Zootaxa 2347: 1–36 (2010)
www.mapress.com/zootaxa/
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Article

ISSN 1175-5326 (print edition)
ZOOTAXA
ISSN 1175-5334 (online edition)

Revision of the North American Genera *Tetracis* Guenée and Synonymization of *Synaxis* Hulst with Descriptions of Three New Species (Lepidoptera: Geometridae: Ennominae)

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Accepted by L. Gall: 8 Dec. 2009; published: 29 Jan. 2010

Abstract

The genus *Synaxis* is synonymized with *Tetracis*. The thirteen North American species in genus *Tetracis* (some formerly in *Synaxis*) are discussed, including descriptions of three new species from western North America: *Tetracis australis*, *T. montanaria*, *T. pallidata*. Two additional species, *"Synaxis" triangulata* and "*S." brunneilinearia* are excluded. A key to species, descriptions, check list, illustrations of adults and genitalia, and distribution maps are included. The formerly presumed lost types of the taxa *aurantiacaria*, *cervinaria*, and *jubararia* were located and are illustrated.

Key words: Arizona, British Columbia, California, DNA barcoding, Ennominae, Geometridae, Mexico, *Synaxis*, *Tetracis*, *Tetracis australis*, *Tetracis barnesii*, *Tetracis cachexiata*, *Tetracis cervinaria*, *Tetracis crocallata*, *Tetracis formosa*, *Tetracis fuscata*, *Tetracis hirsutaria*, *Tetracis jubararia*, *Tetracis montanaria*, *Tetracis mosesiani*, *Tetracis pallidata*, *Tetracis pallulata*, Washington

Introduction

Parsons *et al.* (1999) listed ten species in *Tetracis* Guenée, all from the New World with two from North America, the type species *T. crocallata* Guenée, [1858], and *T. cachexiata* Guenée, [1858]. Pitkin (2002) subsequently transferred three neotropical species to a new genus (*Costalobata* Pitkin), and stated that another five neotropical species are likely or possibly misplaced in *Tetracis*, leaving only *crocallata* and *cachexiata* Guenée within *Tetracis* (*sensu stricto*). Within *Synaxis* Hulst, Parsons *et al.* (1999) placed eleven species, ten from North America and a Chilean species originally described as *Erosina strigata* Bartlett-Calvert, 1893. Based on male genitalia, Pitkin (2002: 325) stated that the affinity of *strigata* is unknown, and that it is misplaced in *Synaxis* [type species: *Tetracis pallulata* Hulst, 1886]. Based on male genitalia, Ferris (2009a, b) removed two additional taxa from *Synaxis*, namely *Metanema brunneilinearia* Grossbeck and *Sabulodes triangulata* Barnes & McDunnough. Pitkin (2002) also suggested that *Synaxis* was near to and might be a (junior) synonym of *Tetracis*. The purpose of the current work is to revise the generic concepts of *Tetracis* and *Synaxis*, and provide descriptions of three new western North American species together with a synopsis and diagnosis of all North American species.

There have been no modern reviews of either *Synaxis* or *Tetracis*, although Pitkin (2002) discussed the neotropical species of *Tetracis*, and suggested that *Synaxis* may prove to be synonym. McGuffin (1987) gave diagnoses of both genera, with differences between the two essentially limited to wing markings. Comparison of the type-species of both genera, and additional species not examined by McGuffin (1987) and/or Pitkin (2002) shows that genitalic structure is remarkably consistent across these taxa, and fit well within the generic diagnosis of *Tetracis* by Pitkin (2002). *Synaxis triangulata* is not congeneric with *Tetracis (sensu stricto*), as it lacks the characteristic gnathos and juxta (Ferris 2009a). Larval characters are also indicative of a monophyletic *Tetracis*/*Synaxis* group; for species where larvae are known (*S. pallulata*, *S. jubararia*, *S. cervinaria*, *T. cachexiata*, *T. crocallata*), The following structural characters are common to all species and in combination may prove to be synapomorphic: second thoracic segment abruptly swollen dorsally, 4th, 5th and 8th abdominal segments with paired dorsal warts (sometimes joined by ridge) (McGuffin 1987; Miller 1995; Wagner *et al.* 2001; Duncan 2006). Three adult morphological characters are synapomorphic for *Tetracis*, a quadrate dorso-caudal margin of the gnathos, and the presence of two to four (occasionally five) widely separated, dorsally projecting teeth on the dorso-caudal margin of the gnathos and an anellus with median spinulose furca. Possibly a fourth synapomorphy is the symmetric or only slightly asymmetric placement of the furca, which is usually strongly asymmetric in the Ourapterygini (Pitkin 2002). Based upon these factors, *Synaxis* is synonymized under *Tetracis*, which takes publication priority.

Materials and methods

Abbreviations and definitions used herein (See also Fig. 1)

AM	antemedian line.
A/P	female genitalia: approximate length ratio of anterior apophysis to posterior apophysis.

MB median band = area between DFW AM and PM lines.
D, V dorsal, ventral.
DFW, DHW dorsal forewing, dorsal hindwing.
FW, HW forewing, hindwing.
FWL forewing length, base to apex.
PM postmedian line.
VFW, VHW ventral forewing, ventral hindwing.

Repository abbreviations

Specimens were examined from or are cited in the following collections:

UASM University of Alberta Strickland Museum, Edmonton, Alberta, Canada.
BIO Biodiversity Institute of Ontario, Guelph, Ontario, Canada.
CDF Personal collection of C. D. Ferris, Laramie, WY, USA.
CM Carnegie Museum, Pittsburgh, PA, USA.
CNC Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Ontario, Canada.
CSU C. P. Gillette Museum of Arthropod Diversity, Colorado State Univ., Ft. Collins, CO, USA.
EME Essig Museum of Entomology, University of California, Berkeley, CA, USA.
JBW Personal collection of J. B. Walsh, Tucson, AZ, USA.
LACM Los Angeles County Museum of Natural History, Los Angeles, CA, USA.
MCZ Museum of Comparative Zoology, Harvard University, Cambridge, MA, USA.
MNHU Museum fü r Naturkunde der Humboldt-Universitä t, Berlin, Germany.
NDSIRC North Dakota State Insect Reference Collection, Fargo, ND, USA.
UCD Bohart Museum, University of Caifornia, Davis, CA, USA.
USNM National Museum of Natural History, Washington, DC, USA.

Distribution records. Distribution records were obtained from: specimen labels of material examined; individual collectors; museum databases; pertinent literature. Because of the volume of material involved, detailed localities and collector names are not generally included. Full data are provided for type material associated with the newly described taxa; for other species, state and county records are cited for the United States, and provinces for Canada. The distribution maps (Figs. 133–145) are not intended to be all-inclusive, but rather to illustrate the general distribution of species and reflect records available to the authors.

Dissections. Multiple dissections were conducted for all species. Additional prepared slides from museums were examined directly or by digital photographs.

DNA barcoding. Molecular variation was sampled based on the 658 base-pair 'barcode' region of the first subunit of the cytochrome oxidase (cox1) gene (Hebert *et al.* 2003) for ten of the 13 species of *Tetracis* (Table 1). Three species (*Tetracis formosa, T. fuscata, T. mosesiani*) were not available for molecular analysis. DNA was extracted from one or two legs removed from a dried specimen, sent to the University of Guelph in dry Eppendorf tubes, and processed as part of the "All Leps Barcode of Life Campaign" (www.lepbarcoding.org). DNA extraction, amplification and sequencing protocols for the Barcode of Life initiative are detailed in Hebert *et al.* (2003). Haplotypes of representative specimens were compared using a Neighbour-joining (NJ) analysis, with phyletic distances calculated using the Kimura-2-parameter (K2P) distance model. Maximum parsimony (MP) analyses were implemented using heuristic searches with the parameters: 100 random addition replicates; stepwise addition; tree bisection-reconnection (TBR). Branch support was calculated using bootstrap support values, obtained through 100 bootstrap replicates using the heuristic search methods given above. All NJ and MP analyses were conducted in PAUP 4.0*b10 (Altivec) (Swofford, 2002). *Prochoerodes lineola* (Gö ze) and *Sabulodes edwardsata* (Hulst), both representing genera of Ourapterygini closely related to *Tetracis* (Pitkin 2002), were used as pre-defined outgroups in the MP analysis.

TABLE 1. Voucher data for the barcoded *Tetracis* specimens. Genbank accession numbers for *Tetracis australis* and *T.hirsutaria* were not available at the time of publication.

Species	Country	State/Prov.	Locality	Date	Collector	Depository	DNA Voucher #	GenBank #
Prochoerodes lineola	Canada	Alberta	Edmonton, 30km E. Blackfoot Rec. Area	9/5/02	G.G. Anweiler	UASM	USAM59403	GU145092
Sabulodes edwarsata	USA	California	Shasta Co., Hat Creek US Forest Service insect lab	7/8/01	M.A. Valenti	CNC	CNCLEP00033231	GU145093
Tetracis australis	USA	California	Riverside Co., Pine Cove, San Jacinto Mtns.	02-Jun-2005	J. Brown	BIO	06-BLLOC-306	
Tetracis barnesii	USA	Colorado	Mesa Co., Nat. Mon. HQ Residence	04-Oct-1997	P. Opler	CNC	CNCLEP00054340	GU145097
Tetracis cachexiata	Canada	Br. Columbia	Salmon Arm, 1 mi. E	16-Jun-1979	J.D. Lafontaine	CNC	CNCLEP00033225	GU145100
Tetracis cervinaria	USA	California	Shasta Co., Old Station 1.0 mi. W of Logan Lake	08-Jun-1990	M.A. Valenti	CNC	CNCLEP00033223	GU145094
Tetracis crocallata	Canada	Alberta	Ministik Hills, 15 km W Tofield	20-Jun-2000	B.C. Schmidt	CNC	CNCLEP00033367	GU145101
Tetracis hirsutaria	USA	California	San Diego Co., Torrey Pines St. Res.	05-Nov-2005	N. Bloomfield	BIO	06-BLLOC-040	
Tetracis jubararia	Canada	Alberta	Bashaw, 9 mi. NW	04-Sept-1973	J.D. Lafontaine	CNC	CNCLEP00033220	GU145095
Tetracis montanaria	USA	Arizona	Graham Co., Mt. Graham, Cunningham campground	01-Oct-2008	C.D. Ferris	CNC	CNCLEP00054337	GU145099
Tetracis pallidata	USA	Washington	Kittitas Co., 8 mi. S. Ellensburg, Umptanum Cr. at dam	29 Sept-2008	L.G. Crabo	CNC	CNCLEP00054338	GU145098
Tetracis pallulata	Canada	Br. Columbia	Trinity Valley	18-Sept-1960	W.C. McGuffin	CNC	CNCLEP00033221	GU145096

Illustrations. Adult images were taken with a Fuji S1 FinePix Pro digital SLR camera. The genitalic images were taken using an Olympus SZ60 stereozoom microscope with a Fuji S3 FinePix Pro camera body attached to the microscope photo tube. Image post-processing was with two versions of Adobe Photoshop® . Various stains were used to enhance genitalic features. All figures, excepting Fig. 2, and related dissections were prepared by Ferris.

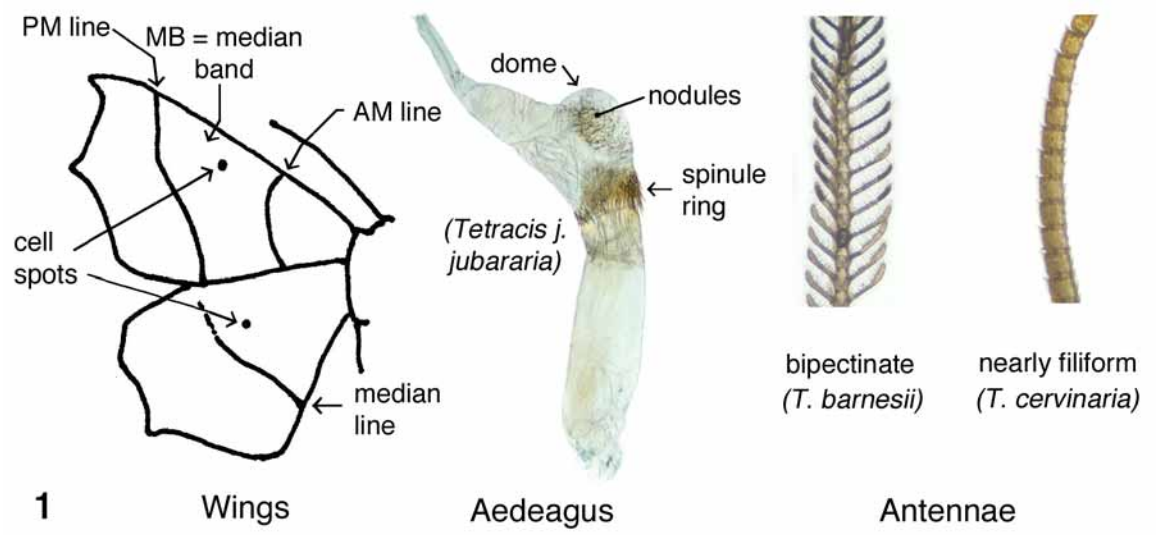


FIGURE 1. Structural definitions used in this revision.

Genus *Tetracis* Guenée

Guenée, A., [1858], *in* Boisduval, J. B. A. de & Guenée, A., Histoire naturelle des insectes. Species général des lépidoptères, Paris, vol. 9:140.
Type species: *Tetracis crocallata* Guenée, [1858].
Synaxis Hulst, 1896, A classification of the Geometrina of North America, with descriptions of new genera and species. *Transactions of the American Entomol. Society.* 23:324, 377. **Syn. nov.**Type species: *Tetracis pallulata*, Hulst, 1887.
Prionotetracis, Warren, W., 1894. *Novitates Zoologicae*. 1:461. **Rev. syn.**
Type species: *Tetracis pallulata*, Hulst, 1887.

Diagnosis: *Adults*. Medium-sized (typical FWL: 16–26 mm) moths varying in color from white, yellow, ochreous, to dark gray, and chocolate brown. Male antenna nearly filiform (laminate, prismatic or serrate) or bipectinate; female antenna essentially filiform, densely setose ventrally. PM line present, but AM line may be

absent; varying patterns of dark maculation may be present. Wing outer margins arcuate at vein M3. No patch of setae or comb on male third abdominal sternite. *Male genitalia*. Uncus tapered. Gnathos with spine-like projections arising from dorso-caudal margin. Apex of valve with or without a single pointed projection. Prominent median furca. Aedeagus with or without ring of spinules at posterior end at base of vesica; cornuti present, but vary widely with species. The male genitalia manifest three synapomorphies: gnathos with quadrate dorso-caudal margin; dorsal margin of gnathos with dorsally-projecting spines, usually in one or more pairs, but sometimes randomly spaced in individual specimens; anellus with median spinulose furca. *Female genitalia*. For all species, the ovipositor lobes are lightly setose, basally broad and taper to bluntly pointed tips. The colliculum is well-developed. The ductus seminalis originates at the top of the ductus bursae just below the colliculum. The ductus bursae and corpus bursae provide diagnostic features for species recognition. Length of ductus bursae variable with or without sclerotization. One signum (usually dentate) present in corpus bursae.

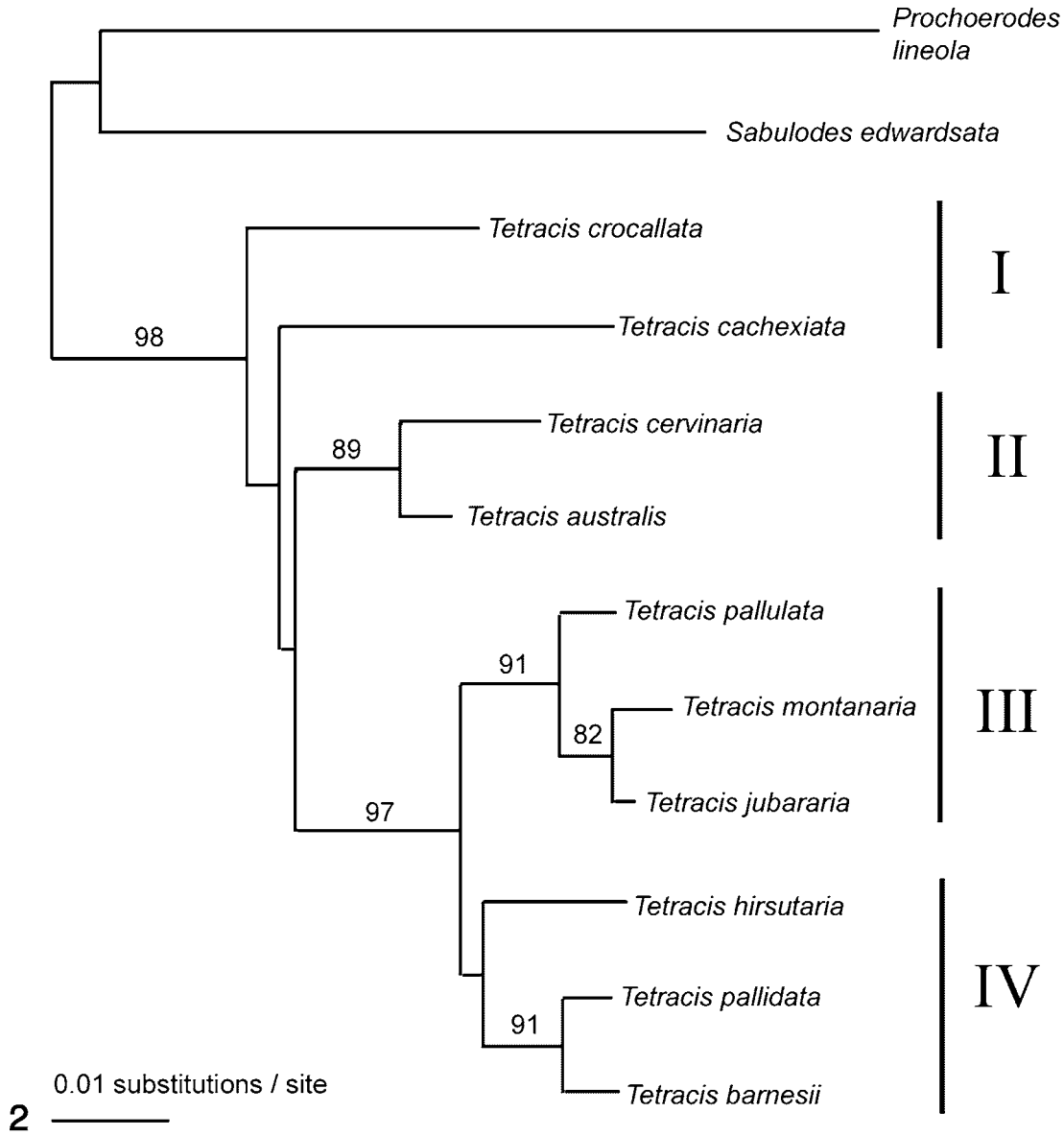
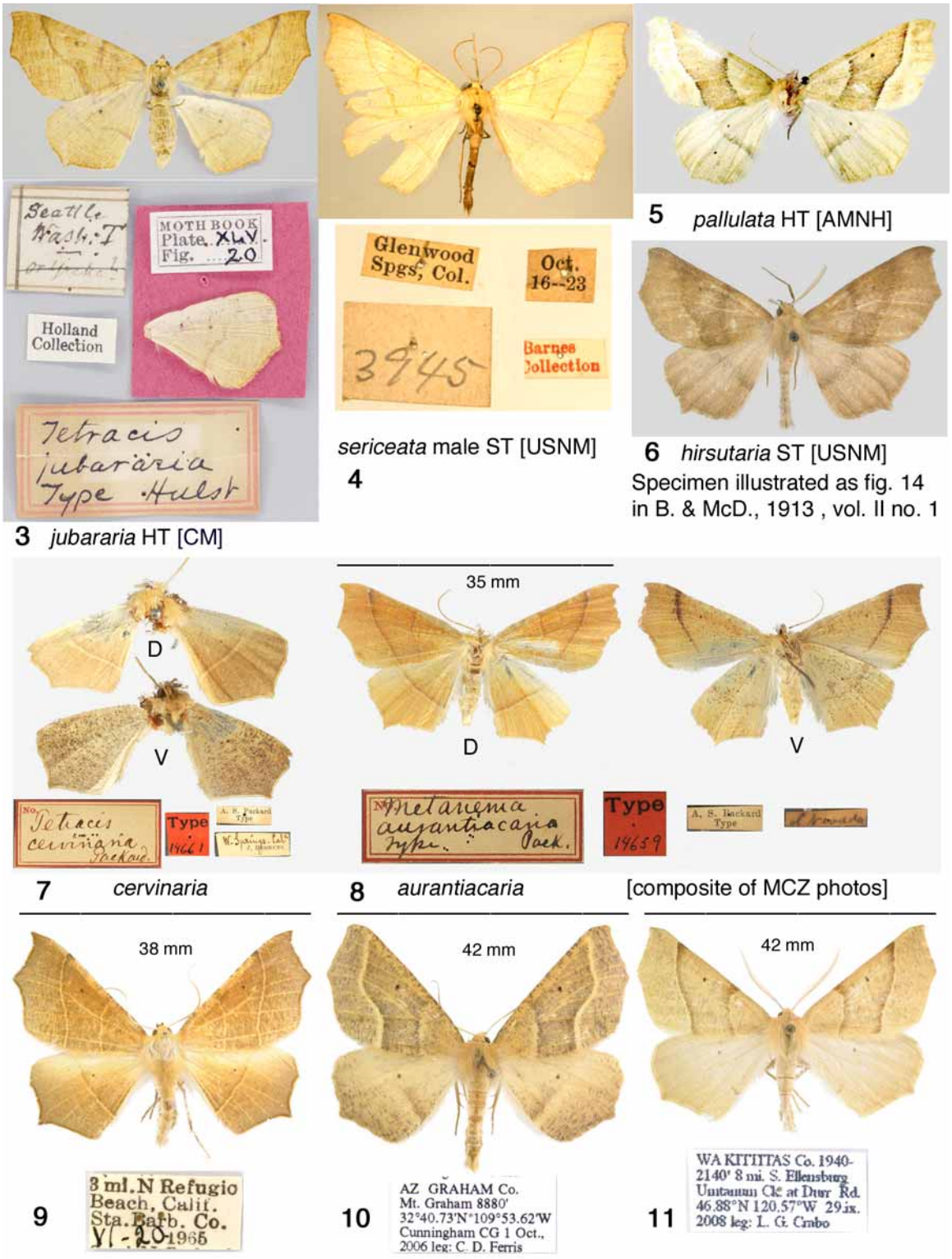


FIGURE 2. Neighbor-joining tree of cox1 'barcode' haplotypes of *Tetracis* species. Vertical bars on the right indicate species-groups referred to in text. *Prochoerodes lineola* and *Sabulodes edwardsata* were used as outgroups in the MP analysis, with bootstrap support values greater than 50% indicated above each node.



FIGURES 3–11. Type specimens: 3, *Tetracis j. jubararia* [CM photo]; 4. *Synaxis jubararia sericeata* [AMNH photo]; 5. *Synaxis pallulata* [AMNH photo]; 6. *Synaxis hirsutaria* (syntype) [author photo]; 7. *Metanema cervinaria* dorsal (D) & ventral (V) [composite of MCZ photos, used by permission]; 8 *Metanema aurantiacaria* dorsal (D) & ventral (V) [composite of MCZ photos, used by permission]; 9. *Tetracis australis*; 10. *Tetracis montanaria*; 11. *Tetracis pallidata*.

Species-group definitions based on morphology

Group I: *crocallata, cachexiata*.

Male antennae nearly filiform, densely setose ventrally. Wings uniform in color (varying shades from yellow to white); AM line and median band absent; transverse PM line nearly straight from apex to inner margin. *Male genitalia*: valve without apical projection; quadrate dorso-caudal margin of gnathos with two upcurved pointed projections. Sparse ring of spinules at posterior margin of aedeagus. *Female genitalia*: variable.

Group II: *cervinaria, australis.*

Male antennae nearly filiform, densely setose ventrally. Wing color variable, AM, PM lines present. PM line nearly straight. *Male genitalia*: valve without apical projection; quadrate dorso-caudal margin of gnathos with 4-6 (typical) upcurved pointed projections that may or may not be symmetrically positioned along margin; posterior margin of aedeagus without ring of spinules; sclerotized plate before dome. *Female genitalia*: ductus bursae well sclerotized with linear ridges.

Group III: *fuscata, pallulata, mosesiani, jubararia, montanaria.*

Male antennae nearly filiform, densely setose ventrally. Wing color variable within and across species, AM, PM lines present. PM line angles basad at vein M3. *Male genitalia*: apex of valve with small broad-based triangular projection; quadrate dorso-caudal margin of gnathos with two or more upcurved pointed projections that may or may not be symmetrically positioned along margin; spinulose ring encircles posterior rim of aedeagus; broad dome lightly setose or with multiple sclerotized nodal projections. *Female genitalia*: unsclerotized long tubular ductus bursae; corpus bursae only slightly larger in diameter than ductus bursae.

Group IV: *barnesii, formosa, hirsutaria, pallidata.*

Male antennae bipectinate. Wing color variable within and across species, AM, PM lines present. PM line angles basad at vein M3. *Male genitalia*: apex of valve with narrow sharply pointed projection; quadrate dorso-caudal margin of gnathos with two or more upcurved pointed projections that may or may not be symmetrically positioned along margin; spinulose ring containing three (usually) closely-spaced robust spines and multiple smaller spinules encircles posterior rim of aedeagus; small hemispherical dome with small patch of deciduous dark setae. *Female genitalia*: short ductus bursae and elongate (oval) corpus bursae.

Key to species

(based on male antennae, dorsal forewing color and maculation, genitalic characters)

1. Male antennae nearly filiform 2
- Male antennae bipectinate 11
2. DFW clear yellow, pale yellow, creamy white, white 3
- Not as above 4
3. DFW yellow or yellowish-white; AM line absent; transverse straight brown PM line from apex to inner margin; small brown discal spot ..... *crocallata*
- DFW creamy white or white; transverse pale brown PM line from apex to inner margin (sometimes indistinct); AM line and discal spot absent ..... *cachexiata*
4. DFW medium gray or gray-brown (fuscous); black AM, PM lines ..... *fuscata*
   DFW various ochreous hues 5
5. Males. DFW apex strongly falcate; tawny or cinnamon-tan; AM and PM line narrow, pale ochre with or without dark edging. Females. DFW often orange or cinnamon-rufous; well-defined brown or brownish-orange AM and PM lines Early season, February to mid-July (stragglers) 6
- Not as above; late July–December 7
6. Male genitalia. Length of furca approximately equal to length of aedeagus (ratio ca. 0.9). Female genitalia. Corpus bursae pointed at fundus. Coastal southern California (Monterey Co.) south to Baja California ..... *australis*
- Male genitalia. Length of furca shorter than length of aedeagus (ratio ca. 0.7). Female genitalia. Corpus bursae

rounded at fundus. Central and northern California, north to British Columbia and eastward to Wyoming and Texas ..... *cervinaria*

7. DFW buff (yellow-ochre) with well-defined brown AM and PM lines; median and marginal areas occasionally with blotchy "dead leaf" pattern; Rocky Mountain and Intermountain regions ..... *jubararia sericeata*
- DFW tan, cinnamon-tan, cinnamon-rufous, orange-brown 8
8. Median band darker than basal and marginal areas; brown PM line with prominent pale edging distally; PM line bends sharply basad in cell pace Cu1–Cu2. Southeastern Arizona (montane) in early October ..... *montanaria*
- Not as above 9
9. PM line does not bend sharply basad in cell space Cu1–Cu2. Color ochreous yellow-orange in males and PM line with pale shading distad and dark shading basad; color darker in females (sometimes brown) usually with reduced pale shading along PM line ..... *pallulata*
- Not as above 10
10. DFW apex normally sharply falcate; DFW dark tan to medium brown in males; orange-tan in females. PM line thin and brown, with or without distal pale shading in males; prominent dark PM line in females normally without distal pale shading. Male genitalia. Dome of everted vesica covered with long, slender, dark setae ..... *mosesiani*
- DFW apex not normally strongly falcate; color variable: ochreous, tan, cinnamon-tan, cinnamon-rufous, orange-brown. PM line thin, brown, usually with some pale distal shading. Median band often with central diffuse dark area; submarginal area dark banding frequently present. Patchy dark markings may be present producing a "dead-leaf" aspect. Male genitalia. Dome of everted vesica without long dark setae ..... *jubararia jubararia*
11. DFW gray to gray-brown (paler at low elevation in California). Narrow wavy black or dark brown PM line; black or dark brown AM line angles diagonally outward and upward, terminating at dark discal spot; distinct dark submarginal line ..... *formosa*
- Not as above 12
12. DFW dark tan with slightly orange cast; median band slightly darker than basal and marginal areas; AM line brown, sometimes incomplete to inner margin; sinuous pale ochre PM line; distinct dark discal spot; usually a faint brown median line on hindwing with pale shading distally ..... *barnesii*
- Not as above 13
13. DFW buff or pale ochreous with brown or orange-brown PM lines. Discal spot present, but often very small. Broad median band sometimes slightly darker than basal and submarginal areas. DHW paler than DFW, nearly unmaculated; discal spot and median line virtually obsolete. Western Idaho, Washington, British Columbia ..... *pallidata*
- DFW of males variable from pale yellow-ochre through various shades of tan to chocolate brown. AM line brownish and often faint; thin brown PM line often broken within cells producing a beaded effect, usually with distal pale shading. Some males orange-tan with well-defined orange-brown AM and PM lines; discal spot usually small and often indistinct. Width of median band variable. Females. DFW gray to gray-brown with a speckled/peppered aspect; forewing apex strongly falcate ..... *hirsutaria*

Group I: *crocallata, cachexiata.*

***Tetracis crocallata* Guenée**
(Figs. 12–15, 87, 102, 118, 133)

Tetracis crocallata Guenée, A., [1858] *in* Boisduval, J. B. A. de & Guenée, A., Histoire naturelle des insectes. Species général des lépidoptères, Paris, vol. 9:141. Syntype(s), Amérique septentrionale [North America]. Location of type(s) unknown.

T. aspilatata Guenée, A., [1858] *in* Boisduval, J. B. A. de & Guenée, A., Histoire naturelle des insectes. Species général des lépidoptères, Paris, vol. 9:141. Synonomy by Forbes, 1948:107. This is the pale spring form of *crocallata* (Forbes, 1948:107). Syntypes 1 ♂, 1 ♀, [USA], New York, Canada. Location of syntypes unknown.

Diagnosis: Recognized by yellow or yellowish-white wings, DFW straight transverse brown PM line, absent AM line, small brown discal spot.

Description: *Adults* (Figs. 12–15): FWL: 17–25 mm. Antenna (stated as serrate by some authors) basically filiform in both sexes, but in males ventrally minutely setose and weakly fasciculate; ventrally minutely setose in females. Palpi, upcurved, short (about to horizontal midline of eye), yellowish-tan scales on outer side, paler inward. Head, thorax, abdomen, legs, wings concolorous varying across individuals from pale yellowish-white to yellow, with sparse sprinkling of individual brown scales; tarsal spines brown. *Wings:*

DFW yellow or yellowish-white with straight brown transverse PM line from apex to inner margin and brown discal spot; DHW usually with brown discal spot and normally incomplete (sometimes absent) brown transverse median line. Underside as above, but less strongly marked. April specimens from Alabama are often irrorated with dark scales. Kimball (1965, p. 189) mentioned similar maculation in Florida specimens. *Male genitalia* (Figs. 87, 102)*:* Uncus decurved, slender, tapering to pointed apex. Gnathos with pair of upcuved spines projecting from dorso-caudal margin. Robust club-like furca from middle of anellus with approximately 90° bend about one-third distance below rounded apex. Valve of nearly constant width with rounded apex lacking an apical projection. Aedeagus with ring of widely-spaced spinules at posterior end at base of vesica; everted vesica balloon-like with central dense patch of slender spinules. *Female genitalia* (Fig. 118): A/P = 0.55. Short, linearly sclerotized ductus bursae expands downward to join spherical upper portion of unsclerotized corpus bursae; lower half of corpus bursae tapers to elongate tube ending in rounded fundus. Large irregular elongate slightly spinose signum situated on upper portion of corpus bursae.

Material examined: Numerous specimens, number not recorded; four dissections in addition to examination of genitalic illustrations in the literature.

Biology: Life history by Forbes (1948) and McGuffin (1987:85). Recorded larval hosts include *Alnus*, *Castanea*, and *Salix*. Adults May—August, depending upon locality. Two generations in New York [and southward], late May and August (Forbes, 1948:107). A generalist regarding ecozones.

Distribution (Fig. 133): Nova Scotia, New Brunswick, southern Manitoba, southern Saskatchewan, to Alberta (Edmonton–Red Deer region), south to northern Florida, west to Kansas, Nebraska, North Dakota, and extreme eastern Texas. Specific state/county/province records are: CANADA: MANITOBA. Porcupine Forest Reserve. NOVA SCOTIA. Kings Co. QUEBEC. Numerous localities across southern Quebec were cited by Handfield (1999). UNITED STATES: ALABAMA. Bibb, Dekalb, Jackson, Madison, Monroe. ARKANSAS. Clark, Garland. CONNECTICUT. Litchfield, New Haven. FLORIDA. Alachua, Gasden, Liberty, Suwanee. GEORGIA. Bartow, Douglas, Emanuel, Floyd, Fulton, Gilmer, Lumpkin, Paulding, Telfair, Whitfield. INDIANA. Elkhart, Lagrange, St. Joseph. ILLINOIS. Cook, Decatur, IOWA. Story, Woodbury. KANSAS. Cherokee, Douglas. KENTUCKY. Laurel. LOUISIANA (Parishes). Ascension, Iberville, St. Tammany, West Feliciana. MAINE. Franklin, Piscataquis, Penobscot. MICHIGAN. Barry, Calhoun, Cheboygan, Chippewa, Keweenaw, Otsego. MARYLAND. Alleghany, Baltimore, Caroline, Dorchester, Harford, Prince George's, Talbot, Wicomico, Worchester. MASSACHUSETTS. Middlesex. MINNESOTA. Anoka, Clearwater, Hubbard, Lake. MISSISSIPPI. Forest, George, Grenada, Lee, Pike, Rankin, Tishomingo, Warren, Wilkinson, Winston. MISSOURI. Clay, Jackson. NEBRASKA. Lancaster. NEW HAMPSHIRE. Sullivan. NEW JERSEY. Burlington, Essex, Morris, Passaic. NEW YORK. Albany, Bronx, Erie, Kings, Monroe, Orleans, Richmond (Staten Is.), Suffolk, Tompkins, Warren. NORTH CAROLINA. Alleghany, Ashe, Avery, Durham, Haywood, Macon, Stokes, Swain. OHIO. Athens, Butler, Cuyahoga, Erie, Geauga, Greene, Hamilton, Hancock, Hocking, Holmes, Jefferson, Lake, Lawrence, Licking, Lucas, Mahoning, Montgomery, Pike, Portage, Preble, Richland, Seneca, Trumbull, Vinton, Wayne. PENNSYLVANIA. Beaver, Bucks, Centre, York. SOUTH CAROLINA. Charleston, Greenville, Pickens. SOUTH DAKOTA. Day, Marshall. TENNESSEE. Blount, Cocke, Sevier. TEXAS. Hardin, Morris, Sabine. VERMONT. Chittenden. VIRGINIA. Montgomery, Rockingham. WISCONSIN. Ashland, Brown, Burnett, Chippewa, Crawford, Dane, Douglas, Florence, Fon du Lac, Forest, Grant, Jackson, Jefferson, Juneau, Marathon, Marinette, Milwaukee, Monroe, Ozaukee, Pierce, Richland, Sauk, Sheboygan, Trempealeau, Vernon, Walworth, Washington, Waushara.

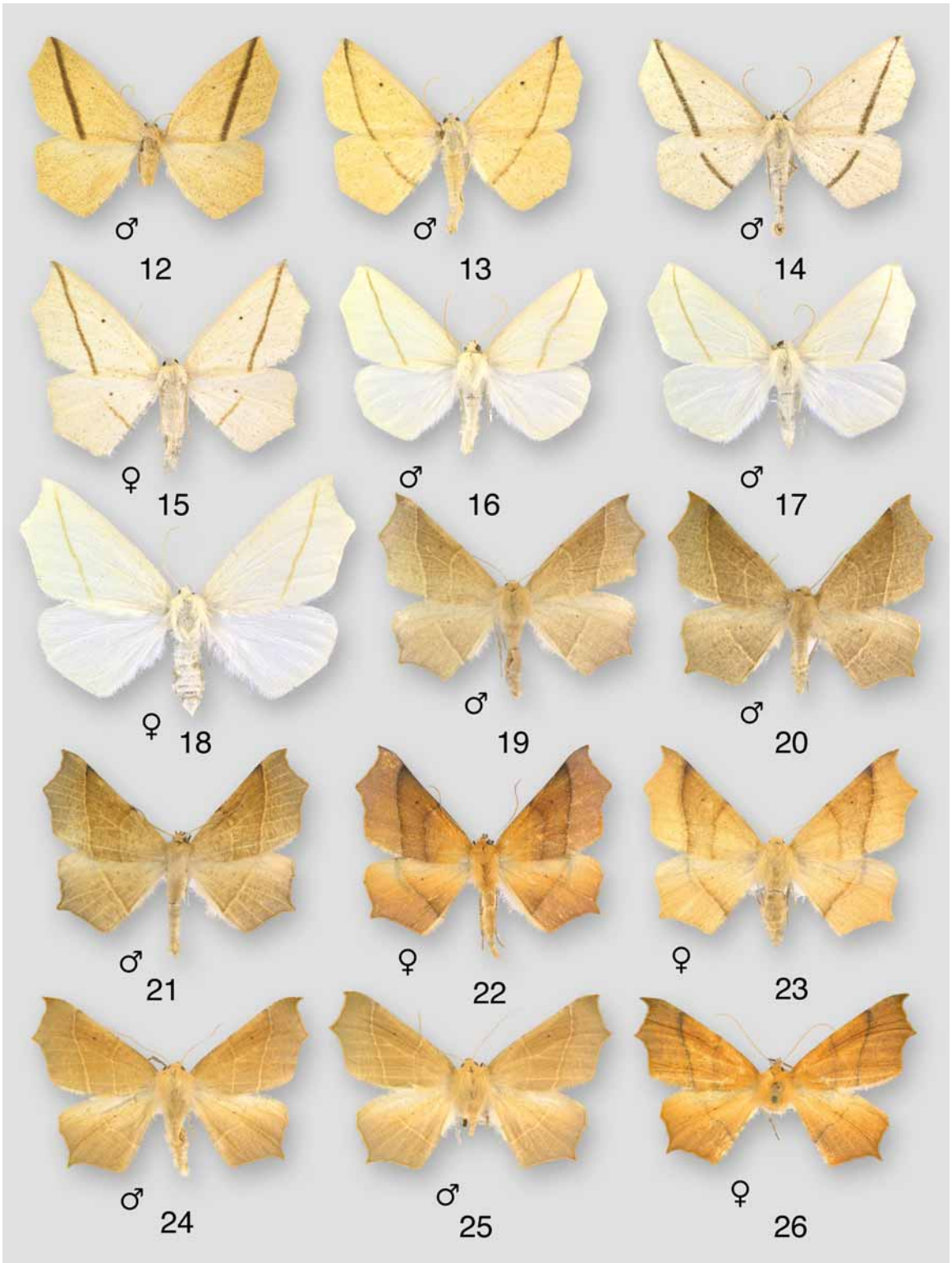
Tetracis cachexiata **Guenée**

(Figs. 16–18, 88, 103, 119, 134)

Tetracis cachexiata Guenée, A., [1858] *in* Boisduval, J. B. A. de & Guenée, A., Histoire naturelle des insectes. Species général des lépidoptères, Paris, vol. 9:142. Holotype ♀, "Nouvelle-Hollande" [Australia], incorrect locality, actually North America [MNHU].

T. lorata Grote, A. R., 1864. *Proceedings of the Entomological Society of Philadelphia*, 3:91. Syntypes ♂, ♀, Eastern and Middle States [USA]. Location of types unknown. Note: After his death, the specimens in Grote's collection were scattered and many were damaged or destroyed.

Diagnosis: Recognized by white or creamy-white wings, DFW transverse pale brown PM line, absent AM line and discal spot.



FIGURES 12–26. *Tetracis* adults: 12–15. *T. crocallata*, 12. Penobscot Co., ME, 13–14. Lagrange Co., IL, 15. Elkhart Co., IN; 16–18. *T. cachexiata*, Elkhart Co., IN; 19–23. *T. cervinaria*, 19, 23. Franklin Co., ID, 20–22. Wallowa Co., OR; 24–26. *T. australis*, Los Angeles Co., CA, paratypes.

Description: *Adults* (Figs. 16–18): FWL: 19–26 mm. Antenna (stated as prismatic by some authors) essentially filiform, ventrally minutely setose, thinner in females. Palpi, upcurved, short (about to horizontal midline of eye), tan scales on outer side, paler inward. Head, thorax, abdomen, legs, wings concolorous varying across individuals from white to creamy-white; tarsal spines brown. *Wings:* DFW with thin straight brown transverse PM line from apex to inner margin (sometimes indistinct) discal spot absent; DHW unmarked. Underside unmaculated. *Male genitalia* (Figs. 88, 103)*:* Uncus decurved, slender, tapering to pointed apex. Gnathos with pair of robust upcuved spines projecting from dorso-caudal margin. Stubby furca from middle of anellus tapers to rounded apex. Valve broad, tapering slightly to rounded apex lacking an apical projection. Aedeagus with incomplete ring of widely-spaced spinules at posterior end at base of vesica; everted vesica elongate with expanded midsection on which is situated an oblong sclerotized plate containing short spinules. *Female genitalia* (Fig. 119): A/P = 0.55. Very short, linearly sclerotized ductus bursae expands to join unsclerotized sack-like corpus bursae. Signum oval and strongly dentate.

Material examined: Numerous specimens, number not recorded; two dissections in addition to examination of genitalic illustrations in the literature.

Biology: Life history by Forbes (1948) and McGuffin (1987:84). Many recorded larval hosts, some of which are *Alnus*, *Betula*, *Prunus*, *Salix*, *Tilia*, *Ulmus*, *Viburnum*, *Abies*, *Larix*, *Pinus*, *Tsuga*. See also Heppner, 2003, p. 348. Adults May—early July, depending upon locality. A montane and piedmont species.

Distribution (Fig. 134)**:** Nova Scotia to central British Columbia, south to northern Florida, and west to Montana and northern Colorado. Specific province/state/county records are: CANADA: ALBERTA. East and south of Calgary and Red Deer to Saskatchewan and Montana border. MANITOBA. Duck Mtn. Prov. Park. QUEBEC. Numerous localities across southern Quebec were cited by Handfield (1999). UNITED STATES: ALABAMA. Clay, Cleburne, Dekalb, Jackson, Madison. ARKANSAS. Logan. COLORADO. Larimer. CONNECTICUT. New Haven. FLORIDA. Panhandle region (Heppner, 2003). GEORGIA. Gilmer. Towns, Whitfield. ILLINOIS. Cook, McHenry, Putnam. INDIANA. Elkhart, Lagrange. KANSAS. Douglas, Pottawatomie. KENTUCKY. Grayson. MAINE. Hancock, Kennebec, Penobscot, Piscataquis. MARYLAND. Alleghany, Anne Arundel, Baltimore, Calvert, Garrett, Harford, Kent, Prince George's. MASSACHUSETTS. Hampden, Norfolk. MICHIGAN. Baraga, Chippewa, Cheboygan, Chippewa, Keweenaw, Montcalm, Muskegon. MINNESOTA. Carver, Hennepin, Houston, Hubbard, Lake, St. Louis. MISSISSIPPI. Oktibbeha, Tishomingo. MISSOURI. Clay. MONTANA. Lewis & Clark. NEBRASKA. Sioux. NEW HAMPSHIRE. Coos, Grafton, Sullivan. NEW YORK. Bronx, Kings, Nassau, Orleans, Rockland, Tompkins, Ulster. NORTH CAROLINA. Allegheny, Ashe, Avery, Carteret, Craven, Durham, Jones, Haywood, Macon, New Hanover, Swain. NORTH DAKOTA. Bottineau, Cass, Ransom, Rolette. OHIO. Adams, Athens, Cuyahoga, Erie, Geauga, Hamilton, Hocking, Lucas, Mahoning, Pickaway, Portage, Seneca, Vinton, Wayne. PENNSYLVANIA. Beaver, Bucks, Carbon, Centre, Chester, Mifflin, York. SOUTH CAROLINA. Greenville. SOUTH DAKOTA. Day. TENNESSEE. Blount, Cocke, Sevier, Sullivan. VERMONT. Chittenden, Windham. VIRGINIA. Arlington, Grayson, Rockingham, Smyth. WEST VIRGINIA. Pendleton. WISCONSIN. Adams, Brown, Florence, Iowa, Juneau, La Crosse, Manitowoc, Marquette, Menomonee, Milwaukee, Monroe, Sauk, Shawano, Sheboygan, Rock, Washburn, Waukesha, Waupaca.

Group II: *cervinaria*, *australis.*

The two species that comprise this group cannot be separated visually without observing male genitalic characters. Initially they were discovered by DNA barcoding, and subsequent examination of the male genitalia uncovered distinct diagnostic characters (Figs. 88–89, 120–121). These species may also be separated by geography as shown in the distribution maps (Figs. 135–136). To date, Ferris has not found any overlap in their respective distributions.

***Tetracis cervinaria* (Packard)**
(Figs. 7–8, 19–23, 89, 104, 120, 135)

Metanema cervinaria Packard, 1871. *Proceedings of the Boston Society of Natural History*, 13:386. Holotype ♂, "W. Springs, Cal. Behrens." [MCZ]. Note: The naturalist James Behrens came to America from Germany in 1853 and settled in San Francisco, California. He collected in the San Francisco Bay Area and around the northern part of the state. Ferris interprets "W. Springs" to be an abbreviation for Warm Springs, Alameda Co, California, and hereby fixes this location as the type locality. The holotype (Fig. 7) is missing its forewings, abdomen, and most of the antennae and legs.

Metanema aurantiacaria Packard. 1873. *Proceedings of the Boston Society of Natural History*, 16:34. Holotype ♀ "S. Nevada." [MCZ]. The holotype (Fig. 8) is in good condition except for a missing antenna.

Synaxis cervinaria McDunnough, 1938, page 173, entry 5191.

Diagnosis: The nearly straight DFW PM line, typically fawn color, and early-season flight period (February–June; stragglers to mid-July) separate *cervinaria* from its congeners except *australis*. Genitalic characters (male genitalia: length of furca shorter than length of aedeagus, ratio ca. 0.7) and geography (widely distributed in western North American, but not in coastal southern California) separate *cervinaria* from *australis*.

Description: *Adults* (Figs. 7–8, 19–23): FWL: 19–23 mm. Antenna (both sexes) dorsally white, nearly filiform, densely setose ventrally. Head (except frons), thorax, abdomen, basal and outer marginal areas of wings essentially concolorous; frons and terminal segment of palpi darker. Palpi broad, upcurved, slightly longer than width of eye. Abdomen laterally and ventrally sparsely speckled with individual brown scales. Legs whitish overlaid nonuniformly with dark brown scales defining diffuse bands. *Wings*: DFW apex strongly falcate; males tawny or cinnamon-tan with narrow pale ochre AM and PM lines with or without dark edging, PM line nearly straight, MB frequently darker; females often orange or cinnamon-rufous with well-defined brown or brownish-orange AM and PM lines with usually darker MB. DHW with nearly straight median line duplicating color of PM line, in some examples there is a distal indistinct convex dark satellite line originating from the top to the middle of the median line; small FW and HW discal dots are present. Ventrally the dorsal markings are repeated to some degree depending upon individual specimens; there is also a widely distributed speckling by dark scales. *Male genitalia* (Figs. 89, 104)*:* Uncus slightly decurved, basally broad tapering to rounded apex. Gnathos typically with 2 or 3 robust upcuved spines projecting from opposite ends of dorso-caudal margin. Robust furca from middle of anellus tapers to rounded apex, length of furca shorter than length of aedeagus, ratio ca. 0.7. Valve broad with even margins, tapering slightly to rounded apex lacking an apical projection. Aedeagus with lightly sclerotized projection at posterior end, but without ring of spinules at base of vesica; everted vesica with well-defined dome; irregularly-shaped setose lightly sclerotized plate at base of vesica; smaller irregularly-shaped slightly setose sclerotized plate and scattered small sclerotized nodules on dome. *Female genitalia* (Fig. 120): A/P = 0.4. Tubular ductus bursae moderately long, linearly sclerotized; corpus bursae ovoid with rounded fundus, slightly shorter than length of ductus bursae; large oval and strongly dentate signum below junction with ductus bursae.

Material examined: 160 specimens with 30 dissections. Additional material and genitalic preparations examined by digital photographs.

Biology: Mature larva described by McGuffin (1987). Previous literature citations of larval hosts are suspect because localities are generally not provided, so that it is not known to which group II species they pertain. Based on label data from museum specimens reared from wild-caught larvae, two confirmed hosts in northern California for *cervinaria* are *Prunus emarginata* (Douglas) D. Dietrich and *P. virginiana* L. *Quercus garryana* Dougl. was cited by Jones (1951) in British Columbia. Adults as early as February into June, with female stragglers into mid-July.

Distribution (Fig. 135)**:** British Columbia south to Kern Co., California and eastward to western Montana, SE Idaho, Carbon Co., Wyoming, and Larimer Co., Colorado, from 2600–7800' (790-2375m). Records by province/state/county are: CANADA: ALBERTA. Waterton Lakes. BRITISH COLUMBIA. Vancouver, Vancouver Is. UNITED STATES: CALIFORNIA. Alameda, Alpine, Amador, Contra Costa, El Dorado, Fresno, Humboldt, Inyo, Kern, Lake,, Madera, Marin, Mariposa, Mendocino, Modoc, Mono, Napa,

Placer, Plumas, Santa Clara, Santa Cruz, Shasta, Sierra, Siskiyou, Solano, Sonoma, Trinity, Tulare, Tuolumne, Yolo. COLORADO. Garfield, Larimer, Mesa, Rio Blanco. IDAHO. Bannock, Franklin, Washington. MONTANA. Lewis & Clark. NEVADA. Lander, White Pine. OREGON. Benton, Douglas, Harney, Klamath, Union, Wallowa. UTAH. Summit. WASHINGTON. Benton, Island, Pend Oreille, Yakima. WYOMING. Carbon.

***Tetracis australis* Ferris, New Species**
(Figs. 9, 24–26, 90, 105, 121, 136)

Diagnosis: The nearly straight DFW PM line, fawn color, and early-season flight period (February–June; stragglers to mid-July) separate *australis* from its congeners except *cervinaria*. Genitalic characters (male genitalia: length of furca nearly as long as aedeagus, ratio ca. 0.9; ca. 0.7 in *cervinaria*; valves longer and narrower than in *cervinaria*) and geography (coastal southern California to Baja California) separate *australis* from *cervinaria*. Some males of *australis* have a slightly ruddy aspect not usually seen in *cervinaria*, but this is not a reliable character for species separation. The ventral maculation of *australis* is paler and more diffuse than in *cervinaria*.

Description: *Adults* (Figs. 9, 24–26): FWL: 19–23 mm. External morphology as for *cervinaria*. *Male genitalia* (Figs. 90, 105)*:* Uncus slightly decurved, basally broad tapering to rounded apex. Gnathos typically with 2 or 3 robust upcuved spines projecting from opposite ends of dorso-caudal margin. Slender robust furca from middle of anellus tapers to rounded apex, expanding slightly before apex, length of furca almost as long as aedeagus, ratio ca. 0.9. Valve basally broad with even margins, tapering to rounded apex lacking an apical projection. Aedeagus with lightly sclerotized projection at posterior end, but without ring of spinules at base of vesica; everted vesica with well-defined dome; ribbon-like lightly setose sclerotized plate at base of vesica; small irregularly-shaped slightly setose sclerotized plate and scattered small sclerotized nodules on dome. *Female genitalia* (Fig. 121): A/P = 0.4. Tubular ductus bursae moderately long, linearly sclerotized, expanding slightly before joining corpus bursae; corpus bursae plum-shaped with pointed fundus, slightly shorter than length of ductus bursae; large oval and strongly dentate signum below junction with ductus bursae.

Type material. Holotype ♂ : CALIFORNIA, Santa Barbara Co., 3 mi. N. Refugio Beach, 20 June, 1965, (no collector) [UCB, Berkeley, California]. **Paratypes**: 27 ♂ , 19 ♀) CALIFORNIA: Los Angeles Co., Carnavon Way, Los Angeles, 17 April, 1983 (1 ♀), 4–21 May, 1983, F. P. Sala (3 ♂), , Buckham Camp, Angeles Crest, 7000', 9 June, 1952, F. P. Sala (1 ♀); Monterey Co., Big Creek Reserve (UC NRS), 5/8 June, 1989, Y-F Hsu & J. Powell (3 ♂), 5/6–27/29 April, 1990 Y. F. Hsu & J. Powell (4 ♂ , 7 ♀), 3/5–14/16 June, 1991, Y. F. Hsu & J. A. Powell (2 ♀), 2/4 May, 1992, C. A. Geiger (1 ♂ ,1 ♀) 12/13–23/24 May, 1992, J. Powell & Scaccia (3 ♂), 7/9 June, 1993, Y. F. Hsu & J. A. Powell (1 ♀), 25/26 April, 1997, J. Powell & J. Kruse (1 ♀); San Luis Obispo Co., 3 mi. W. Paso Robles, 28 April, 1968, J. A. Powell & P. A. Opler (4 ♂ , 2 ♀), 2 mi. W. Paso Robles, 28 April, 1968, J. Powell (1 ♂), 7 mi. E. Morro Bay, 23 June, 1965, J. S. Buckett (1 ♂), 3 mi. S. Atascadero, 26 April, 1968, P. A. Opler (1 ♂), Pozo, 1 May, 1962, R. L. Langston (1 ♂); Santa Barbara Co., Mission Cyn., Santa Barbara, 2 March, 1987, J. Powell (1 ♂), 3 mi. N. Refugio Beach, 20 June, 1965, J. Powell (1 ♂), 24 June, 1965 J. Powell (1♀); Ventura Co., Cherry Ck., 6 mi. E. Pine Mtn. Summit, 25 May, 1984, J. Powell & DeBenedictis (1 ♂ , 1 ♀). MEXICO, Baja California Norte, Los Encinos, San Pedro Martir, 6000', 2 June, 1958, J. Powell (1 ♂ , 1 ♀). Paratypes deposited in EME and CDF.

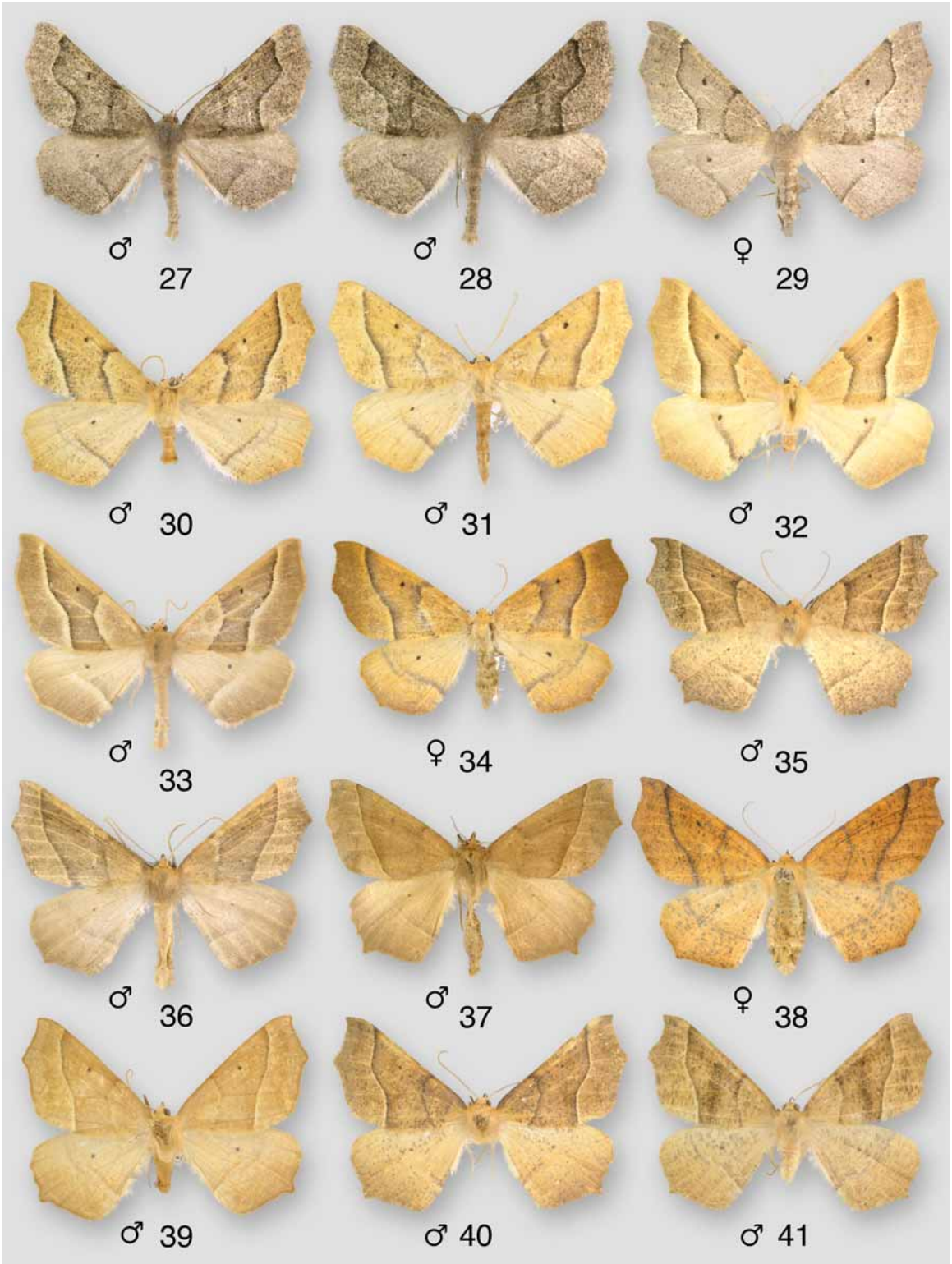
Material examined: Additional material was examined that is not included in the type series.

Etymology. The adjectival name *australis* reflects the southern geographic distribution of this species.

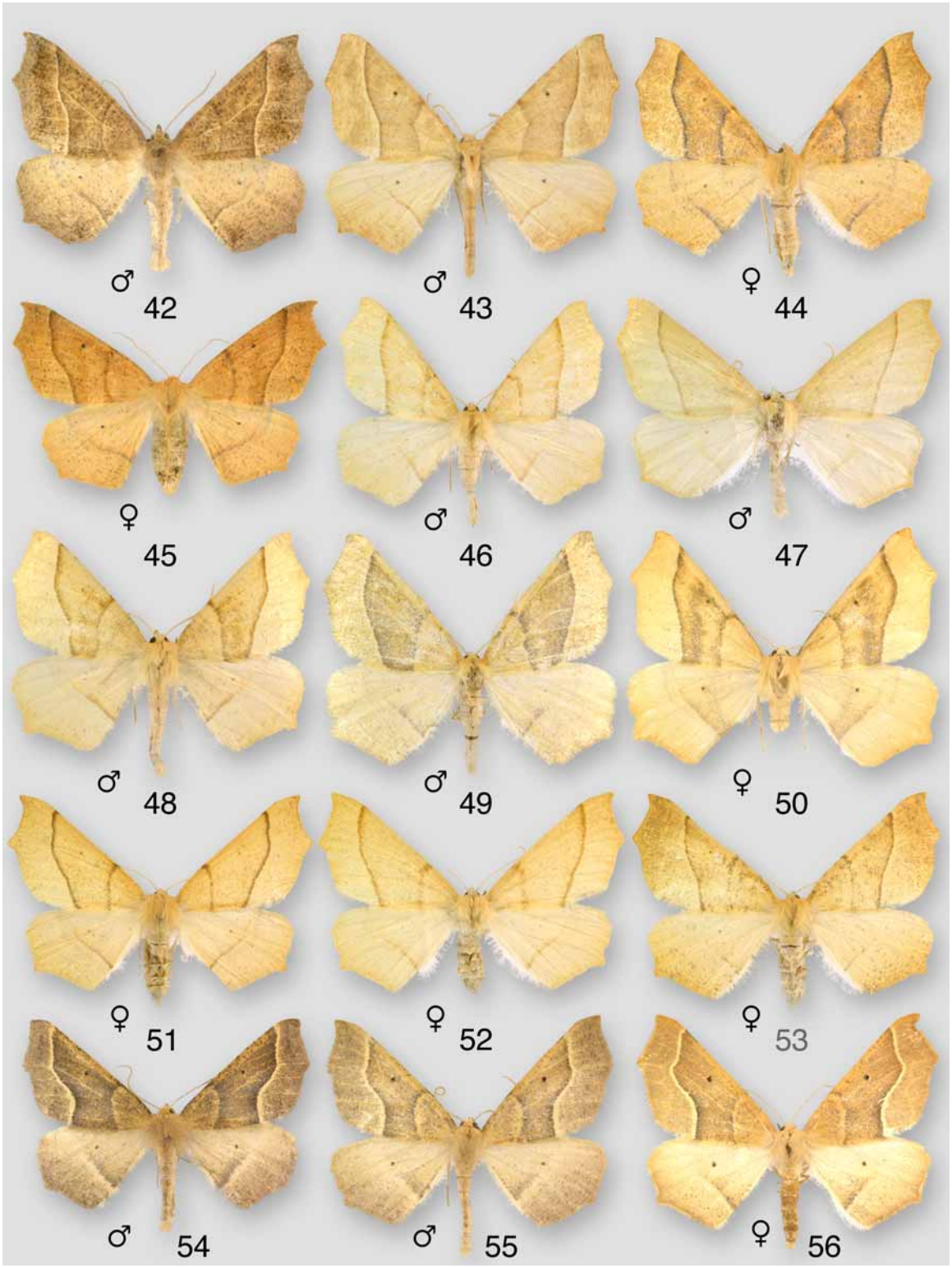
Biology: Incompletely known. In pine-oak-manzanita habitat. McFarland (1965, as *cervinaria*) cited larval hosts as *Quercus* and *Populus* in the Santa Monica Mts., Los Angeles Co., California. Adults from March to late June.

Distribution (Fig. 136)**:** Coastal southern Caifornia from Monterey Co. south to Los Encinas, San Pedro Martir, Baja California Norte, Mexico at elevations from near sea level to 7000' (2135m). Records by state/

county are: UNITED STATES: CALIFORNIA. Los Angeles, Monterey, Orange, Riverside, San Bernardino, San Diego, San Luis Obispo, Santa Barbara. MEXICO: Baja Caifornia Norte.



FIGURES 27–41. *Tetracis* adults: 27–29. *T. fuscata*, 27–28. Albany Co., WY, 29. Mesa Co., CO; 30–34. *T. pallulata*, 30. British Columbia, 31, 34. Curry Co., OR, 32. Plumas Co., CA, 33. Clark Co., NV; 35–38. *T. mosesiani*, 35–36, 38. Monterey Co., CA, 37. Los Angeles Co., CA; 39–41. *T. j. jubararia*, 39. Coos Co., OR, 40–41. Alameda Co., CA.



FIGURES 42–56. *Tetracis* adults: 42–45. *T. j. jubararia*, 42. Marin Co., CA, 43. Elmore Co., ID, 44. Boise Co., CA, 45. Monterey Co., CA; 46–53. *T. j. sericeata*, Albany Co., WY; 54–56. *T. montanaria*, Graham Co., AZ, paratypes.

Group III: *fuscata, pallulata, mosesiani, jubararia, montanaria*

The species in this group can generally be separated by adult external morphology and genitalia. *Tetracis montanaria* when first collected was thought to be an undescribed species. Since *montanaria* differs in

phenotype from *jubararia*, and the amount of DNA divergence, although relatively small, is consistent with other closely related *Tetracis* (*pallidata* vs. *barnesii*), *montanaria* is treated as a species rather than a subspecies of *jubararia*.

***Tetracis fuscata* (Hulst)**
(Figs. 27–29, 91, 106, 122, 137)

Synaxis fuscata Hulst, 1898. Descriptions of new genera and species of the Geometrina of North America. *Canadian Entomologist* 30(8): 217. Holotype ♂, Glenwood Springs [Garfield Co.], Colorado [AMNH]. Note: Hulst, 1898, misspelled the locality as "Glenmore Springs."

Diagnosis: The angulate black DFW PM line, well-defined brown-black AM line, and lack of bipectinate antennae in males separate *fuscata* from its congeners *formosa* and gray forms of *hirsutaria*.

Description: *Adults* (Figs. 27–29): FWL: 19–23 mm. Antenna light brown and serrate in male; in female nearly filiform, densely setose ventrally. Palpi slender, porrect, about 1.5x eye width, banded brown and fuscous. Head, thorax, abdomen, legs grayish-brown (Hulst's "dirty fuscous"); abdomen speckled with dark scales. *Wings*: Grayish brown, well-peppered with dark scales. DFW with brown-black AM and PM lines; PM line angled basad at M3; MB only slightly darker than rest of wing; small discal spot present. DHW with poorly developed and incomplete dark median line; discal spot absent. Ventrally paler with dorsal markings lightly repeated. Female slightly larger and paler than male. *Male genitalia* (Figs. 91, 106): Uncus broad, slightly decurved, tapering to bluntly pointed tip. Dorso-caudal margin of gnathos concave with a robust upcurved spine at either side. Stubby robust furca from middle of anellus tapers to rounded apex, slightly enlarged before apex. Valve moderately broad with even margins, tapering to narrow rounded apex with a small triangular apical projection at the dorsal margin. Aedeagus with ring of spinules at posterior end at base of vesica; everted vesica with patch of sclerotized nodules on dome. *Female genitalia* (Fig. 122): A/P = 0.44. Long unsclerotized tubular ductus bursae (ca. 2x length of corpus bursae). Corpus bursae ovoid with small oval dentate signum located about 2/3 length of bursae above fundus.

Material examined: 33 specimens with 3 dissections.

Biology: Unknown. The timing of the adult flight in late August into September varies annually depending upon climatic conditions and flight ceases with the onset of the first hard mountain frost.

Distribution (Fig. 137)**:** UNITED STATES: COLORADO. Garfield, Larimer. WYOMING. Albany (Snowy Range Mts., Sherman Hills at southern end of Laramie Range) 7600–8200' (2320–2500m).

***Tetracis pallulata* Hulst**
(Figs. 5, 30–34, 92, 107, 123, 138)

Tetracis pallulata Hulst, 1887. New species of Geometridae No. 3. *Entomologica Americana* 2(11): 211. Holotype ♂ (Fig. 5), Crater Lake, Oregon [AMNH].

Synaxis pallulata Hulst, 1896. A classification of the Geometrina of North America, with descriptions of new genera and species. *Transactions of the American Entomological Society.* 23: 324, 377.

Diagnosis: *Tetracis pallulata* generally can be separated from the other group III ochreous species by the presence of pale shading distad and dark shading basad of the PM line.

Description: *Adults* (Figs. 5, 30–34): FWL: 18–24 mm. Antenna dorsally whitish, laminate (very slender, but densely setose ventrally) in male; female similar, but narrower. Palpi slender, slightly decurved, about 1.7x eye width, ochreous, dark brown at tip. Head, thorax, abdomen, legs ochreous, varying in hue across individuals. *Wings*: Ochreous, varying in color across individuals. FW apex falcate. DFW irrorated with dark scales; with very dark brown (nearly black) AM and strongly-developed PM lines; PM line broadly pale-shaded outwardly; the degree to which PM line angles inwardly at M3 varies across individuals; MB colored

as rest of wing, or only very slightly darker. DHW with well-developed dark median line that fades out toward upper margin. Dark discal spots on FW and HW well-developed. Ventrally paler with dorsal markings lightly repeated. Some females tend to be much darker in hue than males with one brown example examined. *Male genitalia* (Figs. 92, 107): Uncus broad, slightly decurved, tapering to bluntly pointed tip. Dorso-caudal margin of gnathos concave with a robust upcurved spine at either side. Short (about 0.5x width of valve base) robust furca from middle of anellus tapers to rounded apex, enlarging slightly before apex. Valve moderately broad with even margins, tapering to narrow rounded apex with a triangular apical projection at the dorsal margin. Aedeagus with ring of spinules at posterior end at base of vesica; everted vesica with patch of sclerotized nodules on dome, denser at base of dome, becoming diffuse toward crown. *Female genitalia* (Fig. 123): A/P = 0..66. Long unsclerotized tubular ductus bursae (ca. 1.5x length of corpus bursae). Corpus bursae ovoid with small oval dentate signum located at middle.

Material examined: 57 specimens with 11 dissections.

Biology: Mature larva and pupa described by McGuffin (1987:82). Larval hosts are members of the Cupressaceae and Pinaceae. Specific hosts for reared specimens that Ferris examined were *Abies concolor* Lindl. & Gord. (San Bernardino Co., CA), *Picea englemanni* Engelmann and *Tsuga heterophylla* Sargent. Jones (1951:139) listed *Picea sitchensis* Carr. Larval hosts of reared specimens from British Columbia in the CNC are: *Abies grandis* Lindl., *Pseudotsuga menziesii* (Mirbel) Franco, *Tsuga canadensis* Carr, *Tsuga* species. The citations in Parsons *et al.* (1999:911) of *Rubus* (Rosaceae) and of other families in Jones (1951:139) most probably represent misidentifications of *T. jubararia*. Adults from August to October.

Distribution (Fig. 138)**:** Southern California north to British Columbia, eastward to Idaho (Clearwater Co.) and western Montana (Lewis and Clark Co.) from near sea level to 7200' (2200m). Records by province/state/county are: CANADA: ALBERTA. Waterton Lakes, N.P. BRITISH COLUMBIA. Falkland, McGillvray Creek, Trinity Valley UNITED STATES: CALIFORNIA. Alpine, Contra Costa, Del Norte, El Dorado, Glenn, Humboldt, Kern, Los Angeles, Marin, Monterey, Napa, Nevada, Placer, Plumas, San Bernardino, Sonoma, Tehama, Tulare, Ventura. IDAHO. Clearwater. MONTANA. Lewis & Clark. OREGON. Curry, Grant, Lincoln, Klamath, Wallowa. WASHINGTON. Kittitas.

***Tetracis mosesiani* (Sala)**
(Figs. 35–38, 93, 108, 124, 140)

Synaxis mosesiani Sala, [1971]. *Synaxis mosesiani* Sala; a new *Synaxis* from southern California. *Journal of Research on the Lepidoptera* 9(3): 185–190. Holotype ♂ , Carnavon Way, Los Angeles, L[os] A[ngeles] County, California [LACM].

Diagnosis: *Tetracis mosesiani* and *T. jubararia* are easily confused. The antennae in *mosesiani* are basically filiform, but when rotated slowly under magnification a serrate outer margin can be seen. The antennae in *jubararia* are similar, but very slightly wider with longer ventral setae. The differences are subtle. Reliable separation of *Tetracis mosesiani* from *T. jubararia* is only by genitalic characters. The dome of the everted vesica in *mosesiani* is setose, while covered with widely-separated small nodules in *jubararia*. The DFW of *jubararia* often exhibits a dark elongate patch within the MB (absent in *mosesiani*) and a submarginal diffuse dark band (rare, but occasionally indistinct in some *mosesiani*).

Description: *Adults* (Figs. 35–38): FWL: 17–23 mm. Antenna pale ochreous dorsally, nearly filiform with serrate outer margin, narrower in females. Palpi moderately slender, decurved, about 2x eye width, brownish-tan, darker dorsally and at tips. Head, thorax, abdomen, legs brownish-tan to orange-tan (females), varying in hue across individuals. Legs and ventral abdomen flecked with scattered brown scales. *Wings*: Base color generally tan (males) and orange-tan (females). FW apex falcate. AM and PM lines brown; PM line with pale outer edge and slightly concave at vein M3; MB colored as rest of wing, or only very slightly darker. DHW with poorly-developed median line that fades out toward upper margin. Small dark discal spots on FW but may be obsolete on HW. Ventrally paler with dorsal markings lightly repeated; wing surfaces irrorated with dark scales. *Male genitalia* (Figs. 98, 108): Uncus of medium width, slightly decurved, tapering to

bluntly pointed tip. Dorso-caudal margin of gnathos concave with a robust narrow tapering upcurved spine at either side. Robust furca from middle of anellus tapers to rounded apex, enlarging only slightly before apex. Valve moderately broad with even margins, tapering to rounded apex with a triangular apical projection at the dorsal margin. Aedeagus with ring of dense spinules at posterior end at base of vesica; everted vesica with setose patch on dome giving a hirsute aspect. *Female genitalia* (Figs. 124): A/P = 0.5. Long unsclerotized tubular ductus bursae expanding slightly at junction with corpus bursae, obscuring junction (ca. 2x length of corpus bursae). Corpus bursae ovoid with small oval dentate signum located at middle. Note: Apparently the female specimen that Sala dissected ([1971]:188, fig. 6) was deformed or the bursa copulatrix had not expanded; the corpus bursae is not as Sala illustrated.

Material examined: 53 specimens with 10 dissections.

Biology: Partial description by Sala. The larval host is *Lonicera hispidula* Douglas. With respect to the early stages, Sala stated (p. 189): "These are known for the species, but will be described in detail in a subsequent publication." Publication never occurred. Adults from October to early December.

Distribution (Fig. 140)**:** Coastal California from near sea level to 3000' (915m). Specific state/county records are: UNITED STATES: CALIFORNIA. Alameda, Los Angeles, Marin, Mendocino, Monterey, Orange, San Bernardino, San Diego, Santa Barbara, Ventura. from near sea level to 3000' (915m).

Tetracis jubararia jubararia **Hulst**

(Figs. 3, 39–45, 94, 109, 125, 141)

Tetracis jubararia Hulst, 1886. New species of Geometridae, No. 2. *Entomologica Americana* 2(6):120. Holotype ♀, (Fig. 3) Seattle, Wash[ington] [CM]. HT figured by Holland (1904, Plate XLV, fig. 20).
Synaxis jubararia McDunnough, 1938, page 173, entry 5189.

Diagnosis: Separation of *T. jubararia jubararia* from *T. mosesiani* in coastal California counties is difficult and positive identification is by genitalia (see "Diagnosis" for *T. mosesiani*). Over the remainder of its range (inland and northern California north to British Columbia), the absence of pale shading distad of the PM line separates *jubararia* from similarly colored examples of *pallulata*. *T. jubararia jubararia* does not exhibit the buff (pale yellow-ochre) color found in its subspecies *sericeata*.

Description: *Adults* (Figs. 3, 39–45): FWL: 17–26 mm. Antenna pale ochreous to whitish dorsally, nearly filiform, ventrally densely setose with gaps between segments (laminate), narrower in females. Palpi moderately broad, porrect or slightly upcurved, about 2x eye width, dark ochreous with dark brown tips. Head, thorax, abdomen, legs ochreous, varying in hue across individuals. Legs and ventral abdomen flecked with scattered brown scales. *Wings*: Base color generally tan and dark brown-tan (males) and orange-tan (females). FW apex falcate. AM and PM lines brown; PM line narrow, sinuate, sometimes with very narrow pale outer edge, bending basad at vein M3; MB colored as rest of wing, often with a diffuse darker central patch; submarginal area dark diffuse banding frequently present. Additional patchy markings may be present producing a "dead-leaf" aspect. DHW with poorly-developed median line that fades out toward upper margin. Dark discal spots on FW and HW. Ventrally paler with dorsal markings repeated; wing surfaces with widely-scattered dark scales suggesting a "dead-leaf" pattern. *Male genitalia* (Figs. 94, 109): Uncus of medium width, slightly decurved, tapering to bluntly pointed tip. Dorso-caudal margin of gnathos concave with a robust narrow tapering upcurved spine at either side. Robust furca from middle of anellus tapers to rounded apex, enlarging only slightly before apex. Valve moderately broad with even margins, tapering to rounded apex with a small triangular apical projection at the dorsal margin. Aedeagus with an incomplete ring of spinules at posterior end at base of vesica; everted vesica with patch of scattered sclerotized nodules on dome. *Female genitalia* (Fig. 125): A/P = 0.46. Long unsclerotized tubular ductus bursae expanding slightly at junction with corpus bursae, obscuring junction (ca. 2x length of corpus bursae). Corpus bursae ovoid with small oval dentate signum located at middle.

Material examined: 138 specimens with 17 dissections.

Biology: Full description of early stages by McGuffin (1987:81). Adults from mid-August to late November, depending upon locality and elevation. Reported larval hosts include *Alnus*, *Betula*, *Cornus*, *Populus*, *Ribes*, among others; *Prunus subcordata* Benth. in Modoc Co., California (label data from reared museum specimen). Host records for reared specimens in the CNC are: alder, *Salix*, *Picea glauca* Voss, *Picea engelmanni* Parry, *Pseudotsuga menziesii*, *Thuja* sp. (numerous records from British Columbia and Alberta).

Distribution (Fig. 141)**:** Southern California northward to British Columbia and eastward to central Saskatchewan, southwestern Idaho, and White Pine Co., Nevada at elevations from 490–7400' (150–2255m). Records by province/state/county are: CANADA: BRITISH COLUMBIA. Nanaimo. UNITED STATES: CALIFORNIA. Alameda, Contra Costa, Del Norte, Humboldt, Lake, Marin, Mendocino, Modoc, Monterey, Napa, Orange, Placer, Plumas, San Mateo, Santa Clara, Shasta, Siskiyou, Solano, Sonoma, Stanislaus, Tulare, IDAHO. Boise, Elmore. OREGON. Baker, Coos, Lake. WASHINGTON. King, Kittitas.

Tetracis jubararia sericeata (Barnes & McDunnough)

(Figs. 4, 46–53, 95, 110, 124, 141)

Synaxis jubararia sericeata Barnes & McDunnough, 1917. *Contributions to the Natural History of the Lepidoptera* III(4):261. Syntypes 1♂ (Fig. 4), 1♀ , Glenwood Springs, Colorado [USNM].

Diagnosis: This is the only subspecies with buff (pale yellow-ochre) wings, fully-developed AM and PM lines, and without bipectinate male antennae.

Description: *Adults* (Figs. 4, 46–53): FWL: 17–26 mm. Antenna as in *T. j. jubararia*. Palpi pale ochreous with only the end of the tip brown. *Wings*: As for *j. jubararia* excepting the pale yellow-ochre color and absence ventrally of widely-scattered dark scales suggesting a "dead-leaf" pattern. *Genitalia* (Figs. 95, 110, 124): As in *j. jubararia*.

Material examined: 78 specimens with 6 dissections.

Biology: Unknown. Adults from September to mid-November.

Distribution (Fig. 141)**:** Rocky Mountain and Intermountain Regions from 6000–8500' (1830–2590m). Records by province/state/county are: ALBERTA. Red Deer region, Edmonton region. COLORADO. Garfield, La Plata, Larimer, Mesa. IDAHO. Cassia. NEVADA. White Pine. UTAH. Tooele. WYOMING. Albany, Carbon, Washakie.

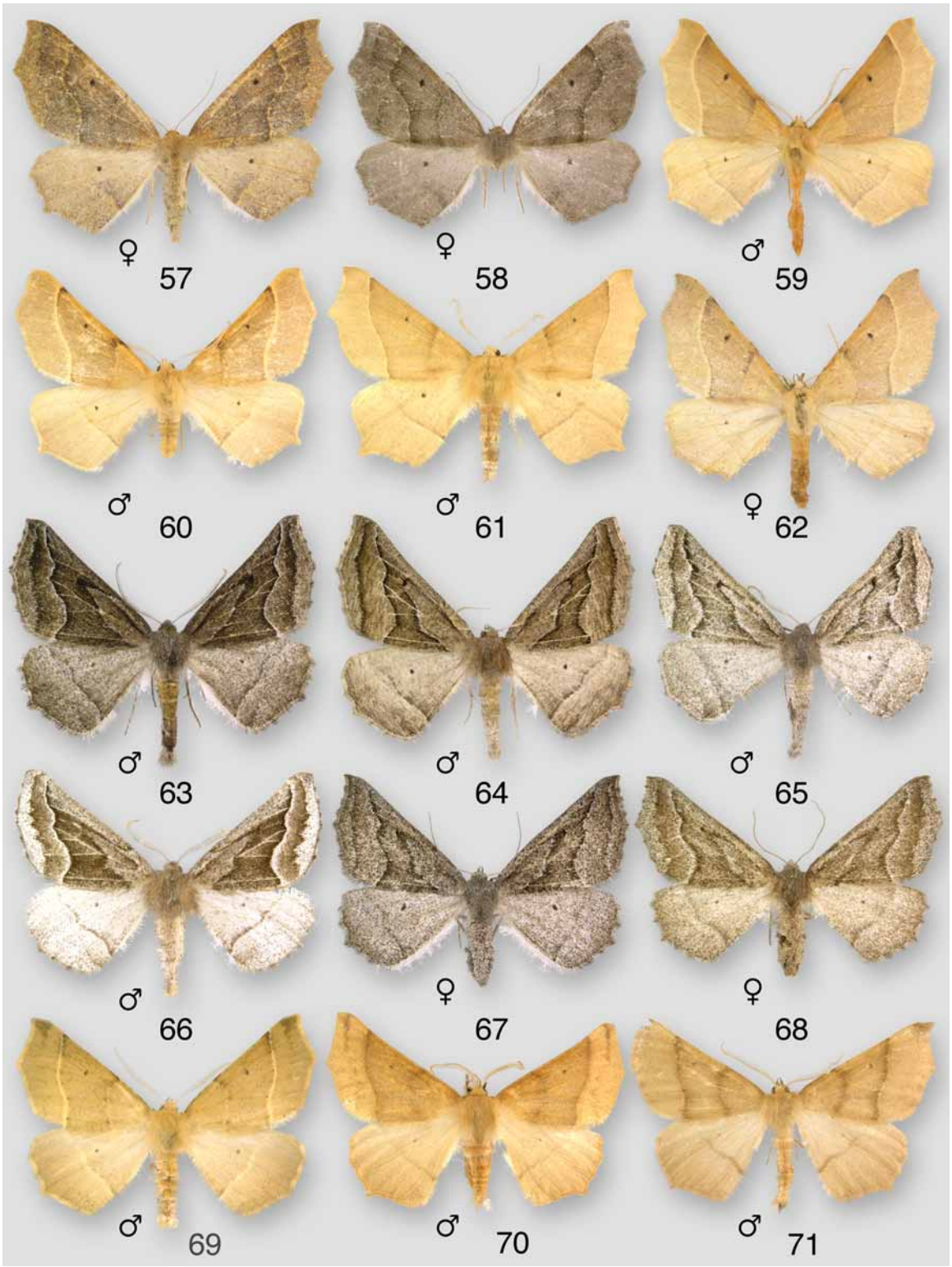
Tetracis montanaria Ferris, New Species

(Figs. 10, 54–58, 96, 111, 127–128, 139)

Diagnosis: Geography alone separates this species, since no other *Tetracis* species are known from the mountains of SE Arizona. The two similar species, *T. j. jubararia* and *T. pallulata* do not have a PM line that breaks sharply basad at M3 and manifests a flattened "S-shape" overall.

Description: *Adults* (Figs. 10, 54–58): FWL: 22–25 mm. Antenna pale ochreous to whitish dorsally, nearly filiform, ventrally densely setose with gaps between segments (laminate), narrower in female. Palpi moderately broad, porrect or slightly upcurved, about 1.8x eye width, dark ochreous with dark brown tips. Head, thorax, abdomen, legs ochreous, varying in hue across individuals. Legs and ventral abdomen flecked with scattered brown scales. *Wings*: Base color generally ochreous orange-brown. FW apex weakly falcate. AM and PM lines brown; PM line narrow, flattened "S-shape", with very narrow pale outer edge, bending sharply basad at vein M3; MB slightly darker then rest of wing. DHW with poorly-developed median line that fades out toward upper margin. Dark discal spots on FW and HW. Ventrally paler with dorsal markings repeated lightly. *Male genitalia* (Figs. 96, 111): Uncus of medium width, slightly decurved, tapering to bluntly pointed tip. Dorso-caudal margin of gnathos concave and irregular, with a robust narrow tapering upcurved spine at either side. Stubby furca (ca. 0.5x width of valve base) from middle of anellus tapers to pointed apex. Valve moderately broad with even margins, tapering to rounded apex with a well-developed triangular apical

projection at the dorsal margin. Aedeagus with an incomplete ring of slender spinules at posterior end at base of vesica; everted vesica with patch of scattered sclerotized nodules on dome. *Female genitalia* (Fig. 127): A/P = 0.6. Long unsclerotized tubular ductus bursae expanding very slightly at junction with corpus bursae, obscuring junction (ca. 1.7x length of corpus bursae). Corpus bursae ovoid with oval dentate signum located at middle.



FIGURES 57–71. *Tetracis* adults: 57–58. *T.montanaria*, Apache Co., AZ; 59–62. *T. barnesii*, 59, 62. Mesa Co., CO; 60. Emery Co., UT, 61. Yavapai Co., AZ; 63–69. *T. formosa*, 63, 65. Albany Co., WY, 64. Grand Co., CO, 66, 68. Los Angeles Co., CA, 67. Washakie Co., WY. 69–71. *T. hirsutaria*, 69. Los Angeles Co., CA (reared), 70–71. Riverside Co., CA.

Type material. Holotype ♂ . UNITED STATES: ARIZONA, Graham Co., Mt. Graham, 8880' (2708m), 32° 40.73'N, 109° 53.62'W, Cunningham Campground, 1 October, 2006, C. D. Ferris. [AMNH]. **Paratypes:** Same locality as holotype, 1.x.2006 (25 ♂ , 1 ♀), 9.x.2007 (6♂), 1.x.2008 (3♂); ARIZONA, Pima Co., Bear Wallow Rd., Santa Catalina Mts., 8000' (2440m), 6.x.2002, J. B. walsh (1♂). Paratypes in CNC, CDF, and JBW. Two female specimens (Figs. 57-58) from Apache Co., Arizona [Greer, 8 October, 2005, J. Vargo] are not included in the type series because of their very different color. Their correct placement can not be established until males are available for study. Their genitalia (Fig. 128), however, are consistent with *T. montanaria*, as are the shapes of the AM and PM lines.

Etymology. Adjective, "of the mountains."

Material examined: No additional specimens beyond those mentioned above were examined; 8 dissections were made.

Biology: Unknown. Habitat is aspen-coniferous forest. Adults in early October (and possibly late September).

Distribution (Fig. 139)**:** Southeastern Arizona, Graham Co., Mt. Graham and Pima Co., Santa Catalina Mts. from 8000–8900' (2440–2715m); ?Apache Co., White Mts.

Group IV: *barnesii, formosa, hirsutaria, pallidata.*

The species in this group can generally be separated by adult external morphology and genitalia. *Tetracis pallidata* when first examined was thought to be an undescribed species, which barcoding then confirmed

***Tetracis barnesii* (Hulst)**
(Figs. 59–62, 97, 112, 129, 142)

Gonodontis barnesii Hulst, 1896. A classification of the Geometrina of North America, with descriptions of new genera and species. *Transactions of the American Entomological Society.* 23(3):374. Holotype ♂ , "Greenwood" [Glenwood] Springs, Colorado, October, 1892 (W. Barnes) [AMNH].
Synaxis barnesi McDunnough, 1938, page 173, entry 5194.

Diagnosis: The combination of the DFW dark orange-tan color, sinuous brown PM line smeared inwardly at the costal margin, and outwardly bordered for its length by a narrow pale yellow-ochre line separate *Tetracis barnesii* from its congeners.

Description: *Adults* (Figs. 59–62): FWL: 19–23 mm. Antenna nearly white dorsally, bipectinate in male, nearly filiform in female and densely setose ventrally. Palpi narrow, porrect but terminal segments decurved, slightly longer than eye width, mixed dark ochreous and brown scales, tips darker. Head, abdomen, legs ochreous, varying in hue across individuals. Ventral abdomen and legs paler; legs with scattered dark brown scales. Thorax dorsally and ventrally orange-ochreous and very setose. *Wings*: Base color ochreous orange-brown. FW apex weakly falcate. AM and PM lines brown; both slightly convex outwardly; sinuous PM line with only a moderate change in curvature at M3, pale yellow-ochre its entire length (occasionally with some narrow brown shading inwardly), with brown shading inwardly at costal margin. MB only slightly darker than remainder of wing; small dark brown discal spot. DHW paler centrally with darker shading along outer margin; median line poorly developed; discal spot small and faint. Ventrally paler with dorsal markings repeated lightly. *Male genitalia* (Figs. 97, 112): Uncus of medium width, slightly decurved, tapering to bluntly pointed tip. Dorso-caudal margin of gnathos concave and irregular, with a slender tapering upcurved spine at either side. Stubby furca (ca. 0.45x width of valve base) from middle of anellus tapers uniformly to sharply-pointed apex. Valve broad with even margins, tapering to rounded apex with a narrow sharply-pointed apical projection at the dorsal margin. Aedeagus with a ring of slender spinules at posterior end at base of vesica including a group of long setae; everted vesica with small ovoid unsclerotized dome. *Female genitalia* (Fig. 129): A/P ca. 0.37. Curved very short sclerotized ductus bursae joins ovoid (sac-like) corpus bursae, with

dentate signum located about 1/3 of corpus bursae length below junction. Corpus bursae with lightly sclerotized pouch above signum at junction with ductus bursae. Ductus seminalis robust.

Material examined: 36 specimens with 5 dissections.

Biology: Unknown. Habitats range from high-desert riparian canyons (Colorado, Utah) to dry coniferous forest (Oregon) from 5100–6250' (1555–1905m). Adults in early September to late October.

Distribution (Fig. 142)**:** Records by state/county are: UNITED STATES: ARIZONA. Gila, Yavapai. CALIFORNIA. Alpine, Colusa, Humboldt, Lassen, Modoc, Nevada, Placer, Shasta. COLORADO. Garfield, Mesa. MONTANA. Silver Bow. OREGON. Harney. UTAH. Emery.

***Tetracis formosa* (Hulst)**
(Figs. 63–68, 98, 113, 130, 143)

Gonodontis formosa Hulst, 1896. A classification of the Geometrina of North America, with descriptions of new genera and species. *Transactions of the American Entomological Society.* 23(3):375. Two syntypes: ♂ San Bernardino Co., California (Type USNM 3910, missing abdomen and no genitalic side); ♀ Glenwood Springs [Garfield Co.], Colorado (no USNM type label, dissected). [USNM]. Note: Barnes & McDunnough illustrated a male "type" of *Gonodontis formosa* from Glenwood Springs, Colorado (1912, Pl. XVI, fig. 5).
Synaxis formosa McDunnough, 1938, page 173, entry 5193.

Diagnosis: *Tetracis formosa* separates from its congeners by its gray to gray-brown DFW color (paler at low elevation in Caifornia) and the following characters: narrow, wavy black or dark brown PM line; black or dark brown AM line that angles diagonally outward and upward from inner margin, terminating at the dark discal spot; dark submarginal line or band.

Description: *Adults* (Figs. 63–68): FWL: 17–23 mm. Antenna nearly white dorsally, bipectinate in male, nearly filiform in female and densely setose ventrally. Palpi broad about 1.5x eye width, speckled with gray, brown, and black scales. Head (frons gray), abdomen, legs gray to gray-brown, varying in color according to habitat. Montane specimens are mostly gray, high-desert specimens gray-brown, becoming paler at lower elevations in California (Los Angeles Co.). Ventral abdomen, legs paler and flecked with dark brown scales. Thorax dorsally and ventrally hirsute. *Wings*: Base color pale gray to white; overall aspect gray to gray-brown because of overlying gray, brown, and dark brown scales. FW apex acute but barely falcate. AM and PM lines dark brown; PM line narrow, sinuate, with a narrow white outer border its entire length. AM line with narrow white border basad; AM line angles diagonally outward and upward from inner margin, terminating at the dark discal spot. MB at most only slightly darker than basal area. Submarginal area divided by narrow irregular dark brown band; in many specimens the wing color is paler distad of this band. Veins outlined in white. DHW paler centrally with darker shading along outer margin; dark brown median line irregular, usually well-developed; discal spot small and dark. Wings ventrally very pale, lightly irrorated by brown scales. PM line, DHW median line, and discal spots strongly repeated; AM line indistinct. *Male genitalia* (Figs. 98. 113): Uncus of medium width, slightly decurved, tapering to bluntly pointed tip. Dorso-caudal margin of gnathos concave and irregular, with a slender tapering upcurved spine at either side. Furca short (ca. 0.4x width of valve base) from middle of anellus tapers uniformly to sharply-pointed apex. Valve broad with even margins, tapering to rounded apex with a robust sharply-pointed apical projection at the dorsal margin. Aedeagus with a ring of slender spinules at posterior end at base of vesica including a group of long setae; everted vesica with small unsclerotized dome; a pouch or diverticulum below dome. *Female genitalia* (Fig. 130): A/P = 0.63. Length of lightly sclerotized tubular ductus bursae is ca. 0.75x length of corpus bursae. Corpus bursae elongated and ovoid with irregularly-shaped dentate signum.

Material examined: 279 specimens with 6 dissections.

Biology: Incompletely known. A museum specimen examined was reared from a wild-caught larva on *Prunus andersonii* Gray (Desert Peach) from Washoe Co., Nevada. Habitats range from desert riparian canyons (Colorado, Utah) to dry coniferous forest (Wyoming). Adults in early September to late November.

Distribution (Fig. 143)**:** Colorado, eastern Utah, and eastern Wyoming west to California and north to southern British Columbia and southern Alberta from 2850–7600' (870–2320m). Records by province/state/county are: CANADA: ALBERTA. NE of Brooks. UNITED STATES: CALIFORNIA. Alpine, El Dorado, Inyo, Lassen, Los Angeles, Modoc, Mono, Riverside, San Bernardino, San Luis Obispo, Santa Cruz, Ventura. COLORADO. Mesa. IDAHO. Owyhee. NEVADA. Washoe. OREGON. Harney. UTAH. Grand, San Juan, Sevier, Utah. WASHINGTON. Kittitas. WYOMING. Albany, Washakie.

Discussion: It is possible that the California arid region populations represent a sibling species of *T. formosa*, but no genitalic differences were noted. Suitable specimens were not available for molecular analysis.

***Tetracis hirsutaria* (Barnes & McDunnough)**
(Figs. 6, 69–83, 99, 114–115, 131, 144)

Metanema hirsutaria Barnes & McDunnough, 1913. *Contributions to the Natural History of the Lepidoptera* II(3): 131. Syntypes 8 ♂ (Fig. 6), San Diego, California [USNM]. Prior to the formal description, two syntypes were illustrated by Barnes & McDunnough, 1913. *Contributions to the Natural History of the Lepidoptera* II(1), Plate III, figs. 14, 16.

Synaxis hirsutaria McDunnough, 1938, page 173, entry 5195.

Adult color of *Tetracis hirsutaria* and maculation, to some degree, are extremely variable. Several reared series were examined. The species is sexually dimorphic. Reared series of specimens, genitalic dissections, and DNA barcoding, however, all suggest a single species.

Diagnosis: *Tetracis hirsutaria* is most likely to be confused with similarly-colored specimens of *T. barnesii*, as males of both species have bipectinate antennae. The AM and PM lines are diagnostic. In *hirsutaria*, there are dark dots (magnification may be necessary) where these lines cross the veins (often faint on the AM line); in *barnesii* there are no such dots.

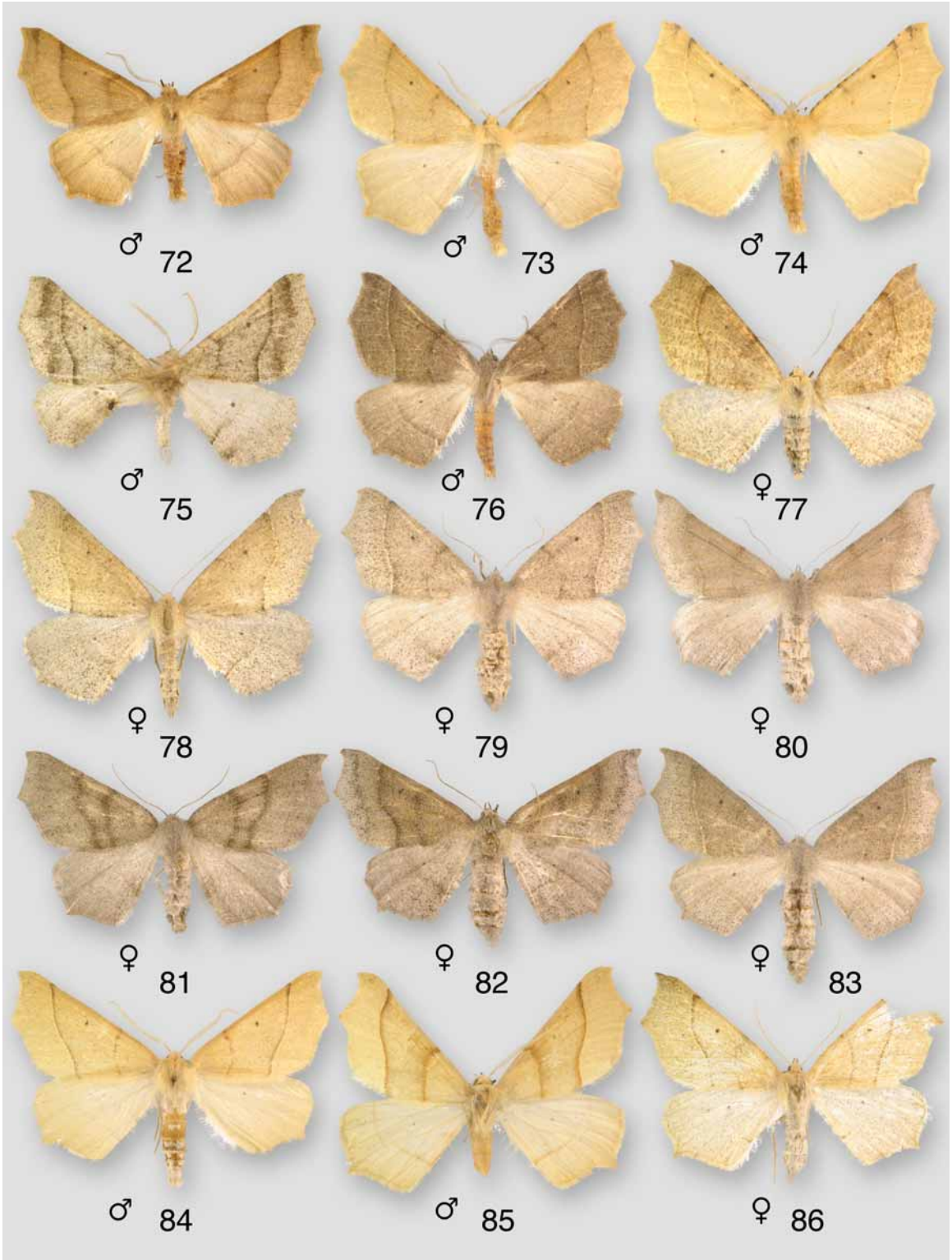
Description: *Adults* (Figs. 6, 69–83): FWL: 17–23 mm. Antenna nearly white dorsally, bipectinate in male, nearly filiform in female and densely setose ventrally. Palpi medium width about 2x eye width, tan to brown, porrect, tips slightly decurved. Head, thorax,, abdomen, legs concolorous with base color of wings. Thorax dorsally and ventrally hirsute [the basis for the name, but no more so than in *barnesii* and *formosa*]. *Wings*: Base color variable in males, gray, pale ochreous, orange-ochreous, cinnamon, to chocolate brown; females gray or grayish-brown, irrorated with brown scales D and V. FW apex falcate, more so in females than males. DFW: AM line convex; PM line thin, sinuate, and only slightly bent basad at M3. PM line may appear brown with pale thin border distad, or pale with thin dark border line basad. Brown spots appear where the AM and PM lines cross the veins (magnification may be required to see these spots). Small brown discal spot present. DHW slightly paler than DFW with incomplete median line; brown discal spot small to obsolete. Wings much paler ventrally with dorsal maculation repeated lightly, or obsolete; wings lightly irrorated with brown scales. *Male genitalia* (Figs. 99, 114–115): Uncus of medium width, slightly decurved, tapering to bluntly pointed tip. Dorso-caudal margin of gnathos evenly concave, with a broad-based, tapering upcurved spine at either side. Furca short (ca. 0.45x width of valve base) from middle of anellus, cylindrical, then tapers to pointed apex. Valve broad with even margins, tapering to rounded apex with a small sharply-pointed apical projection at the dorsal margin. Aedeagus with a partial ring of slender spinules and setose patch at posterior end at base of vesica including a group of 3 long setae; everted vesica with small unsclerotized dome except for occasional small dark patch of apparently deciduous setae on crown. *Female genitalia* (Fig. 131): A/P = 0.65. Length of lightly sclerotized short ductus bursae is ca. 0.1x length of corpus bursae. Corpus bursae elongated and ovoid with centrally-located oval dentate signum. Ductus seminalis robust.

Material examined: 176 specimens were examined with 12 dissections.

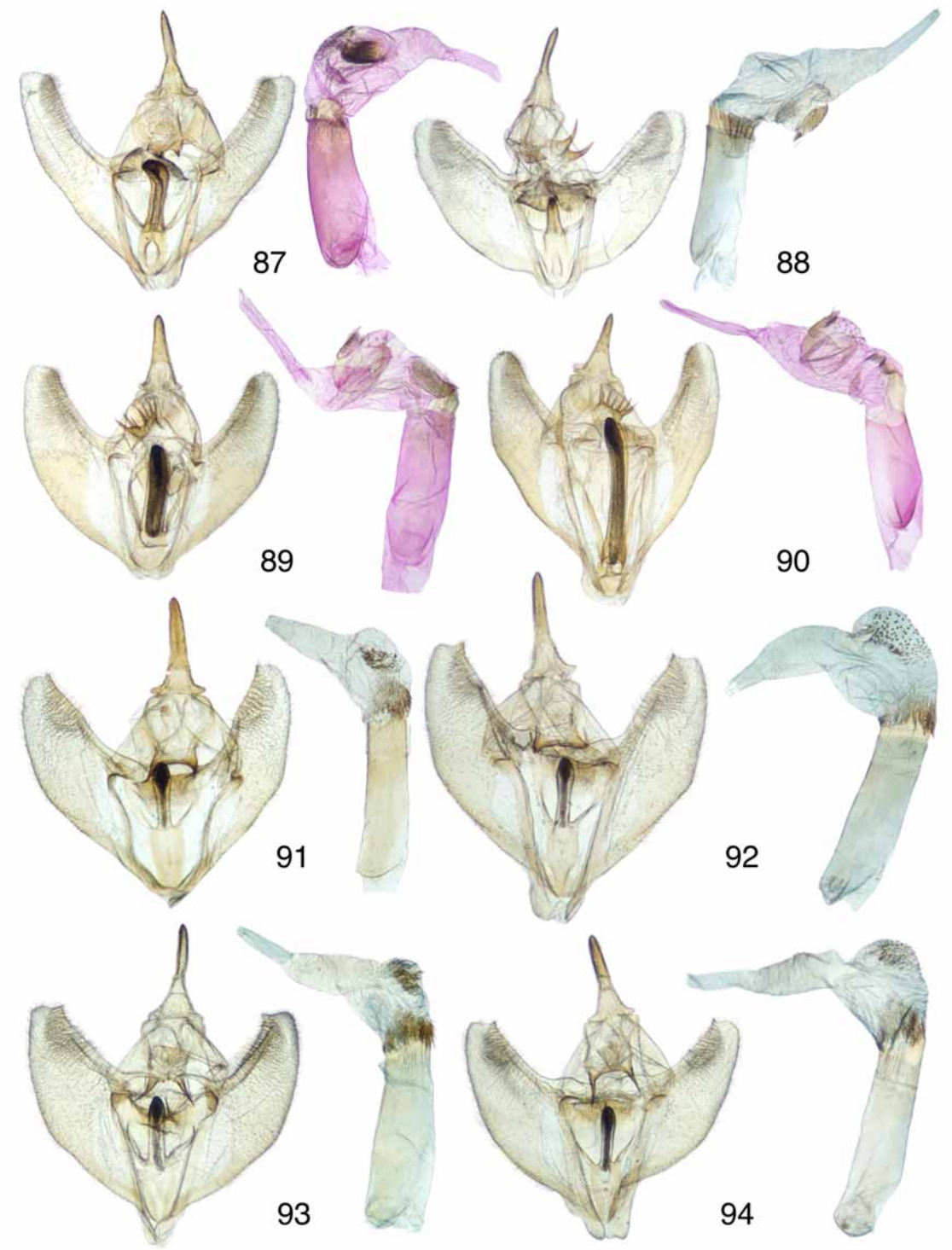
Biology: Incompletely known. Based on label data from museum specimens reared from wild-caught larvae, host plants are *Ceanothus* sp. (Monterey Co., CA), *Ceanothus cuneatus* (Hook.) Nutt. (buckbrush, Los Angeles Co., CA), *Cercocarpus* sp. (Los Angeles Co., CA), *Cercocarpus betuloides* Nutt. (San Bernardino

Co., CA), *Prunus emarginata* Walp. (Modoc Co., CA) and *Ribes malvaceum* Sm. (Los Angeles Co., CA). Adults early October–November.

Distribution (Fig. 144)**:** UNITED STATES: California and extreme southern Nevada. Records by state/county are: CALIFORNIA. Contra Costa, Kern, Lake, Los Angeles, Mono, Monterey, Napa, Nevada, Orange, Placer, Plumas, Riverside, San Bernardino, San Diego, Santa Barbara, Santa Clara, Shasta, Solano, Sonoma, Stanislaus, Tulare, Ventura, Modoc; NEVADA. Clark. Elevations range from 68–5100' (21–1555m).



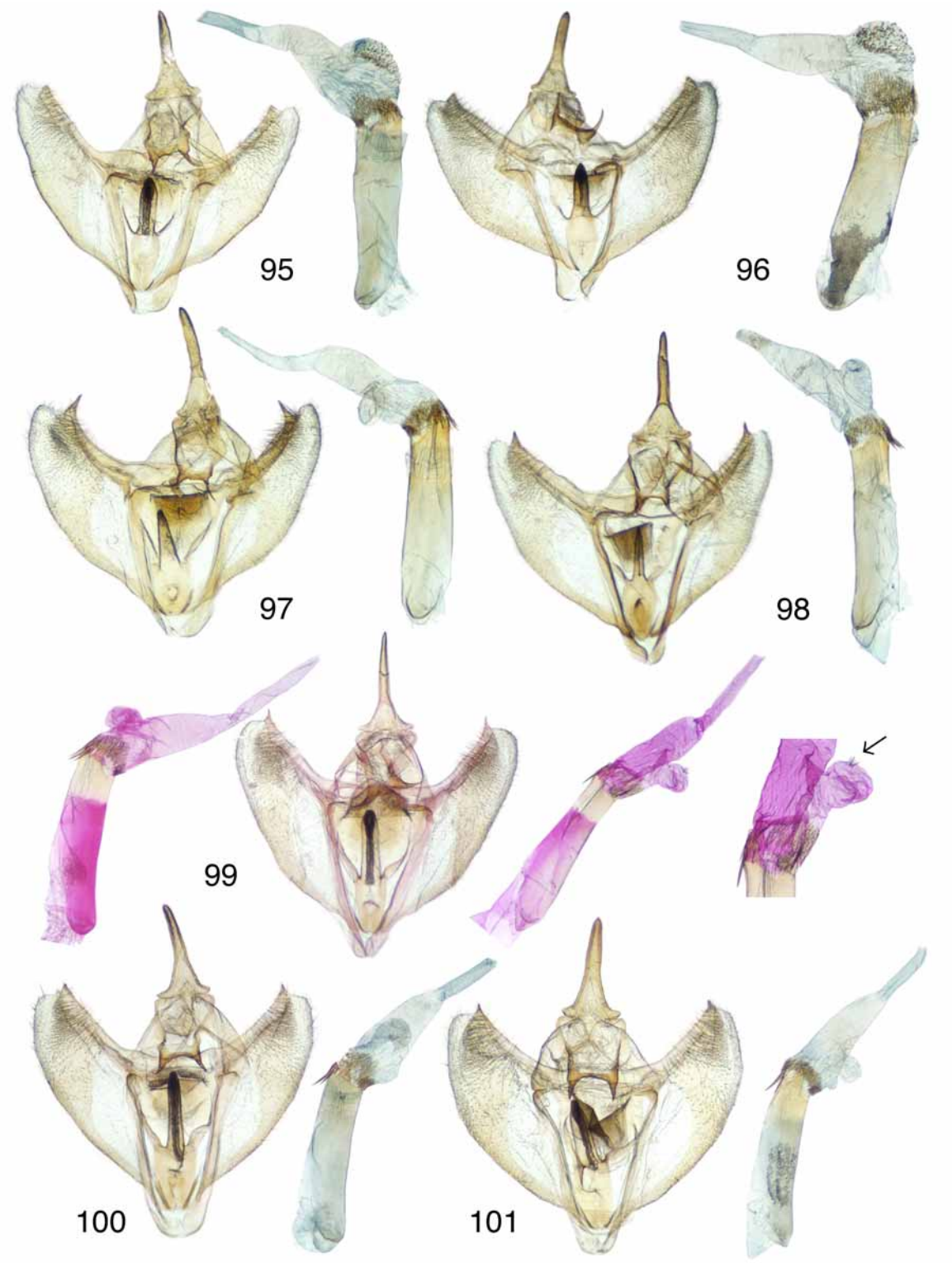
FIGURES 72–86. *Tetracis* adults: 72–83. *T. hirsutaria*, 72, 76, 81–82. Riverside Co., CA (reared, ex-ova), 73–74, 79–80, 83. Los Angeles Co., CA (reared, ex-ova), 75, 78. Mono Co., CA, 77. Nevada Co., CA; 84 –86. *T. pallidata*, 84. Oliver, BC, 85. Owyhee Co., ID, 86. Kittitas Co., WA, paratypes.



FIGURES 87–94. *Tetracis* male genitalia with aedeagus removed and aedeagus with vesica everted. 87. *T. crocallata*. 88. *T. cachexiata*. 89. *T. cervinaria*. 90. *T. australis*. 91. *T. fuscata*. 92. *T. pallulata*. 93. *T. mosesiani*. 94. *T. j. jubararia*. Aedeagus enlarged relative to remaining structures.

***Tetracis pallidata* Ferris, New Species**
(Figs. 11, 84–86, 100–101, 116–117, 132, 145)

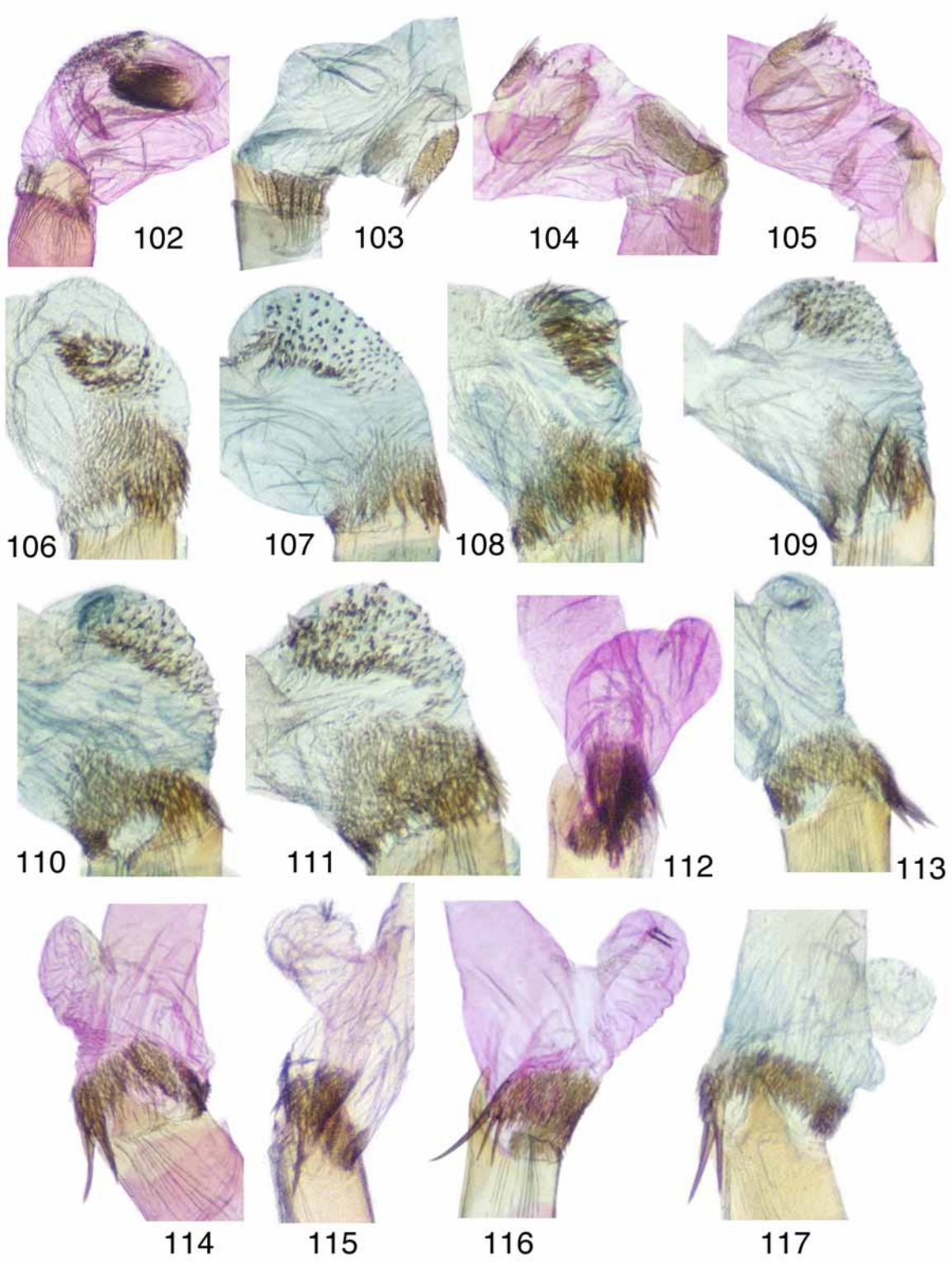
Diagnosis. Similar to *T. barnesii*, but color paler ochreous and PM line brown, not pale yellow-ochre its entire length. DFW less maculated than in *barnesii*, and nearly immaculate in most specimens.



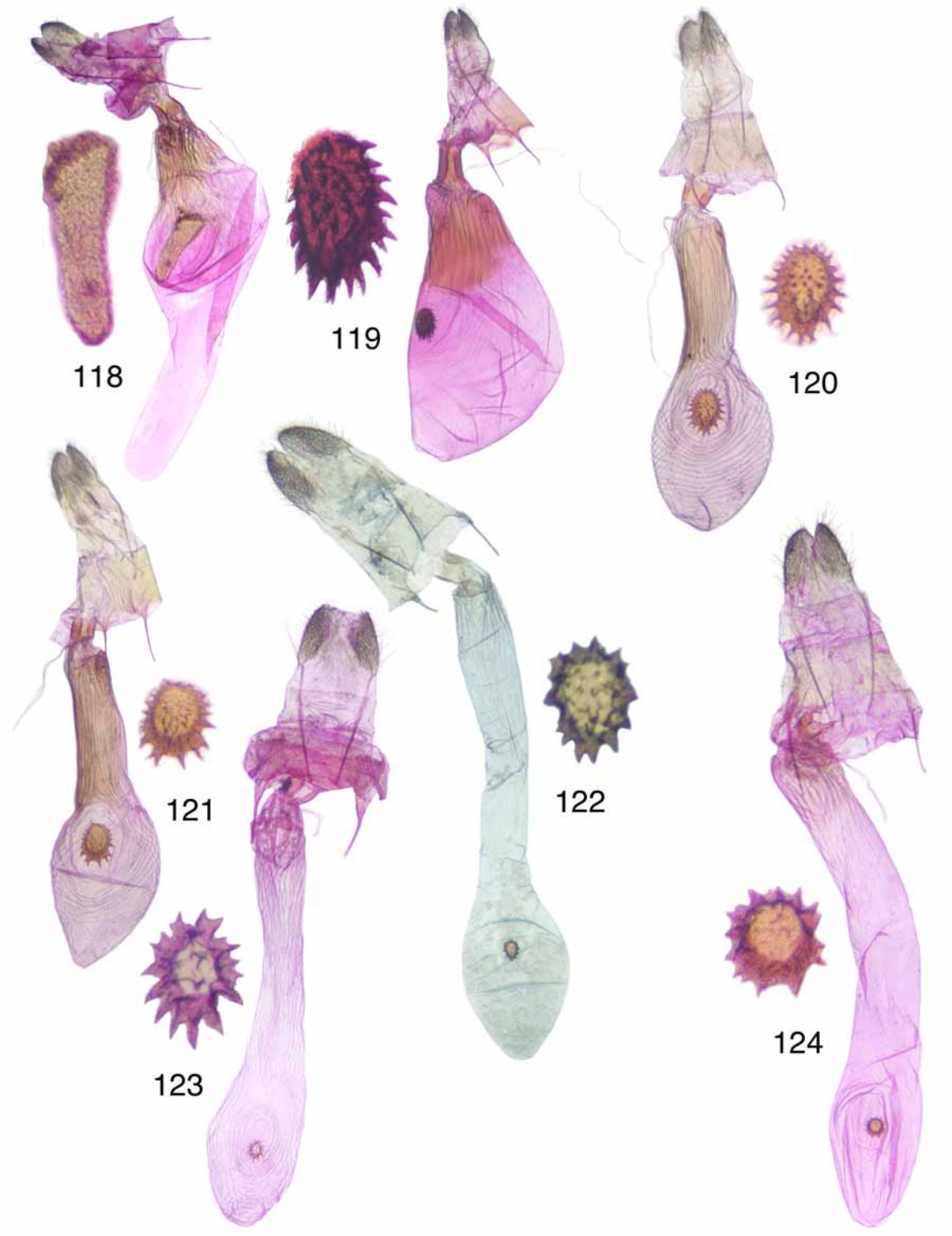
FIGURES 95–101. *Tetracis* male genitalia with aedeagus removed and aedeagus with vesica everted. 95. *T. j. sericeata*. 96. *T. montanaria*. 97. *T. barnesii*. 98. *T. formosa*. 99. *T. hirsutaria* (arrow points to deciduous setae). 100–101. *T. pallidata*. Aedeagus enlarged relative to remaining structures.

Description. *Adults* (Figs. 11, 84–86): FWL: 20–23 mm. Antenna nearly white dorsally, bipectinate in male, nearly filiform in female and densely setose ventrally. Palpi of medium width, porrect but terminal segments decurved, slightly longer than eye width, pale ochreous lightly flecked with brown scales. Head, thorax, and abdomen pale ochreous without any dark speckling, with abdomen slightly paler; thorax very

setose. Legs pale ochreous with faint brown speckling at joints. *Wings*: Ground color ochreous and not irrorated with darker scales. FW apex falcate. AM and PM lines brown; both slightly convex outwardly; PM line narrow with only a slight change in curvature at M3, and without any noticeable distal pale shading; in a few specimens, PM line thickens slightly just below costal margin. In most specimens, MB not darker than remainder of wing; small brown discal spot. DHW nearly immaculate in most specimens and slightly paler



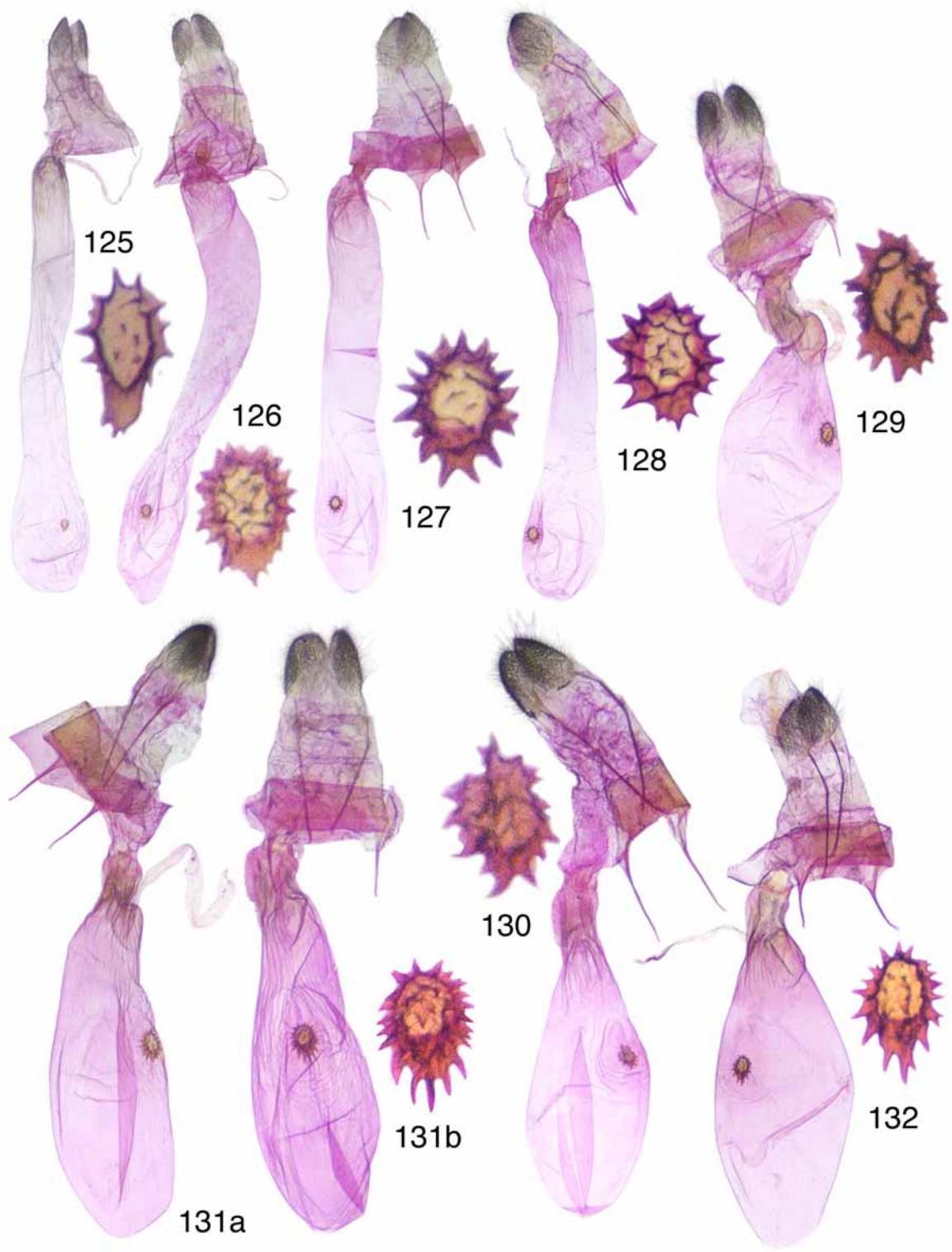
FIGURES 102–117. *Tetracis* male genitalia, domes of everted vesica. 102. *T. crocallata*. 103. *T. cachexiata*. 104. *T. cervinaria*. 105. *T. australis*. 106. *T. fuscata*. 107. *T. pallulata*. 108. *T. mosesiani*. 109. *T. j. jubararia*. 110. *T. j. sericeata*. 111. *T. montanaria*. 112. *T. barnesii*. 113. *T. formosa*. 114–115. *T. hirsutaria*. 116–117. *T. pallidata*.



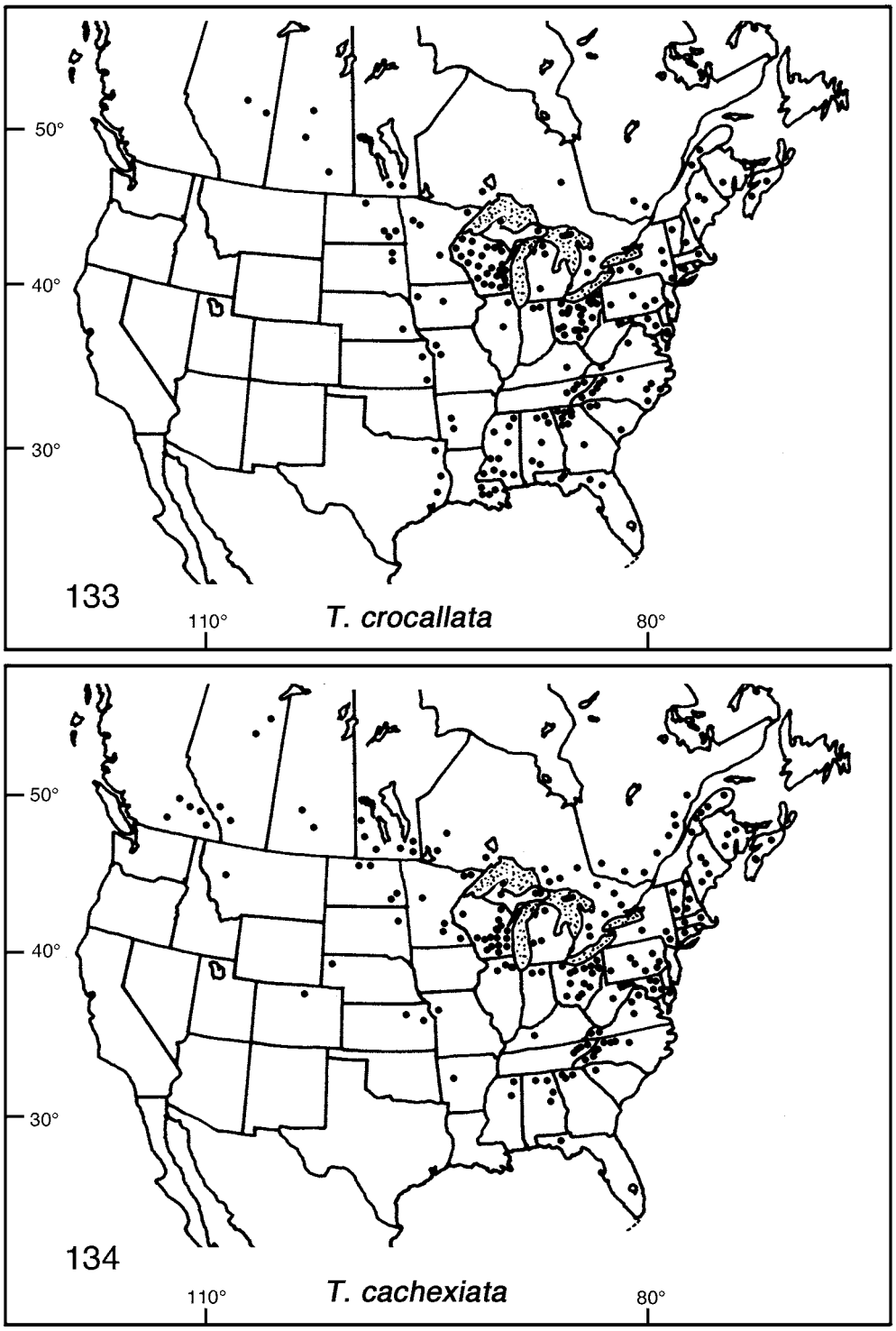
FIGURES 118–124. Female genitalia with enlarged view of signa. 118. *T. crocallata*. 119. *T. cachexiata*. 120. *T. cervinaria*. 121. *T. australis*. 122. *T. fuscata*. 123. *T. pallulata*. 124. *T. mosesiani*.

than DFW; discal spot faint when present,; in some specimens a slight suggestion of median line at inner margin. Not paler ventrally and nearly immaculate with only a suggestion of the dorsal markings. *Male genitalia* (Figs. 100–101, 116–117): Uncus of medium width, slightly decurved, tapering to bluntly pointed tip. Dorso-caudal margin of gnathos concave, with a slender tapering upcurved spine at either side. Cylindrical furca (ca. 0.65x width of valve base) from middle of anellus tapers uniformly to bluntly-pointed apex. Valve broad with even margins, tapering to rounded apex with a small pointed triangular apical

projection at the dorsal margin. Aedeagus with a ring of slender spinules at posterior end at base of vesica, with 2–3 long slender spines; everted vesica with small unsclerotized dome except for occasional pair of apparently deciduous setae on crown. *Female genitalia* (Fig. 132): A/P ca. 0.4. Slightly curved short lightly sclerotized tubular ductus bursae expands very slightly at junction with corpus bursae (ca. 0.2x length of corpus bursae). Corpus bursae ovoid with oval dentate signum located above middle. Corpus bursae with small pouch at junction with ductus bursae.



FIGURES 125–132. Female genitalia with enlarged view of signa. 125. *T. j. jubararia*. 126. *T. j. sericeata*. 127. *T. montanaria*. 128. ? *T. montanaria*, Apache Co., AZ. 129. *T. barnesii*. 130. *T. formosa*. 131. *T. hirsutaria* (2 preparations) 132. *T. pallidata*.



FIGURES 133–134. *Tetracis* distribution maps. 133. *T. crocallata*. 134. *T. cachexiata*. Louisiana records from Vernon Antoine Brou, Jr.

Type material. Holotype ♂ : WASHINGTON, Kittitas Co., 8 mi. S. of Ellensburg, Umtanum Creek at Durr Rd.., 46.88° N, 120.57° W, 1940–2140’ (590–650m), 29 September, 2008, L. G. Crabo. [AMNH]. **Paratypes:** Same data as holotype, (21 ♂ , 1 ♀); IDAHO, Elmore Co., 43° 17.53’N, 115° 19.32’W, 5300’ (1615m), 14–15.ix.1999, C. D. Ferris (1 ♂); Owyhee Co., Owyhee Uplands, 42° 42.39’N, 116° 28.15’W, 6200’ (1890m), 15–16.ix.1999, C. D. Ferris (5 ♂); Township 9 South, Range 2 West, SE Section 4, off Mud Lake Rd., 6000’ (1830m), 16–17.ix.1999, C. D. Ferris (1 ♂). CANADA, BRITISH COLUMBIA, Oliver,

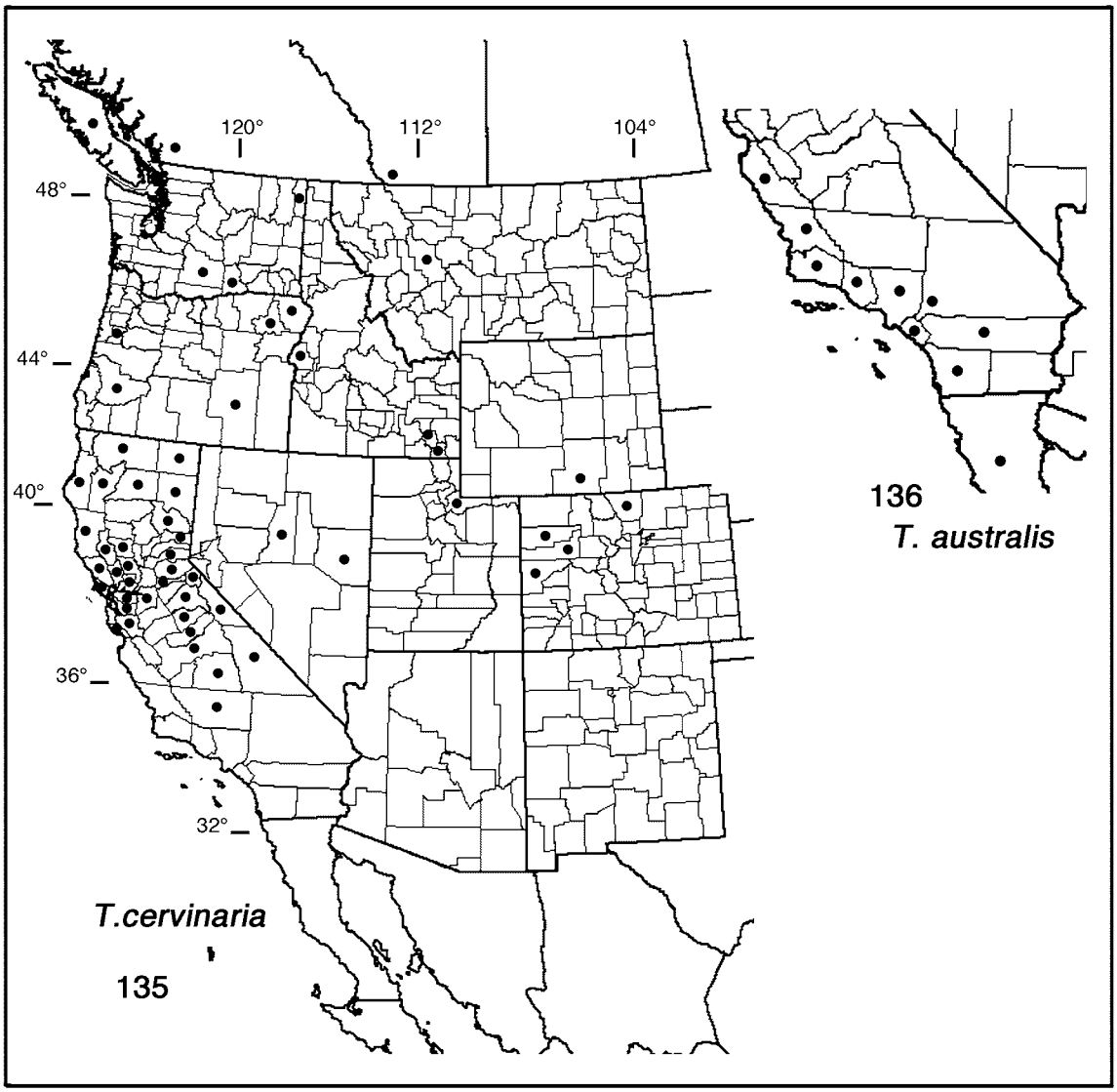
1000’ (305m), 18.ix.1953, (1 ♂); 5 km SE of Okanagan Falls, 9–15.ix.1990, (6 ♂), 1–6.x.1990 (1 ♂) J. Troubridge, 11–17.x.1992, Troubridge & Gardiner (1 ♂); Kamloops, 11.ix.1951, A. Thomson (1 ♂); Hedley, reared by W. C. McGuffin, emerged 5.ix.1967 (1 ♂). Paratypes in CNC and CDF.

Material examined: 5 additional male specimens were examined from the Priest Lake area, Bonner Co., ID; 6 dissections were made.

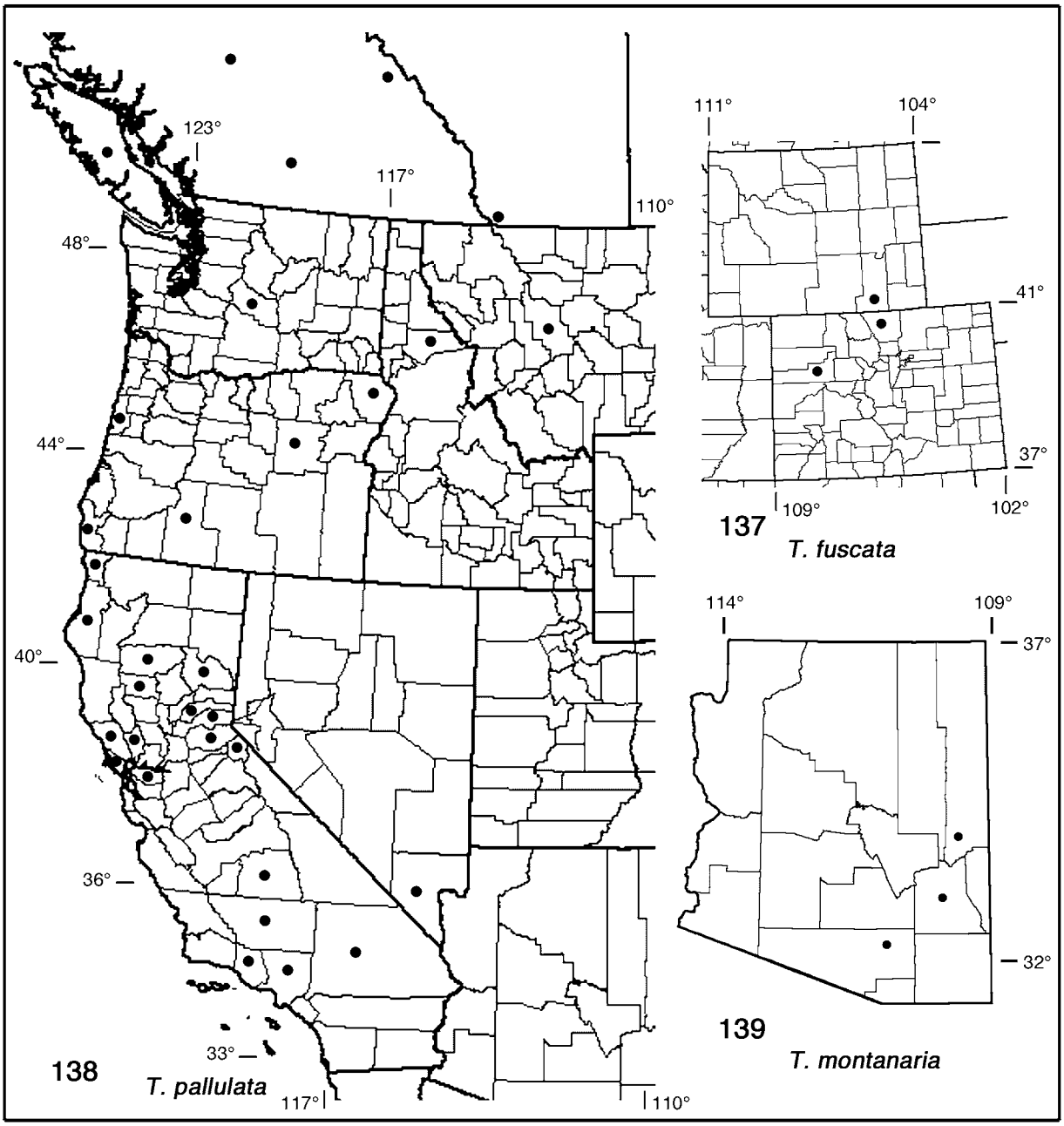
Etymology. The adjectival name *pallidata* describes the pale aspect of this species.

Biology. Incompletely known. Habitats are mixed riparian forest (cottonwood with aspen and willows intermingled with choke cherry) in sage-shrub steppe, riparian in the ecotone between ponderosa pine and shrub steppe, and in Owyhee Co., Idaho, sage-shrub steppe with juniper and mountain mahogany (*Cercocarpus ledifolius* Nutt.). One specimen from Hedley, British Columbia was reared on *Ribes* sp. by W. C. McGuffin. Adults from mid–September into early October.

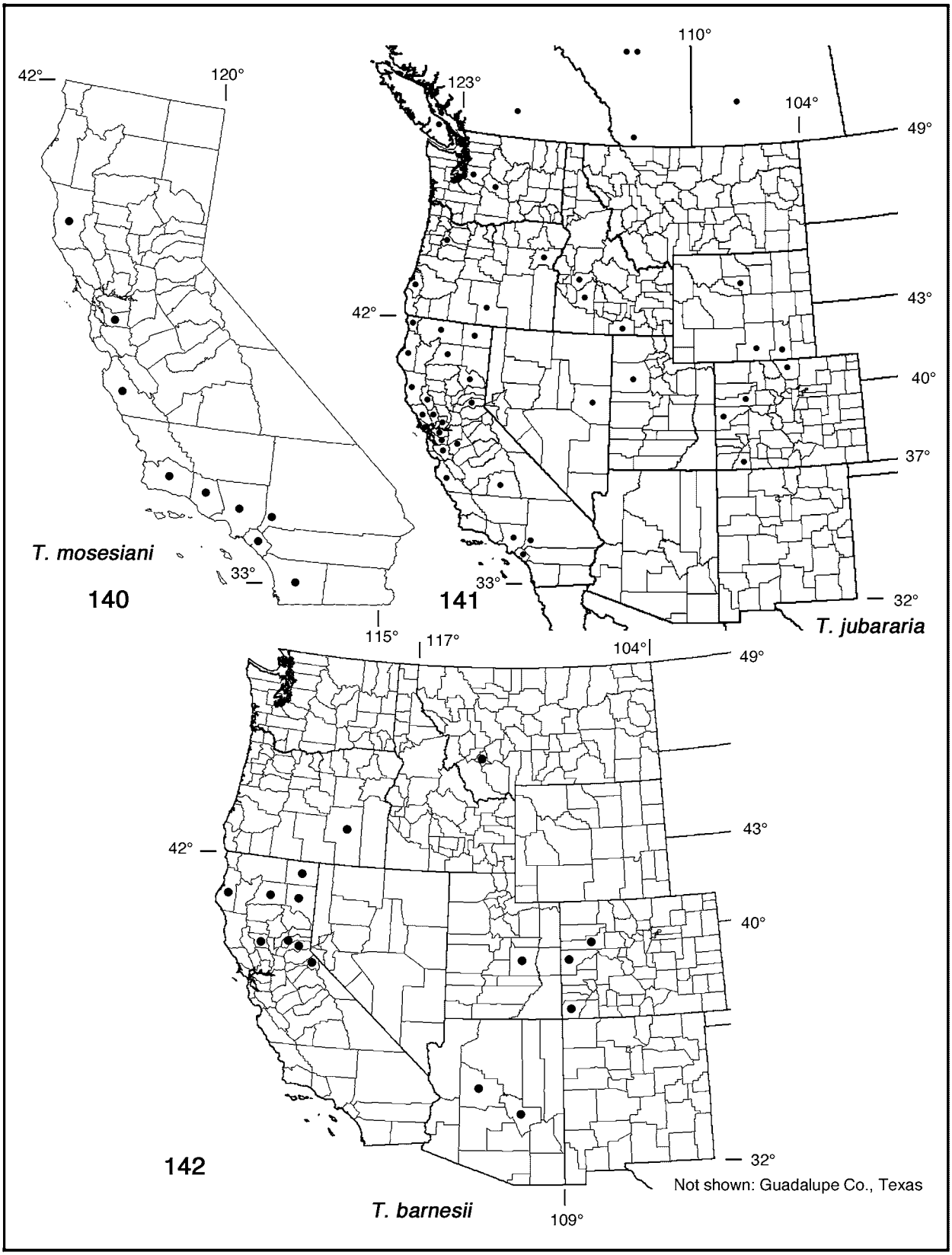
Distribution (Fig. 145)**:** CANADA: BRITISH COLUMBIA. Hedley, Kamloops, Oliver, Okanagan Falls. UNITED STATES: IDAHO. Bonner, Elmore, Owyhee. WASHINGTON. Kittitas.



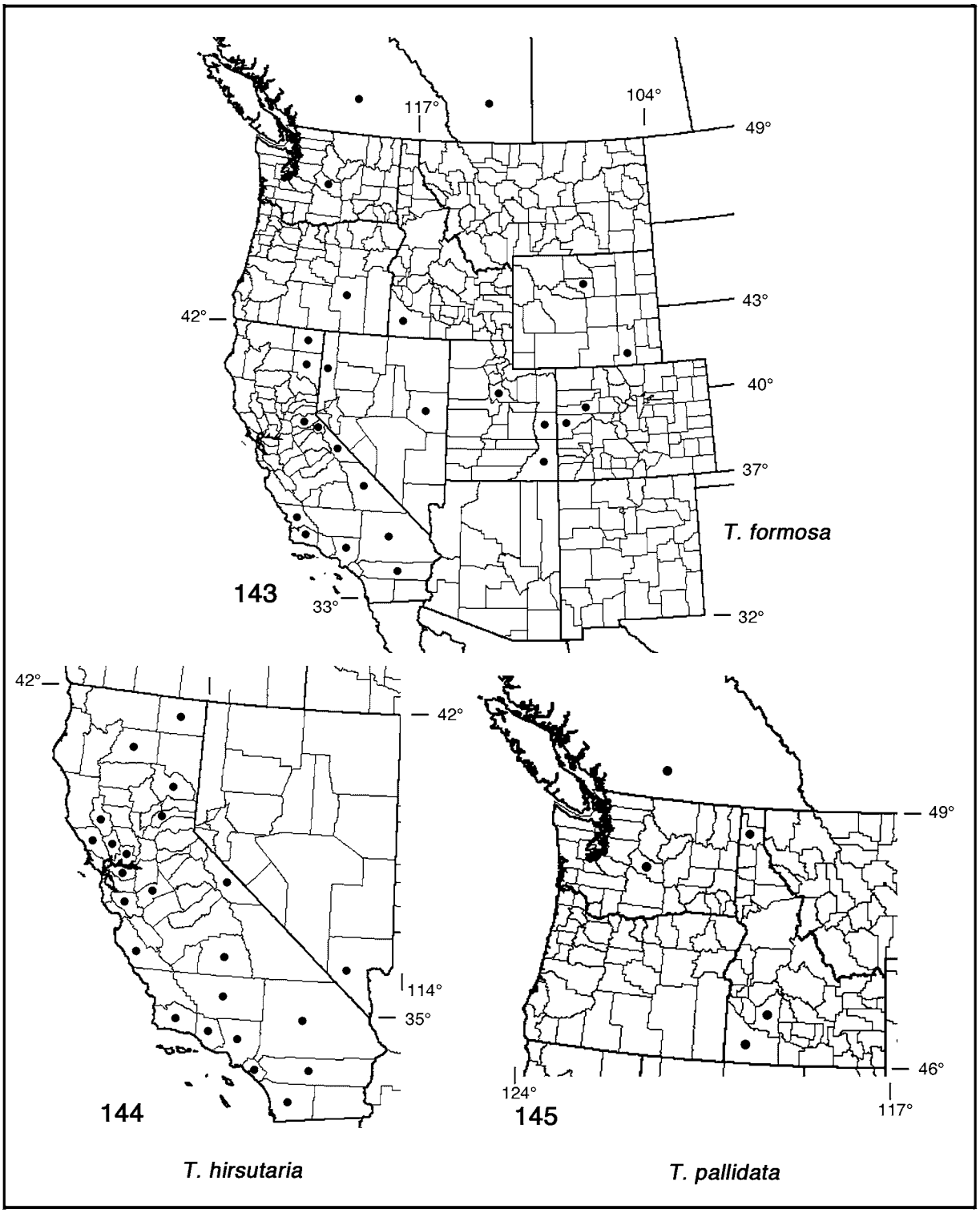
FIGURES 135–136. *Tetracis* distribution maps. 135. *T. cervinaria*. 136. *T. australis*.



FIGURES 137–139. *Tetracis* distribution maps. 137. *T. fuscata*. 138. *T. pallulata*. 139. *T. montanaria*.



FIGURES 140–142. *Tetracis* distribution maps. 140. *T. mosesiani*. 141. *T. jubararia*. 142. *T. barnesii*.



FIGURES 143–145. *Tetracis* distribution maps. 143. *T. formosa*. 144. *T. hirsutaria*. 145. *T. pallidata*.

Check List of North American *Tetracis*
(Alphabetical Order)

TETRACIS Guenée, [1858]
PRIONOTETRACIS Warren W., 1894 **rev. syn.**
SYNAXIS Hulst, 1896 **syn. n.**
australis Ferris, 2009
barnesii (Hulst, 1896) **comb. n.**
cachexiata Guenée, [1858]
lorata Grote, 1864
cervinaria (Packard, 1871) **comb. n.**
aurantiacaria Packard, 1873
crocallata Guenée, [1858]
aspilatata Guenée, [1858]
formosa (Hulst, 1896) **comb. n.**
fuscata (Hulst, 1898) **comb. n.**
hirsutaria (Barnes & McDunnough, 1913) **comb. n.**
jubararia Hulst, 1886 **comb. rev.**
a. jubararia Hulst, 1886
b. sericeata (Barnes & McDunnough, 1917) **comb. n.**
montanaria Ferris, 2009
mosesiani (Sala, [1971]) **comb. n.**
pallidata Ferris, 2009
pallulata Hulst, 1887 **comb. n.**

Acknowledgments

The senior author wishes to express his thanks and appreciation to the many individuals who supplied specimens on loan or for retention, distribution data, digital photographs, bibliographic material as follows: J. K. Adams, Calhoun, GA; G. J. Balogh, Portage, MI; V. A. Brou, Jr., Abita Springs, LA; R. L. Brown, Mississippi State, MS; R. M. Brown, Stockton, CA; C. V. Covell, Jr., Gainesville, FL; L. G. Crabo, Bellingham, WA; J. P. Donahue, LACM, Los Angeles, CA; R. Eastwood, MCZ, Cambridge, MA; L. A. Ferge, Middleton, WI. I. L. Finkelstein, Atlanta, GA; G. Fauske, NDSIRC, Fargo, ND; L. F. Gall, Yale Univ., New Haven, CT: P. Gentilli-Poole, USNM, Washington, DC; Jocelyn Gill, CNC, Ottawa, Ontario, Canada; S. R. Green, AMNH, New York, NY; C. H. Grisham, Huntsville, AL; S. L. Heydon, UCD, Davis, CA; E. C. Knudson, Houston, TX; J. D. Lafontaine, CNC, Ottawa, Ontario, Canada; R. Leuschner, Manhattan Beach, CA; T. M. Mustelin, Seattle, WA; J. S. Nordin, Laramie, WY; P. A. Opler, CSU, Ft. Collins, CO; R. M. Patterson, Bowie, MD; P. D. Perkins, MCZ, Cambridge, MA; N. Pierce, MCZ, Cambridge, MA; J. A. Powell, EME, Berkeley, CA; J. E. Rawlins, CM, Pittsburgh, PA: K. M. Richers, Bakersfield, CA; F. B. Ruggles, Ohio Lepidoptera Survey, Dayton, OH; M. Sabourin, Danville, VT; F. P. Sala (deceased), Carmel, CA; B. Scholtens, Charleston, SC; S. M. Spomer, Lincoln, NE. J. B. Sullivan, Beaufort, NC; J. T. Vargo, Mishawaka, IN; J. B. Walsh, Tucson, AZ; W. Xie, LACM, Los Angeles, CA. Some of the records for *Tetracis crocallata* and *T. cachexiata* were extracted from the National Park Service, ATBI (All Taxon Biological Inventory) database for the Great Smoky Mountains National Park. Three external reviewers, two anonymous and Ron Leuscher, provided valuable suggestions concerning the initial manuscript. We thank Jeremy deWaard, Paul Hebert and other members of the Barcode of Life Project at the University of Guelph, Ontario, Canada, for providing DNA data. Molecular analyses were carried out through grants from the National Science and Engineering Research Council of Canada and Genome Canada through the Ontario Genomics Institute.

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