

Contributions to the Systematics of New World Macro-Moths

Edited by

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&

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Contributions to the Systematics of New World Macro-Moths

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This issue of ZooKeys marks the first of several planned volumes entitled “Contributions to the Systematics of New World Macro-Moths,” initiated as a compilation of alpha-taxonomic based projects on the New World macro-moths. The focus of this series will be the North American noctuoid and geometrid fauna, although several additional manuscripts on the Neotropical fauna are already in preparation for future volumes. The North American macro-moth fauna is typically thought of as being relatively well-known, but our taxonomic knowledge base is far from complete – we are aware of over 200 unrecognized North American species of Noctuoidea, with similar numbers for the Geometridae, to say nothing of the Central and South American fauna. Many new species and taxonomic problems have been highlighted by the advent of molecular ‘barcoding’ (Ratnasingham and Hebert 2007), particularly cryptic species (i.e. species that have not been recognized as distinct due to similarity with another species); however, three other sources continue to be significant reservoirs of unnamed species: new species never collected before; species long recognized as distinct (in some cases over 50 years!), but without an available name; and dissection of genitalia in poorly studied genera that reveal species complexes. It is our hope that this series will not only fill in some of these knowledge gaps, but encourage further research on baseline taxonomy at a time when it is so desperately needed.

Since the publication of the last check list of North American Noctuoidea over 25 years ago (Hodges et al. 1983), the family-group systematics of the Noctuoidea has changed dramatically. In addition, over 500 noctuoid species have been added to the North American fauna: 320 described as new species, 124 as new records (mostly from Arizona, Texas and Florida), and 56 as taxonomic splits resulting in subspecies or synonyms being given species status. A revised catalogue of North American Noctuoidea is forthcoming in the next volume of “Contributions to the Systematics of New World Macro-Moths,” planned for the winter of 2009/10; the content of the current volume has accordingly focused on the Noctuidae so that the species names described herein be available for this check list. However, expansion of coverage to other groups, particularly Geometridae, is planned for future volumes, and interested authors are encouraged to contribute. Already, this collaborative effort of both amateur and professional lepidopterists and taxonomists has brought together a significant contribution to noctuid taxonomy within a relatively short time frame, as a result of contributions from 16 authors, editors and/or reviewers. Eighteen new species and one new genus are described herein, and we hope subsequent volumes will elicit equally positive responses. Prospective authors are encouraged to contact the section editors.

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A new species of *Rivula* Guenée (Lepidoptera, Noctuidae) from southeastern United States

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Abstract

Rivula stepheni **sp. n.** (Noctuidae, Rivulinae) is described from material collected in North Carolina and Louisiana. Illustrations of genitalia and adults of *Rivula* found in the United States are provided. The generic placement within the Noctuoidea is discussed.

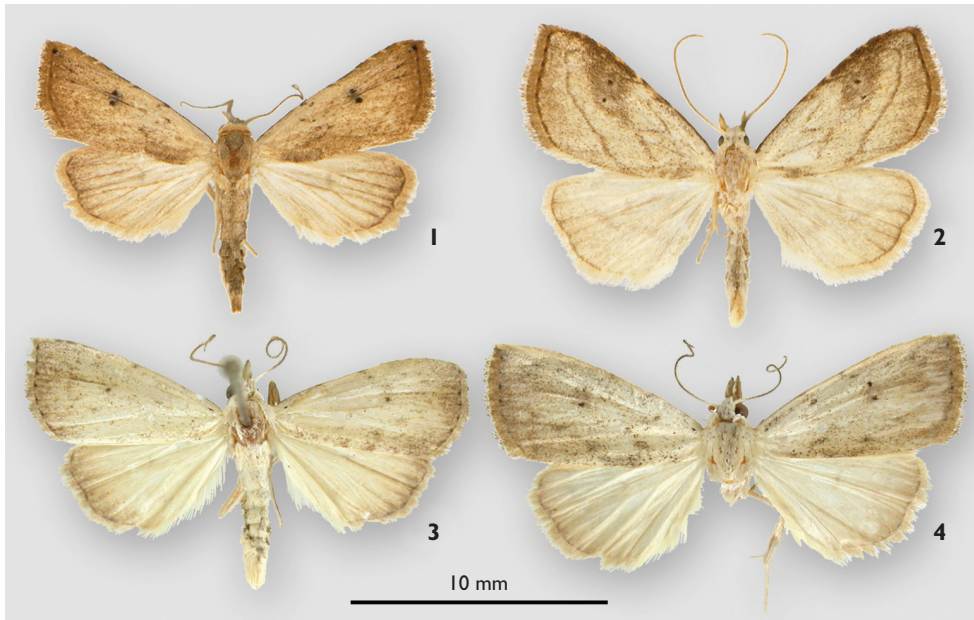
Keywords

Rivula, *Oxyecilla*, *Macrochilo*, North Carolina, Louisiana, Florida

Introduction

The genus *Rivula* Guenée currently is represented in the United States by two species. *Rivula pusilla* Möschler, 1890 (Fig. 1) is found in Florida and Texas (Heppner 2003). *Rivula propinquinialis* Guenée, 1854 (Fig. 2) is distributed throughout eastern North America from southern Canada southward to Florida and Texas and westward in the north to British Columbia and Washington. In North Carolina it is found from the Appalachian Mountains to the Atlantic coast.

During 1995 I collected a single specimen of what appeared to be an undescribed species of *Rivula*. In subsequent years additional specimens were collected occasionally. Eventually, enough specimens were collected to access its variation and describe the species.



Figures 1-4. Adult *Rivula*. **1.** *Rivula pusilla* Möschler. 1.4 mi WSW Anthony, Marion Co., Florida, 2 Jan. 2006, Terhune Dickel. **2.** *Rivula propinqualis* Guenée. Edmundston, New Brunswick, 8 Sept 1987, Henry Hensel. **3.** *Rivula stepheni* Sullivan. Holotype. Macpherson Creek, Ft. Bragg, Cumberland Co., N.C., 20 June 2001. J. Bolling Sullivan. **4.** *Rivula stepheni* Sullivan. Croatan National Forest Road 3046, Craven Co., N.C., 7 April 1998, J. Bolling Sullivan.

Materials and methods

Repository abbreviations

BMNH Natural History Museum, London, UK

CNC Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Ontario, Canada

USNM National Museum of Natural History, Washington, District of Columbia, USA

JBS J. Bolling Sullivan, Beaufort, North Carolina, USA

VAB Vernon A. Brou, Jr., Abita Springs, Louisiana, USA

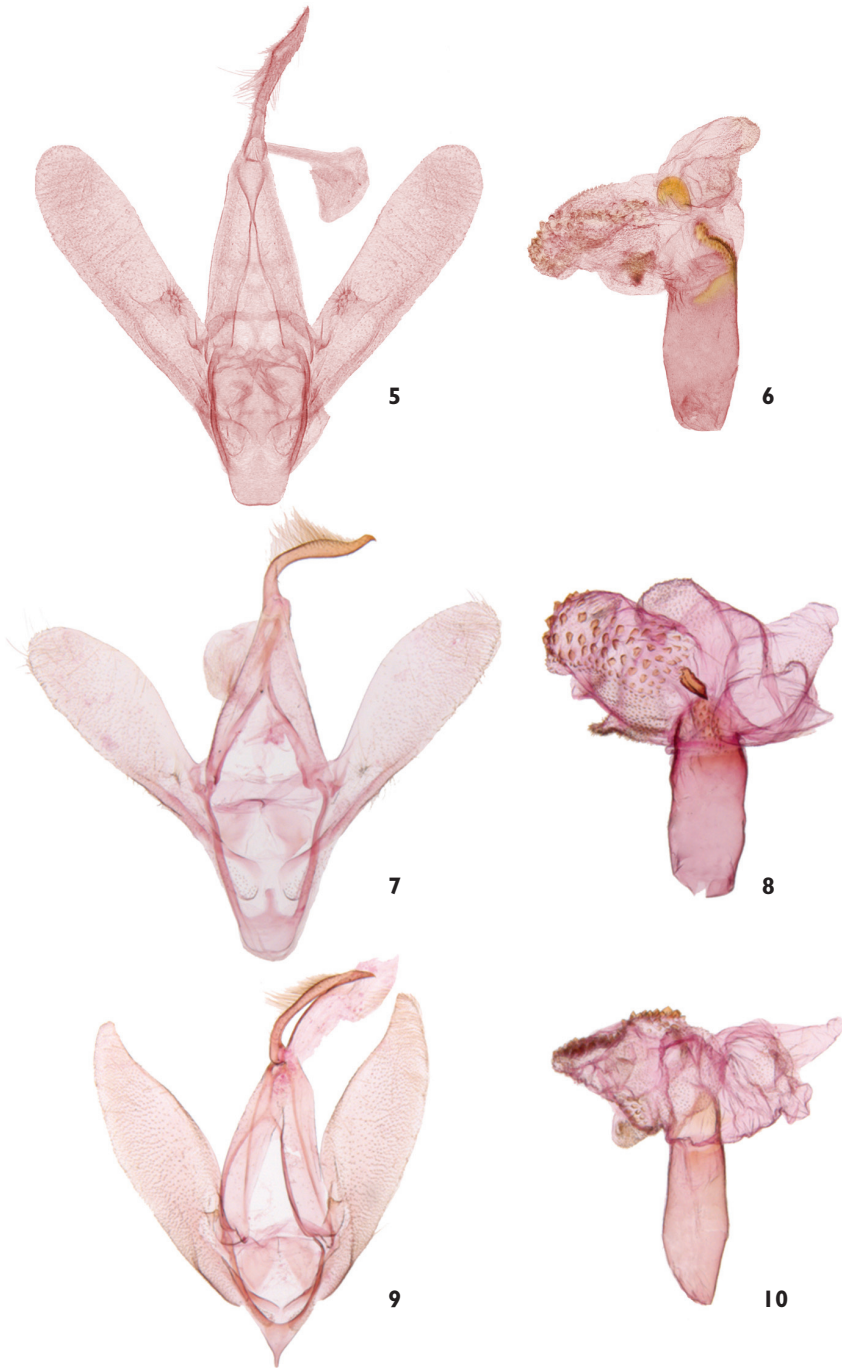
Specimens were examined from the USNM and pictures were sent to various active collectors in southeastern United States to determine if they had collected the new species. Genitalia were prepared by digestion in 10 % potassium hydroxide, dissected in water, stained with Eosin or chlorasol, and photographed with a Nikon Coolpix Camera. Legs from recently collected specimens were sent to Paul Hebert at the University of Guelph for barcode (CO1) analyses (sequencing of 658 base pairs of mitochondrial DNA from the 5' region of the gene coding for cytochrome oxidase subunit 1) (Ratnasingham and Hebert 2007).

***Rivula stepheni* Sullivan, sp. n.**

urn:lsid:zoobank.org:act:D97F6D3C-55D4-4C19-B5CA-24DFF70646AE

Figs. 3-6, 11

Type locality. MacPherson Creek, Ft. Bragg, Cumberland County, North Carolina, USA.**Type material. Holotype, male:** USA, North Carolina: Cumberland Co., Ft. Bragg, MacPherson Creek, 20 Jun 2001, J. B. Sullivan (USNM). **Paratypes:** 29 ♂, 3 ♀: USA, **North Carolina:** Onslow Co., Camp LeJune, Verona Loop, 25 Jul 1995 (♂); Craven Co., Croatan National Forest Rd. 147, 22 Apr. 1996 (♂); Croatan National Forest Rd. 3046, Craven Co., 7 Apr. 1998 (♂); Craven Co., Croatan National Forest Rd. 169, 16 Aug 1999 (♂); Cumberland Co., Ft. Bragg, MacPherson Creek, 21 Jun 2001 (♂); Craven Co., Have-lock, off Sunset Drive, 31 Aug 2005 (♀) and 27 Sep 2005 (♂); Jones Co., Croatan National Forest, Haywood Landing, 24 Jun 2006 (♂); Craven Co., Croatan National Forest Rd. 3046, 20 Jun 2008 (2 m), all collected by J. B. Sullivan (BMNH, USNM, JBS). **Louisiana:** St. John the Baptist Parish, Edgard, 4 Sep 1975 (♂); 4.2 mi NE of Abita, 25 Oct 1984 (♂), 16 Sep 1986 (♂), 8 Oct 1989 (♂), 29 Aug 1992 (♂), 24 Sep 1994 (♂), 25 Sep 1994 (♂), 30 Sep 1994 (♂), 3 Oct 1994 (♂), 16 Oct 1994 (♂), 29 Oct 1994 (♂), 26 Sep 1995 (♂), 4 Oct 1996 (♂), 10 Oct 1996 (♂), 11 Oct 1996 (♂), 29 Oct 1997 (♂), 6 Oct 1997 (♂), 26 Oct 1998 (♂), 20 Sep 2002 (♂), 23 Dec 2002 (♀), 15 Jun 2005 (♂); West Feliciana Parish, Weyanoke, 8 Sep 1980 (♀), all collected by V. A. Brou, Jr. (CNC, VAB).**Other material examined.** One additional specimen was examined from pictures supplied by Hugo L. Kons, Jr.: Florida, Gadsden Co., south side of Dolan Road, 0.1 miles W. of Hwy. 269, 23 May 1999, UV light trap, Hugo L. Kons, Jr. and Robert J. Borth.**Etymology.** This species is named for Stephen A. Hall of the North Carolina Natural Heritage Program, whose tireless work to preserve natural habitats in North Carolina and to describe the natural communities in those habitats has greatly enriched the people of North Carolina.**Diagnosis.** *Rivula stepheni* is a plain, ivory-colored species with scattered black markings but easily distinguished from other species with which it might be confused. *Rivula propinqualis* has a smooth diagonal postmedial line that approximately follows the line of the wing margin. In *R. stepheni* it is less well marked but clearly undulated. Additionally, there is a moderately large black spot (coastal plain specimens) or smudge (mountain specimens) along the forewing costa near the apex of the wing in *R. propinqualis* but two very small dots in *R. stepheni*. *Macrochilo louisiana* (Forbes) is superficially similar but has prominent labial palps. Wear quickly eliminates some of the scattered black markings in *R. stepheni*.**Description. Male** (Figs. 3, 4): **Head** – antenna fasciculate, setae approximately length of shaft diameter; scape white; antenna scaled dorsally, white basally, becoming tan terminally; length of shaft 60 % of wing length; lower half of frons covered with straw to tan flattened scales; upper half of frons white medially, tan laterally, with narrow scales overlain with broader scales, all of which point anteriorly projecting over lower frons; eye without setae, slightly flattened toward thorax, scaling around eye straw to tan colored.; ocellus present; tongue normal; labial palp slightly porrect anteriorly,



Figures 5-10. Male genitalia of *Rivula*. **5.** *Rivula stepheni* Sullivan. Valves. Craven Co., N. C. (JBS 2290). **6.** Aedeagus. Same data as valves. **7.** *Rivula propinqualis* Guenée. Valves. Edmundston, New Brunswick (CNC Noc. 14849). **8.** Aedeagus. Same data as valves. **9.** *Rivula pusilla* Möschler. Valves. Marion Co., Florida (CNC Noc 14848). **10.** Aedeagus. Same data as valves.

flattened dorsally; second segment $3 \times$ longer than other two segments, broadly scaled dorsally and with large flattened scales ventrally, color tan on exterior, straw on interior; neck and collar covered with white scales. **Thorax** – with flattened scales overlaying pointed scales, with occasional darker scales intermixed; tegulae scales and coloration similar to remainder of thorax; leg scales white and straw with darker scales scattered throughout; prothoracic femur with grey scaling dorsally. **Forewing** – length 8.2-10.2 mm; ground color ivory with darker tan scaling along margins; reniform spot visible as two black spots, upper one slightly closer to thorax; basal black spot between vein Sc and R1; wing margins with tan scaling, a spot formed at extremity of each major vein; cross lines visible but often very diffuse. **Hindwing** – similar to forewing but without black spots. Underside similar to upperside but may be darker and without reniform or basal spots; retinaculum on base of costa, neither bar-like nor well defined. **Abdomen** – scales blunt tipped, white with occasional dark scales scattered throughout, particularly posteriorly. **Male genitalia** (Figs. 5, 6) – valves symmetrical; uncus elongate, widest in middle, knife shaped, setae found over entire surface but longest dorsally; base of uncus forms a window at junction with tegumen; gnathos and socii absent; anal tube strongly sclerotized dorsally; tegumen arms broad, forming inverted “V;” vinculum U-shaped, narrower, articulating directly with base of tegumen without pleural sclerite; valva 1.62 mm long, unsclerotized, membranous, with a subbasal broad, rounded ampulla covered with pimple-like processes bearing setae; costa excavated at base; juxta lightly sclerotized and difficult to see; transitilla membranous; aedeagus: length 0.41 mm, short, stout, with ductus entering at base; vesica with two principal diverticula;



Figures 11-12. Female genitalia of *Rivula*. **11.** *Rivula stepheni* Sullivan. Craven Co., N. C. (JBS 2212). **12.** *Rivula propinqualis* Guenée. Alleghany Co., N. C. (JBS 2210).

base with band of short tooth-like projections; two diverticula separated by a broad, sclerotized, thumb-like disc; larger evagination on left covered with sharpened, peg-like cornuti over entire surface but largest on dorsal side; right diverticulum slightly scombinate. **Female** – similar to male except antennal setae sparse. **Female genitalia** (Fig. 11) – anal papillae with pimples bearing setae on inner surface; outer surface with long sparsely placed setae; each papilla triangular with blunt tip; posterior apophyses slightly longer than anterior ones, slender, with slightly rounded tips; ostium membranous, ductus bursae lightly sclerotized and striated, moderately thickened; corpus bursae with accessory bursa posteriorly on right side; posterior half of corpus bursae cylindrical, 2-3 × as broad as ductus bursae and slightly striated; anterior half of corpus bursae forming heart-shaped chamber containing three embedded plate-like signa; two signa situated posterior to third signum, all well sclerotized; total length of female genitalia 3.93 mm.

Distribution and biology. Initially thought to be limited in distribution to eastern North Carolina, a picture of an unknown moth collected in Gadsden County, Florida by Hugo Kons, Jr. and Robert Borth was provided and is *Rivula stepheni*. All North Carolina specimens were found in mesic mixed pine and hardwood forests near small streams with cane (*Arundinaria* spp.) growing nearby. The adjacent upland areas contain both hardwoods and loblolly pine (*Pinus taeda* L.) with American holly (*Ilex opaca* Ait.) and witch hazel (*Hamamelis virginiana* L.) in the understory. Typically, cabbage palmettos (*Sabal palmetto* (Walter) Lodd. ex Schult. & Schult. f.) are in the floodplain of the stream. Grasses and small sedges are common in the floodplain area and both *Rivula propinqualis* and *R. stepheni* have been found in the same trap. The Florida specimen was collected on May 23, 1999 in Gadsden County in essentially identical habitat (Hugo Kons, Jr., personal communication). North Carolina specimens have been captured from early April (Fig. 4) through September indicating that the species bred continuously in the area (likely representing three or four broods). Summer captures are most common and spring specimens are approximately 20 % larger than individuals from subsequent broods (see Sullivan and Miller 2007).

Twenty two additional specimens were collected by Vernon A. Brou, Jr. in Louisiana, primarily at his home near Abita Springs. These specimens were collected during an extensive year round trapping program ongoing statewide for 40 years. They were taken in June (1), August (1), September (8), October (10), November (1), December (1) and each was a singleton capture in one of six traps operated each night. This would indicate that the species is not breeding at the trapping site but instead is wandering into the trapping area from some presumed nearby site. *Rivula pusilla* is known to migrate late in the year into the Gainesville, Florida area in some years (Hugo Kons, Jr., personal communication) and the European *R. sericealis* is known to migrate within Europe and to Britain (Sparks et al. 2007; Wood et al. 2009). Captures in the Abita Springs area may derive from a similar wandering/migratory behavior in the fall and their infrequent occurrence would indicate that the species is limited in distribution in Louisiana as well as in Florida and North Carolina.

Reported host plants for species of *Rivula* are grasses and sedges. Larvae pupate in loose cocoons covered with debris (figured in Kitching and Rawlins 1999).

Discussion

The genus *Rivula* has a peculiar history. It has no known closely related genera (however, see *Zebeeba* Kirby in Speidel et al. 1996) and has been placed in the Rivulinae, Hypheninae, Herminiinae and near the arctiids and lymantriids (Kitching 1984; Mitchell et al. 2005; Lafontaine and Fibiger 2006). The genus is characterized by unique larval characters, and in the adult by the rudimentary pockets of the tympanum (Richards 1933), and perhaps the microsculpturing of the proboscis (Speidel et al. 1996). None of the diagnostic characters is easy to score. Based on the hindwing venation (Forbes 1954), a fully scaled frons, and the simple, unsclerotized valves, *Rivula* is placed among the more primitive quadrifine noctuids (Lafontaine and Fibiger 2006).

Based on examination of the three North American species of *Rivula* (Figs. 1-4), the European *R. sericealis* (Scopoli), and Asian species treated by Holloway (2008), several characters may prove to be unique (probably in combination) for rivulines. In the forewing the reniform spot appears as two distinct dots. This is overlaid with black scaling in many *R. propinqualis* (Fig. 2) and *R. sericealis*. These twinned dots seem to be present in Bornean species as well (Holloway 2008). In *Oxycilla* Grote (Boletobiinae), a possible sister group, twinned spots are visible in *O. mitographa* (Grote) and *O. ondo* (Barnes) but not in the other three species currently placed in the genus. Most *Macrochilo* Hübner (Herminiinae) species also show the twinned dots. In the male genitalia of *Rivula* (Figs. 5-10) the valves are not sclerotized, the clasper is usually limited to a small ampulla, and the aedeagus is short and straight but wide and large relative to the rest of the genital capsule. The vesica is moderately complex (a series of diverticula) and granulose, often with numerous peg-like cornuti. In the female bursae (Figs. 11-12) signa are present as three distinct plates in *R. propinqualis* and *R. stepheni* and as thin longitudinal plates in the Bornean species (Holloway 2008). The yellowish, straw-colored pattern of *R. sericealis* is repeated in *R. propinqualis*, some Bornean species and some neotropical species. Worn *R. stepheni* are almost white, but otherwise are similar to the *R. propinqualis* and *R. sericealis*. Other Bornean and New World species of *Rivula*, including our *R. pusilla* (Fig. 1), show another forewing pattern with a reddish ground color and light spotting. Examination of the CO1 sequences ('barcode fragment', 658 residues) reveals sequence differences of about 4-5 % between *R. propinqualis*, *R. stepheni* and *R. sericealis*. That branch of three species is somewhat more isolated from *R. pusilla* and several other neotropical species. Most neotropical species have not been dissected so their placement in *Rivula* must be considered provisional. Some 26 sequences of *R. propinqualis* from Ontario, Quebec, Maryland, Tennessee, and North Carolina are heterogeneous with intraspecific differences of up to 2 %. However, these differences do not sort geographically nor do variations in the diverticula of the vesica in samples from North Carolina, New Brunswick, Ontario and British Columbia. The same can be said for seven sequences of CO1 from *R. pusilla* from Florida and Costa Rica and genitalia preparations from Florida, Dominica and Costa Rica. The type locality of *R. pusilla* is Puerto Rico. Interestingly, several unplaced neotropical species from Costa Rica, currently in the Scolocampinae, another primitive

quadridrid noctuid group, bear a striking resemblance in maculation to *Rivula*. Larvae of both groups are thought to feed on grasses, fungi and decaying litter.

Acknowledgements

I would like to thank Don Lafontaine for dissecting specimens at the CNC and Jocelyn Gill for preparation of the figures. Paul Hebert allowed the use of unpublished CO1 sequence data. Hugo Kons, Jr. and Vernon A. Brou Jr. graciously communicated unpublished information. Don Lafontaine, Chris Schmidt and Hugo Kons, Jr. read the manuscript and improved it.

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A new species of *Lithophane* Hbn. (Lepidoptera, Noctuidae, Xyleninae) from southeastern United States

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Abstract

A new species of a noctuid moth in the genus *Lithophane* is described and illustrated. *Lithophane abita* Brou & Lafontaine, **sp. n.** is known from the mid-Atlantic coastal states southward to Florida and the Gulf Coast states.

Keywords

Lepidoptera, Noctuidae, *Lithophane*, taxonomy, Alabama, Florida, Georgia, Louisiana, Maryland, Mississippi, North Carolina, winter moths

Introduction

Beginning in 1982, specimens of an undescribed species of *Lithophane* Hübner were captured at a single southeast Louisiana location using four to eight ultraviolet light traps operated at this location throughout the year regardless of weather conditions. Typical of numerous other winter-active moths, this new species is on the wing from

late November until late March during an extended four month flight period in south-eastern Louisiana. The adult, genitalia, and flight period of this species were previously illustrated (Brou 2005). This new species is described below.

***Lithophane abita* Brou & Lafontaine, sp. n.**

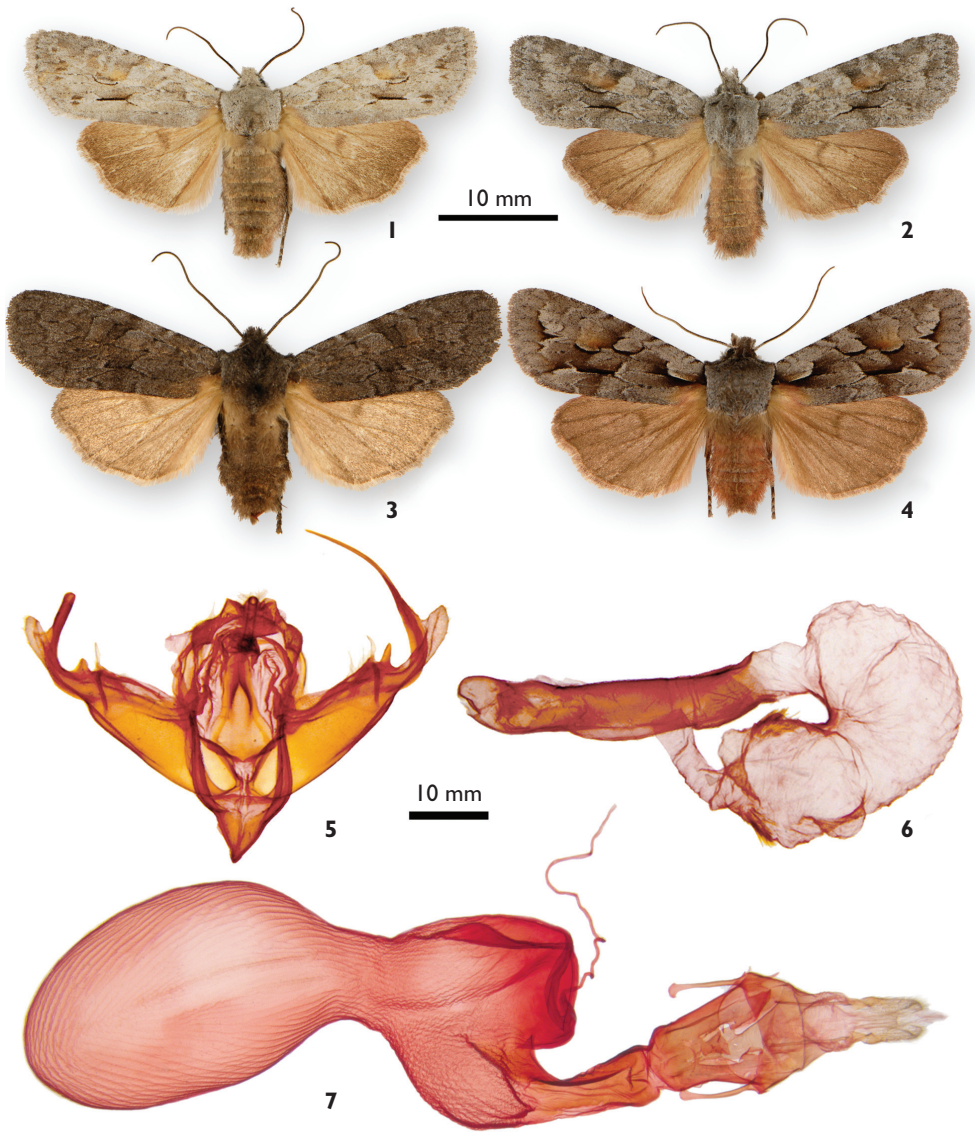
urn:lsid:zoobank.org:act:346FF58C-13A6-42AF-8560-71D612F30B98

Figs 1, 2, 5, 6, 7

Type material. Holotype ♂ (Fig. 1): USA, Louisiana, St. Tammany Parish, 4.2 miles (6.8 km) NE of Abita Springs, Sec[tion] 24, T[ownship] 6 S[outh], R[ange] 12 E[ast], 14 Feb. 2002, Vernon A. Brou Jr. Deposited in Canadian National Collection of Insects, Arachnids, and Nematodes (CNC), Ottawa, Canada.

Allotype ♀ (Fig. 2): same locality and collector, 6 Dec. 2003. Deposited in CNC.

Paratypes: 145 ♂, 162 ♀. **Alabama:** Baldwin Co., Bon Secour National Wildlife Refuge, Sec.24, T9S,R2E, 18 Jan. 1993, Richard L. Brown (1 ♂). **Florida:** Alachua Co., Gainesville, 19 Dec. 1982, Edward C. Knudson (1 ♀); Alachua Co., Gainesville, 14 Feb. 2004, Jeffrey R. Slotten (1 ♀); Baker Co., Baxter, 29 Dec. 1990, John S. Kutis (1 ♀), Pinhook Swamp, 24 Feb. 2001, Hugo L. Kons Jr. (1 ♂); Collier Co., Golden Gate Estates 26 Jan. 1991, John S. Kutis (1 ♂); Duval Co., Jacksonville, 11 Mar. 1977, H.D. Baggett (1 ♀); Hernando Co., 1 Mar. 2007, James T. Vargo (1 ♂); Hillsborough Co., Lutz, Florida, 13 & 22 Mar. 1911, F. W. Friday (2 ♀); Marion Co., Bay Lake, 0.5 mi. west of CR315, 7 Feb. 1991, John S. Kutis (1 ♂); Pasco Co., Clay Sink, Withlacoochee St. Forest, 6 Feb. 1991, John S. Kutis (1 ♀); Putnam Co., Putnam Hall Post Office, 3 Mar. 2004, Jeffrey R. Slotten (1 ♂); Sumpter Co., Withlacoochee St. Forest, 5 Feb. 1991, John S. Kutis (1 ♀), same location and collector, 9 Feb. 1991 (1 ♀), same location, 9 Feb. 1991, Richard M. Gillmore (1 ♀); Volusia Co., Cassadaga, 11 Feb. 1963, S.V. Fuller (1 ♂), 15 Feb. 1964, same location and collector (1 ♂), 23 Feb. 1966, same location and collector (1 ♂, 1 ♀). **Georgia:** Long Co., Griffin Ridge Wildlife Management Area, NE of Altamaha River, 3 mi. SW of Ludowici, 3–4 Mar. 2004, James K. Adams (1 ♀). **Louisiana:** same locality and collector as for holotype, 21 Nov.–29 Mar. 1982–2009 (128 ♂, 138 ♀). **Maryland:** Calvert Co., Battle Creek Cypress Swamp, D. Williams/A. Brown, 14 Feb. 1990, H. Godwin Stevensen (2 ♂); same locality and collector, Dwight F. Williams, 22 Oct. 1989 (1 ♂); Worcester Co., Pokomoke State Forest, 17 Oct. 1996 and 18 Oct. 1998, J. Glaser (3 ♀); Worcester Co., Sturges Creek Cypress Swamp, 18 Oct. 1998, J. Glaser (1 ♀). **Mississippi:** Tishomingo Co., Tishomingo State Park, 34° 35' 54" N, 88° 10' 43" W, 3 Apr. 1998, Richard L. Brown (1 ♂). **North Carolina:** Carteret Co., Junction of Hwy 101 and Mill Creek Road, 22 Nov. 1973, J. Bolling Sullivan (1 ♀); Craven Co., North Harlow, 25 and 31 Mar. and 12 Nov. 1990, 13 and 18 Feb. and 20 Mar. 1991, J. Bolling Sullivan (3 ♂, 5 ♀); Jones Co., Haywood Landing, 3 Apr. 1996 and 8 Mar. 2000, J. Bolling Sullivan (1 ♂, 1 ♀); Pender Co., Shelter Gamelands, 5 Apr. 1996, J. Bolling Sullivan (1 ♀). Paratypes deposited in CNC; Florida State Collection of Arthropods,



Figures 1-7. *Lithophane* spp. **1.** *L. abita* Brou & Lafontaine, male, holotype, USA, Louisiana, St. Tammany Parish, 4.2 miles (6.8 km) NE of Abita Springs. **2.** *L. abita* Brou & Lafontaine, female, allotype, USA, Louisiana, St. Tammany Parish, 4.2 miles (6.8 km) NE of Abita Springs. **3.** *L. adipel* (Benjamin), USA, New Jersey, Lakehurst. **4.** *L. thaxteri* Grote, male, Canada, New Brunswick, Edmundston. **5.** *L. abita* Brou & Lafontaine, male genital capsule. **6.** *L. abita* Brou & Lafontaine, male aedeagus with vesica everted. **7.** *L. abita* Brou & Lafontaine, female genitalia.

Gainesville; Louisiana State Arthropod Museum, Baton Rouge; Mississippi Entomological Museum; Cornell University Collection, Ithaca, New York; National Museum of Natural History [USNM], Washington, DC; and the private collections of: James K. Adams, Robert J. Borth, Richard M. Gillmore, Edward C. Knudson, Hugo L. Kons Jr., Jeffrey R. Slotten, J. Bolling Sullivan, and the senior author. Primary types are designated with the words Holotype and Allotype in black text on red labels; paratypes are designated with the word Paratype in black text on yellow labels.

Etymology. The epithet is derived from the type locality near which all of the known Louisiana specimens have been taken, the town of Abita Springs, St. Tammany Parish, Louisiana, USA.

Diagnosis. *Lithophane abita* is a medium-sized species of *Lithophane* with a gray forewing and pinkish-fuscous hindwing. The forewing maculation tends to be pale and muted, except for a contrasting black line in the fold connecting the deeply zigzagged antemedial and postmedial lines. In these superficial characters, it has the appearance of some species in the *Lithophane lepida* Grote species-group of which only *Lithophane adipel* (Benjamin) (Fig. 3) occurs in southeastern United States. It is even more similar to *Lithophane thaxteri* Grote (Fig. 4), which like *L. abita*, has a brown flush to the area around the reniform spot and a black line defining the lower edge of the reniform spot, but *L. thaxteri* occurs in the boreal zone of Canada and in eastern United States as far south as New Jersey, but probably will not be found within the range of *L. abita*. The male genitalia of *L. abita*, however, are unique within the genus and the characteristic shape of the apices of the valves can be seen by brushing away some scales from the end of the abdomen. The digitus of the right valve projects beyond the apex of the valve as a long, curved, saber-like spine that is almost $\frac{2}{3}$ as long as the valve (Fig. 5); that of the left valve is short, stout, and apically blunt with the part of the digitus extending beyond the valve about $\frac{1}{4}$ of the length of that of the right valve. The spine-like process at the apex of the right valve can often be seen with the naked eye protruding from the end of the abdomen. The association of *L. abita* with bald cypress (*Taxodium distichum* Rich.), the probable larval host, is also unique within *Lithophane*.

Description. Males and females similar in all external characters except size. *Head*: color usually light to medium slate gray, occasional specimens dark gray; pronounced frontal tuft; a wide lateral black band of scales on center of head between eyes defined above and below by a bright white line of scales, upper line at a position above eye and below antenna; antenna filiform, simple, slender, and acuminate, similar gray in color, more so dorsally and near base of shaft; labial palp with black scales laterally and gray scales ventrally and dorsally; labial palp peppered with either black or gray scales with white tips; ventral surface of palp with long scales forming a pointed tuft projecting anteroventrally slightly beyond apex of palp. *Thorax*: dorsal color similar to that of head and forewing ground color except for wide transverse dark brown band on prothoracic collar with upper margin defined by distinct black line with upper scales forming a bright white line; anterior part of thorax with dorsal partially divided tuft of scales; ventral color of thorax light pinkish brown, gray, or fuscous, with area between legs and wings entirely black; outer side of foreleg coxa a mixture of black and white scales

(appearing gray to naked eye), with a short group of longitudinal black scales emanating from base; scales on the inner side of coxa brownish gray with a fine longitudinal line of black scales; femur covered with black and white scales (appearing gray to naked eye) with black scales more concentrated near trochanter; scales on coxa of midleg a mixture of gray and white, except near trochanter, where scales form a band of black followed by a band of white; similar black and white bands continue along remainder of midleg femur, tibia, and tarsus; hindleg similar in color and appearance to midleg. *Abdomen*: dorsal color fuscous with pink suffusion throughout; ventral color same as dorsal. *Forewing*: dorsal ground color matching that on dorsum of head and thorax; maculation varying from strongly marked to barely distinguishable; weakly marked specimens appear to have been on the wing longer, but do not necessarily appear exceptionally worn; most specimens with very faint, sometimes barely distinguishable, bifurcating black basal dash; antemedial (am) line mostly faint, deeply zigzagged, defined in paler gray and partly bordered on outer edge by black, except in area of fold where am line sharply defined in black forming an outward projecting "V" that extends into prominent, black dash in fold parallel to lower margin of wing and extends to postmedial (pm) line; pm line deeply serrated but faint, partly defined by pale gray and dark gray scales; subterminal line also faintly defined in pale and dark gray but usually bordered in subterminal area by series of diffuse, dark-gray, wedge-shaped spots; terminal area concolorous with medial area, or very slightly darker with wing veins partly defined in black; terminal line incomplete, dark gray, usually stronger between veins; orbicular spot a rounded or slightly oblong paler gray shade defined mainly by the darker gray shading surrounding it; a prominent crescentic black line extends from outer lower edge of orbicular spot and around lower margin of reniform spot; reniform spot barely distinguishable as a paler gray outline above black line on lower margin of spot; forewing with fuscous-brown scales in area between reniform and orbicular spots, and in lower part of reniform. Ventral color of forewing pale luteous brown on basal half of wing, pinkish brown on distal half and forming a darker marginal shade; reniform spot diffuse, dark brown, usually crescent-shaped; terminal line defined by faint black scales accentuated with conspicuous black scales forming v-shaped wedges between veins; fringe gray. Wing length: male: 16.7 mm (15.7–18.0, $n = 25$); female: 17.1 mm (15.6–18.4, $n = 25$). *Hindwing*: dorsal color fuscous with pinkish suffusion throughout; fringe contrastingly lighter slate gray, especially at base of fringe; terminal line usually expressed as diffuse darker brown lines most often only between veins on outer margin of wing; discal spot crescentic, darker than ground color but barely discernable. Ventral color entirely light pink with numerous tiny brown scales sprinkled over entire surface; terminal line generally similar to that on dorsal surface; discal spot very large, brownish-black spot in center of wing; postmedial line a faint but discernable dark, broad line.

Male genitalia ($n = 6$): genital capsule (Fig. 5) with supporting ring modified, so enlarged vinculum and pleural sclerite occupy basal $\frac{2}{3}$ of ring, presumably to support greatly enlarged base of valve; tegumen proportionally reduced to dorsal $\frac{1}{3}$ of ring; uncus short, cylindrical, expanded at apex; juxta a very large diamond-shaped plate oc-

cupying most of area inside genital ring; valves short and triangular, very large at base and tapering to narrow apex; valves asymmetrical; right sacculus large, twice as long as cucullus; cucullus reduced with sclerotized finger-like process at base of cucullus on dorsal margin of valve; apical part of cucullus reduced to rounded, almost membranous flap without any trace of a corona; digitus massive, arising from costal margin of valve, covering basal b of cucullus, then bending dorsally to project posterodorsally from end of valve as a long, tapered, saber-like spine; clasper reduced to Y-shaped sclerite at apex of valve with ampulla projecting beyond costal margin of valve as lightly sclerotized, finger-like process; left valve similar to right valve, except sacculus not as enlarged dorsally at base, costal process at base of cucullus triangular, part of left digitus projecting from valve $\frac{1}{4}$ as long as saber-like extension of right digitus, and apex of left digitus blunt and rounded. Aedeagus (Fig. 6) cylindrical, heavily sclerotized, about $6 \times$ as long as wide; vesica about $1\frac{1}{2} \times$ as long as aedeagus; basal $\frac{1}{6}$ as wide as aedeagus; apical part inflated and sac-like, curving in an arc 180° to project anteriorly; vesica with two short diverticula, one short preapical on dorsal surface and one on ventral surface at apex; apex of vesica with two subapical patches of spine-like cornuti, one dorsal and one ventral. *Female genitalia* ($n = 5$) (Fig. 7): corpus bursae with prominent postmedial constriction giving it a figure 8-shape; without signa; posterior part of corpus bursae with short, lightly sclerotized, appendix bursae to left of ductus bursae; ductus bursae about $\frac{1}{3}$ as long as corpus bursae, sclerotized posteriorly but more lightly sclerotized anteriorly and wider at corpus bursae; ostium bursae sclerotized, tapered anteriorly, truncated abruptly at membranous connection with ductus bursae; anterior apophyses slightly shorter, but much stouter, than posterior apophyses, about $\frac{1}{4} \times$ longer than ring of abdominal segment VIII; anal papillae lightly sclerotized, rounded at apex, about as long as membranous connection to abdominal segment VIII; covered by mixture of short and longer hair-like setae.

Biology and distribution. Within Louisiana, *Lithophane abita* is single brooded with adults on the wing from November 21 to March 29 (Fig. 8). Elsewhere the flight season extends from 17 October (Maryland) to early April (Mississippi and North Carolina). *Lithophane abita* has been confirmed from the states of Alabama, Florida, Georgia, Louisiana, Maryland, Mississippi, and North Carolina. The suspected host plant is bald cypress, *Taxodium distichum* Rich. In Maryland the three known localities are in bald cypress swamps within a few kilometers of the northernmost site of natu-

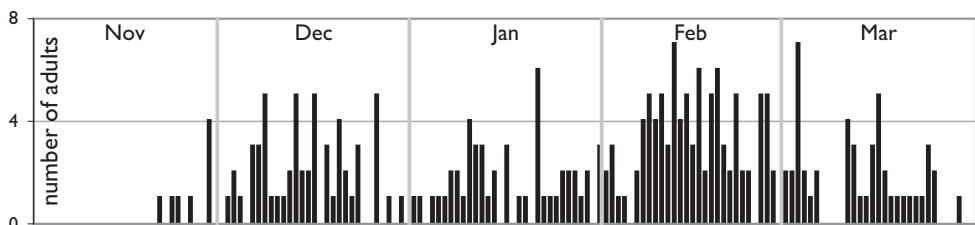


Figure 8. Seasonal occurrence of *Lithophane abita* at type locality (Abita Springs, Louisiana).

rally occurring bald cypress trees. In Florida, this moth is often found in or very close to pond cypress domes (R. M. Gillmore, pers. comm.). A single Florida specimen was labeled as captured at fruit bait.

Remarks. R. M. Gillmore provided the authors with numerous additional Florida records acquired from various sources, from the counties already listed in the paratype series. These specimens are not included as paratypes due to their poor quality.

Within Louisiana, *L. abita* was captured using ultraviolet light traps only at the Abita Springs location despite 39 continuous years of collecting using the same collecting methods throughout the State. No species of *Lithophane* was previously recorded for Louisiana by Chapin and Callahan (1967), who published the only list of Noctuidae for the state. However, intensive collecting by the senior author at the type locality of *L. abita* has turned up about 10 *Lithophane* species, some requiring further study to confirm their identity.[move this and the next paragraph to beginning of Discussion section]

Reference to this undescribed species can be found dating back 44 years to Kimball's (1965) book on the Lepidoptera of Florida. Under the heading *Lithophane* sp., Kimball (1965: 93) states that [John G.] Franclemont is describing it. Kimball listed six specimens from the Florida counties of Alachua, Escambia, Hillsborough, and Jefferson with collecting dates on three of the specimens from Lutz, Hillsborough Co., dating back 93 years. The oldest specimens of *L. abita* we were able to find were captured 98 years ago in 1911, also at Lutz, Florida.

Discussion

Lithophane abita is apparently not closely related to any other species of *Lithophane*, although features of the male genitalic structure and suspected larval host plant suggest affinities to the *L. lepida* and *L. gausapata* groups (discussed below). Among the unique features of *L. abita* are: the strongly asymmetrical male valves; the greatly enlarged base of the valve with the corresponding enlargement of the vinculum and pleural sclerite, and reduction of the tegumen; the greatly reduced cucullus; the very small, mainly membranous, ampulla of the clasper; and the prominent constriction in the female corpus bursae. A phenogram (Fig. 9) based on the 'barcode' fragment of the mtDNA *cox1* gene (Ratnasingham and Hebert 2007) illustrates the relationships among 39 of North American *Lithophane*. The results, in combination with genital structure, show the species of *Lithophane* arranged in nine species-groups. The *L. abita*-group (Group I) is associated with the *L. signosa*-group (Group II), although 4 % divergent from any species in the *L. signosa*-group, which show intraspecific divergences of less than 1 %. There are no derived morphological character states shared by these two groups, so the association based on molecular data may merely be a product of the isolation of the *L. abita*-group from any other group of *Lithophane* rather than a phylogenetic association with the *L. signosa*-group. In the male genitalia of the *L. signosa*-group the cucullus is well developed with an apical corona and the digitus is

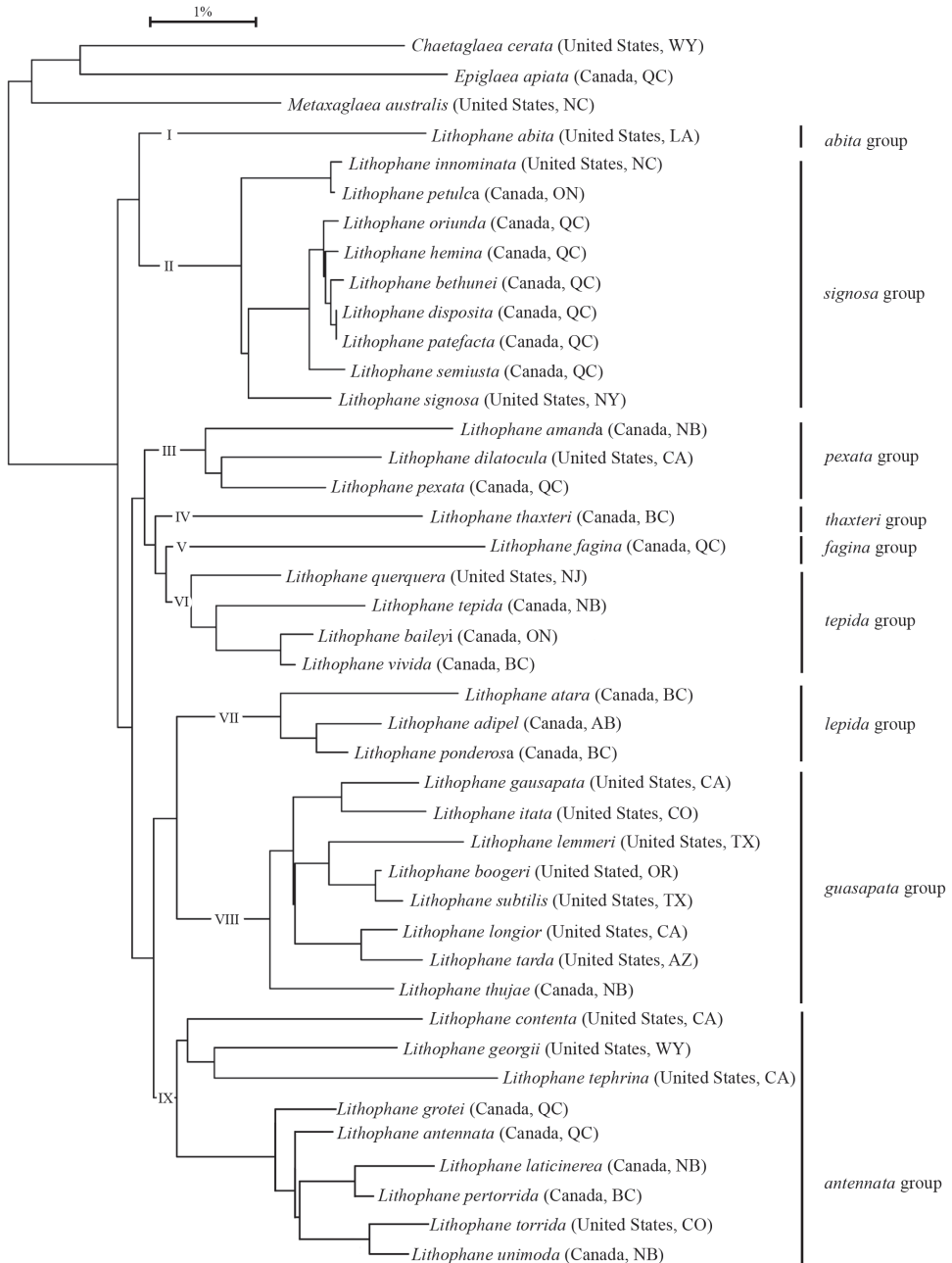


Figure 9. Phenogram of 39 North American *Lithophane* spp. based on the mtDNA 'barcode' fragment of *COI*, constructed using the Neighbor-Joining method with the Kimura 2-parameter (K2P) algorithm implemented in BOLD (Ratnasingham and Hebert 2007).

well developed. The next cluster in Figure 9 shows a loose association of four isolated species-groups of which the first three (*L. pexata*-group (III), *L. thaxteri*-group (IV), and *L. fagina*-group (V)) have male genitalia similar to those of the *L. signosa*-group. The last group in this cluster includes four species of the *L. tepida*-group (Group VI) in which the cucullus is reduced and the digitus forms an apical spine at the end of the valve. This is somewhat suggestive of the apex of the right valve of *L. abita*, but the two groups differ in all the other characters listed as being unique in the *L. abita*-group. In groups VII, VIII, and IX the apex of the valve appears forked because the cucullus is reduced and apically narrow and the digitus forms a second short apical or subapical process. The first two of these groups have similar genitalia and feed on conifers as larvae with the *L. lepida*-group (Group VII) on pines (Pinaceae) and the *L. gausapata*-group (Group VIII) on various Cupressaceae. In the *L. antennata*-group (Group IX) the part of the digitus on the inner surface of the valve forms a rounded, ventrally serrated plate. Both the DNA results, and the many peculiarities of the genitalia, demonstrate the isolated position of the *Lithophane abita*-group within the genus. The suspected larval host plant and the reduction of the cucullus in the male genitalia suggest that *L. abita* is probably most closely related to the conifer-feeding groups (Groups VII and VIII). A phylogenetic analysis using morphological and molecular data would be informative, and may shed some light on the evolutionary relationship of *L. abita* to its congeners.

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Lithophane leaeae (Lepidoptera, Noctuidae, Xyleninae), a striking new species from southeastern Arizona

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Abstract

A new species of noctuid moth in the genus *Lithophane* Hübner is described and illustrated. The largest member in the genus, *Lithophane leaeae* Walsh, **sp. n.** is known from a single female from the Chiricahua Mountains in southeastern Arizona, and is strikingly different from other described species of *Lithophane*. Mitochondrial DNA data place *L. leaeae* closest to (but quite divergent from) *Lithophane atara* (Smith) in the *Lithophane lepida* Grote species-group of pine-feeding *Lithophane* species.

Keywords

Lepidoptera, Noctuidae, *Lithophane*, taxonomy, Arizona, DNA barcode

Introduction

While the mountains of southeastern Arizona are classic moth collecting locations that have been heavily sampled over the past 60 years, they still continue to produce new species. The author has made a conscious effort over the past five years to collect at elevations above 2000 meters in May and June, before the summer monsoons that also lure most moth collectors to Arizona. In the early evening of June 14th, 2007 a large

pink moth flew into a mercury-vapor collecting sheet in the Chiricahua Mountains in Cochise County. Its appearance in flight was very similar to females of *Coloradia doris* Barnes (Saturniidae), which were also flying in some numbers at the time, and so the moth was ignored for several minutes. Upon closer inspection, it turned out to be a very large species of *Lithophane* Hübner, quite distinct from any known species. Despite fairly extensive collecting at this (and nearby) locations from late May through mid-July over the past five years, no other individuals have been found. While there is a quite reasonable reluctance to describe a species from a single specimen, this individual is so distinct from any described *Lithophane* as to make it highly unlikely to be an aberration of a known species. DNA barcoding confirms that this is a distinct species within the *lepida* Grote species-group (as defined by Forbes 1954; also see Troubridge and Lafontaine 2003).

***Lithophane leae* Walsh, sp. n.**

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Figs. 1, 2

Type material. **Holotype** female. (Fig. 1): USA, Arizona, Cochise County, Chiricahua Mountains, Onion Saddle, 7700', 14 June 2007. B. Walsh leg. Presently in the private collection of Bruce Walsh, to be deposited in the McGuire Center for Lepidoptera and Biodiversity. DNA sequence in the BOLD Barcode of life data system (Ratnasingham and Hebert 2007).

Etymology. Known from a singularly unique female festooned in pink, this species is named after the author's wife, Lee Fulmer.

Diagnosis. While superficially similar to *L. atara* (Smith) (Fig. 3) in maculation, *Lithophane leae* is the largest known species in the genus *Lithophane*. Although *Lithophane leae* keys out to *L. atara* in the key of Troubridge and Lafontaine (2003), it clearly differs from *L. atara* in being a significantly larger species (forewing length 25 mm vs. 18-20 mm), with more extensive and brighter pink on the dorsal surface of the hindwing (Fig. 1) and on both wings on the ventral surface (Fig. 2). While the male is presently undescribed, male specimens should be easily recognized once found given the distinct appearance and barcode of *L. leae*.

Description. **Female (male: unknown).** A large species with extensive pink suffusion on the dorsal hind wing and both wings on the ventral surface. **Dorsal surface** – forewing ground color gray brown, with a large reniform spot almost touching the orbicular spot. There is a deep zigzag in antemedial (am) and postmedial (pm) lines into median area fold where am and pm lines are connected by a thick black dash. Similar but thinner dashes occur from medial dash to subterminal (st) line, from lower margin of reniform spot to st line, and at wing base. Subterminal line deeply zigzagged. Basal two-thirds of hindwing heavily suffused with pink, with a light brown on outer third. Discal lunule prominent and brown. **Ventral surface** – ground color heavily suffused with pink on basal two-thirds of both fore- and hindwing. Reniform spot and discal



Figures 1-3. Adults of *Lithophane* species. **1,2.** *L. leae* Walsh, holotype. USA, Arizona, Cochise County, Chiricahua Mountains, Onion Saddle, 7700', 14 June 2007. **3.** *L. atara* (Smith), Canada, B. C., Summerland, 18 November 1994.

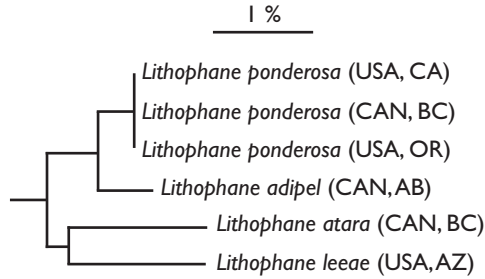


Figure 4. DNA phenogram of the *Lithophane lepida* species-group, based on the Neighbor-Joining reconstruction method with the Kimura 2-parameter (K2P) algorithm implemented in BOLD (Ratnasingham and Hebert 2007). Compare with the more extensive phenogram of the entire genus in the preceding paper by Brou and Lafontaine (2009).

lunule dark brown and prominent. **Abdomen** – pink lateral tufts of hair at distal end. Differs from *L. atara* in its much larger size (25.0 versus 18.0 mm forewing length in *L. atara*) and extensive bright pink suffusion on dorsal hindwing and very extensive pink suffusion on fore- and hindwings ventrally.

Biology and Distribution. The only known specimen was collected in mid-June at 7700' elevation in the Chiricahua Mountains, Arizona. Attracted to mercury-vapor lights. Based on its phylogenetic position and biology of other *Lithophanae*, *L. leeeae* is most likely a pine-feeder and probably hibernates as an adult, flying in early spring.

Discussion

In the subsequent paper in this issue, Brou and Lafontaine (2009) present a phenogram of the relationships among 39 species of North American *Lithophane* based on the barcode fragment of cytochrome c oxidase 1 (CO1). This gene, located in the mitochondrial genome, is the basis for DNA “barcoding” (Hebert et al. 2003). Base pair differences are shown as percentages, and within-species differences for *Lithophane* were less than one percent. Based on the CO1 sequence, *L. leeeae* is indeed a distinct species with a greater than three percent difference from its closest relative, *L. atara* (Smith). It clearly falls within the *L. lepida* Grote species-group (Brou and Lafontaine’s Group VII). Figure 4 provides a more detailed DNA-based phenogram of this group based on sequences in the BOLD barcode data base (Ratnasingham and Hebert 2007). Troubridge and Lafontaine (2003) present a revision of this group, whose members are all apparently pine (Pinaceae) feeders.

The closest relative of *L. leeeae*, *L. atara*, feeds on Ponderosa pine (*Pinus ponderosa* C. Lawson). Arizona pine (*P. arizonica* Engelm.), which historically has been treated as a variety of *P. ponderosa* but more recently viewed as a distinct species (Farjon and Styles 1997), is found at the type locality. Two other species of pine found at the type locality are also at the northern end of their distributions; both are more common in

the Sierra Madre Occidental in Mexico. These are Apache Pine (*P. engelmannii* Carrière) and Chihuahua Pine (*P. leiophylla* Schiede & Deppe). Any of these three species are potential hosts for *L. leeeae*.

Why has *L. leeeae* not been found before? The most obvious explanation would be that it is an early flier at high elevation. Historically, high elevations in the Chiricahua Mountains were not even modestly collected until late June. Hence, the type specimen could simply be a late individual that was unfortunate enough to have been collected. A second explanation could be that it represents a stray from the nearby mountains in northern Sonora (strays from which are well documented for numerous species of butterflies). The high elevations of the Chiricahuas contain other large, spectacular moth species such as *Caloecia entima* Franclemont (Lasiocampidae) and *Biston multidentata* (Guedet) (Geometridae: Bistonini) that are early summer fliers, rare in collections, and not seen in most years. For example, *B. multidentata* is known from less than a dozen individuals, and *C. entima* has only been taken sporadically, usually being absent for years at a time, although it can be common when taken. We can now add *L. leeeae* to this group of large, but quite elusive, species.

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Sincere thanks to Don Lafontaine of the Canadian National Collection of Insects, Arachnids, and Nematodes (CNC) for guiding this statistical geneticist through his first species description. Jocelyn Gill (CNC) did an outstanding job of preparing the color plate, working hard to capture *Lithophane leeeae*, and Chris Schmidt (CNC) was kind enough to provide measurements and information on *Lithophane*'s in the CNC, as well as offering useful comments on the manuscript. Finally, I thank Paul Hebert and the other members of the Barcode of Life Project at the University of Guelph, Ontario, for providing DNA data.

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Review of the *Acontia areli* group with descriptions of three new species (Lepidoptera, Noctuidae, Acontiinae)

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Abstract

The six-species of the *Acontia areli* group are examined. In addition to the existing species *A. areletta*, *A. areli*, and *A. areloides*, three new species are described from southwestern North America: *A. toddi* **sp. n.**, *A. geminocula* **sp. n.**, and *A. albifusa* **sp. n.**. A key to species, descriptions, illustrations of adults and genitalia, and distribution maps are included.

Keywords

Taxonomy, *Acontia areletta*, *Acontia areli*, *Acontia areloides*, *Acontia toddi*, *Acontia geminocula*, *Acontia albifusa*, Arizona, California, Colorado, Mexico, Nevada, New Mexico, Texas, USA, Utah, Wyoming

Introduction

The *Acontia areli* group consists of six species from southwestern North America and Mexico that are very similar in adult appearance, but differ in their genitalia. The basal

half of the dorsal surface of the forewing is white or buff colored with scattered dark markings, the outer half is a maculate dark brown with a prominent white preapical costal spot. *Acontia areli* was described by F. H. H. Strecker in 1898, *A. areletta* by H. G. Dyar in 1907, and *Tarache* [= *Acontia*] *areloides* by W. Barnes and J. McDunnough in 1912. Subsequently, in the 1950's and 1960's, E. L. Todd identified three additional species and applied manuscript names to specimens in the collection of the National Museum of Natural History, Smithsonian Institution, Washington. Todd died before a manuscript was prepared. In the ensuing years, these names appeared on specimen labels in various collections, and in many cases misidentifications were made. For this reason, we decided not to perpetuate the Todd manuscript names and are providing new names to accompany the formal descriptions of the three new species.

Materials and methods

Repository abbreviations

Specimens were examined from the following collections:

- CNC** Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Ontario, Canada.
CDF Personal Collection of Clifford D. Ferris, Laramie, Wyoming, USA.
CUIC Cornell University Insect Collection, Ithaca, New York, USA.
FMNH The Field Museum, Chicago, Illinois, USA.
JBW Personal collection of J. Bruce Walsh, Tucson, Arizona, USA.
USNM National Museum of Natural History, Washington, District of Columbia, USA.

Dissecting methods and genital terminology. Dissection of genitalia and terms for genital structures and wing markings follow Lafontaine (2004).

Description abbreviations

- DFW** Dorsal forewing.
DHW Dorsal hindwing.
VFW Ventral forewing.
VHW Ventral hindwing.

Acontia areli group

Diagnosis. The *Acontia areli* group is superficially characterized by the division of the forewing into a dark brownish-gray outer half and a pale white or buff inner half; a prominent, single, subapical white patch on the costa; a large, rounded, partially blue-filled reniform spot, and an orbicular spot usually reduced to black upper and lower arcs.

Key to species of *Acontia areli* group

- 1 Forewing with dark shading on outer half of wing extending basally to cover all or part of orbicular spot; subapical white patch elongated, trapezoidal, about 2 × as long on costa as wide..... **2**
- Forewing with orbicular spot surrounded by pale shading on basal half of wing; subapical white spot triangular or square, about as long on costa as wide **3**
- 2 Hindwing white without fuscous band around margin; central Mexico ***A. areletta* Dyar**
- Hindwing with fuscous band around margin; Arizona, New Mexico ***A. areloides* (Barnes & McDunnough)**
- 3 Forewing with pale shading on basal half of wing diffusing into outer half of wing below reniform spot and usually partially surrounding it; Arizona ***A. albifusa* Ferris & Lafontaine, sp. n.**
- Forewing with pale shading in basal half of wing and dark shading on outer half separated by sharp line basal to reniform spot (usually on outer edge of remnant of orbicular spot) **4**
- 4 Forewing with large mainly blue reniform spot with black patch on inner side of spot; a similar spot on medial line below reniform spot and resembling it, except black patch on outer edge of spot; Arizona, Mexico, Texas ***A. geminocula* Ferris & Lafontaine, sp. n.**
- Forewing with dark shading in reniform spot forming central “pupil,” or of scattered dark scales; medial line below reniform spot with irregular black area usually with some scattered blue scales; widely distributed in western North America... **5**
- 5 Forewing with pale basal area buff or yellowish white, contrasting with white subapical spot on costa; dark patch in lower part of medial line prominent and usually with many scattered blue scales; reniform spot with black central “pupil” ***A. areli* Strecker**
- Forewing with pale basal area white, similar in color to subapical spot on costa; dark patch in lower part of medial line small, with few scattered blue scales; reniform spot filled with blue and gray scales..... ***A. toddi* Ferris & Lafontaine, sp. n.**

Descriptions***Acontia areli* Strecker**

Figs. 1, 2-4, 17, 23, 28

Acontia areli Strecker, 1898: 11.

Type material. Lectotype ♂: New Mexico [FMNH, Chicago, USA]. Described from two males from New Mexico and one female from Arizona. A male labeled “*A. areli* ♂,

*areli*

circular reniform with black pupil
 irregular patch; inner margin
 with some bluish scales
 DFW basal area buff

*areloides*

large white trapezoidal spot
 orbicular, reniform nearly
 obsolete
 even vertical margin, some-
 times obliterating orbicular
 DFW basal area dark buff

*todd*

reniform less prominent
 area nearly uniformly brown with
 only a few scales of different
 color
 DFW basal area nearly white

*geminocula*

reniform inwardly produced with
 dark patch
 second "reniform" spot with dark
 outer patch
 DFW basal area nearly white, or
 very pale yellowish

*albifusa*

prominent dark patch distad of
 reniform
 mottled, not uniformly dark

DFW basal area creamy yellow

Figure 1. Diagnostic characters for separating the five *Acontia areli* group species found in the United States. The Mexican *A. areletta* is similar to *A. areloides*, but with an all white hindwing.

Orig. Type. N.M. [red border]/ *Acontia Areli* Streck[er], 415. Arizona, Orig. types, H. K. M[orrison] [red border]/ *Acontia areli* Streck., Arizona, HKM, Orig. types, Strecker Colln 35726, Field Museum Nat. Hist./ Lepidoptera Type Photograph No. 339 Field Museum” is **hereby designated as Lectotype**. It is the widely distributed species generally known as *Acontia areli*, and is in good condition, except for a slightly frayed fringe at the apex of the left forewing.

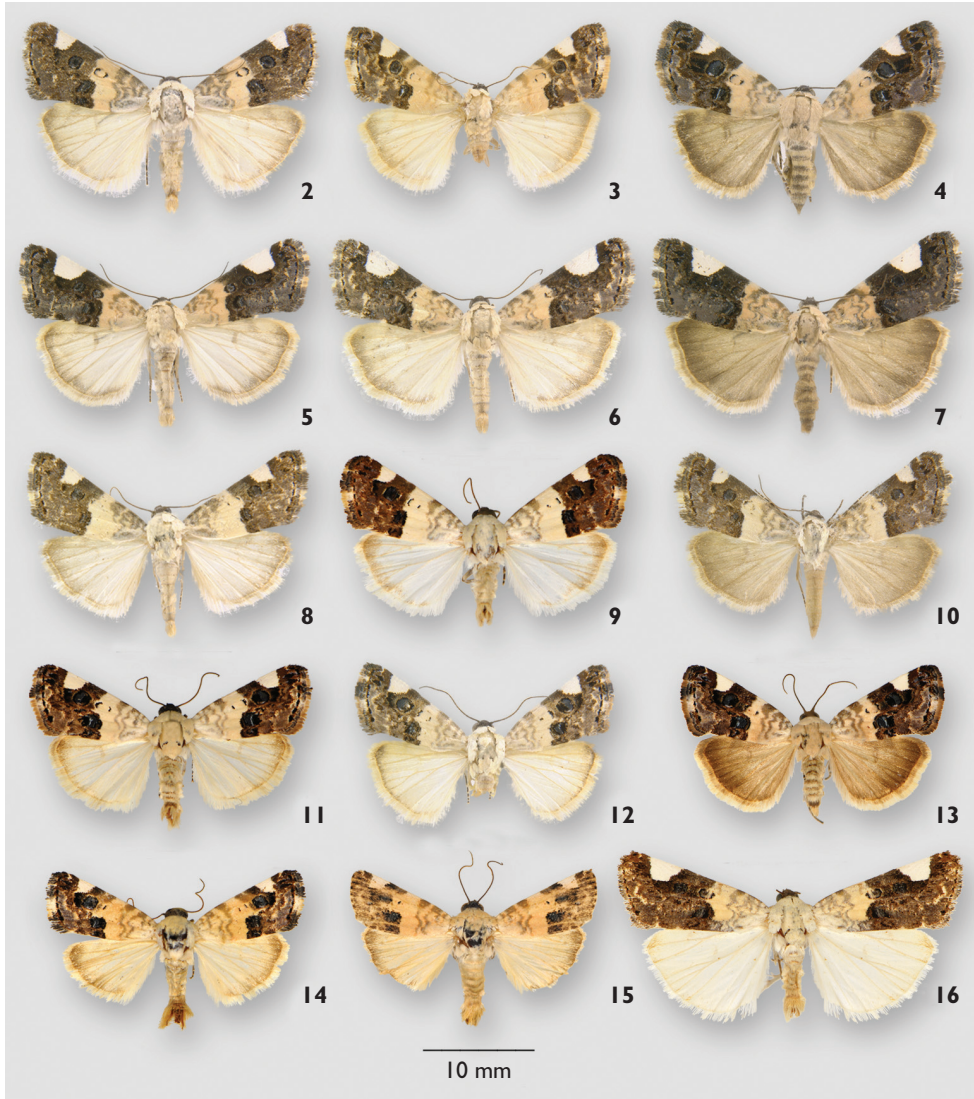
The remaining two syntypes have similar labels to the first three labels of the lectotype, but differ in the type numbers (Strecker Colln 35728 for the other male from New Mexico, and Strecker Colln 35727 for the female from Arizona). They are the species described below as *Acontia geminocula*.

Other material examined and distribution (Fig. 28). Approximately 1,200 specimens of both sexes were examined from western North America (17 dissections). **Arizona:** Apache, Cochise, Pima, Yavapai counties; canyons in Chiricahua and Huachuca Mts. **California:** Riverside, San Bernardino, San Diego counties. **Colorado:** Eagle, Garfield, La Plata, Mesa counties. **Nevada:** Elko, White Pine counties, Angel Lake, Humboldt Mts. **New Mexico:** Catron, Colfax, Grant, Hidalgo, McKinley, Otero, Rio Arriba, Sandoval, Socorro counties. **Texas:** Brewster, Culberson, Jeff Davis counties, Davis and Guadalupe Mts. **Utah:** Cache, Sanpete, Sevier, Juab, Utah counties. **British Columbia:** Kaslo. **Mexico:** Durango, 10 mi. (16 km) W of Durango. This species seems to have the widest geographic range of the six species in the group.

Diagnosis. *Acontia areli* is separated from its congeners by the DFW incompletely dark ringed pale orbicular spot, and from other species in the *A. areli* group by the black central pupil in reniform spot, irregular inner margin of brown area and associated irregular dark patch on the medial line with some bluish scales, and the buff color of the basal area of the forewing that contrasts with the white preapical spot.

Description. Adult male: Head – dark brown; antenna filiform; palpus porrect slightly longer than eye width, white basally, outer half brown with broad vertical white band in middle. **Thorax** – prothoracic collar, thorax, and abdomen creamy white, a few brown scales toward tip of tegula and on metathorax. **Foreleg:** coxa white with a few brown scales; femur and tibia outwardly brown, inwardly white, with white ring at middle and apex of tibia; tarsus brown with white rings at joints. **Middle leg:** femur white turning brown at femoral-tibial joint; tibia brown with white ring at base and near apex; tarsus brown with white rings at joints. **Hindleg:** femur and tibia white with light brown shading at tibial-tarsal joint; first tarsal joint white shading to brown at second segment joint; remaining tarsi brown, white-ringed at joints. **Wings:** male (forewing length (FWL): 10-12.5 mm). Dorsal forewing (DFW): ground color creamy-white over basal half with four irregular pale gray-brown vertical striations, remainder of wing brown with scattered paler areas producing a very sight mottled aspect; prominent white trapezoidal costal patch before apex; orbicular spot an incomplete narrow brown ring with creamy white center; reniform a circular dark ring with internal iridescent blue scales and black pupil; a brown irregular patch below reniform spot with some blue scales extending to inner margin of wing; terminal line and irregular series of dark dashes; fringe scales basally brown, paler at tips, with brown patch

below apex and at tornus. Dorsal hindwing (DHW): luminous white, nearly hyaline, with pale brown marginal band; fringe white. **Female** (FWL: 10-12 mm) – similar to male, but color generally darker, especially fringes, DHW light brown basally, shading to brown on outer margin. **Male genitalia** (Fig. 17) – *uncus*: decurved, slender, tapering to a pointed tip. *Valves*: asymmetrical; right valve broad, approximately rectangular,



Figures 2-16. *Acontia areli* group adults. **2-4.** *A. areli*, **2** ♂, Catron Co., NM; **3** ♂, Grant Co., NM; **4** ♀, Grant Co., NM; **5-7.** *A. areloides*, **5** ♂, Grant Co., NM; **6** ♂, Catron Co., NM; **7** ♀, Catron Co., NM. **8-10.** *A. toddi*, **8** ♂, holotype, Emery Co., UT, **9** ♂, Yavapai Co., AZ, **10** ♀, Emery Co., UT. **11-13.** *A. geminocula*, **11** ♂, holotype, Yavapai Co., AZ; **12** ♂, Cochise Co., AZ; **13** ♀, Pima Co., AZ. **14-15.** *A. albifusa*, **14** ♂, holotype, Pima Co., AZ, **15** ♀, Pima Co., AZ. **16.** *A. areletta* ♂, San Jacinto, Mexico.

apex pointed dorsally, without apical corona; clasper on ventral margin wraps around valve end; right valve with smooth saccular extension tapering evenly to apex; left valve without saccular extension. *Aedeagus*: smoothly sclerotized except for a narrow finely spiculate posterior band that extends on to base of vesica; everted vesica with three diverticula, an unequally bilobed, unarmed, subbasal diverticulum, a shorter, rounded diverticulum on left with a large, tapered, curved, heavily sclerotized cornutus at apex, and a very small ventral diverticulum with a similar cornutus; apical part of vesica with two large swollen lobes, both densely covered with field of short, stout spines forming rasp-like patches; lower (right) lobe with central keel of larger spines. **Female genitalia** (Fig. 23) – ostium bursae broad, funnel like; ductus bursae broad, expanding toward junction with corpus bursae, length ca. $0.7 \times$ length of corpus bursae; corpus bursae ovoid with spine-filled pouch posteriorly on left.

Biology. Unknown. Habitats are open pinyon-juniper-oak areas and open ponderosa pine forest. Adults during July and August in canyons and forested plateaus from 4800-7500' (1460-2285 m).

Acontia areloides (Barnes & McDunnough)

Figs. 1, 5-7, 18, 24, 29

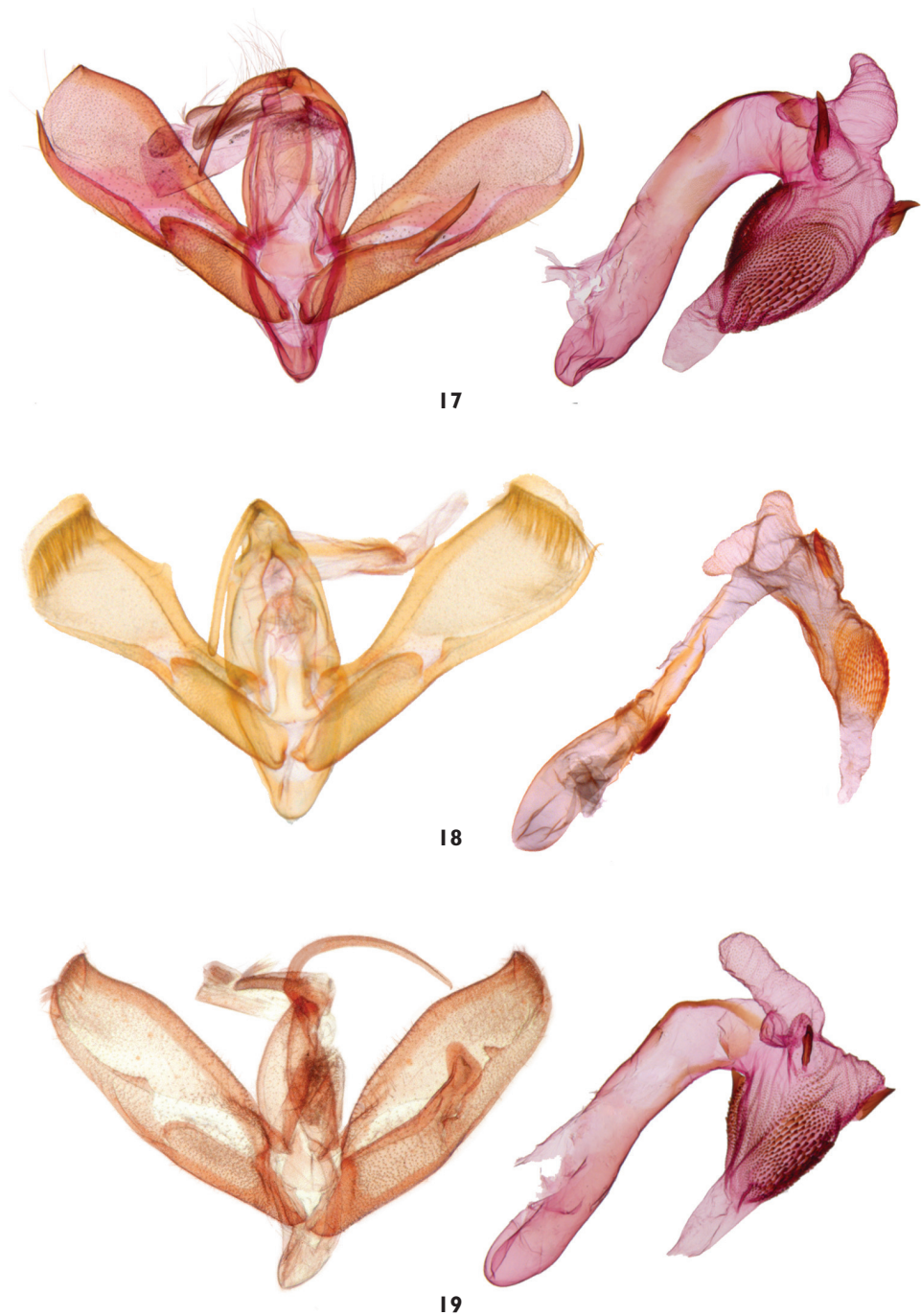
Tarache areloides Barnes and McDunnough, 1912: 92.

Type material. Syntypes 3 ♂, 5 ♀: Arizona, White Mts. [USNM, Washington, DC].

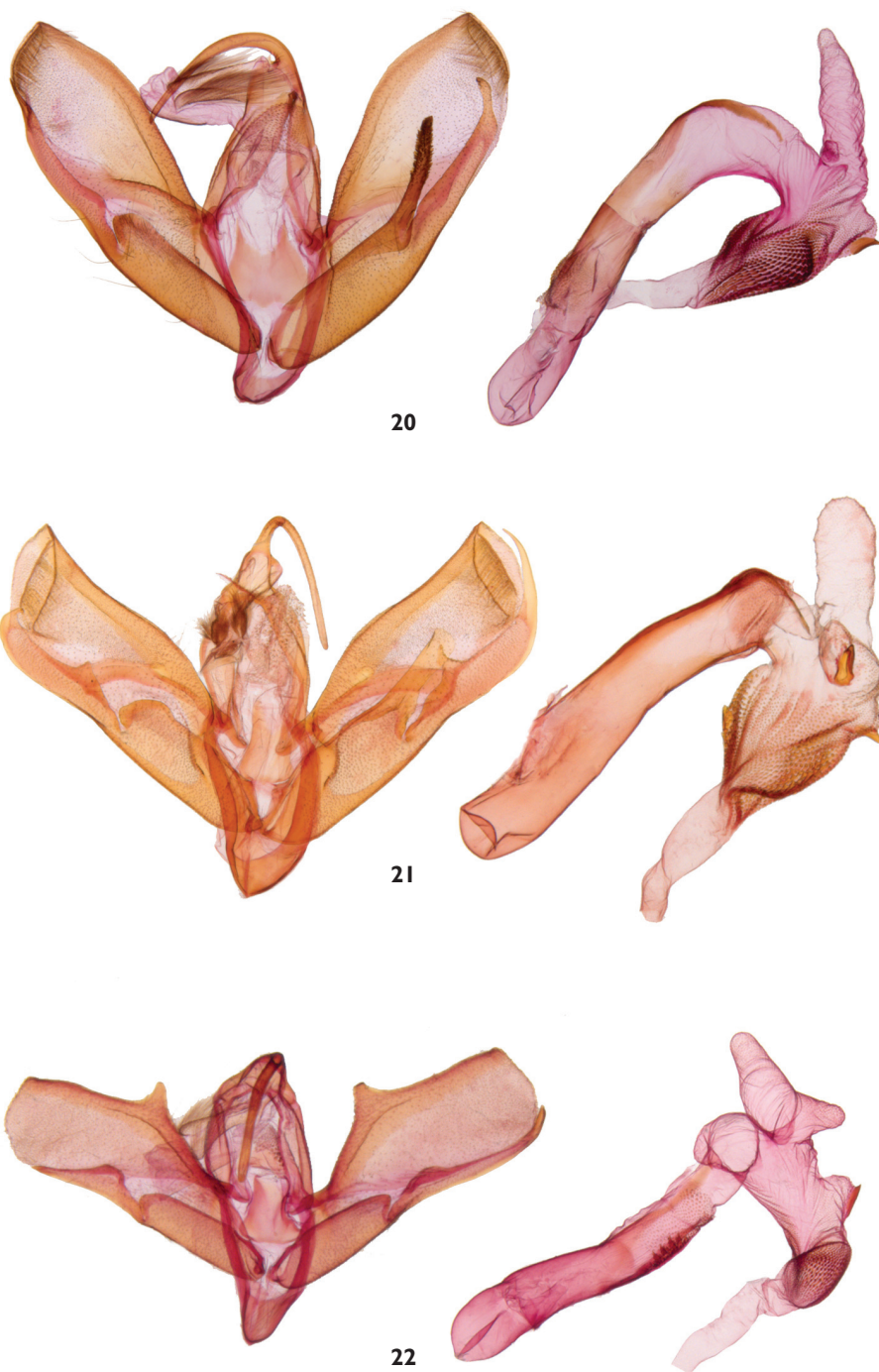
Other material examined and distribution (Fig. 29). Ninety-five specimens were examined (7 dissections). **Arizona:** Apache and Coconino cos.; White Mts. **New Mexico:** Bernalillo, Catron, Grant, Lincoln, McKinley, Rio Arriba, Sandoval, and Socorro cos.; Magdalena, Pinos Altos, Sandia, and San Francisco Mts.

Diagnosis. *Acontia areloides* is separated from its congeners by its larger size, even vertical margin between the buff basal half of the forewing and the brown outer half, the latter obscuring the orbicular and reniform spots, and large white trapezoidal preapical costal spot, and the fuscous infusion on the hindwing.

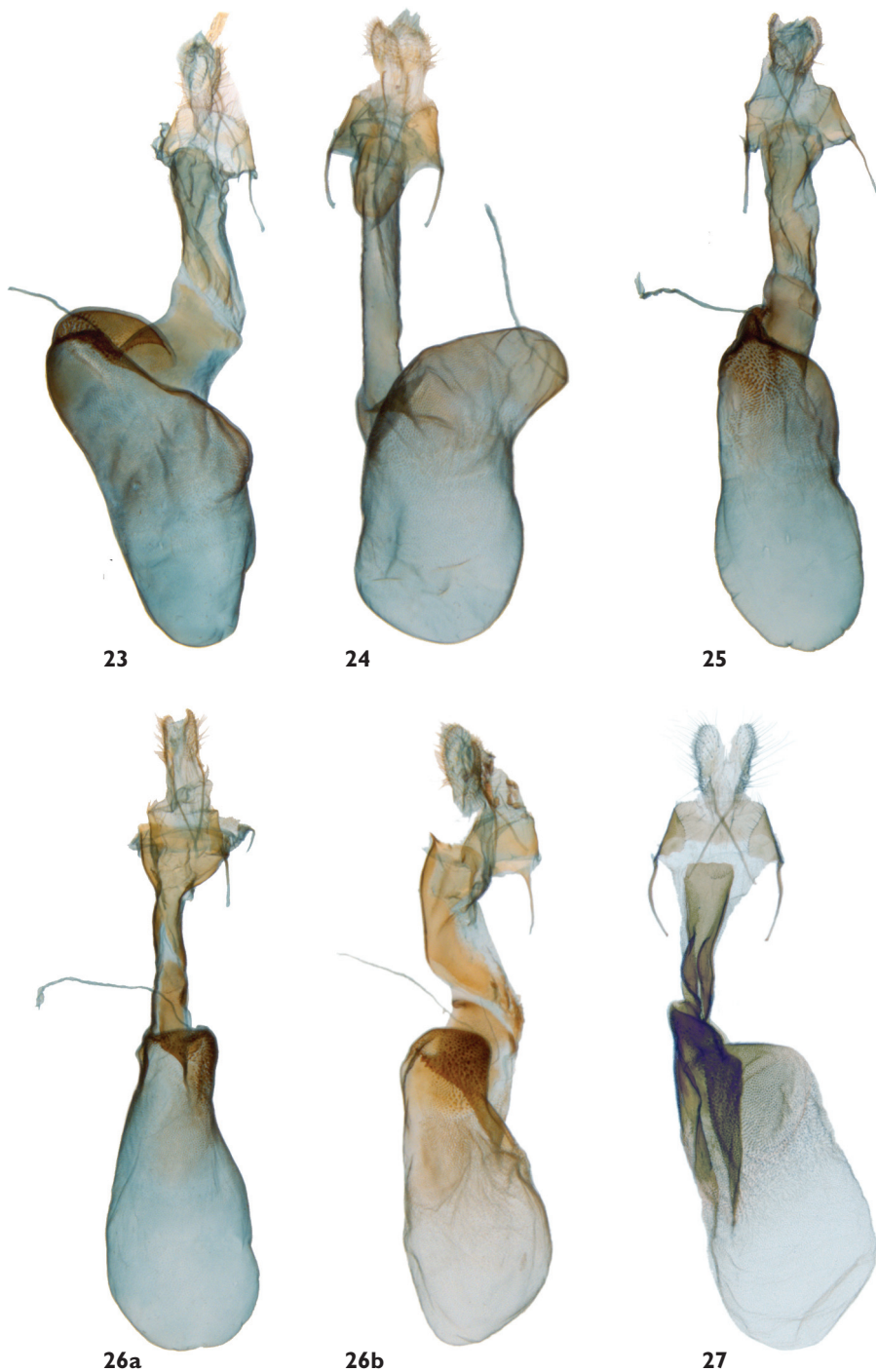
Description. Adult male: Head – dark brown; antenna filiform; palpus porrect, slightly longer than eye width, white basally, outer half brown with vertical paler band in middle. **Thorax** – prothoracic collar and thorax creamy white with a few widely scattered brown scales. *Foreleg*: coxa white with a brown patch; femur and tibia outwardly brown, inwardly white, tan brush at tibial-tarsal joint; tarsi brown with white rings at joints. *Middle leg*: femur white, turning brown at femoral-tibial joint; tibia brown, white ringed at tibial-tarsal joint; tarsi brown with white rings at joints. *Hindleg*: femur, tibia white with brown “knee” at femoral-tibial joint and light brown shading at tibial-tarsal joint; first tarsal joint white shading to brown at second segment joint; remaining tarsi brown, white-ringed at joints. *Wings*: male (FWL 12-14 mm). DFW: ground color dark creamy-white over basal half with several irregular light brown vertical striations, then sharp nearly straight vertical transition to brown for remainder of wing, with some



Figures 17-19. *Acontia areli* group male genitalia (left – ventral; right – lateral). **17** *A. areli*, **18** *A. arelodes*, **19** *A. toddi*.



Figures 20-22. *Acontia areli* group male genitalia (left – ventral; right – lateral). **20** *A. geminocula*, **21** *A. albifusa*, **22** *A. areletta*.



Figures 23-27. *Acontia areli* group female genitalia. **23** *A. areli*, **24** *A. areloides*, **25** *A. toddi*, **26** *A. geminocula*, (26a ventral; 26b lateral), **27** *A. albifusa*.

scattered paler areas producing only a very slightly mottled aspect; prominent large white trapezoidal costal patch basad of apex; orbicular spot straddles pale-to-brown boundary, a brown ring with blue interior and brown pupil; reniform spot a circular dark ring with internal iridescent blue scales and black pupil; below orbicular spot a dark brown crescent and distally smeared patch with some bluish scales; terminal line a series of dark dashes; fringe brown interrupted by small white patch below apex and another at middle of outer margin of wing. DHW: luminous white, nearly hyaline, with pale brown marginal band; fringes white. **Female** (FWL 12-14 mm) – similar to male, but color generally darker, especially fringes, DHW light brown basally shading to brown on outer margin. **Male genitalia** (Fig. 18) – *uncus*: decurved, very long and narrow with slightly expanded rounded apex. *Valves*: asymmetrical; right valve narrower at base than apex with triangular process on dorsal margin beyond middle, apex rounded, with corona; clasper on lower margin of valve with triangular dorsal process near base, apex spine-like, curving around lower end of valve; sacculus broad with apex rounded, without saccular extension; left valve similar to right valve except sacculus smaller and clasper shorter with less prominent dorsal bulge. *Aedeagus*: similar to that of *A. areli*, but more slender and spiculate band at apex ending well before base of vesica; everted vesica with trilobed subbasal diverticulum, a medial, rounded diverticulum with a heavily sclerotized, fin-like cornutus dorsally, and a distal lobe covered with rasp-like oval patch of small heavily chitinized projections. **Female genitalia** (Fig. 24) – ostium bursae funnel-like; ductus bursae a long unsclerotized tube joining kidney-shaped corpus bursae at midpoint; corpus bursae mostly membrane, lightly sclerotized posteriorly.

Biology. Unknown. Adults in late July–September in forested mountain canyons from 5600-8300' (1710-2530 m).

Note. A single male specimen was examined from San Juan del Rio, Queretaro, south-central Mexico that is nearly identical to *A. areloides*, but differs in some aspects of the male genitalia. We do not feel it appropriate to describe a new species based upon a single specimen.

Acontia areletta Dyar

Figs. 16, 22

Acontia areletta Dyar, 1907: 229.

Type material. Holotype ♂: Mexico, Mexico City [USNM, Washington, DC].

Other material examined. 1 ♂, Mexico, Federal District, San Jacinto.

Diagnosis. *Acontia areletta* resembles *A. areloides*, from which it can be separated by its white hindwing, lacking the fuscous band around the margin as found in *A. areloides*.

Description. As for male of *A. areloides* excepting the dorsal hindwing, which in *A. areletta* is pure white, without a fuscous marginal band. The female is unknown. **Male genitalia** (Fig. 22; 2 dissections) – *uncus*: decurved, very long and narrow with very slightly expanded rounded apex. *Manica* (membranous tube posterior to juxta) with

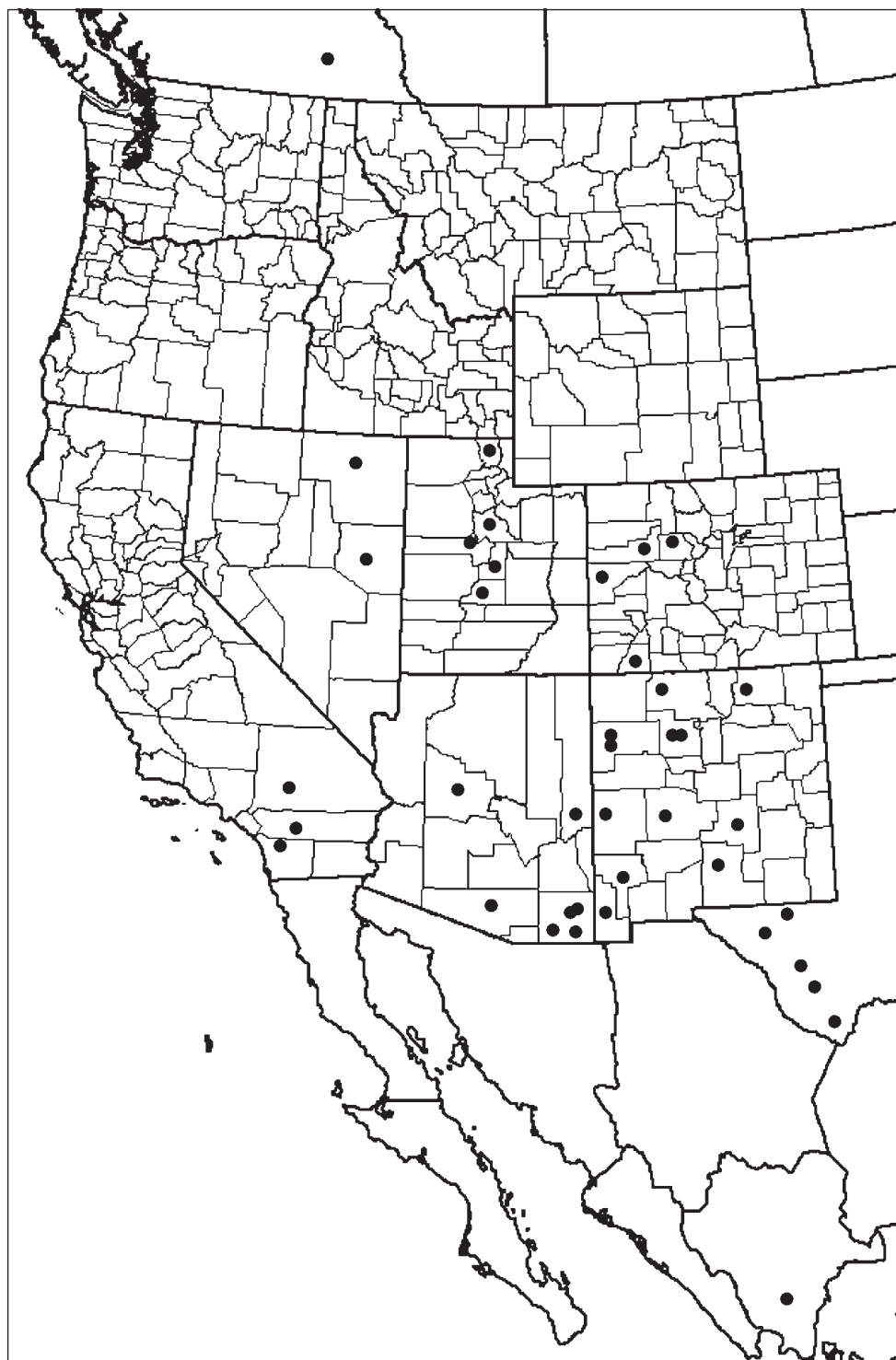
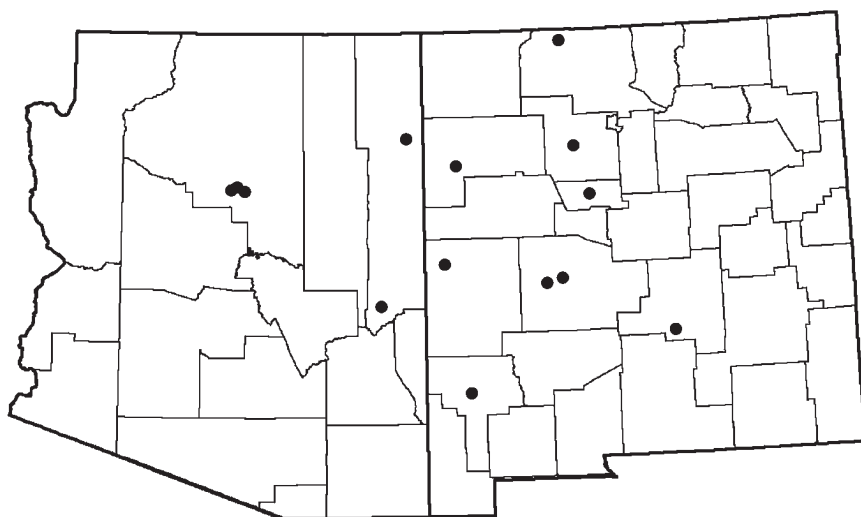
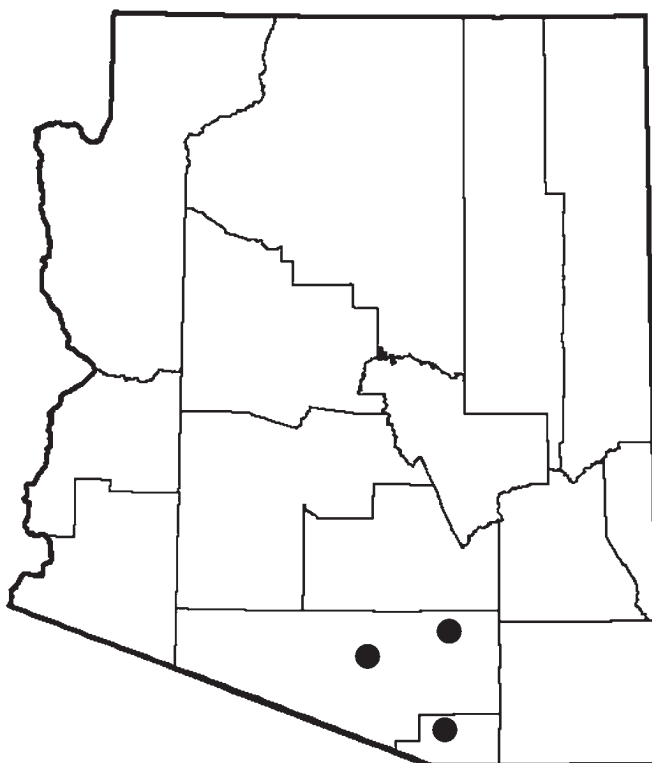


Figure 28. *Acontia areli* distribution map.



29



30

Figures 29-30. *Acontia* distribution maps. 29 *A. arelioides*. 30 *A. albifusa*.

stout spine-like field of sclerites (attached to outer edge of aedeagus in Fig. 22). *Valves*: asymmetrical; right valve broad, approximately rectangular, with blunt process near middle of dorsal margin, apex pointed dorsally, without apical corona; sacculus without posterior extension; clasper swollen basally on dorsal margin, then tapering evenly to spine-like apex extending slightly beyond ventral margin of valve; left valve similar to right, but sacculus smaller and clasper much shorter. *Aedeagus*: similar to that of *A. areloides*; everted vesica similar to that of *A. areloides*, but with two small additional subbasal diverticula. **Female genitalia** – unknown.

Biology. Unknown. Adults from late October to November.

***Acontia toddi* Ferris & Lafontaine, sp. n.**

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Figs. 1, 8–10, 19, 25, 31

Type material. **Holotype** ♂: Utah, Emery Co., San Rafael Reef area, 38° 39.2' N, 110° 43.1' W, 5500' (1675 m), 18–19 May, 1999, C. D. Ferris [CNC, Ottawa, Canada].

Paratypes: 10 ♂, 13 ♀. UTAH: Beaver Co., Beaver, 6 mi E, 6300', D. F. Hardwick (2 ♀); Emery Co., San Rafael Reef area, 5300', 22 May, 2003 (1 ♂, 2 ♀), 15 May, 2007 (4 ♂, 4 ♀); Garfield Co., Star Springs, 36 mi S Hanksville, 6300', 27 Aug. 1971, D. F. Hardwick (2 ♀); Juab Co., Callao, 29 July 1941, G. F. Knowlton & F. C. Harmston (1 ♂); Juab Co., Eureka, 16 July–21 Aug. 1911, Tom Spalding (4 ♂, 3 ♀). Paratypes deposited in CNC, USNM, and the personal collection of C. D. Ferris.

Other material examined and distribution (Fig. 31). 184 specimens not included in type series were examined (28 dissections). **Arizona.** Apache, Cochise, Coconino, Mohave, Pima, Pinal, and Yavapai cos.; Chiricahua, Huachuca, Hualupai, Santa Catalina, and White Mts. **California.** San Bernardino and Riverside cos.; Iwapah Mts. **Montana.** Sweet Grass Co. **Nevada.** Clark, Esmeralda, Lincoln, Lyon, and Nye cos. **New Mexico.** Chaves, Grant, Hidalgo, Luna, and Otero cos. **Oregon.** Baker Co. **Texas:** Culberson, Jeff Davis cos., Davis Mts. **Wyoming.** Weston Co.; Black Hills. **Mexico.** Baja California Norte 29° 46' N 114° 46' W. April–August in dry forest clearings, desert canyons, riparian and reef areas from 2900–7600' (885–2320 m). Apparently two generations in some areas (e.g., Grant Co., New Mexico).

Note. Material of this species was distributed by E. L. Todd under the unpublished manuscript name “*Acontia deserticola*.”

Etymology. We take pleasure in naming this species in honor of the late E. L. Todd.

Diagnosis. DFW basal area nearly white in both sexes; dark brown distal area nearly uniformly brown with only a few scales of different color; orbicular spot nearly obsolete; reniform spot less prominent than in *A. areli* and *A. geminocula*, and without dark “pupil.”

Description. Adult male: Head – dark brown with a few whitish scales at antennal base; antenna filiform; palpus porrect, slightly longer than eye width, white basally, brown at tip. **Thorax** – prothoracic collar and thorax. *Foreleg:* brown, white-ringed in middle of tibia and at joints. *Middle leg:* femur and tibia white with brown rings

at joints; tarsi brown, white ringed at joints. *Hindleg*: femur white; tibia white with light brown shading at tibial-tarsal joint; first tarsal segment white shading to brown at joint with second segment; remaining tarsi brown, white-ringed at joints. *Wings*: male (FWL 10-13 mm). DFW: ground color white over basal half with two small very pale brown patches on costa and a few scattered pale brownish scales basad; outer half of wing brown with a few scattered small white and dark scale patches; prominent, ap-

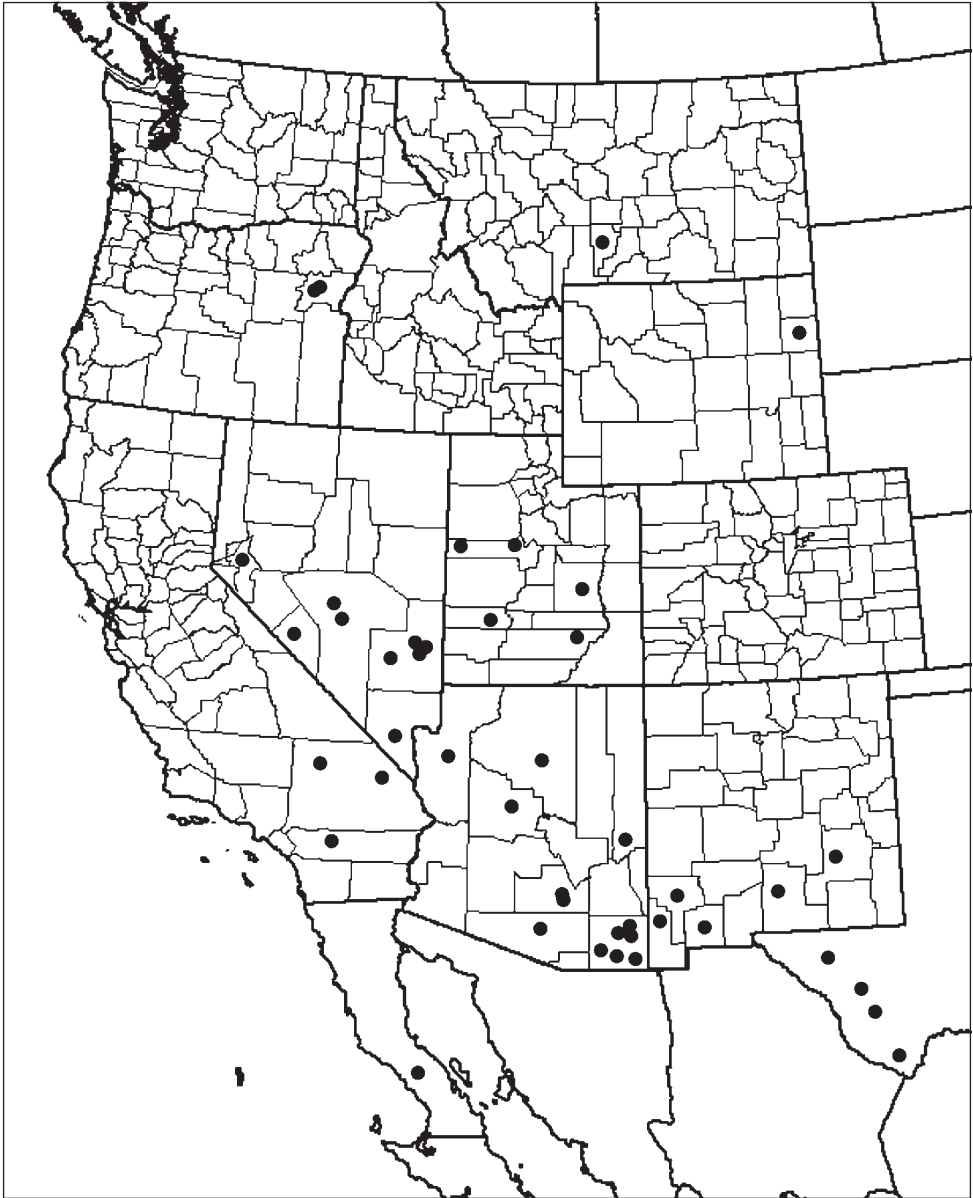


Figure 31. *Acontia toddi* distribution map.

proximately square, white preapical patch on costa; orbicular spot virtually obsolete, defined only by a few dark scales; reniform spot circular, filled with darker scales than background; terminal line a series of dark dashes; fringe basally brown, white at tips. DHW: luminous white, nearly hyaline, with pale brown marginal band; fringe white. **Female** (FWL 10-12 mm) – similar to male but DFW basal area with increased darker overscaling; DHW pale tan with pale brown marginal band. **Male genitalia** (Fig. 19) – *uncus*: long, slender, slightly swollen at mid-length, tapers to pointed tip. *Valves*: asymmetrical; right valve broad, tapering slightly toward apex with slight preapical concavity on dorsal margin; apex rounded with slight dorsal point; corona present but with fewer setae than in other species; clasper on ventral margin with triangular process near middle of dorsal margin, apex spine-like, extending around posteroventral angle of valve; right sacculus with apically spatulate extension; left valve similar but sacculus smaller and without posterior extension; clasper with broad, triangular, dorsal process near base. *Aedeagus*: similar to that of *A. areli*; everted vesica membrane plum-shaped with large unarmed thumb-like dorsal diverticulum subbasally; two large, heavily sclerotized horn-like cornuti, one at base of diverticulum and one near middle of outer margin of vesica; apical part of vesica with two large fields of chitinized projections forming rasp-like patches with band of stouter spines along middle of each patch. **Female genitalia** (Fig. 25) – ostium bursae funnel-like, tapering only slightly to junction with ductus bursae; ductus bursae tubular, lightly sclerotized, length about $0.6 \times$ length of ovoid corpus bursae; spine-filled posterior pouch of corpus bursae to left of ductus.

Biology. Unknown. Adults April–August in dry forest clearings, desert canyons, riparian and reef areas from 2900-7600' (885-2320 m). Apparently two generations in some areas (e.g., Grant Co., New Mexico).

***Acontia geminocula* Ferris & Lafontaine, sp. n.**

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Figs. 1, 11-13, 20, 26, 32

Type material. Holotype ♂. Arizona, Yavapai Co., Granite Dells, 4 mi N Prescott, 2 Sept., 1970, L. M. Martin. [CNC, Ottawa, Canada]. **Paratypes** 110 ♂, 133 ♀ (13 dissections): **Arizona.** Same locality and collector as for holotype, 9 Aug.–23 Sept. 1970 (3 ♂); Cochise Co., Chiricahua Mts., Cave Creek Canyon, 5400', 1 July–4 Sept. 1966, J. G. Franclemont (12 ♂, 7 ♀); Cochise Co., Chiricahua Mts., Cave Creek Canyon, 4880', 7 July–25 Aug. 1967, J. G. Franclemont (7 ♂, 11 ♀); Cochise Co., Garden Canyon, 4 Aug. 1966, R. F. Sternitsky (1 ♀); Cochise Co., Huachuca Mts., Miller Canyon, 5000', 29 June–17 Aug., 1974, J.G. Franclemont (20 ♂, 32 ♀); Cochise Co., Huachuca Mts., Ramsey Canyon, 23 Sept. & 4 Oct., 1967, R. F. Sternitsky (4 ♀); Cochise Co., Paradise, Barnes Coll. (6 ♂, 1 ♀); Cochise Co., Portal, 5 mi SW, 5400', 2 Oct., 1969, D. F. Hardwick (1 ♂); Cochise Co., Sierra Vista, 12 Sept. 1967, R. F. Sternitsky (2 ♀); Cochise Co., Huachuca Mts., Ash Canyon, 5170' (1575 m), 3 July, 2005, C. D. Ferris (1 ♂, 1 ♀). Pima Co., Baboquivari Mts., 5000', 1-7 July

1923 & 5700', 15-30 July 1923 & 1-15 Sept. 1923, O. C. Poling (2 ♂, 2 ♀); Pima Co., Baboquivari Mts., Brown Canyon, 4100', 20 Aug. 2006, T. Mustelin & 20 Aug. 2008, C. Schmidt & L. Crabo (1 ♂, 1 ♀); Santa Cruz Co., Canelo, 20 Aug. 1966, R. F. Sternitsky (1 ♀); Santa Cruz Co., Sycamore Canyon, 4400' (1340 m), 9 Aug., 1990, C. D. Ferris (1 ♂); Santa Cruz Co., Huachuca Mts., Copper Canyon, 6050', 9 July 2004, J. B. Walsh (2 ♂); Santa Cruz Co., Patagonia Mts., Harshaw, 4900', 27 June 2006, J. B. Walsh (1 ♂); Santa Cruz Co., Peña Blanca, 3950', 11, 18, 23 Aug., 1960, J. G. Franclemont (6 ♂, 1 ♀); Santa Cruz Co., Santa Rita Mts., Madera Canyon, 4880', 4 July–6 Sept., 1959 & 23 July–28 Aug., 1960, J. G. Franclemont (43 ♂, 67 ♀) & Madera Canyon, 5100', 10-26 July 1964, D. R. Davis (2 ♂); Santa Cruz Co., T20S, R14E. Sec. 2, Madera Canyon, Santa Rita Lodge, 4840', 5 July 1987, E. H. Metzler (1 ♂, 1 ♀). Yavapai Co., Prescott, 2, 4 Sept., 1907, R. C. Kunze (2 ♂). **Texas:** Brewster Co., 6.5 mi south of Alpine, 30°17.4'N 103°35.6'W 9 Aug. 1991, Eric H. Metzler (1 ♂, 1 ♀). Paratypes deposited in CNC, CUIC, USNM, and the personal collections of C. D. Ferris, E. H. Metzler, and J. B. Walsh.

Other material examined and distribution (Fig. 32). Mexico. Chihuahua, Mesa del Huracán (1 ♂).

Note. Material of this species was distributed by E. L. Todd under the unpublished manuscript name "*Acontia vasticola*."

Etymology. The name of this species refers to the pair of eye-like spots on each forewing.

Diagnosis. DFW basal area nearly white in male (like *A. toddi*), pale buff in female (like *A. areli*); distal area brown mottled with paler areas; reniform spot inwardly produced with dark distal patch. Differs from other four similar species in having a second reniform-like spot with dark outer patch below reniform.

Description. Adult male: Head – dark brown; antenna filiform; palpus porrect slightly longer than eye width, white basally, outer half brown with vertical white band in middle. **Thorax** – prothoracic collar, thorax and abdomen white. *Foreleg:* coxa white with brown patch near middle; femur, tibia, and tarsus brown, white-ringed in middle of tibia and at joints. *Middle leg:* femur and tibia white with brown rings at femoral-tibia joint and near apex of tibia; tarsus brown, white-ringed at joints. *Hindleg:* femur and tibia white with light brown shading at tibial-tarsal joint; first tarsal segment white shading to brown at joint with second segment; remaining tarsi brown, white-ringed at joints. *Wings:* male (FWL 10-11 mm). DFW: ground color creamy-white over basal half with pale brown patchy maculation, brown on remainder of wing with scattered paler areas producing a mottled aspect; prominent white skewed, trapezoidal preapical patch on costa; orbicular spot virtually obsolete, defined only by a few dark scales; reniform spot circular with iridescent blue scales filling distal half, below which a second reniform-like patch with brown and blue scales; a brown bar along inner margin below reniform spot; terminal line a series of dark dashes; fringe brown basally, white at tips, with brown patch below apex. DHW: luminous white, nearly hyaline with pale brown marginal band; fringe white. **Female** (FWL 10-12 mm) – similar to male, but DFW basal area buff; DHW pale tan, shading to pale brown on marginal band. **Male genitalia**

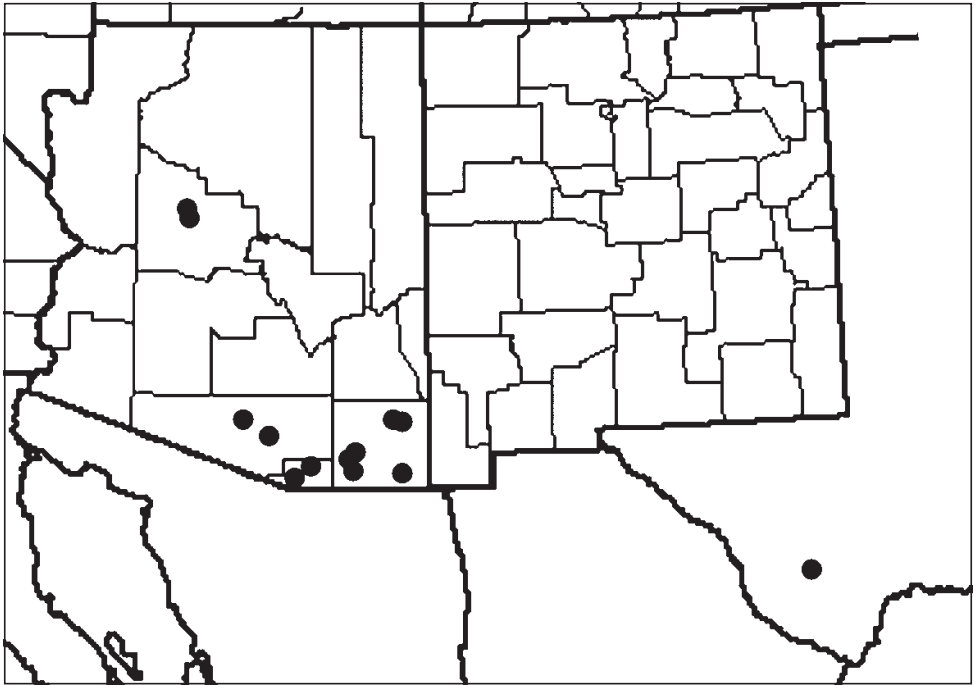


Figure 32. *Acontia geminocula* distribution map.

(Fig. 20) – *uncus*: decurved, long, narrow, tapering to pointed tip. *Valve*: asymmetrical; right valve broad mesially, tapered toward apex, weakly pointed apically; corona present but weak; right valve with clasper on ventral margin; clasper only slightly tapered until 1/5 from apex, then abruptly tapered to finger-like process with rounded apex that bends dorsally toward middle of cucullus; saccular extension elongate, apical 2/3 densely spiny, like a mace; left valve similar to right valve, but sacculus and valve narrower and clasper more evenly tapered to apex; apex sharply pointed. *Aedeagus*: very similar to that of *A. toddi* except two rasp-like spine patches in everted vesica with more evenly sized sclerites and subbasal diverticulum without cornutus near base. **Female genitalia** (Fig. 26) – most similar to those of *A. toddi*, but ostium bursae much wider and spine-filled pouch at end of corpus bursae to right of ductus bursae in *A. geminocula*.

Biology. Unknown. Adults July–September in riparian canyons from 4100–7400' (1250–2250 m).

***Acontia albifusa* Ferris & Lafontaine, sp. n.**

urn:lsid:zoobank.org:act:0454EE2E-1B4D-4C51-9A87-CD5CE24B84CA

Figs. 1, 14-15, 21, 27, 30

Type material. **Holotype** ♂: Arizona. Pima Co., Mt Lemmon Hwy., mi 2.2, 3500', saguaro forest habitat, 13 Aug. 2004, J. B. Walsh. [CNC, Ottawa, Canada]. **Paratypes**

8 ♂, 1 ♀ (6 dissections): **Arizona:** Pima Co., Mt Lemmon Hwy., mi 5.7, 4400', oak riparian habitat, 18 June & 14 Sept. 2004, J. B. Walsh (2 ♂); Pima Co., Baboquivari Mts., 15-30 Aug., 1924, O. C. Poling (1 ♂); Pima Co., Baboquivari Mts., Brown Canyon, 3880' (1183 m), 19 Aug., 2006, C. D. Ferris (1 ♂); "Arizona" (2 ♂); Santa Cruz Co., Santa Rita Mts., Madera Canyon, 4800', 30 June & 2 July 1959, 1 July 1960, J. G. Franclemont (2 ♂, 1 ♀). Paratypes deposited in CNC, CUIC, USNM, and the personal collections of C. D. Ferris and J. B. Walsh.

Distribution (Fig. 30).

Note. Material of this species was distributed by E. L. Todd under the unpublished manuscript name "*Acontia agricola*."

Etymology. The name of this species refers to the pale basal coloring that diffuses into the dark outer shading.

Diagnosis. DFW basal area creamy yellow in both sexes; brown area mottled, not uniformly dark; prominent dark patch distal to reniform spot.

Description. Adult male: Head – dark brown with circular pale patch on frons; antenna filiform; palpi porrect slightly longer than eye width, white basally, shading to brown distally head dark brown. **Thorax** – prothoracic collar and thorax white. **Foreleg:** coxa white with middle brown spot; femur, tibia and tarsus brown with white-ring in middle of tibia and at joints. **Middle leg:** femur and tibia white with brown rings at femoral-tibia joint and near apex of tibia; tarsus brown, white-ringed at joints. **Hindleg:** femur and tibia white; first tarsal segment white shading to brown at joint with second segment; remaining tarsi brown, white-ringed at joints. **Wings:** male (FWL 9.5-11 mm). DFW: ground color dark creamy-white over basal half of wing with pale brown transverse lines; splotchy brown and pale on remainder of wing producing a very mottled aspect; prominent white preapical patch on costa; orbicular spot virtually obsolete, defined only by a few dark scales; reniform spot circular, outlined in black and filled mainly with iridescent blue scales; a prominent dark bar distal to reniform spot; a second reniform-like spot below and proximal to reniform spot irregularly outlined in black and with some blue scales in middle; a brown bar below this spot on inner margin; terminal line an irregular series of dark dashes; fringe a mixture of white, gray, and pale brown scales with pale-colored scales concentrated to form a patch near middle of wing and a smaller patch distal to reniform spot. DHW: luminous white, nearly hyaline, with pale brown marginal band; fringe white. **Female** (FWL 10.5 mm, 1 specimen) – similar to male. **Male genitalia** (Fig. 21) – *uncus*: decurved, long, narrow, tapering to pointed tip. *Valve*: asymmetrical; right valve roughly rectangular, pointed at apex of dorsal margin; corona well-developed; clasper on ventral margin of right valve, narrower near base than at ventral apex of cucullus where clasper abruptly tapers into a long, curved spine follows outer margin of cucullus almost to apex; dorsal margin of clasper with elongated, triangular process on dorsal margin near base; saccular process smooth, broad, somewhat spatulate apically, lying along dorsal margin of clasper; left valve similar to right valve but saccular extension absent and apical part of clasper with spine-like apical part reduced to short inward hook at ventral apex of valve. *Aedeagus*: very similar to that of *A. toddi* except cornutus at base of subbasal diverticulum larger

than in *A. toddi*. **Female genitalia** (Fig. 27) – ostium bursae funnel-like, tapering only slightly to junction with ductus bursae; lower portion of tubular ductus bursae moderately sclerotized, in length about $0.45 \times$ length of ovoid corpus bursae; spinose pouch of corpus bursae to left of ductus.

Biology. Unknown. Adults June–September in oak habitat riparian canyons and saguaro cactus forest, 3500-4800' (1065-1465 m).

Acknowledgments

We thank Michael Pogue (Systematic Entomology Laboratory, National Museum of Natural History, Washington, DC), Martin Honey (Natural History Museum, London, UK), Bruce Walsh (Tucson, Arizona), Richard Hoebeke and James Liebherr (Cornell University, Ithaca, New York), and Eric Metzler (Alamogordo, New Mexico) for the loan of specimens. We thank John Rawlins (Carnegie Museum of Natural History, Pittsburgh, Pennsylvania) for providing us with a photograph of a type specimen of *Acontia areli*, James Boone (FMNH, Chicago) for provided us with information on the three syntypes in The Field Museum, and Gracen M. Brilmyer, Division of Insects at The Field Museum, for photographing the three syntypes and their labels. We also thank Jocelyn Gill (CNC, Ottawa, Canada) for assistance with the preparation of the genitalia and photographs. Larry Prevett, Bisbee, Arizona, kindly provided the blank map images in digital format. Christian Schmidt (CNC, Ottawa) and Eric Metzler reviewed the manuscript and provided us with many helpful suggestions.

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The Lepidoptera of White Sands National Monument, Otero County, New Mexico, USA 1. Two new species of Noctuidae (Lepidoptera, Noctuinae, Agrotini)

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[§] [urn:lsid:zoobank.org:author:BA8A85BE-5E04-4649-8DC4-107A40CCA5A5](https://doi.org/urn:lsid:zoobank.org:author:BA8A85BE-5E04-4649-8DC4-107A40CCA5A5)

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Abstract

The white gypsum dune ecosystem in the Tularosa Basin in south central New Mexico is the largest gypsum dune field on earth, covering 712.25 km². White Sands National Monument in Otero County, New Mexico, protects approximately 40 %, 297.85 km², of this dune field. In 2006 the US National Park Service initiated a long term study of the Lepidoptera at White Sands National Monument, resulting in the discovery of two new species, *Euxoa lafontainei* Metzler & Forbes, **sp. n.** and *Protogygia whitesandsensis* Metzler & Forbes, **sp. n.** described herein. Adult moths and male and female genitalia are illustrated for *Euxoa lafontainei*, and adults and male genitalia are illustrated for *Protogygia whitesandsensis* and its relatives.

Keywords

Lepidoptera, Noctuidae, White Sands National Monument, Tularosa Basin, New Mexico, biological diversity, white gypsum dunes, National Park, Otero County

Introduction

The North American species of the genus *Euxoa* Hübner, [1821] were revised by Lafontaine (1987), and the North American genus *Protophygia* McDunnough, [1929] was revised by Lafontaine and Fauske (2004). In 2007 and 2008 adults of *E. lafontainei* Metzler & G.S. Forbes, sp. n., and in 2007, 2008, and 2009, adults of *P. whitesandsensis* Metzler & G.S. Forbes, sp. n., were collected in the dune field at White Sands National Monument, Otero County, New Mexico. No specimens of either of these two species were known prior to the beginning of this study of insects at the Monument. The dearth of specimens of these two species, prior to this study, can probably be attributed to their occurrence in the gypsum dune ecosystem, which is under the jurisdiction of the US Department of Defense and the National Park Service.

Methods and materials

One hundred eighty two samples of moths and other night flying insects were collected in USDA-type black light traps and at black light and sheet (Covell 1984). All specimens of moths from the black light traps were retained. All non-lepidopterous insects from traps were placed in ethyl alcohol and deposited in New Mexico State University Arthropod Collection, Las Cruces, New Mexico (NMSU). Selected specimens of Lepidoptera and other insects, collected at black light and sheet, were pinned, spread, labeled, and identified, or frozen and retained for deposition in NMSU.

Genitalia were examined following procedures outlined in Clarke (1941), Hardwick (1950), and Lafontaine (2004). Abdomens were removed from the moths, wetted in 95 % ethyl alcohol, and soaked in 10 % KOH. Genitalia were dissected in 5 % ethyl alcohol, stained with Safranin O and Chlorazol Black in water, dehydrated in 100 % ethyl alcohol, cleared in oil of cloves, rinsed in xylene, and slide mounted in Canada balsam.

Terminology for wing pattern elements, morphology, and genital structures follows Forbes (1954) and Lafontaine (1987, 2004). Forewing lengths were measured to the nearest mm, using a stereo-microscope. Forewing measurements were from the base to the apex excluding fringe.

All specimens were collected as part of a long term study of Lepidoptera at White Sands National Monument. Specimens are deposited in the following collections: New Mexico State University Arthropod Collection, Las Cruces, New Mexico (NMSU); the Museum of Southwestern Biology, University of New Mexico, Albuquerque, New Mexico (MSWB); Albert J. Cook Arthropod Research Collection, Department of Entomology, Michigan State University, East Lansing, Michigan (MSU); Eric H. Metzler, Alamogordo, New Mexico, for subsequent transfer to MSU (EHM); Canadian National Collection, Ottawa, Ontario, Canada (CNC); McGuire Center for Lepidoptera and Biodiversity, University of Florida, Gainesville, Florida (UFL); Natural History

Museum, London, UK (BMNH); White Sands National Monument, New Mexico (WHSN); and specimens are provisionally deposited in National Museum of Natural History (Smithsonian Institution), Washington, DC (USNM) pending mutual resolution and agreement with the National Park Service regarding specimen deposition.

Plant names follow Martin and Hutchins (1981) and Sivinski (1994).

Results

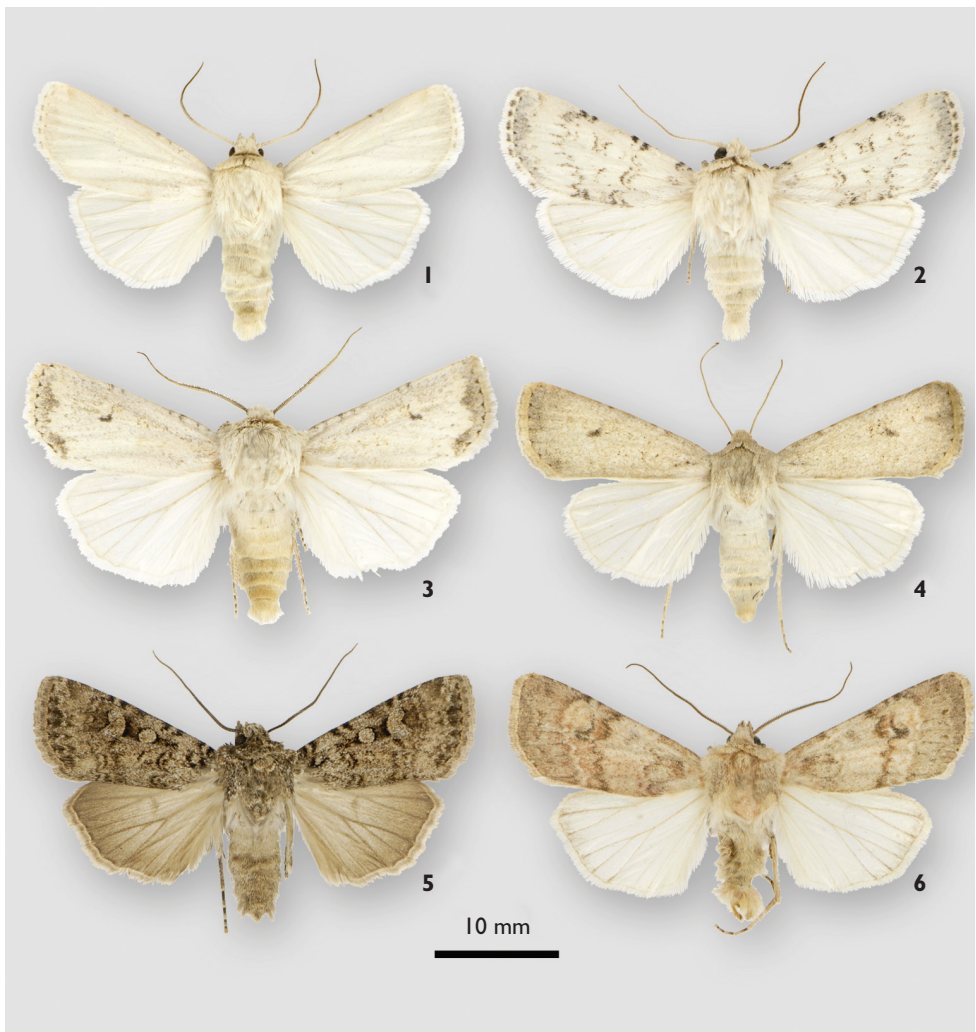
Euxoa lafontainei Metzler & Forbes, sp. n.

urn:lsid:zoobank.org:act:75E35369-23BC-4F23-AA1D-F44278BA8E4A

Figs. 1, 2, 7, 10, 19, 20

Type Material. Holotype: Male: USA: NM: Otero Co. White Sands Nat[ional] Mon[ument] interdunal/edge of dunes veg[etation] 106°11.32' W 32°45.72' N 4,000' 3 Jun 2008. WSNM9 Eric H. Metzler uv tr[a]p Accession #: WHSA – 00131. (USNM) **Paratypes:** 128 males and 46 females: USA, New Mexico: Otero County, White Sands National Monument (hereafter WSNM), 4004', 32°45'36.47" N 106°11'28.22" W, 11 Jun 2008, G. Forbes, interdune area with cottonwoods 2.3 mi SW Admin. Bldg., 15 w blacklight, Accession # WHSA – 00131. WSNM, Admin. Bldg., 4 Jun 2008, G. Forbes, Accession # WHSA – 00131. WSNM, 4006', storage area W of Big Pedestal Rd., 32°46'43.12" N 106°10'48.88" W, 26 Jun 2008, G. Forbes, 15w blacklight interdune area, Accession # WHSA – 00131. WSNM, 4006', storage area W of Big Pedestal Rd., 32°46'43.12" N 106°10'48.88" W, 30 May 2008, G. Forbes, 15w blacklight interdune area, Accession # WHSA – 00131. WSNM, 4002', ca 100 yards NE of end of Big Pedestal Rd., 32°45'43.62" N 106°11'18.73" W, 30 May 2008, G. Forbes, Baccharis grassland W side of rd., Accession # WHSA – 00131. WSNM, 3999', 32°46' 46.60" N 106°10' 26.70" W, 11 Jun 2007, G. Forbes, UV/MV lights Admin Bldg gypsum soil *Atriplex* scrub. Accession # WHSA – 00131. NM: Otero Co. WSNM 3999' 32 deg 46' 46.60" N. 106 deg 10' 26.70" W 18 May 2007 G.S. Forbes. admin. bldg. gypsum soil *Atriplex* scrub. Accession # WHSA 00131. WSNM, 4000' 32°45' 44.33" N 106°11' 19.51" W 22 Jun 2007 G. Forbes. Gypsum grassland at end Big Pedestal Road. Accession # WHSA 00131. NM: Otero Co. WSNM interdunal vegetation 106°11.49' W 32°45.60' N 4,000' 3 Jun 2008. WSNM8 Eric H. Metzler uv trp Accession # WHSA 00131. NM: Otero Co. WSNM edge of dunes/basin 106°11.24' W 32°45.70' N 4,001' 11 Jun 2007 WSNM3 Eric H. Metzler Accession # WHSA 00131. USA: NM: Otero Co. WSNM interdunal vegetation 32°45.57' N 4,006' 106°11.59' W 11 Jun 2007 WHSA2 Eric H. Metzler Accession # WHSA 00131. USA: NM: Otero Co. WSNM Edge of dunes veg. 106°11.32' W 32°45.72' N 4,000' 3 Jun 2008 WSNM9 Eric H. Metzler uv trp Accession # WHSA 00131. NM: Otero Co. WSNM dunes no vegetation 32°45.78' N 4,014' 106°11.49' W gypsum 13 May 2007 Eric H. Metzler WSNM1 Accession # WHSA 00131. NM: Otero Co. WSNM edge of dunes veg 106°11.32' W 32°45.72'

N 4,000' 3 Jun 2008 WSNM8 Eric H. Metzler uv trp Accession # WHSA 00131. NM: Otero Co. WSNM edge of dunes veg 106°11.32' W 32°45.72' N 4,000' 22 Jul 2008 WSNM8 Eric H. Metzler uv trp Accession # WHSA 00131. USA: NM: Otero Co. WSNM interdunal vegetation 32°45.57' N 4,006' 106°11.59' W 13 May 2007 WHSA2 Eric H. Metzler Accession # WHSA 00131. USA: NM: Otero Co. WSNM interdunal vegetation 106°11.49' W 32°45.60' N 4,000' 3 Jun 2008 WSNMB Eric H. Metzler uv trp Accession # WHSA 00131. USA: NM: Otero Co. WSNM dunes crest vegetation 106°11.42' W 32°45.67' N 4,014' 3 Jun 2008 WSNMC Eric H. Metzler uv trp Accession # WHSA 00131. USA: NM: Otero Co. WSNM edge of dunes/basin 32°45.70' N 4,001' 106°11.24' W 13 May 2007 WHSA3 Eric H. Metzler Accession



Figures 1-6. Adults of *Euxoa* species. **1.** *E. lafontainei*, male paratype. **2.** *E. lafontainei*, male paratype. **3.** *E. misturata*, male. **4.** *E. tronellus*, female. **5.** *E. simulata*, male. **6.** *E. medialis*, male.

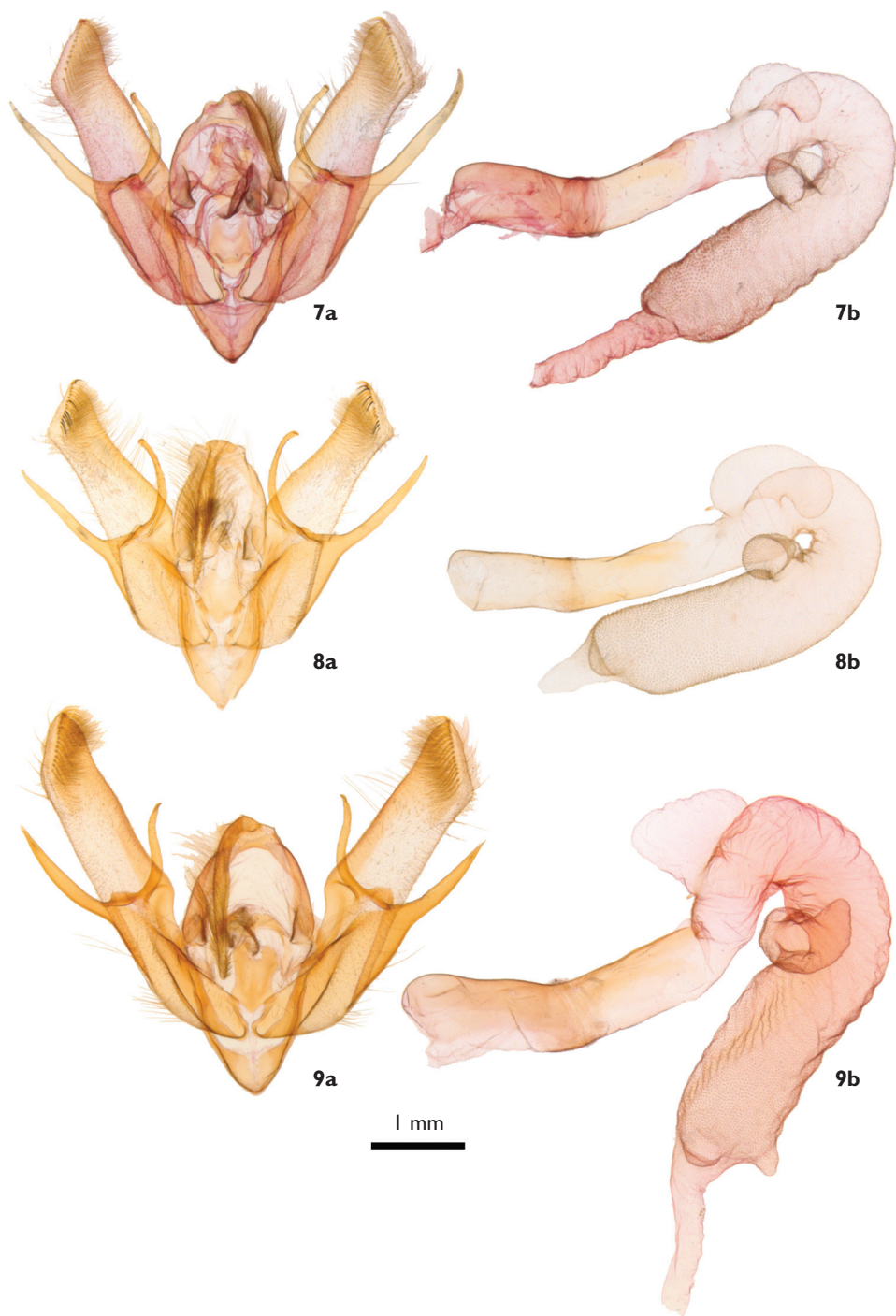
WHSA 00131. USA: NM: Otero Co. WSNM 106°11.39' W 32°45.78' N 4014' 13 May 2007 Eric H. Metzler Accession # WHSA 00131. USA: NM: Otero Co. WSNM 106°11.59' W 32°45.57' N 4006' 11 Jun 2007 Eric H. Metzler Accession # WHSA 00131. Paratypes are deposited with NMSU, MSWB, MSU, EHM, UFL, CNC, BMNH, USNM, and WHSA.

Etymology. The specific epithet of this species, *lafontainei*, recognizes J. Donald Lafontaine's contributions to the study of *Euxoa*. Don Lafontaine and Eric Metzler share a personal friendship going back to the late 1960s. We are pleased to name this species for Don Lafontaine.

Diagnosis. *Euxoa lafontainei* is a silky white moth. Some specimens are pure white whereas others show faint pale-gray traces of normal transverse noctuid markings. A few specimens have pale gray normal markings on a white ground color. A combination of four characteristics quickly distinguish *Euxoa lafontainei* from other species of *Euxoa*: 1) both sexes with reflective white forewings; 30 % of males ($n=104$) and 42 % of females ($n=26$) have traces of faint pale gray normal transverse noctuid markings; 2) pure white hind wings; 3) adults fly in May, June, and July in the gypsum dune field in the Tularosa Basin of south central New Mexico; 4) the characters of the male genitalia place *E. lafontainei* in the subgenus *Euxoa*. Other species of *Euxoa* that fly in the dunes, *E. misturata* (Smith, 1890) and *E. tronellus* (Smith, 1903), are both pale colored moths; *E. misturata* (Fig. 3) has pale gray markings, and *E. tronellus* (Fig. 4) is pale tan. *Euxoa misturata* and *E. tronellus* have more or less obvious reniform spots and dark gray in the subterminal area. Male genitalia are most like those of *E. simulata* McDunnough, 1946 (Figs. 5, 8, 11), and female genitalia are most like *E. medialis* (Smith, [1888]) (Figs. 6, 9, 12). The adults of *E. simulata* and *E. medialis* are dark in color.

In the *Euxoa* species key of Lafontaine (1987), *E. lafontainei* males key out to couplet 31, which gives a choice of right saccular extension $1.25 \times$ longer than left one, versus right saccular extension less than $1.25 \times$ as long as left one. In *E. lafontainei* the right saccular extension is $1.25 \times$ the length of the left one, so both couplets 32 and 34 must be followed. Couplet 32 gives two options, neither of which could apply to the new species, so following couplet 34 is evident. *Euxoa lafontainei* then keys out to the *Euxoa simulata* group in couplet 46 and the group only includes *Euxoa simulata*. *Euxoa lafontainei* differs from *E. simulata* in the color of the adults. Females of *E. lafontainei* key out to the *E. bostoniensis* (Grote, 1874) group and not the *E. simulata* group because of the fine-tipped setae on the anal papillae. Within the *E. bostoniensis* group *E. lafontainei* keys out to *E. medialis*, but differs from *E. medialis* in the color of the adults.

Description. Adult male (Fig. 1, 2): **Head** – frons rough, front closely scaled, white; vertex scales narrow strap-like, white, erect; labial palpus white; basal and medial segments with erect hair-like and strap-like scales, closely scaled laterally and mesally, longer scales form longer ragged fringe ventrally and shorter ragged fringe dorsally; apical segment angled anteriorly, closely scaled; haustellum coiled between labial palpi with more than four complete loops; antenna biserrate, dorsally white, closely scaled,



Figures 7-9. Male genitalia of *Euxoa* species: a-valves, b-aedeagus with vesica everted. **7.** *E. lafontainei* paratype. **8.** *E. simulata*. **9.** *E. medialis*.

ventrally naked, brown. **Thorax** – dorsum white, scales long white (rarely tipped with gray) hair-like or deeply forked apically, underside white, scales erect long white hair-like. Legs: coxa and femur white, closely scaled with long hair-like scales on ventral surface forming a shaggy fringe; fore tibia white, closely scaled, with stout setae on lateral margins; mid – and hind tibia white, closely scaled, shaggy long hair-like scales basally, tibial spurs white; tarsomeres dirty white. Fore wing: length 13-15 mm, mean 14 mm, $n = 8$. ground color white, reflective, normal noctuid transverse lines and spots usually absent; some specimens with scattered gray scales (Fig. 2), rarely the gray scaling complete enough to form normal noctuid transverse lines, spots, and fringe; subterminal and terminal areas dirty white; fringe shining white, occasionally with gray and dirty white scales; underside white with dirty white costa; fringe shining white. Hind wing: white, reflective, terminal area dirty white, veins lined with dirty white scales; fringe white; underside white, terminal area dirty white, veins lined with dirty white scales; fringe white. **Abdomen** – dorsum closely scaled, white, overlaid with long shaggy hair-like scales, white to dirty white; underside closely scaled, white. **Genitalia** (Fig. 7)



Figures 10-12. Female genitalia of *Euxoa* species. **10.** *E. lafontainei* paratype. **11.** *E. simulata*. **12.** *E. medialis*.

– tegumen not expanded laterally, lateral lobes at junctures with valvae, narrowed at dorsum; uncus cylindrical, narrowed at base, slightly wider from 1/5 length to 3/4 length, setae on dorsum at widest part, long and dense; preapical setae on ventral surface short, stout, cylindrical; saccus V shaped, slightly longer than wide; juxta oval, narrowly cleft from posterior margin; valve strap-like, costal margin slightly longer than ventral margin; saccular extension on right side $1.25 \times$ length of saccular extension on left side; saccular extensions directed down and away from cucullus; clasper (harpe) slightly flattened distally, lightly setose, C shaped; corona well differentiated, 16-19 stout setae in a single row, directed basad. Aedeagus slightly bent at mid-point, $4-5 \times$ as long as wide; vesica lightly sclerotized, at 1/3 length from aedeagus curved right 90° , subbasal and medial diverticula present.

Adult female – similar to male; fore wing: length 13-17 mm, mean 15 mm, $n = 24$. Antenna filiform. **Genitalia** (Fig. 10) – papilla analis sclerotized, cylindrical, conical, setae on distal 1/3 progressively shorter apically, apex bluntly rounded, not fused; posterior apophysis extending anteriorly to anterior margin of 8th abdominal segment; anterior apophysis shorter, extending to anterior margin of 8th abdominal segment, slightly bent, apically flattened; ostium bursae lightly sclerotized; plates in dorsal and ventral walls of ductus bursa sclerotized, extending from ostium bursae anteriorly to 2/3 length, straight; bursa copulatrix bisaccate, membranous; corpus bursa extended to right, $2 \times$ as long as maximum width, signa absent; appendix bursae extended ventro-laterally to left, size and shape similar to corpus bursa; ductus seminalis attached near ventral posterior end.

Remarks. This new species is placed in the genus *Euxoa* based on the structure of the male and female genitalia. The characters of the male genitalia place *E. lafontainei* in the subgenus *Euxoa* and in the *E. simulata* species-group.

Distribution and Biology. *Euxoa lafontainei* occurs in White Sands National Monument, Otero County, New Mexico (Figs. 19, 20). Adults were collected in black light traps and at a sheet with a black light and/or mercury vapor light placed in the white gypsum dunes, interdunal areas, and at the Administration Building. The immature stages are unknown.

***Protygia whitesandsensis* Metzler & Forbes, sp. n.**

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Figs. 13, 17, 19, 20

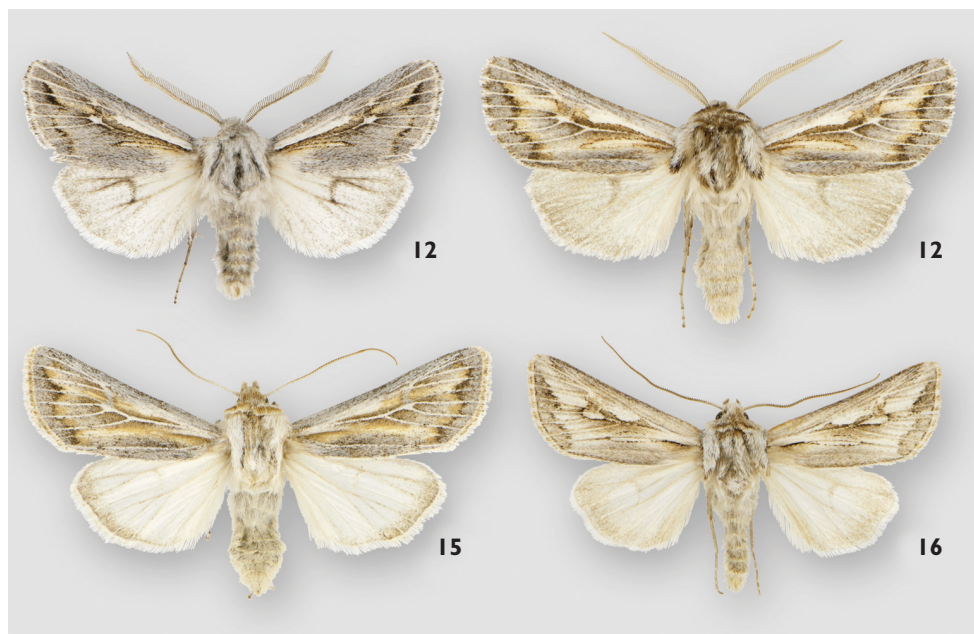
Type material. Holotype: Male: USA: NM: Otero Co. White Sands Nat[ional] Mon[ument] interdunal vegetation $32^\circ 46.62' N$ $106^\circ 10.82' W$ 4,008' 26 February 2009 Eric H. Metzler WHSAD uv tr[a]p Accession #: WHSA – 00131. (USNM).

Paratypes: 18 males as follows: USA, NM: Otero County, White Sands National Monument (hereafter WSNM), interdunal vegetation $106^\circ 11.49' W$ 4,000' $32^\circ 45.60' N$ 15 Mar 2008 WSNMB Eric H. Metzler uv trp Accession # WHSA 00131. WSNM, interdunal vegetation, $32^\circ 45.57' N$ 4,000' $106^\circ 11.59' W$ gypsum 12 Mar 2007

WHS2 Eric H. Metzler Accession # WHSA 00131. WSNM, interdunal vegetation 32°46.62' N 106°10.82' W 4,008' 26 Feb 2009 Eric H. Metzler WHSAD uv trp Accession #: WHSA – 00131. WSNM, interdunal vegetation 106°11.59' W 32°45.57' N 4006' 15 Mar 2008 uv trp WSNM2 Eric H. Metzler Accession # WHSA – 00131. WSNM, interdunal vegetation 106°11.33' W 32°45.5' N 4004' uv trp 6 Apr 2008 Eric H. Metzler WSNMA Accession # WHSA – 00131. WSNM, edge of dunes vegetation 32°45.72' N 106°11.32' W 4,000' WSNM9 26 Feb 2009 uv trp Eric H. Metzler Accession # WHSA – 00131. WSNM, interdunal vegetation 32°45.60' N 106°11.49' W 4,000' 26 Feb 2009 Eric H. Metzler uv trp WSNMB Accession # WHSA – 00131. WSNM, 106°11.59' W 32°45.57' N 4006' 12 Mar 2008 WSNM2 Eric H. Metzler Accession # WHSA – 00131. Paratypes are deposited in NMSU, MSWB, MSU, EHM, CNC, USNM, and WHSA.

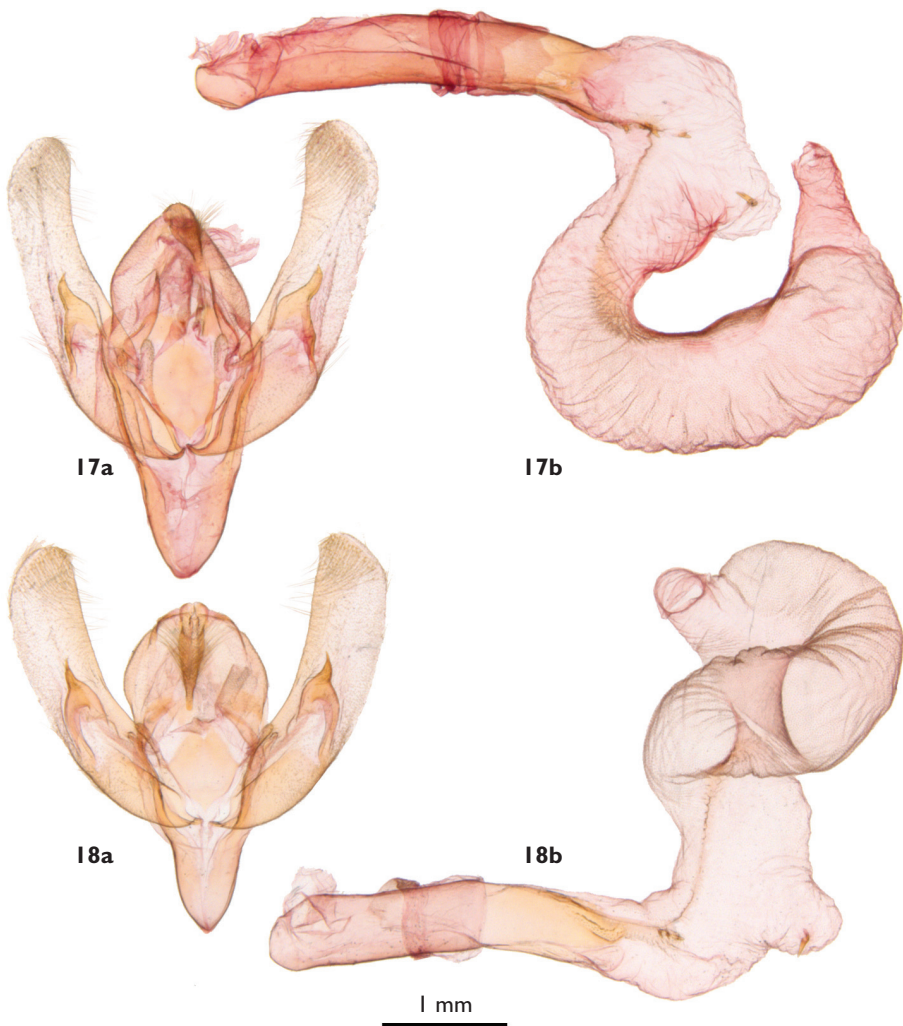
Etymology. The specific epithet of this species, *whitesandsensis* (-ensis is a Latin suffix denoting “place, locality”) identifies the white gypsum dunes at White Sands National Monument as the type locality. The name recognizes the importance of White Sands National Monument for its unique ecosystem and accompanying biota.

Diagnosis. *Protogygia whitesandsensis* is a pale silvery-gray moth without most normal transverse noctuid markings and spots. A combination of 6 characteristics distinguish *Protogygia whitesandsensis* from other species of *Protogygia*: 1) pectinations of male antenna are $9.6 \times$ width of antenna whereas pectinations of male antenna of *P. pectinata* Lafontaine, 2004 (Fig. 14) are $7 \times$ width of antenna; those of *P. biclavis*



Figures 13-16. Adults of *Protogygia* species. **13.** *P. whitesandsensis* male paratype. **14.** *P. pectinata*, male. **15.** *P. comstocki*, female. **16.** *P. biclavis*, male.

(Grote, 1879) (Fig. 16) are $2 \times$ width of antenna; those of *P. comstocki* McDunnough, 1934 (Fig. 15) are $1.5 \times$ width of antenna; 2) fore wing color pale silvery gray; 3) fore wing with dark and white streaks from the base to the medial area, postmedial area, and outer margin; basal dashes of *P. pectinata*, *P. comstocki* and *P. biclavus* extend to antemedial area; 4) forewing with a prominent white shade in the cell between the base and the reniform spot; 5) adults fly in February and March in the gypsum dunes in the Tularosa Basin of south central New Mexico; 6) adults most closely resemble *P. pectinata*. The colors of *P. whitesandsensis* are more gray and muted than *P. pectinata*. The colors of *P. pectinata* are more brown and contrasting than *P. whitesandsensis*.



Figures 17-18. Male genitalia of *Protogygia* species: a-valves, b-aedeagus with vesica everted. **17.** *P. whitesandsensis*, paratype. **18.** *P. pectinata*.

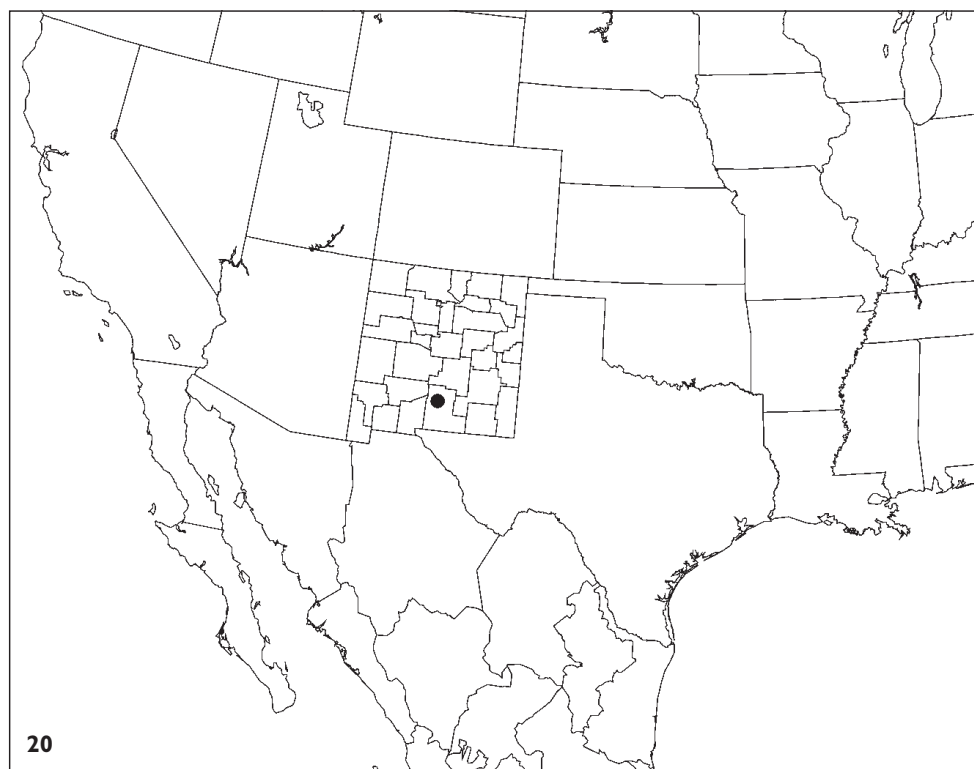
In Lafontaine and Fauske (2004) this species easily keys out to *P. pectinata*, but *P. whitesandsensis* has wider antennae, less orange on the forewing, less contrasting veins, and a different distribution.

Description. Adult male (Fig. 13): **Head** – vertex, narrow and narrow hair-like scales, white, occasional black scales, erect; front, narrow hair-like scales, white, a narrow band of scales across the front between the eyes, black, hair-like; labial palpus white with black scales, blackened laterally; basal and medial segments erect, hair-like scales, shaggy; apical segment angled anteriorly, closely scaled dorsally and anteriorly, white; haustellum coiled between labial palpi with more than four complete loops; antenna broadly bipectinate, dorsally white, scattered black scales, pectinations and ventral surface naked, dark brown. **Thorax** – color white, scattered black scales; tegula white, scattered black scales, laterally and mesally lined with black; dorsum white, scattered black scales, mid-dorsal black stripe; underside white, mixed with black scales, hair-like, long erect, shaggy appearance. Legs: coxa and femur white mixed with black giving a dirty appearance, closely scaled with long hair-like scales on ventral surface forming a shaggy fringe, fore tibia and mid-tibia black terminus, tarsomeres similarly white with black scales, each tarsomere terminus ringed with black. Fore wing: length 14–17 mm, mean 15.2 mm, $n = 14$. pale silvery gray; basal line, antemedial line, medial shade, postmedial line, claviform spot, and orbicular spot absent; prominent subcostal white shade in cell from base to reniform spot; basal dash, 3 elements, black, prominent, from base to reniform spot, white, not prominent, from base to medial area, black, not prominent, from base to antemedial area; subterminal line black, contrasting, zig zag from costa to inner margin; radial, medial, cubital, and anal veins lined with white; reniform lower and upper lobes lined with white; terminal line vaguely white; fringe, base marked with black scales, otherwise white; underside pale silvery gray, dusky shade in cell, veins variously lined with white, fringe concolorous. Hind wing: pale gray; veins variously lined with white or darker gray scales; discal spot dark gray; fringe, base concolorous, outer half white; underside concolorous; discal spot absent; fringe concolorous. **Abdomen** – dorsum light gray mixed with black scales, closely scaled, overlaid with long hair-like scales; underside of segments 3, 4, and 5 black and white contrasting, gray elsewhere with admixture of black scales. **Genitalia** (Fig. 17) – tegumen widened laterally, narrowed dorsally; uncus widened mesally, abruptly down-turned and pointed apically, long hairs dorsally; vinculum V shaped; valve strap-like slightly wider in saccular area, apex with dense setae, directed basad on mesial surface; clavi length $3 \times$ width; clasper sinuous, tear drop shaped, ending in drawn-out point apically; aedeagus slightly bent at middle; vesica bent to right, base of vesica with 6 or 7 stout setae; subbasal diverticulum short with one stout terminal seta.

Adult female: unknown.

Remarks. This new species is placed in the genus *Protygyia* based on the male genitalia, and the adult male's close resemblance to *P. pectinata*.

Distribution and biology. *Protygyia whitesandsensis* occurs in White Sands National Monument, Otero County, New Mexico (Figs. 19, 20). Adults were collected in black light traps placed within the gypsum dunes. Females and the immature stages are unknown.



Figures 19-20. 19. White dunes habitat of type locality of *Euxoa lafontainei* and *Protophygia whitesandsensis*. 20. Distribution map for *Euxoa lafontainei* and *Protophygia whitesandsensis*.

Discussion

In 2006 the US National Park Service invited Metzler to initiate a long term study of the Lepidoptera at White Sands National Monument, Otero County, New Mexico. A primary purpose of the study was to compile an inventory of moths in habitats within and immediately adjacent to the white gypsum dunes in the Monument. This is the first in a series of papers pertinent to a detailed study of the Lepidoptera at White Sands National Monument.

White Sands National Monument preserves 297.85 km² (275 square miles), or about 40 %, of the world's largest white gypsum dune field. The dune field is located in the northern Chihuahuan Desert in southern New Mexico's Tularosa Basin (Schneider-Hector 1993). The dunes were created from dissolved gypsum crystals originating in large playa lakes at the southwestern boundary of the dune field. As water evaporates from the water surface gypsum crystallizes out of solution and forms on the dry surface of the playa. As the crystals disintegrate sand-sized crystals are formed. Winds, predominately from the southwest, blow the sand-sized crystals from the dry lake bed or lake edge onto the dune field. The dunes can be as high as 10 m. Plants and soils are successively covered and uncovered as the blowing sand moves the ridge crests from the southwest to the northeast as much as 9 m per year (McKee and Moiola 1975).

Plants respond to the harsh conditions of shifting pure gypsum soils in several ways. They add stem length rapidly to accommodate encroaching dunes, they send out rhizomes (lateral roots) so new shoots can sprout up 10 to 20 meters away from the original plant, and they form large gypsum pedestals (two to three meters high) as dunes pass by providing support for the 3 meter high root system that formed as they grew to avoid being taken over by a passing dune. Common examples of plants exhibiting these adaptations at the Monument are *Yucca elata* Engelm. (Agaveaceae), *Rhus trilobata* Nutt. (Anacardiaceae), *Poliomintha incana* (Torr.) Gray (Lamiaceae), and *Populus fremontii* var. *wislizenii* Wats. (Salicaceae).

There are several common gypsophilous plants which are very faithful to gypsum habitats and will always indicate gypseous soils when found in the field. The New Mexico gypsum flora is often dominated by *Tiquilia hispidissima* (Torr. & Gray) A. Richards (Boraginaceae), *Sporobolus nealleyi* Vasey (Poaceae), *Bouteloua breviseta* Vasey (Poaceae), *Nerisyrenia linearifolia* (S. Watson) Greene (Brassicaceae), and *Calylophus hartwegii filifolius* (Eastw.) Towner & Raven (Onagraceae). Other common, but less abundant, species include *Anulocaulis gypsogenus* Waterfall (Nyctaginaceae), *Selinocarpus lanceolatus* Woot. (Nyctaginaceae), *Nama carnosum* (Woot.) C.L. Hitchc. (Hydrophyllaceae), *Dicranocarpus parviflorus* Gray (Asteraceae), and *Centaurium maryannum* B.L. Turner (Gentianaceae) (Sivinski 1994).

At first glance much of the white gypsum dunes may appear bleak and devoid of animal life, but a closer look reveals seven subspecies that are endemic to the white sands. These animals are specifically adapted to life in the white dunes by their permanently white color, or apparent lack of color. These are *Holbrookia maculata ruthveni*

Smith, 1943 (Squamata), *Sceloporus undulatus cowlesi* Lowe & Norris, 1956 (Squamata), *Cnemidophorus inornatus gypsi* Wright & Lowe, 1993 (Squamata), *Perognathus flavescens apache* Merriam, 1889 (Rodentia), *Neotoma micropus leucophaea* Baird, 1855 (Rodentia), *Ammobaenites phrixocnemoides arenicolus* (Strohecker, 1947) (Orthoptera), and *Daihinoides hastiferum larvale* (Strohecker, 1947) (Orthoptera). At least four species are variable in color, but individuals collected on the white substrate at the Monument are pale, when compared to nearby populations that do not live in the dunes. These animals are *Spermophilus spilosoma* Bennett, 1833 (Rodentia), *Cibolecris parviceps arida* (Brunner, 1889) (Orthoptera), *Phrynosoma cornutum* (Harlan, 1825) (Squamata) (Kain 2000) and *Copablepharon serratigrande* Lafontaine, 2004 (Lepidoptera). Animals that are naturally white, or pale in color else where may reside at White Sands to take advantage of the white sands substrate include *Olla v-nigrum* (Mulsand, 1866) (Coleoptera), and animals maintain their pigment but use elements of the environment or secrete a waxy substance to appear white and blend into the substrate such as a lycosid spider (Araneida) (Bugbee 1942).

There is a dearth of research on the invertebrate fauna in the gypsum dune field in the Tularosa Basin of New Mexico. Highlights of past research at White Sands National Monument pertinent to insects are Stroud (1950) who listed 452 species of insects and Strohecker (1947) who described 2 species of colorless camel crickets endemic in the gypsum dunes.

In 1950 Stroud reported 20 species of Lepidoptera from the Monument. In the period 9 February 2007 through 31 December 2008 Metzler and Forbes identified more than 300 species of Lepidoptera (unpublished data) from the Monument. Because of the unusual physical and biological qualities of the New Mexico white gypsum dunes, we were especially aware of the possibility of finding undescribed species of moths. The white color of the two new species described herein is consistent with the color of animals endemic to the study area. The study of Lepidoptera at White Sands National Monument is projected to last approximately ten years.

Acknowledgments

The Western National Parks Association, Tucson, Arizona contributed funding for travel and logistics for this study of Lepidoptera at White Sands National Monument. We are especially grateful for their financial support. J. Donald Lafontaine prepared the genitalic slides. Jocelyn D. Gill photographed and created the color plates. Thanks to both.

In 2005 J. Donald Lafontaine suggested to Metzler the importance of studying the moth faunas associated with dunes. Several persons from the US National Park Service were instrumental in arranging and promoting this study of the moths at White Sands National Monument. National Park Service Chihuahuan Desert Network Inventory and Monitoring Network Coordinator Hildy Reiser supported the idea that Metzler submit a proposal to study moths at the Monument. White Sands National Monu-

ment Resource Program Manager Diane White recommended and Superintendent Cliff Spencer approved the study for 2007. The National Park Service renewed the study for 2008 and 2009. Superintendent Kevin R. Schneider was enthusiastic in continuing the support of the National Park Service. Robert D. Barber and Steven J. Cary offered important comments and contributed data on butterflies they observed at the Monument. Representatives from research collections provided insect pins, alcohol, identification services, research consultation, and storage space for specimens collected. We thank the following persons for offering support from their respective institutions: David B. Richman (NMSU) Kelly B. Miller, Sandra L. Brantley, and David C. Lightfoot (MSWB), Frederick W. Stehr, Anthony I. Cognato, Gary L. Parsons, and Richard W. Merritt (MSU), Charles V. Covell, Jr., Jacqueline Y. Miller, and Thomas C. Emmel (UFL), J. Donald Lafontaine (CNC), Larry Berger Ohio Department of Agriculture, and David G. Furth (USNM). Patricia A. Metzler faithfully accompanied Metzler on his many collecting trips to the Monument, and she accompanied him on several long driving trips to Washington, DC and New York City, New York for the purpose of identifying specimens. She contributed financially to the study. We thank David L. Anderson for comments on botanical aspects of the paper. We thank Steven J. Cary, J. Donald Lafontaine, and B. Christian Schmidt for reviewing the manuscript and offering valuable suggestions.

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Revision of the “*Aemilia*” *ambigua* (Strecker) species-group (Noctuidae, Arctiinae)

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Abstract

The New World taxa related to *Aemilia ambigua* (Strecker) are revised and transferred to the genus *Pseudohemihyalea* Rego-Barros, resulting in the following nomenclatorial changes: *Pseudohemihyalea ambigua* **comb. n.**, *P. fallaciosa* (Toulgoët) **comb. n.**, and *P. syracosia* (Druce) **stat. rev., comb. n.** Two Mexican species are newly described, *P. sonora* **sp. n.**, and *P. potosi* **sp. n.** “*Aemilia*” *carmen* Schaus is also closely related to the *ambigua*-group, and is transferred to *Pseudohemihyalea*, **comb. n.** Like most species of *Pseudohemihyalea*, the *ambigua* species-group is restricted to southwestern North America and Central America. The forewing pattern and habitat association of the *ambigua*-group are likely the result of a novel larval host switch from broadleaf trees to pines (*Pinus* spp., Pinaceae). Adults and genitalia of all species are illustrated, except the female of *P. potosi* which is unknown. A key to the species of the *ambigua*-group is provided.

Keywords

Arctiinae, Phaegopterini, *Aemilia*, *Pseudohemihyalea*, *Hemihyalea*, *Amastus*, Nearctic, Neotropic, taxonomy

Introduction

The genus *Aemilia* Kirby currently includes six neotropical species, with an additional nine species misplaced in the genus (Watson and Goodger 1986; Toulgoët 1997) including the North American taxon *A. ambigua* (Strecker). *Aemilia* (*sensu stricto*) was

associated with the *Euchaetes* Harris generic group by Watson and Goodger (1986) within the phaegopterines (Arctiini: Phaegopterina; family-group names used herein follow the changes proposed by Lafontaine and Fibiger 2006). *Aemilia ambigua* was correctly associated with *Hemihyalea* Hampson by Franclemont (1983), who placed *A. ambigua* prior to *Apocrisias* Franclemont and *Hemihyalea* in the North American checklist. The generic group placement of *Aemilia* within the Phaegopterina remains uncertain; based on the male genitalia of the type species, *Aemilia rubriplaga* (Walker, 1855), *Aemilia* does not appear to belong to the *Euchaetes* group as it lacks the characteristic complex structure of the uncus (Weller et al. 2008), nor does it belong to the *Amastus*-group, here defined as including *Amastus* Walker, *Pseudohemihyalea* Rego-Barros, *Apocrisias* Franclemont, and *Praeamastus* Toulgoët.

As discussed below, the *ambigua*-group species exhibit structural characters unambiguously placing them in *Pseudohemihyalea* Rego-Barros, although the wing pattern of the *ambigua*-group is atypical of *Pseudohemihyalea*. The forewing pattern of longitudinal striae along the wing veins (Figs. 1-5), appears to mimic the dried pine needles common in the habitat of these moths, whereas the typical wing pattern of other *Pseudohemihyalea* consists of a weakly defined transverse pattern (see for example Toulgoët 1994). Although *Pseudohemihyalea* has received more study than most neotropical arctiines, the dissimilarity in wing pattern between the *ambigua*-group and other *Pseudohemihyalea* has likely resulted in the oversight of this group's true generic affinity.

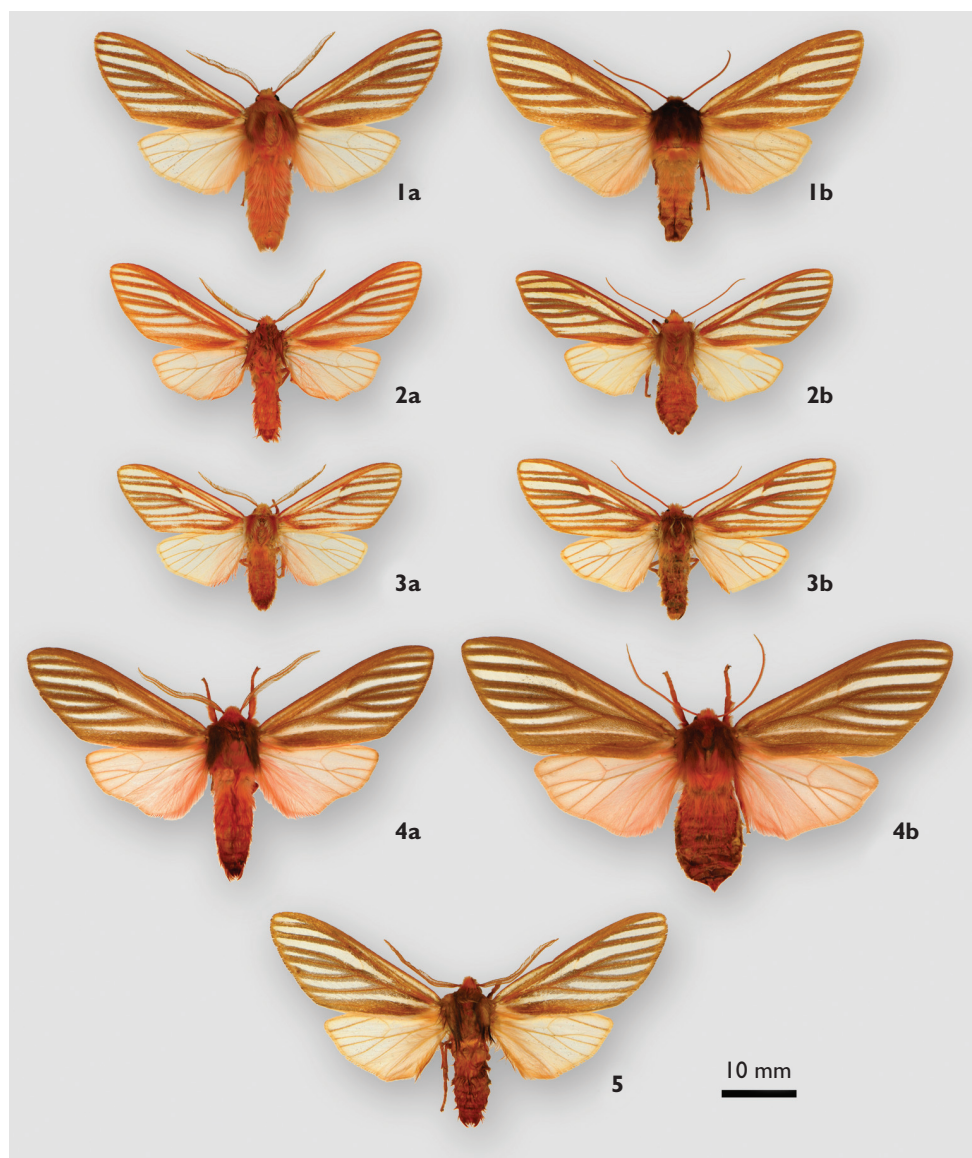
The purpose of this paper is to revise the generic placement and provide a taxonomic review of the "*Aemilia*" *ambigua* species-group and the closely related "*Aemilia*" *carmen* (Schaus). Two new species are described, and one name is raised from synonymy.

Methods and materials

Adult genitalia were prepared following the methods detailed by Lafontaine (2004). Line drawings were prepared from genitalia suspended in 30 % ethanol, using a *camera lucida* mounted to a Leica M-165C dissecting microscope. Approximately 500 specimens were examined from the following collections: CNC, CSU, CMNH, DEB and USNM.

Repository abbreviations

- AMNH** American Museum of Natural History, New York, New York, USA.
- CNC** Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Ontario, Canada.
- CSU** C.P. Gillette Museum of Arthropod Diversity, Colorado State University, Ft. Collins, Colorado, USA.
- CMNH** Carnegie Museum of Natural History, Pittsburgh, Pennsylvania, USA.
- DEB** Personal collection of Don E. Bowman, Pueblo West, Colorado, USA.
- FMNH** Field Museum of Natural History, Chicago, Illinois, USA.
- MNHN** Muséum National d'Histoire Naturelle, Paris, France.



Figures 1-5. **1a.** *P. ambigua* male (Santa Cruz Co., AZ, USA). **1b.** *P. ambigua* female (Cochise Co., AZ, USA). **2a.** *P. syracosia* male (Zacapa Dpto., Guatemala). **2b.** *P. syracosia* female (Chiapas, Mexico). **3a.** *P. fallaciosa* male (Chiapas, Mexico). **3b.** *P. fallaciosa* female (Zacapa Dpto., Guatemala). **4a.** *P. sonora* male paratype (Sonora, Mexico). **4b.** *P. sonora* female paratype (Sonora, Mexico). **5.** *P. potosi* male holotype (Nuevo Leon, Mexico).

BMNH Natural History Museum, London, UK.

USNM National Museum of Natural History (formerly United States National Museum), Washington, DC, USA.

Systematics

Generic placement of the “*Aemilia*” *ambigua*-group

The unnatural placement of *Aemilia ambigua* within *Aemilia* was recognized by Watson and Goodger (1986), who placed this taxon within *Aemilia* “sensu lato.” An additional *Aemilia* species, *A. carmen* Schaus, was inadvertently omitted by these same authors. While investigating the generic placement of *A. ambigua*, it became apparent that the male genitalic structure of *A. ambigua* is virtually identical in gross morphology to that of *A. carmen* (illustrated in Watson 1971), despite marked differences in wing pattern. “*Aemilia*” *carmen* and the *ambigua*-group are very similar structurally to *Pseudohemihyalea daraba* (Druce) and *P. anapheoides* (Rothschild) and to a lesser extent also to *P. testacea* (Rothschild) and *P. ochracea* (Rothschild). Furthermore, the phenotype of *P. anapheoides* shows characters transitional between those of the typical banded *Pseudohemihyalea* pattern and that of the *ambigua*-group in that the forewing banding is highly reduced, the ground colour is whitish yellow, and the veins are outlined in rusty brown. The pink colouration of the dorsal abdomen is shared among *P. ambigua*, *P. schausi*, *P. testacea*, *P. daraba* and *P. anapheoides*. The following structural characters are shared between *A. carmen*, the *ambigua*-group, *P. daraba* and *P. anapheoides*: base of uncus broad and lobe-like (deeply excavated in *P. schausi* and the *P. edwardsii* group), apex of uncus tapering to a point (bifid in *edwardsii* group), process of transtilla relatively small and scobinate (with large cornuti in some *Pseudohemihyalea* species; transtilla elongate, large and finger-like in *Amastus*); valve flattened and lobate overall, divided into two lobes beyond apical third or less (deeply divided and/or with a third, costal process in some *Pseudohemihyalea* and most *Amastus* species). Wing venation, palp structure and structure of the spines on the legs are fairly constant across *Amastus* and *Pseudohemihyalea*, and are consistent with those of the *ambigua*-group and *A. carmen*.

The close relationship between *ambigua* and *carmen* as indicated by male genitalic morphology (female *carmen* were unavailable for study) is also supported by molecular data (mtDNA *cox1* gene), with the two clustering together (4 % divergence) in a neighbour-joining tree containing representatives of most Central and North American arctiine genera (C. Schmidt, M. Laguerre, B. Vincent, unpubl. data). Both *ambigua* and *carmen* group within the current concept of *Pseudohemihyalea*, including the type species, *P. schausi* Rothschild. Based on this morphological and molecular evidence, *Pseudohemihyalea ambigua* **comb. n.** and *P. carmen* **comb. n.** are accordingly transferred to *Pseudohemihyalea*. *Pseudohemihyalea carmen* and *P. daraba* are possibly the sister group to the *ambigua*-group, as suggested by morphology and mtDNA sequence data (*COI* barcode fragment). The striate forewing pattern of the *ambigua*-group appears to be a derived trait, likely linked with a larval host shift to conifers from the broad-leaved trees utilized by other *Pseudohemihyalea* species (e.g., *P. edwardsii* on *Quercus* species; McFarland 1975). Larvae of *P. ambigua* feed on Ponderosa pine (*Pinus ponderosa* Dougl. ex Lawson) (R. Nagle, pers. comm.), and it is probable

that other species of the *ambigua*-group also feed on pines. The striate white-and-tan wing pattern (mimicking dead pine needles) is an interesting example of convergent evolution in cryptic colouration in pine-feeding Lepidoptera, as a similar pattern occurs also in such unrelated groups as the Geometridae, such as the *Caripeta piniata* (Pack.) group and particularly *Sabulodes niveostriata* (Cockerell, 1894), which often occurs in strict sympatry with *P. ambigua*. A parallel (but evolutionarily independent) host switch has occurred (possibly multiple times) in *Lophocampa* Harris, where two lineages (*L. roseata*-group and *L. argentata*-group) feed on conifers, compared to deciduous trees for most congeners.

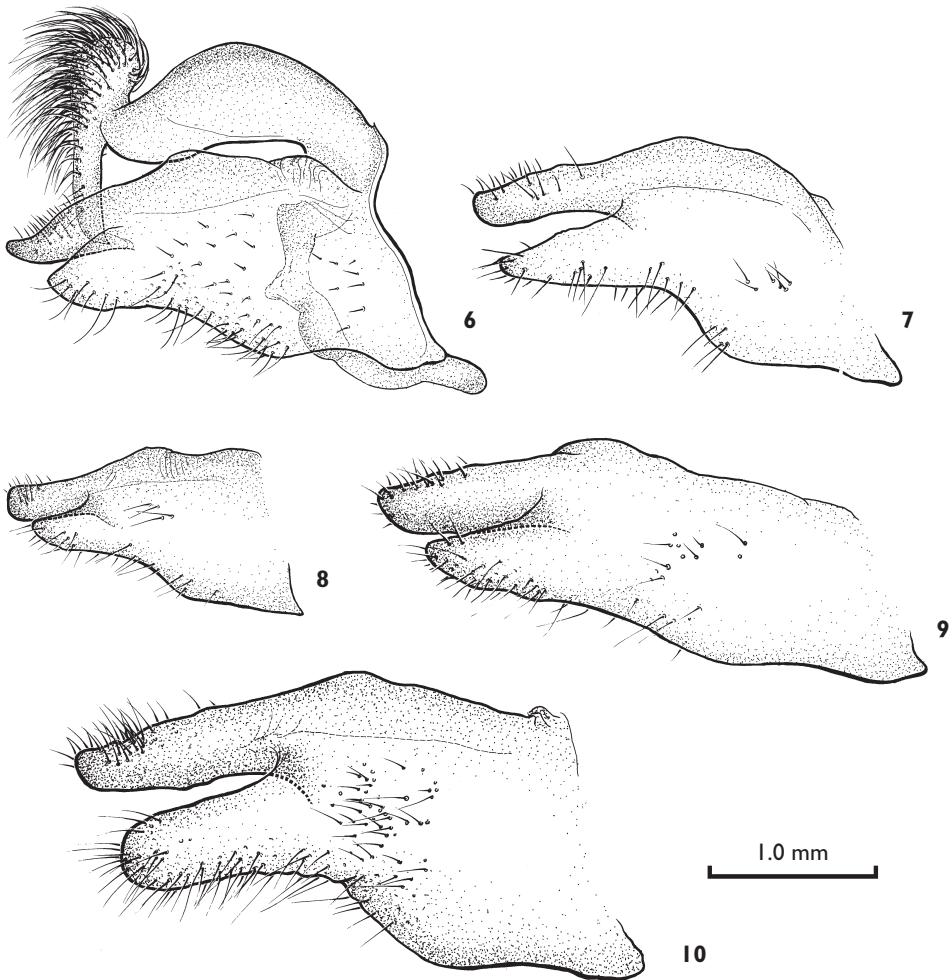
Pseudohemihyalea has a long and confusing taxonomic history, primarily a result of confusion with the genus *Amastus*. In describing *Hemihyalea*, Hampson (1901) distinguished this genus from *Amastus* by differences in the branching of the forewing radial veins. As noted by Dyar (1914), the branching pattern of the radial vein is highly variable in *Hemihyalea* and *Amastus* (as it is in a number of other arctiine genera such as *Grammia*, *Apantesis* and *Phragmatobia*), so this character is not diagnostic. In reviewing *Hemihyalea*, Rego-Barros (1956) recognized two additional genera, *Machadoia* Rego-Barros and *Pseudohemihyalea*, although only six species were examined. *Pseudohemihyalea* was later placed into synonymy under *Hemihyalea* by Watson and Goodger (1986). Toulgoët (1988) considered the type species of *Hemihyalea* (*Phaegoptera cornea* Herrich-Schäffer, 1853) to be congeneric with *Amastus* and accordingly synonymized the two, subsequently raising *Pseudohemihyalea* from synonymy (Toulgoët 1992) and providing a review of the genus (Toulgoët 1994), consisting primarily of those species treated as *Hemihyalea* by Watson and Goodger (1986). To complicate matters further, when describing *Pseudohemihyalea*, Rego-Barros believed the type-species to be *Phaegoptera rhoda* Druce, 1894 but the species he diagnoses and illustrates is *Hemihyalea schausi* Rothschild, 1909 (Toulgoët 1994). Following Toulgoët's (1994) review, several additional taxa were described or revised (see Toulgoët 1996, 2001).

In summary, *Pseudohemihyalea* as currently defined is a relatively small group of about 30 species restricted to Central America and southern North America. Toulgoët (1994) arranged 20 species of *Pseudohemihyalea* into three groups, but provided no diagnostic characters or synapomorphies for the genus or for the three species-groups. Genitalic structure is very diverse in the *mansueta*-group (Toulgoët 1994) which may prove to be a polyphyletic assemblage. In addition, at least one species likely does not belong to *Pseudohemihyalea* (Toulgoët 1994), so much work is still needed to establish relationships among *Pseudohemihyalea* and related genera, and to objectively define the generic limits of the genus.

***Pseudohemihyalea ambigua* species-group**

Diagnosis. Members of the *ambigua* species-group can be immediately recognized by the simple, striate forewing pattern (Figs. 1-5). Internally, the male uncus in dorsal

profile is characteristically shaped like a bicycle saddle (Figs. 11-15), with the apex slightly down-turned, pointed and beak-like (Fig. 6). The posterior portion of the uncus consists of two heavily setose, globose or slightly flattened lobes (Fig. 6). The male valve is relatively simple and bipartite (tripartite in most *Amastus* and a few *Pseudohemihyalea*), with the apical 1/3 to 1/4 divided into costal and saccular processes (figs. 6-10). The transtilla is low, hump-like and finely scobinate (coarsely spinose or scobinate in most other *Pseudohemihyalea*, long, prong-like and variously scobinate in *Amastus*). Female genitalia are relatively simple across the whole *Pseudohemihyalea*-*Amastus* group, and no characters were found that distinguish the *ambigua*-group from



Figures 6-10. 6. *P. ambigua*, right lateral view of male genital capsule, aedeagus removed. 7. *P. syracosia*, lateral view of right valve. 8. *P. fallaciosa*, lateral view of right valve. 9. *P. sonora*, lateral view of right valve. 10. *P. potosi*, lateral view of right valve.

other *Pseudohemihyalea*, although the shape of the lamella antevaginalis may prove useful in a more in-depth review of the group. The pine-feeding habits of the larvae (*P. ambigua*) are unique within the genus.

Key to species of the *Pseudohemihyalea ambigua* species-group

- 1 Forewing posterior cubital vein and anal vein with separate brown striae; forewing with prominent hook-like mark at distal end of discal cell (fig. 3); male forewing length less than 20 mm, female less than 22 mm; uncus of male with basal lobes flattened and raised dorsally, basally with broad, u-shaped cleft (fig. 13) ***P. fallaciosa***
- Forewing posterior cubital vein and anal vein with confluent, broad brown striae; forewing with hook-like mark at distal end of discal cell small or absent (figs. 1,2,4,5); male and female forewing length variable; uncus of male with basal lobes globose (Figs. 11, 12, 14, 15) **2**
- 2 Male forewing length greater than 25 mm, female greater than 28 mm; uncus length more than 1.7 mm (Figs. 14, 15); corpus bursae length more than 3 mm and about 3 x diameter of bulla seminalis (fig. 22)..... **3**
- Male forewing length less than 25 mm, female less than 28 mm; uncus length less than 1.7 mm (Figs. 11, 12); corpus bursae length less than 3 mm and about 1-1.5 x diameter of bulla seminalis (Figs. 21, 23) **4**
- 3 Male valve elongate, approximately 3 x as long as wide (fig. 9); vesica with thin, spine-like cornuti (fig. 20), uncus widest at basal fourth (fig. 15); hindwing with distinct pink flush; northern Sierra Madre Occidental, Mexico
..... ***P. sonora***
- Male valve broad, approximately 2 x as long as wide (fig. 10); vesica with small, stout cornuti (fig. 19), uncus widest at basal third (Fig. 14); hindwing with faint pink flush; Sierra Madre Oriental, Mexico (females unknown)
..... ***P. potosi***
- 4 Male uncus long and narrow in dorsal aspect, averaging 2.4 x longer than wide, with basal cleft narrow (fig. 12); saccular process about as long as wide (fig. 7); lateral margins of female lamella antevaginalis parallel or flaring outward towards caudal margin, with caudal concavity broad, *i.e.* more than 2 x width of ductus bursae; southern Mexico to Honduras
..... ***P. syracosia***
- Male uncus broad in dorsal aspect, averaging 1.8-2.0 x longer than wide, with basal cleft broad and relatively shallow, *i.e.* $\frac{1}{4}$ or less the width of uncus (fig. 11); width of saccular process at base approximately equal to process length (fig. 6); lateral margins of female lamella antevaginalis tapering inwards to caudal margin, with caudal concavity narrower, *i.e.* less than 2 x width of ductus bursae (fig. 21); western USA south through Sierra Madre Occidental, Mexico ***P. ambigua***

***Pseudohemihyalea ambigua* (Strecker), comb. n.**

Figs. 1, 6, 11, 16, 21, 25

Halisidota ambigua Strecker, 1878: 274, pl. 9, fig. 7.*Seirarctia bolteri* H. Edwards, 1885: 121.

Type material. *Halisidota ambigua*: Male holotype [FMNH], not examined. Type locality: "Colorado [USA]." The male holotype is a badly damaged specimen with the abdomen, ventral thorax and head missing, although the wings are mostly intact, with the apex of the right forewing missing (J. Rawlins, pers. comm.).

Seirarctia bolteri: Holotype [unknown], not examined. Type locality: "Las Vegas, N[ew]. Mex[ico]., 7000 feet [USA]." The sex of the holotype is not indicated in the original description; the type is not among the Edwards type material in the AMNH (B. Vincent, pers. comm.). Given the distinctive original description and absence of species similar to *P. ambigua* in the USA, *bolteri* is retained as a junior synonym of *ambigua*.

Diagnosis. *Pseudohemihyalea ambigua* is very similar to *P. syracosia* externally, but the two can usually be separated without dissection by the slightly larger size, broader forewing striae (Figs. 1 and 2) and more northerly distribution (Fig. 25) of *P. ambigua*. Internally, both the saccular process (cf. Figs. 6 and 7) and uncus (cf. Figs. 11 and 12) are shorter and wider compared to *P. syracosia* (mean length to width ratio of uncus 1.9 in *P. ambigua*, 2.4 in *P. syracosia*). The coecum of the aedeagus is longer and more conical in *P. ambigua* (cf. Figs. 16 and 17). In females, the antevaginal plate is less flared laterally with a shallower distal indentation compared to *P. syracosia* (cf. Figs. 21 and 23).

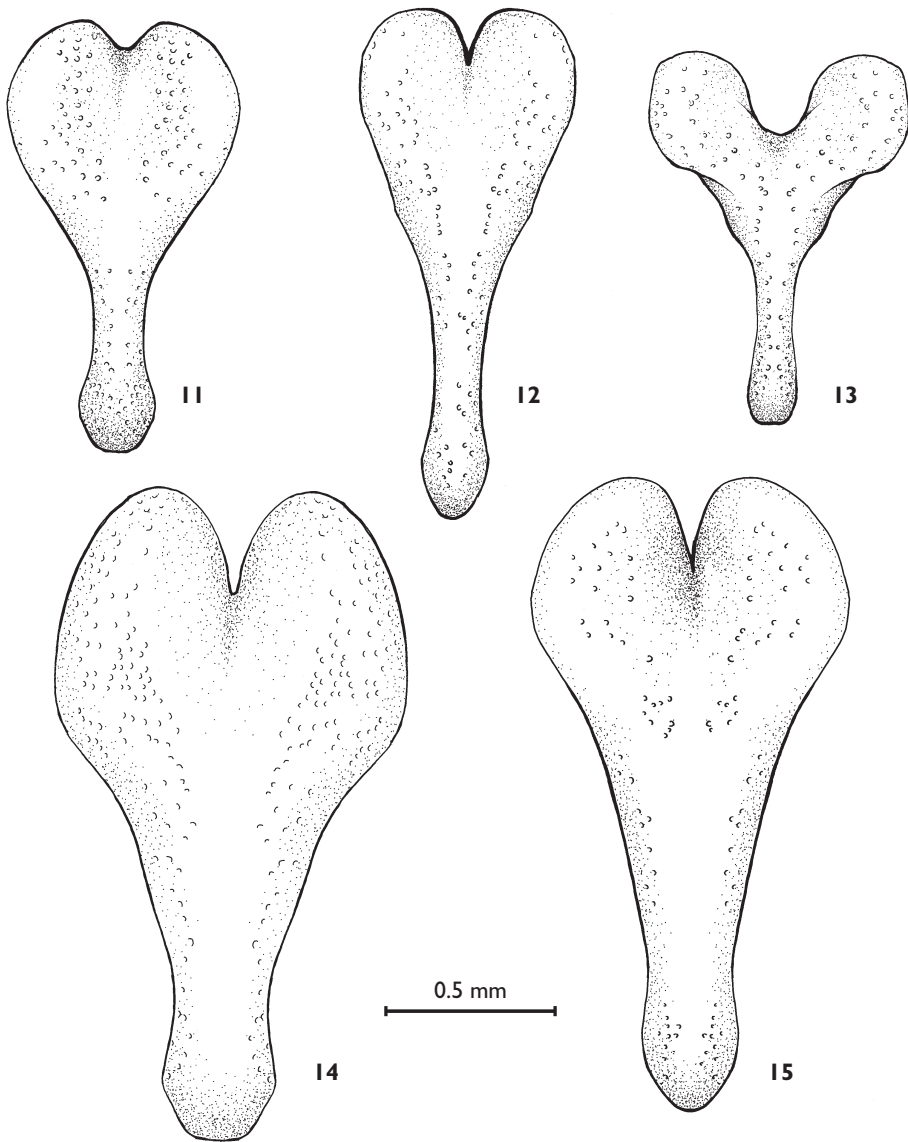
Biology and distribution. Collection dates indicate the peak flight is in July, with extreme dates ranging from mid June to early August, presumably representing a single annual brood. *Pseudohemihyalea ambigua* is the most widespread of the *ambigua*-group, occurring from southern Wyoming (Ferguson et al. 2000) to Durango, Mexico (Fig. 25). Ferguson et al. (2000) show *P. ambigua* as occurring in Tamaulipas, Mexico, but no specimens from Tamaulipas could be located and their record may refer to another species, possibly *P. potosi*.

***Pseudohemihyalea syracosia* (Druce), stat. nov., comb. n.**

Figs. 2, 7, 12, 17, 23, 25

Halisidota syracosia Druce, 1889: 87.*Aemilia ambigua* Toulgoët, 1997 *nec.* Strecker, 1848.

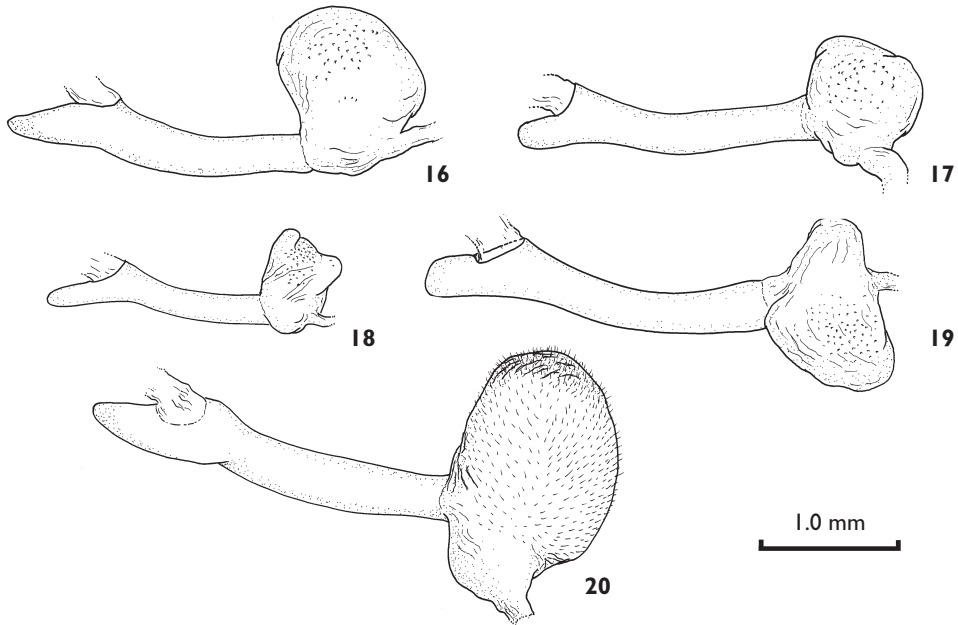
Type material. Female holotype [BMNH], photograph examined. Type locality: "Mexico, Omilteme [Omiltemi], Guerrero, 8000 feet." The right antenna and abdomen of the holotype are missing, but the wings are in excellent condition. The abdomen associated with the holotype (in a separate vial) was determined by A. Watson not



Figures 11-15. Dorsal view of uncus (setae omitted). 11. *P. ambigua*. 12. *P. syracosia*. 13. *P. fallaciosa*. 14. *P. potosi*. 15. *P. sonora*.

to belong to the holotype; the holotype abdomen has apparently been lost, since no matching slide exists either (M. Honey, pers. comm.).

Diagnosis. *Pseudohemihyalea syracosia* is most similar to and was long confused with *P. ambigua*. They can usually be distinguished without dissection, since *P. syracosia* is slightly smaller and less robust with narrower rust-brown forewing striae on average and less rust brown overall. This species also has a more southern distribution than *P. ambigua*. Sexual size dimorphism is less pronounced in *P. syracosia* than in



Figures 16-20. Left lateral view of aedeagus, with fully inflated vesica. **16.** *P. ambigua*. **17.** *P. syracosia*. **18.** *P. fallaciosa*. **19.** *P. potosi*. **20.** *P. sonora*.

P. ambigua, with female *P. syracosia* averaging very nearly the same size as males (mean forewing length 20 mm), whereas *P. ambigua* females average about 24 mm in forewing length compared to 22 mm in males. Genitalic differences are given under *P. ambigua*.

Biology and distribution. The immature stages are unknown. Adults have been collected in pine-oak forest, from 1700 m to 2230 m. Collection dates range from mid-May to early September. *Pseudohemihyalea syracosia* occurs from Michoacan, Mexico to Honduras (Fig. 25), flying in strict sympatry with *P. fallaciosa* at some sites.

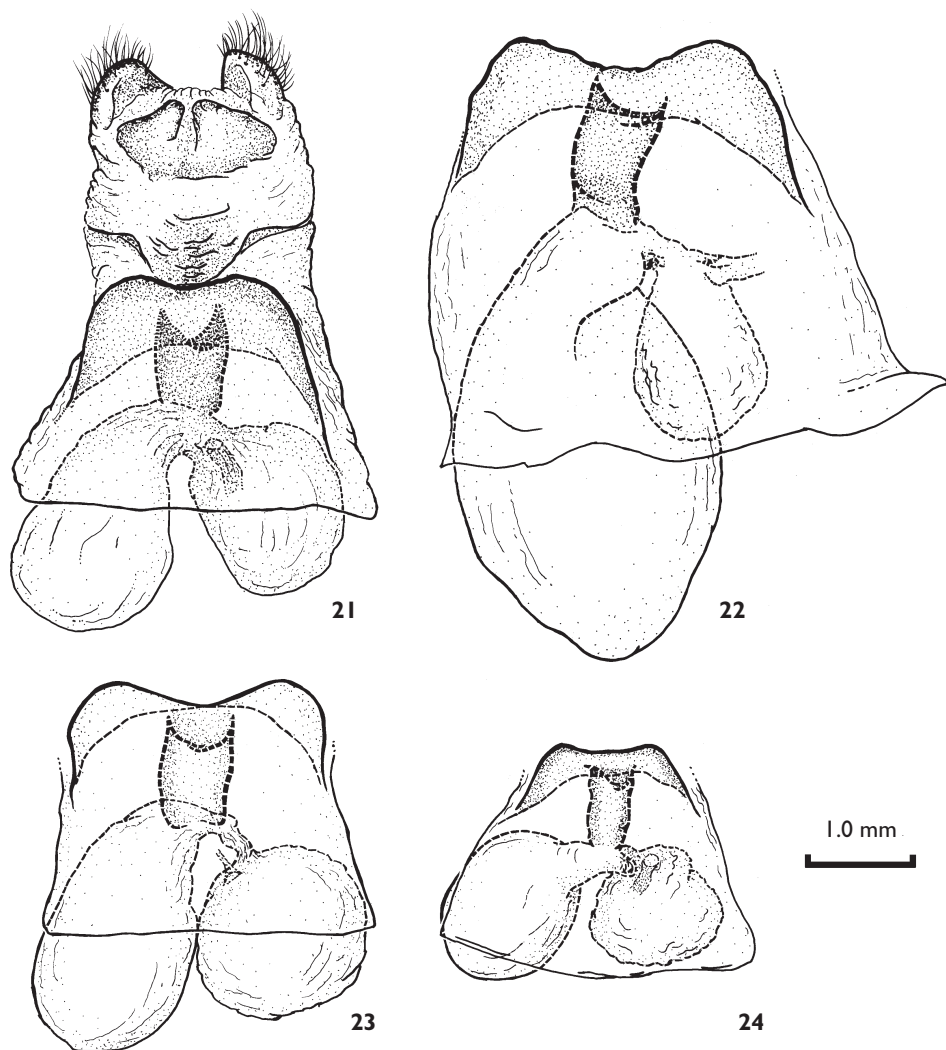
Remarks. *Pseudohemihyalea syracosia* has long been treated as a subjective synonym of *P. ambigua*, but the characters given above in the diagnosis and species key show it is distinct from *P. ambigua*, with a more southerly and apparently allopatric distribution. The diagnosis and illustrations of “*P. ambigua*” given by Toulgoët (1997) apply to *P. syracosia*.

***Pseudohemihyalea fallaciosa* (Toulgoët), comb. n.**

Figs. 3, 8, 13, 18, 24, 25

Aemilia fallaciosa Toulgoët, 1997, 81, figs. 3, 4, 7, 10.

Type material. Male holotype, female allotype [MNHN] and 39 paratypes [MNHN, BMNH]. Type locality: “Honduras, P. Morazan, 24 km N.E. de Tegucicalpa [Tegucigalpa], La Tigra, 1900 m.”



Figures 21-24. Ventral view of female 8th sternite and bursa copulatrix (corpus bursae on left, bulla seminalis on right). **21.** *P. ambigua*. **22.** *P. sonora*. **23.** *P. syracosia*. **24.** *P. fallaciosa*.

Diagnosis. This is the most easily recognized member of the *ambigua*-group. The tooth-like mark at the distal end of the forewing cell and the presence of a lined posterior cubital vein are diagnostic. Other diagnostic characters are the small size (mean male forewing length 18.4 mm), and thin forewing vein lines. Internally, the basal lobes of the uncus are slightly flattened (globose in other species) and divided by a broad, u-shaped cleft, compared to the narrow, v-shaped cleft in other species.

Biology and distribution. Collection dates for *P. fallaciosa* are late May to late July and early September. It has been collected at elevations of 1400 m to 1900 m, from Chiapas, Mexico south to Guatemala and Honduras.

***Pseudohemihyalea sonora* Schmidt, sp. n.**

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Figs. 4, 9, 15, 20, 22, 25

Type material. Holotype – ♂, Mexico, Sonora, Mesa Compañera, 12 mi. w. Yecora, 2600 m, 10-14 Sep 2004, P.A. Opler [CNC]. **Paratypes.** 2 ♀♀, same data as holotype [CSU]; 1♂, 4♀♀, Same locality as holotype, 10 sep 2004, leg. Bowman and Opler [DEB].

Diagnosis. This species is superficially most similar to *P. ambigua* and *P. potosi* **sp. n.**, but *P. sonora* can be separated from both by its significantly larger size, distinct pink hindwing cast, and late flight period (September vs. June-July). Internally, the uncus is 1.4 x longer than that of *P. ambigua*, averaging 1.8 mm compared to 1.3 mm in *P. ambigua*; the uncus has a deeper, narrower basal cleft than *P. ambigua* (cf. Figs. 15 and 11); compared to *P. potosi* **sp. n.**, *P. sonora* has an elongate, not triangular saccular process, and a much longer and narrower valve overall (cf. Figs. 9 and 10). The male vesica is covered in hair-like spines, unlike the small thorn-like cornuti of all other *ambigua*-group species. In females, the corpus bursae is nearly 3 x as large as the bulla seminalis (fig. 22), compared to about 1.5 x in other members of the *ambigua*-group.

Description. Head – male antenna strongly bipectinate, longest rami about 6.0 x longer than segment length; dorsal antennal scales pale rusty brown; vestiture of palps mostly pink with a few rust scales, frons and vertex rust, pinkish red bordering patagia. **Thorax** – vertex of thorax, patagia and tegulae rusty tan, tegulae slightly paler mesially; ventrally, thorax rusty tan tinged with pink; legs rusty tan, pink dorso-medially. **Forewing** – length (♂) 26.1 mm ($n = 2$), (♀) 31.2 mm ($n = 2$); intervenal areas ivory white, sparsely scaled, semi-translucent; veins broadly lined with rusty tan; fringe and costal margin tan-lined, anal margin with narrow white border; pattern similar ventrally but colours appearing washed-out. **Hindwing** – sparsely scaled, semi-translucent, pale pink; anal margin more densely scaled with pink scales. **Abdomen** – pink dorsally, pale tan ventrally; coremata absent. **Male genitalia** – uncus shaped like a bicycle saddle, i.e., with broad, bilobed base and tapering, finger-like apex; basal lobes heavily setose dorsally, apical portion slightly wider than median, with a spade-shaped dorsal profile; apex bluntly pointed, slightly down curved; division between costal and saccular processes extending slightly less than one-third of total valve length; apex of costal process bluntly rounded, tapering more gradually dorsally than ventrally; saccular process rounded-triangular, tapering to rounded apex; vinculum a short, broad scobinate conical projection; juxta urn-shaped in outline, with medial keel along dorso-ventral axis; saccus short, extending slightly cephalad beyond tegumen; aedeagus without spines; vesica simple, globose, lacking spines but with very fine indistinct cornuti. **Female genitalia** – lamella antevaginalis broad, flangelike, caudal margin concave; ductus bursae sclerotized, 2 x longer than wide and strongly flattened dorso-ventrally; corpus bursae simple, globose-ellipsoidal, signa lacking; ductus seminalis arising dorsally from caudal part of bursa near junction with ductus; bulla seminalis globose, approximately 1/3 diameter of corpus bursae when inflated.

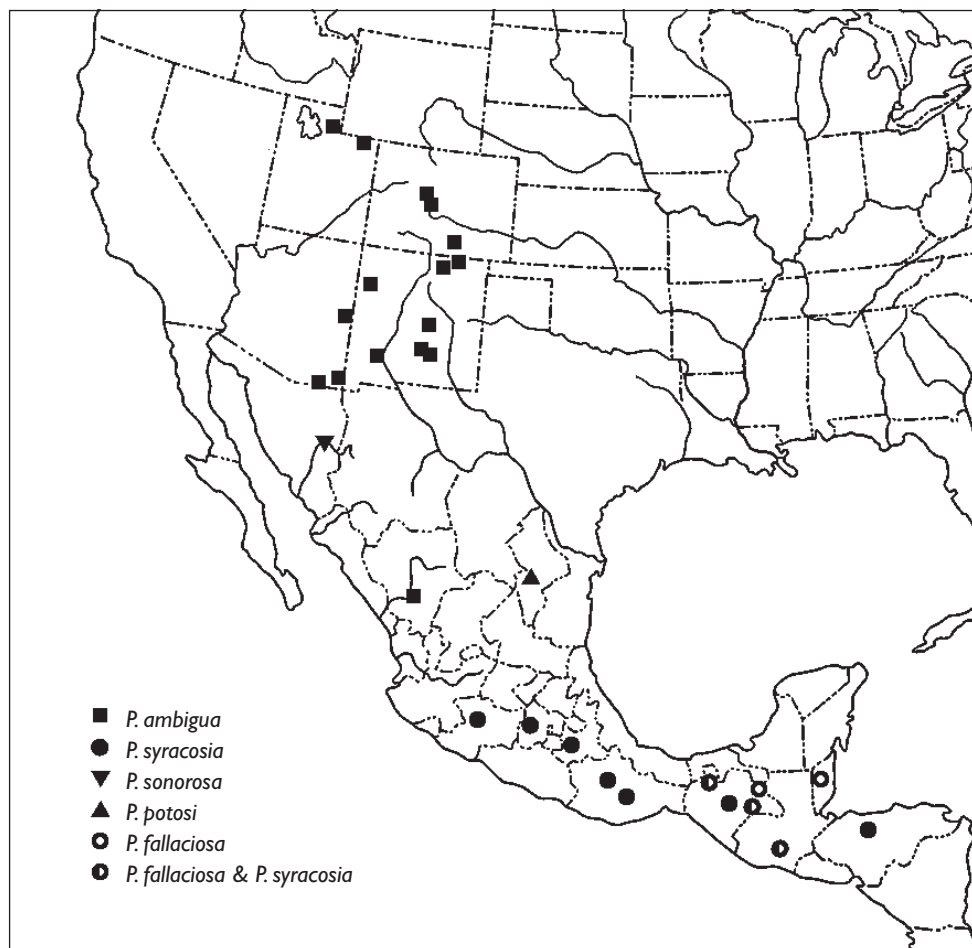


Figure 25. Distribution of examined specimens of *Pseudohemihyalea*.

Biology and distribution. The immature stages are unknown. *Pseudohemihyalea sonora* flies in upper elevation pine-oak forests of the Sierra Madre Occidental, Mexico during September. It is known only from the type locality, in the state of Sonora.

Remarks. The name *sonora* is derived from both its occurrence in the state of Sonora and its pronounced rose-coloured hindwings.

***Pseudohemihyalea potosi* Schmidt, sp. n.**

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Figs. 5, 10, 14, 19, 25

Type material. **Holotype** – ♂, Mexico, N[uevo] L[eón], Cerro Potosí, 10,300', 15-16 Jul 1963, H. and A. Howden [CNC]. **Paratypes** – 2 ♂♂, same data as holotype [CNC].

Diagnosis. *Pseudohemihyalea potosi* is most similar to *P. ambigua*, but can be distinguished by its larger size (forewing length 25 mm or more, vs. 24 mm or less in *P. ambigua*). Internally, the saccular process is long and rounded in *P. potosi*, short and triangular in *P. ambigua*, and the uncus is half again as large with a deeper basal cleft and more elongate basal lobes.

Description. **Head** – male antennae strongly bipectinate, longest rami about 5.7 x longer than segment length; dorsal antennal scales pale rusty brown; vestiture of palpi mostly pink with a few rust scales, frons and vertex rust, pinkish red bordering patagia. **Thorax** – vertex of thorax, patagia and tegulae rusty tan, tegulae tinged with pink laterally; ventrally, thorax rusty tan tinged with pink; legs rusty tan, pink dorso-medially. **Forewing** – length 25.7 mm ($n = 3$); intervenal areas ivory white, sparsely scaled, semi-translucent; veins broadly lined with rusty tan; fringe and costal margin tan-lined, anal margin with narrow white border; pattern similar ventrally but colours appearing washed-out. **Hindwing** – sparsely scaled, semi-translucent, pale tan white overall; anal margin more densely scaled with faintly pinkish scales, although colours may be somewhat faded due to age of the specimens at hand. **Abdomen** – pink tan dorsally, pale tan ventrally; coremata absent. **Male genitalia** – uncus shaped like a bicycle saddle, basal lobes heavily setose dorsally; apical portion slender, finger-like, slightly wider than median portion, with a spade-shaped dorsal profile; apex bluntly pointed, slightly down curved; division between costal and saccular processes extending over slightly more than one-third of total valve length; apex of both processes bluntly rounded; vinculum consisting of a short, broad, scobinate conical projection; juxta urn-shaped in outline, with medial keel along dorso-ventral axis; saccus short, extending slightly cephalad beyond tegumen; vesica relatively small, simple, globose, without spines but with very fine indistinct cornuti. **Female genitalia** – unknown.

Biology and distribution. *Pseudohemihyalea potosi* is currently known only from Cerro Potosí, the highest peak in the Sierra Madre Oriental in the state of Nuevo Leon, Mexico. This area is known for its high plant diversity and endemism.

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I thank Paul Opler (Gillette Museum, Colorado State University) and Don Bowman (Pueblo West, Colorado) for providing specimens of *P. sonora* and bringing them to my attention. Martin Honey (BMNH) kindly provided images of the holotype of *Halysidota syracosia*. I thank John Rawlins for the loan of study specimens and information on the holotype of *P. ambigua*, Jocelyn Gill for her production of flawless colour figures. Reviews of this manuscript by James Adams, Gary Anweiler and Benoit Vincent were much appreciated.

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A new species of *Dodia* Dyar (Noctuidae, Arctiinae) from central Canada

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Abstract

Dodia tarandus Macaulay & Schmidt, **sp. n.**, a cryptic species previously confused with *D. albertae* Dyar, is described from Alberta, Canada. A key to North American *Dodia* is provided. Adults and genitalia of *D. albertae* and *D. tarandus* are illustrated.

Keywords

Dodia, Callimorphina, Holarctic, cryptic species

Introduction

Species of the genus *Dodia* Dyar (Arctiinae: Arctiini: Callimorphina) inhabit cold-climate habitats, notably taiga, and alpine- and subarctic tundra. The genus is distributed across northern North America and central- to eastern Asia. Tshistjakov and Lafontaine (1984) reviewed the genus, and included three species. Tschistjakov (1988, 1989) reviewed the Palaearctic taxa and described four new subspecies. Two additional species have been described since, one from Russia (Dubatolov 1990) and one from the Yukon Territory, Canada (Lafontaine and Troubridge 1999). The three Nearctic

taxa are illustrated in Lafontaine and Troubridge (1999) and also Troubridge and Lafontaine (2004). Extensive recent field work in Alberta, Canada, has shown that two similar (and locally sympatric) species have been going under the name *D. albertae* Dyar (Schmidt et al. 2004). The purpose of this paper is to describe the new species previously confused with *D. albertae*, and provide an updated identification key to North American *Dodia* species.

Methods and materials

Adult genitalia were prepared following the methods detailed by Lafontaine (2004). Line drawings were prepared from genitalia suspended in 30 % ethanol, using a *camera lucida* mounted to a Leica M-165C dissecting microscope. Repository abbreviations are as follows:

CNC	Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Ontario, Canada.
UASM	University of Alberta Strickland Entomological Museum, Edmonton, Alberta, Alberta.
USNM	National Museum of Natural History (formerly United States National Museum), Washington, D.C., USA.
ZIN	Zoological Institute Nauk, St. Petersburg, Russia.
ZMHB	Zoologisches Museum, Humboldt Universität, Berlin, Germany.

Key to North American *Dodia* species

- 1 Forewing an even, translucent grey, without transverse bands; width of male valve at midpoint greater than $\frac{1}{4}$ total length of valve; vesica with two clusters of spines, one at apex and one at base; female corpus bursae slightly constricted medially.....***D. kononenkoi***
- Forewing with light and dark transverse bands; width of male valve at midpoint $\frac{1}{4}$ or less total length of valve; vesica with single apical cluster of spines (Figs. 6, 7); numerous smaller peg-like spinules may also be present (Fig. 6); female corpus bursae oval, wider posteriorly than anteriorly.....**2**
- 2 Forewing transverse bands meeting posterior margin at right angles; known only from dry, rocky tundra habitat in the Yukon (male unknown)***D. verticalis***
- Forewing transverse bands meeting anal margin at acute angle, running more or less parallel to outer margin; occurring in wet tundra and boreal peat bogs.....**3**
- 3 Forewing and thorax markings varying from nearly unmarked to moderately contrasting (subapical pale dash always contrasting), but never with basal and

- antemedial area paler than outer half of wing (Fig. 1); male valve apex with two short, blunt projections (Fig. 4); juxta wider than long (Fig. 4a); inflated vesica approximately as long as aedeagus (Fig. 6).....*D. albertae*
- Forewing and thorax contrastingly marked in mouse grey and whitish-grey banding, with basal and antemedial area noticeably paler than outer half of wing (Figs. 2, 3); male valve apex strongly bifurcate, with 2 longer narrower prongs (Fig. 5); juxta longer than wide (Fig. 5a); inflated vesica 2/3 or less length of aedeagus (Fig. 7) *D. tarandus*

Systematics

Dodia albertae Dyar

Figs. 1, 4, 6, 8

Dodia albertae Dyar, 1901: 85.

Hypocrita atra A. Bang-Haas, 1912: 109.

Hyperborea kozhantshikovi Sheljuzhko, 1918: 104.

Dodia albertae eudiopta Tshistjakov, 1988: 638, fig. 5; subspecies.

Type material. *Dodia albertae* – Type locality: “Calgary, Alberta, [Canada], head of Pine Creek.” Male lectotype designated by Tshistjakov and Lafontaine (1984), USNM type No. 5747 [USNM, photograph examined].

Hypocrita atra – Type locality: “Arasagun-gol (Sajan)” according to original description, label on lectotype reads “Arasagun-go / Sajan” [Sayan Mountain range, Mongolia]. Male lectotype designated by Tshistjakov and Lafontaine (1984) [ZMHB, photograph examined]. Note – *Hypocrita* is an incorrect subsequent spelling of *Hypocrita* Hübner, [1807].



Figures 1-2. Adult habitus of *Dodia albertae* (1) (Ft. McMurray, AB) and *D. tarandus* holotype (2) (Caribou Mtns, AB).



Figure 3. *Dodia tarandus*, live adult (Holmes Crossing, AB).

Hyperborea kozhantshikovi – Type locality: “in montes Dzhugdzhuz [Dzhugdzhur], ad flum. Dzhelinda” [Dzhugdzhur Mountains, Dzhelinda River, eastern Siberia; near the head of the Aldan River according to Tschistjakov (1988)]. Described from 1 male and 1 female syntype; male lectotype (and four paralectotypes) designated by Tshistjakov and Lafontaine (1984) [ZIN, genitalia slide no. 15,191; not examined]. Since only one male was included in the original type material, it is not clear which if any of the lectotype designations are valid. We follow Tschistjakov’s (1988) synonymy; he examined a genitalic preparation of the lectotype in his review of Palearctic specimens of *D. albertae*, and treated *kozantshikovi* as a synonym of *D. albertae albertae*.

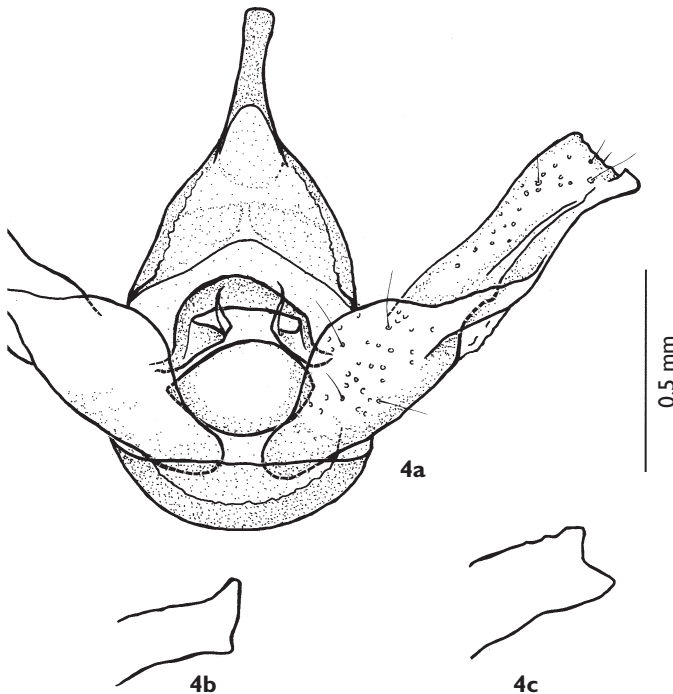


Figure 4. Male genitalia of *D. albertae*, ventral view of genital capsule (a) (Calgary, AB) and variation in valve apex (b – Caribou Mtns, AB; c – Muskox Lake, YT)

Dodia albertae eudiopta Tshistjakov, 1988 – Type locality: [Olenek River between lower Tomba and Alakit River, Russia]. Holotype male [ZIN; not examined]. The diagnosis and genitalic illustration of this taxon in the original description clearly show that it is more closely allied to *D. albertae* than to the new species described below.

Diagnosis. See species key, and diagnosis of *D. tarandus*.

Distribution and biology. *Dodia albertae* is widely distributed across the northern hemisphere in wet subarctic and subalpine tundra and boreal peat bog habitats (Fig. 9). In Eurasia it occurs from the Sayan Mountains eastward to eastern Siberia. In North America, it is distributed from the Yukon eastward to Labrador (Fig. 8).

***Dodia tarandus* Macaulay & Schmidt, sp. n.**

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Figs. 2, 3, 5, 7, 6

Type Material. **Holotype** ♂: “CAN[ADA]: Alberta, Caribou Mtns., / E[ast] shore of Wentzel L[ake]. / 59.060°N, 114.430°W / 17 – Jun – 2003 / BC Schmidt & GG Anweiler”; “UASM# / 34567”; “[DNA barcode voucher number] BCSC# / 93”; “Voucher Specimen / Western CDN Moths / DNA Barcode Project / B.C. Schmidt 2005/06 [blue label]”; “Database # / CNC LEP / 00053353”. [CNC]. **Paratypes:** 3

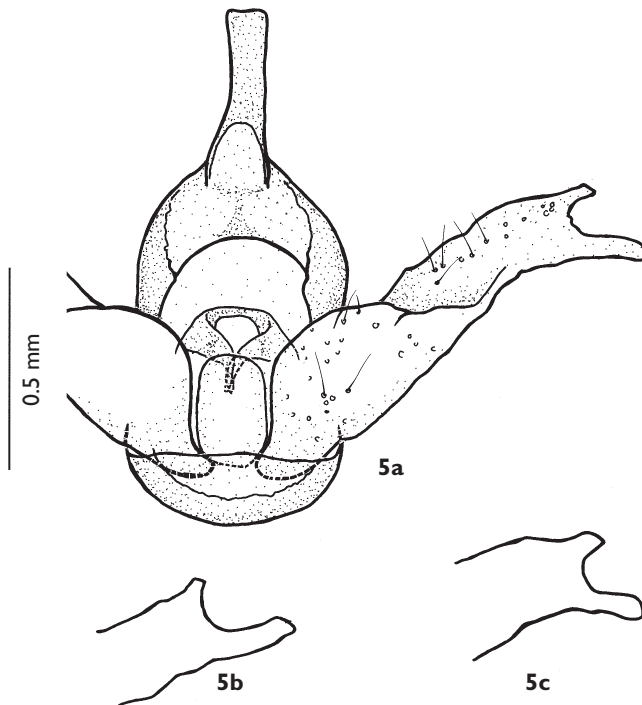
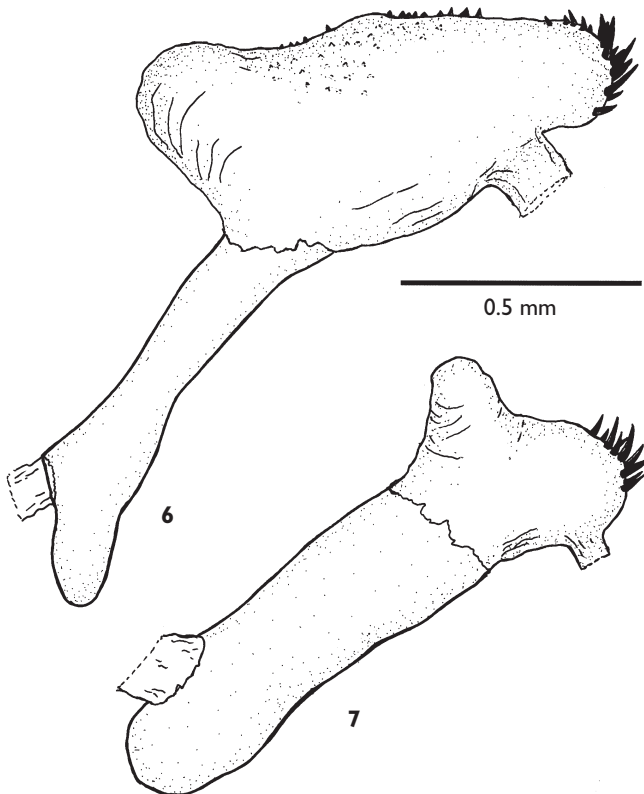


Figure 5. Male genitalia of *D. tarandus*, ventral view of genital capsule (a) and variation in valve apex (b – Caribou Mtns, AB; c – Harlan, SK).

♂ 1 ♀. Alberta, Caribou Mountains, Wentzel Lake, 59.05208°N 114.42628°W, 8 Jul 2003, D.A. and S.M. Macaulay, 1 ♀; Alberta, Holmes Crossing Ecological Reserve, 9 km southeast of Fort Assiniboine, 59.276°N, 114.826°W, 9 Jun 2004, D.A. Macaulay, 1 ♂; Saskatchewan, Harlan, 9 Jun 1942, P.F. Bruggemann, 1 ♂; same data as previous, 19 Jun 1946, 1 ♂; Manitoba, Gillam, 1 Jul 1939, G.S. Brooks, 1 ♂ [CNC, UASM].

Diagnosis. *Dodia tarandus* can usually be distinguished from *D. albertae* by external characters, namely the more extensive white coloration of the forewings, slightly more robust and more contrastingly marked thorax (Figs. 2, 3). Internally, the valve apex is strongly bifid (Fig. 5) (bluntly so in *D. albertae*, Fig. 4), the aedeagus is 4 × longer than wide (Fig. 7) (5 × in *D. albertae*, Fig. 6), and the vesica is approximately ½ the length of the aedeagus (Fig. 7) (equal in length to aedeagus in *albertae*, Fig. 6). Identification of male specimens can be confirmed by brushing the scales off of the valve apex and examining the apical processes.

Description. **Head** – Antennae in both sexes simple and filiform, ciliate ventrally (females more sparsely ciliate), with a lateral, subapical seta on each side of segment; antenna covered with grey-brown and white scales dorsally; eyes large, rounded and widely spaced; palpi short, reaching lower margin of eye with long hair-like white scales; frontal tuft consisting of long brown and white, hair-like and paddle-like scales. **Thorax**



Figures 6-7. Aedeagus with inflated vesica of *D. albertae* (6) and *D. tarandus* (7).

– slender and proportioned similar to that of most Geometridae; covered in grey-brown and whitish hair-like and paddle-shaped scales; patagia and tegulae brown centrally, bordered with whitish scales; ventral thorax and legs brown-scaled. **Forewing** – (Figs. 2, 3) average length 15.6 mm ($n = 3$) for males, 14.3 mm ($n = 1$) for female; broad and translucent, covered with white hair-like and paddle-shaped scales; patterned white with vertical grey-brown banding basally with denser banding medially; females with more white scaling and slightly narrower wing shape; both sexes with distinct subterminal white dash at costa. **Hindwing** – (Fig. 2) smoky grey, translucent, lacking any distinguishable markings. **Male genitalia** – (Figs. 5, 7) uncus broad basally and constricted subapically with blunt, truncate apex; apex of valve with a pointed process dorsally and slightly longer, straight, finger-like process ventrally; aedeagus $4 \times$ longer than wide; vesica simple with basal diverticulum located dorsally, and apical diverticulum with crest-like row of 5–6 spines, smaller spinules absent; ductus ejaculatorius positioned ventrally below apical diverticulum. **Female genitalia** – not distinguishable from those of *D. albertae*; unforked anterior part of anterior apophysis about twice as long as forked part and similar in length to posterior apophysis; ductus bursae cylindrical and membranous; corpus bursae oval (length to width ratio 5:4), lacking signa; dorsal pheromone gland similar in length to papillae anales, apical quarter split into two broad, blunt branches.

Distribution and biology. *Dodia tarandus* has been found in boreal black spruce bogs and adjacent open pine uplands from central Alberta eastward to Manitoba (Fig. 8). In Alberta, specimens were collected in wet, shrubby spruce bogs and adjacent open pine woods at Holmes Crossing Ecological Reserve and the Caribou Mountains (Fig. 9),

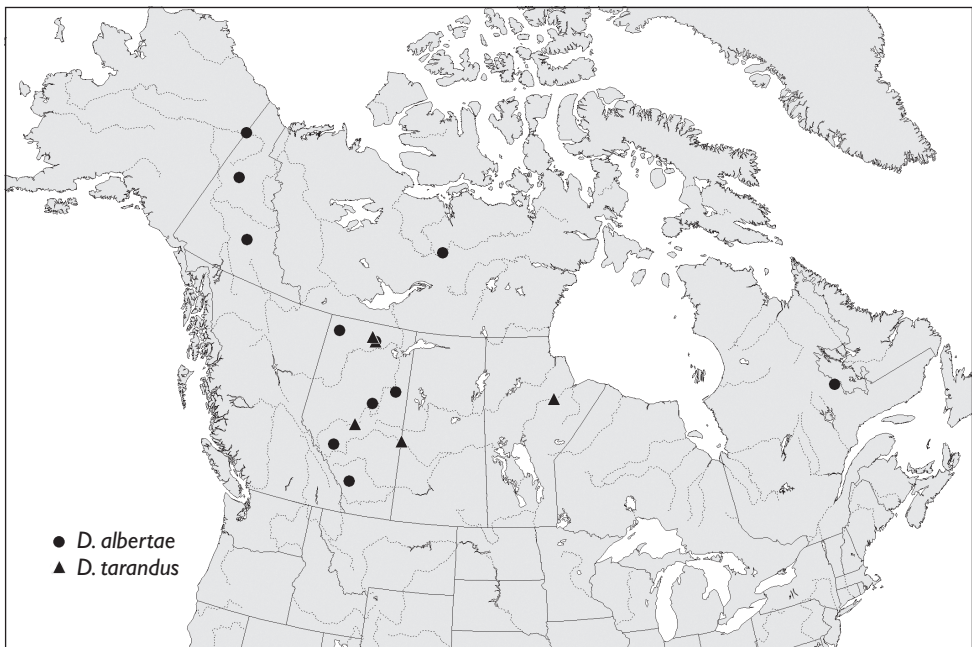


Figure 8. Distribution of examined specimens of *D. albertae* and *D. tarandus*.



Figure 9. Habitat of *D. albertae* and *D. tarandus*, showing typical wet peat bog habitat near Wentzel Lake, Caribou Mountains, Alberta. Dominant vegetation consists of *Eriophorum* sp. (left foreground), *Picea mariana* (Mill.) BSP, *Ledum* sp., *Kalmia* sp. and *Sphagnum* sp.

flying in strict sympatry with *D. albertae* at the latter site. Males have been collected at ultraviolet and mercury vapour light, and the sole known female was netted during the day. Adults have been collected between early June and early July. Larval biology and host plants are not known, but host plants are likely to be one or more species of the plant groups common in peatland habitats such as *Salix* and various Ericaceae. In central Asia, *D. sazonovi* Dubatolov larvae hibernate and feed on *Dryas* (Rosaceae), and accept dandelion in captivity (Murzin 2003), suggesting the larvae are generalists.

Etymology. The name *tarandus* reflects this species' initial discovery and occurrence in the Caribou Mountains of Alberta, and also the habitat it shares with the also elusive Woodland Caribou, *Rangifer tarandus* (L.).

Discussion

Although *Dodia* species are rarely collected, the few records of *D. tarandus* suggest it to be less widespread than *D. albertae*; so far it is known only from the boreal region of central Canada. It is expected that additional surveying of peatlands will show *D.*

tarandus to be more widespread, since nearly all boreal forest Lepidoptera species have a broad, nearly transcontinental distribution.

Comparisons of molecular data ('barcode' fragment of *cox1* mtDNA; Barcode of Life Data System, Ratnasingham and Hebert 2007) from two specimens of *D. tarandus* (Caribou Mountains) were 2 % divergent from *D. albertae* samples (Alberta, Yukon, Labrador), including sympatric specimens from the Caribou Mountains. However, one Alberta and one Yukon specimen of *D. albertae* also exhibited *D. tarandus* haplotypes. The cause of this discordance is currently not clear; arctiines appear to be particularly prone to gene tree paralogy, including the genus *Grammia* Rambur (Schmidt and Sperling 2008) and also other genera such as *Neoarctia* Neumögen and Dyar, *Virbia* Walker, and *Haploa* Hübner (Schmidt, unpubl. data).

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Thanks to Wayne Nordstrom and other Alberta Parks and Protected Areas staff for issuing permits to collect in Holmes Crossing Ecological Reserve and the Caribou Mountains Wildland Park. We also thank Ted Johnson of Alberta Parks and Protected Areas who coordinated the biophysical inventory work of the Caribou Mountains, where the existence of an unrecognized *Dodia* came to light, and Gary Anweiler, Sherri Macaulay, Carey Booth and Gerald Hilchie who assisted with collecting. Gary Anweiler, Greg Pohl, Hartmut Rietz and Danny Shpeley kindly provided access to specimens in their care, and Gary Anweiler and Don Lafontaine reviewed this paper.

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A new genus and two new species of arctiine tiger moth (Noctuidae, Arctiinae, Arctiini) from Costa Rica

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Abstract

Leichosila **gen. n.** is described based on two new species, *Leichosila talamanca* **sp. n.** and *L. wagneri* **sp. n.**, from montane rain forests of Costa Rica. *Leichosila* is allied to the North American *Hyphantria* Harris generic group (subtribe Spilosomina) which is largely temperate-subtropical in distribution, suggesting that *Leichosila* is derived from North American faunal elements rather than Andean / South American.

Keywords

Arctiini, Spilosomini, Spilosomina, Arctiidae, Neotropics, taxonomy

Introduction

The subtribe Spilosomina is a relatively small group in the New World, with 10 North American genera (Schmidt and Opler 2008) and approximately twelve more described and undescribed strictly Neotropical genera, excluding misplaced genera (Schmidt, in prep.). By comparison, more than 60 genera occur in the eastern hemisphere (Kôda 1988; Goodger and Watson 1995; Dubatolov 2006), with the greatest diversity in the Oriental and Afrotropical regions. Spilosomina has previously been treated either as a tribe (here ranked as a subtribe following the changes proposed by Lafontaine and Fibiger 2006), or considered synonymous with a broader concept of the Arctiina (*e.g.*

Arctiini *sensu* Franclemont 1983; Watson and Goodger 1986). Although a phylogeny of the Arctiina *sensu lato* with broader taxon- and character sampling is still needed, a preliminary phylogeny of the Arctiina (*s.l.*) (Schmidt 2007) shows that the Spilosomina are well supported as a monophyletic group.

The genus-level diversity of North American spilosomines is greatest in Mexico, where representatives of all genera occur, with the exception of *Phragmatobia* Stephens (northern boreo-cordilleran), *Caribartia* Ferguson (Hispaniolan) and *Seirarctia* Packard (Eastern North American). This suggests that the mid-latitude Americas are a possible centre of origin for many North American spilosomines, consistent with the fact that North American species associated *Spilosoma* Curtis are a paraphyletic group of species, none congeneric with Eurasian *Spilosoma* (*sensu stricto*) (Schmidt, in prep.).

As a rule, spilosomines feed on low-growing herbaceous plants as larvae (Wagner 2005), and are accordingly most common in non-forest habitats, typically xeric woodland, savannah, grasslands and wetlands. *Hyphantria cunea* (Drury) is the only known exception to this herb-feeding habit, and is exceedingly polyphagous on deciduous trees and shrubs (Wagner 2005). The discovery of a new genus related to temperate North American spilosomines was therefore surprising given that members of this new genus inhabit tropical forests, and occur much farther south than most other species of the group.

Methods and materials

Adult genitalia were prepared following the methods detailed by Lafontaine (2004). Line drawings were prepared from genitalia suspended in 30 % ethanol, using a *camera lucida* mounted to a Leica M-165C dissecting microscope. Genitalia were photographed from Euparal-mounted microscope slides using a Nikon D200. Repository abbreviations are as follows:

CNC	Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Ontario, Canada.
INBIO	Instituto Nacional de Biodiversidad, Santo Domingo de Heredia, Costa Rica.
JBS	Personal collection of J. Bolling Sullivan, Beaufort, North Carolina.
BVC	Personal collection of Benoit Vincent, Saint-Denis, France.

Systematics

Leichosila Schmidt, gen. n.

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Type species. *Leichosila talamanca* Schmidt, sp. n.

Diagnosis. *Leichosila* can easily be distinguished externally from all other New World arctiines by the unique wing pattern and colour, consisting of a grey to whitish-

grey ground colour with a pattern of dark grey-black, incomplete forewing bands that are ochre yellow centrally (Figs 1, 2). Structurally, the following combination of characters is unique: male antennae simple (Fig. 9), juxta very broad and shallow ($5 \times$ wider than long; Fig. 8); male valve lacking medioventral lobe (Figs. 3a, 4a), abdominal markings absent (Figs. 1, 2). The juxta shape is a putative autapomorphy of the genus and is unlike that of any other New World spilosomine.

Description. Male (female unknown). **Head** – Male antenna filiform in dorsoventral view, ciliate and subserrate ventrally; segment slightly longer than wide (Fig. 9); dorsal antennal scales greyish brown; palpi porrect, 3rd segment $\frac{1}{2}$ length of 2nd segment; vestiture of palpi, frons and vertex dusty brown grey; haustellum reduced and poorly sclerotized, presumably non-functional. **Thorax** – Vestiture of vertex and ventrum of thorax, patagia, tegulae and legs dusty brown grey and shaggy; apex of prothoracic tibia with two subequal, blunt, triangular projections; two meso- and metathoracic tibial spurs, the posterior spur slightly longer than anterior, length of spurs approximately equal to tibial width at apex; metepisternum with rounded ridge along anterior margin, microtymbals absent. **Forewing** (Figs. 1, 2) – length 13.4 to 16.1 mm; ground colour dark mouse grey to whitish grey; 5 transverse bands of yellowish ochre, outlined in dark charcoal grey; bands evident as five discrete cells along costa, three basal bands obsolete in medio-basal area, and again present along anal margin except for basal-most band; ochre and grey areas of three distal bands confluent in costal half, with ochre scaling extending along veins; distal band often darkest and most complete; pattern similar ventrally, but colours washed-out. **Hindwing** (Figs. 1, 2) – ground colour dusty grey to whitish grey, with irregular dark-grey subterminal spots and medial spot, these varying in contrast from pronounced to obsolete against darker ground colour; pattern similar ventrally, but colours of subterminal spots washed-out; medial spot darker ventrally than on dorsum, often extending to costa and basally along costal margin. **Abdomen** – vestiture dusty brown grey dorsally and ventrally; evenly coloured without distinguishable markings (Figs. 1, 2); coremata between 7th and 8th sternite absent (Fig. 5); 8th sternite moderately sclerotized, trapezoidal, $2 \times$ as wide as long (Fig. 5); lateral sclerites of 8th sternite moderate sclerotized basally, mem-

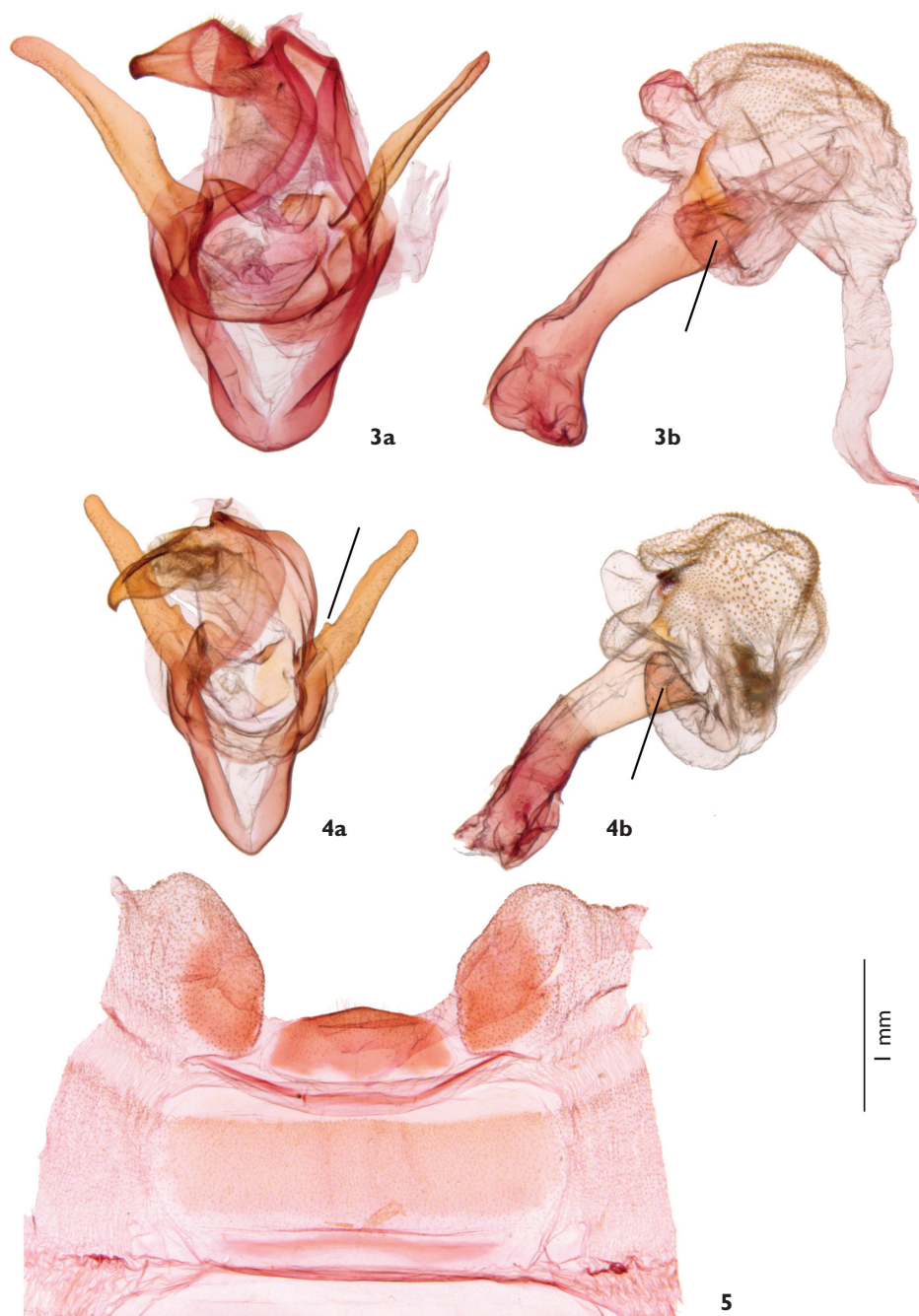


Figures 1-2. Adult habitus of *Leichosila* gen. n. **1.** *Leichosila talamanca* sp. n., male holotype. **2.** *Leichosila wagneri* sp. n., male holotype.

branous distally, equalling width of sternite in length (Fig. 5); 8th tergite sclerotized, entire. **Male genitalia** – Uncus triangular to bottle-shaped in dorsal view, length 2 × that of basal width (Figs. 6, 7); basal half sparsely setose; apical third flattened laterally, down curved, resembling a bird's beak in lateral view; apex truncate in caudal view; ventrally with membranous area extending halfway to apex (Figs. 6, 7); dorsal margin of tegumen recurved caudad, extending to base of uncus; valve consisting of a simple, sickle-shaped, slightly laterally flattened process (Figs. 3a, 4a) extending dorso-caudally as far as uncus apex (in natural position); valve devoid of processes and lobes (Fig. 3a), or with small sub-basal process on dorsal margin of costa (Fig. 4a); lateral process of transtilla consisting of a poorly delineated, sclerotized region contiguous with membranous area dorso-laterad of anellus, forming shallow, rounded pyramidal prominences directed dorsad; saccus broadly u-shaped, length equalling $\frac{3}{4}$ height of genital capsule; juxta u-shaped and slightly convex ventro-caudally, very broad and shallow, about 5 × broader than height at midline (Fig. 8); phallus unadorned and relatively stout, approximately 4 × as long as wide (Figs. 3b, 4b); coecum strongly curved ventrad by 90°; vesica globose with four basal diverticula (Fig. 4b), total diameter equalling length of phallus; two diverticula positioned basally and left-laterad, adjacent to each other; two additional diverticula positioned ventro-basally and also adjacent to each other; left half of vesica scobinate, grading to smaller spicules on right side; ductus ejaculatorius positioned right laterad.

Etymology. The name is feminine in gender, and is derived from the Greek stem for lichen, *leichos*, and the Latin for yellow ochre, *silaceus*, reflecting the odd yellow-ochre colour of the forewing bands, very unusual for an arctiine. This colour pattern is presumably cryptic on lichen-covered trees.

Remarks. The caudally recurved dorsal margin of the tegumen and lateral lobes of the 8th sternite of *Leichosila* are unique autapomorphies of the Spilosomina (Schmidt 2007). The morphology of the male genitalia (valve prong-like and relatively simple, uncus broadly triangular) and wing shape/pattern place *Leichosila* near the *Hyphantria* Harris group of genera, consisting of *Hyphantria*, “*Spilosoma*” (*sensu lato*), *Alexicles* Grote, *Estigmene* Hübner, and the “*Hypercompe*” *permaculata* (Packard) group, although I could find no synapomorphies to suggest a possible sister genus. The fili-form antenna and absence of dorsal abdominal markings are rare among all spilosomines, but this condition occurs in some *Hypercompe* species and *Spilosoma vagans* (Boisduval), respectively. An incomplete ‘barcode’ fragment (319 base pairs) of the *cox1* mtDNA gene of a single *L. talamanca* specimen (Barcode of Life Data System; Ratnasingham and Hebert 2007) was approximately equally divergent from species of all *Hyphantria*-group genera by 5.6 % to 7 %. This level of divergence is congruent with the highly autapomorphic morphology of *Leichosila*, but unfortunately does not provide possible clues to generic relationships to the rest of the group. The *Hyphantria* group is restricted to Central and North America (except for *Estigmene albida* (Stretch) which occurs south to Colombia), but *Leichosila* is more closely allied to this group than to Neotropical *Paracles* Walker and Andean “*Phragmatobia*” to which *Leichosila* shows some superficial similarities but structurally it is quite different.



Figures 3-5. Male genitalia of *Leichosila*. **3a.** *L. talamanca* (paratype), genital capsule (ventral view); **3b.** phallus (left lateral view), with inflated vesica (ventrobasal diverticulum highlighted); **4a.** *L. wagneri* (holotype), genital capsule (ventral view); **4b.** phallus (left lateral view) with inflated vesica (ventrobasal diverticulum highlighted); **5.** *L. talamanca*, 8th abdominal sternite, showing medioventral sclerite and lateral lobes.

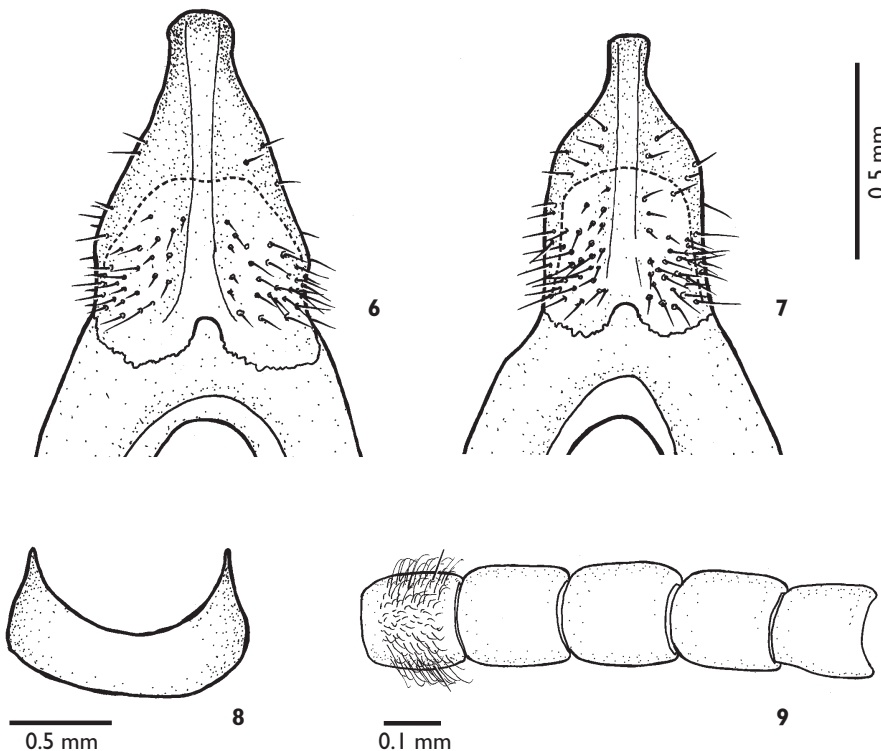
***Leichosila talamanca* Schmidt, sp. n.**

urn:lsid:zoobank.org:act:7EB77263-5DE4-4AA2-86AE-C02C45C7C0E4

(Figs 1, 3, 5, 6, 8, 9)

Type material. **Holotype** male – “Costa Rica: P[rovincia]. Cartago [locality actually in San José Province] / R. F. Los Santos / Sendero Los Robles / 9° 33' 25.51 N 83° 47' 55.47 W / 2400 m, 21-27 March 2004 / J.B. Sullivan & J.D. Lafontaine;” “Data-based for CNC / NOCTUOIDEA # / 13709” [green label]; Barcodes of Life Project / University of Guelph / DNA # Noctuoidea / 13709” [blue label]; HOLOTYPE / *Leichosila* / *talamanca* / Schmidt” [red label]; deposited in INBIO. **Paratypes** – 15 ♂♂, same data as holotype [INBIO, CNC, JBS]; 5 ♂♂, Costa Rica, San Jose, Parc national Chirripo, sentier pédestre vers Mont Chirripo Km 4.7, 2310m, 1 V 2005, leg B. Vincent [white label]; BV 392 to BV 396 [white label]; [BVC].

Diagnosis. Both *Leichosila talamanca* and *L. wagneri* can be easily distinguished from all other New World arctiines by the wing pattern and colour, consisting of a grey to whitish grey ground colour with a pattern of dark grey-black, incomplete forewing bands which are ochre yellow centrally (Figs 1, 2). *Leichosila talamanca* differs from



Figures 6-9. Structural features of *Leichosila*. **6.** *L. talamanca*, uncus (dorsal view); **7.** *L. wagneri*, uncus (dorsal view); **8.** *L. talamanca*, juxta; **9.** *L. talamanca*, antenna (segments 14 – 18), ventral view (setae and cilia omitted except on segment 14).

L. wagneri in its larger size, paler grey colouration of the wings, and internally by the more triangular uncus (parallel-sided in *L. wagneri*, figs 6, 7), lack of a basal process on the costal margin of the valve (Fig. 3), and a broadly joined pouch-like diverticulum of the vesica that is pointed and conical in *L. wagneri* (Figs 3b, 4b).

Description. A detailed description is given above in the generic description. Characters specific to *L. talamanca* are as follows: Male (female unknown). **Forewing** – length averaging 15.4 mm (14.9–16.1 mm, $n = 4$); ground colour mouse grey to whitish grey. **Hindwing** – ground colour mouse grey to whitish grey, with irregular dark-grey subterminal spots, and medial spot. **Male genitalia** – Uncus triangular in dorsal view; vesica with left diverticulum of two ventro-basal diverticula pouch-shaped and broadly joined to main chamber of vesica (Fig. 3b).

Etymology. This species occurs in montane broadleaf forest of the Cordillera de Talamanca, Costa Rica, hence the name.

Distribution and biology. *Leichosila talamanca* is known only from two localities in the Cordillera de Talamanca. At the type locality, the habitat is dominated by mature oaks (*D. Lafontaine*, pers. comm.) within the Talamancan montane forest at 2400 m elevation. Collection dates are for the last week of March and early May.

***Leichosila wagneri* Schmidt, sp. n.**

urn:lsid:zoobank.org:act:98429FDA-3B9D-44BA-8259-6D83D11CFFBB
(Figs. 2, 4, 7)

Type material. **Holotype** male – “C[osta]. RICA: Heredia: / 6 km ENE Vara Blanca, / 1950–2050m, 10°11'N / 84 07'W; 15 ii 2002 / David L. Wagner coll”; “INBio-OET-ALAS / transect / 20/L/01/011”; “Project / ALAS / INB0003216237”; “HOLOTYPE / *Leichosila* / *wagneri* / Schmidt” [red label]; “Genitalia / CNC slide # / 14541”; deposited in INBIO.

Diagnosis. Distinguished from *L. talamanca* by the smaller size and darker colouration of *L. wagneri*, and by the genitalic characters given under the diagnosis for *L. talamanca*.

Description. A detailed description is given above in the genus description. Characters specific to *L. wagneri* are as follows: Male (female unknown). **Forewing** – length 13.4 ($n = 1$); ground colour dark grey. **Hindwing** – ground colour dark grey, with indistinct, irregular dark grey subterminal spots and medial spot. **Male genitalia** – Uncus parallel-sided basally, then tapering apically, *i.e.* bottle-shaped in dorsal profile (Fig. 7); vesica with left diverticulum of two ventro-basal diverticula conical and pointed (Fig. 4b).

Etymology. This species is named after David L. Wagner, who collected the type specimen, and whose studies continue to vastly improve our knowledge of the larval biology of North American Lepidoptera.

Distribution and biology. *Leichosila wagneri* is known only from the type specimen, collected in high elevation forest (1950–2050 m) on Volcán Barva (Cordillera Central) in mid February.

Acknowledgements

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Revision of the New World *Panthea* Hübner (Lepidoptera, Noctuidae) with descriptions of 5 new species and 2 new subspecies

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Abstract

The New World species of *Panthea* Hübner are revised. Five species and two subspecies are described as new: *Panthea apanthea* **sp. n.**, *Panthea reducta* **sp. n.**, *Panthea greyi* **sp. n.**, *Panthea judyae* **sp. n.**, *Panthea guatemala* **sp. n.**, *Panthea furcilla australis* **ssp. n.**, and *Panthea acronyctoides nigra* **ssp. n.** Lectotypes are designated for *Panthea leucomelana* Morrison and *Panthea furcilla* (Packard), and a neotype is designated for *Platycerura gigantea* French. *Panthea pallescens* McDunnough, **syn. n.** is synonymized with *P. furcilla* (Packard), *P. acronyctoides albosuffusa* McDunnough, **syn. n.** is synonymized with *P. acronyctoides acronyctoides* Walker, *P. portlandia* Grote, **syn. n.**, *P. portlandia suffusa* McDunnough, **syn. n.**, and *P. angelica* (Dyar), **syn. n.** are all synonymized with *P. virginarius* (Grote). Adults of all New World *Panthea* are illustrated in color, and black and white illustrations of the genitalia of both sexes are provided where known. A key to adults of both sexes and dot maps showing distribution for all species are provided.

Keywords

Pantheinae, lectotype, neotype, Guatemala, Mexico, Dominican Republic

Introduction

Panthea Hübner, 1820 (Noctuidae, Pantheinae) is Holarctic, with six Old World and nine New World species (Poole 1989; Hodges et al. 1983; Thony 1996). In the eastern

hemisphere *Panthea* occur south to Southeast Asia, in the western hemisphere south to Central America and the Caribbean. *Panthea* is most diverse in the American Southwest, and all species for which there are habitat data are denizens of coniferous woodlands.

Panthea are placed in the Pantheinae, traditionally treated as a subfamily of the Noctuidae (Poole 1989; Franclemont and Todd 1983). Kitching and Rawlins (1999) elevated Pantheinae to family status, but Lafontaine and Fibiger (2006) revised them back to subfamily status in their expanded concept of Noctuidae, which is followed here.

Panthea are robust, medium-sized (approximately 3-6 cm wingspan) noctuid moths with a forewing pattern of five black lines crossing a white or gray ground. The extent of sexual dimorphism varies in expression among species, and where it occurs it is expressed as females being larger and darker than males. Male antennae are bipectinate, female antennae simple. The eyes are hairy, and the mouthparts of both sexes are greatly reduced and apparently non-functional. The male uncus and female sterigma are greatly modified and provide excellent characters for identification at the species-group and species levels. Several taxa have a variety of forms, with some populations of one species occurring in a form that resembles a form of another species more than other populations of the same species. As a result a number of taxa have been overlooked, others have been described more than once, and misidentifications are frequent in museum collections and in the literature (McDunnough 1942; Bowman 1951; Crumb 1956; Prentice 1962). Melanism is frequent in some eastern populations of nominate *P. furcilla* (Packard), and has also been reported for *P. furcilla australis* and some eastern populations of nominate *P. acronyctoides* (Walker) (Klots 1964; Klots 1966; Klots 1968; Brou pers. comm. 2008; Anweiler, unpublished data). This phenomenon appears to be more or less restricted to the eastern United States and is extremely rare or non-existent in other *Panthea* populations. The hairy larvae of all species, so far as is known, feed only on needles of conifers (Pinaceae) and in particular pines (Smith and Dyar 1898; Crumb 1956; Prentice 1962; Duncan 2006; Anweiler unpublished data).

The purpose of this paper is to revise the New World *Panthea*, describe new taxa, and provide illustrations, keys and distribution maps that will assist in identifying these interesting moths. Life history and habitat information is briefly summarized when available.

Materials and methods

Procedures for dissecting and preparing genitalia and terminology for wing markings follows that of Lafontaine (1987). Terminology for genitalic structures follows Lafontaine (2004).

Specimens or photographs of specimens were obtained from the following institutional collections and individuals; abbreviations used are as follows:

BMNH The Natural History Museum (formerly British Museum [Natural History]), London, United Kingdom.

CNC	Canadian National Collection of Insects, Arachnids and Nematodes, Ottawa, Ontario, Canada.
CSU	Colorado State University, Fort Collins, Colorado, USA.
JKA	personal collection of James Adams Dalton, Georgia, USA.
JTT	personal collection of Jim Troubridge, Selkirk, Ontario, Canada.
LACM	Los Angeles County Museum of Natural History, Los Angeles, California, USA.
MCZ	Museum of Comparative Zoology, Cambridge, Massachusetts, USA.
MSU	Michigan State University, Lansing, Michigan, USA.
NYSM	New York State Museum, Albany, New York, USA.
RHL	personal collection of Ron Leuschner, Los Angeles, California, USA.
RMB	personal collection of Richard M. Brown, Stockton, California, USA.
UASM	University of Alberta Strickland Entomological Museum, Edmonton, Alberta, Canada.
USNM	National Museum of Natural History (formerly United States National Museum), Washington, D.C., USA.

Panthea Hübner, [1820]

Type species: *Phalaena coenobita* Esper.

Elatina Duponchel, [1845]. Type species: *Phalaena coenobita* Esper [extralimital].

Audela Walker, 1861. Type species: *Audela acronymctoides* Walker.

Platyserura Packard, 1864. Type species: *Platyserura furcilla* Packard.

Diphthera Hampson, 1913, not Hübner, [1809]. Type species: *Phalaena coenobita* Esper [extralimital].

Diagnosis. The genus *Panthea* is characterized by a combination of characters including a dorsal forewing with a white or gray ground and a complete pattern of five black cross lines with the normal spots (reniform, orbicular and claviform) obsolete or nearly so. Male antennae are bipectinate and both sexes have greatly reduced apparently non-functional mouthparts. Male genitalia have simple heavily sclerotized valves with a well-developed clasper, a laterally compressed uncus with a high crown, triangular in cross-section and in lateral profile resembling a bird's head with beak, and a simple vesica armed with 1-3 large sclerotized cornuti. Females have a well-developed or massive sclerotized sterigma and a simple oval or oblong bursa copulatrix, lacking both appendices and signa.

Description. The genus *Panthea* is described and illustrated in detail in Smith and Dyar (1898). **Head** – broad, retracted; frons flat; eyes widely separated; ocelli small, concealed; proboscis greatly reduced, short, weak, apparently non-functional; palps small, slender, hardly extending to front; antenna bipectinate in male, simple in female; eyes hairy, without lashes. **Thorax** – quadrate, wider than long, with smooth hairy somewhat loose vestiture; legs short, stout, all similar in size, clothed with long loose hair; unarmed except for short, weak spurs; tarsal claws weak. **Dorsal forewing**

– broadly triangular, outer margin oblique, with apex produced so costa is about $2 \times$ length of inner margin, clothed with a mixture of dark-gray or brownish-black and white scales, generally appearing gray; five black transverse lines; spots obsolete in most species, reniform and/or orbicular spot a small patch or bar of dark scales in a few species. **Dorsal hindwing** – usually lighter in color than forewing, poorly marked with several diffuse gray bands, or entirely gray in some forms. **Abdomen** – cylindrical, plump, longer in female, without tufts, clothed in short, stiff hair. **Male genitalia** – valve simple but robust, heavily sclerotized with prominent erect clasper at distal end of sacculus; tegumen with a pair of large ear-like subuncal lobes; uncus highly modified, laterally compressed with high rounded crown sloping down and tapering to a narrow terminus; aedeagus cylindrical, slightly expanded at terminus in some species; vesica a membranous sac, armed with 1-3 large sclerotized cornuti in all but one species. **Female genitalia** – sterigma in all but one species well-developed, massively sclerotized in *P. judyae* group; ductus bursae variable in size and proportions, sclerotized or partially sclerotized in most species, usually folded or twisted and with a thickened wall; corpus bursae a simple translucent oval or oblong sac, with thick-walled upper and thin-walled lower section in *P. furcilla* group; signa absent.

Key to the New World *Panthea*

- 1 Antenna bipectinate (male).....2
- Antenna simple (female) (**Note:** female of *P. reducta* unknown)12
- 2 Hindwing black except fringe, scales tiny, hair-like exposing membrane, appearing glassy (label can be read through wing); Caribbean: Hispaniola (Fig. 3).....*P. reducta*
- Hindwing with white scales, or if without white scales dark scales not greatly reduced, wing opaque3
- 3 Small (FW length 14-15 mm); wing pattern blurred or appearing out of focus; uncus obsolete (Fig. 45); aedeagus without sclerotized cornuti, but armed with patch of many soft fleshy-appearing spines (Figs. 1, 45)*P. apanthea*
- Larger (FW length 16 mm or more); wings with lines clear, contrasting; uncus present; aedeagus armed with 1-2 large sclerotized cornuti (Figs. 46-57).....4
- 4 Terminus of uncus bifurcate (Fig. 48)*P. gigantea*
- Terminus of uncus not bifurcate; square, rounded or pointed (Figs. 46, 47, 49-57)5
- 5 Everted vesica long, narrow, $3-5 \times$ long as wide (Figs. 54-56).....6
- Everted vesica short, bulbous, $1-2 \times$ long as wide (Figs. 46-53)8
- 6 Vesica with large bent or curved terminal cornutus (Fig. 56); sw USA*P. greyi*
- Vesica with large straight terminal cornutus (Figs. 54-55); eastern USA and Canada7

- 7 Vesica with second smaller cornutus near base of vesica (Figs. 55, 57), south-eastern USA (Fig. 71) *P. furcilla australis*
- Vesica without second cornutus (Fig. 54); eastern USA and Canada (Fig. 71) (**Note:** specimens from zone where *furcilla* and *australis* meet show intermediate characters) *P. furcilla furcilla*
- 8 Vesica with large curved claw-like basal cornutus and finger-like diverticulum with a small straight terminal cornutus (Fig. 50) *P. virginarius*
- Vesica without finger-like diverticulum (Figs. 46–49) (**Note:** some specimens of *virginarius* from Wyoming and southern Idaho may have a greatly reduced diverticulum with a very small or obsolete spine) (Fig. 51) **9**
- 9 Vesica with two large, curved, approximately equal-sized cornuti (Fig. 59) ...
..... *P. guatemala*
- Vesica with two prominent cornuti, one much smaller in size (Figs. 46; 52–53) **10**
- 10 Vesica with one short curved cornutus and one long, thin, straight or re-curved cornutus; clasper simple, not scoop-shaped or forked (Figs. 52–53) **11**
- Vesica with large basal and small terminal cornutus; large scoop-shaped clasper (Fig. 46) *P. judyae*
- 11 Wings with prominent white areas (Figs. 36–38); eastern and boreal North America (Fig. 71) *P. acronyctoides acronyctoides*
- Wings without prominent white areas, or if white area present, confined to small areas of outer edge of FW postmedian line and anal angle of HW (Figs. 40–43); Rocky Mountains and foothills (Fig. 71)
..... *P. acronyctoides nigra*
- 12 Sterigma vestigial or obsolete (Fig. 58); sw USA *P. apanthea*
- Sterigma well developed (Figs. 59–68) **13**
- 13 Corpus bursae with thick-walled opaque upper and thin-walled translucent lower sections (Figs. 65–68) **14**
- Corpus bursae single, an oval or oblong, thin-walled translucent sac (Figs. 59–64) **16**
- 14 Ductus bursae narrow, finely folded or “corrugated,” expanding abruptly to corpus bursae (Figs. 65–67); eastern USA and Canada **15**
- Ductus bursae wider, with large folds, widening gradually and with folds extending onto upper section of corpus bursae (Fig. 68); sw USA (Fig. 71)
..... *P. greyi*
- 15 Ductus bursae strap-like, few twists and folds (Fig. 67); east and se USA (Fig. 71) *P. furcilla australis*
- Ductus bursae not strap-like, with many finer “corrugated” folds (Fig. 65); northeastern USA and Canada (Fig. 71) (**Note:** specimens of ssp. *australis* and *furcilla* show intermediate characters where the ranges meet)
..... *P. furcilla furcilla*
- 16 Sterigma massive, heavily sclerotized (Figs. 58–61) **17**
- Sterigma not massive, only moderately sclerotized (Figs. 62–64) **19**

- 17 Ductus bursae heavily sclerotized to or almost to corpus bursae (Fig. 61)..... *P. guatemala*
 – Ductus bursae with heavily sclerotized part extending no more than half way to corpus bursae (Figs. 59-60)..... **18**
- 18 Ductus bursae between sterigma and corpus bursae narrow; corpus bursae tear-drop or oval shape (Fig. 59); FW length less than 25 mm..... *P. judyae*
 – Ductus bursae below sterigma wide; corpus bursae oblong (Fig. 60); FW length greater than 25 mm..... *P. gigantea*
- 19 Ductus bursae slightly curved, smooth, with expanded rim at ostium (Figs. 63-64) **20**
 – Ductus bursae straight, wrinkled, without expanded rim at ostium (Fig. 62) *P. virginarius*
- 20 Wings with prominent white areas (Figs. 36-38); eastern and boreal North America (Fig. 72) *P. acronyctoides acronyctoides*
 – Wings without prominent white areas (Figs. 40-43); Rocky Mountains and foothills (Fig. 69) (**Note:** specimens of *acronyctoides* show intermediate characters in central Alberta) *P. acronyctoides nigra*

Panthea apanthea species-group

The *Panthea apanthea* species-group contains only *P. apanthea*.

Panthea apanthea Anweiler, sp. n.

urn:lsid:zoobank.org:act:A120BA18-CACF-4F2C-A9D5-E7CB60A1E2D4

Figs. 1-2, 45, 58, 69

Type material. **Holotype** male – “[United States] White Mts. AZ [Arizona] / El. 7200-12500 ft./ 10-30 Aug 1925./ O. C. Poling coll”; “Barnes collection”; “HOLOTYPE / *Panthea apanthea* / Anweiler” [red label]; “Photographed by J.D. Gill (CNC)/ 260” [orange label]; deposited in USNM.. **Paratypes** (8 ♂, 2 ♀): **Arizona:** Coconino Co., Oak Creek Canyon, 5000', 6.viii.1986, R.H. Leuschner, coll. (1 ♂); same locality and collector, 7.viii.1986 (2 ♂); Coconino Co., 7 miles west Williams, 8-15.viii.1956, Noel McFarland, coll. (2 ♂); Flagstaff, 12.viii.1999, R. M. Brown, coll. (3 ♂, 1 ♀). **Colorado:** El Paso Co., 20 miles east Colorado Springs, 18.viii.1965, Sam Johnson (1 ♂); Starr Ranch nr. Colorado Springs, 16.viii.1965, 6600', Sam Johnson, coll. (1 ♀) [CNC; RHL; RMB].

Etymology. The name is Latin and means “not *Panthea*,” and refers to the unusual structure of the genitalia, which differ so much in appearance from other American *Panthea*.

Diagnosis. The typical *Panthea* pattern will identify *P. apanthea* to genus, and the very small size will separate it from all other western *Panthea*, with the possible excep-

tion of very small males of *P. judyae*. The lack of any sharply contrasting black lines on the forewings will separate it from all other *Panthea*. Internally the lack of sclerotized spines on the vesica and the lack of a heavily sclerotized sterigma are unique to *P. apanthea*, and unusual for *Panthea*.

Description. Male and female moderately dimorphic, female larger and with darker hindwing than male; forewing length: 4-15 mm (male), 18 mm (female). **Head** – male antenna bipectinate, pectinations approximately $1.5 \times$ as long as width of antennal shaft, female antenna simple; palps greatly reduced, clothed in dark brownish-gray hair-like scales. **Thorax** – collar, thorax and tegulae a mix of dark black-brown and white hair-like scales; tegulae with two poorly defined oblique bands; femur and tibia clothed in a mixture of black and white hair; tarsus banded black and white. **Dorsal forewing** – with an even mixture of brownish-black and white scales, appearing gray. Lines black but not strongly contrasting with ground and difficult to trace. Basal line indicated by a small patch of black scales, antemedial line black, complete, more prominent than other lines, straight to anal vein, bending distad before continuing to lower margin; medial line faint, slightly erratic, less prominent than basal line and difficult to trace in some specimens, merging or nearly so with black scales at end of cell; postmedial line slightly more prominent and more erratic, bending distad at fold and wandering outward toward costa; subterminal line erratic, bordered on distal side mainly on upper half by a few white scales; terminal line black, broken at veins; fringe black, lightly checkered with white at veins. Normal spots obsolete, except reniform spot indicated by a small, dark, poorly defined crescent or bar at end of cell; veins lightly lined with dark scales. **Dorsal hindwing (male)** – white with four very faint diffuse bands formed by tiny hair-like scattered gray scales, with long pale-gray hairs along inner margin and a dark gray-black terminal line; fringe dark gray black, lightly checkered at veins. **Dorsal hindwing (female)** – as in male, but with a heavier dusting of small dark scales forming wider bands, appearing light gray overall. **Abdomen** – covered with short stiff brownish-black and white hair-like scales. **Male genitalia** – (Fig. 45) valve relatively short, sacculus large, extending two-thirds distance across valve, with rows of small saw-like teeth along inner ridge; cucullus extending only a short distance beyond clasper, ending in a small wing-like flap folding in toward clasper; clasper large with almost half length extending past upper margin of valve, straight, tapering to a wide base; tegumen with ear-like subuncal lobes; uncus nearly obsolete, reduced to a pair of widely spaced flat rounded lobes, reminiscent of arachnid palps; aedeagus $2 \times$ as long ventrally as dorsally; inflated vesica a short oblong sac, about $2 \times$ as long as wide, exiting aedeagus at 90 degrees dorsad, with a large teardrop-shaped field of densely packed fleshy-appearing spines on right side near terminus; ductus exiting from terminus of vesica, oriented anteriorly. **Female genitalia** – (Fig. 58) papillae anales large, soft, oblong, with sparse fine long setae; posterior and anterior apophyses approximately equal in size and of average length; sterigma poorly developed, lightly sclerotized, with two large shallow indentations above ostium; ductus bursae short, wide, expanding into a thicker walled wrinkled section with a series of parallel

wrinkled and sclerotized “gullies” along dorsal wall, widening gradually into an oblong, thin-walled translucent corpus bursae, without signa; ductus seminalis exiting dorsad on upper right.

Distribution and biology. *Panthea apanthea* is known from only 10 specimens and from only three areas in the southwestern United States; Coconino County and Apache County (White Mountains) in Arizona, and El Paso County in east-central Colorado (Fig. 69). It has been collected at moderate elevations (1500-2150 m) during the first three weeks of August. Nothing else is known of its biology.

Remarks. The essentially obsolete uncus, poorly developed sterigma, and the replacement of the one to three large cornuti found on the aedeagus in all other species of New World *Panthea* by a dense patch of fleshy spines (Fig. 45), are all unique among the New World *Panthea*. However, similar fields of small spines are present in other genera of Pantheinae e.g., *Lichnoptera decora* (Morrison) (Fig. 44), *Colocasia coryli* (L.), as well as in *Panthea ronnyi* Thony, recently described from North Vietnam (Thony 1996). This suggests that the large sclerotized cornuti present in all other New World taxa is a derived character, and that *P. apanthea* is the most basal of the New World *Panthea*. *Panthea apanthea* has such divergent genitalia that an argument could be made for placing it in a genus of its own; however, in all other characters (form of the bipectinate antenna in male; reduced, apparently non-functional mouthparts and palps; overall color and pattern) it is placed in *Panthea* to maintain a more inclusive concept of the genus. DNA ‘barcode’ fragment data of *cox1* mtDNA (Ratnasingham and Hebert 2007) also places *apanthea* with *Panthea*.

Panthea reducta species-group

The *Panthea reducta* species-group includes only *P. reducta*.

Panthea reducta Anweiler, sp. n.

urn:lsid:zoobank.org:act:B84ACB81-796A-43FD-89C9-BEFB55E0FFC4

Figs. 3, 47, 70

Type material. **Holotype** male – “Republica Dominicana: / Pedemales; P.N. Sierra de Bahoruco / Caseta 2; 18°12.24' N 71°31.11' W / 12 v 2004 *el.* 1790 m A Luz Mercurio / *coll.* D. Lawrie and C. Nuñez”; HOLOTYPE / *Panthea reducta* / Anweiler” [red label]; deposited in CNC [for eventual return to Dominican Republic]. **Paratypes** – (4 ♂): Dominican Republic, same data as holotype, except 1 ♂, 11.vi.2004 [CNC – for eventual return to Dominican Republic].

Etymology. The name refers to the greatly reduced size and density of scales on the hindwing.

Diagnosis. *P. reducta* can be recognized as a *Panthea* by the typical *Panthea* forewing pattern, and by structural characters including the reduced and apparently non-

functional mouthparts and characteristic modified *Panthea* uncus. The glassy translucent hindwing is unique in *Panthea*. It is also the only *Panthea* known from the Caribbean. Females are unknown.

Description. Head – male antenna bipectinate, pectinations about $2 \times$ as long as width of antennal shaft; head and collar clothed in long dense white, light-gray, and brown-black hair-like scales. **Thorax** – with long dense white and black hair-like scales, tegulae crossed midway and along edge by poorly defined dark bands. **Dorsal forewing** – length 16–18 mm, ($n=4$), ground a mixture of white, gray-brown and black scales; basal line indicated by a small patches of black scales; antemedial line black, erratic, angled distad at anal vein; medial line broad, incomplete and poorly defined, most prominent as patches of black scales below cubital vein and at and below costa; postmedial line black, slightly erratic, angled outward below vein Cu₂, defined by white scales bordering distal side; subterminal line parallel to postmedial line, starting at anal angle, almost obsolete and defined by white scales outlining distal border; fringe gray with bright white outer edge, checkered with white at veins. **Dorsal hindwing** – translucent, clothed in tiny hair-like black scales, some finely forked at the tip under magnification, mixed with sparse long dark hair, densest along inner margin; white scales confined to small area along upper and lower margin; fringe black, with white tips in some specimens, checkered at veins with white; wing membrane exposed by reduced scales, glassy, translucent, allowing the lettering on label below to be clearly discerned through wing. **Abdomen** – clothed in short stiff lead-gray and white hair-like scales. **Male genitalia** – (Fig. 47) valve simple, short and broad, approximately $2 \times$ as long as wide; cucullus bluntly rounded; clasper well-developed, slightly flattened, rod-like with a blunt tip, about $\frac{1}{2}$ as long as width of valve at midpoint; tegumen with pair of small subuncal lobes; uncus approximately $2 \times$ as wide as high, resembling a duck's beak; tapering gradually to a broad, blunt terminus; aedeagus short, thick, about $3 \times$ as long as wide; inflated vesica bulbous, short, wide, shaped like a hammer head, armed with a single large sharp curved cornutus on dorsal side near base, oriented anteriorly; ductus seminalis exits near base of vesica on dorsal side.

Distribution and biology. *P. reducta* has been collected at 1800 m elevation in a Hispaniolan pine (*Pinus occidentalis* Swartz) forest in Sierra de Bahoruco National Park in the Dominican Republic (Fig. 70). Hispaniolan pine is the presumed larval host.

Panthea judyae species-group

The *Panthea judyae* species-group is comprised of three species that occur in pine forests of western North America south to Guatemala in Central America: *P. judyae*, *P. gigantea*, and *P. guatemala*. The group is characterized by a large bifurcate scoop-shaped clasper, bulbous vesica with two large curved cornuti and anterior oriented ductus in the male, and a large, massively sclerotized sterigma in the female.

***Panthea judyae* Anweiler, sp. n.**

urn:lsid:zoobank.org:act:77024DF7-A3FD-4FB4-850F-E2B6E54E11F9

Figs. 4-5, 46, 59, 69

Type material. Holotype male: “USA [United States of America]: NEW MEXICO: / Socorro Co. [County]. Cibola N. F. [National Forest]. / pine forest, elev. 7620' / 33° 55.1' N 107° 36.9' W / 28 July 1991 / Eric H. Metzler”; “HOLOTYPE / *Panthea judyae* / G.G. Anweiler” [red label]; “Moths of AB & BC / Barcode Voucher / G.G. Anweiler” [pink label]; “UASM 99688”; deposited in CNC. **Paratypes**: 8 ♂, 2 ♀. United States. New Mexico: same data as holotype, 1 ♀; Grant Co., Gila National Forest. at Emory Pass, Eric Metzler (2 ♂); Grant County., Big Burro Mountains, Gila National Forest, Tyrone Rd. 3 mi. west of Hwy. 90 (13 mi. SSW Silver City), 32°37.10'N, 108° 24.34' W, 6300', 12.viii.2001, at MV light in Ponerosa Pine forest, D. Lawrie (2 ♂); Pinos Altos (above Silver City), 1981 m. el., 14.viii.1987, Ron Leuschner, coll. (1 ♂); Arizona: Cochise Co., Huachuca Mountains, Copper Canyon, 1829 m, 30.vii.2000, B. Walsh, coll. (1 ♂, 1 ♀). (CNC; USNM; LACM; UASM).

Additional material examined. 4 ♂, 1 ♀ from northern Mexico that are slightly larger and darker than the type material and have been excluded from the type series. Two additional male specimens from Arizona missing abdomens are also excluded: Mexico: Chihuahua, Sierra de la Catarina, 18 road miles southwest Buenaventura, 2408 m. el., 21.viii.1976, J.P. & K.E. Donahue, coll. (1 ♂); Sierra de Choreachic Microwave Station on Hwy. 16, 14 road miles west Cuauhtemoc, 2316m, 22.viii.1976, J.P. and K.E. Donahue, coll. (1 ♂); Creel, 13.vii.1968, T. McCabe, coll. (1 ♀); same locality and coll., 11.viii.1969 (1 ♂) and 8.viii.1969 (1 ♂). United States: Arizona, Cochise Co., Huachuca Mountains, Sunnyside, 9.vii.1958, Lloyd Martin, coll. (2 ♂).

Etymology. I take pleasure in naming this moth after my wife, Judy Weisgarber, in appreciation for her patience and support in her role as “moth widow.”

Diagnosis. The combination of small size (male FW length 16-19.5 mm; female 22 mm) and white hindwing will separate *P. judyae* from all other *Panthea* except *P. apanthea*. The more complete and strongly contrasting black lines on the forewing and the massive sterigma and prominent uncus will separate *P. judyae* from *P. apanthea*.

Description. Sexually dimorphic, female significantly larger and with darker hindwing than male; forewing length of male 17-19 mm, female 21-22 mm; male with bipectinate antenna, female with simple antenna. **Head** – male antenna with pectinations 1.5 x as long as width of antennal shaft; palps reduced, clothed in dark gray and black scales, frons light gray with scattered black hair-like scales. **Thorax** – collar and thorax a mixture of light-gray, dark-gray and black hair-like scales; tegulae with two oblique black stripes; legs densely covered with long brownish-black and gray hairs; tarsus banded light gray and black. **Dorsal forewing** – grizzled or powdery gray, produced by an even mixture of very pale-gray and dark brownish-black narrow scales; basal line indicated by a few black scales; antemedial line prominent, black, straight; medial line similar to antemedial line but angled slightly toward base between veins CuA2 and 1A+2A; postmedial line more oblique, angled toward base below vein M3, approaching

or meeting medial line between veins CuA2 and 1A+2A before angling slightly distally before reaching lower margin; subterminal line erratic and mostly obsolete, marked with black from costa to near vein M1, then traceable by lighter scales bordering distal side; veins on outer third of wing lightly lined with dark scales; fringe dark brownish black with scattered white scales; reniform spot faintly indicated at end of cell by an oval or crescent of darker scales. Female forewing proportionally broader than male; color and markings as in male but slightly darker gray. **Dorsal hindwing** – male white with long gray hair along the inner margin and small patches of light-gray scales along leading edge, at cell, and forming an indistinct postmedial band ending in a gray patch where it meets margin at anal angle; veins lined with gray brown scales; terminal line narrow, brownish black; fringe white with scattered dark scales. Female hindwing darker than that of male, crossed by three broad, poorly defined gray bands with areas between bands mixed with scattered gray scales creating an overall gray tone hardly contrasting with forewing; fringe an even mix of dark and light scales, with white scales marking veins. **Abdomen** – with short, stiff brownish-gray scales, paler at joints and appearing slightly banded. **Male genitalia** – (Fig. 46) valves simple in form, heavily sclerotized, cucullus rounded to a rough ragged terminus; clasper scoop-shaped with double blade-like arms, upper arm extending across valve to or just beyond upper margin, lower arm much shorter and buttressing upper arm; tegumen with two ear-like subuncal lobes; uncus with a wide base and raised crown ridge, tapering to a narrow, rounded terminus; aedeagus short, curving down and flaring into a plate-like extension on lower side, which appears to support inflated bulbous vesica that exits aedeagus ventrad at almost 90 degrees; vesica armed with a large slightly curved cornutus on right side near base and a similar but much smaller cornutus at apex; vesica tapering abruptly into a long narrow dorsally oriented ductus seminalis. **Female genitalia** – (Fig. 59) papillae anales a pair of soft, curved bands clothed with sparse long hair; sterigma massive, heavily sclerotized, fused above ostium; ductus bursae short and very broad, thickly sclerotized for about ½ its length, slightly farther on right side, narrowing abruptly to neck of non-sclerotized thin-walled teardrop-shaped corpus bursae; bursa covered in rows of minute spicules visible under higher magnification; without signa.

Distribution and biology. *Panthea judyae* has been collected in the Mogollon and Big Burro Mountains of southwestern New Mexico, the Huachuca Mountains of southeastern Arizona, and the Sierra Madre Occidental of northern Mexico, at elevations of 1800–2400 m (Fig. 69). Collection dates range from July 9–August 28. Two of the Arizona specimens were collected in Ponderosa pine forest.

Panthea gigantea (French)

Figs. 6–9, 48, 60, 70

Platyserura gigantea French 1890: 134.

Panthea gigantea (French); Smith 1891: 34; Franclemont and Todd 1963: 134.

Diphthera gigantea (French); Draudt in Seitz 1924: 18.

Type material. *Platycerura gigantea* was described by French from a single male received from David Bruce from Colorado, where he is known to have traveled and collected widely (Brown 1966). A search for the type, which was retained by French (Smith 1893), has been unsuccessful and it is apparently lost, possibly in the fire that destroyed much of his collection in 1892 (Southern Illinois University Carbondale 2009). As it appears the present concept of *P. gigantea* may encompass more than a single taxon, the following neotype is designated to establish stability of the name: **Neotype** male – “CO [Colorado] / Larimer Co.[County]”; “Estes Park [40° 22.315' N 105° 31.645' W] / 15 July 1993 / R. A. Belmont / UV BL”; “NEOTYPE / *Platycerura* / *gigantea* French / Anweiler 2009” [red label]; deposited in CNC. The neotype is a male missing the left antennae and showing minor greasing, but is otherwise in good condition.

Diagnosis. *Panthea gigantea* is on average the largest New World species of *Panthea* with some females having a wingspan in excess of 6 cm. Only *P. guatemala* from southern Mexico and Guatemala and some populations of *P. virginarius* from the western USA overlap *P. gigantea* in size. The male of *P. gigantea* can be recognized by the combination of large size (FW length 22-27.5 mm), dark gray-black, or gray-brown (Mexico only) forewing and contrasting white hindwing, and can be separated from all other New World *Panthea* by the unique bifurcate uncus. The female of *P. gigantea* can be separated from that of *P. guatemala* by range (Fig. 70) and by the much less extensively sclerotized ductus bursae of *P. gigantea* (Fig. 60) and from the female of *P. virginarius* (Fig. 61) by the much larger and more heavily sclerotized sterigma of *P. gigantea*.

Distribution and biology. *Panthea gigantea* is found throughout much of the warmer and drier regions of western North America from south-central British Columbia, Canada south to the state of Durango, Mexico and from the Black Hills of South Dakota, western Nebraska and the Texas Panhandle west to Washington, Oregon and the coast of California (Fig. 70). *Panthea gigantea* is replaced in the cooler and more humid Pacific Northwest and northern Rocky Mountain regions by *P. virginarius*. *Panthea gigantea* is associated with Ponderosa pine forest (*Pinus ponderosa* Dougl. [ex Laws.]), and Ponderosa pine is the only known larval host. (Duncan 2006; Anweiler unpub.). The larva of *P. gigantea* was illustrated in color by Duncan (2006).

Remarks. Compared to material from farther north and west, specimens of *P. gigantea* from Arizona and New Mexico show differences in the genitalia of both sexes, including in the proportions and shape of the valve in the male and the width and length of the ductus bursae in the female. DNA ‘barcode’ fragment data of *cox1* mtDNA for 6 specimens from Arizona and New Mexico show a mean difference of about 1.7 % from two specimens from Idaho and British Columbia, and sequence from a single specimen from west central California is about 1.8 % divergent from the Idaho-British Columbia samples and about 0.8 % divergent from the Arizona-New Mexico samples (Anweiler unpublished data). The forewings of the four Mexican specimens examined are gray brown instead of gray black with a less “powdery” appearance, so the antemedial, medial and postmedial lines contrast much more prominently than on

non-Mexican material (Figs. 8, 9). Additional and more recent material is needed in order to evaluate the taxonomic status of these different *P. gigantea* populations.

***Panthea guatemala* Anweiler, sp. n.**

urn:lsid:zoobank.org:act:B73B5B00-C011-41B9-B7A2-0F285C41234E

Figs. 10-11, 49, 61, 70

Type material. Holotype male – “GUATEMALA / San Lorenzo 1700 m [15° 7.002' N 89° 37.998' W] / 6-10.vi.1986 / P.T. Dang”; “HOLOTYPE / *Panthea* / *guatemala* / G.G. Anweiler” [red label]; deposited in CNC. **Paratypes** (17 ♂, 2 ♀): same data as holotype (10 ♂); MEXICO. Chiapas: Lagos de Colores, Route 17, 13.vi.1969, A. Mutura, coll. (1 ♂); San Cristobal, 21 miles southeast, Rt.190, 1850 m, 30.vi.1989, Wolfe, Valverde and Mullins, coll.(1 ♂); Tapilula, 21.vi.1969, A. Mutuura (2 ♂). Oaxaca: Tierra Azul, 3 mi. n. Tlaxiaco, 7.viii.1992, 7500', H. Romack., coll. (1 ♂); 7 mi. s. Miahuatlan, 19.viii.1992, 7000', H. Romack, coll. (1 ♂, 1 ♀); 3 mi. e. La Trinidad, 2.viii.1992, 8500', H. Romack, coll. (1 ♂); Sierra Juarez, Gulf slope, 4500', 8.iv.1992, J. Kemner, coll., (1 ♀); Sierra Madre del Sur, ca. 32 km N. San Gabriel Mixtepec, 1590 m., 10.vii.1991, J. Kemner and H. Romack, coll. (1 ♂). [LACM; CNC; NYSM].

Etymology. The name refers to the country Guatemala, where the holotype and much of the type series originated.

Diagnosis. *Panthea guatemala* is externally very similar to *P. gigantea* from northern Mexico. Their large size will separate them from all other Mexican *Panthea* except *P. gigantea*. Both sexes of *P. guatemala* can be separated from *P. gigantea* by range (Fig. 70) and by genitalic characters, the male by the narrow fused uncus (Fig. 49), which is bifurcate in *P. gigantea*, and the female by the laterally compressed and heavily sclerotized ductus bursae of *P. guatemala* (Fig. 61). Both sexes of *P. guatemala* have a faint but consistent white streak on the lower forewing from just basad of the antemedial line to just beyond the postmedial line; this streak is absent or much fainter in *P. gigantea*.

Description. Sexually dimorphic; female larger and with broader forewing and darker hindwing than male; forewing length of male 22-25 mm, female 27-28 mm. **Head** – male antenna bipectinate with pectinations about 1.5 × as long as width of antennal shaft; female antenna simple; palps and frons a mix of dark brownish-gray and white hair-like scales. **Thorax** – collar and thorax a mix of dark brownish-gray and white hair-like scales; tegulae crossed by two diffuse oblique brownish-black bands; legs densely covered with long wooly gray-black and white hairs; tarsi banded white and gray. **Dorsal forewing (male)** – a mix of white and brownish-gray scales producing a smooth pale brownish-gray ground; basal line poorly marked; antemedial, medial and postmedial lines prominent, black; basal and antemedial lines straight or nearly so, medial line sinuous, bending outward at cubital vein then continuing almost straight to lower margin; postmedial line straight to vein M2, then bending inward and connecting with medial line in fold, diverging outward just before reaching lower margin;

subterminal line nearly obsolete, very erratic, curving inward between veins M1 and M3, M3 and CuA1, CuA1 and 1A+2A, and defined by abrupt shift from gray to white scales, shading back to gray prior to reaching margin. A short, thin poorly defined black bar marks end of cell, and a faint diffuse white dash runs parallel to and below cubital vein between antemedial and postmedial lines. Fringe gray brown lightly checkered with white scales at veins. **Dorsal forewing (female)** – as in male but broader, more rounded and with fewer white scales and therefore darker overall. **Dorsal hindwing (male)** – white with long gray-brown hair, darkest in basal area and along inner margin; leading edge light gray; poorly defined faint light-gray medial and postmedial bands, latter terminating in a patch of gray at anal angle; narrow dark-gray terminal line; veins narrowly lined with dark gray; fringe white with a few dark scales between veins. **Dorsal hindwing (female)** – suffused with gray, medial band narrow, postmedial band much wider leaving only a narrow band of lighter scales along margin; terminal line wider than in male; fringe dark gray with a few white scales, checkered with white at veins. **Abdomen** – clothed with stiff brownish-gray hair. **Male genitalia** – (Fig. 49) valves simple, heavily sclerotized, cucullus rounded to a blunt ragged point; clasper large, scoop-shaped with double blade-like arms, inner branch longer, extending beyond upper margin of valve; tegumen with two large squared subuncal lobes; uncus flattened laterally with high rounded crown curving down, ending in narrow terminus bluntly to sharply truncated; aedeagus about $4 \times$ as long as wide, somewhat flattened, flaring at terminus; vesica bulbous, tapering gradually into long ductus seminalis angled dorsad at about 45 degrees, oriented anteriorly; armed with two large cornuti, one on right near base, other larger and near crown. **Female genitalia** – (Fig. 61) papillae anales large, soft, thinly covered with stiff hairs, fused at base on dorsal side; sterigma massive, rounded, relatively smooth; ductus bursae wide, twisted to right, compressed laterally, thickly sclerotized for half its length or more before gradually flaring into corpus bursae; corpus bursae an oblong thin-walled sac, without signa.

Distribution and biology. *Panthea guatemala* has been collected in the mountains of Guatemala and the states of Oaxaca and Chiapas in adjacent southern Mexico at elevations of 1580-1850 m (Fig. 70). Collection dates range from late May to late July (Mexico) and early November (Guatemala). The Guatemala specimens were collected in pine-oak forest at 1700 m.

Panthea furcilla species-group

The *P. furcilla* species-group is closely related to the *P. acronytoiodes* group. It includes two species, *P. furcilla* (Packard) and *P. greyi* sp. n. *Panthea furcilla* is further segregated into two subspecies, with *P. furcilla australis* ssp. n. described as new. The group is characterized by the long, narrow vesica, 3-5 \times as long as wide when everted and inflated, armed with a large terminal cornutus (Figs. 54-56), and by the elongated corpus bursae, partially constricted mesially forming a thick-walled outer section and a translucent thin-walled inner section (Figs 65-68).

Panthea furcilla furcilla (Packard)

Figs. 12-18, 54, 65, 71

Platycerura furcilla Packard, 1864: 3: 331.

Panthea furcilla (Packard); Smith 1891: 31; Smith and Dyar 1898:15; Dyar 1902: 98; Smith 1903: 98; Barnes and McDunnough 1917: 83; McDunnough 1938: 54; Franclemont and Todd 1983: 134.

Diphthera furcilla (Packard); Draudt. In: Seitz 1924: 18.

Panthea furcilla pallescens McDunnough, 1937: 153; McDunnough 1938: 54. **New synonymy.**

Panthea pallescens McDunnough, 1942; Forbes 1954: 291; Franclemont and Todd 1963: 134.

Panthea pallescens centralis McDunnough, 1942: 94; Franclemont and Todd 1983: 134. **New synonymy.**

Panthea pallescens var. *atrescens* McDunnough, 1942; Franclemont and Todd 1983: 134. unavailable infrasubspecific name. **New synonymy.**

Type material. *Platycerura furcilla* Packard, 1864. (2 syntypes, one apparently lost). The extant syntype is a dissected male in MCZ, Cambridge MA bearing the following labels: “*Furcilla* Type”/ “M.C.Z. Type 26319”/ *Platycerura furcilla* Pack. Type”/ “745”/ #245” and is accompanied by a slide preparation of the valves, aedeagus with everted vesica, and abdominal pelt, with two labels reading “MCZ 1139”/ and “#MZ –1 *Platycerura furcilla* Pack. Type J.G. Franclemont.” This specimen is hereby designated as lectotype and a label printed on red card reading “Lectotype/ *Platycerura furcilla* Pack./ G.G. Anweiler 2009” will be placed with the specimen. Dorsal and ventral images of the specimen, the slide and all labels except the lectotype label are available online at <http://insects.oeb.harvard.edu/MCZ/FMPro>.

Type Locality: Massachusetts, USA.

Panthea furcilla pallescens McDunnough, 1937. Holotype male, CNC, examined. Type locality: White Point Beach, Queens Co., Nova Scotia, Canada.

Panthea pallescens centralis McDunnough, 1942. Holotype male, CNC, examined. Type Locality: Norway Bay, Québec, Canada.

Panthea pallescens var. *atrescens* McDunnough, 1942. Holotype male, CNC, examined. Type Locality: Norway Bay, Québec, Canada. Unavailable infra-subspecific name.

Diagnosis. The genitalic characters defining the *P. furcilla* species-group (inflated vesica elongate with a single terminal cornutus in the male; corpus bursae partially constricted creating two sections in the female) will separate *P. furcilla* from all other *Panthea* except *P. greyi*. The male of *P. furcilla* can be separated from that of *P. greyi* by range (*P. greyi* west of the Great Plains from Colorado south, *P. furcilla* in Canada and eastern United States east of the Great Plains), and by the much smaller, straighter, terminal cornutus on the vesica. The female of *P. greyi* has a wide ductus bursae that gradually expands into the corpus bursae; *P. furcilla* has a narrow ductus that expands

abruptly into bursa. Nominate *P. furcilla* can be separated from ssp. *australis* by the second, smaller cornutus near the base of the vesica in *australis*.

Distribution and biology. *Panthea furcilla* occurs widely in coniferous woodlands, in particular pine forests, throughout eastern USA and eastern Canada, from eastern Texas east to Florida, north to the northern edge of the boreal forest in Canada, west to northeastern British Columbia (Fig. 71). Adults fly almost year round at the southern edge of the range in Texas and Louisiana (V. Brou pers. comm.), with the flight period shortening to June and July in boreal Canada.

Remarks. For the past 50 years, since McDunnough (1942) treated *pallescentis* as a species apart from *P. furcilla*, the name *pallescentis* has generally been applied at the species level to the smaller, lighter gray populations of *Panthea* occurring widely across the northeastern United States and boreal Canada; they are characterized as having a single cornutus on the vesica. The name *furcilla* has generally been used for the larger, darker *Panthea* in southeastern United States that has a second smaller “rose-thorn” cornutus on the vesica near the base. McDunnough sent specimens from eastern Canada and from New Jersey to a Dr. Banks to compare with the type of *furcilla* in MCZ, and based on the response he received, concluded that the male genitalia of *furcilla* had a short, thick pointed cornutus in the vesica and an apical spine of the so called rose-thorn type. The primaries were of a rather even purplish gray with all cross-lines very heavy and black with scarcely any white edging except on the outside of the subterminal line (McDunnough 1942). Based on this information, McDunnough elevated the pale northern population that he had initially described as ssp. *pallescentis* to species status (McDunnough 1942). However, examination of images of the male type of *furcilla* and in particular the genitalic slide, shows clearly that the type of *furcilla* is a specimen of the smaller, paler northern *Panthea* lacking the second “rose-thorn” cornutus, and that the name *pallescentis* is a junior synonym of *furcilla*.

The relationship of these two forms, one smaller and paler with a single cornutus and one larger and darker with a second cornutus (and corresponding differences in the female genitalia) is problematic. There is no clear-cut boundary between the two populations, and no place where the two occur together. Although differing significantly from each other in size, color and genitalic structures over most of their range, specimens gradually shift in all characters from one type to the other across a band from Kentucky north and east through southern Pennsylvania, Maryland and New Jersey (Figs. 19-20, 56 a-d, 66). This appears to be another example of a species separated during the last glacial maximum into populations northwest and southeast of the Appalachians that have since re-established contact, as has been proposed for *Grammia virgo* by Schmidt (in press). Arguments can be made for recognizing these two taxa as either species or as subspecies; however based on the fact that they show a progressive gradation from one form to the other in color, pattern and genitalic structures, as well as the fact that the two forms do not occur together anywhere, I treat these populations as a single species. The southern form is described as a new subspecies.

True melanic specimens of *P. furcilla* (Fig. 18) are common in some populations of nominate form in eastern United States (Klots 1964, Klots 1966, Klots 1968; Ginevan

1971). Melanic specimens are overall sooty brown with the black lines standing out. Form *atrescens* (Fig. 16) from Ontario and Quebec is a black and white form, very different in appearance from true melanic specimens.

***Panthea furcilla australis* Anweiler, ssp. n.**

urn:lsid:zoobank.org:act:F22C8E8D-9DAE-4C15-A215-6BD0ED85D641

Figs. 21-24, 55, 67, 71

Panthea furcilla of authors, not Packard, 1864.

Type material. **Holotype** male – United States. "GEORGIA: Whitfield Co.[County] / Rocky Face Area / 16.x.1992, at light / J. K. Adams"; "HOLOTYPE / *Panthea furcilla* / ssp. *australis* / Anweiler" [red label]; "UASM# 57801"; [34° 48.311 N 85° 1.655 W]. deposited in CNC. **Paratypes** (12 ♂, 7 ♀): UNITED STATES: Georgia: Whitfield County, Rocky Face area, 3.viii.1992 (1 ♂); 14.x.1992 (1 ♂); 27.iv.1993 (1 ♂); 9.ix.1993 (1 ♂); 15.ix.1993 (3 ♀); 19.ix.1993 (1 ♀); 28.ix.1993 (1 ♀); Rocky Face area, junction Hwys. 41/201, 27.iv.1992 (2 ♂); Dalton area, 19.iv.1991 (1 ♀); 25.v. 1991 (1 ♀); 4.ix.1992 (2 ♂); 28.ix.1992 (1 ♂); 27.iv.1994 (1 ♂); 20.vi.1997 (1 ♂); Carbondale, exit 326 off I-75, 23.iii.2002 (1 ♂); all J.K. Adams, coll. [CNC; UASM; USNM; JKA]

Etymology. *Australis* is Latin for southern and refers to the fact that *australis* occupies the southern part of the range of *P. furcilla*.

Diagnosis. *Panthea furcilla australis* can be separated from all *Panthea* species other than those of the *P. furcilla* species-group by the characters given above in the *P. furcilla* species-group diagnosis. The larger size, darker gray color and in particular the presence of a second cornutus on the vesica of the male, will separate males of *australis* from those of both *P. greyi* and nominate *P. furcilla*. Females of ssp. *australis* can be recognized by the larger size and darker color, and by the narrow sclerotized strap-like ductus bursae with few folds compared to the narrow and finely corrugated ductus of nominate *P. furcilla* and wide, deeply wrinkled ductus of *P. greyi*. Intermediate specimens from the zone of contact along the northwestern side of the Appalachian Mountains, from Kentucky north and east to southern Pennsylvania and New Jersey, can be recognized by the gradual loss of the *australis* characters, and in particular in the gradual reduction in the size of the smaller cornutus in the vesica of the male. These three taxa are also separated by range, with *australis* in southeastern United States, nominate *furcilla* in the northeastern United States and Canada, and *P. greyi* in the southwestern United States (Fig. 71).

Description. Sexes dimorphic, with female larger and darker than male; male forewing length 18-22 mm; female forewing 24-25 mm. **Head** – male antenna bipectinate, female antenna simple; Palps reduced, clothed in dark red-brown and black scales. **Thorax** – and tegulae a mixture of dark red-brown and pale gray or white hair-like scales, appearing gray; tegulae with an oblique black medial band and black edging. **Dorsal forewing** – ground a mixture of black and white scales, appearing light

gray powdered with black, crossed by five prominent black lines; Basal line indicated by small patches of black scales, antemedial line complete, straight or nearly so, medial line complete, angled distad slightly in most specimens to meet postmedial line in fold before separating and slanting basad to lower margin; postmedial line similar in form to medial line to about vein M1, bending basad to meet medial line in fold before angling distad to lower margin; subterminal line broad, erratic, usually incomplete, jutting outward between veins R4 and R5, at veins M1 and M2, and at lower margin of wing; area distad to lower postmedial line and in particular distad to subterminal line suffused with white scales; fringe dark gray or black, checkered with white at veins; faint pale gray longitudinal streak on basal half of wing above and below cubital vein.

Dorsal hindwing – dull gray, slightly darker in basal half, with faint dark medial band, diffuse postmedial band; terminal band white, incomplete, often reduced to a narrow marginal patch of white scales, especially in female; fringe white between veins with gray on veins. **Abdomen** – clothed in short, stiff light and dark-gray hair-like scales.

Male genitalia – (Fig. 55) valve simple, cucullus tapering to a blunt terminus; clasper simple, flat, blade-like s-shaped, arising from lower margin at distal end of sacculus, approximately as long as valve is wide at that point; tegumen with large triangular subuncal lobes; uncus laterally compressed with a high crown, tapering to a rounded terminus with a flattened tip; aedeagus 4-5 × as long as wide, slightly bent ventrad, expanding at apex, terminating in a semi-detached or detached plate on left side bearing a prominent, sharp cornutus; inflated vesica long and narrow, approximately 4 × as long as wide, bending ventrad near base and expanding into a slight pouch before gradually tapering to terminus; armed with a large, sharp terminal cornutus; ductus seminalis exiting at right-angle dorsad near base of vesica. **Female genitalia** – (Fig. 67) papillae anales short, wide, soft, curved, with sparse setae; sterigma well-developed and sclerotized, but not massive; ductus bursae heavily sclerotized, strap-like, 3-4 × as long as wide, bent and twisted near middle with several longitudinal folds or corrugations in posterior half, expanding abruptly into a large oblong corpus bursae, partially constricted midway, forming approximately equal-sized upper and lower sections; upper section with partially sclerotized, thickened walls; lower section thin-walled, translucent; without signa.

Distribution and biology. *P. furcilla australis* occurs in pine woods throughout the southeastern United States from eastern Texas and Florida north approximately to Virginia (Fig. 71). A single specimen has also been seen from Oregon County in southeastern Missouri. *Panthea furcilla australis* intergrades with nominate *P. furcilla* in a band along the northwest side of the Appalachian Mountains; specimens from Kentucky, Maryland, southern Pennsylvania and New Jersey are variably intermediate.

A series of specimens in MSU labeled as collected in Starr County, Texas is assumed to be mislabeled, as there is no coniferous habitat in Starr Co. (C. Bordelon pers. comm.).

Specimens of *australis* from northern Georgia were seen from every month from March through October. In Louisiana it has been collected year-round, with peaks at approximately 30-day intervals except in May and June (V. Brou pers. comm.).

***Panthea greyi* Anweiler, sp. n.**

urn:lsid:zoobank.org:act:0225DA43-EDA5-458B-AE4D-64188BAB8944

Figs. 25-27, 57, 68, 71

Type material. **Holotype** male – UNITED STATES “AZ [Arizona] Cochise Co.[County] 7700 ft / Chiricahua Mtns [Mountains], Onion / Saddle MV lights / 4 Aug 2000 J.B. Walsh leg.”; “HOLOTYPE / *Panthea greyi* / Anweiler” [red label]; [31° 56.006' N 109° 15.804' W]. Deposited in CNC. Paratypes (32 ♂, 4 ♀): UNITED STATES. Arizona: Cochise County: same data as holotype (1 ♂); Chiricahua Mtns, Pinery Canyon, Upper Camp, 5.vii.1956, 1 ♂, 1 ♀); same locality and coll., 6.vii.1956 (1 ♂); same locality, 7.vii.1956, Lloyd Martin, John A. Comstock and Will. A. Rees, coll. (2 ♂); Chiricahua Mtns, Pinery Canyon, 6800', 26.vii.1965, RH Leuschner, coll. (2 ♂); same locality and coll., 26.vi.1992 (1 ♂); Pinery Canyon cmpgd, 31.93° N 109.27° W, 6500' 5.viii.08 C. Schmidt and B. Walsh (3 ♂). Apache Co., White Mountains, Greer, 8300', 1-3.vii.1993, R. Leuschner, coll. (2 ♂); same locality and coll., 24-25.vii.1965 (2 ♂); same locality and coll., 8200', 6.vi.1990 (1 ♂); Greer, 28-30.vii.2005, James Adams and Doug Yanega, coll. (1 ♂); Junction Hwy. 260-373, 2.vii.1986, Pat Savage, coll. (1 ♂). Graham Co.: Pinaleno Mtns, Mt. Graham, Pine Crest, 7300', 28.vi.1955, Lloyd Martin, John A. Comstock and Will. A. Rees, coll. (1 ♂). Coconino Co.: Oak Creek Canyon, 5000', 6.viii.1986, RH. Leuschner, coll. (1 ♂); same locality and coll., 7.viii.1986 (1 ♂); same locality and coll., 5500', 23.vii.1989 (1 ♂). Gila Co.: Mogollon Rim, Tonto Creek State Fish Hatchery, 6400', 21.vi.1957, Lloyd M. Martin, Robert J. Ford and William A. Rees, coll. (1 ♂). New Mexico: Colfax Co.: Sangre de Cristo Mts., Cimarron Canyon, 7900', 7.vii.1962, E. and I. Munroe, coll. (1 ♂, 1 ♀); same locality and coll., 10.vii.1962 (1 ♂). Otero Co.: 3 mi sw Cloudcroft, 8830', 23.v.2006, Greg Forbes, coll. (1 ♀); Sacramento Mtns, Dry Canyon Rd., 2.1 mi. n. Rte 82, 6 mi. east Rt. 244 at Cloudcroft., G. Forbes, coll. (1 ♂). Lincoln Co.: Ruidosa, Cedar Creek campground, 7000', 28.vii.1962, E. and I. Munroe, coll. (1 ♀). Grant Co.: Gila National Forest at Emory Pass, 32°52.5'N 107°45.0'W, 7160', 5.viii.1991, E. Metzler, coll. (1 ♂). Colorado: Larimer Co.: Big Thompson Canyon, 6500', 9.vii.1955, R.H. Leuschner, coll. (1 ♂). Archuleta Co.: Pagosa Springs, 7000', 7.vii.1988, R.H. Leuschner, coll. (1 ♂). Teller Co.: Florissant, Big Springs Ranch, 14.viii.1960, TC. Emmel, coll. (1 ♂); same locality and coll., 12.viii.1960 (1 ♂). Boulder Co.: Left Hand Canyon, 6000', 22.vii.1958, RH. Leuschner, coll. (2 ♂).

Etymology. I take pleasure in naming this species in honor of the late L. Paul Grey, who encouraged my budding interest in noctuid moths and who sent me the first specimen of this new *Panthea*.

Diagnosis. *Panthea greyi* belongs to the *P. furcilla* species-group, and can be separated from all *Panthea* with the exception of *P. furcilla* by the characters listed in the diagnosis for the group, namely the elongate vesica with one terminal spine in the male and the two-chambered corpus bursae in the female. It can be separated from *P. furcilla* by range, with *P. greyi* occurring in southwestern United States west of the Great Plains and *P. furcilla* east of the Great Plains in eastern United States and north of the Great

Plains in Canada. Externally, *P. greyi* is most similar to *Panthea virginarius* and *Panthea acronyctoides nigra*. *P. virginarius* occurs west and north of the range of *P. greyi*. *Panthea acronyctoides nigra* may occur with *P. greyi* in northern Colorado where *P. greyi* can be recognized by the light, banded hindwing and *P. acronyctoides* by the dark hindwing, as well as by the genitalic characters. *Panthea gigantea* is a larger species with two cornuti in the male vesica and a single chambered, thin-walled corpus bursae in the female.

Description. Sexes similar and overlapping in size, female only slightly darker than male; male forewing length 19-22.5 mm, female 21-25 mm. **Head** – Male antenna bipectinate, with pectinations about $2 \times$ as long as width of antennal shaft; female antenna simple; palps reduced, both palps and lower part of frons clothed in dark red-brown or black hairs; remainder of head a mixture of light-gray, dark-brown and black hair-like scales. **Thorax** – collar, thorax and tegulae a mixture of light gray, dark brown and black hair-like scales; tegulae crossed by two oblique dark bands midway and along outer edge; legs clothed in dense long light gray and dark gray hair, tarsus banded black and white. **Dorsal forewing** – ground a mix of white or very light gray and dark brownish-black scales, appearing powdery gray; crossed by five black lines; basal line marked by one or two small patches of black scales; antemedial line straight or nearly so, bending distad in fold before continuing to wing margin; medial line most prominent, straight except for bending distad slightly in fold before reaching lower margin; postmedial line narrower, erratic, bent distad at each vein and angling basad below vein CUA1, contacting or closely approaching medial line below veins CuA2 before bending distad to lower margin of wing; subterminal line incomplete, often reduced to a few dark patches of scales near upper margin, erratic, defined by white scales along distal side; fringe dark gray black, checkered with a few white scales at veins; small black bar or crescent marking the end of the cell. **Abdomen** – clothed in short, stiff dark gray-brown hair, paler at joints. **Dorsal hindwing** – white with long gray hair-like scales along inner margin, crossed by poorly defined light gray antemedial, medial and postmedial bands and with a narrow dark gray terminal line; fringe checkered with dark gray and white; veins narrowly lined with dark scales. **Male genitalia** – (Fig. 57) valve simple, elongate, cucullus rounded, clasper a simple prominent blade near apex, about as long as width of valve; tegumen with large triangular earlike subuncal lobes; uncus laterally compressed with crown approximately as high as wide; ending in a rounded terminus resembling a duck's beak viewed from above; inflated and everted vesica long, narrow, about $3-4 \times$ as long as wide, angled to left midway and armed with a single massive slightly bent or curved terminal cornutus, oriented toward head; ductus seminalis exiting midway at right angle to right. **Female genitalia** – (Fig. 68) papillae anales a pair of soft curved bands with sparse hairs; posterior and anterior apophyses about equal in size and of average length; sterigma well-developed, average in size and amount of sclerotization; ductus bursae wide, about $2 \times$ as long as wide, mostly heavily sclerotized with deep creases and folds, expanding gradually into posterior section of corpus bursae; corpus bursae slightly constricted midway, forming a thick-walled and partially sclerotized posterior section united with lower half of ductus, and a thin-walled, translucent globular anterior section.

Distribution and biology. *Panthea greyi* has been collected in the mountains of Arizona, New Mexico, Colorado and southern Utah, at elevations of 1524–2545 m (Fig. 71). Collection dates range from June 6 through September 23. It has been collected in Arizona in oak-pine woodland.

***Panthea acronyctoides* species-group**

The *P. acronyctoides* species-group contains a single species pair, *P. acronyctoides* and *P. virginarius*, with *P. acronyctoides* populations arranged into two subspecies. The male is characterized by the bulbous vesica armed with a pair of unequal-sized cornuti, the female by the globular or oval single chambered corpus bursae and a short wide ductus, about 2 × as long as wide. Both species have populations with a strongly contrasting black and white pattern, very similar in external appearance to each other and to the Palaearctic species *P. coenobita* (Esper), but not found in any other North American species. The *P. acronyctoides* group appears to be most closely related to the *P. furcilla* group. DNA *cox-1* barcode sequence data shows little differentiation within or between the two groups (Anweiler unpubl. data).

***Panthea acronyctoides acronyctoides* (Walker)**

Figs. 36–38, 53, 64, 72

Audela acronyctoides Walker, 1861: 37.

Panthea leucomelana Morrison, 1876: 428.

Diphthera acronyctoides (Walker); Draudt 1924 In: Seitz 1924: 18

Panthea acronyctoides (Walker); McDunnough 1937: 153; Franclemont and Todd 1983: 134.

Panthea acronyctoides albosuffusa McDunnough, 1937: 153; Franclemont and Todd 1983: 134. **New synonymy.**

Type material. *Audela acronyctoides*: Holotype male, Montcalm Co., Quebec, Canada, in CNC. The holotype male is in poor condition (photograph examined).

Panthea leucomelana: described by Morrison from 2 specimens, from Maine and New Hampshire. According to Smith (1893), Morrison's type is in the Tepper collection, which resides in MSU. There is a single specimen, from "Maine" in the Tepper collection at MSU, presumed to be one of the two Morrison types; the other specimen is apparently lost (Wilterding 1997). The Maine specimen bears a Lectotype label placed there by J. H. Wilterding; however this action was never published (Wilterding pers. comm.). I hereby designate this specimen as **Lectotype** of *P. leucomelana* Morrison. A label printed on red cardstock reading "LECTOTYPE"/ *Panthea* / *leucomelana* Morrison / G.G. Anweiler" will be affixed to this specimen.

Panthea acronyctoides var. *albosuffusa*. Holotype male, White Point Beach, Queen's Co., Nova Scotia, Canada (in CNC, type #4223). The holotype and 3 ♂ 3 ♀ paratypes from Nova Scotia, Canada in CNC (examined).

Diagnosis. Throughout most of its range, nominate *Panthea acronyctoides* can be recognized by smaller size and black and white or gray and white pattern. The only other *Panthea* species occurring with nominate *P. acronyctoides* is *P. furcilla*, a larger and darker gray and black species. In western North America, ssp. *nigra*, occurs with both *P. greyi* and *P. virginarius*. Both subspecies of *P. acronyctoides* can be separated from all other *Panthea* by the combination of a small spine and a second long thin spine on the male vesica, and smooth-walled ductus bursae with an expanded rim in the female.

Remarks. Although described as a subspecies by McDunnough, *albosuffusa* is clearly a form as pointed by Forbes (1954), who refers to a brood reared from eggs produced by a female *albosuffusa* that produced about ¼ *albosuffusa*, ¼ typical and ½ melanic specimens (Forbes 1954). Specimens of small dark dwarfed populations of *P. acronyctoides* have been seen from bogs in the southern four tiers of counties in Michigan. These are much smaller and darker than *P. acronyctoides* found elsewhere, and are possibly environmentally induced by the cool wet habitat they occupy. The genitalia of these specimens do not differ from those of typical *P. acronyctoides* except in size.

Distribution and biology. Nominat *P. acronyctoides* is found throughout much of the wooded parts of eastern and northern North America, from northern Georgia north to Newfoundland and Nunavut, west across the northeastern tier of states and southern and central Canada to Alberta. It intergrades with ssp. *nigra* in central Alberta (Fig. 72). Nominat *P. acronyctoides* occupies a range of coniferous habitats, including spruce, larch, fir and mixed forest.

The larva of *P. acronyctoides* is described and illustrated by Brown and McGuffin (1942).

***Panthea acronyctoides nigra* Anweiler, ssp. n.**

urn:lsid:zoobank.org:act:D0C7898C-597C-4D4D-918B-18C07D689FC9

Figs. 40-43, 52, 63, 72

Panthea angelica of authors, not Dyar, 1921.

Panthea virginarius of authors, not Grote, 1880.

Type material. Holotype male – “USA [United States of America], CO [Colorado]. Gilpin Co. [County] / Roosevelt N. F. Cpg [National Forest Campground] / 3 km S Nederland, 2600 m / 12.vii.1993, MVL / leg. B. Landry”; “HOLOTYPE / *Panthea acronyctoides* / ssp. *nigra* / Anweiler” [red label]; [39° 55.103 N 105° 30.46 W], deposited in CNC. **Paratypes:** 21 ♂, 1 ♀ UNITED STATES: Colorado: Gilpin Co.: Lump Gulch, 9.vii.1955, Hugo Rodeck, coll. (1 ♂); Allenspark, 14-15.vii.1982, W.D. Winter, coll. (1 ♂). Grand Co.: Harbison Picnic Area, RMNP [Rocky Mountain National Park], 8450', 7.vii.1995, P.A. Opler, coll. (1 ♂, 1 ♀);

same locality, 13.viii.1995, P. A. Opler and E. Buckner, coll. (1 ♂); St. Louis Creek, vic. of Fraser, 8.vii.1988, Jack Oder, coll. (1 ♂). Teller Co.: Florissant, 4.ii.1993, M.R. Belmont, coll. (1 ♂). RMNP, Sprague's, 22.vii.1933, Grace H. and John L. Sperry, coll. (1 ♂). Wyoming: Albany Co.: 0.4 mi. sw Fox Park, T13N R78W S21, 9040', 26.vii.1999, J. Nordin, coll. (3 ♂); same date and collector, Fox Park at Fox Creek, T13N R78W S21, 9040' (3 ♂); Hidden Valley Picnic Ground, T14N R72W S35, 8540', 6.vii.1999, J.S. Nordin, coll. (2 ♂); Upper Blair PG [Picnic Ground] n. of Rd. 705, T14N R71W S7, 8200', 8.vi.2000, J.S. Nordin, coll. (1 ♂); Telephone Creek, s. of Hwy. 130, T16N R79W S14, 13.vii.1999, 10170', J. S. Nordin, coll., (1 ♂); T15N R72W S35, 8550', 12-13.vi.2000, C.D. Ferris, coll. (1 ♂); T13N R78W S21, 9060', vic. FR 530, 26-27.vii.1999 (1 ♂); T14N R71W S7 SE4, 8200', 22-23.vi.1999, C.D. Ferris, coll. (1 ♂), T15N R71W S18S, 8200', 19-20.vi.1999, C.D. Ferris, coll. (1 ♂).

Etymology. The name *nigra* means black and refers to the overall dark color of the adults of both sexes.

Diagnosis. *Panthea acronyctoides nigra* can be separated from nominate *P. acronyctoides* by the overall dark coloration and by distribution, *nigra* in the foothills and mountains of western Alberta and British Columbia south to Colorado, nominate *acronyctoides* from central and eastern Alberta eastward (Fig. 72). Specimens in central Alberta are intermediate. Subspecies *nigra* occurs with both *P. greyi* (Colorado) and *P. virginarius* (north of Colorado). The three species can be very similar in external appearance, but are easily separated by genitalic characters. The male of ssp. *nigra* (Fig. 52) has two spines on a bulbous vesica, one of which is long and thin, whereas *P. greyi* (Fig. 56) has a single massive spine on an elongate vesica. The male of *nigra* can be separated from those of *P. virginarius* by the lack of the massive, curved spine near the base of the vesica present in *P. virginarius* (Figs. 50, 51). The female of *nigra* can be separated from those of both *P. greyi* and *P. virginarius* by the smooth-walled ductus bursae with an expanded rim (Fig. 63); the ductus bursae in *P. virginarius* (Fig. 62) and *P. greyi* (Fig. 68) is wrinkled or folded and without an inflated rim.

Description. Sexes similar, except female on average slightly larger and darker than male; Forewing length 18-21 mm. **Head** – male antenna bipectinate, female simple; male antennal pectinations about 1.25-1.5 × as long as width of antennal shaft; palps reduced, covered in gray-brown hairs; head and collar gray. **Thorax** – gray; tegulae gray with two oblique black stripes; legs clothed in long gray hair; tarsus banded blackish brown and light gray. **Dorsal forewing** – ground color a mixture of brownish-black and white scales producing a powdery dark gray appearance, crossed by five black lines that can be difficult to trace against the dark background in many specimens; basal line indicated by a small patch of black scales; antemedial line slightly erratic, angled basad below veins R and M and angled distad below vein 1A+2A; medial line wider and more prominent than other lines, shallowly zigzagged, bending distad below vein 1A+2A; postmedial line narrow, dragged outward at each vein, bending basad below vein M3 and approaching me-

dial line, fusing with medial line for a short distance in some specimens before angling distad between veins CuA2 and 1A+2A; subterminal line most prominent near costa, angled sharply distad between veins R5 and M1, becoming diffuse and difficult to trace below, bordered on distal side by lighter gray or white scales; fringe dark gray or black, checkered with small patches of white scales at veins; orbicular spot indicated by a small patch of dark scales in some specimens, and reniform spot by a small crescent or bar at end of cell. **Abdomen** – clothed in a mixture of short stiff dark-brown and dirty-white hair, appearing faintly banded at joints. **Dorsal hindwing** – dark brownish gray with faint darker gray medial and postmedial bands, shading to a narrow dark terminal line; veins lightly lined with dark scales; usually with a faint white streak or small patch of white scales near lower margin; fringe white, lightly checkered with gray between veins. **Male genitalia** – (Fig. 55). valve simple; sacculus with a prominent clasper at distal end, s-shaped, flattened blade-like with a rounded terminus, approximately as long as width of valve at mid-point, supported at base with a small buttress; cucullus bluntly pointed; tegumen with a pair of large rounded or triangular subuncal lobes; uncus modified, laterally compressed with a high crown, about as high as wide, tapering very gradually to a very narrow terminus; aedeagus 3-4 × as long as wide; everted inflated vesica small, rounded, globular, tapering into a long narrow ductus seminalis, oriented distad at a shallow angle, armed with two cornuti, smaller cornutus on right side near apex, second cornutus much longer, thin, straight or slightly recurved, on left side closer to apex. **Female genitalia** – (Fig. 68) papillae anales squared, soft, clothed with sparse fine setae; sterigma well-developed but not massive, smooth; ductus bursae short and wide, about 2 × as long as wide, with smooth thick walls, expanding into a smooth rim around ostium, resembling mouth of a milk-bottle; corpus bursae a large, thin-walled single-chambered oval or slightly teardrop shaped sac, with rows of minute spicules over much of surface; without signa.

Distribution and biology. Subspecies *nigra* replaces nominate *P. acronyctoides* in the foothills and mountains of western Alberta westward to central British Columbia and southward in the Rocky Mountains to Colorado; a disjunct population is in the Black Hills of South Dakota (Fig. 72). In Alberta and in the Black Hills of South Dakota, *nigra* has been collected at elevations of 1220-1370 m, in Wyoming and Colorado to 3050 m. Subspecies *nigra* occurs in Lodgepole pine (*Pinus contorta* Dougl. ex Loud.) forests. Five reared specimens from British Columbia in the CNC were obtained from larvae collected on Lodgepole pine. Adult collection dates range from June 8 through August 13.

Remarks. Previous literature reports of *P. acronyctoides* from British Columbia (Smith and Dyar 1898; Forbes 1954; McDunnough 1937) almost certainly refer to black and white specimens of *P. virginarius*, as all museum specimens examined from the Rocky Mountains westward labeled as *P. acronyctoides* were misidentified specimens of *P. virginarius*. Conversely, specimens of *P. acronyctoides nigra* from Colorado were found in institutional collections misidentified as either *P. angelica* (Dyar) or *P. portandia* Grote, new synonyms of *P. virginarius*.

***Panthea virginarius* Grote**

Figs. 29-35, 50-51, 62, 69

Biston virginarius Grote, 1880: 220.

Lycia virginaria (Grote); Dyar 1902: 328.

Panthea virginaria (Grote); Barnes and McDunnough 1917: 83; McDunnough 1938: 54; Franclemont and Todd 1983: 134.

Panthea portlandia Grote, 1896: 14; Dyar 1902: 98; Smith 1903: 98; Barnes and McDunnough 1917: 83; McDunnough 1938: 54; Franclemont and Todd 1883: 134.

New synonymy.

Panthea angelica Dyar, 1921: 142; McDunnough 1938: 54; Franclemont and Todd 1883: 134. **New synonymy.**

Panthea portlandia suffusa McDunnough, 1942: 94; Franclemont and Todd 1883: 134. **New Synonymy.**

Type material. *Biston virginarius*: Holotype female, Soda Springs, Shasta Co, California, USA (BMNH). Photograph examined

Panthea angelica: Mt. Lowe, Los Angeles, California, USA. Holotype male (USNM) Photograph examined; genitalia slide apparently lost.

Panthea portlandia: described by Grote from 2 specimens from Portland, Oregon, USA. Types could not be located in either the BMNH or USNM and may be lost.

Panthea virginaria suffusa: described from a holotype male from Dixon Creek, Barriere, British Columbia, Canada. The specimen was reared from a larva collected from *Picea engelmanni*. (Type #5282 in CNC). Adult and genitalia slide examined.

Diagnosis. *Panthea virginarius* varies greatly in size and color pattern depending on location and habitat. Both sexes of *P. virginarius* can be very difficult to separate from those of *P. gigantea* where they occur together unless genitalia characters are used. The tip of the uncus can usually be examined without dissection by brushing the scales from the end of the abdomen; the male of *P. gigantea* has a bifurcate tip to the uncus (Fig. 48), *P. virginarius* does not (Fig. 50). Females can be separated by the structure of the sterigma, which is much larger and more massively sclerotized in *P. gigantea* (Fig. 60) than in *P. virginarius* (Fig. 62). Black and white specimens of *P. virginarius* from southern British Columbia and Idaho (Fig. 35) have been mistaken for nominate *P. acronyctoides* (Fig. 36), but the two taxa are well separated by range (Figs. 69, 72). In the Rocky Mountains from Alberta and British Columbia southward *P. virginarius* can be confused with *P. acronyctoides nigra*. *Panthea virginarius* is larger and the male has a paler, banded hindwing than *nigra*; females can be differentiated by examining the ductus, which is wrinkled in *P. virginarius* (Fig. 62), smooth with an expanded rim around the ostium in *nigra* (Fig. 63).

Distribution and biology. *Panthea virginarius* occurs mainly west and north of the Great Basin, from the coast of southern California northward to the Queen Charlotte Islands of British Columbia and the Alaskan Panhandle, eastward to central California, northern Nevada, Idaho, northwestern Wyoming, western Montana, and southwest-

ern Alberta; a disjunct population is in the Cypress Hills of Alberta and Saskatchewan (Fig. 69). Large black and white populations (syn. "*portlandia*") occur along the coast from central California to southern British Columbia. These are replaced by gray and black populations both farther north and farther south along the coast, and at higher elevations inland. Intermediate populations occur at lower elevations eastward as far as western Montana and extreme southwestern Alberta.

Panthea virginarius is found in coniferous forests, in particular but not confined to Douglas-fir forest (*Pseudotsuga menziesii* (Mirb.) Franco) at elevations ranging from sea-level to near tree-line.

Remarks. *Panthea virginarius* appears in checklists as both the original spelling *virginarius* (e.g., Grote 1880; Poole 1989) and *virginaria* (e.g., Franclemont and Todd 1983) with the ending changed from the original spelling for gender congruity. The original spelling is used herein.

The taxonomy of *Panthea virginarius* has suffered from the same plethora of errors as has occurred elsewhere in the genus, starting with Grote describing *virginarius* as a geometrid (*Biston*), and finishing with McDunnough describing *suffusa* as a form of *portlandia* because the *P. virginarius* specimens he used for comparison were misidentified specimens of *P. acronyctoides nigra*.

Panthea angelica is a population of *P. virginarius* in southern coastal California (Los Angeles and San Bernardino counties). Internally it is identical to nominate *virginarius*, and externally differs only by being slightly more suffused with dark scales and thus appearing less powdery. The name *angelica* has been widely misapplied, both in the literature (e.g., Crumb 1956) and on museum specimens of *P. greyi* and *P. acronyctoides nigra*, lending weight to the apparently mistaken belief that *angelica* was a good species.

Panthea portlandia is the name that has been applied to the large and striking black and white coastal populations of *P. virginarius* that occur mainly at lower elevations from northern California to southwestern British Columbia. Inland, and at higher elevations, this form intergrades with typical *P. virginarius*, but some of the white shading of the *portlandia* phenotype is still evident as far east as western Montana and southwestern Alberta. Both white and gray forms occur together at some locations in central Washington. The genitalia are indistinguishable from those of typical *P. virginarius*, so the name *portlandia* is also placed in synonymy under *P. virginarius*.

Panthea portlandia suffusa was described by McDunnough after comparing it to what he believed were specimens of *P. virginarius* from Colorado and Alberta, but which were in fact specimens of *P. acronyctoides nigra*. This is evident from his description of the genitalia of *P. virginarius*, which accurately describes *P. acronyctoides*, not *portlandia* (McDunnough 1942). An examination of his slides in the CNC confirms this. It also explains his puzzling (but accurate) statement that based on the genitalia slides of males from Colorado and Nordegg, Alberta, *P. virginarius* seemed to be merely a large western race of *P. acronyctoides* Walker (McDunnough 1942).

Specimens of *P. virginarius* from northwestern Wyoming tend to be lighter gray, and specimens from Wyoming and adjacent areas of Idaho tend to have the diverticulum of the vesica and its terminal spine greatly reduced in size, and occasionally obsolete.

The various forms of *P. virginarius* vary greatly in both size and in the proportions of black and white scaling, and thus external appearance varies greatly over a very large geographic area. However, with the exception of specimens in a small area of north-western Wyoming, little significant variation occurs in the genitalia of either sex, and all are treated as forms rather than subspecies. Further study, particularly in California, may show that one or more populations there should be recognized at the subspecies level, *e.g.*, a silvery-gray population on the Monterey Peninsula that has been reared on Monterey pine (*Pinus radiata* D. Don) (Frank Sala pers. comm.).

The life history of *P. virginarius* on Vancouver Island, British Columbia, is briefly described by Hardy (1963). The larva and adult female are illustrated in color (as *P. portlandia*) by Miller and Hammond (2003), and the larva is described and illustrated in color by Duncan (2006).

Phylogenetic checklist of New World *Panthea*

PANTHEA Hübner, [1820]

ELATINA Duponchel, 1845

AUDELA Walker, 1861

PLATYCERURA Packard, 1864

DIPHTHERA Hampson, 1913, not Hübner, [1809]

apanthea Anweiler, 2009

reducta Anweiler, 2009

judyae Anweiler, 2009

gigantea (French, 1890)

guatemala Anweiler, 2009

furcilla (Packard, 1874)

a. *furcilla* (Packard, 1874)

pallescens McDunnough, 1937 **syn. n.**

atrescens McDunnough, 1942, form, unavailable infrasubspecific name

centralis McDunnough, 1942 **syn. n.**

b. *australis* Anweiler, 2009

greyi Anweiler, 2009

acronyctoides (Walker, 1861)

a. *acronyctoides* (Walker, 1861)

leucomelana Morrison, 1876

albosuffusa McDunnough, 1937 **syn. n.**, form

b. *nigra* Anweiler, 2009

virginarius (Grote, 1880)

angelica (Dyar, 1921) **syn. n.**

portlandia (Grote, 1896) **syn. n.**

suffusa McDunnough, 1942 **syn. n.**

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I thank Don Lafontaine, Jim Troubridge, and Chris Schmidt at the CNC for courtesies too numerous to list, in particular for access to the collections in their care and for prodding me to finish this project. Many thanks to Jocelyn Gill (CNC) for photographing specimens and preparing the plates. The following individuals contributed by lending material in their care, or in many cases loans or donations of specimens from their personal collections: Ron Leuschner, Julian Donohue, Paul Opler, Bruce Walsh, Dave Lawrie, Richard M. Brown, James Adams, Mo Nielsen. Martin Honey (BMNH) has, as always, provided information and leads. Felix Sperling and George Ball have provided ongoing encouragement, support, and a base at the Strickland Museum to work in and from. And last but not least my wife Judy, for her ongoing patience and support.

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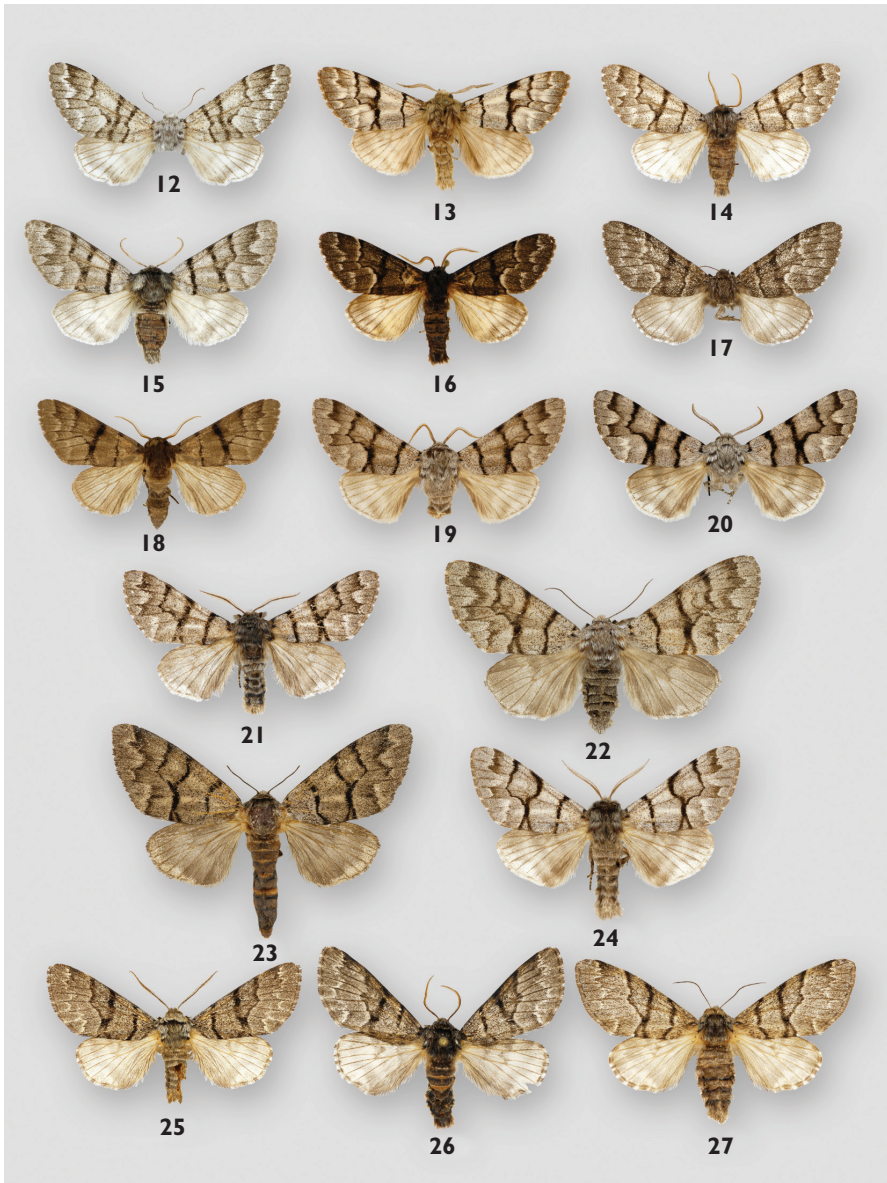
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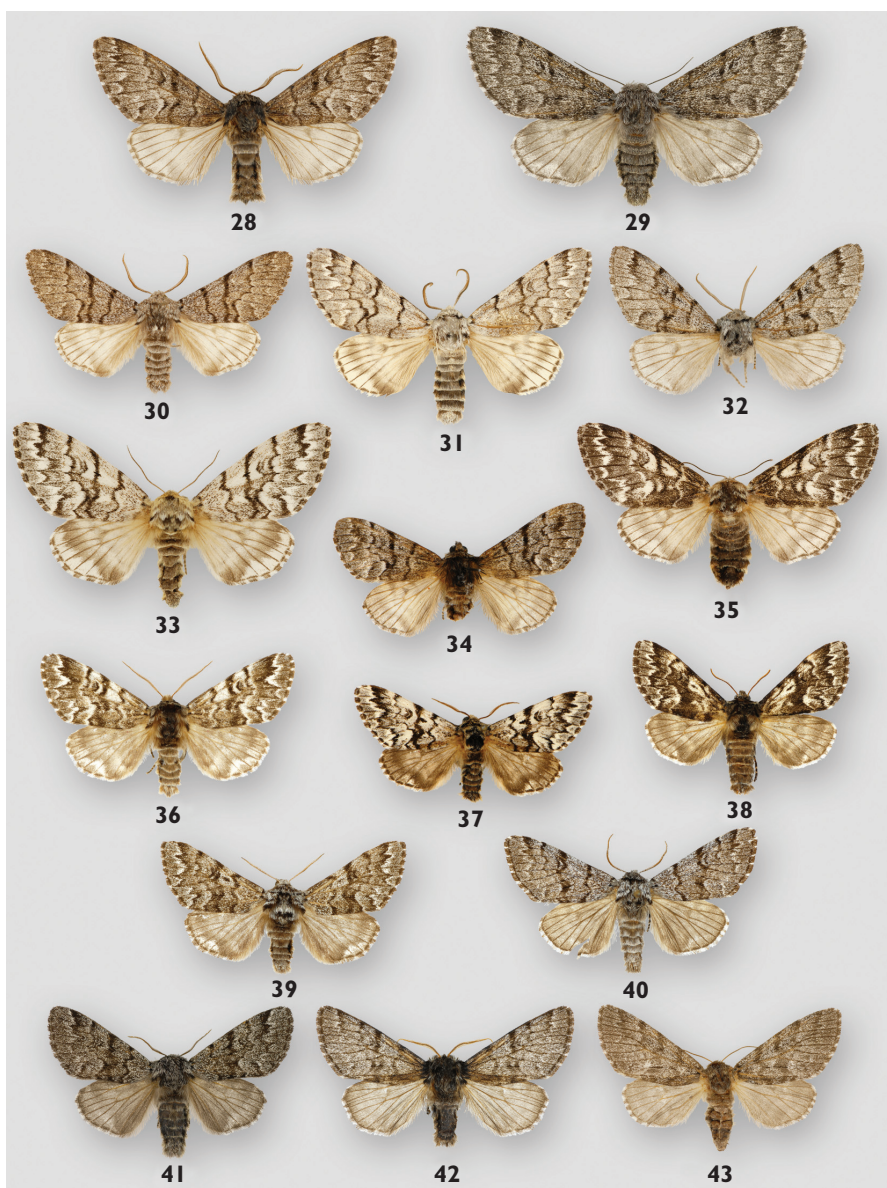
Figures 1-11. *Panthea* adults

1. *P. apanthea* ♂ holotype, White Mountains, AZ, USA; **2.** *P. apanthea* ♀, Coconino Co., AZ, USA; **3.** *P. reducta* ♂ holotype, Pedemales N.P., DR; **4.** *P. judyae* ♂, Grant Co., NM, USA; **5.** *P. judyae* ♀, Cochise Co., AZ, USA; **6.** *P. gigantea* ♂ neotype, Larimer Co., CO, USA; **7.** *P. gigantea* ♀, Grant Co., NM, USA; **8.** *P. gigantea* ♂, Durango, MEX; **9.** *P. gigantea* ♀, Chihuahua, MEX; **10.** *P. guatemala* ♂ holotype, San Lorenzo, GUA; **11.** *P. guatemala* ♀, Oaxaca, MEX.



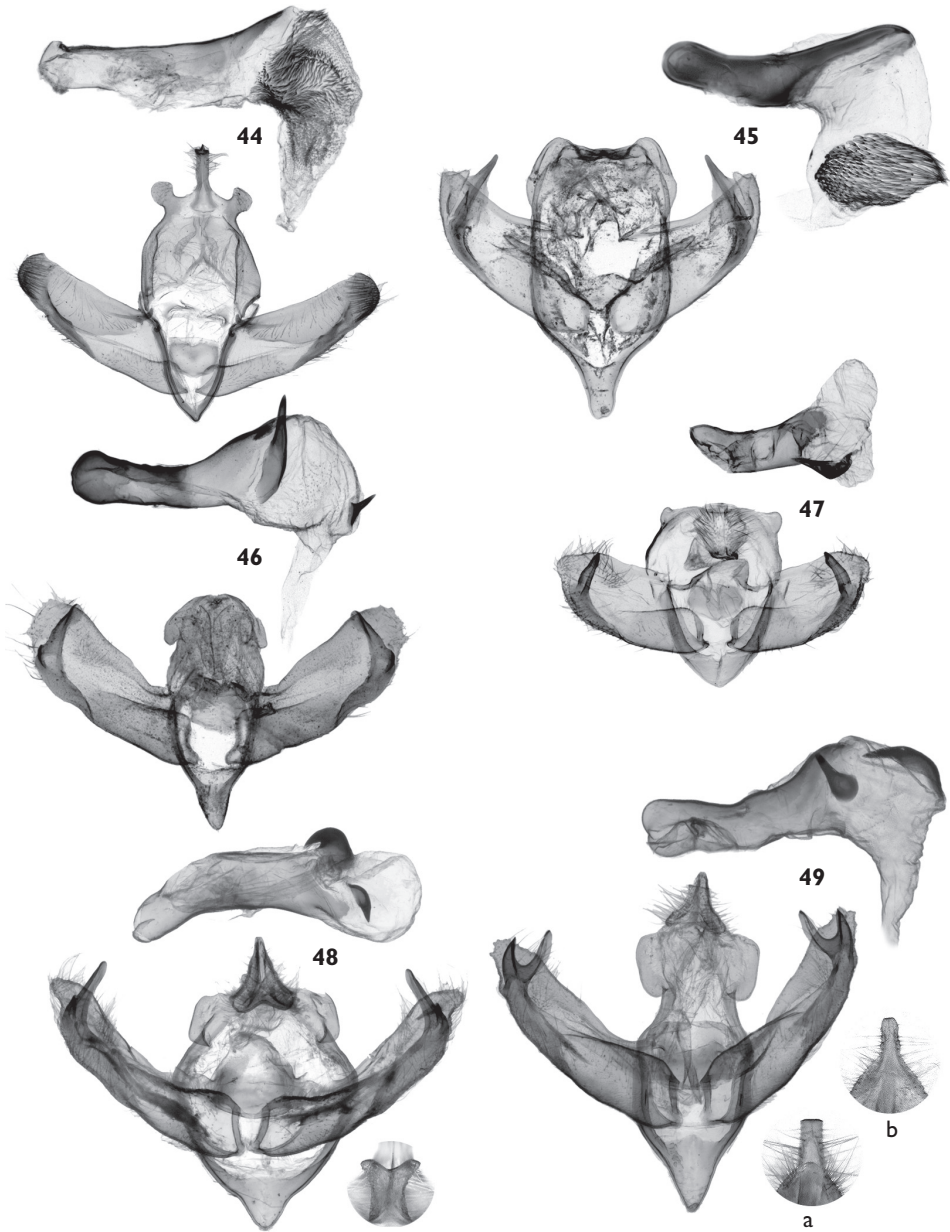
Figures 12-27. *Panthea* adults

12. *P. f. furcilla* ♀, Berkshire Co., MA, USA; **13.** *P. f. furcilla* ♂, holotype of *pallescent*, Queen's Co., NS, CAN; **14.** *P. f. furcilla* ♂ Franklin Co., MA, USA; **15.** *P. f. furcilla* ♂ Redwater, AB, CAN; **16.** *P. f. furcilla* ♂, holotype of *atrescens*, QC, CAN; **17.** *P. f. furcilla* ♂, holotype of *centralis*, QC, CAN; **18.** *P. f. furcilla* ♂ (melanic), Windham Co., CT, USA; **19.** *P. f. furcilla* – *f. australis* intermediate ♂, Owsley Co., KY, USA; **20.** *P. f. furcilla* – *f. australis* intermediate ♂, Owsley Co., KY, USA; **21.** *P. f. australis* ♂ holotype, Whitfield Co., GA, USA; **22.** *P. f. australis* ♀, Whitfield Co., GA, USA; **23.** *P. f. australis* ♀, Oregon Co., MO, USA; **24.** *P. f. australis* ♂, Jefferson Co. TX, USA; **25.** *P. greyi* ♂, Cochise Co., AZ, USA; **26.** *P. greyi* ♂ holotype, Cochise Co., AZ, USA; **27.** *P. greyi* ♀, Cochise Co., AZ, USA.



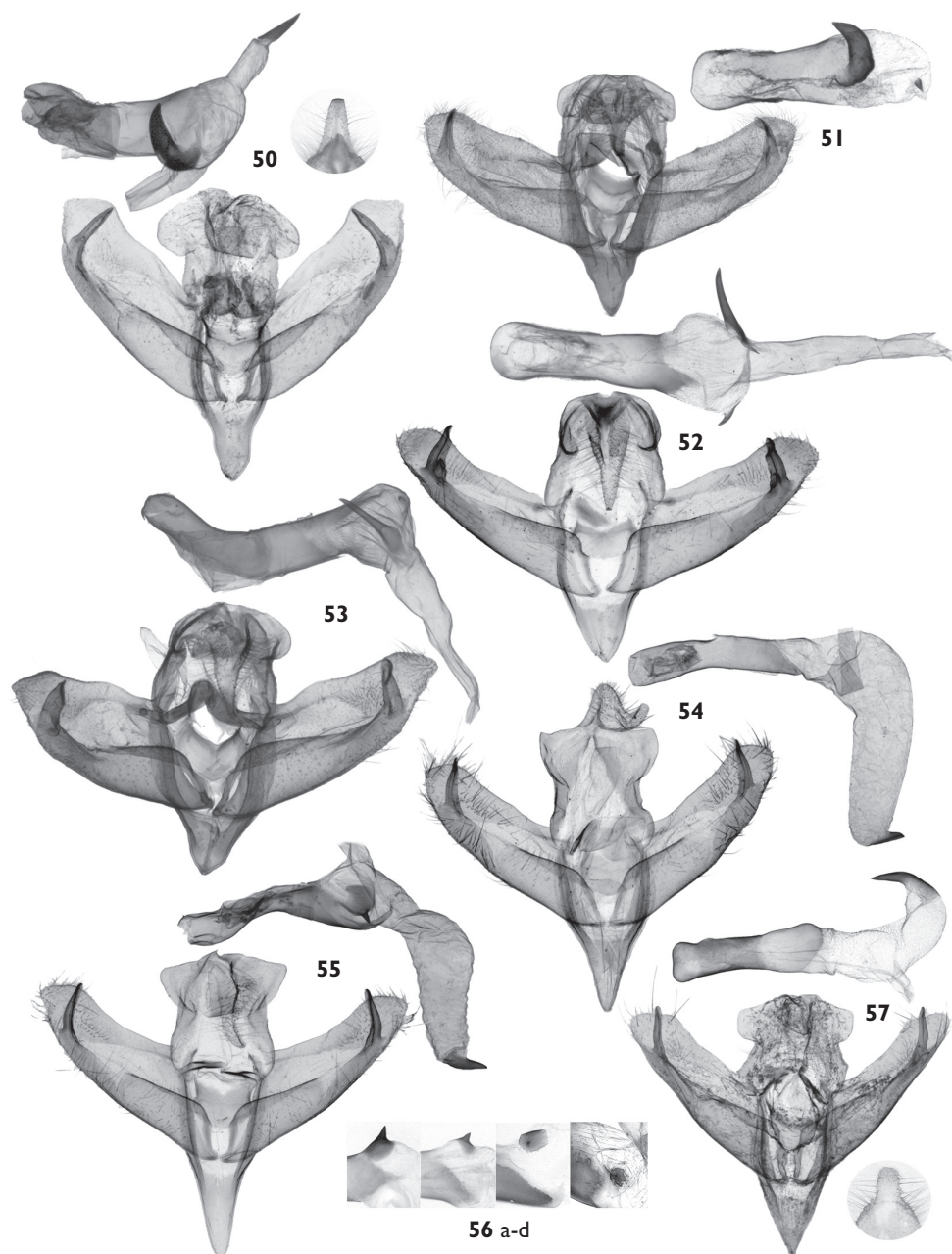
Figures 28-43. *Panthea* adults

28. *P. virginarius* ♂, Nevada Co., CA, USA; **29.** *P. virginarius* ♀, Waterton Lk. N.P. AB, CAN; **30.** *P. virginarius*, ♂, LA Co., CA, USA; **31.** *P. virginarius* ♀, Monterey Co., CA, USA; **32.** *P. virginarius* ♂, Lincoln Co., WY, USA; **33.** *P. virginarius* ♀, Cowlitz Co., WA, USA; **34.** *P. virginarius* ♂ - holotype of *suffusa*, Barriere, BC, CAN; **35.** *P. virginarius*, Vavenby, BC, CAN; **36.** *P. a. acronyctoides* ♂ Edmonton, AB, CAN; **37.** *P. a. acronyctoides*, ♂ holotype of *albosuffusa*, Queen's Co., NS, CAN; **38.** *P. a. acronyctoides* ♂, Penobscot, ME, USA; **39.** *P. a. acronyctoides* – *a. nigra* intermediate, Edmonton, AB, CAN; **40.** *P. a. nigra* ♂ holotype, Gilpin Co., CO., USA; **41.** *P. a. nigra* ♂, Jasper N.P., AB, CAN; **42.** *P. a. nigra* ♂, Grand Co., CO, USA; **43.** *P. a. nigra* ♀, Grand Co. CO, USA.



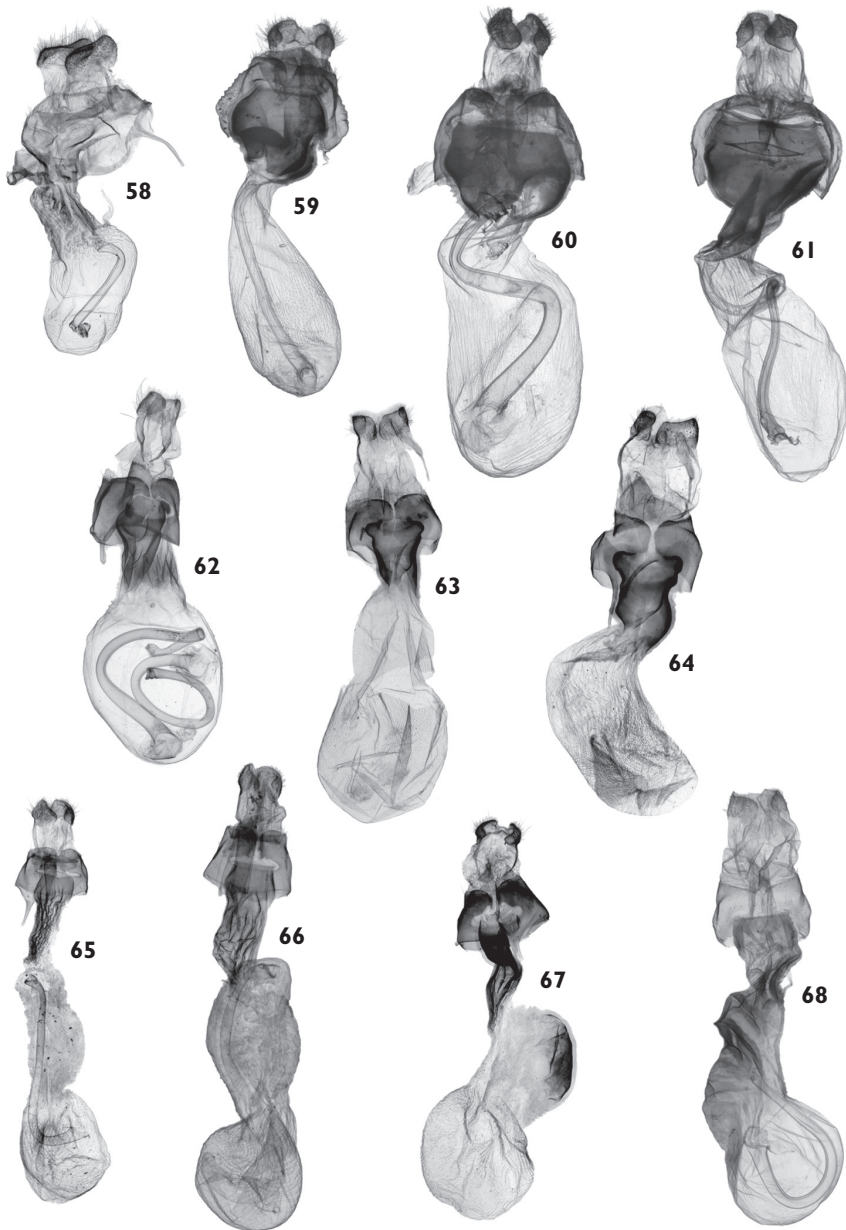
Figures 44-49. *Panthea* male genitalia

44. *Lichnoptera decora*, Queretero, MEX; **45.** *P. apanthea*, El Paso Co., CO., USA; **46.** *P. judyae* Grant Co., NM, USA; **47.** *P. reducta*, Pedemales, DR; **48.** *P. gigantea*, El Dorado Co., CA., USA, **a.** tip of uncus; **49.** *P. guatemala*, Oaxaca MEX., **a.** tip of uncus, Oaxaca, **b.** tip of uncus, Chiapas, MEX.



Figures 50-57. *Panthea* male genitalia

50. *P. virginarius*, Josephine Co. OR., USA; **51.** *P. virginarius* Wyoming variant, Lincoln Co., WY., USA; **52.** *P. acronyctoides nigra*, Albany Co., WY, USA; **53.** *P. a. acronyctoides*, Steuben, ME, USA; **54.** *P. furcilla furcilla*, Norfolk Co., MA., USA; **55.** *P. furcilla australis*, Whitfield Co., GA. USA; **56.** *Panthea f. furcilla - f. australis* intermediate specimens, showing variation in size of basal cornuti; **a.** P.G. Co., MD; **b, c.** Owsley Co., KY; **d.** Elko Co., PA. **57.** *P. greyi*. Coconino Co., AZ, USA.



Figures 58-68. *Panthea* female genitalia

58. *P. apanthea*, Coconino Co, AZ, USA; **59.** *P. judyae*, Chihuahua, MEX; **60.** *P. gigantea*, Chihuahua, MEX; **61.** *P. guatemala*, Oaxaca, MEX; **62.** *P. virginarius*, Missoula Co., MT., USA; **63.** *P. acronyctoides nigra*, Teller Co., CO., USA; **64.** *P. a. acronyctoides*, Ashland Co., WI, USA; **65.** *P. f. furcilla*, Windham Co., CT, USA; **66.** *P. f. furcilla-f. nigra* intermediate, Dauphin Co., PA., USA; **67.** *P. furcilla australis*, Whitfield Co., GA, USA; **68.** *Panthea greyi*, Apache Co., AZ., USA.

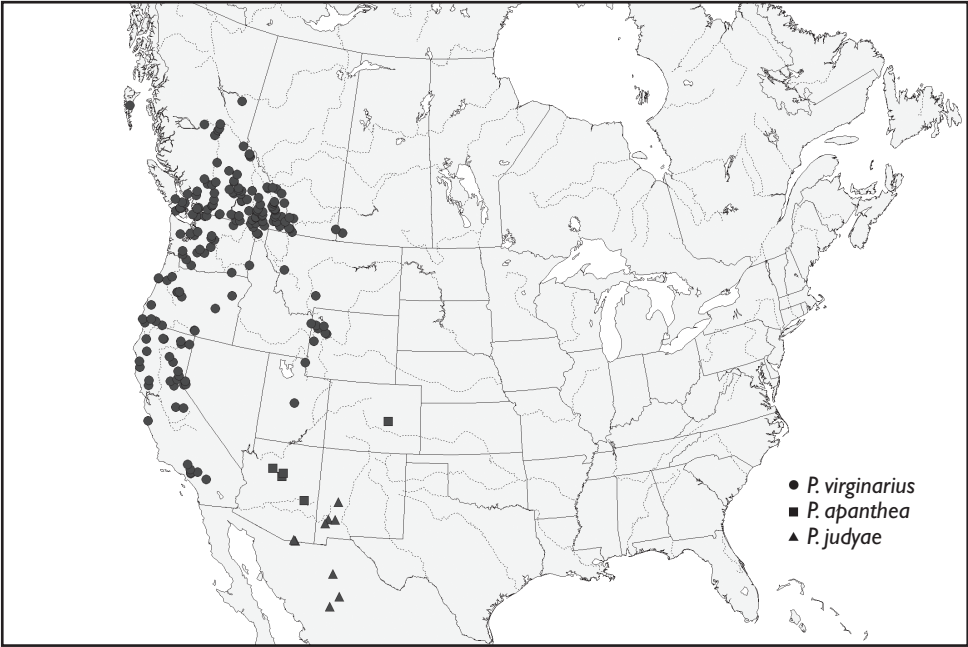


Fig. 69. Distribution of examined specimens of *P. virginarius*, *P. apantea* and *P. judyae*.

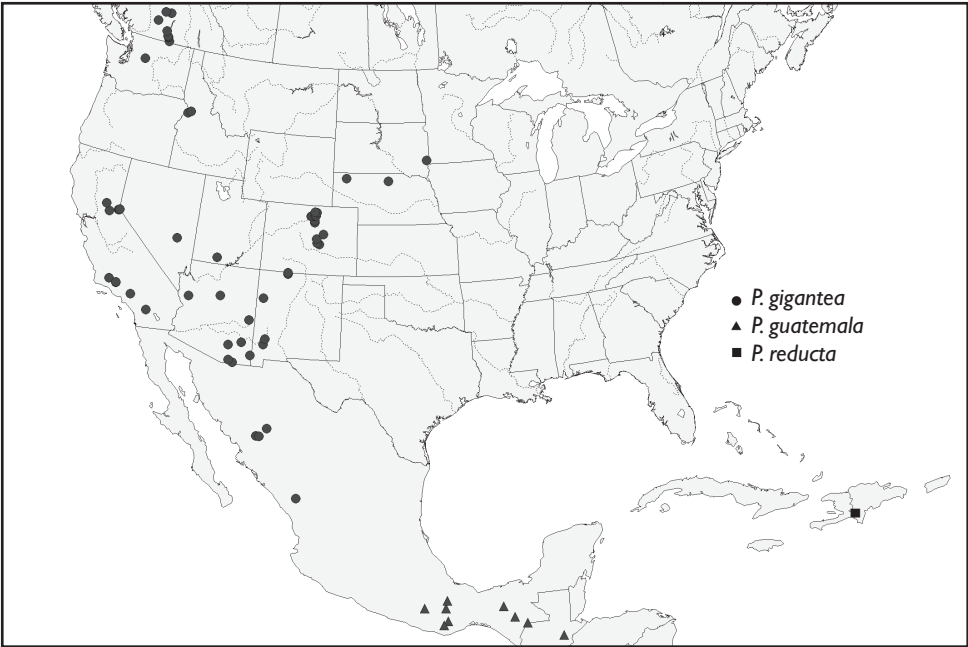


Fig. 70. Distribution of examined specimens of *P. gigantea*, *P. guatemala*, and *P. reducta*.

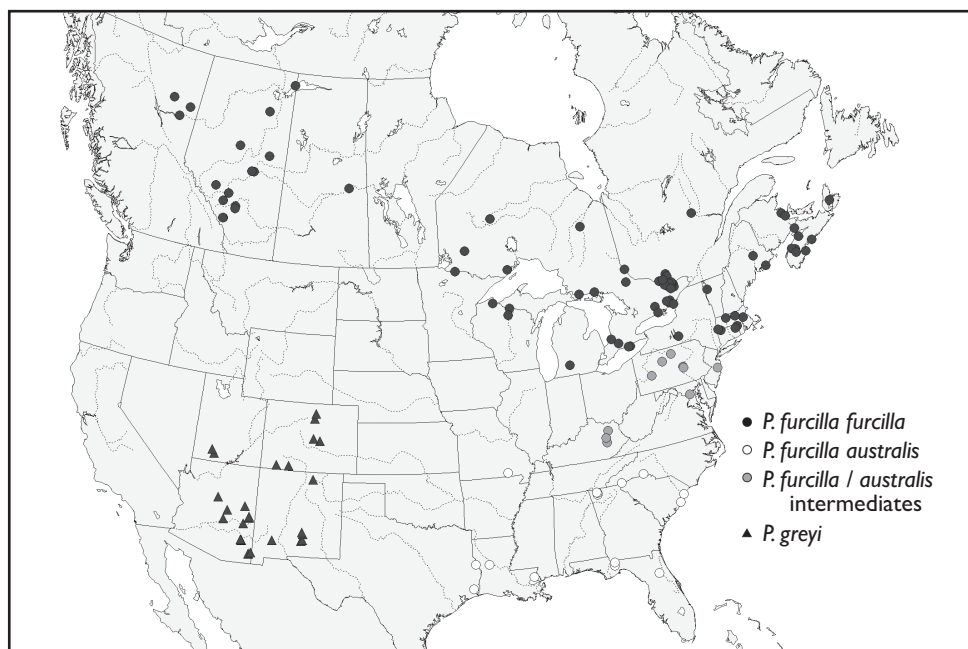


Fig. 71. Distribution of examined specimens of *P. furcilla* and *P. greyi*.

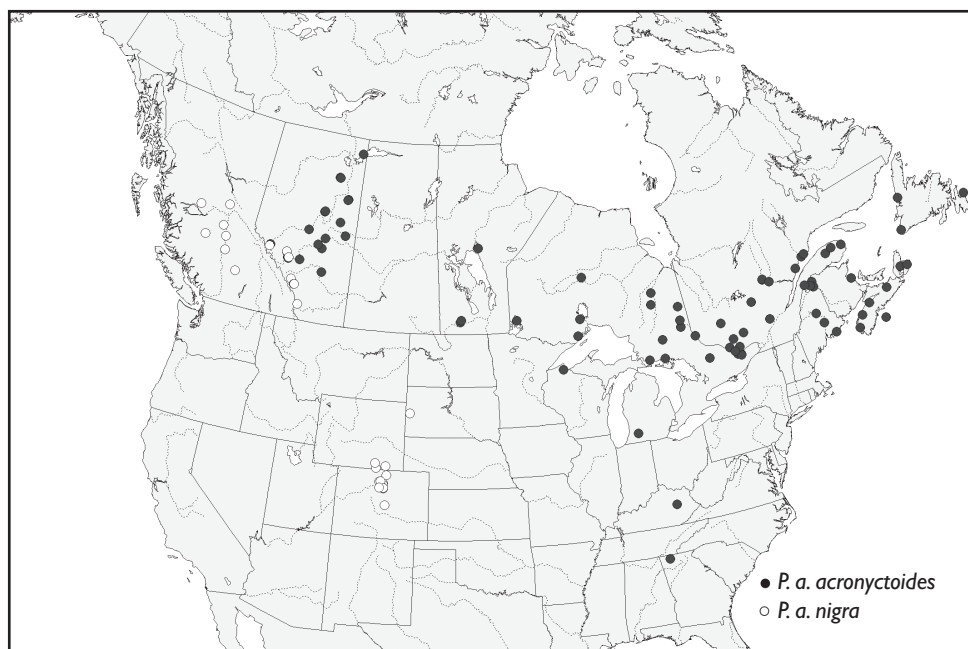


Fig. 72. Distribution of examined specimens of *P. acronyctoides*.