriorly by orange-brown to blackish-brown band from base to mid-wing; area between CuA, and inner margin with white suffusion and thin longitudinal dark streaking; area between central streak and costa variably suffused with white, often with inconspicuous whitish streak along costa; median fascia complete, consisting of outwardly oblique bar from mid-costa to distal end of cell and a triangular mark on inner margin extending along proximal edge of ocellus; ocellus conspicuous, bordered laterally by pale lustrous gray bars, whitish-tan central field crossed by two thin dashes; costal strigulae white, sharply defined beyond median fascia, separated on costa by elongate dark marks, and connected in subcostal area by longitudinal white streak from median fascia to apex; termen with pale diffuse line from tornus to apex; fringe scales dark gray with white apices. Hindwing: Dark gray brown. *Abdomen*. Male genitalia (n = 5): Uncus bulgelike, weakly divided medially by shallow indentation, with pair of ridgelike projections on

ventral surface; dorsolateral shoulders of tegumen hunched; socius tapering from broad base to narrowly rounded apex; phallus stout, tapering gradually toward apex; vesica with 28–34 deciduous cornuti; valva with costal margin concave, ventral emargination moderate, NR = 0.58, SA = 121°; cucullus with dorsal lobe strongly produced, apex rounded, distal margin weakly convex, anal angle weakly produced and narrowly rounded, basoventral margin projecting in ridgelike fashion onto medial surface of neck, medial surface densely setose. Female genitalia (n = 3): Papillae anales laterally facing, moderately setose, and densely microtrichiate; lamella postvaginalis microtrichiate; lamella antevaginalis ringlike; posterior margin of sternum 7 invaginated to full length of sterigma and fused with lateral margins of lamella postvaginalis; sternum 7 with posterolateral margins weakly concave and lateral projections semitriangular; scaling of sternum 7 dense on posterior lobes and lateral extremities, comparatively sparse elsewhere; ductus bursae encircled and distorted by sclerotized band at juncture with ductus seminalis; corpus bursae with one signum slightly larger than the other.

**Holotype** (Plate 24:66c). ♂, Colorado, Fremont County, 4.6 mi SE of Salida on W side of US 50, 7,100 feet, 38.495° N, 105.920° W, D. J. Wright, 13 August 1999, slide 144982, USNM.

**Paratypes**. COLORADO. Same location and collector as holotype, 22 August 1997 (24 3, slides DJW 374, 3350; 2 2), 13 August 1999 (18 3; 6 2, slides DJW 658, 3351); Otero County, Comanche National Grassland, 15 mi S La Junta, D. J. Wright, 27 August 2000 (2 3, 1 2), 29 August 2000 (1 3); Otero County, Vogel Canyon Picnic Area, 15 mi S La Junta, D. J. Wright, 18 August 1997 (1 3); Morgan County, 9 mi S Fort Morgan, 3 mi W of County Road 19, D. J. Wright, 6 September 2000 (2 3); Weld County, 2.5 mi NE of Roggen on CR# 386, 4,664 feet, 40.1958° N, 104.3393° W, C. Harp, 25–26 August 2007 (1 2, slide DJW 1923); Larimer County, Phantom Canyon Ranch, T10N R11W S52, 6,700 feet, P. A. Opler (1 3, slide DJW 268). KANSAS. Morton County, Cimarron National Grassland, 7.5 mi N Elkhart, D. J. Wright, 26 August 2000 (1 3, 2 2). NEW MEXICO. Otero County, Hwy 82 mile 11.5, W of Cloudcroft, G. J. Balogh, 16 September 2004 (1 3, slide DJW 1744). WYOMING. Albany County, 1.5 mi NW of Woods Landing, Fox Creek, J. S. Nordin, 4 August 2001 (3 3), 18 August 2001(1 3), 16 September 2003 (1 3). Paratype depositories: AMNH, CNC, CSU, EME, MEM, USNM, ESUW, DJW.

**Etymology**. The specific epithet refers to the town of Salida, Colorado, near which many of the types were collected.

**Distribution and biology**. We examined specimens from Colorado, southwest Kansas, southern New Mexico, and southeast Wyoming. Adults fly from early August to mid-September.

#### 67. Eucosma fertoriana (Heinrich, 1923)

(Plate N, 67a–b; Plate 25, 67a–g)

*Thiodia fertoriana* Heinrich 1923:264; McDunnough 1939:44. *Phaneta fertoriana*: Powell 1983:33; Brown 2005:493; Wright 2013:179. *Eucosma fertoriana*: Gilligan and Wright 2013b:308.

Holotype. A, Canada, British Columbia, Goldstream, 24 May 1903, slide 72767, USNM.

This species was described from three specimens  $(1 \ 3, 2 \ 2)$  collected in 1903 at the type locality: the females (one in the USNM, the other in the AMNH) on 10 May and the male (in the USNM) on 24 May. Heinrich (1923) referred to the male as the "type" and the females as paratypes, hence the interpretation of the male as the holotype. The capture date for the holotype (24 May 1903) was taken from the specimen label and differs from that reported by Heinrich (1923) (10 May 1903).

The white central forewing streak is mostly obscured by brownish-gray suffusion, the dark line along its posterior margin is weakly expressed, and the median fascia is complete but fades toward the inner margin. *Eucosma fertoriana* and *E. crassana* are the only gray-brown members of the *clavana* group with a prominent white line on the termen from tornus to apex. The latter species has a conspicuous white streak along the costa from base to median fascia, a feature that is obscure to absent in *E. fertoriana*. The two species are easily separated by the shapes of the valva and sternum 7.

This species is broadly distributed in western North America. We examined 54 specimens collected from late March to mid-July in British Columbia, Manitoba, Arizona, California, New Mexico, South Dakota, Oregon, and Wyoming.

#### 68. Eucosma crassana (McDunnough, 1938)

(Plate N, 68a–c; Plate 25, 68a–g)

*Thiodia crassana* McDunnough 1938:99; McDunnough 1939:44. *Phaneta crassana*: Powell 1983:33; Brown 2005:493; Wright 2013:184. *Eucosma crassana*: Gilligan and Wright 2013b:307.

**Holotype**. ∂, British Columbia, Kreuger Mountain, Osoyoos, A. N. Gartrell, 9 May 1936, slide TOR-989, CNC.

The prominent white line on the forewing termen distinguishes *E. crassana* from all other gray-brown members of the *clavana* group except *E. fertoriana*. *Eucosma crassana* has a conspicuous central white streak and a white costal streak from base to median fascia, both of which are subdued to absent in *E. fertoriana*.

*Eucosma crassana* is readily identified by genitalia. Male valva shape is unlike that of any other member of the *clavana* group, and the straight to weakly convex posterolateral margins of sternum 7 distinguishes females from all other group members except *E. labiata. Eucosma labiata* differs from *E. crassana* in sterigma shape and in the presence of microtrichia on the inner surface of the ductus bursae near the juncture with the ductus seminalis.

We examined 15 specimens from Alberta, British Columbia, and Nevada (Lander County), all of which were collected in May.

**69.** *Eucosma labiata* (Wright, 2010) (Plate O, 69a–c, Plate 25, 69a–e)

*Phaneta labiata* Wright 2010:121. *Eucosma labiata*: Gilligan and Wright 2013b:310.

**Holotype** (Plate 25:69a).  $\mathcal{E}$ , Texas, Cottle County, Paducah, A. and M. E. Blanchard, 4 June 1970, slide 137413, USNM.

*Eucosma labiata* is variable in forewing color (pale grayish yellow to gray) and in the expression of the central white streak. It has been confused with whitish phenotypes of *E. indagatricana* (Plate M:63a) (Wright 2010), but the two taxa are easily separated by genitalia.

The valva has a long tapering neck, a broadly rounded saccular corner (rendering the SA and NR illdefined), and a liplike protrusion from the ventral margin of the basal excavation. The lamella postvaginalis is about three times as broad as it is long, with anterolateral corners connecting to sternum 7; the lamella antevaginalis is well separated from sternum 7 by a band of membrane; and sternum 7 is a broad U-shaped band of nearly uniform width. The inner surface of the ductus bursae has a conspicuous patch of microtrichia at the juncture with the ductus seminalis (Plate 25:69e).

We examined specimens from Alberta, California, Colorado, Idaho, Montana, New Mexico, Texas, and Wyoming. Capture dates range from 28 May to 25 August.

# The *spiculana* group (species 70–73)

The following four species are similar in forewing appearance and genitalia. The group namesake, *E. spiculana*, has been missunderstood since Zeller described it in 1875. We examined the holotype and concluded that it is conspecific with the taxon known as *E. argenticostana* (Walsingham 1879), so the latter name is treated here as a junior synonym. *Eucosma spiculana* is broadly distributed in western North America. It is sympatric with *E. fulvotegulana* and *E. pecosana* in the southern Great Plains and with *E. fulvotegulana* in southeastern Utah.

*Forewing*. Mean FWL 7.2–9.9 mm; AR: 3.27–3.46. Costa white from base to apex, with distal one-half interrupted by gray/brown marks and/or striae associated with costal strigulae; discal cell with prominent white streak from base nearly to ocellus, flanked on anterior and posterior margins by orange-brown to yellow-brown bands; central field of ocellus pale, with remnants of two or three black dashes.

*Male genitalia*. Uncus weakly to moderately developed; socii short and stout; valva with dorsal margin concave, ventral emargination moderate to somewhat shallow (NR: 0.47–0.56), saccular corner angulate (SA: 104–132°); cucullus with dorsal lobe strongly developed, distal margin weakly convex to nearly straight, ventral lobe weakly to moderately developed, basoventral margin weakly extending in ridgelike manner onto medial surface of neck.

*Female genitalia*. Papillae anales moderately setose and microtrichiate; lamella postvaginalis semirectangular and microtrichiate; sternum 7 with posterolateral margins concavely inflected and lateral extremities strongly produced; ductus bursae with one signum slightly larger than the other.

70. Eucosma spiculana (Zeller, 1875)

(Plate O, 70a–d; Plate 26, 70a–f)

Grapholitha spiculana Zeller 1875:289.

Thiodia spiculana: Fernald 1903:462; Heinrich 1923:57; McDunnough 1939:44.

Eucosma spiculana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:315.

Phaneta spiculana: Powell 1983:33; Brown 2005:496.

Semasia argenticostana Walsingham 1879:61; new synonymy.

Thiodia argenticostana: Fernald 1903:461; Heinrich 1923:57; McDunnough 1939:44.

Eucosma argenticostana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:304.

Phaneta argenticostana: Powell 1983:33; Brown 2005:492; Gilligan et al. 2008:99.

**Types**. *Grapholitha spiculana*. Holotype (Plate O:70a). ♀, Texas, Dallas, Boll, MCZ (abdomen missing). *Semasia argenticostana*. Lectotype (here designated). ♂, to Fort Dalles, Wasco County, Oregon, Walsingham, 15–22 April 1872, BMNH(E) #819941, slide 11582, BMNH.

*Eucosma spiculana* was described from a single female collected by Jacob Boll in the vicinity of Dallas, Texas. The holotype, which lacks an abdomen and right forewing, is indistinghishable from *E. argenticostana*, hence the new synonymy. Walsingham described *E. argenticostana* from a male and two females that he collected in northern Oregon; the lectotype designated here was selected by Obraztsov.

The forewing has orange-brown bands flanking the central white streak, a gray band along the inner margin that continues narrowly along the termen to the apex, and an elongate gray mark on the distal one-third of the costa that is associated with irregularly expressed, semi-longitudinal, pale brown striae. The distal margin is concave, producing a slightly falcate apex, and the fringe is grayish with a variably expressed white line on the termen. This is the largest member of the group (mean FWL = 9.9 mm). Differences between this species and *E. fulvotegulana* (species 71) are discussed in the diagnosis of the latter taxon.

Genitalic characteristics include: ventral emargination of the valva moderate (NR = 0.51), distal margin of the cucullus convex of nearly uniform curvature, and posterior lobes of sternum 7 extending to three-fourths the length of the sterigma and fused with the lateral margins of the lamella postvaginalis.

The USNM has specimens that were reared by J. F. G. Clarke in Whitman County, Washington from *Artemisia dracunculus* L. (wild tarragon) and *Artemisia vulgaris* L. (mugwort). The range of *E. spiculana* extends from the Pacific Coast of the United States east to Manitoba, Michigan, Indiana, and Texas. Adult flight occurs from March (in Arizona and southern California) to mid-June (in Manitoba and Michigan).

#### 71. Eucosma fulvotegulana Wright and Gilligan, new species

(Plate O, 71a–b; Plate 26, 71a–f)

**Diagnosis**. Eucosma fulvotegulana is similar to but somewhat smaller than *E. spiculana* (mean FWL = 8.2 vs. 9.9 mm). It differs from the latter species in the following respects: frons gray rather than white, tegulae orange brown instead of grayish, distal one-third of the forewing costa marked by two triangular brown marks and four associated transverse striae as opposed to one elongate grayish mark and two or three irregularly defined semi-longitudinal striae, and forewing termen with sharply defined thin black line and bright white band extending from tornus to apex vs. irregularly expressed, whitish band with grayish suffusion. Genitalic differences between *E. fulvotegulana* and *E. spiculana* include: medial two-thirds of distal margin of cucullus straight instead of evenly convex, lamella postvaginalis tapering posteriorly rather than uniform in width, posterior margin of sternum 7 invaginated to full length vs. three-fourths length of sterigma, and lateral margins of lamella postvaginalis connected to posterior lobes of sternum 7 by large triangular sections of sclerotized membrane vs. narrow sclerotized bands.

**Description**. *Head*. Frons gray; vertex gray to gray brown; labial palpus with first segment white, medial surface and ventral margin of second segment white, lateral surface of second segment grayish, third segment grayish; antenna with dorsal surface grayish, ventral surface white. Thorax. Dorsal surface gray; tegula orange brown; fore- and mid-legs with anterior surfaces pale brown, posterior surfaces whitish; hind-legs more uniformly whitish; tarsi with whitish annulations. Forewing: ♂ FWL 6.1–9.2 mm (mean = 8.1, n = 27), AR = 3.32;  $\Im$  FWL 6.4–10.5 mm (mean = 8.2, n = 10), AR = 3.36; male without costal fold; costa nearly straight; apex acute; termen weakly concave; costa white from base to apex, interrupted on distal one-third by two semi-triangular brown marks and four associated brown striae; white central streak extending from base nearly to ocellus, gradually attenuating distally, variably edged with black, and flanked anteriorly and posteriorly by orange-brown bands; inner margin with broad grayish band from base to tornus; ocellus surrounded by grayish scaling and bordered proximally and distally by lustrous pearl bars; central field of ocellus marked by two fragmented black dashes; termen with thin black line from tornus to apex followed distally by bright white band; outer fringe grayish. Hindwing: Pale gray brown. Abdomen. Male genitalia (n = 5): Uncus weakly developed and moderately differentiated from dorsolateral shoulders of tegumen; socii fingerlike, relatively short; phallus stout, tapering gradually toward apex; vesica with 27-40 deciduous cornuti; valva with costal margin concave, ventral emargination U-shaped, NR = 0.47, SA =  $104^{\circ}$ ; cucullus with dorsal lobe strongly produced, apex convex and somewhat flattened, distal margin with medial two-thirds nearly straight, anal angle moderately produced, medial surface densely setose. Female genitalia (n = 3): Papillae anales moderately setose and densely microtrichiate, margins of anal opening facing ventrally; tergum 8 with band of medium length setae along posterior margin; apophyses anteriores slightly shorter than apophyses posteriores; lamella postvaginalis microtrichiate and tapering posteriorly (length of posterior margin about 2/3 ostium diameter), with lateral margins connected to sternum 7 by large triangular patches of sclerotized membrane; sternum 7 with posterior margin invaginated to full length of sterigma, posterolateral margins concavely inflected, lateral extremities lobelike and well developed; scaling of sternum 7 moderately dense on posterior and lateral lobes, sparse elsewhere; ductus bursae encircled and contorted by sclerotized band at juncture with ductus seminalis; corpus bursae with signa nearly equal in size.

**Holotype** (Plate O:71a). *A*, Texas, Cottle County, Paducah, A. and M. E. Blanchard, 17 April 1968, slide 141827, USNM.

**Paratypes**. COLORADO. Weld County, 2 mi SSE of Roggen, P. A. Opler, 5 June 1993,  $(1 \[3])$ , USNM;  $(1 \[2])$ , AMNH. OKLAHOMA. Oklahoma City, D. R. Davis, 22 May 1953  $(1 \[3])$ , slide 70068), USNM. TEXAS. Same data as holotype  $(13 \[3])$ , slides 90355, DJW 3364; 3  $\[2]$ , slides 90354, 141826), USNM; Randall County, Palo Duro Canyon State Park, A. and M. E. Blanchard, 15 April 1969  $(2 \[3])$ , slide DJW 3365; 2  $\[2]$ , slide DJW 3366), USNM; Hemphill County, Canadien, A. and M. E. Blanchard, 14 April 1969  $(1 \[3])$ , USNM; Montgomery County, Conroe, A. and M. E. Blanchard, 28 April 1968  $(1 \[3])$ , slide 90356), USNM; Ward County, Monahans Sand Hills State Park, Rozen and Schrammel, 16 April 1961, AMNH. UTAH. Emery County, Goblin Valley Dunes, Goblin Valley Road, 3.4 mi W jct. Hwy 24, 18 May 2008, P. A. Opler  $(7 \[3])$ , CSU, TMG.

**Etymology**. The specific epithet refers to the orange-brown color of the tegulae, a character state that distinguishes this species from *E. spiculana*.

**Discussion**. *Eucosma fulvotegulana*, *E. spiculana*, and *E. goblinana* have all been collected in May at Goblin Valley in Emery County, Utah, and *E. fulvotegulana* has been collected with *E. spiculana* in April in Cottle County, Texas.

#### 72. Eucosma pecosana Wright and Gilligan, new species

(Plate O, 72a–c; Plate 27, 72a–g)

**Diagnosis**. *Eucosma pecosana* is similar to but slightly smaller than *E. goblinana* (species 73) (mean FWL = 7.2 vs. 8.6 mm). In comparison to the latter species, the forewing is orange brown rather than yellow brown, it does not have brownish-gray suffusion around the ocellus and along the inner margin, and the costal striae are paler and fewer in number. The available data indicate that the geographical distributions of the two species are separated by the Rocky Mountains: *E. goblinana* is known only from Emery County, Utah; *E. pecosana* from eastern Colorado, Oklahoma, Texas, and eastern New Mexico. We found no genitalic characters that reliably separate males of the two species. In females, the posterolateral corners of the lamella postvaginalis appear to be more strongly flared in *E. pecosana*.

**Description**. *Head*. White. *Thorax*. Dorsal surface white; tegula pale orange brown; legs whitish with anterior surfaces of fore- and mid-legs pale brown; tarsi with pale brown annulations. Forewing:  $\eth$  FWL 6.9–7.9 mm (mean = 7.3, n = 7), AR = 3.28;  $\bigcirc$  FWL 6.6–7.3 mm (mean = 7.0, n = 2), AR = 3.23; male without costal fold; costa nearly straight; apex acute; termen weakly convex; dorsal surface mostly orange brown, with narrow white streaks on costal and inner margins and a prominent white streak in cell from base to ocellus; distal one-half of costa with four thin striae associated with vaguely defined costal strigulae; ocellus bordered proximally and distally by pale lustrous gray bars; central field of ocellus with two fragmented blackish dashes; fringe scales near tornus uniformly white, otherwise white with gray-

brown cross-marks. Hindwing: Gray brown. *Abdomen*. Male genitalia (n = 4): Uncus well developed, distally rounded, and clearly differentiated from dorsolateral shoulders of tegumen; socii fingerlike, relatively short; phallus stout, tapering gradually toward apex; vesica with 14–24 deciduous cornuti; valva with costal margin concave, ventral emargination broad and shallow, NR = 0.56, SA = 131°; cucullus with dorsal lobe strongly produced, apex rounded, distal margin weakly convex, anal angle weakly produced, medial surface densely setose. Female genitalia (n = 2): Papillae anales moderately setose and densely microtrichiate, margins of anal opening facing ventrally; tergum 8 with mixture of setae and scales on ventrolateral projections; lamella postvaginalis rectangular and microtrichiate, with posterolateral corners flared; sternum 7 with posterior margin invaginated to full length of sterigma and approximate to but not fused with lateral margins of lamella postvaginalis; scaling of sternum 7 dense on posterior projections and lateral extremities, relatively sparse elsewhere; ductus bursae with sclerotized band at juncture with ductus seminalis; corpus bursae with signa of unequal size.

**Holotype** (Plate O:72a; Plate 27:72a, b).  $\mathcal{O}$ , New Mexico, Chaves County, Mescalero Dunes east of Roswell, G. J. Balogh, 22 September 2003, slide 144983, USNM.

**Paratypes.** COLORADO. El Paso County, Colorado Springs, 7 July 1935 (1  $\Diamond$ ), 12 July 1933 (1  $\Diamond$ ), AMNH. NEW MEXICO. Otero County, White Sands National Monument, 32.7782° N, 106.1897° W, E. H. Metzler, 10 August 2010, (1  $\bigcirc$ , slide DJW 3300), 25 August 2009 (1  $\bigcirc$ , slide DJW 2542), MSU; 32.7600° N, 106.1915° W, E. H. Metzler, 25 August 2009 (1  $\Diamond$ , slide DJW 2538), MSU. OKLAHOMA. Oklahoma City, D. R. Davis, 22 May 1955 (1  $\Diamond$ , slide 137245), USNM. TEXAS. Cottle County, Matador Wildlife Management Area, E. C. Knudson, 8 May 1981, (2  $\Diamond$ , slide 137244), USNM.

**Etymology**. The specific epithet refers to the Pecos River, which drains much of southeastern New Mexico.

73. Eucosma goblinana (Wright, 2010)

(Plate O, 73a–c; Plate 27, 73a–g)

*Phaneta goblinana* Wright 2010:124. *Eucosma goblinana*: Gilligan and Wright 2013b:308.

**Holotype** (Plate 27:73c).  $\mathcal{J}$ , Utah, Emery County, Route 24 and Goblin Valley Road, 5,010 feet, J. S. Nordin, 11 May 2001, slide 142988, USNM.

This species is similar to but slightly larger than *E. pecosana* (species 72) (mean FWL = 8.6 vs. 7.2 mm). Differences in forewing appearance include: color yellow brown rather than orange brown, inner margin and area surrounding ocellus suffused with gray instead of orange brown, and costal striae darker and more numerous. We found no substantial genitalia differences between the two species.

*Eucosma goblinana* is known only from the vicinity of Goblin Valley State Park in Emery County, Utah, where the desertlike habitat features very sparsely vegetated dunes. Adults have been collected only in May.

# The *corculana* group (species 74–77)

The grouping of the next four species is based on similarity of male genitalia and, to a lesser extent, forewing maculation. Females exhibit two distinct forms of sterigma-sternum 7 structure, giving rise to the two subgroups defined below. These species were reviewed by Wright (2010). Common characters include:

*Forewing.* Mean FWL: 7.3–9.3 mm; AR = 3.13–3.43; dorsal surface pale yellow to reddish brown; median fascia complete but weakly contrasting with interfascial areas (absent in *E. arenana*); subbasal fascia sometimes discernable as outwardly oblique shade from inner margin to cubitus; proximal one-half of wing with variably expressed thin longitudinal streaking; ocellus conspicuous; costal strigulae well defined from median fascia to apex.

*Male genitalia*. Uncus moderately developed with rounded apex; dorsolateral shoulders of tegumen hunched; valva with dorsal margin concave, ventral emargination deep, saccular corner angulate, SA obtuse; cucullus with dorsal and ventral lobes strongly developed, distal margin convex, occasionally with concave inflection near anal angle, basoventral margin overlapping medial surface of neck; anal angle acute to broadly rounded.

*Female genitalia*. Papillae anales moderately setose and very finely microtrichiate; sterigma ovate to elongate; lamella postvaginalis microtrichiate, with lateral margins fused with posterior lobes of sternum 7; lamella antevaginalis absent to ringlike; sternum 7 with strongly-developed triangular lateral extremities; ductus bursae with sclerotized ring posterior to juncture with ductus seminalis; corpus bursae with signa nearly equal in size.

The *corculana-arenana* subgroup (species 74–75). These two species are distinguished from the other members of the *corculana* group by the following characteristics of the female genitalia:

*Female genitalia*. Sterigma ovate; lamella antevaginalis absent; anterior and lateral margins of ostium fused with sternum 7; lamella postvaginalis weakly developed; exterior surface of sternum 7 with outwardly projecting bulges on posterior lobes.

#### 74. Eucosma corculana (Zeller, 1874)

(Plate P, 74a–e; Plate 28, 74a–g)

Semasia corculana Zeller 1874:433; Walsingham 1884:141. Thiodia corculana: Fernald 1903:461; Heinrich 1923:41; McDunnough 1939:44. Eucosma corculana: Barnes and McDunnough 1917:171; Gilligan and Wright 2013b:307. Phaneta corculana: Powell 1983:33; Brown 2005:493; Wright 2010:118.

**Holotype**. Q, [British Columbia], Vancouver, Mathis, 74, BMNH(E) #819939, slide 11547, BMNH.

*Eucosma corculana* was described from a single female collected on Vancouver Island, British Columbia. The holotype has reddish-brown forewings (as in Plate P:74a), but specimens currently recognized as this species based on similarity of genitalia exhibit considerable variation in forewing color. Individuals from the Northwest are often brown (Plate P:74c–d). The specimen in Plate P:74e shows a particularly dark phenotype collected on Mount Evans in Clear Creek County, Colorado at an elevation of 12,800 feet. Most specimens have some subcostal red-brown or orange-brown tinting near the apex.

The cucullus is roughly symmetric about its horizontal center line, but the apex is semicircular, and the anal angle is triangular. In some specimens (Plate 28:74e) the distal margin of the cucullus is weakly inflected near the anal angle. The posterior margin of sternum 7 is invaginated to the full length of the sterigma and is fused with the anterior edge of the ostium and the lateral margins of the lamella postvaginalis. This sterigma-sternum 7 arrangement differs from that of typical *Eucosma* in that there is no lamella antevaginalis separating the two structures. *Eucosma arenana* (species 75) is the only other Nearctic *Eucosma* with this irregularity. We placed both in *Eucosma* because, in all other respects, these species are typical of that genus.

*Eucosma corculana* ranges from Saskatchewan to British Columbia, south to Colorado, Utah, and central California. We examined one male in the USNM from Newfoundland that may be this species based on similarity of genitalia. Adults fly from early April (Washington and California) to late August, with most collections in July and August.

# 75. Eucosma arenana (Wright, 2010)

(Plate P, 75a–b; Plate 28, 75a–e)

*Phaneta arenana* Wright 2010:120. *Eucosma arenana*: Gilligan and Wright 2013b:304.

**Holotype** (Plate P:75a; Plate 28:75a).  $\mathcal{J}$ , Utah, Emery County, Goblin Valley Road, 5,010 feet, J. S. Nordin, 9 May 2007, slide 137267, USNM.

This is the largest species in the group (mean FWL = 9.3 vs. 7.3-7.5 mm). It also has the most distinctive forewing appearance (uniformly pale brownish yellow with no markings except the short dark costal dashes associated with the strigulae). It is known only from the sandy desertlike region near Goblin Valley State Park in Emery County, Utah, where it flies in May.

The male genitalia are similar to those of *E. corculana*, but the valval neck is slightly narrower, and the anal angle is slightly falcate. The female genitalia of the two species are essentially indistinguishable, but the surface of sternum 7 seems to be a little more strongly sculptured in *E. arenana*.

The *mormonensis-browni* subgroup (species 76–77). Subgroup characteristics include:

*Male genitalia*. Valval neck evenly tapering from saccular corner to cucullus; distal end of neck narrow; cucullus with ventral lobe distinctly broader than dorsal lobe.

*Female genitalia*. Lamella postvaginalis elongate and rectangular, with lateral margins fused with posterior lobes of sternum 7; lamella antevaginalis present and ringlike.

#### 76. Eucosma mormonensis (Heinrich, 1923)

(Plate P, 76a–d; Plate 29, 76a–g)

*Thiodia mormonensis* Heinrich 1923:44; McDunnough 1939:44. *Phaneta mormonensis*: Powell 1983:33; Brown 2005:494; Wright 2010:119. *Eucosma mormonensis*: Gilligan and Wright 2013b:311.

**Holotype**.  $\mathcal{E}$ , Utah, Salt Lake City, C. N. Ainslie, slide 72772, USNM.

This species was described from six specimens (5 3, 1 2) collected in Utah and Colorado. Heinrich (1923) singled out the "type" by illustrating its genitalia, hence the interpretation of the above specimen as a holotype.

*Eucosma mormonensis* resembles *E. corculana* in size (both with mean FWL = 7.5 mm) and maculation, but the forewing is yellow brown to olive brown and lacks any of the red/orange tints in the latter species. Brown specimens of the two taxa (Plate P:76d, 74c–d) require dissection for positive determination.

Males are separated from other members of the group by cucullus shape, with the ventral lobe about twice as wide as the dorsal lobe and the anal angle broadly rounded; females are substantially identical in genitalia to *E. browni* (species 76).

We examined specimens from Arizona, California, Colorado, Idaho, Montana, New Mexico, and Utah. Capture dates range from mid-May to early September.

#### 77. Eucosma browni (Wright, 2010)

(Plate P, 77a–d; Plate 29, 77a–e)

*Phaneta browni* Wright 2010:119. *Eucosma browni*: Gilligan and Wright 2013b:305.

**Holotype**. ♂, Colorado, Chaffee County, 4 mi N of Buena Vista, County Road 375, 8,800 feet, 38.90° N, 106.13° W, D. J. Wright, 15 August 1999, USNM.

*Eucosma browni* is similar to *E. mormonensis* in size (mean FWL = 7.3 vs. 7.5 mm), but the forewing is slightly more elongate (AR = 3.43 vs. 3.15). Both species have brown forewings, but most specimens of *E. browni* lack the yellowish tints frequently seen in *E. mormonensis*. The proximal one-half of the forewing is usually more strongly streaked than in other members of the group.

The valva of *E. browni* differs from that of *E. mormonensis* in the following respects: basoventral margin of cucullus nearly straight (vs. distinctly convex), ventral lobe of cucullus semitriangular (vs. semicircular), vertex of anal angle with two moderately robust spiniform setae (vs. no spiniform setae). The female genitalia of the two species are essentially indistinguishable.

The range of *E. browni* includes Arizona, Colorado, New Mexico, Utah, and Wyoming. Adults fly mostly in August and September at elevations between 6,000 and 9,000 feet and appear to prefer sagebrush (*Artemisia* L.) habitat.

# The *tarandana* group (species 78–81)

More than eighty years have elapsed since the last of the four members of this group was described. During that time numerous specimens associated with these taxa have accumulated in North American collections, but uncertainty remains as to how many species they represent. Heinrich (1923) recognized these taxonomic difficulties, but his analysis of forewing maculation and male genitalia failed to resolve the material at his disposal into well-diagnosed taxa. Jaeger et al. (2013), utilizing two genes (one mitochondrial and one nuclear) as well as morphological characters, found support for the contention that the species historically recognized as *E. montanana* is distinct from that which generally has been interpreted as *E. tarandana*. That study was based on populations in Alberta, British Columbia, and Saskatchewan.

Moths referable to this group are found (often in abundance) from the Pacific Coast to the Great Plains and eastward through the Great Lakes region. The group's namesake, *E. tarandana*, was described from Labrador. These moths exhibit considerable variation in forewing color and maculation, with numerous instances of intergradation between the most distinctive phenotypes. Moreover, the male genitalia are quite uniform and of little help in distinguishing between the putative species. The female genitalia have never been analyzed for taxonomically useful characters, probably because females are poorly represented in collections. We examined the available female material and found that sterigma shape appears to distinguish *E. transversa* from the other members of the group (SR = 2.41 vs. 1.40-1.55, respectively). Our treatment utilizes this distinction to separate *E. transversa* from *E. tarandana* and relies on various features of forewing color and maculation to distinguish the other species. The results are less than satisfying because there are many intermediate specimens that cannot be positively assigned to species based on the criteria discussed here. Nevertheless, the images illustrate the scope of the problems presented by this group and perhaps will motivate some future researcher to take up the challenge of resolving them.

*Forewing*. Mean FWL: 10.3–11.8 mm; AR = 3.14–3.39; forewing color variable, with whitish, grayish, yellowish, or orange-brown interfascial areas and brown to black fasciate markings; subbasal fascia chevron-shaped, usually interrupted on the radial vein, often indiscernible between radius and costa; median fascia complete but sometimes faintly expressed; ocellus concolorous with interfascial areas; costal strigulae concolorous with interfascial areas and usually conspicuous from median fascia to apex; termen with whitish line from tornus to apex (nearly obsolete in *E. benjamini*).

*Male genitalia*. Uncus weakly developed but clearly differentiated from dorsolateral shoulders of tegumen; valva with dorsal margin concave, ventral emargination moderate (NR: 0.46–0.57), saccular corner angulate, SA: 109–115°; cucullus with dorsal lobe strongly developed, distal margin weakly convex, ventral lobe moderately to strongly developed, anal angle somewhat narrowly rounded.

*Female genitalia*. Papillae anales moderately setose and microtrichiate; lamella postvaginalis rectangular and microtrichiate, with lateral margins fused with posterior lobes of sternum 7; sternum 7 with posterolateral margins weakly concave to straight, lateral extremities well developed, scaling dense on posterior lobes and lateral extremities; ductus bursae with sclerotized ring at juncture with ductus seminalis; corpus bursae with one signum slightly larger than the other.

#### 78. Eucosma tarandana (Möschler, 1874)

(Plate Q, 78a-i; Plate 30, 78a-e)

Phaneta tarandana: Powell 1983:33; Brown 2005:496.

**Types**. *Grapholitha tarandana*. Three  $\Diamond$  syntypes, Labrador, presumed lost. *Thiodia triangulana*. Lectotype (designated by Klots 1942; Plate Q:78g).  $\Diamond$ , Saskatchewan, Regina, 18 July 1904, AMNH.

Möschler (1874) described this species from Labrador, the mainland portion of the Canadian province of Newfoundland and Labrador. He mentioned three male syntypes but reported nothing more specific in the way of collection data. The type specimens appear to be lost or destroyed (Brown 2005). We enquired at the BMNH and the Museum für Naturkunde, Leibniz Institute for Research on Evolution and Biodiversity, Berlin, the latter being the depository for many of Möschler's types, but didn't succeed in locating these specimens. Heinrich (1923) reported a specimen from Labrador in the Fernald Collection (now in the USNM) that he thought likely to be the "type" (Plate Q:78a). It bears a determination label believed by Heinrich to have been written by Möschler, but it does not have the square green "type" label that is characteristic of Möschler's types. The USNM has another specimen from Labrador (Plate Q:78b) that is determined as *E. tarandana* and is labelled "Hamfelt Collection." It was captured in 1899 and, therefore, cannot be a syntype. Plate Q:78c shows one of two specimens in the USNM from Aweme, Manitoba that Heinrich determined as *E. tarandana*.

Grapholitha tarandana Möschler 1874:165.

Semasia tarandana: Fernald 1882a:43; Walsingham 1895:515.

Thiodia tarandana: Fernald 1903:461; Heinrich 1923:52; McDunnough 1939:44.

Eucosma tarandana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:315.

*Thiodia triangulana* Kearfott 1905a:47; Heinrich 1923:65; McDunnough 1939:45; Powell 1983:33; Brown 2005:494; new synonymy. *Eucosma triangulana*: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:311.

Kearfott (1905a) described *T. triangulana* from four male syntypes, two from Regina, Saskatchewan, dated 18 July (in the AMNH) and 20 July (depository unknown), and two from Aweme, Manitoba, dated 29 June [1904] and 31 September [1904] (both in the USNM). Klots (1942) pointed out that the "type" referred to by Heinrich (1923) is not a syntype (being from Beulah, Manitoba), and therefore designated the specimen in the AMNH from Regina as the lectotype. This name has been treated as a synonym of *E. montanana* since Heinrich (1923). One of the Aweme syntypes is referable to *E. montanana*, but the lectotype and the other Aweme specimen more closely resemble *E. tarandana* in forewing appearance, so we have transferred *T. triangulana* to the synonymy of *E. tarandana*.

Among the specimens we are referring to *E. tarandana* is a male-female pair (Plate Q:78d–e) collected by C. Harp on 6–7 August 2010 in Chaffee County, Colorado. We rely on this pair to associate the sexes of this species. The female differs from those we interpret as *E. transversa* in the shape of the sterigma (SR = 1.55 vs. 2.4, respectively). Specimens figured in Plate Q:78h–i show an associated male-female pair representing a population discovered by G. Balogh on the shore of Lake Superior in Keweenaw County, Michigan (near the west end of the Upper Peninsula). Aside from the black and white coloration, they agree in forewing pattern and genitalia with the pair from Chaffee County, Colorado. The specimen in Plate Q:78f, though presented here as *E. tarandana*, is typical of many pale specimens for which we have no associated females and, therefore, no current basis for determination to species.

Of more than 200 *tarandana*-like specimens examined, we determined 15 males and 10 females from Labrador, Manitoba, Colorado, Michigan, and Wyoming as *E. tarandana*. Jaeger et al. (2013) reported *E. tarandana* from Alberta, British Columbia, and Saskatchewan. Adults fly from June through August.

#### 79. Eucosma transversa (Walsingham, 1895)

(Plate Q, 79a–f; Plate 30, 79a–e)

Semasia transversa Walsingham 1895:514.

Thiodia transversa: Fernald 1903:463; Heinrich 1923:51; McDunnough 1939:44.

Eucosma transversa: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b: 315.

Phaneta transversa: Powell 1983:33; Brown 2005:496.

**Lectotype** (here designated; Plate Q:79a). ♂, Colorado, [Larimer County], Loveland, Smith, September 1891, BMNH(E) #819896, slide 11595, BMNH.

*Eucosma transversa* was described from a male and a female collected in September and July, respectively, of 1891 in Loveland, Colorado. Obraztsov chose the male as lectotype. He dissected the female, and his photograph of the genitalia indicates that sternum 7 was damaged during preparation, but the sterigma is intact, with an approximate SR value of 2.11. This value associates this specimen with a number of other female specimens in this group that have an elongate sterigma (mean SR = 2.41), and it is this character that we use to separate *E. transversa* from the other members of the group.

The lectotype, figured in Plate Q:79a, agrees in forewing appearance with Obraztsov's photograph of the female paralectotype. The specimen in Plate Q:79c is a female in the USNM from Whitman County, Washington with an SR value of 1.90. It was reared by J. F. G. Clark on *Senecio serra* Hook. (tall ragwort), a plant whose range includes the region from Colorado to California north to the Canadian border. This specimen (assuming it is correctly identified) provides the only record of a larval host for *E. transversa*. The other figured specimens (Plate Q:79b, d–f) are males that were selected based on similarity of forewing pattern with the lectotype.

We examined thirty specimens from British Columbia, California, Colorado, Oregon, and Washington that we tentatively refer to *E. transversa*. The capture dates range from early June to September.
#### 80. Eucosma montanana (Walsingham, 1884)

(Plate R, 80a–i; Plate 31, 80a–e)

Semasia montanana Walsingham 1884:143.

Thiodia montanana: Fernald 1903:463; Heinrich 1923:65; McDunnough 1939:45.

Eucosma montanana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b: 311.

Phaneta montanana: Powell 1983:33; Brown 2005:494; Gilligan et al. 2008:100.

Phaneta clarkei Blanchard and Knudson 1983b:847; Brown 2005:492; new synonymy.

Eucosma clarkei: Gilligan and Wright 2013b: 306.

**Types**. Semasia montanana. Holotype (Plate R:80a). *(*), Montana, Yellowstone R[iver], Morrison, 1880, BMNH(E) #819878, slide 5741, BMNH. *Phaneta clarkei*. Holotype (Plate R:80f). *(*), Texas, Hemphill County, Canadian National Grassland, Lake Marvin, E. Knudson, 9 October 1982, USNM.

Walsingham (1884) described *S. montanana* from a single male from Montana. Blanchard and Knudson based *P. clarkei* on a series of 12 specimens from the Texas panhandle. We are unable to separate the two species based on forewing appearance or genitalia, hence the new synonymy.

Typical *E. montanana* (Plate R:80a–b) has a straw yellow forewing with weakly expressed fasciate markings and thin olive-brown to blackish-brown longitudinal streaking that accentuates the veins. The range of color variation is illustrated in Plate R:80c–d, which depict specimens from a population in Oceana County, Michigan on the eastern shore of Lake Michigan. Usually the longitudinal streaking is pronounced, but the USNM has several pale specimens from Kittitas County, Washington (e.g., Plate R:80e) in which the markings and streaks are barely discernable. The specimens in Plate R:80f–g are the holotype and a paratype, respectively, of *E. clarkei*, and Plate R:80h is a paralectotype of *E. triangulana* (a name treated above as a synonym of *E. tarandana* based on the forewing appearance of the lectotype) that we believe is referable to *E. montanana*. Plate R:80i is a reddish-brown specimen from Mojave County, Arizona that has forewing similarities with both *E. montanana* and *E. benjamini*. We consider its identity to be uncertain but have tentatively referred it to *E. montanana*.

The genitalia of *E. montanana* are similar to those of *E. tarandana*. Females of the two species have SR values of 1.40 and 1.55, respectively.

Artemisia dracunculus L. (wild tarragon) was reported as a larval host by Heinrich (1923) based on specimens reared from root-boring larvae collected by L. P. Rockwood in Washington County, Oregon. The pale individuals mentioned above from Kittitas County, Washington were reared by J. F. G. Clarke, also on *A. dracunculus* L. We examined specimens from Manitoba, Colorado, Illinois, Michigan, Montana, North Dakota, South Dakota, Texas, and Washington that we consider to be *E. montanana*. We also examined numerous specimens that seem to be intermediate between *E. montanana* and *E. tarandanal transversa* (based on forewing appearance) and a few specimens from Arizona and Utah that have the streaked forewing of *E. montanana* and the coloration of *E. benjamini*. Adults have been collected from May to October, but most records are from August and September. There appear to be two broods in Texas: May through June, and October.

# **81.** *Eucosma benjamini* (Heinrich, 1923)

(Plate R, 81a–f; Plate 31, 81a–g)

*Thiodia benjamini* Heinrich 1923:66; McDunnough 1939:45. *Phaneta benjamini*: Powell 1983:34; Brown 2005:492. *Eucosma benjamini*: Gilligan and Wright 2013b:305. Holotype (Plate R:81a; Plate 31:81b). *(*, Utah, [Utah County], Vineyard, T. Spalding, 12 September 1912, slide 72763, USNM.

*Eucosma benjamini* is a denizen of the desert southwest. It was described from Utah, but most museum specimens are from southern California. It is distinguished from the other members of the group by its orange-brown forewing color and weakly expressed (often barely discernible) fasciate markings. We have seen a few specimens from Utah and Arizona (e.g., Plate R:80i) in which the combination of color and streaking is intermediate between typical *E. benjamini* and *E. montanana*, rendering determination to species problematic. The genitalia of *E. benjamini* resemble those of *E. montanana*. Females have an SR value of 1.50.

We examined specimens from Kern, Los Angeles, San Bernardino, San Diego, San Luis Obispo, and Ventura counties, California; Utah County, Utah; and Lander County, Nevada. Adults fly from August to early November.

# The *elongana* group (species 82–85)

This group consists of four medium-sized species from western North America with strong similarities in male genitalia. Species boundaries for two of the taxa, *E. rupestrana* and *E. umbraticana*, are largely conjectural at this point due to a scarcity of material and what appears to be considerable intraspecific variation.

*Forewing.* Mean FWL: 9.7–12.6, AR: 3.28–3.41; dorsal surface gray to brown; fasciate markings dark brown to orange brown; subbasal fascia weakly expressed, often reduced to oblique shade from inner margin to cell; median fascia complete but often weakly expressed (nearly indiscernible in *E. offectalis*); costal strigulae from median fascia to apex weakly to strongly expressed; terminal strigulae sometimes present (particularly in *E. offectalis*); ocellus well-defined to diffuse.

*Male genitalia*. Uncus moderately developed, distal margin usually with shallow medial indentation; dorsolateral shoulders of tegumen slightly hunched; valva with costal margin weakly concave to weakly sinuous, ventral emargination moderate to shallow, saccular corner angulate (except in *E. offectalis*), SA obtuse; cucullus with dorsal lobe strongly developed and somewhat narrowly rounded, distal margin straight to weakly convex, ventral lobe moderately to strongly developed, anal angle rounded, basoventral margin extensively overlapping medial surface of neck.

*Female genitalia*. Papillae anales moderately setose and microtrichiate; lamella postvaginalis semirectangular to tapering posteriorly, with lateral margins fused to posterior lobes of sternum 7; ductus bursae with sclerotized patch or ring at juncture with ductus seminalis; signa in corpus bursae unequal in size.

#### 82. Eucosma elongana (Walsingham, 1879)

(Plate S, 82a–f; Plate 32, 82a–g)

Semasia elongana Walsingham 1879:56. Eucosma elongana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:307. Thiodia elongana: Fernald 1903:461; Heinrich 1923:52; McDunnough 1939:44. Phaneta elongana: Powell 1983:33; Brown 2005:493.

**Lectotype** (here designated; Plate S:82a).  $\Diamond$ , Oregon, Wasco County, to Fort Dalles, Walsingham, 15–22 April 1872, BMNH(E) #819888, slide 11580, BMNH.

*Eucosma elongana* was described from two males. The specimen designated here as lectotype was selected and labeled as such by Obraztsov.

This species is sexually dimorphic in size and, to a lesser extent, in forewing appearance. Males are larger than females (mean FWL = 12.5 vs. 10.6 mm) and tend to be grayer, with faintly expressed maculation and especially thin black lines crossing an obscure ocellus; females are brownish, with median fascia and ocellus strongly expressed (Plate S:82a–b, d–e vs. 82c, f). Both sexes have weakly expressed whitish terminal strigulae. The male-female association presented here is based on a pair of specimens (Plate S:82b–c) collected on the same night at Cottonwood Pass in Chaffee County, Colorado. It is supported by a similar pair (Plate S:82e–f) collected at Silverton, Colorado, the male 16–23 July, the female 1–7 August.

Males are similar in genitalia to *E. rupestrana*. In both species the valval neck tapers distally (NR = 0.45), the basoventral margin of the cucullus extends over 70–80% of the neck, and the phallus has a ventral bulge (Plate 32:82e), but the basoventral margin of the cucullus is sinuous in *E. elongana* and straight in *E. rupestrana*. The lamella postvaginalis in *E. elongana* is rectangular and relatively long (SR = 2.59). In *E. rupestrana* it tapers posteriorly, with SR = 1.46. In both species the posterolateral margins of sternum 7 are essentially straight, but in *E. rupestrana* the lateral extremities of that sternite are more strongly developed.

We examined specimens from Alberta, British Columbia, Arizona, California, Colorado, Idaho, Nevada, Oregon, Utah, Washington, and Wyoming. Adults fly from mid-April to early August at elevations between 5,000 and 12,200 feet.

### 83. Eucosma rupestrana (McDunnough, 1925)

(Plate S, 83a–g; Plate 32, 83a–e)

*Thiodia rupestrana* McDunnough 1925:17; McDunnough 1939:44. *Phaneta rupestrana*: Powell 1983:33; Miller 1987:45; Brown 2005:495. *Eucosma rupestrana*: Gilligan and Wright 2013b:314. *Thiodia vernalana* McDunnough 1942:67; new synonymy. *Phaneta vernalana*: Powell 1983:33; Brown 2005:497. *Eucosma vernalana*: Gilligan and Wright 2013b:316.

**Types**. *Thiodia rupestrana*. Holotype (Plate S:83a). ♂, Alberta, Nordegg, McDunnough, 19 June 1921, CNC. *Thiodia vernalana*. Holotype (Plate S:83e). ♂, Ontario, S March, McDunnough, 30 May 1941, slide TOR-1081, CNC.

This species appears to be variable in forewing appearance. The extent of that variation is uncertain, but according to McDunnough (1925), it includes the specimens in Plate S:83a (the holotype) and Plate S:83d (a paratype), the latter of which resembles the holotype of *E. vernalana* (Plate S:83e). Finding no substantial genitalia differences between these specimens, we treat *E. vernalana* as a synonym of *E. rupestrana*. We have seen other specimens with this sort of male genitalia that are sufficiently different in forewing appearance to question their conspecificity with *E. rupestrana* (e.g., Plate S:83f and 83g from Jefferson County, Colorado and Lassen County, California, respectively), but none in numbers sufficient to make a meaningful comparison. The resolution of these issues, and with it a more accurate circumscription of *E. rupestrana*, remains to be accomplished.

The genitalia of *E. rupestrana* are similar to those of *E. elongana*. Differences include the shape of the cucullus and the relative length of the sterigma, as discussed under the latter species.

We examined specimens from Alberta, British Columbia, Ontario, Colorado, Michigan, and South Dakota. Capture dates range from 18 May to 4 July.

#### 84. Eucosma umbraticana (Heinrich, 1923)

(Plate S, 84a–b; Plate 33, 84a–b)

*Thiodia umbraticana* Heinrich 1923:70; McDunnough 1939:45. *Phaneta umbraticana*: Powell 1983:34; Brown 2005:496. *Eucosma umbraticana*: Gilligan and Wright 2013b:316.

**Holotype** (Plate S:84a; Plate 33:84a).  $\mathcal{E}$ , Colorado, foothills above Golden, Dyar and Caudell, 13 March 1901, slide 72781, USNM.

Strictly speaking, this species is known only from the holotype (Plate S:84a). That specimen resembles *E. elongana* in forewing appearance, but Heinrich considered its genitalia (Plate 33:84a) to be sufficiently distinctive to warrant a different name. The valva differs from that of *E. elongana* in the following respects: the neck is broader (NR = 0.81 vs. 0.45), the apex of the cucullus is more narrowly rounded, and the basoventral margin of the cucullus is weakly convex, not sinuate. There is a male in the USNM from Platte Canyon, Colorado that is similar to the holotype in forewing appearance (Plate S:84b) and genitalia (Plate 33:84b) and may be conspecific with *E. umbraticana*. The holotype was collected on 13 March; the other specimen has no capture date. The USNM also has two males from Lake and Tuolumne counties, California that agree in forewing appearance with the specimen in Plate S:84b, but in each case the genitalia more closely resemble those of *E. rupestrana*.

#### 85. Eucosma offectalis (Hulst, 1886)

(Plate T, 85a–i; Plate 33, 85a–f)

Crambus offectalis Hulst 1886:166.

Thiodia offectalis: Fernald 1903:463; Heinrich 1923:70; McDunnough 1939:45.

Eucosma offectalis: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:312.

Phaneta offectalis: Powell 1983:34; Brown 2005:495; Powell and Opler 2009:133.

Semasia obliterana Walsingham 1895:513.

Thiodia obliterana: Fernald 1903:463; synonymy by Heinrich 1923:70; McDunnough 1939:45.

Eucosma obliterana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:312.

Phaneta obliterana: Powell 1983:34; Brown 2005:495.

**Types**. *Crambus offectalis*. Holotype. ♀, Colorado, AMNH. *Semasia obliterana*. Lectotype (here designated). ♂, Arizona, Morrison, 35319, 1883, BMNH(E) #819897, slide 11593, BMNH.

Hulst (1886) described *C. offectalis* from a single female collected in Colorado. Brown (2005) reported that specimen as lost, and Heinrich (1923) referred to its location as "unknown." We found it in the AMNH. *Semasia obliterana* was described from an unspecified number of syntypes from Arizona. Notes made by Obraztsov indicate that he selected the lectotype from a group of three specimens  $(2 \Diamond, 1 \heartsuit)$  in the BMNH. The lectotype has been reported previously as a holotype (Brown 2005; Gilligan and Wright 2013b).

This species is quite variable in forewing color. Specimens in Plate T:85c–d show a phenotype common in Colorado and Wyoming that closely resembles that of the holotype. The specimen in Plate T:85a is representative of several specimens collected at Cottonwood Pass, Colorado at an elevation of 11,900 feet that resemble *E. elongana* in forewing appearance but whose genitalia (Plate 33:85d) are more similar to those of *E. offectalis*. The reddish specimen in Plate T:85e is from Great Sand Dunes National Park in Alamosa County, Colorado. Specimens figured in Plate T:85f–h illustrate pale specimens from Cochise

County, Arizona that are similar to *E. obliterana*, and Plate T:85i shows a darker version of that phenotype from Oso Flaco Lake in San Luis Obispo County, California. All of these specimens have conspicuous whitish terminal strigulae.

The male genitalia are similar to those of *E. elongana*, but the neck is considerably broader (NR = 0.71 vs. 0.45), the saccular corner is more broadly rounded, the distal margin of the cucullus is nearly straight, and the basoventral margin of the cucullus lacks the sinuate quality in the latter species. The sterigma is somewhat similar to that of *E. rupestrana*, but the two species differ in the shape of sternum 7 (Plate 33:85e vs. Plate 32:83e).

Heinrich (1923) cited *Artemisia* L. as a larval host without indicating the source of that information. The USNM has a specimen collected in 1901 in Arizona with a label indicating that it was reared from *Artemisia* L. There are two reports of rearings from *Senecio* L.: *S. riddellii* Torr. & A. Gray (Riddell's ragwort) (Sites and Phillips 1989); *S. spartioides* Torr. & A. Gray (broomlike ragwort) (Powell and Opler 2006). We examined specimens from Arizona, California, Colorado, New Mexico, Utah, and Wyoming. The adult capture dates range from 15 February to 3 October.

# The pastigiata group (species 86-87)

The next two species were reviewed by Wright and Gilligan (2010). Their association here is based on similarity of genitalia.

*Forewing*. Dorsal surface pale brown to gray, with a prominent white streak along the termen; fasciate markings weakly expressed to obsolete; ocellus obscure.

*Male genitalia*. Uncus bulgelike to moderately developed; valva with costal margin concave to nearly straight, ventral emargination deep and U-shaped (NR: 0.32, 0.36), saccular corner angulate (SA approximately 90°); cucullus with ventral lobe strongly developed and with a series of moderately robust setae on the distal margin from anal angle to three-fourths distance to apex.

*Female genitalia*. Papillae anales sparsely setose and lacking microtrichia; lamella postvaginalis long, narrow, and rectangular (SR: 3.25, 3.68), with anterior two-thirds of lateral margins fused with posterior lobes of sternum 7; sternum 7 with posterior lobes long and narrow, lateral extremities semitriangular and moderately produced; ductus bursae with sclerotized ring at juncture with ductus seminalis; corpus bursae with one signum slightly larger than the other.

# 86. Eucosma pastigiata (Heinrich, 1929)

(Plate T, 86a–c; Plate 33, 86a–f)

*Thiodia pastigiata* Heinrich 1929:3; McDunnough 1939:45. *Phaneta pastigiata*: Powell 1983:34; Brown 2005:495. *Eucosma pastigiata*: Gilligan and Wright 2013b:313.

Holotype. (7, California, Tulare County, Monachee Meadows, 8,000 feet, 8–14 July, slide 72780, USNM.

*Eucosma pastigiata* was described from a male "type" and 12 paratypes (8  $\Diamond$ , 4  $\bigcirc$ ) from the type locality. Heinrich (1929) singled out the holotype by illustrating its genitalia.

This species has a pale brownish/grayish forewing with diffuse blackish-brown patches in the subbasal and median areas. The only other markings are black dashes along the costa delimiting the costal strigulae and three black dots (sometimes confluent) on the distal margin of the ocellus.

In males the ventral margin of the valval neck is slightly scooped-out. Females have a long and narrow sterigma (SR = 3.25), approximately one-third of which extends beyond the posterior extremities of sternum 7. This feature is shared by no other Nearctic *Eucosma* except *E. hodgesi*.

We examined 24 specimens from Mono, Tulare, and San Bernardino counties in California, Alamosa County, Colorado, and Lander County, Nevada. Adults fly in June and July.

#### 87. *Eucosma hodgesi* (Wright and Gilligan, 2010)

(Plate T, 87a–c; Plate 34, 87a–f)

*Phaneta hodgesi* Wright and Gilligan 2010:107. *Eucosma hodgesi*: Gilligan and Wright 2013b:309.

Holotype (Plate T:87a; Plate 34:87c).  $\Diamond$ , Colorado, Alamosa County, Zapata Ranch, 7,900 feet, R. W. Hodges, 26 June 1982, slide 137206, USNM.

The forewing color is predominantly pale gray, sometimes with a pale orange tint. The orange-brown subbasal mark (conspicuous on the holotype) varies in expression and appears to degrade quickly in flight worn specimens. The specimen in Plate T:87c is representative of five individuals in the CNC and EME from Mono and San Bernardino counties, California. They are slightly larger than *E. hodgesi* (mean FWL = 7.8 vs. 7.1 mm), lack the orange-brown mark on the forewing, and differ subtly in male valva shape (Plate 34:87a–b), but for the time being we refer them to that taxon.

The male genitalia of *E. hodgesi* differ from those of *E. pastigiata* in the following respects: uncus more strongly developed, ventral margin of neck not scooped-out, and cucullus more nearly symmetric about horizontal center line. The female genitalia of the two species are indistinguishable.

We examined specimens from Arizona, California, Colorado, Nevada, and Wyoming. Adult flight occurs from late May to early July.

#### The *stramineana* group (species 88–91)

This group was reviewed by Wright (2010). It consists of *E. stramineana* and *E. parvana*, species that were misidentified in North American collections for nearly a century; *E. grindeliana*, a name now associated with a complex of presumably unresolved species that range across southern United States from North Carolina to Baja California; and *E. clementeana*, a taxon described by Wright (2010). These relatively small species are similar in forewing appearance and genitalia. Confusion with regard to their identities dates to Heinrich (1923, 1929), who misidentified *E. stramineana* and *E. parvana*, illustrating under those names, respectively, the male genitalia of *E. grindeliana* and those of a *Eucosma* species that remains unnamed (Wright 2010). Subsequent mistaken determinations resulted in most grindeliana-like material being referred to *E. stramineana*. Group characteristics include:

*Forewing*. Mean FWL: 5.9–6.3 mm; AR: 2.99–3.49; interfascial areas yellow to white, sometimes suffused with brownish gray; fasciate markings obscure to obsolete (in all but *E. clementeana*); costa marked from base to apex with short blackish dashes associated with the costal strigulae; ocellus concolorous with interfascial areas; termen with a black line and a narrow salt-and-pepper-colored band from tornus to apex.

*Male genitalia*. Uncus weakly developed, sometimes weakly differentiated from dorsolateral shoulders of tegumen; valva with costal margin weakly concave to nearly straight, ventral emargination moderate, saccular corner angulate to broadly rounded; cucullus with dorsal and ventral lobes moderately developed, distal margin weakly convex to nearly straight, anal angle acute.

*Female genitalia*. Papillae anales sparsely setose and microtrichiate; sterigma elongate (SR: 2.25–2.90), with lamella postvaginalis narrowing posteriorly and fused along lateral margins with posterior lobes of sternum 7; sternum 7 with semitriangular, moderately produced, lateral extremities; ductus bursae with sclerotized ring at juncture with ductus seminalis; corpus bursae with signa nearly equal in size.

#### 88. Eucosma stramineana (Walsingham, 1879)

(Plate U, 88a-c; Plate 34, 88a-c)

Semasia stramineana Walsingham 1879:60. Thiodia stramineana: Fernald 1903:462; Heinrich 1923:69; McDunnough 1939:45. Eucosma stramineana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:315. Phaneta stramineana: Powell 1983:34; Brown 2005:496; Wright 2010:129.

**Lectotype** (designated by Wright 2010; Plate U:88a; Plate 34:88a). ♂, Colorado, Denver, Walsingham, July 1872, BMNH(E) #819906, side 11601, BMNH.

Walsingham (1879) described *E. stramineana* from two syntypes  $(1 \ 3, 1 \ 2)$  collected in July of 1872 at Denver, Colorado. The male was chosen as lectotype by Obraztsov and was so designated by Wright (2010). The female, which lacks an abdomen, is not conspecific with the male. It resembles *E. pallidarcis* (species 106) in forewing appearance.

This is a small species (mean FWL = 6.1 mm). The forewing is elongate (AR = 3.43) and pale yellow, with strongly expressed costal dashes from mid-wing to apex. Some specimens (Plate U:88b–c) have an incomplete median fascia represented by dark rectangular marks on the costa and inner margin.

The male genitalia appear to be indistinguishable from those of *E. parvana*, but they serve to separate *E. stramineana* from *E. clementeana* and *E. grindeliana*: anal angle with one or two spiniform seta at the apex as opposed to none, and saccular corner sharply angulate instead of moderately to broadly rounded. The female genitalia of *E. stramineana* and *E. parvana* are unknown; those of *E. clementeana* and *E. grindeliana* are essentially identical.

We examined specimens from Colorado, Oregon, Nevada, Utah, and Wyoming. Adults fly in June and July.

#### 89. Eucosma parvana (Walsingham, 1879)

(Plate U, 89a–c; Plate 34, 89)

Semasia parvana Walsingham 1879:60.

*Thiodia parvana*: Fernald 1903:462; Heinrich 1923:55; Heinrich 1929:6; McDunnough 1939:44. *Eucosma parvana*: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:313.

Phaneta parvana: Powell 1983:33; Brown 2005:495; Wright 2010:134.

**Lectotype** (designated by Wright 2010; Plate U:89a; Plate 34:89a): ♂, Oregon, Grant County, Camp Watson, Walsingham, April 1872, BMNH(E) #819913, slide 11600, BMNH.

Walsingham (1879) described this species from two males that he collected in eastern Oregon in April, 1872. Obraztsov selected the lectotype, and Wright (2010) published the designation. There is a third specimen in the BMNH collected by Walsingham at the type locality and dated March–April 1872. We examined these three specimens along with a series of males in the LACM from Tulare County, California (Plate U:89c) that we refer to this species. All were collected in March or April. The female is unknown.

*Eucosma parvana* is similar in size and forewing appearance to *E. stramineana*, but the interfascial areas are whitish rather than yellowish, with a generous amount of blackish-gray suffusion. The male genitalia of the two species are indistinguishable except that *E. parvana* sometimes has two spiniform setae at the anal angle of the cucullus, a character that is probably not reliable.

#### 90. Eucosma clementeana (Wright, 2010)

(Plate U, 90a–c; Plate 34, 90a–e)

Phaneta clementeana Wright 2010:135. Eucosma clementeana: Gilligan and Wright 2013b:307. Phaneta stramineana: (in part, not Walsingham 1879) Powell and Opler, 2009.

**Holotype** (Plate U:90a).  $\mathcal{J}$ , California, Los Angeles County, San Clemente Island, Wilson Cove, Powell and De Benedictis, 1 October 2002, EME.

This species is known only from southern California. It is similar in size to *E. stramineana* and *E. parvana* (mean FWL = 6.3 vs. 6.1 and 5.9 mm, respectively) but has a slightly broader forewing (AR = 3.00 vs. 3.43 and 3.49, respectively). The forewing is brownish yellow with brown markings, the latter including a bandlike median fascia from mid-costa to inner margin and dark spots on the cubitus and inner margin representing the subbasal fascia.

The male genitalia resemble those of *E. grindeliana*, the saccular corner being broadly rounded and the anal angle lacking spiniform setae. Females of the two species appear to differ slightly in the length of the sterigma, with SR = 2.9 and 2.5 in *E. clementeana* and *E. grindeliana*, respectively.

We examined specimens from Los Angeles, San Diego, San Luis Obispo, and Santa Barbara counties, California. There appear to be two or three generations per year, based on spring, summer, and autumn capture dates. Specimens from San Clemente Island were reared from *Isocoma menziesii* (Hook. & Arn.) G. L. Nesom (Menzies' goldenbush), the larva creating a gall-like shelter causing the twig to curl just below the flower (J. A. Powell, pers. comm.).

#### 91. Eucosma grindeliana (Busck, 1906)

(Plate U, 91a-f; Plate 35, 91a-j)

Cydia grindeliana Busck 1906:211. Thiodia grindeliana: Heinrich 1923:69; McDunnough 1939:45. Phaneta grindeliana: Powell 1983:34; Brown 2005:493; Wright 2010:134. Eucosma grindeliana: Gilligan and Wright 2013b:309. Thiodia stramineana: (not Walsingham 1879) Heinrich 1923:69. Phaneta stramineana: (not Walsingham 1879) Gilligan et al. 2008:100.

Lectotype (designated by Wright 2010).  $\circlearrowleft$ , Texas, [Donley County], Clarendon, W. D. Pierce, 19 September 1905 [immature collected], 28 September 1905 [adult emergence], slide 137422, USNM.

Busck described *E. grindeliana* from an unspecified number of syntypes from the panhandle of Texas that were reared from *Grindelia squarrosa* (Pursh) Dunal (curly-cup gumweed) by W. D. Pierce, an employee of the U.S. Department of Agriculture. We examined nine of these specimens ( $4 \stackrel{?}{\circ}, 5 \stackrel{\circ}{\circ}$ ), one of which is illustrated in Plate U:91a. They have a mean FWL of 8.2 mm.

Over the past century, numerous *grindeliana*-like specimens have accumulated in North American collections, most of which are considerably smaller than the *E. grindeliana* syntypes (mean FWL = 6.1 vs. 8.2 mm). They vary in color, maculation, and genitalia as illustrated in Plate U:91b–f and Plate 35:91a–j and likely represent a complex of sibling species that remains to be resolved into well-diagnosed taxa. We provisionally refer all of them to *E. grindeliana*.

The types of *E. grindeliana* and the specimens we examined from southwestern Kansas (Plate U:91a–c) have blackish-gray to olive-gray scaling on the vertex, the third segment of the labial palpus, the scape, and the dorsal surface of the antenna; specimens from California, Arizona, and Baja California (Plate U:91f) have the head and forewing concolorous. Most specimens have at least some indication of longitudinal streaking on the proximal two-thirds of the forewing, a feature that is particularly exaggerated in some material from Florida (Plate U:91d–e).

We examined specimens from Alabama, Arizona, California, Florida, Kansas, New Mexico, North Carolina, Oklahoma, Texas, and Baja California. Adults have been captured from Feburary to November, the early spring and late fall specimens from southern California, south Texas, and Florida.

Haplopappus Cass. has been reported as a larval host in Arizona and Texas (Brown et al., 1983, under *Phaneta stramineana*) and in California (J. Powell, per. comm.); and Powell and Opler (2009) reported (under *P. stramineana*) the larvae feeding in terminals of *Isocoma menziesii* (Hook. & Arn.) G. L. Nesom (Menzies' goldenbush).

#### The *convergana* group (species 92–93)

*Eucosma convergana* and *E. modernana* are strikingly similar in forewing appearance and genitalia. They are poorly represented in collections; we examined six specimens of *E. convergana* and four of *E. modernana*, all males. Females are unknown.

*Forewing*. Mean FWL = 7.8, 8.1 mm, AR = 3.03, 3.05; dorsal surface with gray-brown interfascial areas and dark brown markings; subbasal and median fasciae complete and bandlike, the former often fading to near obsolescence between mid-cell and costa; preterminal fascia represented by irregularly shaped patch from costa to anterior margin of ocellus; ocellus obscure, concolorous with interfascial areas, and crossed by three black dashes; termen with brown band from tornus to apex followed distally by an obscure pale line.

*Male genitalia*. Uncus moderately developed, with apex rounded; valva with dorsal margin concave, ventral emargination relatively long and shallow, saccular corner angulate, SA obtuse; cucullus with dorsal lobe strongly developed, apex rounded, distal margin convex, ventral lobe semitriangular and moderately developed, anal angle acute, basoventral margin weakly extending onto medial surface of neck.

#### 92. Eucosma convergana (McDunnough, 1925)

(Plate V, 92a–c; Plate 35, 92a–c)

*Thiodia convergana* McDunnough 1925:15; McDunnough 1939:44. *Phaneta convergana*: Powell 1983:33; Miller 1987:45; Brown 2005:493; Gilligan et al. 2008:96. *Eucosma convergana*: Gilligan and Wright 2013b:307.

Holotype (Plate V:92a). *(*), Manitoba, Aweme, N. Criddle, 21 May 1922, CNC.

This species is similar to *E. modernana*, but the interfascial areas are paler and grayer. There appear to be no substantial differences between the two species in male genitalia, and the females are unknown.

We examined specimens from Manitoba, Indiana, and Kentucky. The Indiana specimens came from dune habitat along the south shore of Lake Michigan. McDunnough (1925) mentioned paratypes from Calgary, Alberta and Saskatoon, Saskatchewan, and Miller (1987) reported one record from Michigan. All of these specimens were collected between 5 May and 1 June.

#### 93. Eucosma modernana (McDunnough, 1925)

(Plate V, 93a–b; Plate 35, 93a–c)

*Thiodia modernana* McDunnough 1925:13; McDunnough 1939:44. *Phaneta modernana*: Powell 1983:33; Miller 1987:45; Brown 2005:494. *Eucosma modernana*: Gilligan and Wright 2013b:311.

Holotype (Plate V:93a).  $\mathcal{E}$ , Quebec, Aylmer, J. McDunnough, 27 May 1919, CNC.

*Eucosma modernana* was described from two males collected at the type locality on 27 May 1919 and 3 June 1920. It is similar in nearly all respects to *E. convergana* but has a darker overall appearance, with slightly broader subbasal and median fasciae and a conspicuous brown postmedian stria from the costa to the ocellus. Besides the two types, we examined two males in the USNM from the Fernald Collection, one without data, the other labeled Amherst, Massachusetts (Plate V:93b). The specimens with data were collected between 5 May and 3 June.

#### The *parmatana* group (species 94–98)

The species known today as *E. parmatana* has a complicated taxonomic history. Described by Clemens in 1860, it was not assigned to a eucosmine genus (*Phaneta*) until Miller (1973) reviewed the Clemens olethreutine types and, where necessary, designated lectotypes. In the intervening period, seven names were proposed for various *parmatana*-like phenotypes that were presumed to be distinct species based mostly on subtle differences in the size of a white interfascial spot on the inner margin of the forewing. The application of these names was inconsistent due to considerable variation in forewing appearance and a lack of diagnostic genitalic characters. Miller (1983), citing intergradation of the character states previous authors had relied on to separate the putative species, treated five of the names as synonyms of *parmatana*, thus recognizing only *E. parmatana*, *E. marmontana*, and *E. oregonensis* as valid species. This arrangement has persisted to the present day, the only recent taxonomic change being the transfer of those taxa from *Phaneta* to *Eucosma* by Gilligan and Wright (2013b).

We made a cursory examination of more than 200 *parmatana*-like specimens, including the primary types of all the described taxa in this group except the two Clemens species (*E. parmatana* and *E. crispana*), which were illustrated by Miller (1973). Approximately fifty genitalia preparations revealed a moderate amount of variation in valva and sterigma shape. We did not find any genitalia characters that reliably subdivide the group into well-defined species. Forewing color varies from gray to brown and often includes bright brownish tints near the apex and/or termen. The white spot on the inner margin of the forewing varies from absent to rather large, in the latter case nearly confluent at times with the ocellus. Only two of the forewing phenotypes seem to be stable, those associated with the names *crispana* and *perfuscana*, in which cases the white interfascial spot is entirely absent. These last two names may in fact apply to valid species, but we hesitate to change their status without a thorough study of the complex, preferably with some supporting molecular or biological evidence. We found no compelling reason to retain *E. marmontana* as a distinct species and therefore relegate it to the synonymy of *E. parmatana. Eucosma* 

*oregonensis* has been interpreted historically as a western relative of *E. parmatana*, and we treat it as such. However, the genitalic features cited by previous authors as distinguishing the two species are subtle and possibly not reliable, and no clear understanding of the two geographic ranges has been established.

In addition to the aforementioned complex, we include *E. ochroterminana*, *E. tomonana*, and *E. raracana* in the *parmatana* group by virtue of their similarity in genitalia with *E. parmatana*. These three species are identified readily by forewing appearance.

*Forewing (E. parmatana* and *E. oregonensis)*. Mean FWL: 6.0, 8.5 mm; AR: 2.75, 2.85. dorsal surface with gray-brown interfascial areas, weakly expressed blackish-brown subbasal and median fasciae, and a variably expressed white interfascial spot on the the inner margin; ocellus conspicuous, with central field crossed by two or three black dashes; costal strigulae well-defined, often white, but sometimes concolorous with grayish interfascial areas.

*Male genitalia*. Uncus moderately developed, with apex usually rounded; valva with costal margin concave, ventral emargination deep to moderate and U-shaped (NR: 0.32–0.40), saccular corner angulate, SA: 95–99°; cucullus elongate, with dorsal lobe strongly developed, apex rounded, distal margin convex to nearly straight, ventral lobe moderately developed, anal angle narrowly rounded.

*Female genitalia*. Papillae anales moderately setose and microtrichiate; sterigma moderately elongate (SR: 2.05–2.89); lamella postvaginalis rectangular, with lateral margins fused with posterior lobes of sternum 7; sternum 7 with moderately to strongly developed semitriangular lateral extremities; scaling of sternum 7 dense on posterior lobes and lateral projections, relatively sparse elsewhere; ductus bursae with sclerotized ring at juncture with ductus seminalis; corpus bursae with one signum slightly larger than the other.

#### 94. Eucosma parmatana (Clemens, 1860)

(Plates V–W, 94a–p; Plate 36, 94a–j)



**Types**. *Ephippiphora parmatana*. Lectotype (designated by Darlington 1947). ♂, No. 144, type locality given as unknown by Miller (1973), as Pennsylvania by Brown (2005), slide WEM 347, ANSP. *Steganoptycha crispana*. Lectotype (designation attributed to Heinrich 1923 by Darlington 1947 and to Darlington 1947 by Miller 1973). ♀, No. 488, type locality given as unknown by Miller (1973), as "Virginia?" by Heinrich (1923), ANSP (abdomen missing). *Epinotia kennebecana*. Lectotype (designated by Heinrich 1923; Plate V:94f). ♂, Maine, [York County], Kennebunkport, G. H. Clapp, August, slide CH 14 Dec 1919, AMNH. *Thiodia perfuscana*. Holotype (Plate W:94m). ♂, Pennsylvania, Allegheny County, Oak Station, F. Marloff, 19 August 1909, slide CH 3 March 1921, AMNH. *Thiodia alterana*. Holotype (Plate V:94e). ♂, Maryland, Montgomery County, Plummers Island, A. Busck, August 1903, slide 72761, USNM. *Thiodia sinestrigana*. Holotype (Plate V:94g). ♂, Nova Scotia, Queens County, White Point Beach, J. McDunnough, 15 August 1936, CNC. *Proteopteryx marmontana*. Lectotype (here designated; Plate W:94o). ♂, Canada, Manitoba, Rounthwaite, L. E. Marmont, 11 July 1905, AMNH.

The issues regarding type fixation for the two Clemens species were addressed by Miller (1973, 1983). Heinrich (1923) illustrated the male genitalia of the "types" of *E. kennebecana*, *E. perfuscana*, and *E. alterana* and thereby singled out a particular specimen in each case. His comments are therefore considered valid designations for the lectotype and two holotypes, respectively. The AMNH has two syntypes of *E. marmontana* from Rounthwaite that conform to Heinrich's (1923) statements about the "type," hence the present lectotype designation. That particular specimen bears a green "LECTOTYPE" label attached by Klots.

The specimens figured in Plate V:94a–d depict what we consider to be the typical *parmatana* forewing pattern based on Miller's (1973) photograph of the lectotype. Heinrich (1923) did not treat E. parmatana because he mistakenly interpreted Clemens' description as applying to a species of *Laspeyresia* Hübner (now Cydia) (Heinrich 1926; Miller 1973). Instead he proposed the name alterana and, judging from his determinations of USNM specimens, he applied it to individuals of the *parmatana* phenotype. It appears that Heinrich also was confused about the identity of *E. crispana*. Clemens made no mention of a white spot on the forewing in his description of this species, but Heinrich frequently applied the name to specimens of the *parmatana* phenotype. Our interpretation of *E. crispana*, based on the photograph of the lectotype in Miller (1973), is illustrated in Plate W:94k-l. The specimen in Plate V:94f is the lectotype of E. kennebecana, a species that was described in Epinotia by Kearfott (1907), transferred to *Epiblema* by Heinrich (1923), and finally recognized as conspecific with *E. parmatana* by Miller (1983). McDunnough described E. sinestrigana (Plate V:94g) from Nova Scotia but apparently was unaware of its similarity to *E. kennebecana*, probably because at the time the latter species was placed in *Epiblema*. Specimens illustrated in Plate V:94h-i are from Pennsyvania and Ohio, respectively, and are intermediate between typical E. kennebecanal sinestrigana and E. parmatana. The specimen in Plate V:94j depicts a particularly dark phenotype with an especially reduced interfascial spot that is commonly encountered in the Midwest. The specimens in Plate W:94m-n are the holotype of *E. perfuscana* and a similar specimen from Macon County, North Carolina; they are more uniformly brown (including the central field of the ocellus) than the other phenotypes. The specimens in Plate W:940-p are the lectotype and a paralectotype of E. marmontana.

Under our interpretation, the range of *E. parmatana* includes most of North America east of the Rocky Mountains. We examined material from Nova Scotia to Alberta south to North Carolina, Alabama, Louisiana, and northern Arizona. Capture dates range from mid-May to mid-September, with the vast majority of collections occurring in July and August. Putman (1942) reported rearing *E. perfuscana* from *Eurybia macrophylla* (L.) Cass. ex Nees (big-leaf aster) and *E. alterana* from *Eurybia macrophylla* and *Symphyotrichum lanceolatum* (Willd.) G. L. Nesom subsp. *lanceolatum* var. *lanceolatum* (white panicle aster), the larvae feeding in flower heads. McDunnough (1938) flushed the type series for *E. sinestrigana* 

from a patch of *Aster* L. (not determined to species) in Nova Scotia and mentioned that *E. alterana* had been reared from *Symphyotrichum ciliolatum* (Lindl.) Á. Löve & D. Löve (fringed blue aster) in southern Ontario.

95. Eucosma oregonensis (Heinrich, 1923)

(Plate W, 95a-c; Plate 36, 95a-e)

*Thiodia oregonensis* Heinrich 1923:47; McDunnough 1939:44. *Phaneta oregonensis*: Powell 1983:33; Brown 2005:495. *Eucosma oregonensis*: Gilligan and Wright 2013b:312.

Holotype (Plate W:95a; Plate 36:95a). &, Oregon, Crater Lake, 24–31 July, slide 69980, USNM.

*Eucosma oregonensis* resembles typical *E. parmatana* in maculation but is somewhat larger (mean FWL = 8.5 vs. 6.0 mm). In the material we examined the forewing is gray, without brown suffusion near the apex and/or termen, and the white interfascial spot does not vary much in size. Heinrich (1923) distinguished *E. oregonensis* from similar species by the following two features: cucullus somewhat broader medially, posterior black dash in the ocellus semicircular rather than straight (e.g., Plate W:95b). The first, though subtle, agrees with our observations. The second appears to be problematic. We have collected specimens in Larimer County, Colorado (Plate V:94d) that have both a curved dash in the ocellus and a narrow *parmatana*-like cucullus (Plate 36:94d).

We examined specimens from California, Oregon, Utah, and Washington, the capture dates ranging from mid-June through July.

# 96. Eucosma ochroterminana (Kearfott, 1907)

(Plate W, 96a-b; Plate 37, 96a-e)

*Thiodia ochroterminana* Kearfott 1907a:57; Heinrich 1923:40; McDunnough 1939:44. *Eucosma ochroterminana*: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:312. *Phaneta ochroterminana*: Powell 1983:33; Miller 1987:44; Brown 2005:495; Gilligan et al. 2008:95.

Lectotype (here designated). I, New Jersey, Montclair, W. D. Kearfott, 22 August 1899, AMNH.

Kearfott based *E. ochroterminana* on a series of 35 specimens from Manitoba, Ontario, Illinois, Maryland, Massachusetts, New Jersey, and Pennsylvania. Heinrich (1923) reported a "type" in the AMNH from Montclair, New Jersey. The AMNH has three syntypes from Montclair, collected on 22, 24, and 25 August 1899. We selected the specimen dated 22 August as the lectotype. It bears a red "TYPE Collection of W. D. Kearfott" label, Kearfott's handwritten "Cotype" label, and our yellow designation label.

*Eucosma ochroterminana* is a small species (mean FWL = 5.4 mm) with dark blue-gray interfascial areas that are barely distinguishable from the dark brown fasciae. The result is a blackish-brown forewing appearance that is relieved only by the brownish-yellow coloration of the ocellus, apex, and termen. The male genitalia are similar to those of *E. parmatana*, the cucullus being long and relatively narrow, but the ventral lobe of the cucullus has a stronger tendency to angle toward the saccular corner. Females have a particularly elongate sterigma (SR = 2.89).

This species is widely distributed in eastern North America, from the Great Plains to the Atlantic Coast, and is commonly encountered in old fields and prairie habitat in August and September. Putman (1942) reported rearing it from *Solidago altissima* L. (late goldenrod).

#### 97. Eucosma tomonana (Kearfott, 1907)

(Plate W, 97a–b; Plate 37, 97a–e)

*Eucosma tomonana* Kearfott 1907a:78; Barnes and McDunnough 1917:170; Gilligan and Wright 2013b:315. *Eucosma limigena* Meyrick 1912:36, unnecessary replacement name for *tomonana*. *Thiodia tomonana*: Heinrich 1923:48; McDunnough 1939:44. *Phaneta tomonana*: Powell 1983:33; Miller 1987:44; Brown 2005:496; Gilligan et al. 2008:95.

Lectotype (here designated). *A*, New Jersey, Essex County Park, W. D. Kearfott, 22 August, AMNH.

The AMNH has three specimens satisfying Heinrich's 1923 statements about the "type." The one here designated as lectotype bears a green "LECTOTYPE" label attached by Klots.

*Eucosma tomonana* is a small species (mean FWL = 6.4 mm) with pale gray interfascial areas and partially expressed subbasal and median fasciae, the latter consisting of dark brown marks from the inner margin to the cell and associated small dark marks (sometimes barely discernable) on the costa. This distinctive forewing pattern is not uncommon in Eucosmini, resulting in *E. tomonana* being confused from time to time with taxa such as *Suleima helianthana* (Riley) and *Pelochrista consobrinana* (Heinrich) (see Gilligan et al. 2008; species 165 and 199). The genitalia, however, clearly separate this species from other eucosmines of similar forewing appearance.

This species is broadly distributed in eastern North America, the adults flying in August and September. It was reared by Putman (1942) from larvae feeding in the flower heads of *Symphyotrichum novae-angliae* (L.) G. L. Nesom (New England aster).

#### 98. Eucosma raracana (Kearfott, 1907)

(Plate W, 98a-b; Plate 37, 98a-e)

*Thiodia raracana* Kearfott 1907b:44; Heinrich 1923:41; McDunnough 1939:44. *Thiodia fastidiosa* Meyrick 1912:34, unnecessary replacement name for raracana. *Phaneta raracana*: Powell 1983:33; Miller 1987:43; Brown 2005:495; Gilligan et al. 2008:95. *Eucosma raracana*: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:314.

**Lectotype** (here designated).  $\mathcal{E}$ , Arkansas, Washington County, [A. J. Brown], August, AMNH.

We selected the lectotype from four specimens in the AMNH that agree with Heinrich's (1923) remarks about the "type." It bears a red "TYPE Collection of W. D. Kearfott" label, Kearfott's handwritten "Cotype" label, and our yellow designation label.

*Eucosma raracana* is recognized easily by its small size (mean FWL = 5.7 mm), white head, and rustyred forewings. It is a common resident of old fields and grasslands in eastern North America and has been collected as far west as Arizona. Adults fly in August and September, often along with *E. ochroterminana*.

The male valva has a series of moderately stout setae on the distal margin of the cucullus from the anal angle to about two-thirds the distance to the apex, a feature that distinguishes this species from other members of the group. Moreover, the distal margin of the cucullus is nearly straight (except for the portion near the anal angle) and is nearly perpendicular to the ventral margin of the sacculus.

Heinrich (1923) reported *Solidago* L. (goldenrod) as a larval host but did not supply the source of that information.

# The ochrocephala group (species 99–102)

This group consists of four moderately small species with yellowish forewings and brown markings. They are essentially indistinguishable based on male genitalia but are separated by various aspects of forewing appearance, by distribution, and to some extent, by the scaling and setation of tergum 8 and the lamella postvaginalis. Common characters include:

*Forewing*. Mean FWL: 5.8–7.8 mm; AR: 2.76–3.14; dorsal surface with brown chevron-shaped subbasal and median fasciae (variable in expression) and yellowish interfascial areas; ocellus obscure to sharply defined, with yellowish central field crossed by two or three black dashes, the latter often fragmented; costal strigulae from median fascia to apex usually well delimited by brown marks and brownish striae.

*Male genitalia*. Uncus convex and moderately developed; valva with costal margin concave, ventral emargination moderate (NR: 0.49–0.62), saccular corner angulate, SA: 121–137°; cucullus with dorsal lobe strongly developed, apex rounded, distal margin convex of nearly uniform curvature, ventral lobe moderately developed, anal angle rounded.

*Female genitalia*. Papillae anales moderately setose and microtrichiate; tergum 8 with taxonomically useful patterns of scaling and setation; lamella postvaginalis rectangular, with lateral margins partially fused with posterior lobes of sternum 7; sternum 7 with posterolateral margins concavely inflected, lateral extremities semitriangular and moderately developed; scaling of sternum 7 dense on posterior lobes and lateral extremities, relatively sparse elsewhere; ductus bursae with sclerotized ring at juncture with ductus seminalis; corpus bursae with one signum slightly larger than the other.

#### 99. Eucosma ochrocephala (Walsingham, 1895)

(Plate X, 99a–c; Plate 38, 99a–b)

Cydia imbridana Fernald 1905:400.

Phaneta imbridana: Miller 1970; Powell 1983:34; Brown 2005:494.

**Types**. *Semasia ochrocephala*. Lectotype (designated by Miller 1983). ♂, Colorado, Loveland, Smith 31160, July 1891, BMNH(E) #819915, slide 11594, BMNH. *Cydia imbridana*. Lectotype (designated by Miller 1970). ♂, Kansas, Onaga, F. Crevecoeur, USNM.

Walsingham (1895) cited a male "type" and "several specimens." In unpublished notes, Obraztsov interpreted the "type" as a holotype and noted that there are three "paratypes" in the BMNH, with Smith numbers 30696, 30739, and 30754. Miller (1983) designated the "type" as lectotype, attributing the selection to Obraztsov.

This species has a bright yellow head, hence the specific epithet. It differs subtly from the other members of the group in forewing color, the dominant hue being dull straw yellow. The subbasal and median fasciae are well defined, usually complete, and separated between the inner margin and the cell by a patch of brownish-orange scales. In females, tergum 8 has no scales but is uniformly and somewhat sparsely covered with moderately long setae. The range of *E. ochrocephala* extends from the Great Plains to the Atlantic Coast. The larva feeds on seeds of *Xanthium strumarium* L. (rough cocklebur) and overwinters in the stem, where pupation occurs the following summer (Hare 1977). Adults fly from mid-August to early October.

Semasia ochrocephala Walsingham 1895:513.

Eucosma ochrocephala: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:312.

Thiodia ochrocephala: Fernald 1903:463; Heinrich 1923:42; McDunnough 1939:44.

Phaneta ochrocephala: Miller 1983:100; Powell 1983:33; Miller 1987:47; Brown 2005:494; Gilligan et al. 2008:94.

Eucosma imbridana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:312.

Thiodia imbridana: Heinrich 1923:68; McDunnough 1939:45; synonymy by Miller 1983:100.

#### 100. Eucosma sableana Wright and Gilligan, new species

(Plate X, 100a–c; Plate 38, 100a–e)

**Diagnosis**. This name is proposed for a population of *ochrocephala*-like moths that are residents of Sable Island, Nova Scotia, a small sandy island in the Atlantic Ocean located approximately 100 miles east of mainland Nova Scotia. This species is similar to *E. ochrocephala* in size (mean FWL = 7.1 vs. 7.2 mm) and genitalia (Plate 37:100 vs. 99) but differs in forewing color (orange yellow vs. dull straw yellow). The maculation resembles that of *E. ochrocephala* but is much more subdued (Plate X:100a) and, in many cases (Plate X:100b–c), is barely discernable. It seems plausible that this population split from *E. ochrocephala* and developed subtly different characteristics as a result of its geographic isolation.

**Description**. Head. Pale yellow; labial palpus white, sometimes with a pale yellowish tint, second segment with pale brownish spot on lateral surface; antenna white. Thorax. Dorsal surface concolorous with head; tegula with a few brownish scales at apex; legs concolorous with head; tarsi with pale brownish annulations. Forewing: ♂ FWL 6.3–7.4 mm (mean = 6.9, n = 5), AR = 2.95; ♀ FWL 6.9–7.6 mm (mean = 7.2, n = 6), AR = 2.89; male without costal fold, costa weakly arched; apex acute; termen straight to weakly convex; dorsal surface yellow to orange yellow, immaculate in some specimens, variably suffused with brownish irrorations in others; subbasal and median fasciae pale brown, chevron-shaped, and obscure to barely discernable; ocellus obscure, edged proximally and distally by pale metallic gray bars, with yellow central field crossed by two black dashes; costal strigulae variably delineated by brown dashes, indiscernable in immaculate specimens; fringe uniformly yellow to orange yellow, sometimes with a few pale brownish scales near apex. Hindwing: Pale gray brown. Abdomen. Male genitalia (n = 3): Uncus moderately developed, with rounded apex; dorsolateral shoulders of tegumen slightly hunched; socii fingerlike; phallus stout, tapering toward apex; vesica with 29-37 deciduous cornuti; valva with costal margin concave, ventral emargination moderate, NR = 0.57,  $SA = 121^{\circ}$ ; cucullus with dorsal lobe strongly produced, apex rounded, distal margin weakly convex, anal angle rounded. Female genitalia (n = 2): Papillae anales moderately setose and microtrichiate; tergum 8 sparsely but uniformly setose; lamella postvaginalis rectangular and microtrichiate; SR = 1.62; scaling of sternum 7 somewhat more dense on posterior lobes and lateral projections; ductus bursae with sclerotized band at juncture with ductus seminalis; corpus bursae with one signum slightly larger than the other.

Holotype (Plate 38:100a).  $\mathcal{O}$ , Nova Scotia, Sable Island, D. C. Ferguson, 11–13 August 1978, slide 144984, USNM.

**Paratypes**. Same data as holotype (4  $\Im$ , slides DJW 3203, 3359; 6  $\bigcirc$ , slides DJW 3204, 3229), USNM. **Etymology**. The specific epithet refers to the type locality, Sable Island.

#### 101. Eucosma verniochreana (Heinrich, 1923)

(Plate X, 101a-c; Plate 38, 101a-e)

*Thiodia verniochreana* Heinrich 1923:67; McDunnough 1939:45. *Phaneta verniochreana*: Powell 1983:34; Brown 2005:497. *Eucosma verniochreana*: Gilligan and Wright 2013b:316.

**Holotype**. ∂, New Jersey, [Burlington County], Mount Holly, 19 August 1906, slide CH 22 June 1920, AMNH.

Heinrich (1923) described this species from six specimens (5 3, 1 9), five of which have the same data as the holotype. He illustrated the genitalia of a male that he referred to as the "type," thereby identifying a unique name-bearing specimen. Hence, we interpret that specimen as the holotype.

*Eucosma verniochreana* is the smallest member of the group (mean FWL = 5.8 vs. 7.0-7.2 mm). The forewing is yellow with a slight olivaceous tint. The maculation is brown and includes a partial subbasal fascia represented by a prominent oblique bar from the inner margin to the cell and a weakly expressed median fascia that is sometimes only detectable as a black mark at mid-costa. The male genitalia are essentially identical to those of *E. ochrocephala* and *E. sableana*, but females have some distinguishing features. The posterolateral corners of the lamella postvaginalis are developed into triangular lateral projections, each with approximately a dozen scales, and the ventral lobes of tergum 8 have a mixture of scales and setae. This is the only member of the *ochrocephala* group with scales on the sterigma and the only member with a non-rectangular lamella postvaginalis.

*Eucosma verniochreana* is poorly represented in collections. We examined the type series, which dates to 1906; ten males at the MCZ collected by C. P. Kimball in the 1950's at Barnstable, Massachusetts; three specimens  $(1 \ 3, 2 \ 2)$  in the USNM collected by E. D. Keith at Providence, Rhode Island in 1914 and 1917; and one male in the USNM collected in 1936 by F. M. Jones at Martha's Vineyard, Massachusetts. One of the specimens was captured in mid-September, the others in August.

#### 102. Eucosma knudsoni Wright and Gilligan, new species

(Plate X, 102a–c; Plate 39, 102a–g)

**Diagnosis**. *Eucosma knudsoni* resembles *E. ochrocephala* in size and forewing appearance, but the interfascial areas are bright yellow instead of dull brownish yellow, and the fasciate markings tend to be more sharply defined. The range of *E. knudsoni* overlaps that of *E. ochrocephala* in the southern Great Plains but is disjunct from those of the other two members of the group, which are known only from the Atlantic Coast. The eighth tergite in *E. knudsoni* has a uniformly distributed mixture of scales and setae. The only other member of the group with scales on tergum 8 is *E. verniochreana*, where scales occur on the ventral lobes and posterior margin but are absent from the anterior portion of the dorsal surface.

Description. Head. Yellow; labial palpus with brown spot on lateral surface of second segment and some brownish scaling on third segment; antenna with dorsal surface brown, lateral surfaces yellow. Thorax. Dorsal surface yellow; tegula yellow, sometimes with brown shading at base; fore- and mid-legs with anterior surfaces brownish, posterior surfaces pale yellowish; hind-legs yellowish; tarsi with brown annulations. Forewing: ♂ FWL 6.3–7.9 mm (mean = 7.0, n = 10), AR = 3.20; ♀ FWL 6.3–8.3 mm (mean = 7.4, n = 19), AR = 3.13; male without costal fold, costa nearly straight; apex acute; termen straight; dorsal surface yellow with pale brown to dark brown markings; subbasal and median fasciae chevronshaped and nearly complete, the former interrupted by yellow subcostal band from base to median fascia, the latter sometimes fragmented by yellow lines along the veins (Plate X:102c); interfascial areas variably irrorated with brown; ocellus edged proximally and distally by pale metallic gray bars and capped anteriorly by semicircular brownish band; central field of ocellus yellowish, crossed by two or three fragmented black dashes; costal stigulae yellow and well delineated by brown marks and striae, often with two or three associated metallic gray striae; fringe pale yellow, with some brownish scales near apex in darkly marked specimens. Hindwing: Gray brown. *Abdomen*. Male genitalia (n = 4): Uncus weakly to moderately developed, with ventral surface divided medially by variably developed ridge; dorsolateral shoulders of tegumen slightly hunched; socii short and fingerlike; phallus stout, tapering gradually toward apex; vesica with 25–30 deciduous cornuti; valva with costal margin concave, ventral emargination moderate (NR = 0.62), neck widening slightly toward cucullus, SA =  $137^{\circ}$ ; cucullus nearly symmetric about horizontal center line; with dorsal and ventral lobes moderately produced, apex and anal angle rounded, distal margin convex of nearly uniform curvature, medial surface densely setose. Female genitalia (n = 5): Papillae anales moderately setose and densely microtrichiate; tergum 8 with uniformly distributed mixture of setae and

scales; lamella postvaginalis rectangular, microtrichiate, and partially fused with posterior lobes of sternum 7; SR = 2.03; sternum 7 with posterolateral margins concave, lateral projections acute and moderately produced; scaling of sternum 7 dense on posterior lobes and vertices of lateral projections; ductus bursae with sclerotized band at juncture with ductus seminalis; corpus bursae with two signa of slightly different size.

**Holotype**.  $\bigcirc$ , New Mexico, Lincoln County, Valley of Fires Recreation Area, 4 mi W of Carrizozo, 5,250 feet, 33.6773° N, 105.9280° W, D. J. Wright, 19 August 2005, USNM.

**Paratypes**. ARIZONA. Cochise County, 5131 Bannock St., Pueblo Del Sol, Huachuca Mountains, R. S. Wielgus, 12 August 1986 (1  $arrowsspace{1}, 1 \ colored product (1 \ colored product produ$ 

**Etymology**. This species is named after E. C. Knudson in recognition of his many contributions to our knowledge of the Lepidoptera of Texas.

#### Species not assigned to a group (species 103–133)

103. Eucosma olivaceana (Riley, 1881)

(Plate X, 103a–c; Plate 39, 103a–b)

Grapholitha olivaceana Riley 1881:320. Semasia olivaceana: Fernald 1882a:42. Thiodia olivaceana: Fernald 1903:460; Heinrich 1923:67; McDunnough 1939:45. Eucosma olivaceana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:312. Phaneta olivaceana: Powell 1983:34; Miller 1987:47; Brown 2005:495; Gilligan et al. 2008:101.

**Holotype**. ♂, Illinois, Muhleman, USNM.

*Eucosma olivaceana* was described from a single male collected by J. R. Muhleman in Illinois. It is superficially similar to the members of the *ochrocephala* group, but the forewing is greenish yellow rather than yellow, and the maculation includes a dark streak from the base of the inner margin to the distal extremity of  $R_5$ . This species is a little larger than *E. ochrocephala* (mean FWL = 7.8 vs. 7.2 mm), and its genitalia are subtly different. The uncus is smaller, the socii are shorter, and the cucullus is somewhat smaller. Females have rather broad bands of sclerotized membrane between the lateral margins of the lamella postvaginalis and the posterior lobes of sternum 7.

We examined specimens of *E. olivaceana* that document a range from Nova Scotia to Iowa, south to Maryland and Illinois. Heinrich (1923) reported *Solidago* L. (goldenrod) as a larval host without mentioning the source of his information. Adults fly from mid-June to the end of July.

104. Eucosma viridis (Wright and Gilligan, 2010)

(Plate Y, 104a-b; Plate 39, 104a-e)

*Phaneta viridis* Wright and Gilligan 2010:103. *Eucosma viridis*: Gilligan and Wright 2013b:316.

**Holotype** (Plate Y:104a).  $\mathcal{J}$ , Arizona, Coconino County, Hart Prairie, 10 mi NNW of Flagstaff, 8,500 feet, R. W. Hodges, 24 July 1961, USNM.

This is the only Nearctic *Eucosma* besides *E. olivaceana* with a greenish forewing. It is similar in size to *E. olivaceana* (mean FWL = 8.1 vs. 7.8 mm) but lacks the black diagonal forewing streak in the latter species. *Eucosma viridis* is known only from specimens collected by R. W. Hodges in late July and early August at three locations in Coconino County, Arizona, whereas *E. olivaceana* appears to be restricted to the Midwest and Northeast.

The male genitalia are distinctive: socii moderately long and stout, often with irregular lateral margins; valva with the costal margin concave, NR = 0.58, SA = 98°; cucullus unusually large, with about a dozen moderately stout setae evenly distributed along the strongly convex distal margin from anal angle to three-fourths the distance to the apex. In females the posterolateral margins of sternum 7 are concavely inflected, the deepest points of inflection being aligned with the lamella antevaginalis, and one signum is greatly reduced and pinlike.

# 105. Eucosma modicellana (Heinrich, 1923)

(Plate Y, 105a–d; Plate 40, 105a–e)

*Thiodia modicellana* Heinrich 1923:265; McDunnough 1939:45. *Phaneta modicellana*: Powell 1983:34; Brown 2005:494. *Eucosma modicellana*: Gilligan and Wright 2013b:311.

Holotype. America Aweme, N. Criddle, 2 July 1921, slide TOR-1030, CNC.

Heinrich (1923) described this species from two males collected at Aweme, Manitoba. He illustrated the genitalia of the "type," thereby selecting the specimen that is now interpreted as a holotype.

*Eucosma modicellana* is a small whitish species (mean FWL = 5.9 mm) with no obvious fasciate markings. The forewing is generously suffused with gray (of varying shades) except for a white streak on the costa (interrupted by gray dashes associated with the costal strigulae), a sometimes obscure white streak in the cell from base to mid-wing, and a prominent white line on the termen from tornus to  $R_5$ . The ocellus is somewhat obsure but is usually recognizable.

Genitalia characteristics include: socii short and stubby; ventral emargination of valva long and moderately shallow; NR = 0.56; saccular corner broadly rounded (SA obtuse but often ill defined); cucullus relatively narrow, with dorsal lobe strongly developed, apex semicircular, distal margin evenly convex, ventral lobe moderately developed and narrowly rounded; lamella postvaginalis tapering posteriorly; sternum 7 with posterolateral margins weakly convex; signa nearly equal in size.

We examined specimens from Alberta, Manitoba, California, Colorado, western Iowa, New Mexico, Oklahoma, South Dakota, and Wyoming. Capture dates range from late May in California to late August in Colorado and New Mexico.

# 106. Eucosma pallidarcis (Heinrich, 1923)

(Plate Y, 106a–c, Plate 40, 106a–d)

*Thiodia pallidarcis* Heinrich 1923:60; McDunnough 1939:45. *Phaneta pallidarcis*: Powell 1983:34; Brown 2005:495. *Eucosma pallidarcis*: Gilligan and Wright 2013b:313.

**Holotype**. ♂, California, [San Diego County], San Diego, W. S. Wright, 10 May 1908, slide CH 18 June 1920, AMNH.

This species is based on eleven specimens  $(9 \ 3, 2 \ 2)$  from San Diego and Los Angeles counties, California. Heinrich (1923) illustrated the genitalia of the male "type" and referred to the other specimens as paratypes, thus providing a clear holotype designation.

*Eucosma pallidarcis* is a small species (mean FWL = 6.1 mm) that lacks distinctive forewing maculation. Specimens from the West Coast are pale grayish brown; those from the Great Basin and the Great Plains are pale yellowish white. They all have a thin white streak along the costa and an obscure white streak in the cell from the base to mid-wing. Some specimens show a faint indication of a median fascia. The ocellus is detectable and concolorous with the adjacent portion of the wing.

This species can be confused easily with *E. modicellana* based on size and forewing appearance, but the male genitalia are distinctive: uncus very weakly developed; socii short and stubby; valva with ventral emargination long and shallow, neck broad (NR = 0.74); saccular corner broadly rounded (SA =  $150^{\circ}$ , but often ill defined); cucullus with anal angle very weakly developed. The female genitalia are similar to those of *E. modicellana*, but the lamella postvaginalis is rectangular instead of tapering posteriorly.

We examined specimens from Alberta, British Columbia, California, Colorado, Idaho, Montana, Oregon, Texas, Utah, and Washington. Adults fly in June and July. A female paratype in the USNM from Los Angeles County, California is labeled "from larva in *Artemisia californica*" (= *Artemisia californica* Less.; California sagebrush).

# 107. Eucosma cibolana (Wright, 2010)

(Plate Y, 107a–b; Plate 40, 107a–e)

*Phaneta cibolana* Wright 2010:125. *Eucosma cibolana*: Gilligan and Wright 2013b:306

**Holotype** (Plate 40:107d). ♀, New Mexico, Cibola County, Cibola National Forest, Lobo Canyon Picnic Area, 7,300 feet, 35.2128° N, 107.7202° W, D. J. Wright, 9 August 2005, slide 137412, USNM.

*Eucosma cibolana* is superficially similar to pale forms of *E. parvula* (Plate Y:108a), but it is larger (mean FWL = 6.7 vs. 5.2 mm) and differs from that species in genitalia. The forewing is mostly white, with pale yellow-orange bands flanking a diffuse white longitudinal streak in the cell, black marks and striations on the distal one-half of the costa (defining the strigulae), and fine black reticulations on the proximal and anterior margins of the ocellus. The termen is weakly concave, producing a slightly falcate apex.

In males, the valval shape is similar to that of members of the *stramineana* group. Females have a somewhat teardrop-shaped sterigma and are distinguished by the unusually long and pointed lateral extremities of the sternum 7.

We examined specimens from Alamosa County, Colorado; Oneida County, Idaho; and Cibola and Otero counties, New Mexico. Capture dates range from late June to mid-August.

#### 108. Eucosma parvula (Wright, 2010)

(Plate Y, 108a–b, Plate 41, 108a–e)

*Phaneta parvula* Wright 2010:128. *Eucosma parvula*: Gilligan and Wright 2013b:313.

**Holotype** (Plate Y:108a). (7), Idaho, Oneida County, Curlew National Grassland, T14S R32E Sec 30, D. J. Wright, 28 July 2003, slide 137266, USNM.

*Eucosma parvula* is one of the smallest Nearctic *Eucosma* (mean FWL = 5.2 mm). Forewing appearance varies from grayish white with some yellowish suffusion in the proximal one-half (Plate Y:108a) to mostly blackish gray (Plate Y:108b). Both phenotypes have a weakly expressed white streak in the cell, a dark spot on the cubitus in the subbasal region, and a weakly expressed median fascia that is detectable at the costa and the inner margin but fades at the distal end of the cell. The costa is marked from the base to the apex with short black dashes associated with the costal strigulae.

The male genitalia are distinctive: uncus weakly developed and barely differentiated from dorsolateral shoulders of tegumen; socii short and stubby; valva with ventral emargination deep and U-shaped, neck narrow (NR = 0.36) with ventral margin weakly scooped-out, SA approximately 90°; cucullus with dorsal lobe strongly developed, apex semicircular, distal margin convex of nearly uniform curvature, ventral lobe moderately developed and narrowly rounded. Distinctive female genitalia characteristics include: sterigma with ostium margins ringlike and well separated from sternum 7 by a band of membrane (Plate 41:108e); ductus bursae elongate, with sclerotized band and juncture with ductus seminalis located near constriction anterior to ostium; signa large and equal in size.

We examined specimens from Mesa County, Colorado; Oneida County, Idaho; Phillips County, Montana; and Uintah County, Utah. Adults fly from late July to early September.

#### 109. Eucosma patagoniana Wright, 2014

(Plate Y, 109a–b; Plate 41, 109a–d)

Eucosma patagoniana Wright 2014:193.

Holotype (Plate Y:109a; Plate 41:109b). ♂, Arizona, Santa Cruz County, 8 mi SSE of Patagonia on Harshaw Creek Road, 31.4680° N, 110.7080° W, 5,073 feet, D. J. Wright, 5 August 1999, slide 145023, USNM.

*Eucosma patagoniana* is relatively small (mean FWL = 6.4 mm), with conspicuous black subbasal and median marks (segments of fasciae) from the inner margin to the cell, a white ocellus, and a diffuse white band along the radius from the base to the median fascia. The overall appearance is black and white, but the subcostal area from the median fascia to the apex is suffused with orange brown.

Genitalia characteristics include: socii of moderate length, with papillate apices; dorsal and ventral lobes of the cucullus strongly developed, the former with semicircular apex, the latter narrower and semitriangular; lamella postvaginalis broadening posteriorly (length of posterior margin approximately 1.5 × ostium diameter), the lateral margins fused with posterior lobes of sternum 7.

This species is known from Cochise and Santa Cruz counties in southeastern Arizona. We examined 27 specimens  $(23 \Diamond, 4 \bigcirc)$ , all collected in the first half of August.

#### 110. Eucosma influana (Heinrich, 1923)

(Plate Z, 110a–f; Plate 41, 110a–g)

*Thiodia influana* Heinrich 1923:49; McDunnough 1939:44. *Phaneta influana*: Powell 1983:33; Brown 2005:494; Gilligan et al 2008:98. *Eucosma influana*: Gilligan and Wright 2013b:310. *Phaneta musetta* Blanchard and Knudson 1983b:845; Brown 2005:494; new synonymy. *Eucosma musetta*: Gilligan and Wright 2013b:312.

**Types**. *Phaneta influana* (Plate Z:110a). Holotype. ♂, California, Siskiyou County, Shasta Retreat, 1–7 July, slide 72764, USNM. *Phanta musetta* (Plate Z:110b). Holotype. ♂, New Mexico, Soccoro County, Gran Quivira National Monument, 6,600 feet, 1–3 July 1964, D. R. Davis, slide 25473, USNM.

*Eucosma influana* was described from six specimens  $(4 \ 3, 2 \ 9)$  from northern California. Heinrich (1923) unambiguously identified a "type" by illustrating its genitalia, hence the holotype designation. *Eucosma musetta* was based on a male from New Mexico and a female from Texas (Plate Z:110b–c). They are similar to but paler than the holotype of *E. influana* (Plate Z:110a). We examined 31 *influana*-like specimens from Alberta, Manitoba, California, Iowa, Nebraska, New Mexico, Oregon, Texas, and Wyoming. The forewing pattern is constant. Coloration varies only in the extent of the grayish-brown suffusion in the interfascial areas, which is considerable in specimens from the far west (Plate Z:110a, d), moderate in those from Wyoming, and practially obsolete in those from the upper Midwest (Plate Z:110e–f). Finding no genitalia differences among the various phenotypes, we attribute the color differences to intraspecific variation, hence the new synonymy.

The male genitalia are substantially the same as those of various other species (e.g., members of the *ochrocephala* and *griseocapitana* groups). In females, the setae on the papillae anales are obliquely inclined, unusually stout, and progressively longer with distance from the margin of the anal opening (Plate 41:110g). This condition appears to be unique in Nearctic *Eucosma*.

Most of the specimens we examined were collected in June, but a few were captured in early July, and there is one April record from Texas.

#### 111. Eucosma migratana (Heinrich, 1923)

(Plate Z, 111a–e; Plate 42, 111a–f)

*Thiodia migratana* Heinrich 1923:53; McDunnough 1939:44. *Phaneta migratana*: Powell 1983:33; Brown 2005:494; Wright 2013:182. *Eucosma migratana*: Gilligan and Wright 2013b:311.

**Holotype** (Plate Z:111a; Plate 42:111a).  $\mathcal{J}$ , California, Inyo County, Olancha, 24–30 April, slide 72770, USNM.

In the description of *E. migratana*, Heinrich (1923) cited two specimens  $(1 \land 1 \bigcirc)$ . He referred to the male as "type" and illustrated its genitalia, hence the interpretation of that specimen as a holotype.

This is a medium-sized species (mean FWL = 8.3 mm) with a grayish forewing that is longitudinally streaked with thin black lines. Most specimens have an obscure yellowish subcostal band extending from the base to the median fascia. The subbasal fascia is represented by an oblique mark on the cubitus and the median fascia by a short bar at mid-costa. The ocellus consists of two black dashes on a whitish central field.

Genitalia features include: ventral lobe of cucullus triangular, with apex acute and basoventral margin extending in ridgelike fashion onto medial surface of neck; sterigma somewhat teardrop-shaped; sternum 7 with sharply pointed lateral extremities; signa of equal size.

We examined specimens from California, Colorado, Nevada, Oregon, Utah, and Wyoming. Capture dates range from late March in southern California to late June in Colorado.

#### **112.** *Eucosma complicana* (McDunnough, 1925)

(Plate Z, 112; Plate 42, 112)

*Thiodia complicana* McDunnough 1925:16; McDunnough 1939:44. *Phaneta complicana*: Powell 1983:33; Brown 2005:493; Wright 2013:182. *Eucosma complicana*: Gilligan and Wright 2013b:306.

**Holotype** (Plate Z:112; Plate 42:112).  $\mathcal{J}$ , British Columbia, Osoyoos, C. B. Garrett, 19 May 1923, slide TOR-981, CNC.

This species is known only from the holotype (FWL = 7.4 mm), which is in poor condition (the head is missing, and the forewing is worn). The genitalia are rather distinctive: uncus nearly absent, socii short and stubby, neck narrow, SA approximately 90°, cucullus roughly symmetric about horizontal centerline, distal margin of cucullus with series of spiniform setae from anal angle to two-thirds distance to apex.

#### 113. Eucosma columbiana (Walsingham, 1879)

(Plate Z, 113a–c; Plate 42, 113a–g)

Semasia columbiana Walsingham 1879:57; Fernald 1882a:44. Thiodia columbiana: Fernald 1903:462; Heinrich 1923:44; McDunnough 1939:44. Eucosma columbiana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:307. Phaneta columbiana: Powell 1983:33; Brown 2005:493.

**Lectotype** (here designated). ♂, Oregon, Wasco County, to Fort Dalles, Walsingham, 15–22 April 1872, BMNH(E) #819907, slide 11590, BMNH.

*Eucosma columbiana* was described from four syntypes  $(3 \Diamond, 1 \bigcirc)$  collected by Walsingham in 1872 near the Columbia River in northern Oregon. The lectotype, which was selected by Obraztsov, looks very much like the specimen in Plate Z:113a.

This is a moderately small species (mean FWL = 7.3 mm). The forewing is predominantly gray (of varying shades), with well-defined brown to yellow-brown fasciate markings. The basal and subbasal fasciae are confluent, forming a basal patch with weakly chevron-shaped distal margin; the median fascia is bandlike and usually constricted on  $CuA_2$ . The specimen in Plate Z:113c is representative of an especially pale population at White Sands National Monument in New Mexico.

The male genitalia are distinctive: uncus triangular; socii short and stubby; valval neck narrow basally, broadening distally, with ventrolateral margin scooped-out (NR = 0.26); saccular angle approximately 90°, with vertex rounded; cucullus nearly symmetric about horizontal center line, with dorsal and ventral lobes well developed and distal margin weakly convex. The female genitalia resemble those of species in the *artemisiana* group, but the posterior extremity of the lamella postvaginalis is more narrowly pointed, and the posterolateral margins of sternum 7 are weakly concave instead of straight.

We examined specimens from California, Colorado, Nevada, New Mexico, Oregon, Utah, Washington, and Wyoming. Capture dates range from mid-April to mid-June.

#### 114. Eucosma bucephaloides (Walsingham, 1891)

(Plate AA, 114a–i; Plate 43, 114a–f)

Semasia bucephaloides Walsingham 1891:465; 1895:512. Thiodia bucephaloides: Fernald 1903:463; Heinrich 1923:71; Heinrich 1929:4; McDunnough 1939:45. Eucosma bucephaloides: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:305. Phaneta bucephaloides: Powell 1983:34; Brown 2005:492; Powell and Opler 2009:133.

**Holotype**. ♀, California, Siskiyou County, Little Shasta Creek, Walsingham, 4–5 September 1871, Wlsm 92616, BMNH(E) #1624689, slide 11552, BMNH.

Walsingham (1891) described *E. bucephaloides* from a single female collected in northern California. The holotype looks a great deal like the moth in Plate AA:114b. In the early part of the twentieth century this species was considered conspecific with *E. offectalis* (Fernald 1903; Barnes and McDunnough 1917), but Heinrich (1923) tentatively resurrected the name and later (1929) supported that decision with an illustration of the male genitalia.

This is one of the larger Nearctic *Eucosma* (mean FWL = 12.6 mm). It has three primary color forms: dark gray (Plate AA:114a–b), brown (Plate AA:114e), and grayish white (Plate AA:114g–h), but they are not discrete entities. Each exhibits considerable variation, generating intermediates that intergrade among the principal phenotypes. The gray and brown forms are widely distributed in the West, the white form is associated with dunes near Mono Lake in Mono County, California, and the specimen depicted in Plate AA:114i was collected in the Mojave Desert in southern California.

The genitalia of the various phenotypes are essentially identical. In males, the socii are rather bulbous, and the distal margin of the cucullus is often weakly inflected near the anal angle. Females have a distinctively shaped sterigma (Plate 43:114 f), the lateral margins of the lamella postvaginalis abruptly bending laterally posterior to the ostium, and the posterior margin of sternum 7 is congruently invaginated.

*Eucosma bucephaloides* is broadly distributed from the Pacific Coast to the eastern slope of the Rocky Mountains. Heinrich (1929) reported a series of specimens reared by G. Englehardt from *Lorandersonia linifolia* (Greene) Urbatsch et al. (spearleaf rabbitbrush). Powell and Opler (2006) reared the gray phenotype from *Ericameria nauseosa* (Pall. ex Pursh) G. L. Nesom & G. I. Baird subsp. *nauseosa* var. *nauseosa* (rubber rabbitbrush) in California and the brown phenotype from *Chrysothamnus viscidiflorus* (Hook.) Nutt. (yellow rabbitbrush) in Nevada. Adults have been captured from April through September, but the vast majority of the records are from July and August.

#### 115. *Eucosma salmicolorana* (Heinrich, 1923)

(Plate AA, 115a–c; Plate 43, 115a–e)

*Thiodia salmicolorana* Heinrich 1923:62; McDunnough 1939:45. *Phaneta salmicolorana*: Powell 1983:34; Brown 2005:495. *Eucosma salmicolorana*: Gilligan and Wright 2013b:313.

Holotype. (7, Utah, [Tooele County], Stockton, T. Spalding, 30 July 1913, slide 72774, USNM.

Heinrich (1923) illustrated the genitalia of the specimen he considered the "type," thereby distinguishing it from the other 25 specimens mentioned in the description.

The forewing is pinkish salmon (Plate AA:115a), sometimes generously suffused with gray (Plate AA:115c), with a sometimes obscure white streak in the cell from the base to mid-wing and a white costal streak from the base to the apex, the latter interrupted in the distal one-half of the wing by salmon-colored dashes associated with the costal strigulae. The ocellus is moderately well expressed, and the termen has a broad salt-and-pepper-colored band extending from the tornus to the apex. Mean FWL = 7.6 mm.

The genitalia of this species are distinctive. The male valva is somewhat similar to those of the *artemisiana* group, but the saccular corner is very broadly rounded (SA =  $110^{\circ}$ ); the neck is long, tapering, and quite narrow at its distal extremity (NR = 0.25); and the basoventral margin of the cucullus does not overlap the neck. Females have a V-shaped ribbonlike flap protruding perpendicularly from sternum 7 (Plate 43:115e). Its "vertex" is located near the anterior margin of the sternite, and the arms extend to the concave inflections of the posterolateral margins. The only other Nearctic *Eucosma* with this sort of character is *E. mayelisana* (species 116), in which case the flap is serpentine and transverse, with lateral terminals approaching the lateral extremities of sternum 7.

We examined specimens from Alberta, Arizona, California, Colorado, Idaho, Nevada, Oregon, Utah, and Wyoming. Adults fly from early July to early September.

#### 116. Eucosma mayelisana (Blanchard, 1979)

(Plate AA, 116a–c; Plate 43, 116a–e)

Phaneta mayelisana Blanchard 1979:209; Brown 2005:494. Eucosma mayelisana: Gilligan and Wright 2013b:311.

**Holotype** (Plate AA: 116a).  $\Diamond$ , Texas, Cottle County, Matador Wildlife Management Area near Paducah, A. and M. E. Blanchard, 17 April 1968, USNM.

*Eucosma mayelisana* is a rather striking brown and white species of medium size (mean FWL = 10.5 mm) that is identified readily by forewing appearance: fasciate markings grayish brown; interfascial areas, ocellus, costal strigulae, and termen white.

Distinctive features of the male genitalia include: uncus weakly developed, dorsolateral shoulders of tegumen hunched, socii short, ventral margin of valval neck convex and extending basally in weakly raised ridgelike manner onto medial surface, and basoventral margin of cucullus weakly overlapping medial surface of neck. Females have an ovoid ringlike sterigma, two serpentine elongate flaplike projections on sternum 7 that arise near the middle of the sternite and approach its lateral extremities, a broad sclerotized band that encircles the ductus bursae and surrounds the juncture with the ductus seminalis, and microspinules on the inner surface of the ductus bursae near that juncture.

We examined specimens from Washington County, Colorado; Clark County, Kansas; Emery County, Utah; and Cottle and Hemphill counties, northern Texas. Most of this material comes from the southern Great Plains, but the population in Utah suggests that this species may be more broadly distributed in the Great Basin. Adults fly in April, May, and early June.

# 117. Eucosma tenuiana (Walsingham, 1879)

(Plate BB, 117a–d; Plate 44, 117a–e)

Semasia tenuiana Walsingham 1879:59; Walsingham 1884:143. Thiodia tenuiana: Fernald 1903:462; Heinrich 1923:54; McDunnough 1939:44. Eucosma tenuiana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:315. Phaneta tenuiana: Powell 1983:33; Brown 2005:496; Wright 2013:177.

**Lectotype** (designated by Wright 2013).  $\circlearrowleft$ , California, Siskiyou County, Sheep Rock, Walsingham, 3 September 1871, BMNH(E) #819942, slide 11584, BMNH.

*Eucosma tenuiana* is one of several brownish-gray western *Eucosma* (e.g., species 111, 118, 119, 122) that are similar in size (mean FWL: 6.6–8.3 mm) and forewing appearance and, therefore, difficult to identify reliably without examining the genitalia. Males of these species differ in valval shape; females differ in aspects of the sterigma and sternum 7. *Eucosma tenuiana* often can be recognized by the following combination of characters: labial palpi long and bushy; forewing usually with an orange-brown bar on the inner margin from the base to the subbasal fascia (Plate BB:117c); and adult flight in the fall.

Distinctive genitalic features of *E. tenuiana* include: apex of cucullus angulate, distal margin of cucullus with a series of moderately stout setae from anal angle to bend at two-thirds distance to apex, sternum 7 with strongly developed and sharply pointed lateral projections, signa of distinctly different size.

We examined specimens from Arizona, California, Colorado, Nevada, Oregon, Utah, Washington, and Wyoming. Capture dates range from 25 August to 17 October. Some of the California material was collected in association with *Haplopappus* Cass.

# 118. Eucosma donahuei (Wright, 2013)

(Plate BB, 118a-b; Plate 44, 118a-c)

*Phaneta donahuei* Wright 2013:185. *Eucosma donahuei*: Gilligan and Wright 2013b:307.

**Holotype** (Plate 44:118c).  $\Diamond$ , California, Kern County, Piute Mountains, Rancheria Creek, J. P. and K. E. Donahue, 1–3 June 1973, slide DJW 2796, LACM.

*Eucosma donahuei* is recognized by a combination of male genitalia characteristics: uncus weakly developed; socii short and stubby; valva with ventral emargination shallow, neck elongate and ridgelike along medioventral margin, distal margin of basal excavation ridgelike and setose; cucullus with dorsal lobe strongly developed, apex evenly rounded, distal margin evenly convex, ventral lobe weakly developed with one or two short spiniform setae at vertex of anal angle. The female is unknown.

This species was mistakenly identified and illustrated by Heinrich (1923; Fig. 131) as *E. minimana*. It is known from Inyo, Kern, and San Bernardino counties, California, with adults flying from mid-May to late June.

#### 119. Eucosma nepotinana (Heinrich, 1923)

(Plate BB, 119a–d; Plate 44, 119a–g)

*Thiodia nepotinana* Heinrich 1923:263; McDunnough 1939:44. *Phaneta nepotinana*: Powell 1983:33; Brown 2005:494; Wright 2013:177.

Holotype. &, Utah, [Juab County], Eureka, T. Spalding, 30 May 1911, slide 72771, USNM.

Heinrich (1923) described *E. nepotinana* from the male "type" (reported above) and fifteen specimens (13  $^{\circ}$ , 2  $^{\circ}$ ) that he referred to as paratypes.

This species is similar in color and maculation to *E. tenuiana* but is slightly smaller (mean FWL = 6.6 vs. 8.3 mm), lacks the orange-brown bar at the base of the inner margin in the latter species, and flies in the spring rather than the fall.

The genitalia are unlike those of any other Nearctic *Eucosma*: valva with two ridgelike setose projections on the medial surface, one at the distal margin of the basal excavation, the other parallel to the first and displaced slightly toward the ventral margin of the neck; cucullus with the dorsal lobe moderately developed, the apex broadly rounded, the distal margin nearly straight, and the ventral lobe long and fingerlike; sterigma ovate and ringlike; and sternum 7 with two crescent-shaped flaps projecting from the lateral areas of the sternite and aligned with the anterior margin of the ostium. There are a few males in the USNM from Riverside and San Diego counties, California that have unusually narrow valval necks (Plate 44:119e) and might represent a distinct species.

We examined specimens from southern British Columbia, California, Colorado, Idaho, Nevada, Utah, Washington, and Wyoming. Capture dates range from early April to mid-July. Several individuals in the USNM were reared by O. O. Filmore from *Artemisia tridentata* Nutt. (big sagebrush) in Washington and Idaho.

#### 120. Eucosma kramerana (Wright, 2013)

(Plate BB, 120a–b; Plate 45, 120a–e)

Phaneta kramerana Wright 2013:184. Eucosma kramerana: Gilligan and Wright 2013b:310.

**Holotype** (Plate BB:120a; Plate 45:120d). ♀, California, San Bernardino County, Kramer Hills, J A. Powell, 19 April 1958, slide DJW 2109, EME.

*Eucosma kramerana* is known from only a handful of specimens from Inyo, Los Angeles, and San Bernardino counties in California, all collected in mid-April and early May. This is a small moth (mean FWL = 5.8 mm) with a longitudinally streaked gray and white forewing.

Male valva shape resembles that of *E. mayelisana* (species 116) in that the ventral emargination is long and shallow, the ventral margin of the neck is convex, and the ventral lobe of the cucullus is weakly developed, but the two species are not similar in size or forewing appearance. In females the sterigma is somewhat ovoid and ringlike, the lateral lobes of sternum 7 are triangular and strongly developed, and the signa in the corpus bursae are of distinctly different size.

#### 121. Eucosma subminimana (Heinrich, 1923)

(Plate BB, 121a–c; Plate 45, 121a–e)

*Thiodia subminimana* Heinrich 1923:61; McDunnough 1939:45. *Phaneta subminimana*: Powell 1983:34; Brown 2005:496; Wright 2013:181. *Eucosma subminimana*: Gilligan and Wright 2013b:315.

Holotype. &, California, [San Diego County], San Diego, 1–7 August, slide 72776, USNM.

*Eucosma subminimana* was described from fourteen male specimens from San Diego, California. Heinrich (1923) specified the "type" by illustrating its genitalia and referred to the other specimens as paratypes.

This species is a small (mean FWL = 6.1 mm), nondescript, brown moth that is known only from southern California. The male-female association presented here is based on specimens in the USNM, AMNH, and LACM of similar size and appearance that were collected at San Diego and Del Mar, San Diego County, California.

Both sexes have distinctive genitalia: the cucullus shape is unique in Nearctic *Eucosma* (Plate 45:121 a); sternum 7 is semitriangular, with the posterior vertex invaginated to accommodate an ovate sterigma; and a pair of weakly raised ridges emanate from the anterolateral corners of the sterigma and extend parallel to the lateral margins of the sternite.

We examined specimens from Monterey and San Diego counties, California. Adults have been captured from mid-July to early September.

# **122.** *Eucosma alatana* (McDunnough, 1938) (Plate CC, 122a–c; Plate 45, 122a–c)

*Thiodia alatana* McDunnough 1938:100; McDunnough 1939:44. *Phaneta alatana*: Powell 1983:33; Brown 2005:492; Wright 2013:183. *Eucosma alatana*: Gilligan and Wright 2013b:304.

**Holotype** (Plate CC:122a). *(*<sup>3</sup>, British Columbia, Osoyoos, Kreuger Mountain, A. N. Gartrell, 9 May 1936, slide TOR-948, CNC.

For many years this species was known only from the holotype (Plate CC:122a), the genitalia of which have a long narrow "tongue" projecting obliquely from the medial surface of the valva at the distal margin of the basal excavation. Recently, two series of moths have been collected that resemble the holotype in size and genitalia, one by N. Bloomfield in San Diego County, California in the 1990's (Plate CC:122b), the other by J. Nordin in Albany County, Wyoming in 2013 (Plate CC:122c). Because the male genitalia of these various specimens are indistinguishable, we attribute the differences in forewing appearance depicted in the images to intraspecific variation. The female of this species is unknown. Adults were collected in January and February in southern California and in May in British Columbia and Wyoming.

#### 123. Eucosma vogelana (Wright, 2010)

(Plate CC, 123a–d; Plate 46, 123a–e)

*Phaneta vogelana* Wright 2010:137. *Eucosma vogelana*: Gilligan and Wright 2013b:316.

Holotype (Plate CC:123a; Plate 46:123c). ♂, Colorado, Otero County, Vogel Canyon Picnic Area, 15 mi S of La Junta, 4,340 feet, 37.7703° N, 103.5128° W, 18 August 1997, D. J. Wright, slide 137419, USNM.

This is one of the smallest Nearctic *Eucosma* (mean FWL = 5.2 mm). It is tan to brown, nondescript, and known only from the type locality in southeastern Colorado. Forewing appearance is variable, as indicated by the specimens illustrated in Plate CC:123a–d.

Distinctive genitalic features include: socii long and pendulous; ventral emargination of valva deep and U-shaped; neck short and narrow (NR = 0.26) with ventral margin scooped-out; SA approximately 90°; cucullus with dorsal and ventral lobes strongly developed, the latter longer and narrower than the former; lamella postvaginalis elongate (SR = 2.45) and microtrichiate, with posterolateral corners acute and laterally flared.

The type series was collected on 18 August in short grass prairie habitat at Vogel Canyon Picnic Area in the section of Comanche National Grassland along State Route 109 south of La Junta, Colorado.

#### 124. Eucosma latens (Heinrich, 1929)

(Plate CC, 124a–b; Plate 46, 124a–e)

*Thiodia latens* Heinrich 1929:2; McDunnough 1939:44. *Phaneta latens*: Powell 1983:33; Brown 2005:494; Wright 2010:125. *Eucosma latens*: Gilligan and Wright 2013b:310.

Holotype. *A*, California, Tulare County, Monachee Meadows, 8,000 feet, 8–14 July, slide 72769, USNM.

*Eucosma latens* is a poorly known brownish-gray western species (mean FWL = 7.2 mm). There are two phenotypes, one (Plate CC:124a) with a well-defined median fascia and a dark dash on the cubitus representing the subbasal fascia, the other (Plate CC:124b) with brown suffusion in the proximal two-thirds of the forewing that obscures the fasciate markings. The white ocellus and costal strigulae are conspicuous in both phenotypes.

This species is best identified by its genitalia: uncus weakly developed; socii short and stubby; valva with the neck long and narrowing distally; ventral lobe of the cucullus moderately elongate, with the basoventral margin overlapping about one-half of the medial surface of the neck; lamella postvaginalis rectangular and microtrichiate; and sternum 7 bandlike, U-shaped, of moderately uniform width, with posterolateral margins convex. Valva shape is similar to that of *E. labiata* (species 69), but the two species are separated easily by forewing appearance.

We examined specimens from Kern and Tulare counties, California; Lander County, Nevada; and Benton County, Washington. Capture dates range from 24 May to 21 July. Several of the California specimens have labels with the inscription "*Artemisia*."

#### 125. Eucosma baloghi (Wright, 2010)

(Plate CC, 125a–b; Plate 46, 125a–e)

*Phaneta baloghi* Wright 2010:135. *Eucosma baloghi*: Gilligan and Wright 2013b:305.

Holotype (Plate CC:125a). &, New Mexico, Otero County, vic. Holloman Lakes, G. J. Balogh, 14 September 2004, slide 137418, USNM.

This relatively small species (mean FWL = 6.1 mm) has two color forms, yellow (Plate CC:125a) and pale brown (Plate CC:125b), each with dark brown markings. The subbasal fascia is represented by a mark on the cubitus and an associated mark on the inner margin, the median fascia by a pale oblique bar at mid-costa and a more strongly expressed band along the proximal margin of the ocellus. The ocellus is concolorous with the interfascial areas, marked by two fragmented black dashes, and surrounded on three sides by a contrasting brown band.

Genitalia characteristics include: valva with ventral emargination moderate and U-shaped (NR = 0.49), saccular corner angulate (SA = 118°); cucullus with dorsal lobe strongly developed and tapering toward semicircular apex, dorsal one-half of distal margin nearly straight, ventral lobe weakly developed and broadly rounded; tergum 8 with mixture of scales and setae; lamella postvaginalis rectangular and microtrichiate, with lateral margins fused with posterior lobes of sternum 7; and sternum 7 with lateral projections moderately developed and posterolateral margins concavely inflected.

We examined specimens from Cochise and Pima counties, Arizona; Gove County, Kansas; and Cibola, Lincoln, and Otero counties, New Mexico. Adults were collected in August and September.

#### 126. Eucosma metzleri Wright, 2014

(Plate CC, 126a–b; Plate 47, 126a–e)

Eucosma metzleri Wright 2014:195.

**Holotype** (Plate 47:126b). ♂, New Mexico, Otero County, White Sands National Monument, 4,000 feet, E. H. Metzler, 25 August 2009, 32.762° N, 106.189° W, slide 145022, USNM.

This species is similar in size and color to *E. stramineana* (species 87) and to the yellow form of *E. baloghi* (species 125), all three having mean FWL = 6.1 mm. The forewing lacks the thin black line along the termen in *E. stramineana* and the more strongly produced median fascia in *E. baloghi*.

The male genitalia resemble those of *E. baloghi*, but the valval neck is somewhat narrower (NR = 0.37 vs. 0.49), and the ventral lobe of the cucullus is more strongly developed and of nearly the same width as the dorsal lobe. Females of these two species differ in the shape of the lamella postvaginalis: in *E. metzleri* the width increases posteriorly, with that of the posterior margin approximately twice the ostium diameter; in *E. baloghi* the width is uniform and equal to the ostium diameter.

*Eucosma metzleri* is known only from White Sands National Monument, a gypsum dune system in southern New Mexico. The type series was collected on 25 August.

# **127.** *Eucosma fasciculatana* (McDunnough, 1938) (Plate CC, 127a–b; Plate 47, 127a–b)

Thiodia fasciculatana McDunnough 1938:96; McDunnough 1939:44.

*Phaneta fasciculatana*: Powell 1983:33; Brown 2005:493. *Eucosma fasciculatana*: Gilligan and Wright 2013b:308.

**Holotype** (Plate CC:127a; Plate 47:127a). ♂, British Columbia, Penticton, Shingle Creek, A. N. Gartrell, 16 May 1936, slide TOR-994, CNC.

*Eucosma fasciculatana* is known from two specimens with identical collection data, the male holotype and a female paratype (Plate CC:127a–b).

The genitalia of the holotype lack cornuti in the vesica and have a distinctive ridge on the ventral margin of the neck. In the female, the lamella postvaginalis is rectangular and microtrichiate, with lateral margins connected to the posterior lobes of sternum 7 by broad bands of sclerotized membrane; the ductus bursae lacks sclerotization; and the corpus bursae has one signum larger than the other.

# **128.** *Eucosma spectana* (McDunnough, 1938)

(Plate DD, 128a–c; Plate 47, 128a–f)

*Thiodia spectana* McDunnough 1938:100; McDunnough 1939:44. *Phaneta spectana*: Powell 1983:33; Brown 2005:496; Wright 2013:184. *Eucosma spectana*: Gilligan and Wright 2013b:315.

Holotype (Plate DD:128a). <sup>3</sup>, Alberta, Edmonton, K. Bowman, 31 August 1930, TOR-1062, CNC.

*Eucosma spectana* was described from four males collected by K. Bowman at Edmonton, Alberta. The male-female association presented here is based on two mixed-sex series of specimens that were collected by G. Balogh in Billings and Slope counties in North Dakota. This is a small (mean FWL = 6.5 mm) grayish-brown species that is similar in forewing color and maculation to several western *Eucosma* (e.g., *E. tenuiana*, species 117) but which can be identified readily by male genitalia. Individuals from the northern Great Plains often can be recognized by the presence of yellow-brown suffusion in the subcostal area beyond the median fascia.

Genitalic features include: valva with costal margin nearly straight, saccular corner sharply angulate (SA =  $112^{\circ}$ ), ventral emargination moderate (NR = 0.46), neck tapering distally; cucullus with apex circular, distal margin straight, ventral lobe strongly produced and tapering slightly, anal angle rounded, basoventral margin overlapping one-half of medial surface of neck; lamella postvaginalis rectangular and microtrichiate; and sternum 7 with weakly concave posterolateral margins and well-developed pointed lateral extremities. The valva shape resembles that of *E. apacheana* (species 132), but in the latter species the saccular angle is acute, the neck is shorter, and the basoventral margin of the cucullus does not overlap the neck.

We examined specimens from Alberta, Iowa, Montana, Nevada, North Dakota, and South Dakota. Adults fly from late August through September.

#### **129.** *Eucosma southamptonensis* (Heinrich, 1935)

(Plate DD, 129a–b; Plate 48, 129a–b)

Thiodia southamptonensis Heinrich 1935:29; McDunnough 1939:45. Phaneta southamptonensis: Powell 1983:34; Brown 2005:496. Eucosma southamptonensis: Gilligan and Wright 2013b:315. Eucosma urnigera Meyrick 1937:158; McDunnough 1939:48; Clarke 1955:322; Powell 1983:35; Brown 2005:328, new synonymy.

**Types**. *Thiodia southamptonensis*. Holotype.  $\mathcal{J}$ , Canada, Nunavut Territory, Southampton Island, G. M. Sutton, 12 July 1930, CMNH. *Eucosma urnigera*. Syntypes. 2  $\mathcal{J}$ , NE Baffin Land, Ravenscraig Harbour, J. M. Wordie, 1934, depository unknown.

*Eucosma southamptonensis* was described from three males collected on Southampton Island (at the north end of Hudson Bay). Heinrich (1935) illustrated the "type" with a photograph and a genitalia drawing and indicated that the specimen was deposited in the CMNH. We inquired about that specimen, but our contact at the CMNH was unable to locate it. *Eucosma urnigera* was described from two males collected at Ravenscraig Harbour, which is located midway along the northeast shore of Baffin Island, Nunavut Territory. Clarke (1955) was unable to locate the syntypes of *E. urnigera*, and their fate remains unknown. The only information available on this species is Meyrick's description, which agrees with Heinrich's (1935) photograph of the holotype of *T. southamptonensis*. The two species are similar in size (reported by Meyrick and Heinrich to have wingspans of 19 and 18 mm, respectively), and both come from the arctic habitat of northeast Nunavut Territory. For these reasons we consider them to be conspecific.

We examined five specimens in the CNC collected in the Yukon and the Northwest Territories. They have a mean FWL of 9.6 mm and a pale gray forewing with dark gray markings, the latter including a partial subbasal fascia represented by a narrow bar from inner margin to cell, a complete bandlike median fascia, and two or three semitriangular marks on the costa separating the costal strigulae. The male genitalia are illustrated from a specimen collected at Repulse Bay, Northwest Territories. The valval neck is relatively broad (NR = 0.75), and the basoventral margin of the cucullus weakly overlaps about one-third of the medial surface of the neck. The female is unknown. The three types and the CNC material were captured between 26 June and 1 August.

#### 130. Eucosma minimana (Walsingham, 1879)

(Plate DD, 130a-c; Plate 48, 130a-e)

Semasia minimana Walsingham 1879:60.

*Eucosma minimana*: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:311. *Thiodia minimana*: Fernald 1903:462; Heinrich 1923:61; McDunnough 1939:45.

**Lectotype** (designated by Wright 2010).  $\Diamond$ , California, Siskiyou County, Sheep Rock, 3 September 1871, Walsingham, BMNH(E) #819911, slide 5740, BMNH.

*Eucosma minimana* was described from two syntypes  $(1 \circlearrowleft, 1 \supsetneq)$  collected by Walsingham in 1871. It is a small (mean FWL = 5.9 mm) whitish species with black speckling in the proximal one-half of the forewing and black reticulations narrowly edging the ocellus. The median fascia is represented by an oblique bar at mid-costa, and the costal stigulae are delimited by short black dashes. A salt-and-pepper-colored band extends along the termen from tornus to apex.

Phaneta minimana: Powell 1983:34; Brown 2005:494; Wright 2010:125.

Distinctive genitalia features of *E. minimana* include: valva with ventral emargination long and shallow; neck relatively long and broadening somewhat distally; cucullus with dorsal lobe well developed, apex rounded, distal margin convex of nearly uniform curvature, anal angle weakly developed and narrowly rounded; sterigma ovate, with lamella postvaginalis weakly developed; sternum 7 with posterior lobes broad and extending slightly beyond the posterior margin of the sterigma; ductus bursae long, with narrow sclerotized ring located relatively near ostium; and signa nearly equal in size.

We examined 12 specimens from San Diego and Tulare counties, California and Washington County, Utah. They were collected between 26 August and 25 September.

# 131. Eucosma cruentana (Blanchard and Knudson, 1981)

(Plate DD, 131a–b; Plate 48, 131a–d)

*Phaneta cruentana* Blanchard and Knudson 1981:169; Brown 2005:493. *Eucosma cruentana*: Gilligan and Wright 2013b:307.

**Holotype**. *(*), Texas, Anderson County, Engeling Wildlife Management Area, near Tennessee Colony, A. and M. E. Blanchard, 28 June 1978, USNM.

The forewing of *E. cruentana* is essentially two-toned: brownish yellow from costa to CuA<sub>2</sub>, reddish orange from CuA<sub>2</sub> to inner margin. There are two particularly dark reddish-orange marks on the inner margin, one in the subbasal position, the other proximal to the ocellus, the two flanking a paler interfascial spot at mid-wing. The costa is marked from base to apex with short orange-brown dashes associated with the costal strigulae. No other North American *Eucosma* has this forewing apearance. The genitalia have similarities with members of the *griseocapitana* group and the *ochrocelphala* group.

We examined the holotype and 18 paratypes (12 3, 7 9), all deposited in the USNM. They were collected in Anderson County, Texas, one in early October, the others in June.

#### 132. Eucosma apacheana (Walsingham, 1884)

(Plate DD, 132a–c; Plate 49, 132a–g)

Semasia apacheana Walsingham 1884:143. Thiodia apacheana: Fernald 1903:463; Heinrich 1923:48; McDunnough 1939:44. Eucosma apacheana: Barnes and McDunnough 1917:172; Gilligan and Wright 2013b:304. Phaneta apacheana: Powell 1983:33; Brown 2005:492.

**Lectotype** (here designated).  $\bigcirc$ , Arizona, Morrison, 1883, BMNH(E) #819909, slide 11553, BMNH.

Walsingham (1884) described *E. apacheana* from four syntypes  $(1 \ 3, 3 \ 2)$ , all with the same data, and all deposited in the BMNH. The specimen designated here as lectotype is the only one of the four that is dissected. Obraztsov referred to it as the "allolectotype" in his unpublished notes. The undissected females bear BMNH paralectotype labels, and the male is labeled "Paratype 3/3" (K. Tuck, pers. comm.). It appears that Obraztsov intended the male to be the lectotype but did not get around to dissecting it.

This is a small species (mean FWL = 6.0 mm) with a distinctive forewing appearance. The interfascial areas vary from gray to whitish, and the fasciate markings are reddish brown to dark grayish brown. The median fascia is bandlike, extending from mid-costa to inner margin; the subbasal fascia is represented by a semitriangular mark from inner margin to mid-cell; and the distal one-half of the costa has two prominent dark marks that separate the costal strigulae.

Genitalic features include: uncus moderately developed; socii short and stubby; valva with costal margin straight, ventral emargination deep and U-shaped (NR = 0.31), saccular angle slightly acute; cucullus semitriangular, with dorsal lobe undeveloped, distal margin straight, ventral lobe strongly developed, anal angle acute and rounded; lamella postvaginalis tapering posteriorly, width of posterior margin about one-half ostium diameter, sometimes with posterolateral corners flared laterally; and corpus bursae with one signum nearly obsolete.

Powell and Opler (2009) reported larvae feeding on several species of *Gnaphalium* L. We examined specimens from British Columbia, Arizona, California, and Colorado. Capture dates range from 15 March to 19 November.

#### 133. Eucosma ornatula (Heinrich, 1924)

(Plate DD, 133a–b; Plate 49, 133a–f)

*Thiodia ornatula* Heinrich 1924:385; McDunnough 1939:44. *Phaneta ornatula*: Powell 1983:33; Miller 1987:45; Brown 2005:495; Gilligan et al., 2008:98. *Eucosma ornatula*: Gilligan and Wright 2013b:312.

Holotype. ♂, Pennsylvania, Allegheny County, Oak Station, F. Marloff, 21 June 1909, slide 72779, USNM.

Heinrich (1924) described *E. ornatula* from 30 specimens collected in Illinois, Maryland, New Jersey, and Pennsylvania. He placed a "TYPE" label on one male and referred to the other specimens as paratypes, hence the interpretation of the above specimen as a holotype.

*Eucosma ornatula* has a bright white head and a moderately irrorated, dirty white forewing, the latter with ill-defined black and reddish-brown marks on the inner margin representing the subbasal and median fasciae and a reddish-brown subcostal band from mid-costa to apex.

The male valva is similar in shape to that of *E. mayelisana* (species 116) but lacks the ridgelike development at the base of the neck. In females the lamella postvaginalis widens posteriorly to approximately  $1.5 \times$  ostium width, and the signa in the corpus bursae are nearly equal in size.

This species is widely distributed in eastern North America, from the Great Plains to the East Coast. Adults fly from mid-May through August. Putman (1942) reared the larvae from *Lactuca* L. (lettuce).

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# PLATES

Plates A-DD

## **Adult Photos**

## PLATE A

- 1. *Eucosma circulana* Hübner. FWL: 6.6–10.7 mm (mean = 8.3).
  - a. ♂. NTP. Kentucky, McCracken County, ¼ mi WNW Route 60 and Broad Street, 12 August 2008, 37.0619° N, 88.5989° W, D. J. Wright, USNM.
  - b. J. Kentucky, McCracken County, ¼ mi WNW Route 60 and Broad Street, 9 September 2006, L. D. Gibson, LDG.
- 2. *Eucosma gemellana* Heinrich. FWL: 7.2–12.3 mm (mean = 9.3).
  - a. 👌 Florida, Liberty County, Wilma, 30 September 1996, J. Glaser, USNM.
  - b. ♂. Florida, Marion County, Lake Delaney, Ocala National Forest, 11 September 1991, J. S. Kutis, MEM.
- **3.** *Eucosma paragemellana* Gilligan and Wright. FWL: 5.0–7.6 mm (mean = 6.4).
  - a. J. HTP. Alabama, Baldwin County, Weeks Bay NERS, 22 June 2008, D. J. Wright, USNM.
  - b. J. Alabama, Baldwin County, Weeks Bay NERS, 22 June 2008, D. J. Wright, DJW.
- 4. *Eucosma glomerana* (Walsingham). FWL: 7.7–12.7 mm (mean = 10.2).
  - a. &. Iowa, Pocahontas County, Kalsow Prairie, 25 June 1997, D. J. Wright, DJW.
  - b. J. Iowa, Pocahontas County, Kalsow Prairie, 25 June 1997, D. J. Wright, DJW.
  - c. &. Kentucky, Larue County, Thompson Creek, 31 July 2006, L. D. Gibson, LDG.
  - d. 👌. Illinois, Will County, Grant Creek, 3 August, 2000, R. Panzer, DJW.
  - e. J. Texas, Brisco County, Caprock Cyn. State Park, 29-30 August 1994, E. C. Knudson, ECK.
  - f. Q. Texas, Brisco County, Caprock Cyn. State Park, 2-3 September 1996, E. C. Knudson, ECK.
  - g. 3. Illinois, Cook County, Gensburg-Markham Prairie, 9 September 1997, R. Panzer, DJW.
  - h. J. Ohio, Wyandot County, Killdeer Plains Wildlife Area, 16 August 2006, D. J. Wright, DJW.
  - i. J. Ohio, Greene County, Wright-Patterson AFB, 26 August 1992, E. H. Metzler, DJW.



#### PLATE B

- 5. *Eucosma bilineana* Kearfott. FWL: 10.1–14.8 mm (mean = 13.0).
  - a. 👌. Iowa, Pocahontas County, Kalsow Prairie, 22 June 2000, D. J. Wright, DJW.
  - b. J. Iowa, Pocahontas County, Kalsow Prairie, 25 June 1997, D. J. Wright, DJW.
  - c. J. Iowa, Pocahontas County, Kalsow Prairie, 25 June 1997, D. J. Wright, DJW.
  - d. J. Iowa, Pocahontas County, Kalsow Prairie, 18 June 1992, D. J. Wright, DJW.
  - e. Q. Iowa, Howard County, Hayden Prairie, 23 June 1997, D. J. Wright, DJW.
  - f. Q. Iowa, Johnson County, Williams Prairie, 15 June 1992, D. J. Wright, DJW.
- 6. *Eucosma floridana* Kearfott. FWL: 7.5–9.2 mm (mean = 8.5).
  - a. &. Louisiana, Bossier Parish, Barksdale AFB, 13 September 1995, R. L. Brown, MEM.
  - b. &. Louisiana, Bossier Parish, Barksdale AFB, 14 September 1995, R. L. Brown, MEM.
  - c. Q. Florida, Liberty County, Wilma, 30 September 1996, J. Glaser, USNM.
- 7. *Eucosma monogrammana* (Zeller). FWL: 10.5–13.6 mm (mean = 11.9).
  - a. 👌. HTP. Texas, Dallas, J. Boll, BMNH.
  - b. Q. Louisiana, Bossier Parish, Barksdale AFB, 5 May 1996, D. Pollock, MEM.
- 8. *Eucosma giganteana* (Riley). FWL: 8.6–19.0 mm (mean = 12.8).
  - a. 👌. Kentucky, Bullitt County, 7 mi E of Shepherdsville, 8 July 1988, D. J. Wright, DJW.
  - b. &. Ohio, Adams County, 1 mi SE of Lynx, 3 August 1998, D. J. Wright, DJW.
- **9.** *Eucosma bipunctella* (Walker). FWL: 16.0–19.1 mm (mean = 17.5).
  - a. 👌. Ohio, Erie County, Resthaven Wildlife Area, 19 June 1984, E. H. Metzler, USNM.
  - b. 👌 Ohio, Erie County, Resthaven Wildlife Area, 19 June 1984, E. H. Metzler, DJW.



#### PLATE C

- 10. Eucosma landana Kearfott. FWL: 9.8–12.7 mm (mean = 10.9).
   ♂. Wisconsin, Burnett County, vic. Crex Meadows, 27 April 1999, M. Sabourin, DJW.
- **11.** *Eucosma simplex* Kearfott. FWL: 9.3–11.2 mm (mean = 10.1). ♂. Illinois, Cook County, Air Station Prairie S, 17 May 2001, R. Panzer, DJW.
- **12.** *Eucosma rusticana* Kearfott. FWL: 9.0–12.2 mm (mean = 10.5).
  - a. A. Kentucky, Bullitt County, 7 mi E of Shepherdsville, 8 July 1988, D. J. Wright, DJW.
  - b. Q. Illinois, Cook County, Paintbrush Prairie, 17 August 2004, R. Panzer, DJW.
- 13. *Eucosma haydenae* Wright. FWL: 6.9–8.2 mm (mean = 7.3).
  - a. 👌 Iowa, Howard County, Hayden Prairie, 23 June 1997, D. J. Wright, DJW.
  - b. &. Iowa, Howard County, Hayden Prairie, 23 June 1997, D. J. Wright, DJW.
- **14.** *Eucosma paregoria* Brown. FWL: 7.5–10.7 mm (mean = 9.5).
  - a. 👌. HTP. Iowa, Howard County, Hayden Prairie, 23 June 1997, D. J. Wright, USNM.
  - b. Q. Iowa, Howard County, Hayden Prairie, 23 June 1997, D. J. Wright, DJW.
  - c. &. Iowa, Howard County, Hayden Prairie, 23 June 1997, D. J. Wright, DJW.
- **15.** *Eucosma sombreana* Kearfott. FWL: 7.9–12.4 mm (mean = 9.9).
  - a. 👌 Ohio, Adams County, 1 mi SE of Lynx, 27 June 1998, D. J. Wright, DJW.
  - b. J. Ohio, Adams County, 1 mi SE of Lynx, 27 June 1998, D. J. Wright, DJW.
  - c. J. Ohio, Wyandot County, Killdeer Plains Wildlife Area, 16 August 2006, D. J. Wright, DJW.
- 16. *Eucosma decempunctana* (Walsingham). FWL: 6.9–8.4 mm (mean = 7.7).
  - a. 👌. LTP. Oregon, Wasco County, The Dalles, 20 April 1872, Walsingham, BMNH.
  - b. Q. Oregon, Deschutes County, Tomalo State Park, 5 April 1970, J. F. G. Clarke, USNM.
- 17. *Eucosma amphorana* (Walsingham). FWL: 7.1–10.1 mm (mean = 8.3).
  a. ♂. LTP. Oregon, Grant County, Camp Watson, March–April 1872, Walsingham, BMNH.



#### PLATE D

- 17. *Eucosma amphorana* (Walsingham). FWL: 7.1–10.1 mm (mean = 8.3).
  - b. Q. California, Contra Costa County, Antioch, 9 November 1977, J. A. Powell, EME.
  - c. &. California, Santa Barbara County, San Miguel Island, 15 October 1995, J. A. Powell, EME.
  - d. Q. California, Contra Costa County, Antioch NMR, 11 May 1983, J. A. Powell, EME.
- **18.** *Eucosma refusana* (Walker). FWL: 6.9–8.3 mm (mean = 7.7).
  - a. &. HTP. Ontario, St. Martin's Falls, Albany River, 1844, G. Barnston, BMNH.
  - b. J. Alberta, 8 km SE of Sherwood Park, 5 May 2006, G. R. Pohl, GRP.
  - c. Q. Alberta, Strathcona County, 14 May 2006, G. R. Pohl, GRP.
- **19.** *Eucosma verna* (Miller). FWL: 6.9–9.4 mm (mean = 7.9).
  - a. 👌 New York, Tompkins County, Ithaca, Six Mile Road, 17 May 1958, J. G. Franclemont, USNM.
  - b. ♂. New Mexico, Sandoval County, Valles Caldera National Preserve, 22 June 2010, Brown and Monsalve, USNM.
  - c. &. Ohio, Wyandot County, Killdeer Plains Wildlife Area, 1 May 1992, D. J. Wright, DJW.
- **20.** *Eucosma autumnana* (McDunnough). FWL: 6.5–9.6 mm (mean = 7.7).
  - a. &. HTP. Quebec, Lac. Ste. Marie, 7 September 1935, T. N. Freeman, CNC.
  - b. 👌. North Dakota, Billings County, Sully Springs, 7 September 2002, G. J. Balogh, DJW.
  - c. &. Virginia, Fairfax County, Falls Church, 1 October 1950, J. F. G. Clarke, USNM.
- 21. *Eucosma citricolorana* (McDunnough). FWL: 7.3–10.1 mm (mean = 9.0).
  - a. J. PTP. Saskatchewan, Cypress Hills, 5 June 1939, A. R. Brooks, CNC.
  - b. Q. Alberta, near Fort Assiniboine, 22 June 2002, D. Macaulay, CFSE.
  - c. 👌. Wyoming, Albany County, S of Lodgepole Creek, 14 June 2013, J. S. Nordin, DJW.



























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#### PLATE E

- **22.** *Eucosma annetteana* (Kearfott). FWL: 5.3–8.1 mm (mean = 6.6).
  - a. 👌. LTP. Ohio, Hamilton County, Cincinnati, 13 April 1905, A. F. Braun, AMNH.
  - b. Q. PLTP. Ohio, Hamilton County, Cincinnati, 13 April 1905, A. F. Braun, AMNH.
  - c. J. Mississippi, Oktibbeha County, Osborn Prairie, 12 March 2003, R. L. Brown, MEM.
- **23.** *Eucosma millerana* Wright and Brown. FWL: 4.9–6.7 mm (mean = 5.8).
  - a. &. PTP. Mississippi, Oktibbeha County, Osborn Prairie, 26 August 2003, D. J. Wright, DJW.
- **24.** *Eucosma litorea* Wright and Brown. FWL: 5.1–7.7 mm (mean = 6.0).
  - a. 👌. HTP. Alabama, Baldwin County, Bon Secour NWA, 8–9 August 1994, Brown and Pollock, USNM.
  - b. ♂. Alabama, Baldwin County, 1 mi E of Oyster Bay, 10–14 March 1990, R. L. Brown, DJW. [determination tentative]
- **25.** *Eucosma radiatana* (Walsingham). FWL: 10.1–11.0 mm (mean = 10.7).
  - a. *d*. HTP. Eastern North America, BMNH.
  - b. 👌. Indiana, Newton County, Beaver Lake Prairie Preserve, 23 May 1997, E. H. Metzler, DJW.
  - c. &. Connecticut, New Haven, Hamden, 14 June 1967, D. C. Ferguson. USNM.

*Eucosma radiatana* complex. FWL: 6.8–10.4 mm (mean = 9.1).

- d. 👌 Iowa, Johnson County, Williams Prairie, 15 June 1992, D. J. Wright, DJW.
- e. Q. Iowa, Johnson County, Williams Prairie, 15 June 1992, D. J. Wright, DJW.
- f. &. Iowa, Pocahontas County, Kalsow Prairie, 25 June 1997, D. J. Wright, DJW.

#### **26.** *Eucosma formosana* (Clemens). FWL: 8.3–10.0 mm (mean = 9.1).

- a. 👌 Ohio, Wyandot County, Killdeer Plains Wildlife Area, 16 June 1995, D. J. Wright, DJW.
- b. Q. Ohio, Erie County, Resthaven Wildlife Area, 16 June 1999, E. H. Metzler, DJW.
- c. J. Ohio, Wyandot County, Killdeer Plains Wildlife Area, 15 June 1995, D. J. Wright, DJW.



#### PLATE F

- **26.** *Eucosma formosana* (Clemens). FWL: 8.3–10.0 mm (mean = 9.1).
  - d. J. Ohio, Erie County, Resthaven Wildlife Area, 24 May 1991, D. J. Wright, DJW.
  - e. J. Maryland, Garrett County, Meadow Mountain Run Bog, 13 June 2001, J. Glaser, USNM.
  - f. &. Maryland, Garrett County, Potomac State Forest, 23 May 1995, J. Glaser, USNM.
- **27.** *Eucosma umbrastriana* (Kearfott). FWL: 7.9–10.2 mm (mean = 9.0).
  - a. 👌. LTP. Ohio, Hamilton County, Cincinnati, 22 May 1904, A. F. Braun, AMNH.
  - b. Q. PLTP. Manitoba, Aweme, 22 June 1905, N. Criddle, AMNH.
  - c. 👌 New York, Tompkins County, Ithaca, Six Mile Road, 21 May 1959, J. G. Franclemont, USNM.
  - d. &. Kentucky, Laurel County, Junction 121 and 4158, 18 May 1996, D. J. Wright, DJW.
  - e. Q. Kentucky, Laurel County, Junction 121 and 4158, 18 May 1996, D. J. Wright, DJW.
  - f. Q. Connecticut, New Haven County, Hamden, 8 June 1967, D. C. Ferguson, USNM.

*Eucosma roseoterminana* phenotype. FWL: 8.3–10.5 mm (mean = 9.2).

- g. 👌. LTP. Ohio, Hamilton County, Cincinnati, 20 May 1904, A. F. Braun, AMNH.
- h. 👌 Pennsylvania, Beaver County, New Brighton, 24 May 1904, H. D. Merrick, USNM.
- i. Q. Indiana, Lake County, Hessville, 30 May 1908, A. Kwiat, USNM.

*Eucosma umbrastriana* complex. FWL: 7.9–9.3 mm (mean = 8.4).

- j. 👌 Ohio, Erie County, Resthaven Wildlife Area, 24 May 1991, D. J. Wright, DJW.
- 28. *Eucosma albertana* (McDunnough). FWL: 9.1–10.1 mm (mean = 9.6).
  - a. *d*. HTP. Alberta, Lethbridge, 14 June 1922, H. L. Seamans, CNC.
  - b. Q. Alberta, Chin, 8 June 1929, J. H. P., CNC.





















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#### PLATE G

- **29.** *Eucosma essexana* (Kearfott). ♂ FWL: 9.0–11.3 mm (mean = 10.6); ♀ FWL: 8.2–8.9 mm (mean = 8.5).
  - a. J. LTP. New Jersey, Essex County, Caldwell, 22 May 1904, W. D. Kearfott, AMNH.
  - b. Q. PLTP. New Jersey, Essex County, Caldwell, 22 May 1904, W. D. Kearfott, AMNH.
  - c. 👌 Ohio, Wyandot County, Killdeer Plains Wildlife Area, 3 May 2006, T. M. Gilligan, DJW.
- **30.** *Eucosma awemeana* (Kearfott). ♂ FWL: 8.0–10.4 mm (mean = 8.9); ♀ FWL: 7.4–8.2 mm (mean = 7.8).
  - a.  $\circlearrowleft$ . LTP. Manitoba, Aweme, 2 May 1904, N. Criddle, AMNH.
  - b. Q. PLTP. Manitoba, Aweme, 21 May 1904, N. Criddle, AMNH.
  - c. ♂. New York, Tompkins County, Ithaca, Six Mile Road, 2 May 1955, J. G. Franclemont, USNM.
- **31.** *Eucosma ferruginana* (Fernald). FWL: 6.0–7.1 mm (mean = 6.6).
  - a.  $\bigcirc$ . LTP. Massachusetts, C. H. Fernald, USNM.
  - b. J. New Jersey, Essex County, Caldwell, 22 May 190?, W. D. Kearfott, USNM.
  - c. ♂. Virginia, Falls Church, 1–14 May, August Busck, USNM.
- **32.** *Eucosma indeterminana* (McDunnough). ♂ FWL: 7.7–8.9 mm (mean = 8.4); ♀ FWL: 6.6–7.0 mm (mean = 6.8).
  - a. 👌. HTP. Quebec, Aylmer, 20 May 1920, J. McDunnough, CNC.
  - b. Q. PTP. Quebec, Aylmer, 26 May 1920, J. McDunnough, USNM.
  - c. *A.* PTP. Quebec, Aylmer, 26 May 1920, J. McDunnough, USNM.
- **33.** *Eucosma altana* (McDunnough). FWL: 7.2–8.4 mm (mean = 7.9).
  - a. 👌. HTP. British Columbia, Alta Lake, 11 June 1926, J. McDunnough, CNC.
  - b. Q. PTP. British Columbia, Alta Lake, 10 June 1926, J. McDunnough, CNC.
  - c. Q. New Brunswick, Jacquet River, 22 June 1941, T. N. Freeman, CNC.



#### PLATE H

- **34.** *Eucosma artemisiana* (Walsingham). FWL: 8.4–10.0 mm (mean = 9.1).
  - ♂. Montana, Sweet Grass County, 7.75 mi N of Big Timber, 7 August 1969, J. G. Franclemont, USNM.
- **35.** *Eucosma infimbriana* (Dyar). FWL: 7.5–10.4 mm (mean = 9.0).
  - a. 👌. Montana, Sweet Grass County, 7.75 mi N of Big Timber, 17 July 1969, J. G. Franclemont, USNM.
  - b. &. Montana, Sweet Grass County, 7.75 mi N of Big Timber, 27 July 1969, J. G. Franclemont, USNM.
  - c. 👌 Utah, Sanpete County, Ephraim Canyon Road, 9450 feet, 20 July 2006, D. J. Wright, DJW.
- 36. *Eucosma segregata* (Heinrich). FWL: 7.5–8.8 mm (mean = 8.0).
  - a. Q. PTP. California, Tulare County, Monachee Meadows, 16–23 July, USNM.

*Eucosma castrensis* phenotype. FWL: 7.1–8.7 mm (mean = 7.8).

- b. &. HTP. Wyoming, Yellowstone National Park, 25 July 1928, J. McDunnough, CNC.
- c. &. Colorado, Routt County, Steamboat Springs, 18 July 1994, G. J. Balogh, DJW.
- d. &. Utah, Sanpete County, Ephraim County Road, 20 July 2006, D. J. Wright, DJW.
- e. 🖒. Wyoming, Albany County, Medicine Bow National Forest, 4 August 2001, D. J. Wright, DJW.
- f. &. Colorado, Summit County, 5.3 mi S of Frisco, 30 July 2008, D. J. Wright, DJW.
- g. J. Utah, Sanpete County, Ephraim County Road, 17 July 2006, D. J. Wright, DJW.
- h. 🖒. Utah, Sanpete County, Ephraim State Wildlife Management Area, 19 July 2006, D. J. Wright, DJW.

#### 37. *Eucosma setonana* (McDunnough). FWL: 6.1–7.6 mm (mean = 7.0).

- a. J. HTP. British Columbia, Seton Lake, 2 June 1926, J. McDunnough, CNC.
- b. J. PTP. British Columbia, Seton Lake, 7 June 1926, J. McDunnough, USNM.
- **38.** *Eucosma octopunctana* (Walsingham). FWL: 7.1–9.0 mm (mean = 8.2).

♂. Montana, Sweet Grass County, 7.75 mi N of Big Timber, 8 July 1969, J. G. Franclemont, USNM.





















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## PLATE I

- **39.** *Eucosma festivana* (Heinrich). FWL: 5.6–6.5 mm (mean = 6.1).
  - a.  $\bigcirc$ . PTP. Manitoba, Aweme, 7 June 1921, N. Criddle, CNC.
  - b. 👌. Manitoba, Aweme, 7 June 1921, N. Criddle, USNM.
- **40.** *Eucosma youngi* (McDunnough). FWL: 9.0–11.1 mm (mean = 8.8).
  - a. J. HTP. Alberta, Waterton Lakes, 10 July 1923, C. Y. Young, CNC.
  - b. J. Colorado, San Juan County, W side of Engineer Pass, 24 July 2006, T. M. Gilligan, TMG.
- 41. *Eucosma scalana* (Walsingham). FWL: 6.9–7.9 mm (mean = 7.5).
  - a.  $\mathcal{E}$ . Fernald Collection, USNM.
  - b. 👌 California, Monterey County, Bixby Canyon, 23 July 1948, J. W. Tilden, USNM.
- 42. *Eucosma insignata* (Heinrich). FWL: 7.2–9.1 mm (mean = 8.4).
  - a. J. HTP. Colorado, San Juan County, Silverton, 8–15 July, USNM.
  - b. J. Colorado, Chaffee County, Cottonwood Pass, 18 July 1982, R. W. Hodges, USNM.
  - c. 👌 Colorado, Clear Creek County, Mount Evans, near Summit Lake, 18 July 1993, B. Landry, CNC.
  - d. &. Yukon Territory, Montana Mountain, 29 July 2004, C. Schmidt, CNC.
- 43. *Eucosma camdenana* (McDunnough). FWL: 8.2–9.0 mm (mean = 8.6).
  - a. J. HTP. Alaska, W of Kangengevik, July 1914, Jenness, CNC.
  - b. J. Yukon Territory, Dempster Hwy, km 465, 5–7 July 1980, Wood and Lafontaine, CNC.
- 44. *Eucosma calderana* Wright and Gilligan. FWL: 6.2 mm.
  - ♂. HTP. New Mexico, Sandoval County, Valles Caldera National Preserve, 22 June 2010, Brown and Monsalve, USNM.
- **45.** *Eucosma fulvofasciata* Wright and Gilligan. FWL: 5.4–6.7 mm (mean = 6.4).
  - ¿. HTP. Idaho, Oneida County, Curlew National Grassland, 9 July 2006, D. J. Wright, USNM.
- 46. Eucosma robertsoni Wright and Gilligan. FWL: 10.0 mm.
  - Q. HTP. California, Modoc County, Cedar Pass, N of Alturas, 7 August 1990, R. G. Robertson, EME.











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## PLATE J

- 47. *Eucosma perangustana* (Walsingham). FWL: 6.4–9.0 mm (mean = 7.6).
  - a. J. South Dakota, Spearfish Creek, 16 July 1965, R. W. Hodges, USNM.
  - b. ♂. Nevada, Lander County, Toiyabe National Forest, Bob Scott Campground, 31 May 1974, J. F. G. Clarke, USNM.
  - c. ♂. Nevada, Lander County, Toiyabe National Forest, Bob Scott Campground, 31 May 1974, J. F. G. Clarke, USNM.
- **48.** *Eucosma kiskana* (Kearfott). FWL: 5.3–6.0 mm (mean = 5.6).
  - a. 👌 Ohio, Wyandot County, Killdeer Plains Wildlife Area, 16 June 1995, D. J. Wright, DJW.
  - b. J. Ohio, Wyandot County, Killdeer Plains Wildlife Area, 16 June 1995, D. J. Wright, DJW.
  - c. Q. Ohio, Adams County, 1 mi SE of Lynx, 21 May 2009, D. J. Wright, DJW.
- **49.** *Eucosma lapidana* (Walsingham). FWL: 7.7–8.2 mm (mean = 8.0).
  - 3. LTP. Oregon, Jackson County, Crooked River, near Fort Klamath, 21–23 September 1871, Walsingham, BMNH.
- 50. *Eucosma canusana* (Wright). FWL: 7.7–10.0 mm (mean = 9.1).
  - a. J. PTP. Ohio, Adams County, 1 mi SE of Lynx, 2 March 1992, D. J. Wright, DJW.
  - b. &. PTP. Ohio, Adams County, 1 mi SE of Lynx, 2 March 1992, D. J. Wright, DJW.
- **51.** *Eucosma kokana* (Kearfott). FWL: 9.1–11.5 mm (mean = 10.3).
  - a. A. Ohio, Adams County, 1 mi SE of Lynx, 4 November 1994, D. J. Wright, DJW.
  - b. 🗟. Ohio, Adams County, 1 mi SE of Lynx, 4 November 1994, D. J. Wright, DJW.
  - c. Q. Ohio, Adams County, 1 mi SE of Lynx, 4 November 1994, D. J. Wright, DJW.

#### **52.** *Eucosma ambodaidaleia* (Miller). FWL: 8.4–10.5 mm (mean = 9.4).

- a. J. Ohio, Adams County, 1 mi SE of Lynx, 26 March 1993, D. J. Wright, DJW.
- b. J. Ohio, Adams County, 1 mi SE of Lynx, 26 March 1993, D. J. Wright, DJW.
- c. &. Ohio, Adams County, Lynx Preserve, 20 March 1991, D. J. Wright, DJW.



#### PLATE K

- 53. *Eucosma griseocapitana* (Walsingham). FWL: 6.4–9.7 mm (mean = 8.0).
  - a. ♀. LTP. California, Siskiyou County, Mount Shasta, 2 August–1 September 1871, Walsingham, BMNH.
  - b. ♂. California, Siskiyou County, Mount Shasta, 2 August–1 September 1871, Walsingham, BMNH.
  - c. 👌. Idaho, Oneida County, Curlew National Grassland, 1 August 2001, D. J. Wright, DJW.
  - d. Q. Colorado, Fremont County, 4.6 mi SE of Salida, 13 August 1999, D. J. Wright, DJW.
  - e. Q. California, Kern County, Mount Pinos, 9–10 August 1996, J. A. Powell, EME.
  - f. Q. New Mexico, Otero County, White Sands National Monument, 14 September 2006, E. H. Metzler, MSU.
  - g. Q. California, San Luis Obispo County, Oso Flaco Lake, 3 September 1969, J. A. Powell, DJW.

54. *Eucosma linitipunctana* (Blanchard and Knudson). FWL: 7.2–8.5 mm (mean = 7.8).

- a. J. HTP. Texas, Nueces County, North Padre Island, 9 September 1974, A. and M. E. Blanchard, USNM.
- b. A. PTP. Texas, Hemphill County, Canadian, 15 August 1971, A. and M. E. Blanchard, USNM.
- c. &. PTP. Texas, Nueces County, North Padre Island, 9 September 1974, A. and M. E. Blanchard, USNM.
- d. Q. Colorado, Weld County, County Road 91, 7 August 1996, D. J. Wright, DJW.
- **55.** *Eucosma alabamae* Wright and Gilligan. FWL: 6.0–8.1 mm (mean = 7.0).
  - a. 👌. HTP. Alabama, Baldwin County, Bon Secour NWA, 12–16 October 1991, R. L. Brown, USNM.
  - b. Q. Alabama, Baldwin County, Bon Secour NWA, 15 October 1996, T. L. Schiefer, DJW.
  - c. Q. Alabama, Baldwin County, 1 mi E of Oyster Bay, 13 October 1990, R. L. Brown, DJW.
  - d. ♂. North Carolina, Carteret County, Fort Macon State Park, 6 October 1997, J. B. Sullivan, USNM. [determination tentative]



#### PLATE L

- 56. *Eucosma granulatana* (Kearfott). FWL: 6.6–8.3 mm (mean = 7.6).
  - a.  $\bigcirc$ . Colorado, Platte Canyon, E. J. Oslar, USNM.
  - b. ♂. New Mexico, Otero County, White Sands National Monument, 14 September 2009, E. H. Metzler, DJW.
  - c. &. New Mexico, Otero County, vic. Holoman Lakes, 14 September 2004, G. J. Balogh, DJW.
- 57. *Eucosma argutipunctana* (Blanchard and Knudson). FWL: 4.7–7.4 mm (mean = 6.1).
  - a. 👌. Kansas, Morton County, Cimarron National Grassland, 25 August 2000, D. J. Wright, DJW.
  - b. Q. Alabama, Baldwin County, Bon Secour NWA, 20 June 2008, D. J. Wright, DJW.
  - c. Q. Alabama, Baldwin County, Gulf State Park, 25 July 1985, R. L. Brown, MEM.
- **58.** *Eucosma striatana* (Clemens). FWL: 6.2–9.1 mm (mean = 7.8).
  - a. A. Wyoming, Albany County, 12 mi SE of Laramie, 14 July 2001, D. J. Wright, DJW.
  - b. J. Arkansas, Washington County, Devil's Den State Park, 28 May 1966, R. W. Hodges, USNM.
  - c. ♂. Nebraska, Cherry County, Valentine National Wildlife Refuge, 29 June 1983, R. W. Hodges, USNM.
  - d. 👌 New York, Tompkins County, McLean Bog Reserve, 28 May 1959, J. G. Franclemont, USNM.
  - e. 👌. New York, Tompkins County, McLean Bog Reserve, 28 May 1959, J. G. Franclemont, USNM.
- **59.** *Eucosma occidentalis* (Heinrich). FWL: 7.3–9.7 mm (mean = 8.2).
  - a. Q. Oregon, Jackson County, 3 mi N of Gold Hill, 15 May 1970, J. F. G. Clarke, USNM.
  - b. Q. PTP. California, Siskiyou County, Shasta Retreat, 16–23 June, USNM.
  - c. Q. PTP. California, Siskiyou County, Shasta Retreat, 16–23 June, USNM.

#### **60.** *Eucosma implicata* (Heinrich). FWL: 6.7–9.5 mm (mean = 8.3).

a. &. HTP. Washington, Thurston County, Rochester, 13 June 1929, W. W. Baker, USNM.



### PLATE M

- **60.** *Eucosma implicata* (Heinrich). FWL: 6.7–9.5 mm (mean = 8.3).
  - b. 👌 PTP. British Columbia, Wellington, T. Bryant, USNM.
  - c. Q. California, Santa Clara County, Alma, 23 July 1944, G. E. Pollard, AMNH.
  - d. &. HTP. Washington, Thurston County, Rochester, 13 June 1929, W. W. Baker, USNM.
- 61. *Eucosma pallidicostana* (Walsingham). FWL: 6.2–9.2 mm (mean = 7.7).
  - a. &. LTP. California, Lake County, Scott's Valley, 17–19 June 1871, Walsingham, BMNH.
  - b. Q. California, El Dorado County, Greenwood, 21 June 1967, J. A. Powell, DJW.
  - c. 3. Iowa, Pocahontas County, Kalsow Prairie, 22 June 2000, D. J. Wright, DJW.
  - d. 👌 Colorado, Larimer County, 2 mi W of Mishawaka, 12 July 1993, D. J. Wright, DJW.
- 62. *Eucosma clavana* (Fernald). FWL: 6.4–7.6 mm (mean = 7.0).
  - a. Q. Michigan, Allegan County, T2N R14W S26, 22 August 1986, G. J. Balogh, DJW.
  - b. ♂. Connecticut, New Haven County, Milford Point Audubon Center, 2 July 2004, M. Volovski, DJW.

63. *Eucosma indagatricana* (Heinrich). FWL: 5.4–8.3 mm (mean = 7.2).

- a. 👌 Colorado, Baca County, Picture Canyon Picnic Area, 6 August 2005, D. J. Wright, DJW.
- b. 👌 Colorado, Weld County, County Road 386, 26 July 1995, D. J. Wright, DJW.
- c. J. Montana, Carter County, Custer National Forest, 13 August 2004, D. J. Wright, DJW.
- d. J. New Mexico, Taos County, 10 mi SE of Tres Piedras, 11 August 1999, D. J. Wright, DJW.
- e. J. Montana, Carter County, Custer National Forest, 13 August 2004, D. J. Wright, DJW.
- f. J. Utah, Sanpete County, Ephraim Canyon Road, 17 July 2006, D. J. Wright, DJW.



























#### PLATE N

- **64.** *Eucosma misturana* (Heinrich). FWL: 5.7–8.3 mm (mean = 7.0).
  - a.  $\eth$ . California, Los Angeles County, March, USNM.
  - b. Q. California, San Mateo County, Montara, McNee Ranch, 23 March 2003, V. Albu, DJW.
  - c. ♀. California, Alpine County, Ebbetts Pass, 21 June 1962, J. A. Powell, EME. [determination tentative]
- 65. *Eucosma dorsiatomana* (Kearfott). FWL: 7.9–10.4 mm (mean = 9.3).
  - a. Q. Nevada, Lander County, 2 mi N of Austin, Midas Canyon, 2 June 2003, L. L. Crabtree, DJW.
  - b. J. Washington, Whitman County, Wilma, 19 March 1934, J. F. G. Clarke, USNM.
  - c. Q. Colorado, Larimer County, US 287 at Owl Canyon, 29 June 2010, D. J. Wright, DJW.
- 66. *Eucosma salidana* Wright and Gilligan. FWL: 7.1–10.0 mm (mean = 8.7).
  - a. S. Colorado, Fremont County, 4.6 mi SE of Salida, 22 August 1997, D. J. Wright, DJW.
  - b. Q. Colorado, Fremont County, 4.6 mi SE of Salida, 22 August 1997, D. J. Wright, DJW.
  - c. S. New Mexico, Otero County, W of Cloudcroft, 16 September 2004, G. J. Balogh, DJW.
  - d. Q. Colorado, Fremont County, 4.6 mi SE of Salida, 22 August 1997, D. J. Wright, DJW.
- 67. *Eucosma fertoriana* (Heinrich). FWL: 5.4–8.2 mm (mean = 7.3).
  - a. 👌. British Columbia, Peachland, Kathleen Mountain, 23 June 1936, A. N. Gartrell, CNC.
  - b. ♂. South Dakota, Lawrence County, Hardy Work Center, 19 June 1965, R. W. Hodges, USNM.
- 68. *Eucosma crassana* (McDunnough). FWL: 7.1–8.9 mm (mean = 7.7).
  - a. Q. PTP. British Columbia, Osoyoos, 9 May 1936, A. N. Gartrell, CNC.
  - b. Q. PTP. British Columbia, Osoyoos, 9 May 1936, A. N. Gartrell, CNC.
  - c. Q. Alberta, Lethbridge, 21 May 1938, G. S. W., CNC.


























# PLATE O

- **69.** *Eucosma labiata* (Wright). FWL: 5.4–8.3 mm (mean = 6.9).
  - a. Q. Texas, Hemphill County, Canadian, 28 May 1970, A. and M. E. Blanchard, USNM.
  - b. 👌 Wyoming, Albany County, T15N R73W S1, 21 June 2002, J. S. Nordin, DJW.
  - c. &. Colorado, Summit County, 5.3 mi S of Frisco, 30 July 2008, D. J. Wright, DJW.
- **70.** *Eucosma spiculana* (Zeller). FWL: 7.3–12.2 mm (mean = 9.9).
  - a.  $\bigcirc$ . HTP. Texas, Dallas, J. Bohl, MCZ.
  - b. ♀. Washington, Whitman County, Snake River, opposite Clarkston, 13 May 1932, J. F. G. Clarke, USNM.
  - c. Q. New Mexico, Dona Ana County, Aquirre Springs Campground, 15 April 2005, G. J. Balogh, DJW.
  - d. 👌 Michigan, Montcalm County, T12N R10W S18, 5 June 1987, G. J. Balogh, DJW.
- 71. *Eucosma fulvotegulana* Wright and Gilligan. FWL: 6.1–10.5 mm (mean = 8.2).
  - a. J. HTP. Texas, Cottle County, Paducah, 17 April 1968, A. and M. E. Blanchard, USNM.
  - b. Q. Texas, Randall County, Palo Duro Canyon State Park, 15 April 1969, A. and M. E. Blanchard, USNM.
- 72. *Eucosma pecosana* Wright and Gilligan. FWL: 6.6–7.9 mm (mean = 7.2).
  - a. J. HTP. New Mexico, Chaves County, Mescalero Dunes, 22 September 2003, G. J. Balogh, USNM.
  - b. 👌 Colorado, El Paso County, Fountain Valley School, 7 July 1935, F. Ringe, AMNH.
  - c. ♀. New Mexico, Otero County, White Sands National Monument, 10 August 2010, E. H. Metzler, MSU.

### 73. *Eucosma goblinana* (Wright). FWL: 7.4–9.8 mm (mean = 8.6).

- a. Q. Utah, Emery County, T24S R13E S2, 19 May 2003, J. S. Nordin, DJW.
- b. J. Utah, Emery County, Route 24 and Goblin Valley Road, 11 May 2001, J. S. Nordin, DJW.
- c. &. Utah, Emery County, Goblin Valley Road, 11 May 2001, J. S. Nordin, DJW.































# PLATE P

- 74. *Eucosma corculana* (Zeller). FWL: 5.5–9.0 mm (mean = 7.5).
  - a. &. Colorado, Larimer County, 2 mi W of Mishawaka, 12 July 1993, D. J. Wright, DJW.
  - b. Q. Colorado, Chaffee County, 2 mi N of Buena Vista, 15 August 1999, D. J. Wright, DJW.
  - c. Q. Washington, Whitman County, Union Flat, 20 April 1931, J. F. G. Clarke, USNM.
  - d. Q. California, Tuolumne County, Chipmunk Flats, 1 July 1962, J. A. Powell, EME.
  - e. Q. Colorado, Clear Creek County, Summit Lake, Mount Evans, 24 July 1961, E. W. R., CNC.
- 75. *Eucosma arenana* (Wright). FWL: 7.9–10.0 mm (mean = 9.3).
  - a. J. HTP. Utah, Emery County, Goblin Valley Road, 9 May 2007, J. S. Nordin, USNM.
  - b. Q. Utah, Emery County, Goblin Valley Road and Hwy 24, 17 May 2002, J. S. Nordin, DJW.
- 76. *Eucosma mormonensis* (Heinrich). FWL: 6.3–8.7 mm (mean = 7.5).
  - a. ♂. Utah, Sanpete County, Ephraim State Wildlife Management Area, 19 July 2006, D. J. Wright, DJW.
  - b. ♂. New Mexico, Cibola County, Coal Mine Canyon Campground, 9 August 2005, D. J. Wright, DJW.
  - c. Q. New Mexico, Lincoln County, Valley of Fires, 17 August 2005, D. J. Wright, DJW.
  - d. 👌 California, Contra Costa County, Orinda, 26 June 1957, S. F. C., EME.

#### 77. *Eucosma browni* (Wright). FWL: 6.1–8.2 mm (mean = 7.3).

- a. Q. New Mexico, Taos County, 10 mi SE of Tres Piedras, 11 August 1999, D. J. Wright, DJW.
- b. &. New Mexico, Taos County, 10 mi SE of Tres Piedras, 11 August 1999, D. J. Wright, DJW.
- c. &. Wyoming, Albany County, T15N R73W S1, 30 July 2006, J. S. Nordin, DJW.
- d. 👌 Wyoming, Albany County, T15N R73W S1, 12 August 2003, J. S. Nordin, DJW.

























77d



# PLATE Q

- 78. *Eucosma tarandana* (Möschler). FWL: 8.4–13.6 mm (mean = 10.5).
  - a. S. Labrador, USNM.
  - b. &. Labrador, 23 October 1899, USNM.
  - c. 👌 Manitoba, Aweme, 2 August 1915, N. Criddle, USNM.
  - d. 👌 Colorado, Chaffee County, 2 mi S of Poncho Springs, 6–7 August 2010, C. Harp, DJW.
  - e. Q. Colorado, Chaffee County, 2 mi S of Poncho Springs, 6–7 August 2010, C. Harp, DJW.
  - f. J. Wyoming, Albany County, NE of Pole Mountain, 27 June 2001, J. S. Nordin, DJW.
  - g. Saskatchewan, Regina, 18 July 1904, AMNH. [LTP. E. triangulana]
  - h. A. Michigan, Keweenaw County, 2.2 mi W of Copper Harbor, 30 July 2002, G. J. Balogh, DJW.
  - i. ♀. Michigan, Keweenaw County, 2.2 mi W of Copper Harbor, 30 July 2002, G. J. Balogh, DJW.
- 79. *Eucosma transversa* (Walsingham). FWL: 10.1–13.7 mm (mean = 11.8).
  - a. S. LTP. Colorado, Larimer County, Loveland, September 1891, W. G. Smith, BMNH.
  - b. J. Colorado, Mount McClellan, 30 July 1909, USNM.
  - c. Q. Washington, Union Flat, 21 February 1934, J. F. G. Clarke, USNM.
  - d. 👌 Colorado, Teller County, Sanborn Ranch, 19 July 1982, G. J. Balogh, DJW.
  - e. 👌 Colorado, Clear Creek County, Mount Evans, 16 July 1994, G. J. Balogh, DJW.
  - f. A. Colorado, Chaffee County, 2 mi S of Poncho Springs, 5–6 August 2010, C. Harp, DJW.































### PLATE R

- 80. *Eucosma montanana* (Walsingham). FWL: 8.2–12.6 mm (mean = 10.3).
  - a. J. HTP. Montana, Yellowstone River, 1880, H. K. Morrison, BMNH.
  - b. ð. Montana, Carter County, Medicine Rocks State Park, 4 September 2002, G. J. Balogh, DJW.
  - c. &. Michigan, Oceana County, Little Point Sable, 17 August 1991, G. J. Balogh, DJW.
  - d. J. Michigan, Oceana County, Little Point Sable, 17 August 1991, G. J. Balogh, DJW.
  - e. Q. Washington, Kittitas County, Vantage, 21 September 1940, J. F. G. Clarke, USNM.
  - f. &. Texas, Hemphill County, Canadian National Grassland, 9 October 1982, E. C. Knudson, USNM. [HTP. *E. clarkei*].
  - g. &. Texas, Hemphill County, Gene Howe Wildlife Management Area, 18 May 1985, E. C. Knudson, USNM. [PTP. *E. clarkei*]
  - h. J. Manitoba, Aweme, 31 September 1904, N. Criddle, USNM. [PLTP. E. triangulana]
  - i. 👌. Arizona, Mojave County, Rosy Canyon Road, 22 September 2000, G. J. Balogh, DJW. [determination tentative]
- **81.** *Eucosma benjamini* (Heinrich). FWL: 9.2–13.1 mm (mean = 11.1).
  - a. &. HTP. Utah, Utah County, Vineyard, 12 September 1912, T. Spalding, USNM.
  - b. J. PTP. Utah, Utah County, Vineyard, 11 September 1912, T. Spalding, USNM.
  - c. 👌 California, San Bernardino County, Upper Santa Ana River, 9 September 1948, A. L. Melander, USNM.
  - d. &. California, San Diego County, Jacumba, 29 September 1924, USNM.
  - e. Q. California, Los Angeles County, La Tuna Canyon, 16 October 1942, W. H. Evans, USNM.
  - f. Q. California, San Diego County, Torrey Pines State Reserve, 9-16 November 2005, N. Bloomfield, USNM.



# PLATE S

- 82. *Eucosma elongana* (Walsingham). FWL: 8.3–14.2 mm (mean = 11.8).
  - a. ♂. LTP. Oregon, Wasco County, to Fort Dalles, 15–22 April 1872, Walsingham, BMNH.
  - b. J. Colorado, Chaffee County, Cottonwood Pass Road, 14 July 1982, R. W. Hodges, USNM.
  - c. Q. Colorado, Chaffee County, Cottonwood Pass Road, 14 July 1982, R. W. Hodges, USNM.
  - d. 👌 Oregon, Baker County, Baker, Spring Creek, 3 June 1969, J. H. Baker, USNM.
  - e. 👌 Colorado, San Juan County, Silverton, 16–23 July, USNM.
  - f. Q. Colorado, San Juan County, Silverton, 16–23 July, USNM.
- **83.** *Eucosma rupestrana* (McDunnough). FWL: 8.2–11.3 mm (mean = 9.7).
  - a. &. HTP. Alberta, Nordegg, 19 June 1921, J. McDunnough, CNC.
  - b. Q. South Dakota, Black Hills, 14 June 1991, G. J. Balogh, DJW.
  - c. &. Michigan, Chippewa County, Maxton Plain, 25 May 1991, G. J. Balogh, DJW.
  - d. *A*. PTP. British Columbia, Laggan, T. E. Bean, USNM.
  - e. S. Ontario, S March, 30 May 1941, J. McDunnough, CNC. [HTP. E. vernalana]
  - f. &. Colorado, Jefferson County, Golden, Chimney Gulch, June, E. J. Oslar, USNM. [determination tentative]
  - g. ♂. California, Lassen County, 4 mi E of Bieber, Hwy 299, 26 June 2010, L. L. Crabtree, DJW. [determination tentative]

### **84.** *Eucosma umbraticana* (Heinrich). FWL: 10.6–10.7 mm (mean = 10.7).

- a. 👌 HTP. Colorado, Jefferson County, foothills above Golden, 13 March 1901, Dyar and Caudell, USNM.
- b. &. Colorado, Platte Canyon, E. J. Oslar, USNM.



# PLATE T

- **85.** *Eucosma offectalis* (Hulst). FWL: 10.8–15.8 mm (mean = 12.6).
  - a. 👌 Colorado, Clear Creek County, Loveland Pass, 23 July 1988, P. A. Opler, DJW.
  - b. J. Wyoming, Albany County, Pelton Creek, 8 July 2003, J. S. Nordin, DJW.
  - c. ♀. Colorado, Chaffee County, 2.5 mi ESE of Buena Vista, 23 August 1997, D. J. Wright, DJW.
  - d. Q. Wyoming, Albany County, Upper Blair Picnic Area, 22 July 2003, J. S. Nordin, DJW.
  - e. J. Colorado, Alamosa County, Great Sand Dunes, 28 June 1982, R. W. Hodges, USNM.
  - f. &. Arizona, Cochise County, Cave Creek Canyon, 19 March 1966, J. G. Franclemont, USNM.
  - g. Q. Arizona, Cochise County, Ramsey Canyon, 16 August 1954, J. A. C., LACM.
  - h. J. Arizona, Cochise County, Pueblo Del Sol, 28 March 1986, R. S. Wielgus, USNM.
  - i. Q. California, San Luis Obispo County, Oso Flaco Lake, 20 March 1974, J. A. Powell, EME.

**86.** *Eucosma pastigiata* (Heinrich). FWL: 6.7–9.8 mm (mean = 8.2).

- a. *C*. PTP. California, Tulare County, Monachee Meadows, 8–14 July, USNM.
- b. ♂. Colorado, Alamosa County, Sand Dunes Staff Quarters, 17 June 1982, R. W. Hodges, USNM.
- c. ♂. Colorado, Alamosa County, Great Sand Dunes, Mosca Creek, 22 June 1982, R. W. Hodges, USNM.
- **87.** *Eucosma hodgesi* (Wright and Gilligan). FWL: 6.0–8.1 mm (mean = 7.1).
  - a. 👌. HTP. Colorado, Alamosa County, Zapata Ranch, 26 June 1982, R. W. Hodges, USNM.
  - b. Q. California, Lassen County, Turtle Mountain, 2 July 2003, L. L. Crabtree, DJW.
  - c. ♂. California, San Bernardino County, Apple Valley, 20 May 1955, J. E. M., CNC. [determination tentative]



























# PLATE U

- **88.** *Eucosma stramineana* (Walsingham). FWL: 5.6–6.6 mm (mean = 6.1).
  - a. *C*. LTP. Colorado, Denver, July 1872, Walsingham, BMNH.
  - b. ð. Wyoming, Albany County, T15N R73W S1, 15 July 2004, J. S. Nordin, DJW.
  - c. 👌. Wyoming, Albany County, T15N R73W S1, 12 July 2001, J. S. Nordin, DJW.
- **89.** *Eucosma parvana* (Walsingham). FWL: 5.0–6.4 mm (mean = 5.9).
  - a. J. LTP. Oregon, Grant County, Camp Watson, April 1872, Walsingham, BMNH.
  - b. J. PLTP. Oregon, Grant County, Camp Watson, April 1872, Walsingham, BMNH.
  - c. &. California, Tulare County, Scodie Meadow, 25 April 1976, J. P. Donahue, LACM.
- **90.** *Eucosma clementeana* (Wright). FWL: 5.4–8.0 mm (mean = 6.3).
  - a. 👌. California, Los Angeles County, San Clemente Island, 1 October 2002, J. A. Powell, EME.
  - b. Q. California, Los Angeles County, San Clemente Island, 8 October 2002, J. A. Powell, EME.
  - c. 👌. California, San Diego County, 5 mi NE of Boulevard, October 1967, J. A. Powell, EME.
- **91.** *Eucosma grindeliana* (Busck). FWL: 4.4–9.0 mm (mean = 6.2).
  - a. &. PTP. Texas, Donley County, Clarendon, 19 September 1905, W. D. Pierce, USNM.
  - b. ð. Kansas, Morton County, Cimarron National Grassland, 25 August 2000, D. J. Wright, DJW.
  - c. Q. Kansas, Morton County, Cimarron National Grassland, 25 August 2000, D. J. Wright, DJW.
  - d. 👌 Florida, Marion County, Marion Oaks, 22 May 1990, J. S. K., MEM.
  - e. 👌 Florida, Suwannee County, Suwannee River State Park, 17–20 May 1987, H. D. Baggett, MEM.
  - f. 👌. California, San Diego, 5 mi NE of Boulevard, 5 October 1967, J. A. Powell, EME.



























# PLATE V

- 92. *Eucosma convergana* (McDunnough). FWL: 7.6–8.7 mm (mean = 8.1).
  - a.  $\mathcal{E}$ . HTP. Manitoba, Aweme, 21 May 1922, N. Criddle, CNC.
  - b. 🖧 PTP. Manitoba, Aweme, 21 May 1922, N. Criddle, USNM.
  - c. 👌 Indiana, Lake County, Dupont Dune and Swale, 10 May 2005, R. Panzer, DJW.
- 93. *Eucosma modernana* (McDunnough). FWL: 7.7–8.0 mm (mean = 7.8).
  - a. *(*<sup>3</sup>. HTP. Quebec, Aylmer, 27 May 1919, J. McDunnough, CNC.
  - b. &. Massachusetts, Hampshire County, Amherst, 5 May 1909, Goodell, USNM.

#### **94.** *Eucosma parmatana* (Clemens). FWL: 4.6–7.8 mm (mean = 6.0).

- a. A. Ohio, Adams County, 1 mi SE of Lynx, 21 August 1993, D. J. Wright, DJW.
- b. S. Ohio, Adams County, 1 mi SE of Lynx, 21 August 1993, D. J. Wright, DJW.
- c. Q. Ohio, Adams County, 1 mi SE of Lynx, 21 August 1993, D. J. Wright, DJW.
- d. ♀. Colorado, Larimer County, Viestenz Smith Mountain Park, 27 July 1995, D. J. Wright, DJW.
- e. &. Maryland, Plummer's Island, USNM. [HTP. E. alterana]
- f. &. Maine, York County, Kennebunkport, August, G. H. Clapp, AMNH. [LTP. *E. kennebeckana*]
- g. *(*). Nova Scotia, White Point Beach, 15 August 1963, J. McDunnough, CNC. [HTP. *E. sinestrigana*]
- h. &. Pennsylvania, Susquehanna County, Dimock, 3 August 1987, D. F. Bray, USNM.
- i. 👌 Ohio, Adams County, 1 mi SE of Lynx, 12 August 1998, D. J. Wright, DJW.
- j. Q. Ohio, Hamilton County, Miami Whitewater Park, 2 September 1988, D. J. Wright, DJW.



### **PLATE W**

- **94.** *Eucosma parmatana* (Clemens). FWL: 4.6–7.8 mm (mean = 6.0).
  - k. ♂. Maine, Baxter State Park, 15 July 1989, G. J. Balogh, DJW. [*E. crispana* phenotype]
  - Q. Wisconsin, Villas County, W side of Carlin Lake, 1 July 1986, G. J. Balogh, DJW. [*E. crispana* phenotype]
  - m. J. Pennsylvania, Allegheny County, Oak Station, 19 August 1909, F. Marloff, USNM. [HTP. *E. perfuscana*]
  - n. A. North Carolina, Macon County, Highlands, 4 August 1958, J. G. Franclemont, USNM. *[E. perfuscana* phenotype]
  - o. *(*). Manitoba, Rounthwaite, 11 July 1905, L. E. Marmont, AMNH. [HTP. *E. marmontana*]
  - p. Q. Manitoba, Rounthwaite, 11 July 1905, L. E. Marmont, USNM. [PTP. *E. marmontana*]

**95.** *Eucosma oregonensis* (Heinrich). FWL: 6.7–9.5 mm (mean = 8.5).

- a. ♂. HTP. Oregon, Klamath County, Crater Lake, 24–31 July, USNM.
- b. 👌 PTP. Oregon, Klamath County, Crater Lake, 24–31 July, USNM.
- c. Q. PTP. Oregon, Klamath County, Crater Lake, 24–31 July, USNM.
- **96.** *Eucosma ochroterminana* (Kearfott). FWL: 4.8–6.2 mm (mean = 5.4).
  - a. 👌 Ohio, Hamilton County, Cincinnati, 11 August 2007, D. J. Wright, DJW.
  - b. J. Ohio, Wyandot County, Killdeer Plains Wildlife Area, 16 August 2006, D. J. Wright, DJW.
- **97.** *Eucosma tomonana* (Kearfott). FWL: 5.3–7.3 mm (mean = 6.4)
  - a. 👌 Ohio, Adams County, Chaparral Prairie, 6 September 1991, D. J. Wright, DJW.
  - d. Q. Ohio, Adams County, Chaparral Prairie, 6 September 1991, D. J. Wright, DJW.

#### **98.** *Eucosma raracana* (Kearfott). FWL: 4.8–6.4 mm (mean = 5.7)

- a. A. Ohio, Adams County, 1 mi SE of Lynx, 10 September 1988, D. J. Wright, DJW.
- b. ♀. Ohio, Wyandot County, Killdeer Plains Wildlife Area, 16 August 2006, D. J. Wright, DJW.































### PLATE X

#### **99.** *Eucosma ochrocephala* (Walsingham). FWL: 6.4–8.2 mm (mean = 7.2).

- a. 👌 Ohio, Adams County, Chaparral Prairie, 19 August 1998, D. J. Wright, DJW.
- b. Q. Kentucky, Bracken County, Meldahl Dam, 4 August 1994, D. J. Wright, DJW.
- c. 👌. Ohio, Wyandot County, Killdeer Plains Wildlife Area, 16 August 2006, D. J. Wright, DJW.

#### **100.** *Eucosma sableana* Wright and Gilligan. FWL: 6.3–7.6 mm (mean = 7.1).

- a.  $\bigcirc$ . Nova Scotia, Sable Island, 11–13 August 1978, D. C. Ferguson, USNM.
- b. Q. Nova Scotia, Sable Island, 11–13 August 1978, D. C. Ferguson, USNM.
- c. Q. Nova Scotia, Sable Island, 11–13 August 1978, D. C. Ferguson, USNM.

#### **101.** *Eucosma verniochreana* (Heinrich). FWL: 5.0–6.9 mm (mean = 5.8).

- a. *C*. PTP. New Jersey, Burlington County, Mount Holly, 19 August 1906, USNM.
- b. J. Massachusetts, Barnstable County, Barnstable, 18 August 1959, C. P. Kimball, MCZ.
- c. J. Massachusetts, Barnstable County, Barnstable, 11 August 1952, C. P. Kimball, MCZ.

#### **102.** *Eucosma knudsoni* Wright and Gilligan. FWL: 5.7–8.1 mm (mean = 7.0)

- a. Q. New Mexico, Lincoln County, Valley of Fires, 19 August 2005, D. J. Wright, DJW.
- b. Q. New Mexico, Lincoln County, Valley of Fires, 17 August 2005, D. J. Wright, DJW.
- c. Q. New Mexico, Lincoln County, Valley of Fires, 17 August 2005, D. J. Wright, DJW.

### **103.** *Eucosma olivaceana* (Riley). FWL: 6.3–9.1 mm (mean = 7.8)

- a. 👌. Iowa, Pocahontas County, Kalsow Prairie, 18 July 2003, D. J. Wright, DJW.
- b. Q. Ohio, Erie County, Resthaven Wildlife Area, 16 July 1996, D. J. Wright, DJW.
- c. Q. Ohio, Erie County, Resthaven Wildlife Area, 12 July 1996, D. J. Wright, DJW.



# PLATE Y

- **104.** *Eucosma viridis* (Wright and Gilligan). FWL: 6.0–8.7 mm (mean = 8.1).
  - a. 👌. HTP. Arizona, Coconino County, Hart Prairie, 24 July 1961, R. W. Hodges, USNM.
  - b. Q. Arizona, Coconino County, Fort Valley, 2 August 1961, R. W. Hodges, USNM.

#### **105.** *Eucosma modicellana* (Heinrich). FWL: 4.8–6.6 mm (mean = 5.9).

- a. 👌 Colorado, Fremont County, 4.6 mi SE of Salida, 22 August 1997, D. J. Wright, DJW.
- b. J. Colorado, Larimer County, US 287 at Owl Canyon, 29 June 2010, D. J. Wright, DJW.
- c. J. Colorado, Larimer County, US 287 at Owl Canyon, 29 June 2010, D. J. Wright, DJW.
- d. 👌 Colorado, Larimer County, US 287 at Owl Canyon, 29 June 2010, D. J. Wright, DJW.

### **106.** *Eucosma pallidarcis* (Heinrich). FWL: 4.9–7.3 (mean = 6.1).

- a. 👌. California, Santa Barbara County, Monticeto, 13 July 1945, C. W. K., LACM.
- b. J. Colorado, Weld County, County Road 91, N of I-76, 26 July 1995, D. J. Wright, DJW.
- c. 👌. Idaho, Oneida County, 5 mi ENE of Holbrook, 9 July 2006, D. J. Wright, DJW.
- **107.** *Eucosma cibolana* (Wright). FWL: 6.9–8.0 mm (mean = 6.7).
  - a. Q. HTP. New Mexico, Cibola County, Lobo Canyon Picnic Area, 9 August 2005, D. J. Wright, USNM.
  - b. S. New Mexico, Cibola County, 11 mi NE of Grants, 8 August 2005, D. J. Wright, DJW.

### 108. *Eucosma parvula* (Wright). FWL: 4.9–5.6 mm (mean = 5.2).

- a. 👌. HTP. Idaho, Oneida County, Curlew National Grassland, 28 July 2003, D. J. Wright, USNM.
- b. J. Utah, Uintah County, 3 mi N of Vernal, 4 September 2000, D. J. Wright, DJW.

### **109.** *Eucosma patagoniana* Wright. FWL: 5.2–7.1 mm (mean = 6.4).

- a. J. HTP. Arizona, Santa Cruz County, 8 mi SSE of Patagonia, 5 August 1999, D. J. Wright, USNM.
- b. ♀. Arizona, Cochise County, SW Research Station, Chiracahua Mountains, 13 August 2012, J. W. Brown, USNM.





























# PLATE Z

**110.** *Eucosma influana* (Heinrich). FWL: 6.2–8.2 mm (mean = 7.2).

- a. J. HTP. California, Siskiyou County, Shasta Retreat, 1–7 July, USNM.
- b. ♂. New Mexico, Socorro County, Gran Quivira National Monument, 1–3 July 1964, D. R. Davis, USNM. [HTP. *E. musetta*]
- c. Q. Texas, Tarrant County, Benbrook Reservoir, 20 April 1978, E. C. Knudson, USNM. [PTP. *E. musetta*]
- d. 👌. Oregon, Wallowa County, Wallowa Lake, 19 June 1970, J. F. G. Clarke, USNM.
- e. &. Iowa, Pocahontas County, Kalsow Prairie, 18 June 1992, D. J. Wright, DJW.
- f. 👌. Nebraska, Cherry County, Valentine NWR, 29 June 1983, R. W. Hodges, USNM.

### 111. *Eucosma migratana* (Heinrich). FWL: 6.4–9.8 mm (mean = 8.3).

- a. J. HTP. California, Inyo County, Olancha, 24–30 April, USNM.
- b. J. Wyoming, Albany County, T15N R73W S1, 31 May 2003, J. S. Nordin, DJW.
- c. S. California, Kern County, Mojave, 28 March 1968, J. A. Powell, EME.
- d. Q. Colorado, Alamosa County, Great Sand Dunes, Mosca Creek, 16 June 1982, R. W. Hodges, USNM.
- e. 👌 Oregon, Deschutes County, 8 mi E of Sisters, 25 April 1965, K. Goeden, USNM.

### 112. Eucosma complicana (McDunnough). FWL: 7.4.

- a. J. HTP. British Columbia, Osoyoos, 19 May 1923, C. B. Garrett, CNC.
- **113.** *Eucosma columbiana* (Walsingham). FWL: 6.0–8.6 mm (mean = 7.3)
  - a. 👌 Oregon, Jackson County, Mount Ashland Road, 2 May 1970, J. F. G. Clarke, USNM.
  - b. J. Nevada, Clark County, Charleston Mountains, Kyle Canyon, 26 April 1950, E. C. Johnston, CNC.
  - c. Q. New Mexico, Otero County, White Sands National Monument, 23 April 2009, E. H. Metzler, MSU.































# PLATE AA

#### 114. *Eucosma bucephaloides* (Walsingham). FWL: 8.7–16.5 mm (mean = 12.6).

- a. S. Colorado, Mesa County, Lands End Road, 2 September 2000, D. J. Wright, DJW.
- b. J. California, Modoc County, 6 mi E of Cedarville, 19 August 2009, L. L. Crabtree, DJW.
- c. S. New Mexico, Taos County, 10 mi SE of Tres Piedras, 11 August 1999, D. J. Wright, DJW.
- d. Q. Idaho, Oneida County, Curlew National Grassland, 28 July 2003, D. J. Wright, DJW.
- e. S. Wyoming, Albany County, T15N S73W S1, 16 August 2002, C. D. Ferris, DJW.
- f. Q. California, San Bernardino County, Green Canyon, 28 August 1968, C. H., LACM.
- g. Q. California, Mono County, Dunes NE of Mono Lake, 4 August 1995, R. Robertson, DJW.
- h. J. California, Mono County, Dunes NE of Mono Lake, 4 August 1995, R. Robertson, DJW.
- i. &. California, Mojave Desert, 10 May 1931, LACM.

#### 115. *Eucosma salmicolorana* (Heinrich). FWL: 5.9–9.1 mm (mean = 7.6).

- a. A. Idaho, Oneida County, 5 mi SSE of Holbrook, 1 August 2001, D. J. Wright, DJW.
- b. J. Wyoming, Albany County, Happy Jack Road, 24 July 2003, D. J. Wright, DJW.
- c. J. Wyoming, Albany County, 10 mi ESE of Laramie, 16 July 2001, D. J. Wright, DJW.
- 116. *Eucosma mayelisana* (Blanchard). FWL: 9.3–11.0 mm (mean = 10.5).
  - a. 👌. HTP. Texas, Cottle County, Matador WMA, 17 April 1968, A. and M. E. Blanchard, USNM.
  - b. J. Utah, Emery County, Route 24 and Goblin Valley Road, 11 May 2001, J. S. Nordin, DJW.
  - c. 👌 Colorado, Washington County, Prewitt Reservior State Wildlife Area, 2 June 1989, P. A. Opler, DJW.































# PLATE BB

117. *Eucosma tenuiana* (Walsingham). FWL: 7.0–9.4 mm (mean = 8.3).

- a. &. Colorado, Grand County, Beaver Creek, 25 August 1997, D. J. Wright, DJW.
- b. J. Colorado, Grand County, Beaver Creek, 25 August 1997, D. J. Wright, DJW.
- c. &. Nevada, Esmeralda County, Mount Magruder, 19 September 1939, B. Willett, USNM.
- d. Q. Colorado, Grand County, Beaver Creek, 25 August 1997, D. J. Wright, DJW.

#### 118. *Eucosma donahuei* (Wright). FWL: 6.8–7.9 mm (mean = 7.3).

- a. J. California, Kern County, Piute Mountains, Rancheria Creek, 1–3 July 1973, J. P. Donahue, LACM.
- b. 👌 California, Inyo County, Lone Pine, 15 May 2009, V. Albu, DJW.

#### **119.** *Eucosma nepotinana* (Heinrich). FWL: 4.3–7.8 mm (mean = 6.6).

- a. J. HTP. Utah, Juab County, Eureka, 30 May 1911, T. Spalding, USNM.
- b. J. British Columbia, Summerland, 1 June 1935, A. N. Gartrell, CNC.
- c. &. Nevada, Lander County, Bob Scott Campground, 1 June 1974, J. F. G. Clarke, USNM.
- d. 👌 Colorado, Routt County, Steamboat Lake, 7–8 July 1993, J. A. Powell, EME.

#### **120.** *Eucosma kramerana* (Wright). FWL: 5.3–6.5 mm (mean = 5.8).

- a. Q. HTP. California, San Bernardino County, Kramer Hills, 19 April 1958, J. A. Powell, EME.
- b. &. California, San Bernardino County, Kramer Hills, 19 April 1958, J. A. Powell, EME.

#### **121.** *Eucosma subminimana* (Heinrich). FWL: 5.0–7.1 mm (mean = 6.1).

- a. 👌. California, San Diego County, San Diego, 16–23 August, USNM.
- b. 👌. California, San Diego County, Del Mar, 15 August 1942, LACM.
- c. Q. California, San Diego County, Del Mar, 31 August 1942, LACM.















118b



121b











# PLATE CC

#### **122.** *Eucosma alatana* (McDunnough). FWL: 6.1–8.1 mm (mean = 7.3).

- a. J. HTP. British Columbia, Kreuger Mountain, 9 May 1936, A. N. Gartrell, CNC.
- b. &. California, San Diego County, MCAS Miramar, 17 January 1998, N. Bloomfield, USNM.
- c. S. Wyoming, Albany County, T15N R73W S1, 14 May 2013, J. S. Nordin, JSN.

### **123.** *Eucosma vogelana* (Wright). FWL: 4.8–6.0 mm (mean = 5.2).

- a. J. HTP. Colorado, Otero County, Vogel Canyon Picnic Area, 18 August 1997, USNM.
- b. Q. Colorado, Otero County, Vogel Canyon Picnic Area, 18 August 1997, DJW.
- c. Q. Colorado, Otero County, Vogel Canyon Picnic Area, 18 August 1997, DJW.
- d. Q. Colorado, Otero County, Vogel Canyon Picnic Area, 18 August 1997, DJW.

### **124.** *Eucosma latens* (Heinrich). FWL: 6.4–7.6 mm (mean = 7.2).

- a. 👌. California, Kern County, McGill Campground, Mount Pinos, 18 June 1981, J. A. Powell, EME.
- b. 👌 California, Kern County, McGill Campground, Mount Pinos, 18 June 1981, J. A. Powell, EME.

### **125.** *Eucosma baloghi* (Wright). FWL: 5.3–6.5 mm (mean = 6.1).

- a. J. HTP. New Mexico, Otero County, vic. Holloman Lakes, 14 September 2004, G. J. Balogh, USNM.
- b. J. Kansas, Gove County, Monument Rocks, 24 September 1999, G. J. Balogh, DJW.

### **126.** *Eucosma metzleri* Wright. FWL: 5.7–6.6 mm (mean = 6.1).

- a. 👌 New Mexico, Otero County, White Sands National Monument, 25 August 2009, E. H. Metzler, MSU.
- b. Q. New Mexico, Otero County, White Sands National Monument, 25 August 2009, E. H. Metzler, MSU.

### **127.** *Eucosma fasciculatana* (McDunnough). FWL: 7.4–8.7 mm (mean = 7.9).

- a. J. HTP. British Columbia, Penticton, 16 May 1936, A. N. Gartrell, CNC.
- b. Q. PTP. British Columbia, Penticton, 16 May 1936, A. N. Gartrell, CNC.























127b



### PLATE DD

**128.** *Eucosma spectana* (McDunnough). FWL: 5.5–7.4 mm (mean = 6.5).

- a.  $\mathcal{E}$ . HTP. Alberta, Edmonton, 31 August 1930, CNC.
- b. &. Alberta, Edmonton, 31 August 1936, UASM.
- c. 👌 North Dakota, Slope County, Columnar Juniper Area, 3 September 2002, G. J. Balogh, DJW.

### **129.** *Eucosma southamptonensis* (Heinrich). FWL: 9.2–10.0 mm (mean = 9.6).

- a. *(*<sup>3</sup>). Northwest Territories, Repulse Bay, 28 July 1950, J. E. H. M, CNC.
- b. J. Northwest Territories, Dempster Highway, km 491, 26 June 1960, Wood and Lafontaine, CNC.
- 130. *Eucosma minimana* (Walsingham). FWL: 5.0–7.2 mm (mean = 5.9).
  - a. J. Utah, Washington County, S Beaver Dam Mountains, 25 September 2000, G. J. Balogh, DJW.
  - b. Q. Utah, Washington County, S Beaver Dam Mountains, 25 September 2000, G. J. Balogh, DJW.
  - c. J. Utah, Washington County, S Beaver Dam Mountains, 25 September 2000, G. J. Balogh, DJW.
- **131.** *Eucosma cruentana* (Blanchard and Knudson). FWL: 7.2–7.8 mm (mean = 7.4).
  - a. 👌. Texas, Anderson County, Tennessee Colony, 28 June 1978, A. and M. E. Blanchard, USNM.
  - b. J. Texas, Anderson County, Tennessee Colony, 28 June 1978, A. and M. E. Blanchard, USNM.
- **132.** *Eucosma apacheana* (Walsingham). FWL: 4.9–8.0 mm (mean = 6.0).
  - a. J. Colorado, Douglas County, 8 mi NNW of Castle Rock, 24 July 2000, A. D. Warren, ADW.
  - b. ♂. California, San Diego County, Torrey Pines State Reserve, 1–8 October 2005, N. Bloomfield, USNM.
  - c. Q. California, Siskiyou County, Shasta Retreat, 16–23 August, USNM.

### **133.** *Eucosma ornatula* (Heinrich). FWL: 5.1–6.9 mm (mean = 6.3).

- a. 👌. Kentucky, Bracken County, Meldahl Dam, 24 August 1994, D. J. Wright, DJW.
- b. J. Ohio, Adams County, 1 mi SE of Lynx, 3 August 1998, D. J. Wright, DJW.































Plates 1–49

# **Genitalia Drawings**



PLATE 1. 1. *Eucosma circulana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. 2. *E. gemellana*: a, male; b–c, valvae; d, sterigma/sternum 7. 3. *E. paragemellana*: a, male; b–c, valvae; d, sterigma/sternum 7.


PLATE 2. 4. *Eucosma glomerana*: a, male; b–e, valvae; f, female; g, sterigma/sternum 7. 5. *E. bilineana*: a, male; b–c, valvae; d, sterigma/sternum 7. 6. *E. floridana*: a, male; b–c, valvae; d, sterigma/sternum 7



PLATE 3. 7. *Eucosma monogrammana*: a, male; b–c, valvae; d, sterigma/sternum 7. 8. *E. giganteana*: a, male; b–c, valvae; d, papillae anales/tergum 8, sterigma/sternum 7. 9. *E. bipunctella*: a, male; b–c, valvae; d, sterigma/sternum 7. 10. *E. landana*: a, male; b–c, valva; d, sterigma/sternum 7.



PLATE 4. **11**. *Eucosma simplex*: a, male; b–c, valvae; d, sterigma/sternum 7. **12**. *E. rusticana*: a, male; b–c, valvae; d, sterigma/ sternum 7. **13**. *E. haydenae*: a, male; b–d, valvae; e, female; f, sterigma/sternum 7.



PLATE 5. 14. *Eucosma paregoria*: a, male; b–c, valvae; d, papillae anales/tergum 8; e, sterigma/sternum 7; f, corpus bursae. 15. *E. sombreana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 6. **16.** *Eucosma decempunctana*: a, male; b, valva; c, valva, LTP; d, female; e, sterigma/sternum 7. **17.** *E. amphorana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 7. **18.** *Eucosma refusana*: a, male; b–c, valvae; d, sterigma/sternum 7. **19.** *E. verna*: a, male; b–c, valvae; d, sterigma/sternum 7. **20.** *E. autumnana*: a, male; b–c, valvae; d, sterigma/sternum 7. **21.** *E. citricolorana*: a, male; b, valva, HTP; c, valva; d, sterigma/sternum 7.



PLATE 8. 22. *Eucosma annetteana*: a, male; b–c, valvae; d, sterigma/sternum 7. 23. *E. millerana*: a, male, HTP; b–c, valvae; d, sterigma/sternum 7/signa. 24. *E. litorea*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 9. **25.** *Eucosma radiatana*: a, male; b–c, valvae; d, female [determination tentative]. **26.** *E. formosana*: a, male; b–c, valvae; d, female; e, valval arching.



PLATE 10. **27**. *Eucosma umbrastriana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7; f, male, *E. roseoterminana*; g, male, *E. umbrastriana* complex (adult figured in Plate F:27j). **28**. *E. albertana*: a, male, HTP; b, female.





PLATE 11. **29.** *Eucosma essexana*: a, male; b–c, valvae; d, valval arching; e, female. **30.** *E. awemeana*: a, male; b–c, valvae; d, valval arching; e, female.



PLATE 12. **31**. *Eucosma ferruginana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7, LTP (malformed). **32**. *E. indeterminana*: a, male; b, female. **33**. *E. altana*: a, male; b, female.



PLATE 13. **34.** *Eucosma artemisiana*: a, male; b–c, valvae; d, female; e, sterigma. **35.** *E. infimbriana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7, *E. infimbriana candidula*.



PLATE 14. **36**. *Eucosma segregata*: a, male; b–d, valvae; e, female; f, sterigma/sternum 7. **37**. *E. setonana*: a, male; b, valva; c, sterigma/sternum 7. **38**. *E. octopunctana*: a, male; b, valva; c, sterigma/sternum 7.



PLATE 15. **39.** *Eucosma festivana*: a, male; b, valva; c, sterigma/sternum 7. **40.** *E. youngi*: a, male; b, valva; c, female; d, sterigma/sternum 7. **41.** *E. scalana*: a, male; b, female.



PLATE 16. 42. *Eucosma insignata*: a, male, HTP; b, cucullus; c–d, valvae; e, female; f, sterigma/sternum 7. 43. *E. camdenana*: a, male; b, valva. 44. *E. calderana*: male, HTP. 45. *E. fulvofasciata*: a, male, HTP; b, female.



PLATE 17. **46.** *Eucosma robertsoni*: a, male [determination tentative]; b, female, HTP. **47.** *E. perangustana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. **48.** *E. kiscana*: a, male; b, valva; c, sterigma/sternum 7.



PLATE 18. 49. *Eucosma lapidana*: a, male, LTP; b, female. 50. *E. canusana*: a, male; b–c, valvae; d, sterigma/sternum 7. 51. *E. kokana*: a, male; b, valva; c, sterigma/sternum 7. 52. *E. ambodaidaleia*: a, male; b–c, valvae; d, sterigma/sternum 7.



PLATE 19. **53.** *Eucosma griseocapitana*: a, male; b–e, valvae; f, female; g, sterigma; h, tergum 8. **54.** *E. linitipunctana*: a, male, HTP; b–c, valvae; d, female; e, sterigma/sternum 7; f, tergum 8.



PLATE 20. **55.** *Eucosma alabamae*: a, male; b, valva, HTP; c, valva; d, female; e, sterigma/sternum 7; f, tergum 8. **56.** *E. granulatana*: a, male; b–d, valvae; e, female; f, sterigma/sternum 7; g, tergum 8.



PLATE 21. **57**. *Eucosma argutipunctana*: a, male, HTP; b–d, valvae; e, female; f, sterigma/sternum 7; g, tergum 8. **58**. *E. striatana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 22. **59**. *Eucosma occidentalis*: a, male, HTP; b, valva; c, sterigma/sternum 7. **60**. *E. implicata*: a, male; b, valva; c, sterigma/sternum 7. **61**. *E. pallidicostana*: a, male; b–e, valvae; f, female; g, sterigma/sternum 7.



PLATE 23. **62**. *Eucosma clavana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. **63**. *E. indagatricana*: a, male; b, valva; c, female. **64**. *E. misturana*: a, male; b–c, valvae; d, female.



PLATE 24. **65.** *Eucosma dorsiatomana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. **66.** *E. salidana*: a, male; b, valva; c, valva, HTP; d–e, valvae; f, female; g, sterigma/sternum 7.



PLATE 25. **67.** *Eucosma fertoriana*: a, male; b–e, valvae; f, female; g, sterigma/sternum 7. **68.** *E. crassana*: a, male; b–e, valvae; f, female; g, sterigma/sternum 7. **69.** *E. labiata*: a, male, HTP; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 26. **70.** *Eucosma spiculana*: a, male; b–d, valvae; e, female; f, sterigma/sternum 7. **71.** *E. fulvotegulana*: a, male; b–d, valvae; e, sterigma/sternum 7; f, papillae anales/tergum 8.



PLATE 27. 72. Eucosma pecosana: a, male, HTP; b, valva, HTP; c–d, valvae; e, female; f, sterigma/sternum 7; g, tergum 8. 73. E. goblinana: a, male; b, valva; c, valva, HTP; d, valva; e, female; f, sterigma/sternum 7; g, tergum 8.



PLATE 28. **74.** *Eucosma corculana*: a, male; b–e, valvae; f, female; g, sterigma/sternum 7. **75.** *E. arenana*: a, male, HTP; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 29. **76.** *Eucosma mormonensis*: a, male; b–e, valvae; f, female; g, sterigma/sternum 7. **77.** *E. browni*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 30. **78.** *Eucosma tarandana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. **79.** *E. transversa*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 31. **80.** *Eucosma montanana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. **81.** *E. benjamini*: a, male; b, valva, HTP; c–e, valvae; f, female; g, sterigma/sternum 7.



PLATE 32. **82.** *Eucosma elongana*: a, male; b–d, valvae; e, phallus/anellus complex; f, female; g, sterigma/sternum 7. **83.** *E. rupestrana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 33. 84. *Eucosma umbraticana*: a, male, HTP; b, valva. 85. *E. offectalis*: a, male; b–d, valvae; e, female; f, sterigma. 86. *E. pastigiata*: a, male; b–c, valvae; d, female; e, sterigma.



PLATE 34. 87. *Eucosma hodgesi*: a, male; b, male [determination tentative]; c, valva, HTP; d, valva; e, female; f, sterigma/ sternum 7. 88. *E. stramineana*: a, male, LTP; b–c, valvae. 89. *E. parvana*: male, LTP. 90. *E. clementeana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 35. **91.** *Eucosma grindeliana*: a–b, males; c, valva; d, female; e, sterigma/sternum 7; f, corpus bursae; g–j, unci, socii, and valvae. **92.** *E. convergana*: a, male; b–c, valvae. **93.** *E. modernana*: a, male; b–c, valvae.



PLATE 36. **94.** *Eucosma parmatana*: a, male; b–h, valvae; i, female; j, sterigma/sternum 7. **95.** *E. oregonensis*: a, male, HTP; b–d, valvae; e, sterigma/sternum 7.



PLATE 37. 96. *Eucosma ochroterminana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. 97. *E. tomonana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. 98. *E. raracana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.


PLATE 38. **99.** *Eucosma ochrocephala*: a, male; b, female. **100.** *E. sableana*: a, male, HTP; b–c, valvae; d, female; e, sterigma/sternum 7. **101.** *E. verniochreana*: a, male; b–c, valvae; d, sterigma/sternum 7; e, tergum 8.



PLATE 39. 102. *Eucosma knudsoni*: a, male; b–d, valvae; e, female. 103. *E. olivaceana*: a, male; b, female. 104. *E. viridis*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 40. **105**. *Eucosma modicellana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. **106**. *E. pallidarcis*: a, male; b–c, valvae; d, female. **107**. *E. cibolana*: a, male; b–c, valvae; d, female, HTP; e, sterigma/sternum 7.



PLATE 41. **108**. *Eucosma parvula*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. **109**. *E. patagoniana*: a, male; b, valva, HTP; c, valva; d, female. **110**. *E. influana*: a, male; b–d, valvae; e, valva, HTP of *E. musetta*; f, female; g, papillae anales.



PLATE 42. 111. *Eucosma migratana*: a, male, HTP; b–d, valvae; e, female; f, sterigma/sternum 7. 112. *E. complicana*: male, HTP. 113. *E. columbiana*: a, male; b–e, valvae; f, female; g, sterigma/sternum 7.



PLATE 43. **114.** *Eucosma bucephaloides*: a, male; b–d, valvae; e, female; f, sterigma. **115.** *E. salmicolorana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. **116.** *E. mayelisana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 44. **117**. *Eucosma tenuiana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. **118**. *E. donahuei*: a, male; b, valva; c, valva, HTP. **119**. *E. nepotinana*: a, male; b–e, valvae; f, female; g, sterigma/sternum 7.



PLATE 45. **120.** *Eucosma kramerana*: a, male; b–c, valvae; d, female, HTP; e, sterigma/sternum 7. **121.** *E. subminimana*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. **122.** *E. alatana*: a, male; b–c, valvae.



PLATE 46. **123**. *Eucosma vogelana*: a, male; b, valva; c, valva, HTP; d, female; e, sterigma/sternum 7. **124**. *E*. *latens*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7. **125**. *E*. *baloghi*: a, male; b–c, valvae; d, female; e, sterigma/sternum 7.



PLATE 47. **126.** *Eucosma metzleri*: a, male; b, valva, HTP; c, valva; d, female; e, sterigma/sternum 7. **127.** *E. fasciculatana*: a, male, HTP; b, female. **128.** *E. spectana*: a, male; b–d, valvae; e, female; f, sterigma/sternum 7.



PLATE 48. **129**. *Eucosma southamptonensis*: a, male; b, valva. **130**. *E. minimana*: a, male; b–c, valvae; d, female; e, sterigma/ sternum 7. **131**. *E. cruentana*: a, male; b, valva; c, female; d, sterigma/sternum 7.



PLATE 49. **132.** *Eucosma apacheana*: a, male; b–e, valvae; f, female; g, sterigma/sternum 7. **133.** *E. ornatula*: a, male; b–e, valvae; f, female.

Appendix A

# Numerical Data

			FW	L (mm)		MEAN			
Sp #	Species	Cornuti	Range	Avg	Ν	AR	SA°	NR	SR
1	circulana	22-40	6.6-10.7	8.3	35	2.78	103	0.42	
2	gemellana	20-40	7.2-12.3	9.3	61	2.90	89	0.28	
3	paragemellana	25-28	5.0-7.6	6.4	64	2.66	78	0.19	
4	glomerana	16-37	7.7-12.7	10.2	84	2.91	89	0.37	
5	bilineana	43-50	10.1-14.8	13.0	36	2.89	106	0.43	
6	floridana	28-37	7.5-9.2	8.5	13	2.87	107	0.47	
7	monogrammana	29-30	10.5-13.6	11.9	9	2.88	126	0.57	
8	giganteana	54	8.6-19.0	12.8	26	2.82	113	0.45	2.48
9	bipunctella	47	16.0-19.1	17.5	8	2.83	122	0.45	1.73
10	landana	33	9.8-12.7	10.9	7	2.71	133	0.75	
11	simplex	34	9.3-11.2	10.1	6	3.04	124	0.66	
12	rusticana	25-44	9.0-12.2	10.5	30	2.54	94	0.47	
13	haydenae	20-24	6.0-8.2	7.3	31	2.80	82	0.59	2.50
14	paragoria	32-35	7.5-10.7	9.5	42	2.58	86	0.62	2.17
15	sombreana	35-38	7.9-12.4	9.9	42	2.36	79	0.38	
16	decempunctana	20	6.9-8.4	7.7	7	3.29	102	0.44	2.20
17	amphorana	22-35	7.1-10.1	8.3	30	3.01	131	0.71	1.92
18	refusana	17-34	6.9-8.3	7.7	13	2.89	125	0.74	1.59
19	verna	17-50	6.9-9.4	7.9	61	3.12	114	0.48	2.06
20	autumnana	27-38	6.5-9.6	7.7	72	3.08	88	0.32	2.48
21	citricolorana	26-41	7.3-10.1	9.0	32	3.20	103	0.59	1.81
22	annetteana	16-38	5.3-8.1	6.6	63	3.00	123	0.56	2.80
23	millerana	39-47	4.9-6.7	5.8	45	3.04	121	0.55	3.12
24	litorea	21-26	5.1-7.7	6.0	22	2.71	143	0.69	2.11
25	radiatana	41	10.1-11.0	10.7	5	2.84	103	0.51	
26	formosana	31-40	8.3-10.0	9.1	33	2.89	128	0.60	
27	umbrastriana	42-54	7.9-10.2	9.0	66	2.88	107	0.59	
27	roseoterminana	35-39	8.3-10.5	9.2	16	2.71	103	0.50	
27	<i>umbrastriana</i> cplx	19-31	7.7-9.3	8.4	15	2.75	107	0.56	
28	albertana	26	9.1-10.1	9.6	2	2.96	124	0.54	
29	essexana (ð)	20-31	9.0-11.3	10.6	16	2.75	99	0.52	
29	essexana $(\bigcirc)$		8.2-8.9	8.5	4	2.58			
30	awemeana (ð)	25-42	8.0-10.4	8.9	13	2.87	119	0.54	
30	awemeana (♀)		7.4-8.2	7.8	2	2.52			
31	ferruginana	21-24	6.0-7.1	6.6	10	2.63	119	0.52	
32	indeterminana (♂)	25-31	7.7-8.9	8.4	8	2.82	117	0.59	
32	<i>indeterminana</i> (♀)		6.6-7.0	6.8	2	2.63			
33	altana	31-34	7.2-8.4	7.9	4	2.90	123	0.55	

			FWL (mm)			MEAN			
Sp #	Species	Cornuti	Range	Avg	Ν	AR	SA°	NR	SR
34	artemisiana	22-24	8.4-10.0	9.1	15	2.88	85	0.32	
35	infimbriana	13-24	7.5-10.4	9.0	55	2.84	84	0.27	
36	segregata	21-26	7.5-8.8	8.0	12	2.84	83	0.26	
36	castrensis	20-22	7.1-8.7	7.8	112	2.88	84	0.23	
37	setonana	18-20	6.1-7.6	7.0	10	2.77	94	0.29	
38	octopunctana	18-29	7.1-9.0	8.2	6	2.91	93	0.29	
39	festivana	13-16	5.6-6.5	6.1	7	2.90	93	0.29	
40	youngi	13-17	9.0-11.0	8.8	9	3.10	92	0.33	
41	scalana	22	6.9-7.9	7.5	5	2.81	95	0.36	
42	insignata	13-17	7.2-9.1	8.4	22	3.08	102	0.36	
43	cambdenana	11-15	8.2-9.0	8.6	2	3.02	110	0.43	
44	calderana	11	6.2	6.2	1	2.82	84	0.29	
45	fulvofasciata	16-20	5.4-6.7	6.4	6	2.90	87	0.28	
46	robertsoni	10	5.2-10.0	7.6	2	3.04	88	0.38	
47	perangustana	15-19	6.4-9.0	7.6	23	3.66	120	0.65	
48	kiscana	18-19	5.3-6.0	5.6	14	3.16	123	0.59	
49	lapidana	26-29	7.7-8.2	8.0	3	3.15	102	0.47	1.50
50	canusana	15-26	7.7-10.0	9.1	14	3.22	108	0.37	2.00
51	kokana	28-36	9.1-11.5	10.3	24	3.03	99	0.36	
52	ambodaidaleia	27-34	8.4-10.5	9.4	22	3.16	112	0.51	
53	griseocapitana	20-42	6.4-9.7	8.0	142	3.06	130	0.50	
54	linitipunctana	23-38	7.2-8.5	7.8	18	2.81	140	0.61	1.96
55	alabamae	30-42	6.0-8.1	7.0	33	2.86	131	0.61	1.72
56	granulatana	23-32	6.6-8.3	7.6	17	2.93	125	0.49	
57	argutipunctana	18-33	4.7-7.4	6.1	46	2.77	136	0.62	
58	striatana	15-30	6.2-9.1	7.8	38	3.07	139	0.62	1.77
59	occidentalis	15-26	7.3-9.7	8.2	6	2.98	130	0.57	1.46
60	implicata	19-34	6.7-9.5	8.3	12	2.97	119	0.56	1.55
61	pallidicostana	23-35	6.2-9.2	7.7	50	3.07	125	0.50	1.38
62	clavana	21-30	6.4-7.6	7.0	14	3.37	111	0.48	1.46
63	indagatricana	18-37	5.4-8.3	7.2	148	3.36	96	0.45	1.59
64	misturana	9-21	5.7-8.3	7.0	29	3.26	109	0.44	1.43
65	dorsiatomana	30-39	7.9-10.4	9.3	14	3.15	125	0.72	
66	salidana	28-33	7.1-10	8.7	60	3.35	120	0.57	
67	fertoriana	18-31	5.4-8.2	7.3	31	3.26	109	0.65	
68	crassana	34-43	7.1-8.9	7.7	9	3.33	137	0.56	
69	labiata	21-29	5.4-8.3	6.9	18	3.13	143	0.46	
70	spiculana	20-31	7.3-12.2	9.9	35	3.37	112	0.51	1.60

			FW	L (mm)		MEAN			
Sp #	Species	Cornuti	Range	Avg	Ν	AR	SA°	NR	SR
71	fulvotegulana	15-40	6.1-10.5	8.2	26	3.31	104	0.47	1.47
72	pecosana	14-24	6.6-7.9	7.2	9	3.27	131	0.56	
73	goblinana	13-23	7.4-9.8	8.6	30	3.46	132	0.55	
74	corculana	17-35	5.5-9.0	7.5	64	3.14	104	0.40	
75	arenana	12-33	7.9-10.0	9.3	26	3.32	102	0.36	
76	mormonensis	15-38	6.3-8.7	7.5	35	3.13	134	0.39	
77	browni	17-26	6.1-8.2	7.3	45	3.43	116	0.35	
78	tarandana	21-36	8.4-13.6	10.5	23	3.14	112	0.46	1.55
79	transversa	18-34	10.1-13.7	11.8	28	3.15	109	0.52	2.41
80	montanana	20-37	8.2-12.6	10.3	46	3.34	114	0.57	1.40
81	benjamini	14-27	9.2-13.1	11.1	56	3.39	115	0.57	1.50
82	elongana	18-44	8.3-14.2	11.8	43	3.28	115	0.45	2.59
83	rupestrana	20-26	8.2-11.3	9.7	15	3.35	120	0.46	
84	umbraticana	20-24	10.6-10.7	10.6	2	3.33	136	0.75	
85	offectalis	24-40	10.8-15.8	12.6	83	3.41	148	0.71	
86	pastigiata	10-20	6.7-9.8	8.2	16	3.41	93	0.32	3.25
87	hodgesi	11-17	6.0-8.1	7.1	18	3.20	108	0.36	3.68
88	stramineana	9-14	5.6-6.6	6.1	27	3.43	102	0.58	
89	parvana	15	5.0-6.4	5.9	14	3.49	98	0.49	
90	clementeana	23-37	5.4-8.0	6.3	41	3.00	112	0.46	2.90
91	<i>grindeliana</i> cplx	16-48	4.4-9.0	6.2	125	2.99	121	0.48	2.25
92	convergana	14-15	7.6-8.7	8.1	6	3.05	129	0.65	
93	modernana	9-12	7.7-8.0	7.8	3	3.03	120	0.66	
94	parmatana	13-33	4.6-7.8	6.0	122	2.75	99	0.35	2.35
95	oregonensis	20-28	6.7-9.5	8.5	16	2.85	98	0.40	2.16
96	ochroterminana	22-27	4.8-6.2	5.4	29	2.80	95	0.35	2.89
97	tomonana	15-29	5.3-7.3	6.4	11	2.75	96	0.35	2.05
98	raracana	26-28	4.8-6.4	5.7	22	2.95	86	0.32	2.18
99	ochrocephala	20	6.4-8.2	7.2	12	2.85	125	0.49	1.66
100	sableana	29-37	6.3-7.6	7.1	11	2.91	121	0.57	1.62
101	verniochreana	18-20	5.0-6.9	5.8	12	2.76	137	0.60	1.51
102	knudsoni	14-30	5.7-8.1	7.0	27	3.14	137	0.62	2.03
103	olivaceana	16-23	6.3-9.1	7.8	17	2.81	98	0.43	1.58
104	viridis	15-18	6.0-8.7	8.1	18	3.37	98	0.58	1.43
105	modicellana	15-20	4.8-6.6	5.9	38	3.14	133	0.56	
106	pallidarcis	13-28	4.9-7.3	6.1	56	2.90	150	0.74	
107	cibolana	21-24	6.9-8.0	6.7	12	3.22	118	0.49	
108	parvula	10-15	4.9-5.6	5.2	16	3.15	94	0.36	

			FW	L (mm)		MEAN			
Sp #	Species	Cornuti	Range	Avg	Ν	AR	SA°	NR	SR
109	patagoniana	24-30	5.2-7.1	6.4	13	2.79	113	0.43	
110	influana	18-38	6.2-8.2	7.2	38	3.26	127	0.54	
111	migratana	17-31	6.4-9.8	8.3	42	3.32	118	0.56	
112	complicana	16	7.4	7.4	1	3.36	95	0.33	
113	columbiana	14-23	6.0-8.6	7.3	21	3.20	90	0.26	
114	bucephaloides	24-36	8.7-16.5	12.6	113	3.33	129	0.59	
115	salmicolorana	28-37	5.9-9.1	7.6	75	3.05	110	0.25	
116	mayelisana	20-21	9.3-11.0	10.5	8	3.51	142	0.58	
117	tenuiana	14-24	7.0-9.4	8.3	114	3.39	107	0.51	
118	donahuei	31-46	6.8-7.9	7.3	13	3.17	126	0.42	
119	nepotinana	23-41	4.3-7.8	6.6	49	3.24	129	0.54	
120	kramerana	16-23	5.3-6.5	5.8	8	3.19	141	0.72	
121	subminimana	8-12	5.0-7.1	6.1	26	3.07	64	0.32	
122	alatana	8-14	6.1-8.1	7.3	17	3.50	121	0.64	
123	vogelana	16-21	4.8-6.0	5.2	24	3.18	97	0.26	2.45
124	latens	26-37	6.4-7.6	7.2	19	2.99	146	0.44	
125	baloghi	22-35	5.3-6.5	6.1	11	3.27	118	0.49	
126	metzleri	25-31	5.7-6.6	6.1	5	2.93	109	0.37	
127	fasciculatana	0	7.4-8.7	7.9	3	2.62	130	0.60	
128	spectana	6-12	5.5-7.4	6.5	21	3.29	112	0.46	
129	southamptonensis	23-34	9.2-10.0	9.6	5	3.22	133	0.70	
130	minimana	29-38	5.0-7.2	5.9	8	3.18	134	0.62	
131	cruentana	35-44	7.2-7.8	7.4	6	2.88	142	0.61	
132	apacheana	2-9	4.9-8.0	6.0	30	2.80	72	0.31	
133	ornatula	15-25	5.1-6.9	6.3	16	2.90	151	0.66	

Appendix B

# Genitalia Data

## 1. Eucosma circulana Hübner

- a. Kentucky, McCracken County, ¼ mi WNW Route 60 and Broad St., 9 Sept 2006, L. D. Gibson, slide DJW 2004, DJW.
- b. Florida, Forest County, Camp Shelby near Hattiesburg, 1-15 August 1944, C. D. Michner, slide DJW 1178, AMNH.
- c. Kentucky, McCracken County, ¼ mi WNW Route 60 and Broad St., 9 Sept 2006, L. D. Gibson, slide DJW 1700, DJW.
- d. Texas, Harris County, Houston, 8 June 1968, A. and M. E. Blanchard, slide DJW 2003, USNM.
- e. Kentucky, McCracken County, ¼ mi WNW Route 60 and Broad St., 12 Aug 2008, L. D. Gibson, slide DJW 3104, DJW.

#### 2. Eucosma gemellana Heinrich

- a. Florida, Highlands County, Highlands Hammock State Park, 15 Nov 1987, G. J. Balogh, slide DJW 330, DJW.
- b. Florida, Liberty County, Wilma, 30 September 1996, J. Glaser, slide 141872, USNM.
- c. Florida, Putnam County, Welaka, 17 April 1973, D. C. Ferguson, slide 124081, USNM.
- d. Florida, Lee County, Fort Myers, 22 April 1912, slide DJW 3168, AMNH.

## 3. Eucosma paragemellana Gilligan and Wright

- a. PTP. Alabama, Baldwin County, Weeks Bay NERS, 21 June 2008, D. J. Wright, slide DJW 3124, DJW.
- b. PTP. Mississippi, Jackson County, I-10, 1 mi W of Alabama line, 22 July 1989, T. L. Schiefer, slide DJW 2006, DJW.
- c. PTP. Alabama, Baldwin County, Weeks Bay NERS, 21 June 2008, D. J. Wright, slide DJW 2050, DJW.
- d. PTP. Alabama, Baldwin County, Weeks Bay NERS, 22 June 2008, D. J. Wright, slide DJW 2773, DJW.

#### 4. *Eucosma glomerana* (Walsingham)

- a. Ohio, Greene County, Wright-Patterson Air Force Base, 28 August 1992, E. H. Metzler, slide DJW 70, DJW.
- b. Louisiana, Bossier Parish, Barksdale Air Force Base, 13 September 1996, R. L. Brown, slide DJW 313, MEM.
- c. Indiana, Lake County, Ivanhoe Dune and Swale, 21 August 1999, R. Panzer, slide DJW 2010, DJW.
- d. Illinois, Will County, Grant Creek Prairie Nature Preserve, 3 August 2000, R. Panzer, slide DJW 802, DJW.
- e. Illinois, Cook County, Gensburg-Markham Prairie, 9 September 1997, R. Panzer, slide DJW 417, DJW.
- f. Kentucky, McCracken County, Paducah, 9 September 2006, L. D. Gibson, slide DJW 2008, DJW.
- g. Illinois, Will County, Desplains CAS, 4 August 2001, R. Panzer, slide DJW 2007, DJW.

## 5. Eucosma bilineana Kearfott

- a. Iowa, Pocahontas County, Kalsow Prairie, 22 June 2000, D. J. Wright, slide DJW 3055, DJW.
- b. Iowa, Pocahontas County, Kalsow Prairie, 22 June 2000, D. J. Wright, slide DJW 3054, DJW.
- c. Iowa, Pocahontas County, Kalsow Prairie, 22 June 2000, D. J. Wright, slide DJW 3053, DJW.
- d. Ohio, Wyandot County, Killdeer Plains, 16 June 1995, D. J. Wright, side DJW 1349, DJW.

## 6. Eucosma floridana Kearfott

- a. Louisiana, Bossier Parish, Barksdale Air Force Base, 13 September 1996, R. L. Brown, slide DJW 2019, MEM.
- b. Mississippi, Harrison County, Big Biloxi RA 19 September 2003, R. L. Brown, slide DJW 2048, MEM.
- c. North Carolina, Pender County, Holly Shelter Game Land, 28 August 1997, J. B. Sullivan, slide DJW 2771, USNM.
- d. Florida, Liberty County, Wilma, 30 September 1998, J. Glaser, slide DJW 2781, USNM.

## 7. Eucosma monogrammana (Zeller)

- a. Arkansas, Hempstead County, Columbus Prairie Preserve, 14 May 1999, J. A. Bess, slide DJW 2872, DJW.
- b. Arkansas, Hempstead County, Columbus Prairie Preserve, 14 May 1999, J. A. Bess, slide DJW 3343, DJW.
- c. Arkansas, Hempstead County, Columbus Prairie Preserve, 14 May 1999, J.A. Bess, slide DJW 1331, DJW.
- d. Louisiana, Bossier Parish, Barksdale Air Force Base, 5 May 1996, D. M. Pollock, slide DJW 2866, MEM.

## 8. Eucosma giganteana (Riley)

- a. Ohio, Adams County, 1 mi SE of Lynx, 3 August 1998, D. J. Wright, slide DJW 1352, DJW.
- b. Ohio, Adams County, 1 mi SE of Lynx, 5 July 2002, D. J. Wright, slide DJW 3344, DJW.
- c. Kentucky, Bullitt County, 7 mi E of Shepherdsville, 8 July 1988, D. J. Wright, slide DJW 451, DJW.
- d. Kansas, Riley County, Konza Prairie, 23 July 1995, D. J. Wright, slide DJW 2460, DJW.

## 9. Eucosma bipunctella (Walker)

- a. Illinois, Cook County, Air Station South, 8 July 2000, R. Panzer, slide DJW 1424, DJW.
- b. Illinois, Cook County, Chicago Ridge Prairie, 18 August 2003, R. Panzer, slide DJW 3342, DJW.
- c. Ohio, Erie County, Resthaven Wildlife Area, 19 June 1984, E. H. Metzler, slide DJW 1350, DJW.
- d. Illinois, Will County, Grant Creek Prairie Nature Preserve, 14 June 2000, R. Panzer, slide DJW 2462, DJW.

## 10. Eucosma landana Kearfott

- a. Wisconsin, Burnett County, 27 April 1999, M. Sabourin, slide DJW 640, DJW.
- b. Wisconsin, Burnett County, 27 April 1999, M. Sabourin, slide DJW 640, DJW.
- c. Wisconsin, Burnett County, 27 April 1999, M. Sabourin, slide DJW 640, DJW.
- d. PLTP. Manitoba, Aweme, 12 June 2004, N. Criddle, slide DJW 3338, USNM.

#### 11. *Eucosma simplex* McDunnough

- a. Illinois, Cook County, Air Station South, 17 May 2001, R. Panzer, slide DJW 3234, DJW.
- b. Illinois, Cook County, Air Station South, 17 May 2001, R. Panzer, slide DJW 800, DJW.
- c. Kansas, slide 70424, USNM.
- d. Iowa, Sioux City, 7 May 1916, slide DJW 3337, USNM.

#### 12. Eucosma rusticana Kearfott

- a. Ohio, Wyandot County, Killdeer Plains, 16 June 1995, D. J. Wright, slide DJW 167, DJW.
- b. Illinois, Cook County, Paintbrush Prairie, 12 July 2004, R. Panzer, slide DJW 3341, DJW.
- c. Kentucky, Bullitt County, 7 mi E of Shepherdsville, 8 July 1988, D. J. Wright, slide DJW 3340, DJW.
- d. Illinois, Cook County, Paintbrush Prairie, 17 August 2004, R. Panzer, slide DJW 1289, DJW.

#### 13. Eucosma haydenae Wright

- a. Iowa, Howard County, Hayden Prairie, 23 June 1997, D. J. Wright, slide DJW 556, DJW.
- b. Iowa, Howard County, Hayden Prairie, 23 June 1997, D. J. Wright, slide DJW 556, DJW.
- c. Iowa, Howard County, Hayden Prairie, 28 June 1995, D. J. Wright, slide DJW 131, DJW.
- d. Illinois, Dupage County, West Chicago Prairie, 23 May 2004, R. Panzer, slide DJW 1291, DJW.
- e. Illinois, Dupage County, West Chicago Prairie, 23 May 2004, R. Panzer, slide DJW 1290, DJW.
- f. Illinois, Dupage County, West Chicago Prairie, 23 May 2004, R. Panzer, slide DJW 1290, DJW.

#### 14. Eucosma paregoria Brown

- a. Iowa, Howard County, Hayden Prairie, 23 June 1997, D. J. Wright, slide DJW 590, DJW.
- b. Illinois, Cook County, Gensburg-Markham Prairie, 22 June 2004, R. Panzer, slide DJW 1224, DJW.
- c. Iowa, Howard County, Hayden Prairie, 28 June 1995, D. J. Wright, slide DJW 130, DJW.
- d. Iowa, Howard County, Hayden Prairie, 23 June 1997, D. J. Wright, slide DJW 3339, DJW.

## 15. Eucosma sombreana Kearfott

- a. Ohio, Adams County, 1 mi SE of Lynx, 3 August 2000, D. J. Wright, slide DJW 3001, DJW.
- b. Iowa, Howard County, Hayden Prairie, 28 July 1994, D. J. Wright, slide DJW 168, DJW.
- c. Ohio, Wyandot County, Killdeer Plains, 16 August 2006, D. J. Wright, slide DJW 3000, DJW.
- d. Ohio, Wyandot County, Killdeer Plains, 16 August 2006, D. J. Wright, slide DJW 2999, DJW.
- e. Kentucky, Rowan County, County Road 1273, 26 August 1994, D. J. Wright, slide DJW 1293, DJW.

#### **16.** *Eucosma decempunctana* (Walsingham)

- a. PLTP. Oregon, Wasco County, to Fort Dalles, 15–22 April 1872, Walsingham, slide DJW 3149, BMNH.
  b. Slide 69963, USNM.
- c. LTP. Oregon, Wasco County, to Fort Dalles, 15–22 April 1872, Walsingham, slide 11589, BMNH.
- d. Oregon, Deschutes County, Tumalo State Park, 5 April 1970, J. F. G. Clarke, slide DJW 3240, USNM.
- e. Oregon, Deschutes County, Tumalo State Park, 5 April 1970, J. F. G. Clarke, slide DJW 3240, USNM.

## 17. Eucosma amphorana (Walsingham)

- a. California, Santa Barbara County, San Miguel Island, 15 October 1995, J. A. Powell, slide DJW 2922, EME.
- b. California, Contra Costa County, Antioch NWR, 20 April 1984, J. A. Powell, slide JAP 5313, EME.
- c. California, Santa Clara County, Hale Hills, 22 May 1990, A. E. L., slide JAP 6382, EME.
- d. California, Santa Cruz County, Sunset St Beach, 9-11 April 1989, J. A. Powell, slide DJW 2921, EME.
- e. Oregon, Grant County, Camp Watson, March-April 1872, Walsingham, slide DJW 3150, BMNH.

## 18. Eucosma refusana (Walker)

- a. Minnesota, Anoka County, Carlos Avery WMA, 1 May 1999, M. Sabourin, slide DJW 625, DJW.
- b. Alberta, 8 km SE of Sherwood Park, 5 May 2006, G. R. Pohl, slide DJW 3264, GRP.
- c. Saskatchewan, Oxbow, 28 May 1907, F. Kaub, slide 69964, USNM.
- d. Alberta, Stathcona County, 15 May 2006, G. R. Pohl, slide DJW 3265, GRP.

## 19. Eucosma verna (Miller)

- a. Ohio, Wyandot County, Killdeer Plains, 3 May 2006, T. M. Gilligan, slide DJW 2679, DJW.
- b. Ohio, Wyandot County, Killdeer Plains, 1 May 1992, D. J. Wright, slide DJW 624, DJW.
- c. Ohio, Lucas County, Kitty Todd Preserve, 17 May 1996, E. H. Metzler, slide DJW1338, DJW.
- d. Delaware, Newark, 4 May 1964, slide DJW 3232, USNM.

## 20. Eucosma autumnana (McDunnough)

- a. North Dakota, Billings County, Sully Springs, 7 September 2002, G. J. Balogh, slide DJW 1091, DJW.
- b. Ohio, Adams County, 1 mi SE of Lynx, 8 October 1993, D. J. Wright, slide DJW 3100, DJW.
- c. Ohio, Lucas County, Irwin Prairie, 30 September 1995, E. H. Metzler, slide DJW 3103, DJW.
- d. West Virginia, Morgan County, Sleepy Creek Forest, 2 October 2007, J. G. Franclemont, slide DJW 3269, USNM.

## 21. Eucosma citricolorana (McDunnough)

- a. PTP. Saskatchewan, Cypress Hills, 5 June 1939, A. R. Brooks, slide TOR 1608, CNC.
- b. HTP. Saskatchewan, Saskatoon, 4 July 1929, K. M. King, slide TOR 978, CNC.
- c. Wyoming, Albany County, S of Lodgepole Creek, 9 June 2013, J. S. Nordin, slide DJW 3272, DJW.
- d. Alberta, near Fort Assiniboine, 22 June 2002, D. Macaulay, slide DJW 3266, CFSE.

# 22. Eucosma annetteana (Kearfott)

- a. PLTP. Ohio, Hamilton County, Cincinnati, 13 April 1905, A. F. Braun, slide DJW 1447, AMNH.
- b. Mississippi, Oktibbeha County, T19N R15E S6, 9 March 1990, D. M. Pollock, slide DJW 3109, MEM.
- c. Illinois, Putnam County, 29 April 1939, M. O. Glenn, slide DJW 3180, USNM.
- d. Ohio, Hamilton County, Cincinnati, 27 April 1906, A. F. Braun, slide TOR 1609, CNC.

# 23. Eucosma millerana Wright and Brown

- a. HTP. Minnesota, Clay County, Blanket Flower Sci. and Nat. Area, 23–24 August 2012, R. P. Dana, slide 145170, USNM.
- b. PTP. Mississippi, Oktibbeha County, Osborn Prairie, 28 August 2003, D. J. Wright, slide DJW 3015, DJW.
- c. PTP. Minnesota, Swift County, Chippewa Prairie Preserve, 29–30 August 2011, R. P. Dana, slide DJW 3025, USNM.
- d. PTP. Minnesota, Clay County, Blanket Flower Sci. and Nat. Area, 23–24 Aug 2012, R. P. Dana, slide DJW 3216, USNM.

## 24. Eucosma litorea Wright and Brown

- a. PTP. Alabama, Baldwin County, Bon Secour NWR, 8–9 August 1994, Brown and Pollock, slide DJW 1563, DJW.
- b. PTP. Alabama, Baldwin County, Bon Secour NWR, 8–9 August 1994, Brown and Pollock, slide DJW 3022, DJW.
- c. Alabama, Baldwin County, 1 mi E of Oyster Bay, 10–14 March 1990, R. L. Brown, slide DJW 1564, DJW. [dark form]
- d. PTP. Alabama, Baldwin County, Plash Island, 16–19 June 1984, Brown and Pollock, slide DJW 3121, MEM.
- e. PTP. Alabama, Baldwin County, Bon Secour NWR, 8–9 August 1994, Brown and Pollock, slide DJW 3120, MEM.

# 25. Eucosma radiatana (Walsingham)

- a. Ohio, Wyandot County, Killdeer Plains, 30 May 1997, E. H. Metzler, slide DJW 1585, DJW.
- b. Indiana, Lagrange County, 11 June 1988, D. J. Wright, slide DJW 45, DJW. [determination tentative]
- c. Iowa, Pocahontas County, Kalsow Prairie, 18 June 1992, D. J. Wright, slide DJW 46, DJW. [determination tentative]
- d. Iowa, Johnson County, Williams Prairie, 15 June 1992, D. J. Wright, slide DJW 68, DJW. [determination tentative]

# 26. Eucosma formosana (Clemens)

- a. Ohio, Wyandot County, Killdeer Plains, 14 June 1991, D. J. Wright, slide DJW 56, DJW.
- b. Maryland, Garrett County, Meadow Mountain Run Bog, 13 June 2001, J. Glaser, slide DJW 2738, USNM.
- c. Ohio, Wyandot County, Killdeer Plains, 15 June 1996, D. J. Wright, slide DJW 2741, DJW.
- d. Ohio, Erie County, Resthaven Wildlife Area, 26 June 1999, E. H. Metzler, slide DJW 1452, DJW.
- e. Ohio, Wyandot County, Killdeer Plains, 15 June 1996, D. J. Wright. [not dissected]

# 27. Eucosma umbrastriana (Kearfott)

- a. Kentucky, Boone County, Big Bone Lick State Park, 18 May 1989, D. J. Wright, slide DJW 53, DJW.
- b. Kentucky, Laurel County, Roads 121 and 4158, 18 May 1996, D. J. Wright, slide DJW 1450, DJW.
- c. Kentucky, Laurel County, Roads 121 and 4158, 18 May 1996, D. J. Wright, slide DJW 1334, DJW.
- d. Connecticut, New Haven County, Hamden, 8 June 1967, D. C. Ferguson, slide DJW 2734, USNM.
- e. Kentucky, Laurel County, Roads 121 and 4158, 18 May 1996, D. J. Wright, slide DJW 1335, DJW.
- f. Pennsylvania, Beaver County, New Brighton, 24 May 1906, H. D. Merrick, slide DJW 2723, USNM. [*E. roseoterminana* phenotype]
- g. Ohio, Erie County, Resthaven WLA, 24 May 1991, D. J. Wright, slide DJW 55, DJW. [E. umbrastriana complex]

# 28. Eucosma albertana (McDunnough)

- a. HTP. Alberta, Lethbridge, 14 June 1922, H. L. Seamans, slide DJW 3088, CNC.
- b. Alberta, Chin, 8 August 1929, J. H. P., slide DJW 3089, CNC.

#### 29. Eucosma essexana (Kearfott)

- a. Ohio, Erie County, Resthaven Wildlife Area, 17 May 1997, D. J. Wright, slide DJW 1448, DJW.
- b. Ohio, Wyandot County, Killdeer Plains, 3 May 2006, T. M. Gilligan, slide DJW 2627, DJW.
- c. Ohio, Hamilton County, Miami Whitewater Park, 16 May 1987, D. J. Wright, slide DJW 57, DJW.
- d. Ohio, Wyandot County, Killdeer Plains, 3 May 2006, T. M. Gilligan, DJW. [not dissected]
- e. PLTP. New Jersey, Essex County, Caldwell, 17 May 1903, Kearfott, slide DJW 2722, USNM.

#### 30. Eucosma awemeana (Kearfott)

- a. New York, Tompkins County, near Dryden, 21 May 1965, D. C. Ferguson, slide 124833, USNM.
- b. North Carolina, Ashe County, Mount Jefferson State Park, 2–3 May 2000, J. B. Sullivan, slide DJW 2713, USNM.
- c. New York, Tompkins County, Six Mile Creek, 2 May 1955, J. G. Franclemont, slide DJW 2714, USNM.
- d. Data unknown.
- e. Alberta, Edmonton, 30 May 1924, O. Bryant, slide DJW 2712, USNM.

#### 31. Eucosma ferruginana (Fernald)

- a. New Jersey, Essex County, Caldwell, 22 May 1910, W. D. Kearfott, slide DJW 2727, USNM.
- b. Virginia, Falls Church, 2 May 1914, A. B., slide USNM 69940, USNM.
- c. New Jersey, Essex County, 21 May 1900, W. D. Kearfott, slide DJW 2728, USNM.
- d. New Jersey, Essex County, May 1910, W. D. Kearfott, slide DJW 2729, USNM.
- e. LTP. Massachusetts, slide DJW 2726, USNM.

#### 32. Eucosma indeterminana (McDunnough)

- a. PTP. Quebec, Aylmer, 20 May 1920, McDunnough, slide DJW 2696, USNM.
- b. PTP. Quebec, Aylmer, 20 May 1920, McDunnough, slide DJW 2708, USNM.

#### 33. Eucosma altana (McDunnough)

- a. PTP. British Columbia, Alta Lake, Mons, 2 April 1926, McDunnough, slide DJW 2698, USNM.
- b. PTP. British Columbia, Alta Lake, Mons, 10 June 1936, McDunnough, slide DJW 3074, CNC.

#### 34. Eucosma artemisiana (Walsingham)

- a. Montana, Sweet Grass County, 7.75 mi N of Big Timber, 7 August 1969, J. G. Franclemont, slide DJW 2334, USNM.
- b. Oregon, Malheur County, Nyssa, 15 July 1965, K. Goeden, slide DJW 2335, USNM.
- c. Montana, Sweet Grass County, 7.75 mi N of Big Timber, 7 August 1969, J. G. Franclemont, slide DJW 2334, USNM.
- d. Washington, Pullman, 24 June 1932, J. F. G. Clarke, slide DJW 2337, USNM.
- e. Nevada, Elko County, Angel Creek, 25 July 1971, D. C. Ferguson, slide DJW 2336, USNM.

#### 35. Eucosma infimbriana (Dyar)

- a. Colorado, Grand County, Beaver Creek, 25 August 1997, D. J. Wright, slide DJW 377, DJW.
- b. Utah, Sanpete County, Ephraim Canyon Road, 29 July 2006, D. J. Wright, slide DJW 2243, DJW.
- c. Manitoba, Aweme, 28 July 1921, N. Criddle, slide USNM 70095, USNM. [PTP, T. i. candidula]
- d. Montana, Gallatin County, 6.2 mi SE of Bozeman, 9 August 1969, G. L. Godfrey, slide DJW 2338, USNM.
- e. Manitoba, Cartwright, E. F. Heath, 3 August 1911, slide DJW 2339, USNM. [PTP, T. i. candidula]

#### 36. Eucosma segregata (Heinrich)

- a. PTP. California, Tulare County, Monachee Meadows, 8–15 August, slide DJW 2224, USNM.
- b. PTP. California, Tulare County, Monachee Meadows, 8-14 July, slide DJW 2235, USNM.
- c. Colorado, Routt County, near Steamboat Springs, 16 July 1994, G. J. Balogh, slide DJW 699, DJW.
- d. Colorado, Grand County, N side of US 40, 9 August 1996, D. J. Wright, slide DJW 257, DJW.
- e. Wyoming, Albany County, Medicine Bow National Forest, 4 August 2001, D. J. Wright, slide DJW 2585, DJW.
- f. PTP. California, Tulare County, Monachee Meadows, 16–23 July, slide DJW 2236, USNM.

#### 37. Eucosma setonana (McDunnough)

- a. PTP. British Columbia, Lillooet, Seton Lake, 2 June 1926, McDunnough, slide DJW 2591, USNM.
- b. PTP. British Columbia, Lillooet, Seton Lake, 7 June 1926, McDunnough, slide DJW 2593, USNM.
- c. PTP. British Columbia, Lillooet, Seton Lake, 14 June 1926, McDunnough, slide DJW 2782, MCZ.

## 38. Eucosma octopunctana (Walsingham)

- a. California, San Bernardino Mountains, 1 July 1907, T. Grinnell, slide 70099, USNM.
- b. Utah, Juab County, Eureka, 19 July 1911, T. Spalding, slide 70101, USNM.
- c. British Columbia, Vernon, 3 July 1924, E. P. Venables, slide DJW 3134, CNC.

#### 39. Eucosma festivana (Heinrich)

- a. Manitoba, Aweme, 7 June 1921, N. Criddle, slide DJW 2596, USNM.
- b. PTP. Manitoba, Aweme, 12 June 1921, N. Criddle, slide DJW 2595, USNM.
- c. Manitoba, Aweme, 7 June 1921, N. Criddle, slide DJW 3140, CNC.

#### 40. Eucosma youngi (McDunnough)

- a. PTP. Alberta, Waterton Lakes, 10 July 1923, C. H. Young, slide 70098, USNM.
- b. Colorado, San Juan, County, W side of Engineer Pass, 24 July 2006, T. M. Gilligan, slide DJW 2588, TMG.
- c. Colorado, San Juan, County, W side of Engineer Pass, 24 July 2006, T. M. Gilligan, slide DJW 2589, TMG.
- d. Colorado, San Juan, County, W side of Engineer Pass, 24 July 2006, T. M. Gilligan, slide DJW 2589, TMG.

## 41. Eucosma scalana (Walsingham)

- a. California, Monterey County, Bisby Canyon, 13 July 1948, J. W. Tilden, slide DJW 2594, USNM.
- b. California, Alameda County, August, slide DJW 2592, USNM.

#### 42. Eucosma insignata (Heinrich)

- a. HTP. Colorado, San Juan County, Silverton, 8–15 July, slide 89907, USNM.
- b. Colorado, Clear Creek County, Mount Evans, 27 July 1961, W. R. Mason, slide DJW 3079, CNC.
- c. Colorado, Clear Creek County, Mount Evans, 18 July 1993, B. Landry, slide DJW 3084, CNC.
- d. Yukon Territory, Montana Mountain, 29 June 2004, C. Schmidt, slide DJW 3083, CNC.
- e. Colorado, Chaffee County, Cottonwood Pass, 18 July 1982, R. W. Hodges, slide DJW 3192, USNM.
- f. Colorado, Chaffee County, Cottonwood Pass, 18 July 1982, R. W. Hodges, slide DJW 3192, USNM.

#### 43. Eucosma camdenana (McDunnough)

- a. PTP. Alaska, W of Kangenevik, June, D. Johansen, slide TOR 976, CNC.
- b. Yukon Territory, Dempster Hwy, 5-7 July 1980, Wood and Lafontaine, slide DJW 3078, CNC. [determination tentative]

## 44. Eucosma calderana Wright and Gilligan

a. HTP. New Mexico, Sandoval County, Valles Caldera NP, 22 June 2010, Brown and Monsalve, slide 144579, USNM.

## 45. Eucosma fulvofasciata Wright and Gilligan

- a. HTP. Idaho, Oneida County, 5 mi ENE of Holbrook, 9 July 2006, D. J. Wright, slide 144980, USNM.
- b. PTP. Colorado, Mesa County, Lands End Road, 2 September 2000, D. J. Wright, slide DJW 2246, DJW.

#### 46. Eucosma robertsoni Wright and Gilligan

- a. California, Monterey County, Big Creek Reserve, 21–23 March 1989, Hsu and Powell, slide DJW 2933, EME. [determination tentative]
- b. HTP. California, Modoc County, Cedar Pass, N of Alturas, 7 August 1990, R. G. Robertson, slide DJW 2937, EME.

#### 47. Eucosma perangustana (Walsingham)

- a. Nevada, Lander County, Bob Scott Campground, 31 May 1974, J. F. G. Clarke, slide DJW 2163, USNM.
- b. Nevada, Lander County, Bob Scott Campground, 1 June 1974, J. F. G. Clarke, slide DJW 2185, USNM.
- c. Nevada, Lander County, Bob Scott Campground, 1 June 1974, J. F. G. Clarke, slide DJW 2184, USNM.
- d. Nevada, Lander County, Bob Scott Campground, 31 May 1974, J. F. G. Clarke, slide DJW 2164, USNM.
- e. Nevada, Lander County, Bob Scott Campground, 31 May 1974, J. F. G. Clarke, slide DJW 2164, USNM.

## 48. Eucosma kiscana (Kearfott)

- a. Ohio, Wyandot County, Killdeer Plains, 16 June 1995, D. J. Wright, slide DJW 1386, DJW.
- b. Iowa, Pocahontas County, Kalsow Prairie, 18 June 1992, D. J. Wright, slide DJW 2745, DJW.
- c. Ohio, Wyandot County, Killdeer Plains, 14 June 1991, D. J. Wright, slide DJW 1387, DJW.

## 49. Eucosma lapidana (Walsingham)

- a. LTP. Oregon, Jackson County, Crooked River, near Fort Klamath, 21–23 Sept 1871, Walsingham, slide 11598, BMNH.
- b. PLTP. Oregon, Jackson County, Crooked R., near Fort Klamath, 21–23 Sept 1871, Walsingham, slide DJW 3151, BMNH.

## 50. Eucosma canusana (Wright)

- a. PTP. Ohio, Adams County, 1 mi SE of Lynx, 2 March 1992, D. J. Wright, slide DJW 51, DJW.
- b. PTP. Ohio, Adams County, 1 mi SE of Lynx, 2 March 1992, D. J. Wright, slide DJW 75, DJW.
- c. PTP. Ohio, Adams County, 1 mi SE of Lynx, 2 March 1992, D. J. Wright, slide DJW 52, DJW.
- d. PTP. Kentucky, Bullitt County, E of Shepherdsville, 30 March 1993, D. J. Wright, slide DJW 104, DJW.

## 51. Eucosma kokana (Kearfott)

- a. Ohio, Adams County, 1 mi SE of Lynx, 4 November 1994, D. J. Wright, slide DJW 2660, DJW.
- b. Ohio, Adams County, 1 mi SE of Lynx, 25 October 1991, D. J. Wright, slide DJW 48, DJW.
- c. Ohio, Adams County, 1 mi SE of Lynx, 4 November 1994, D. J. Wright, slide DJW 1391, DJW.

# 52. Eucosma ambodaidaleia (Miller)

- a. Ohio, Adams County, Lynx Preserve, 20 March 1991, D. J. Wright, slide DJW 47, DJW.
- b. Ohio, Adams County, Lynx Preserve, 20 March 1991, D. J. Wright, slide DJW 47, DJW.
- c. Ohio, Adams County, Lynx Preserve, 20 March 1991, D. J. Wright, slide DJW 74, DJW.
- d. Ohio, Adams County, 1 mi SE of Lynx, 8 April 1993, D. J. Wright, slide DJW 1581, DJW.

## 53. Eucosma griseocapitana (Walsingham)

- a. California, Siskiyou County, Mount Shasta, 2 August-1 September 1871, Walsingham, slide 32389, BMNH.
- b. Idaho, Oneida County, Curlew National Grassland, 1 August 2001, D. J. Wright, slide DJW 2532, DJW.
- c. Wyoming, Albany County, T15N R73W S1, 26 July 2004, J. S. Nordin, slide DJW 1186, DJW.
- d. New Mexico, Otero County, Holloman L., 14 Sept 2004, G. J. Balogh, slide DJW 1962, DJW. [determination tentative]
- e. California, Siskiyou County, Mount Shasta, 2 August–1 September 1871, Walsingham, slide 32390, BMNH.
- f. California, Siskiyou County, Mount Shasta, 2 August–1 September 1871, Walsingham, slide 32388, BMNH.
- g. California, Inyo County, 6 mi W of Independence, 10 Sept 1996, J. A. Powell, slide DJW 2231, EME.
- h. California, Siskiyou County, Mount Shasta, 2 August-1 September 1871, Walsingham, slide 32391, BMNH.

## 54. *Eucosma linitipunctana* (Blanchard and Knudson)

- a. HTP. Texas, Nueces County, North Padre Island, 9 September 1974, A. and M. E. Blanchard, slide 25224, USNM.
- b. PTP. Texas, Hemphill County, Canadian, 13 August 1971, A. and M. E. Blanchard, slide 90344, USNM.
- c. PTP. Texas, Nueces County, North Padre Island, 9 September 1974, A. and M. E. Blanchard, slide 90349, USNM.
- d. Colorado, Weld County, County Road 91, 7 August 1996, D. J. Wright, slide DJW 2551, DJW.
- e. PTP. Texas, Hemphill County, Canadian, 13 August 1971, A. and M. E. Blanchard, slide 90346, USNM.
- f. PTP. Texas, Nueces County, North Padre Island, 9 September 1974, A. and M. E. Blanchard, slide 90343, USNM.

## 55. Eucosma alabamae Wright and Gilligan

- a. PTP. Alabama, Baldwin County, 1 mi E of Oyster Bay, 13 October 1990, R. L. Brown, slide DJW 315, DJW.
- b. HTP. Alabama, Baldwin County, Bon Secour NWR, 12–16 October 1991, Brown and Pollock, slide 144981, USNM.
- c. PTP. Alabama, Baldwin County, 1 mi E of Oyster Bay, 13 October 1990, R. L. Brown, slide DJW 3349, DJW.
- d. PTP. Alabama, Baldwin County, 1 mi E of Oyster Bay, 13 October 1990, R. L. Brown, slide DJW 2547, DJW.
- e. PTP. Alabama, Baldwin County, Bon Secour NWR, 15 October 1996, T. L. Schiefer, slide DJW 2548, DJW.
- f. PTP. Alabama, Baldwin County, Bon Secour NWR, 15 October 1996, T. L. Schiefer, slide DJW 2548, DJW.

## 56. Eucosma granulatana (Kearfott)

- a. New Mexico, Otero County, Holloman Lakes, 14 September 2004, G. J. Balogh, slide DJW 1571, DJW.
- b. Utah, San Juan County, Bluff Airstrip, 19 September 2000, G. J. Balogh, slide DJW 1130, DJW.
- c. PLTP. Colorado, Denver, E. J. Oslar, slide 25200, USNM.
- d. Colorado, Weld County, 4 mi NNE of Roggen, 19 August 2007, T. M. Gilligan, slide DJW 2030, DJW.
- e. Colorado, Weld County, 4 mi NNE of Roggen, 17 August 2007, T. M. Gilligan, slide DJW 2031, DJW.
- f. PLTP. Colorado, Platte Canyon, 23 August, E. J. Oslar, slide 25203, USNM.
- g. Colorado, Weld County, 4 mi NNE of Roggen, 17 August 2007, T. M. Gilligan, slide DJW 2031, DJW.

## 57. Eucosma argutipunctana (Blanchard and Knudson)

- a. HTP. Texas, Hemphill County, Canadian, 15 August 1971, A. and M. E. Blanchard, slide 25226, USNM.
- b. PTP. Texas, North Padre Island, 12 October 1979, A. and M. E. Blanchard, slide 25227, USNM.
- c. PTP. Texas, Montgomery County, Camp Strake, 14 September 1977, A. and M. E. Blanchard, slide 90352, USNM.
- d. PTP. Texas, Anderson County, Tennessee Colony, 27 August 1978, A. and M. E. Blanchard, slide 90357, USNM.
- e. Kansas, Morton County, Cimarron National Grassland, 25 August 2000, D. J. Wright, slide DJW 2552, DJW.
- f. Kansas, Morton County, Cimarron National Grassland, 25 August 2000, D. J. Wright, slide DJW 2553, DJW.
- g. Kansas, Morton County, Cimarron National Grassland, 25 August 2000, D. J. Wright, slide DJW 2553, DJW.

## 58. Eucosma striatana (Clemens)

- a. Illinois, Cook County, Air Station Prairie North, 16 August 2000, R. Panzer, slide DJW 2663, DJW.
- b. Colorado, Fremont County, 4.6 mi S of Salida, 13 August 1999, D. J. Wright, slide DJW 2674, DJW.
- c. Wyoming, Albany County, NE of Road 726, 17 July 2010, J. S. Nordin, slide DJW 2673, DJW.
- d. Arkansas, Washington County, Devil's Den State Park, 28 May 1966, R. W. Hodges, slide DJW 2700, USNM.
- e. New Jersey, Montclair, 5 June 1913, W. D. Kearfott, slide DJW 2699, USNM.

# 59. Eucosma occidentalis (Heinrich)

- a. HTP. California, Siskiyou County, Shasta Retreat, 16–23 June, slide 72777, USNM.
- b. Oregon, Jackson County, 3 mi N of North Hill, 15 May 1970, J. F. G. Clarke, slide DJW 2701, USNM.
- c. PTP. California, Siskiyou County, Shasta Retreat, 16–23 June, slide DJW 2703, USNM.

# 60. Eucosma implicata (Heinrich)

- a. PTP. Washington, Thurston County, Rochester, 26 June 1929, W. W. Baker, slide DJW 2252, USNM.
- b. PTP. Washington, Thurston County, Rochester, 26 June 1929, W. W. Baker, slide DJW 2707, USNM.
- c. California, Santa Clara County, Los Gatos, 18 July 1942, G. E. Pollard, slide DJW 3372, USNM.

# 61. Eucosma pallidicostana (Walsingham)

- a. Utah, Juab County, Eureka, 15 August 1911, T. Spalding, slide 70081, USNM.
- b. Colorado, Larimer County, 2 mi W of Mishawaka, 12 July 1993, D. J. Wright, slide DJW 96, DJW.
- c. California, El Dorado County, Greenwood, 21 June 1967, J. A. Powell, slide DJW 2654, DJW.
- d. New Mexico, Grant County, Gold Gulch Road, 9 August 1999, D. J. Wright, slide DJW 2602, DJW.
- e. New Mexico, Lincoln County, 5 mi W of Capitan, 24 September 2003, G. J. Balogh, slide DJW 1149, DJW.
- f. New Mexico, Cibola County, Lobo Canyon Picnic Area, 9 August 2005, D. J. Wright, slide DJW 2603, DJW.
- g. California, El Dorado County, Greenwood, 21 June 1967, J. A. Powell, slide DJW 2655, DJW.

# **62.** *Eucosma clavana* (Fernald)

- a. Michigan, Muskegon County, Muskegon State Park, 11 August 1989, G. J. Balogh, slide DJW 319, DJW.
- b. Connecticut, New Haven County, Milford Point Audubon Center, 2 July 2004, M. Volovski, slide DJW 2680, DJW.
- c. Indiana, Lake County, Ivanhoe Dune and Swale, 14 July 1999, R. Panzer, slide DJW 2681, DJW.
- d. Michigan, Allegan County, T2N R14W S26, 22 August 1986, G. J. Balogh, slide DJW 1388, DJW.
- e. Massachusetts, Martha's Vineyard, 18 July 1945, F. M. Jones, slide DJW 2693, USNM.

# 63. Eucosma indagatricana (Heinrich)

- a. North Dakota, Slope County, Columnar Juniper Area, 1 September 2002, G. J. Balogh, slide DJW 1953, DJW.
- b. Wyoming, Albany County, T15N R73W S1, 20 July 1996, J. S. Nordin, slide DJW 395, DJW.
- c. Utah, Sanpete County, Ephraim Canyon Road, 20 July 2006, D. J. Wright, slide DJW 1945, DJW.

## 64. Eucosma misturana (Heinrich)

- a. California, Los Angeles County, slide 70050, USNM.
- b. California, San Luis Obispo County, A. H. Vachell, slide 70053, USNM.
- c. Manitoba, Aweme, 25 May 1921, N. Criddle, slide 70049, USNM.
- d. Manitoba, Aweme, 19 May 1905, N. Criddle, slide DJW 2158, USNM.

# 65. Eucosma dorsiatomana (Kearfott)

- a. Washington, Whitman County, Wilma, 17 March 1934, J. F. G. Clarke, slide DJW 3190, USNM.
- b. PLTP. Alberta, MacLeod, 2 July 1904, slide 70067, USNM.
- c. Washington, Whitman County, Almota, 26 April 1931, J. F. G. Clarke, slide 70066, USNM.
- d. Colorado, Larimer County, US 287 at Owl Canyon, 29 June 2010, D. J. Wright, slide DJW 2580, DJW.
- e. Nevada, Lander County, 2 mi N of Austin, 2 June 2003, L. L. Crabtree, slide DJW 2716, DJW.

# 66. Eucosma salidana Wright and Gilligan

- a. PTP. Colorado, Fremont County, 4.6 mi S of Salida, 22 August 1997, D. J. Wright, slide DJW 3350, DJW.
- b. PTP. New Mexico, Otero County, Hwy 82, mi 11.5, 16 September 2004, G. J. Balogh, slide DJW 1744, DJW.
- c. HTP. Colorado, Fremont County, 4.6 mi S of Salida, 13 August 1999, D. J. Wright, slide 144982, USNM.
- d. PTP. Colorado, Fremont County, 4.6 mi S of Salida, 22 August 1997, D. J. Wright, slide DJW 374, DJW.
- e. PTP. Colorado, Larimer County, Phantom Canyon Ranch, 17 August 1990, P. A. Opler, slide DJW 268, DJW.
- f. PTP. Colorado, Fremont County, 4.6 mi S of Salida, 13 August 1999, D. J. Wright, slide DJW 3351, DJW.
- g. PTP. Colorado, Weld County, 2.5 mi NE of Roggen, 25 August 2007, C. Harp, slide DJW 1923, DJW.

# 67. *Eucosma fertoriana* (Heinrich)

- a. Wyoming, Albany County, NE of Pole Mtn. 30 May 2002, J. S. Nordin, slide DJW 882, DJW.
- b. California, Kern County, Mount Pinos, 2 July 1965, J. A. Powell, slide DJW 2217, EME.
- c. Oregon, Baker County, 6.4 mi N of Richland, 7 June 1970, J. F. G. Clarke, slide DJW 2216, USNM.
- d. Wyoming, Albany County, NE of Pole Mtn. 30 May 2002, J. S. Nordin, slide DJW 874, DJW.
- e. California, Tuolumne County, 4 mi S of Mather, 12 June 1961, J. A. Powell, slide DJW 2100, EME.
- f. Oregon, Baker County, 6.4 mi N of Richland, 7 June 1970, J. F. G. Clarke, slide DJW 2215, USNM.
- g. Oregon, Baker County, 6.4 mi N of Richland, 7 June 1970, J. F. G. Clarke, slide DJW 2215, USNM.

## 68. Eucosma crassana (McDunnough)

- a. PTP. British Columbia, Kreuger Mountain, Osoyoos, 9 May 1936, A. N. Gartrell, slide 70041, USNM.
- b. Alberta, Lethbridge, 21 May 1938, G. S. W., slide TOR 987, CNC.
- c. Alberta, Lethbridge, 21 May 1938, G. S. W., slide TOR 988, CNC.
- d. British Columbia, Chitcotin, slide 70042, USNM.
- e. Nevada, Lander County, 2 mi N of Austin, 27 May 2003, L. L. Crabtree, slide DJW 2651, DJW.
- f. PTP. British Columbia, Kreuger Mountain, Osoyoos, 9 May 1936, A. N. Gartrell, slide DJW 3071, CNC.
- g. Alberta, Lethbridge, 21 May 1938, G. S. W., slide DJW 3076, CNC.

## 69. Eucosma labiata (Wright)

- a. HTP. Texas, Cottle County, Paducah, 4 June 1970, A. and M. E. Blanchard, slide DJW 2149, USNM.
- b. PTP. California, Inyo County, Westgard Pass, 19 July 1968, P. A. Opler, slide DJW 2113, EME.
- c. PTP. Wyoming, Albany County, T15N R73W S1, 21 June 2002, J. S. Nordin, slide DJW 931, DJW.
- d. PTP. Texas, Hemphill County, Canadian, 28 May 1970, A. and M. E. Blanchard, slide DJW 2153, USNM.
- e. PTP. Texas, Hemphill County, Canadian, 28 May 1970, A. and M. E. Blanchard, slide DJW 2153, USNM.

#### 70. Eucosma spiculana (Zeller)

- a. Michigan, Montcalm County, T12N R10W S18, 5 June 1987, G. J. Balogh, slide DJW 320, DJW.
- b. Arizona, Cochise County, Miller Canyon, 14 April 1968, J. A. Powell, slide DJW 2195, EME.
- c. Indiana, Lake County, Dupont Dune and Swale, 18 May 2004, R. Panzer, slide DJW 2658, DJW.
- d. California, Inyo County, Olancha, 24–30 April, slide 26357, USNM.
- e. New Mexico, Dona Ana County, Aquirre Spring Campground, 15 April 2005, G. J. Balogh, slide DJW 1580, DJW.
- f. Texas, Brewster County, Alpine, 1–7 May 1926, O. C. Poling, slide DJW 2657, USNM.

## 71. Eucosma fulvotegulana Wright and Gilligan

- a. PTP. Texas, Randall County, Palo Duro Canyon St. Pk., 15 April 1969, A. and M. E. Blanchard, slide DJW 3365, USNM.
- b. PTP. Oklahoma, Oklahoma City, 22 May 1953, D. R. Davis, slide 70068, USNM.
- c. PTP. Texas, Cottle County, Paducah, 17 April 1968, A. and M. E. Blanchard, slide 90355, USNM.
- d. PTP. Texas, Cottle County, Paducah, 17 April 1968, A. and M. E. Blanchard, slide DJW 3364, USNM.
- e. PTP. Texas, Randall County, Palo Duro Canyon St. Pk., 15 April 1969, A. and M. E. Blanchard, slide DJW 3366, USNM.
- f. PTP. Texas, Cottle County, Paducah, 17 April 1968, A. and M. E. Blanchard, slide 141826, USNM.

## 72. Eucosma pecosana Wright and Gilligan

- a. HTP. New Mexico, Chaves County, Mescalero Dunes, 22 September 2003, G. J. Balogh, slide 144983, USNM.
- b. HTP. New Mexico, Chaves County, Mescalero Dunes, 22 September 2003, G. J. Balogh, slide 144983, USNM.
- c. PTP. New Mexico, Otero County, White Sands National Monument, 25 Aug 2009, E. H. Metzler, slide DJW 2538, MSU.
- d. PTP. New Mexico, Otero County, White Sands National Monument, 25 Aug 2009, E. H. Metzler, slide DJW 2538, MSU.
- e. PTP. New Mexico, Otero County, White Sands National Monument, 25 Aug 2009, E. H. Metzler, slide DJW 2542, MSU.
- f. PTP. New Mexico, Otero County, White Sands National Monument, 10 Aug 2010, E. H. Metzler, slide DJW 3300, MSU.
- g. PTP. New Mexico, Otero County, White Sands National Monument, 10 Aug 2010, E. H. Metzler, slide DJW 3300, MSU.

## 73. Eucosma goblinana (Wright)

- a. PTP. Utah, Emery County, Goblin Valley Road, 11 May 2001, J. S. Nordin, slide DJW 858, DJW.
- b. PTP. Utah, Emery County, Goblin Valley Road, 11 May 2001, J. S. Nordin, slide DJW 1938, DJW.
- c. HTP. Utah, Emery County, Goblin Valley Road, 11 May 2001, J. S. Nordin, slide 142988, USNM.
- d. PTP. Utah, Emery County, mi 146, Hwy 24, 18 May 2010, J. S. Nordin, slide DJW 2993, DJW.
- e. PTP. Utah, Emery County, Goblin Valley Road, 21 May 2003, J. S. Nordin, slide DJW 1940, DJW.
- f. PTP. Utah, Emery County, Goblin Valley Road, 21 May 2003, J. S. Nordin, slide DJW 1941, DJW.
- g. PTP. Utah, Emery County, Goblin Valley Road, 21 May 2003, J. S. Nordin, slide DJW 1940, DJW.

## 74. Eucosma corculana (Zeller)

- a. Colorado, Larimer County, 2 mi W of Mishawaka, 12 July 1993, D. J. Wright, slide DJW 835, DJW.
- b. Oregon, Klamath County, Crater Lake, 16–23 July, slide 69950, USNM.
- c. Colorado, Clear Creek County, Mount Evans, 10 July 1961, W. R. Mason, slide DJW 2127, CNC.
- d. California, Tulare County, Mineral King, 16–23 July, slide 69951, USNM.
- e. Nevada, Washoe County, Verdi, 1-10 June, A. H. Vachell, slide 69953, USNM.
- f. Colorado, Chaffee County, 4 mi N of Buena Vista, 15 August 1999, D. J. Wright, slide DJW 1965, DJW.
- g. Wyoming, Albany County, T15N R73W S1, 20 August 2002, J. S. Nordin, slide DJW 1994, DJW.

## 75. Eucosma arenana (Wright)

- a. HTP. Utah, Emery County, Goblin Valley Road, 9 May 2007, J. S. Nordin, slide 137267, USNM.
- b. PTP. Utah, Emery County, Goblin Valley Road, 17 May 1998, J. S. Nordin, slide DJW 692, DJW.
- c. PTP. Utah, Emery County, Goblin Valley Road, 9 May 2007, J. S. Nordin, slide DJW 1960, DJW.
- d. PTP. Utah, Emery County, Goblin Valley Road, 9 May 2007, J. S. Nordin, slide DJW 1963, DJW.
- e. Utah, Emery County, Hwy 24 and Goblin Valley Road, 11 May 2009, J. S. Nordin, slide DJW 2992, DJW.

## 76. Eucosma mormonensis (Heinrich)

- a. Utah, Sanpete County, Ephraim SWMA, 19 July 2006, D. J. Wright, slide DJW 1977, DJW.
- b. New Mexico, Lincoln County, Valley of Fires, 19 August 2005, D. J. Wright, slide DJW 1995, DJW.
- c. New Mexico, Cibola County, Coal Mine Canyon Campground, 9 August 2005, slide DJW 1399, DJW.
- d. Montana, Powder River County, Custer National Forest, 12 August 2004, D. J. Wright, slide DJW 1136, DJW.
- e. Idaho, Oneida County, 5 mi SSE of Holbrook, 18 July 2001, D. J. Wright, slide DJW 934, DJW.
- f. Idaho, Oneida County, Holbrook Summit, 15 July 2006, D. J. Wright, slide DJW 1966, DJW.
- g. New Mexico, Grant County, Gold Gulch Road, 9 August 1999, D. J. Wright, slide DJW 1996, DJW.

#### 77. Eucosma browni (Wright)

- a. PTP. Colorado, Mesa County, Lands End Road, 2 September 2000, D. J. Wright, slide DJW 1999, DJW.
- b. PTP. Wyoming, Albany County, T15N R73W S1, 13 August 2001, J. S. Nordin, slide DJW 826, DJW.
- c. PTP. New Mexico, Taos County, 10 mi SE of Tres Piedras, 11 August 1999, D. J. Wright, slide DJW 1998, DJW.
- d. PTP. Wyoming, Albany County, T15N R73W S1, 15 August 2002, C. D. Ferris, slide DJW 2001, DJW.
- e. PTP. New Mexico, Taos County, 10 mi SE of Tres Piedras, 11 August 1999, D. J. Wright, slide DJW 852, DJW.

#### 78. Eucosma tarandana (Möschler)

- a. Colorado, Chaffee County, 2 mi S of Poncho Springs, 6–7 August 2010, C. Harp, slide DJW 3353, DJW.
- b. Wyoming, Albany County, NE of Pole Mtn., 21 June 2001, J. S. Nordin, slide DJW 868, DJW.
- c. Michigan, Keneenaw County, 1 mi E of Agate Harbor, 9 July 2001, G. J. Balogh, slide DJW 797, DJW.
- d. Colorado, Chaffee County, 2 mi S of Poncho Springs, 11–12 August 2010, C. Harp, slide DJW 3352, DJW.
- e. Colorado, Teller County, Florissant, 13 August 1962, T. C. Emmel, slide DJW 2791, LACM.

#### 79. Eucosma transversa (Walsingham)

- a. Colorado, Larimer County, Loveland, 1891, W. G. Smith, slide 70029, USNM. [Fernald Collection]
- b. Colorado, Teller County, 5 mi S of Florissant, 19 July 1982, G. J. Balogh, slide DJW 336, DJW.
- c. Colorado, Teller County, 5 mi S of Florissant, 19 July 1982, G. J. Balogh, slide DJW 352, DJW.
- d. Washington, Whitman County, Union Flat, 21 February 1934, J. F. G. Clarke, slide DJW 2752, USNM.
- e. British Columbia, Kaslo Creek, H. G. Dyar, slide 70016, USNM.

## 80. *Eucosma montanana* (Walsingham)

- a. Montana, Carter County, Medicine Rocks State Park, 4 September 2002, G. J. Balogh, slide DJW 2639, DJW.
- b. Michigan, Muskegon County, T21N R17W S26, 11 June 1993, G. J. Balogh, slide DJW 334, DJW.
- c. Illinois, Lake County, Beach State Park, 11 June 1999, R. Panzer, slide DJW 2640, DJW.
- d. Montana, Carter County, Medicine Rocks State Park, 4 September 2002, G. J. Balogh, slide DJW 2630, DJW.
- e. Montana, Carter County, Medicine Rocks State Park, 5 September 2002, G. J. Balogh, slide DJW 1845, DJW.

## 81. Eucosma benjamini (Heinrich)

- a. California, San Bernardino County, Upper Santa Ana River, 8 September 1947, Melander, slide DJW 2748, USNM.
- b. HTP. Utah, Utah County, Vineyard, 12 September 1912, T. Spalding, slide 72763, USNM.
- c. Arizona, Mojave County, Rosy Canyon Road, 22 September 2000, G. J. Balogh, slide DJW 1125, DJW.
- d. California, San Diego County, Torrey Pines, 19-26 October 2005, N. Bloomfield, slide 124400, USNM.
- e. California, San Diego County, Jacumba, 29 September 1924, slide 70109, USNM.
- f. California, Los Angeles County, La Tuna Canyon, 16 October 1942, W. H. Evans, slide DJW 2749, USNM.
- g. California, San Diego County, Torrey Pines, 19–26 October 2005, N. Bloomfield, slide DJW 2751, USNM.

## 82. Eucosma elongana (Walsingham)

- a. Wyoming, Albany County, Pelton Creek, 14 June 2002, J. S. Nordin, slide DJW 924, DJW.
- b. Colorado, Laramie County, RMNP Fall River Firque, 4 July 1991, P. A. Opler, slide DJW 703, DJW.
- c. Colorado, San Juan County, Silverton, 1–7 August, slide 70004, USNM.
- d. Utah, Sanpete County, Monti-Lasal National Forest, 6 June 2006, V. Albu, slide DJW 2597, DJW.
- e. Utah, Sanpete County, Monti-Lasal National Forest, 6 June 2006, V. Albu, slide DJW 2597, DJW.
- f. Colorado, Chaffee County, Cottonwood Pass, 14 July 1982, J.-F. Landry, slide DJW 2263, CNC.
- g. Colorado, Chaffee County, Cottonwood Pass, 13 July 1982, J.-F. Landry, slide DJW 3020, CNC.

#### 83. Eucosma rupestrana (McDunnough)

- a. PTP. British Columbia, Laggan, T. E. Bean, slide DJW 2718, USNM.
- b. Michigan, Chippewa County, Maxton Plain, 24 May 1991, G. J. Balogh, slide DJW 318, DJW.
- c. PTP. Alberta, Nordegg, 19 June 1921, McDunnough, slide 70017, USNM.
- d. South Dakota, Black Hills, 14 June 1991, G. J. Balogh, slide DJW 1846, DJW.
- e. South Dakota, Black Hills, 14 June 1991, G. J. Balogh, slide DJW 1846, DJW.

#### 84. Eucosma umbraticana (Heinrich)

- a. HTP. Colorado, Jefferson County, 13 March 1901, Dyar and Caudell, slide 72781, USNM.
- b. Colorado, Platt Canyon, E. J. Oslar, slide 70030, USNM. [determination tentative]

## 85. Eucosma offectalis (Hulst)

- a. Wyoming, Albany County, T15N R73W S1, 12 July 2001, J. S. Nordin, slide DJW 2428, DJW.
- b. Colorado, Clear Creek County, Loveland Pass, 23 July 1988, P. A. Opler, slide DJW 688, DJW.
- c. Wyoming, Albany County, Pelton Creek Road, 8 July 2003, J. S. Nordin, slide DJW 976, DJW.
- d. Colorado, Summit County, Loveland Pass, 9 July 1964, P. A. Opler, slide, DJW 704, DJW.
- e. Wyoming, Albany County, Upper Blair Picnic Area, 22 July 2003, J. S. Nordin, slide DJW 2427, DJW.
- f. New Mexico, Socorro County, Bosque del Apache, 4 August 1999, D. J. Wright, slide DJW 2429, DJW.

#### 86. Eucosma pastigiata (Heinrich)

- a. California, San Bernardino County, near Onyx Summit, 26–27 June 1988, J. A. Powell, slide DJW 2111, EME.
- b. Colorado, Alamosa County, Great Sand Dunes, 17 June 1982, R. W. Hodges, slide DJW 2105, USNM.
- c. Colorado, Alamosa County, Great Sand Dunes, 17 June 1982, R. W. Hodges, slide DJW 2105, USNM.
- d. PTP. California, Tulare County, Monachee Meadows, 8-14 July, slide DJW 2174, USNM.
- e. PTP. California, Tulare County, Monachee Meadows, 8–14 July, slide DJW 2174, USNM.

## 87. Eucosma hodgesi (Wright and Gilligan)

- a. PTP. Wyoming, Albany County, T15N R73W S1, 15 July 2004, J. S. Nordin, slide DJW 1121, DJW.
- b. California, S Bern. County, Apple V., 20 May 1955, J. E. H. Martin, slide DJW 2126, CNC. [determination tentative]
- c. HTP. Colorado, Alamosa County, Zapata Ranch, 26 June 1982, R. W. Hodges, slide 137206, USNM.
- d. PTP. Colorado, Alamosa County, Zapata Ranch, 26 June 1982, R. W. Hodges, slide DJW 1836, USNM.
- e. PTP. Nevada, Elko County, Angel Lk. Road above Wells, 15 July 1971, D. C. Ferguson, slide DJW 1933, USNM.
- f. PTP. Colorado, Alamosa County, Zapata Ranch, 26 June 1982, R. W. Hodges, slide DJW 1842, USNM.

## 88. Eucosma stramineana (Walsingham)

- a. LTP. Colorado, Denver, July 1872, Walsingham, slide 11601, BMNH.
- b. Wyoming, Albany County, T15N R73W S1, 17 July 2004, J. S. Nordin, slide DJW 2016, DJW.
- c. Wyoming, Albany County, T15N R73W S1, 12 July 2001, J. S. Nordin, slide DJW 929, DJW.

## 89. Eucosma parvana (Walsingham)

a. LTP. Oregon, Grant County, Camp Watson, April 1872, Walsingham, slide 11600, BMNH.

## 90. Eucosma clementeana (Wright)

- a. PTP. California, Los Angeles County, San Clemente Island, 1 October 2002, J. A. Powell, slide DJW 2091, DJW.
- b. PTP. California, San Diego County, Cardiff, 2 October 1964, J. A. Powell, slide DJW 2177, EME.
- c. PTP. California, Los Angeles County, San Clemente Island, 1 October 2002, J. A. Powell, slide DJW 2178, USNM.
- d. PTP. California, San Diego County, Cardiff, 2 October 1964, J. A. Powell, slide DJW 2094, DJW.
- e. PTP. California, San Diego County, Cardiff, 2 October 1964, J. A. Powell, slide DJW 2179, EME.

## 91. Eucosma grindeliana (Busk)

- a. PTP. Texas, Donley County, Clarendon, 19 September 1905, W. D. Pierce, slide DJW 2206, USNM.
- b. Florida, Marion County, Marion Oaks, 22 May 1990, J. S. Kutis, slide DJW 2027, MEM.
- c. California, San Diego County, 5 mi NE of Boulevard, 5 October 1967, J. A. Powell, slide DJW 2220, EME.
- d. PTP. Texas, Donley County, Clarendon, 19 September 1905, W. D. Pierce, slide DJW 2207, USNM.
- e. PTP. Texas, Donley County, Clarendon, 19 September 1905, W. D. Pierce, slide DJW 2221, USNM.
- f. Florida, Suwannee County, Suwannee River State Park, 21–23 May 1986, H. D. Baggett, slide DJW 2028, MEM.
- g. Florida, Highlands County, Highlands Hammock, 15 November 1987, G. J. Balogh, side DJW 333, DJW.
- h. Kansas, Morton County, Cimarron National Grassland, 2 August 1999, D. J. Wright, slide DJW 536, DJW.
- i. Kansas, Morton County, Cimarron National Grassland, 25 August 2000, D. J. Wright, slide DJW 2208, DJW.
- j. Mexico, Baja California, Arroyo Catavina, 1 April 1976, P. Rude, slide 2218, EME.

#### 92. Eucosma convergana (McDunnough)

- a. PTP. Manitoba, Aweme, 21 May 1922, N. Criddle, slide DJW 3163, USNM.
- b. Indiana, Lake County, Dupont Dune and Swale, 10 May 2005, R. Panzer, slide DJW1428, DJW.
- c. Indiana, Lake County, Dupont Savanah, 25 May 2000, R. Panzer, slide DJW 733, DJW.

#### 93. Eucosma modernana (McDunnough)

- a. PTP. Quebec, Aylmer, 3 June 1920, McDunnough, slide 69982, USNM.
- b. Massachusetts, Amherst, 5 May 1909, slide 69981, USNM.
- c. Fernald Collection, slide 72695, USNM.

#### 94. Eucosma parmatana (Clemens)

- a. Ohio, Adams County, 1 mi SE of Lynx, 21 August 1993, D. J. Wright, slide DJW 1574, DJW.
- b. Maine, Baxter State Park, 15 July 1989, G. J. Balogh, slide DJW 343, DJW. [E. crispana phenotype]
- c. Ohio, Adams County, 1 mi SE of Lynx, 10 September 1998, D. J. Wright, slide DJW 1576, DJW.
- d. Manitoba, Aweme, 28 July 1921, N. Criddle, slide 69975, USNM.
- e. Colorado, Larimer County, 2 mi W of Mishawaka, 9 July 1993, D. J. Wright, slide DJW 94, DJW.
- f. Ohio, Wyandot County, Killdeer Plains, 15 June 1996, D. J. Wright, slide DJW 1575, DJW. [E. marmontana phenotype]
- g. Illinois, Shelby County, Oconee, 1–7 September, slide 69969, USNM.
- h. Mississippi, Oktibbeha County, Osborn Prairie, 26 August 2003, D. J. Wright, slide DJW 996, DJW.
- i. Ohio, Adams County, 1 mi SE of Lynx, 12 September 1998, D. J. Wright, slide DJW 1473, DJW.
- j. Ohio, Adams County, 1 mi SE of Lynx, 21 August 1993, D. J. Wright, slide DJW 2742, DJW.

#### 95. Eucosma oregonensis (Heinrich)

- a. HTP. Oregon, Klamath County, Crater Lake, 24-31 July, slide 69980, USNM.
- b. Utah, Sanpete, Great Basin Environmental Education Center, 19-20 July 1996, P. and S., slide DJW 2934, EME.
- c. California, Placer County, 2 mi S of Tahoe City, 30 June 1966, N. W., slide DJW 2819, LACM.
- d. California, Sierra County, 1 mi E of Bassetts, 29 June 2002, J. A. Powell, slide DJW 2932, EME.
- e. Utah, Sanpete, Great Basin Environmental Education Center, 19–20 July 1996, J. A. Powell, slide DJW 2935, EME.

## 96. Eucosma ochroterminana (Kearfott)

- a. Ohio, Wyandot County, Killdeer Plains, 16 August 2006, D. J. Wright, slide DJW 2608, DJW.
- b. Ohio, Adams County, 1 mi SE of Lynx, 31 August 1989, D. J. Wright, slide DJW 1468, DJW.
- c. Colorado, Yuma County, Bonny Reservoir SRA, 5 August 1996, D. J. Wright, slide DJW 2605, DJW.
- d. Ohio, Adams County, 1 mi SE of Lynx, 10 September 1988, D. J. Wright, slide DJW 1469, DJW.
- e. Ohio, Adams County, 1 mi SE of Lynx, 10 September 1988, D. J. Wright, slide DJW 1469, DJW.

#### 97. Eucosma tomonana (Kearfott)

- a. Ohio, Geauga County, Raintree Road, 17 August 1990, D. J. Wright, slide DJW 2629, DJW.
- b. Ohio, Adams County, 1 mi SE of Lynx, 10 September 1988, D. J. Wright, slide DJW 1470, DJW.
- c. Kentucky, Bullitt County, Pine Creek Forest Road, 6 Sept 1989, D. J. Wright, slide DJW 3357, DJW.
- d. Ohio, Adams County, Chaparral Prairie, 6 September 1991, D. J. Wright, slide DJW 1471, DJW.
- e. Ohio, Adams County, 1 mi SE of Lynx, 31 August 1989, D. J. Wright, slide DJW 80, DJW.

## 98. Eucosma raracana (Kearfott)

- a. Kentucky, Bracken County, Meldahl Dam, 24 August 1994, D. J. Wright, slide DJW 1466, DJW.
- b. Louisiana, Bossier Parish, Barksdale Air Force Base, 13 September 1996, R. L. Brown, slide DJW 2606, DJW.
- c. Ohio, Wyandot County, Killdeer Plains, 16 August 2006, D. J. Wright, slide DJW 3358, DJW.
- d. Ohio, Adams County, 1 mi SE of Lynx, 3 August 1998, D. J. Wright, slide DJW 1467, DJW.
- e. Ohio, Wyandot County, Killdeer Plains, 16 August 2006, D. J. Wright, slide DJW 2607, DJW.

## 99. Eucosma ochrocephala (Walsingham)

- a. Kentucky, Bracken County, Meldahl Dam, 14 August 1994, D. J. Wright, slide DJW 1464, DJW.
- b. Kentucky, Bracken County, Meldahl Dam, 14 August 1994, D. J. Wright, slide DJW 1465, DJW.

# 100. Eucosma sableana Wright and Gilligan

- a. HTP. Nova Scotia, Sable Island, 11–13 August 1978, D. C. Ferguson, slide 144984, USNM.
- b. PTP. Nova Scotia, Sable Island, 11-13 August 1978, D. C. Ferguson, slide DJW 3203, USNM.
- c. PTP. Nova Scotia, Sable Island, 11–13 August 1978, D. C. Ferguson, slide DJW 3359, USNM.
- d. PTP. Nova Scotia, Sable Island, 11–13 August 1978, D. C. Ferguson, slide DJW 3229, USNM.
- e. PTP. Nova Scotia, Sable Island, 11–13 August 1978, D. C. Ferguson, slide DJW 3204, USNM.

#### 101. Eucosma verniochreana (Heinrich)

- a. PTP. New Jersey, Burlington County, Mount Holly, 19 August 1906, slide 26219, USNM.
- b. PTP. New Jersey, Burlington County, Mount Holly, 19 August 1906, slide 26218, USNM.
- c. PTP. New Jersey, Burlington County, Mount Holly, 19 August 1906, slide 26218, USNM.
- d. PTP. New Jersey, Burlington County, Mount Holly, 19 August 1906, slide DJW 3368, AMNM.
- e. PTP. New Jersey, Burlington County, Mount Holly, 19 August 1906, slide DJW 3368, AMNM.

#### 102. Eucosma knudsoni Wright and Gilligan

- a. PTP. Colorado, Fremont County, 4.6 mi S of Salida, 13 August 1999, D. J. Wright, slide DJW 2180, DJW.
- b. PTP. Colorado, Fremont County, 4.6 mi S of Salida, 13 August 1999, D. J. Wright, slide DJW 538, DJW.
- c. PTP. New Mexico, Lincoln County, Valley of Fires, 17 August 2005, D. J. Wright, slide DJW 1987, DJW.
- d. PTP. Colorado, Otero County, Vogel Canyon Picnic Area, 18 August 1987, D. J. Wright, slide DJW 1985, DJW.
- e. PTP. New Mexico, Lincoln County, Valley of Fires, 17 August 2005, D. J. Wright, slide DJW 1988, DJW.

#### 103. Eucosma olivaceana (Riley)

- a. Iowa Pocahontas County, Kalsow Prairie, 2 July 1993, D. J. Wright, slide DJW 2649, DJW.
- b. Ohio, Erie County, Resthaven Wildlife Area, 12 July 1991, D. J. Wright, slide DJW 2650, DJW.

#### 104. Eucosma viridis (Wright and Gilligan)

- a. PTP. Arizona, Coconino County, Fort Valley, 21 July 1961, R. W. Hodges, slide DJW 2058, USNM.
- b. Arizona, Coconino County, slide 118890, USNM.
- c. PTP. Arizona, Coconino County, Fort Valley, 7 August 1961, R. W. Hodges, slide 70142, USNM.
- d. PTP. Arizona, Coconino County, Fort Valley, 28 July 1961, R. W. Hodges, slide DJW 2187, USNM.
- e. PTP. Arizona, Coconino County, Fort Valley, 28 July 1961, R. W. Hodges, slide DJW 2060, USNM.

#### 105. Eucosma modicellana (Heinrich)

- a. Colorado, Larimer County, Stonewall Creek, 30 June 2008, J. S. Nordin, slide DJW 2269, DJW.
- b. New Mexico, Grant County, Gold Gulch Road, 9 August 1999, D. J. Wright, slide DJW 2270, DJW.
- c. Colorado, Larimer County, Viestenz Smith Park, 27 July 1995, D. J. Wright, slide DJW 177, DJW.
- d. Colorado, Larimer County, US 287 at Owl Canyon, 29 June 2010, D. J. Wright, slide DJW 2576, DJW.
- e. California, Santa Barbara County, Santa Cruz Island, 21 May 1984, J.-F. Landry, slide DJW 2138, CNC.

#### 106. Eucosma pallidarcis (Heinrich)

- a. Colorado, Weld County, County Road 91, N of I-76, 22 July 2003, D. J. Wright, slide DJW 2568, DJW.
- b. Idaho, Oneida County, Curlew National Grassland, 9 July 2006, D. J. Wright, slide DJW 2567, DJW.
- c. Colorado, Weld County, County Road 91, N of I-76, 26 July 1995, D. J. Wright, slide DJW 945, DJW.
- d. Texas, Potter County, Lake Meredith NRA, 23 June 1985, E. C. Knudson, slide DJW 2261, USNM.

#### 107. Eucosma cibolana (Wright)

- a. PTP. New Mexico, Cibola County, Coal Mine Canyon Campground, 9 August 2005, D. J. Wright, slide DJW 1395, DJW.
- b. PTP. Idaho, Oneida County, Curlew National Grassland, 18 July 2001, D. J. Wright, slide DJW 1942, DJW.
- c. PTP. Colorado, Alamosa County, Zapata Ranch, 26 June 1982, R. W. Hodges, slide DJW 2159, USNM.
- d. HTP. New Mexico, Cibola County, Coal Mine Canyon Campground, 9 August 2005, D. J. Wright, 137412, USNM.
- e. PTP. Colorado, Alamosa County, Great Sand Dunes, 28 June 1982, R. W. Hodges, slide DJW 2160, USNM.

## 108. Eucosma parvula (Wright)

- a. PTP. Colorado, Mesa County, Lands End Road, 2 September 2000, D. J. Wright, slide DJW 932, DJW.
- b. PTP. Utah, Uintah County, 3 mi N of Vernal, 4 September 2000, D. J. Wright, slide DJW 745, DJW.
- c. PTP. Montana, Phillips County, Malta, 12 August 1928, McDunnough, slide TOR 1046, CNC.
- d. PTP. Utah, Uintah County, Dinosaur National Monument, 12 August 1973, J. A. Powell, slide DJW 2095, DJW.
- e. PTP. Montana, Phillips County, Malta, 8 August 1928, McDunnough, slide DJW 2096, CNC.

#### 109. Eucosma patagoniana Wright

- a. PTP. Arizona, Santa Cruz County, 8 mi SSE of Patagonia, 5 August 1999, D. J. Wright, slide DJW 607, DJW.
- b. HTP. Arizona, Santa Cruz County, 8 mi SSE of Patagonia, 5 August 1999, D. J. Wright, slide 145023, USNM.
- c. PTP. Arizona, Santa Cruz County, Pena Blanca Lake, 10 August 1974, J. A. Powell, slide DJW 1318, DJW.
- d. PTP. Arizona, Santa Cruz County, SW Field Station, 13 August 2012, J. W. Brown, slide DJW 3199, USNM.

#### 110. Eucosma influana (Heinrich)

- a. PTP. California, Siskiyou, Shasta Retreat, 16–23 June, slide 25418, USNM.
- b. Oregon, Wallowa County, Wallowa Lake, 19 June 1970, J. F. G. Clarke, slide DJW 2691, USNM.
- c. Wyoming, Albany County, NW of Woods Landing, 2 June 2001, J. S. Nordin, slide DJW 2684, DJW.
- d. Iowa, Pocahontas County, Kalsow Prairie, 25 June 1997, D. J. Wright, side DJW 2683, DJW.
- e. New Mexico, Socorro County, Gran Quivira NM, 1-3 July 1964, D. R. Davis, slide 25473, USNM. [HTP. E. musetta]
- f. Iowa, Pocahontas County, Kalsow Prairie, 18 June 1992, D. J. Wright, side DJW 2686, DJW.
- g. Iowa, Emmet County, Cayler Prairie, 2 July 1995, E. H. Metzler, slide DJW 2685, DJW.

#### 111. Eucosma migratana (Heinrich)

- a. HTP. California, Inyo County, Olancha, 24–30 April, slide 72770, USNM.
- b. California, Kern County, 10 mi SW of Mojave, 28 March 1968, J. A. Powell, slide DJW 2146, EME.
- c. Wyoming, Albany County, T15N R73W S1, 31 May 2003, J. S. Nordin, slide DJW 970, DJW.
- d. Colorado, Larimer County, Fort Collins, 26 June 1989, P. A. Opler, slide DJW 281, DJW.
- e. PTP. California, Inyo County, Olancha, 24–30 April, slide DJW 2253, USNM.
- f. PTP. California, Inyo County, Olancha, 24–30 April, slide DJW 2253, USNM.

#### 112. Eucosma complicana (McDunnough)

HTP. British Columbia, Osoyoos, 19 May 1923, C. B. Garrett, slide TOR 981, CNC.

## 113. Eucosma columbiana (Walsingham)

- a. Oregon, slide 69987, USNM.
- b. Utah, Utah County, Vineyard, 28 April 1912, T. Spalding, slide DJW 2378, USNM.
- c. Utah, Utah County, Vineyard, 27 April 1912, T. Spalding, slide 69986, USNM.
- d. New Mexico, Otero County, White Sands National Monument, 23 April 2009, E. H. Metzler, slide DJW 2328, MSU.
- e. Washington, Whitman County, Pullman, 14 April 1928, J. F. G. Clarke, slide 69988, USNM.
- f. Fernald Collection, slide DJW 2377, USNM.
- g. New Mexico, Otero County, White Sands National Monument, 23 April 2009, E. H. Metzler, slide DJW 2329, MSU.

## 114. Eucosma bucephaloides (Walsingham)

- a. Colorado, Conejos County, 12.4 mi E of Mannasa, 8 August 2006, C. Harp, slide DJW 2431, DJW.
- b. New Mexico, Taos County, 10 mi SE of Tres Piedras, 11 August 1999, D. J. Wright, slide DJW 2433, DJW.
- c. Wyoming, Albany County, T15N R73W S1, 11 August 2002, C. D. Ferris, slide DJW 2435, DJW.
- d. Colorado, Mesa County, Lands End Road, 2 September 2000, D. J. Wright, slide DJW 2434, DJW.
- e. Idaho, Oneida County, Curlew National Grassland, 28 July 2003, D. J. Wright, slide DJW 2426, DJW.
- f. Colorado, Mesa County, Lands End Road, 2 September 2000, D. J. Wright, slide DJW 2424, DJW.

## 115. Eucosma salmicolorana (Heinrich)

- a. Utah, Sanpete County, Ephraim Canyon Road, 17 July 2008, D. J. Wright, slide DJW 2459, DJW.
- b. Colorado, Grand County, Beaver Creek, 11 August 1996, D. J. Wright, slide DJW 260, DJW.
- c. Wyoming, Albany County, T15N R73W S1, 15 July 2001, J. S. Nordin, slide DJW 828, DJW.
- d. Utah, Daggett County, 4 mi S of Manila, 20 July 1994, G. J. Balogh, slide DJW 2458, DJW.
- e. California, Mono County, McGee Creek Road, 20 August 2005, V. Albu, slide DJW 2457, DJW.

#### 116. Eucosma mayelisana (Blanchard)

- a. Utah, Emery County, Hwy 24 and Goblin Valley Road, 17 May 2002, J. S. Nordin, slide DJW 2647, DJW.
- b. Colorado, Washington County, Prewitt SWA, 2 June 1989, P. A. Opler, slide DJW 389, DJW.
- c. Utah, Emery County, Hwy 24 and Goblin Valley Road, 11 May 2001, J. S. Nordin, slide DJW 864, DJW.
- d. Colorado, Washington County, 12 mi N of Akron, 9 June 1991, P. A. Opler, slide DJW 2638, DJW.
- e. Colorado, Washington County, 12 mi N of Akron, 9 June 1991, P. A. Opler, slide DJW 2638, DJW.

#### 117. Eucosma tenuiana (Walsingham)

- a. Wyoming, Albany County, NW of Woods Landing, 4 September 2003, J. S. Nordin, slide DJW 1009, DJW.
- b. Arizona, Mojave County, 16–23 October, slide 70039, USNM.
- c. California, Nevada County, September, slide 70040, USNM.
- d. Wyoming, Albany County, NW of Woods Landing, 3 September 2005, J. S. Nordin, slide DJW 1937, DJW.
- e. Oregon, Baker, Spring Creek, 28 August 1963, J. H. Baker, slide DJW 2211, DJW.

#### 118. Eucosma donahuei (Wright)

- a. PTP. California, Kern County, Piute Mountains, 1–3 June 1973, J. P. and K. E. Donahue, slide DJW 3062, LACM.
- b. PTP. California, Kern County, Piute Mountains, 1–3 June 1973, J. P. and K. E. Donahue, slide DJW 3063, LACM.
- c. HTP. California, Kern County, Piute Mountains, 1–3 June 1973, J. P. and K. E. Donahue, slide DJW 2796, LACM.

#### 119. Eucosma nepotinana (Heinrich)

- a. Nevada, Washoe County, Verdi, 1–10 June, A. H. Verdi, slide DJW 2165, USNM.
- b. California, Tulare County, Monachee Meadows, 1–7 July, slide 70033, USNM.
- c. Wyoming, Albany County, T15N R73W S1, 5 June 2002, J. S. Nordin, slide DJW 881, DJW.
- d. Washington, Godman Springs, 24 June 1970, J. F. G. Clarke, slide 2610, USNM.
- e. California, Riverside County, Lake Hemet, 9 June 1937, E. C. Johnston, slide 70032, USNM.
- f. PTP. Utah, Juab County, Eureka, 30 May 1911, T. Spalding, slide DJW 2611, USNM.
- g. Idaho, Owyhee County, 7 mi S of Bruneau, 10 April 1963, O. O. Fillmore, slide 2157, USNM.

#### 120. Eucosma kramerana (Wright)

- a. PTP. California, San Bern. County, Kramer Hills, 19 April 1958, J. A. Powell, slide DJW 2108, EME.
- b. PTP. California, San Bern. County, Kramer Hills, 19 April 1958, J. A. Powell, slide DJW 2632, EME.
- c. PTP. California, San Bern. County, Kramer Hills, 19 April 1958, J. A. Powell, slide JAP 234, EME.
- d. HTP. California, San Bern. County, Kramer Hills, 19 April 1958, J. A. Powell, slide DJW 2145, EME.
- e. PTP. California, Inyo County, 1–7 May, slide DJW 2167, USNM.

## 121. Eucosma subminimana (Heinrich)

- a. PTP. California, San Diego County, San Diego, slide DJW 2635, USNM.
- b. PTP. California, San Diego County, San Diego, 16–23 August, slide DJW 2637, USNM.
- c. PTP. California, San Diego County, San Diego, slide 70080, USNM.
- d. California, San Diego County, San Diego, 19 July 1924, slide DJW 2636, USNM.
- e. California, San Diego County, San Diego, 21 July 1924, slide DJW 2634, USNM.

## 122. *Eucosma alatana* (McDunnough)

- a. California, San Diego County, MCAS Miramar, 17 January 1998, N. Bloomfield, slide DJW 2115, EME.
- b. California, San Diego County, NAS Miramar 12, 5 March 1997, N. Bloomfield, slide 87883, USNM.
- c. California, San Diego County, NAS Miramar 6, 30 January 1997, N. Bloomfield, slide DJW 2618, USNM.

#### 123. Eucosma vogelana (Wright)

- a. PTP. Colorado, Otero County, Vogel Canyon Picnic Area, 18 August 1997, D. J. Wright, slide DJW 1935, DJW.
- b. PTP. Colorado, Otero County, Vogel Canyon Picnic Area, 18 August 1997, D. J. Wright, slide DJW 376, DJW.
- c. HTP. Colorado, Otero County, Vogel Canyon Picnic Area., 18 August 1997, D. J. Wright, slide 137419, USNM.
- d. PTP. Colorado, Otero County, Vogel Canyon Picnic Area, 18 August 1997, D. J. Wright, slide DJW 1936, DJW.
- e. PTP. Colorado, Otero County, Vogel Canyon Picnic Area, 18 August 1997, D. J. Wright, slide DJW 427, DJW.

#### 124. Eucosma latens (Heinrich)

- a. California, Kern County, Cerro Noroeste, 15 July 1965, J. A. Powell, slide DJW 2089, EME.
- b. Nevada, Lander County, Austin Summit, 21 July 1968, P. A. Opler, slide DJW 2133, EME.
- c. California, Kern County, Cerro Noroeste, 15 July 1965, J. A. Powell, slide DJW 2134, EME.
- d. California, Kern County, Cerro Noroeste, 15 July 1965, J. A. Powell, slide DJW 2090, EME.
- e. California, Kern County, Cerro Noroeste, 15 July 1965, J. A. Powell, slide DJW 2090, EME.

## 125. Eucosma baloghi (Wright)

- a. PTP. Kansas, Gove County, Monument Rocks, 24 September 1999, G. J. Balogh, slide DJW 651, DJW.
- b. PTP. Kansas, Gove County, Monument Rocks, 24 September 1999, G. J. Balogh, slide DJW 702, DJW.
- c. PTP. New Mexico, Otero County, Holloman Lakes, 14 September 2004, G. J. Balogh, slide DJW 2141, DJW.
- d. PTP. New Mexico, Otero County, Holloman Lakes, 14 September 2004, G. J. Balogh, slide DJW 1948, DJW.
- e. PTP. New Mexico, Lincoln County, Valley of Fires, 19 August 2005, D. J. Wright, slide DJW 1403, DJW.

#### 126. Eucosma metzleri Wright

- a. PTP. New Mexico, Otero County, White Sands Nat. Monument, 25 August 2009, E. H. Metzler, slide DJW 3094, MSU.
- b. HTP. New Mexico, Otero County, White Sands Nat. Monument, 25 August 2009, E. H. Metzler, slide 145022, USNM.
- c. PTP. New Mexico, Otero County, White Sands Nat. Monument, 25 August 2009, E. H. Metzler, slide 145022, MSU.
- d. PTP. New Mexico, Otero County, White Sands Nat. Monument, 25 August 2009, E. H. Metzler, slide DJW 2541, MSU.
- e. PTP. New Mexico, Otero County, White Sands Nat. Monument, 25 August 2009, E. H. Metzler, slide DJW 2544, MSU.

#### 127. Eucosma fasciculatana (McDunnough)

- a. HTP. British Columbia, Penticton, Shingle Creek, 16 May 1936, A. N. Gartrell, slide TOR 994, CNC.
- b. PTP. British Columbia, Penticton, Shingle Creek, 16 May 1936, A. N. Gartrell, slide DJW 3069, CNC.

#### 128. Eucosma spectana (McDunnough)

- a. Nevada, White Pine County, Illipah Reservoir W of Ely, 21 Sept 1993, D. Rubinoff, slide DJW 2619, EME.
- b. Iowa, Woodbury County, Sioux City, C. N. Ainslie, slide DJW 2213, USNM.
- c. North Dakota, Billings County, Sully Springs, 6 September 2002, G. J. Balogh, slide DJW 1092, DJW.
- d. South Dakota, Harding County, Picnic Springs Campground, 2 Sept 2002, G. J. Balogh, slide DJW 935, DJW.
- e. North Dakota, Billings County, Sully Springs, 7 September 2002, G. J. Balogh, slide DJW 2628, DJW.
- f. North Dakota, Slope County, Columnar Juniper Area, 3 Sept 2002, G. J. Balogh, slide DJW 2018, DJW.

#### 129. Eucosma southamptonensis (Heinrich)

- a. Northwest Territory, Repulse Bay, 28 July 1950, J. E. H. Martin, slide DJW 3085, CNC.
- b. Northwest Territory, Dempster Hwy km 491, 26 June 1980, Wood and Lafontaine, slide DJW 3072, CNC.

#### 130. Eucosma minimana (Walsingham)

- a. Utah, Washington County, Beaver Dam Mountains, 25 September 2000, G. J. Balogh, slide DJW 2023, DJW.
- b. Utah, Washington County, Beaver Dam Mountains, 25 September 2000, G. J. Balogh, slide DJW 936, DJW.
- c. Utah, Washington County, Beaver Dam Mountains, 25 September 2000, G. J. Balogh, slide DJW 2170, DJW.
- d. Utah, Washington County, Beaver Dam Mountains, 25 September 2000, G. J. Balogh, slide DJW 2024, DJW.
- e. California, San Diego County, 3 mi E of Julian, 4 September 1999, N. Bloomfield, slide DJW 2107, EME.

#### 131. Eucosma cruentana (Blanchard and Knudson)

- a. PTP. Texas, Anderson County, Tennessee Colony, 28 June 1978, A. and M. E. Blanchard, slide DJW 3188, USNM.
- b. PTP. Texas, Anderson County, Tennessee Colony, 28 June 1978, A. and M. E. Blanchard, slide 24887, USNM.
- c. PTP. Texas, Anderson County, Engeling WMA, 12 June 1980, E. C. Knudson, slide 144582, USNM.
- d. PTP. Texas, Anderson County, Engeling WMA, 12 June 1980, E. C. Knudson, slide 24886, USNM.

## 132. Eucosma apacheana (Walsingham)

- a. California, San Mateo County, Montaro McNee Ranch, 21 March 1997, V. Albu, slide DJW 2600, DJW.
- b. California, Siskiyou County, Shasta Retreat, 16–23 June, slide 69992, USNM.
- c. British Columbia, Kaslo Creek, slide 69993, USNM.
- d. Colorado, Larimer County, Big Thompson Canyon, 25 Aug 2004, T. M. Gilligan, slide DJW 1183, TMG.
- e. California, San Diego County, Torrey Pines, 1–8 October 2005, N. Bloomfield, slide DJW 2259, USNM.
- f. Arizona, 1881, H. K. Morrison, slide DJW 2601, USNM.
- g. California, Siskiyou County, Shasta Retreat, 16–23 June, slide DJW 2258, USNM.

## 133. Eucosma ornatula (Heinrich)

- a. Ohio, Adams County, 1 mi SE of Lynx, 3 August 1998, D. J. Wright, slide DJW 2747, DJW.
- b. Ohio, Adams County, 1 mi SE of Lynx, 25 July 1997, D. J. Wright, slide DJW 1389, DJW.
- c. Maryland, Plummer's Island, August 1903, A. Busck, slide EES 17 May 1924, USNM.
- d. Iowa, Monona County, Loess Hills State Forest, 5 July 1993, D. J. Wright, slide DJW 2746, DJW.
- e. Ohio, Adams County, 1 mi SE of Lynx, 3 August 1998, D. J. Wright, slide DJW 2747, DJW.
- f. Ohio, Lucas County, Oak Openings, 27 August 1996, E. H. Metzler, slide DJW 3191, USNM.
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Don Wright is Professor Emeritus at the University of Cincinnati, where he taught Mathematics for nearly forty years. Born and raised in rural Iowa, he acquired an early enthusiasm for the natural world and its creatures, particularly birds. In mid-life he had the good fortune of meeting a number of amateur lepidopterists from Ohio and Kentucky, and fostered by those friendships he developed a strong avocational interest in Nearctic Lepidoptera. For the past two decades he has focused on the taxonomy of the subfamily Olethreutinae, with emphasis on the tribe Eucosmini, publishing twenty papers on the genera Phaneta, Eucosma, Pelochrista, and Epiblema and a book coauthored with Todd M. Gilligan and Loran D. Gibson entitled Olethreutine Moths of the Midwestern United States. The present book is the first of a projected two volumes that aim to clarify the application of the nearly four hundred available names for the Nearctic species in the genera Eucosma and Pelochrista.



Todd Gilligan is a Research Scientist in the Department of Bioagricultural Sciences and Pest Management at Colorado State University, where he obtained his PhD in 2012. His dissertation primarily focused on the systematics and identification of economically important tortricids, and the majority of his current research involves producing morphological and molecular identification resources for invasive Lepidoptera in conjunction with the USDA's Identification Technology Program (ITP) in Fort Collins, Colorado. Todd has authored or coauthored more than twenty peer-reviewed publications on Tortricidae, including several coauthored with Don Wright on the systematics of Eucosma and related genera. He maintains a website dedicated to tortricids (www.tortricid.net) and hosts the Online World Catalogue of the Tortricidae along with other tortricid resources. Todd served as President of the Lepidopterists' Society from 2013-2015 and currently sits on the Board of Directors for the Wedge Entomological Research Foundation.

Eucosma Hübner is one of the largest genera in the Tortricidae, with more than 230 described species. It achieves its greatest species richness in the Nearctic, where members of the genus can be found in nearly every habitat, from the dunes of the Gulf Coast to the barren summits of the Rocky Mountains. This volume is the first comprehensive treatment of North American *Eucosma* to be published in more than 90 years. One hundred and thirty-three species are reviewed from the contiguous United States and Canada. Nine new species are described, nine new synonymies are proposed, 21 lectotypes are designated, and several unresolved species complexes are discussed. Diagnostic morphological features useful in species identification are emphasized and illustrated with 450 color adult images and 629 detailed genitalia drawings.

"This is a meticulously researched and beautifully illustrated guide to the moths of the tortricid genus *Eucosma* that occur in the lower 48 states and Canada. Taxonomic and nomenclatural problems are resolved, and details are provided to assist in the identification of all species. It is a must-have for those interested in the tortricid fauna of North America."

## – John Brown

Systematic Entomology Laboratory USDA-ARS, Smithsonian Institution

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