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A review of Coelopoetinae (Lepidoptera, Gelechioidea, Pterolonchidae), a moth subfamily confined to western North America, with descriptions of seven new species

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Abstract

Systematics and taxonomy of the gelechioid subfamily Coelopoetinae are reviewed. Following the current classification, this group is considered to form its own monotypic subfamily in Pterolonchidae with one recognized genus, *Coelopoeta*, after a convoluted and, in part, arguably conjectural, historical systematic treatment. On morphological basis (appearance, male genitalia) and with support from DNA barcodes, the genus is divided into two discrete units probably meriting recognition as separate genera. The species groups are informally treated as the nominate *C. glutinosi* species group, and the *C. fissurina* species group. In the absence of knowledge of females or the biologies of any of the species of the *C. fissurina* group, species of both groups are here provisionally included in *Coelopoeta*. In total, 10 species are recognized, seven of which are here described as new: *C. glutinosi* species group: *C. alboflava* Kaila, **sp. nov.**, *C. aprica* Kaila, **sp. nov.**, *C. aurora* Kaila, **sp. nov.**, *C. fulminea* Kaila, **sp. nov.** and *C. sariae* Kaila, **sp. nov.**; *C. fissurina* species group: *C. fissurina* Kaila, **sp. nov.** and *C. valalbui* Kaila, **sp. nov.** The three previously known species, *C. glutinosi* Walsingham, 1907, *C. maiadella* Kaila, 1995 and *C. phaceliae* Kaila, 1995 are redescribed. All three of these species belong to the *glutinosi* species group. A lectotype is designated for *C. glutinosi* Walsingham, 1907. Some southwestern *Coelopoeta* species are potentially under threat of decline or even extinction due to the apparently increasingly intense and frequent forest fires. This threat is significant as the species with known life histories spend their entire life cycles above ground in low vegetation.

Key words: barcode-morphology discrepancy, fire frequency, fire intensity, morphology, new species, systematics, taxonomy

Introduction

Gelechioidea is one of the largest superfamilies of Lepidoptera, and the most species rich among the so-called micro-moths, with a large proportion of species still unnamed or undiscovered (e.g. Vári & Kroon 1986; Hodges 1998; Nieukerken *et al.* 2011). Historically, Gelechioidea cannot be counted to have been among the most appealing groups for Lepidoptera researchers. A reason for this is the drab appearance of many species in combination with often cryptic life histories (e.g. Hoare 2005; Hoare *et al.* 2006; Kaila 2011). These traits make focused collecting laborious, and also make time-consuming scrutiny of accumulated specimens mandatory for better understanding and recognition of the true diversity in gelechioid families. For these reasons, knowledge of them is lagging far behind that of many other Lepidoptera.

The family classification of the Gelechioidea has been unstable and constantly undergoing major and minor alterations since the characterization of the superfamily by Fracker (1915) and Mosher (1916). Bucheli (2009) gave a detailed summary of older classifications. Major recent contributions are provided by Hodges (1998), Minet (1990), Kaila (2004), Kaila *et al.* (2011), Heikkilä *et al.* (2014), Kim *et al.* (2016), Sohn *et al.* (2016) and Wang & Li (2020). Symptomatically, there are no two systematic treatments of Gelechioidea that have proposed the same classification.

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A typical example of a gelechioid genus with unstable history of systematic position is *Coelopoeta* Walsingham, 1907. This genus, originally based on a single species, *C. glutinosi* Walsingham, 1907, was placed in Hyponomeutidae [*sic*] (Walsingham (1907). Barnes & Busck (1920) moved it in Elachistidae in the Gelechioidea as defined by Fracker (1915) and Mosher (1916). Braun (1948) followed this concept, without giving any concrete characters apart from the general mention of "mouth parts, antennal pecten, and general configuration of venation". These are presently known to be either of little significance in their vagueness without any specifications (mouth parts, wing venation) or homoplastic (Kaila 2004), apart from the coalescence of the hindwing veins R_S and M_1 that may indeed be a synapomorphy of Elachistidae: Elachistinae. Braun ignored several contradicting characters such as spine rows on terga of the abdomen or the entirely different genitalia when placing *Coelopoeta* in Elachistidae. Traugott-Olsen & Nielsen (1977) removed *Coelopoeta* [misspelled as *Coleopoeta*] from Elachistidae "to a monobasic taxon, which is closely related to Elachistidae and Oecophoridae". Hodges (1978) suggested that *Coelopoeta* might be derived from the Oecophorini and raised the subfamily Coelopoetinae to denote the genus, but for an unspecified reason retained it in Elachistidae. Kaila (1995) added two more species to the genus, and followed the general American tradition (Braun 1948; Hodges 1978, 1983) and kept it in Elachistidae, explicitly pending further insight. Minet (1990) removed *Coelopoeta* from Elachistidae, even in his much broadened concept, and left it without a family placement. Kaila (2019) did not include *Coelopoeta* in the World catalogue of Elachistinae (= Elachistidae in old sense). Hodges (1998) synonymized Coelopoetinae with Oecophoridae: Oecophorinae, without substantiation, and in spite of contradicting most characters of his own definition of Oecophoridae, such as the presence of a pair of venulae and often also apodemes in sternum 2 (cf. Fig. 4); hindwing veins R_s/M_1 separate (which is actually the prevailing condition in Gelechioidea, cf. Kaila 2004), the absence of an articulation of the gnathos from the tegumen, and the gnathos with dorsal scobination. None of these characters applies to *Coelopoeta*. The morphology-based phylogenetic analysis of Kaila (2004) placed *Coelopoeta* together with Coleophoridae, yet no formal classification was suggested in that work. The placement of *Coelopoeta* as belonging to Coleophoridae was subsequently adopted by Powell & Opler (2009). Kaila *et al.* (2011), in turn, found *Coelopoeta* to be associated with Pterolonchidae using, for the first time, molecular characters, and applied the family rank Coelopoetidae to keep the ranking consistent across the analyzed gelechioid groups. Nieukerken *et al.* (2011) also attributed the family status Coelopoetidae to *Coelopoeta*. In the work by Heikkilä *et al.* (2014) the placement of *Coelopoeta* with Pterolonchidae, along with an assemblage of some other (sub)families or genera formerly of unknown or uncertain position, was further supported by a combination of morphological and DNA data, and the rank as a subfamily Coelopoetinae in the family Pterolonchidae was formalized. This view was adopted by Pohl (2018), Wang & Li (2020, there misspelled as Coleopoetinae) and Kaila (2023), and is followed here.

The genus *Coelopoeta* was first known only by its type species, *C. glutinosi* Walsingham, 1907, from California, until Barnes & Busck (1920) described another species, *C. baldella* that was sunk as a synonym of *C. glutinosi* by Braun (1948). Almost 80 years later Kaila (1995) added two more species to the genus. In the present paper ten species are recognized, seven of them described as new. The new species are presently known only from scarce material, three of them (*C. alboflava*, *C. sariae* and *C. fissurina*) from only one specimen each. Therefore, a revisionary paper might seem premature with such a paucity of material.

Motivation for the publication of this paper comes from two issues: finding further samples, especially with more than a few specimens, has appeared quite difficult, and acquisition of substantial material of species other than *C. glutinosi* Walsingham, *C. phaceliae* Kaila and possibly *C. aurora* **sp. nov.** and *C. fulminea* **sp. nov.** in the near future seems unlikely if reflected by the past history of discoveries. Almost 30 years have passed since the previous contribution, with only a handful of new specimens acquired in that interval, therefore, the amount of material is not expected to grow significantly in the foreseeable future.

Several *Coelopoeta* species inhabit montane areas in western United States, known to host Lepidoptera species specialized to these areas or even endemics (e.g. Lafontaine 1982; Davenport 2018; Albu & Albu 2023). These regions and habitats have been suffering from increased drought due to climate change, recent forest fire intensity and perhaps also frequency (Westerling *et al.* 2006; O'Connor *et al.* 2014; Poulos *et al.* 2021). Even though most of the associated literature is focused on plants, especially on wooden plants (e.g. Kaib *et al.* 1996; Morino *et al.* 2000; Monroy-Gamboy *et al.* 2021; Poulos *et al.* 2021), it is plausible to assume that the phenomenon also affects insects, along with the changes in vegetation, even if this is hardly documented (see Forister *et al.* 2010). In part, the recent intensive forest fires have been due to historical fire suppression and hence accumulation of increased amounts of fuel. Even severe fires are usually patchy in their nature, and they usually leave some areas more or less

unharmed (Keeley *et al.* 1999; Brown *et al.* 2000; Steel *et al.* 2015). Nevertheless, at least some *Coelopoeta* species can be believed to be among the insects more vulnerable to such intense fires as some recent ones. This is because the *Coelopoeta* species with life histories known spend their entire life cycles above ground in low vegetation (Braun 1948; Powell & Opler 2009), with little protection from severe fires. Therefore, species with very limited distributional areas can reasonably be thought to become endangered in such conditions. For these reasons, the present author considers description and naming of the hitherto recognized species warranted in spite of the paucity of material.

Material and methods

The DNA barcode region (a standard 658 bp fragment of mitochondrial COI gene) of 16 specimens was sequenced to obtain insight into genetic patterns within and among putative species. This was executed using standard protocols (Ivanova *et al.* 2006) at the Canadian Centre for DNA barcoding (CCDB, Guelph). Full taxonomic and collection data, including GenBank accession numbers, of these 16 specimens are available through the public dataset DS-COELOPOE at BOLD at http://www.boldsystems.org, accessible from https://doi.org/10.5883/DS-COELOPOE.

The drawings of the male genitalia were made from samples temporarily preserved in glycerol. This was done to enable showing them in different projections (ventral and lateral), and to avoid artificial distortions in fixed slide preparations due to possibly uneven compression and position. The compression and position are difficult to standardize due to the round shape of the tegumen, when mounting them on permanent slides. Euparal was used as the mounting medium in permanent slides.

Redescriptions are given for the species previously described, due to some inaccuracies now discovered in the earlier characterizations. Forewing length was measured from the base of the wing to the tips of the fringe scales at the apex.

Abbreviations of collections

BME	Bohart Museum of Entomology, University of California, Davis, U.S.A.
CAS	California Academy of Sciences, San Francisco, U.S.A.
CBG	Centre of Biodiversity Genomics, Guelph, Ontario, Canada
CNC	Canadian National Collection of Insects, Arachnids, and Nematodes, Ottawa, Canada
DMNS	Denver Museum of Nature & Science, Denver, Colorado, U.S.A.
EME	Essig Museum of Entomology, University of California, Berkeley, U.S.A.
MZH	Finnish Museum of Natural History, Helsinki, Finland
NHMUK	Natural History Museum, London, U.K.
RCDH	Research Collection of David Holden, Port Coquitlam, British Columbia, Canada
USNM	National Museum of Natural History, Smithsonian, Washington D.C., U.S.A.

Results

Barcodes. The BOLD Systems engine recognizes three BINs among the barcodes of *Coelopoeta*, one of which consists of *C. fissurina* and *C. valalbui* which are morphologically highly divergent from the other species of *Coelopoeta* yet close to each other. The cluster of these species differs by about 11.5% from the closest *Coelopoeta*, *C. maiadella*. The magnitude of this difference results in BOLDSystems to associate it nearly randomly not only with some other Gelechioidea, but also with Cossidae, Papilionoidea, Erebidae and Geometridae. The remaining two BINs consist of two discrete groups, the species *C. maiadella* with a 4.5 % difference to the closest match in the third, the *C. glutinosi* BIN. Within this latter BIN barcode differences are small if not negligible, the maximum magnitude being 1.6 % for the taxa here recognized as discrete (Fig. 1) (see Discussion below).

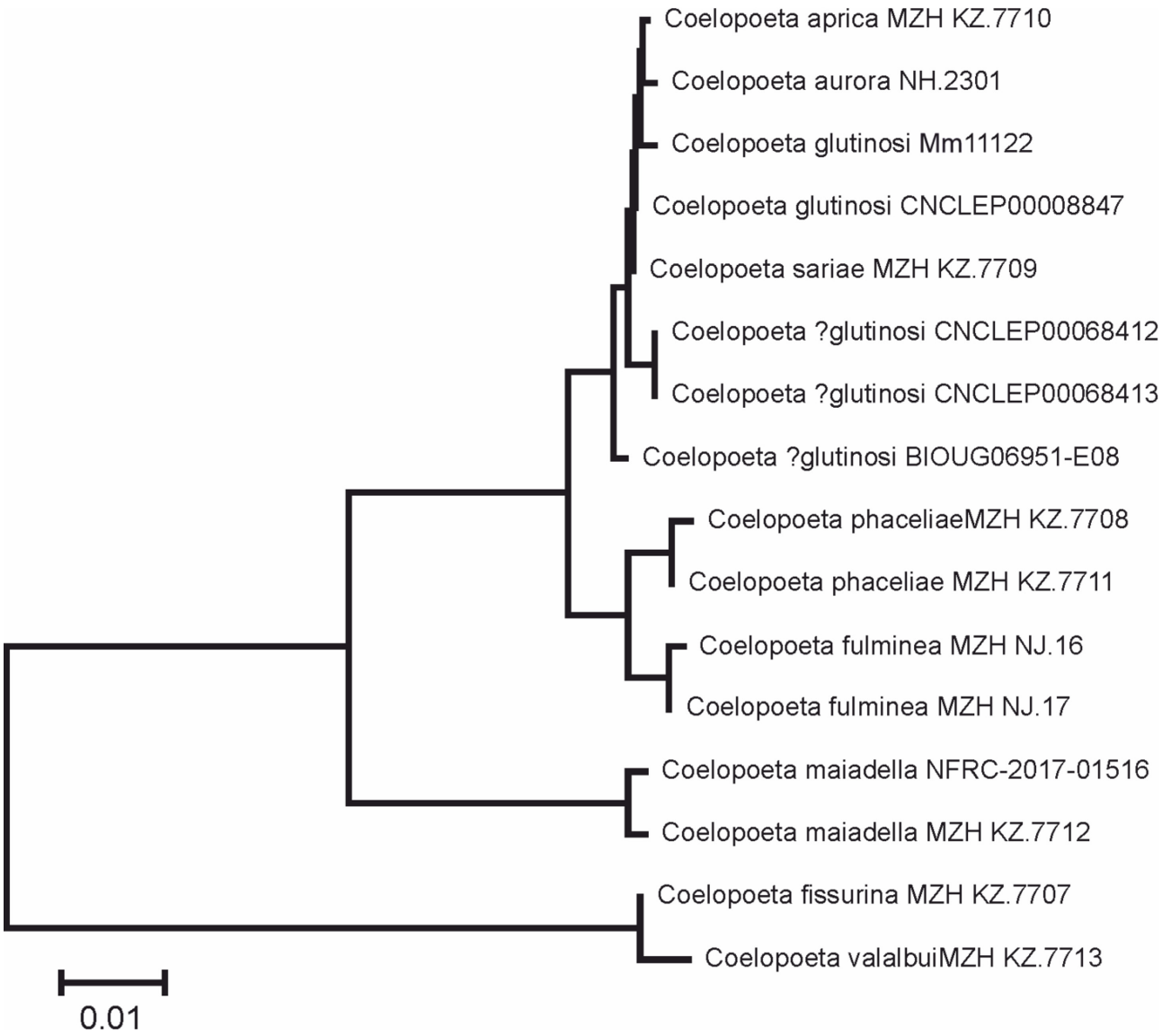


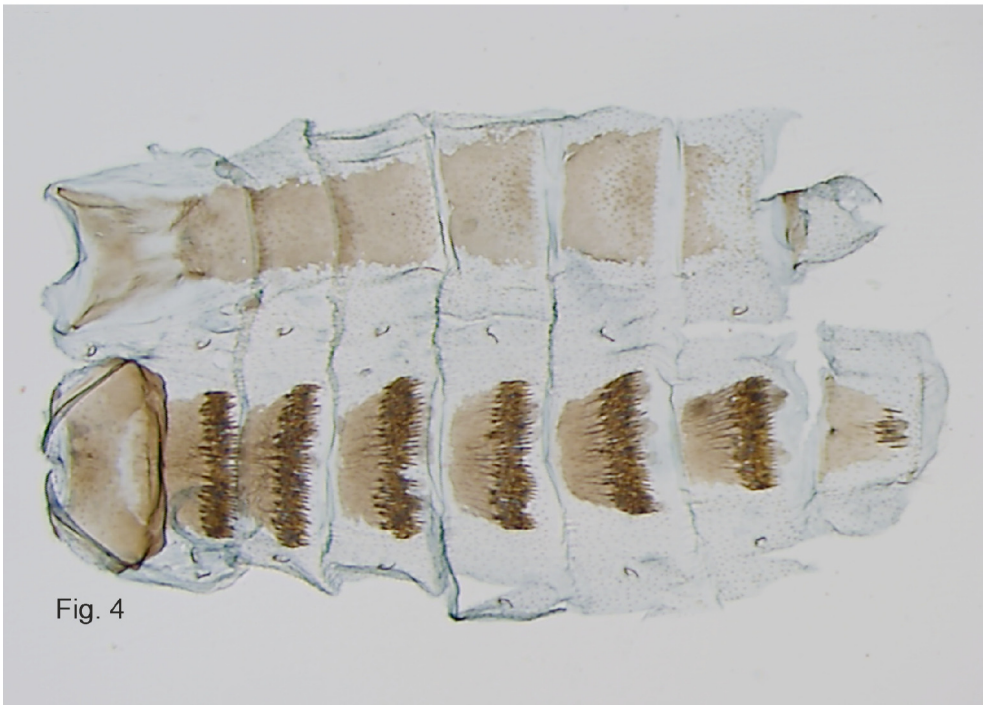
FIGURE 1. A neighbor-joining tree, generated under the K2P nucleotide substitution model of 16 barcode sequences retrieved from *Coelopoeta* specimens.

Morphology. The species here included in *Coelopoeta* form two distinct clusters that are here assigned in the same genus only because no generic name is available for the *C. fissurina* group, nor is the female or biology known for the two species included in this group. Species of *C. glutinosi* group are morphologically homogeneous, yet no more so than in many other genera of Gelechioidea. Several, if not all, species seem to be recognizable from outer appearance, forewing shape and pattern, with the reservation that only few specimens are known for most species. Thus the potential variation in wing pattern is incompletely known. All species can be identified by the male genitalia, and also by the known female genitalia. The male genitalia are very small and shaped as sclerotized capsules rendering their examination difficult. Examination of them from more different angles is necessary. The shape and the size of the phallus, as well as the shape of the valva, afford the best diagnostic characters. The female genitalia are also similar among species, but there seems to be diagnostic characters for each species known.

Systematics

Coelopoetinae (Pterolonchidae)

Diagnosis. Members of Coelopoetinae are small-sized, with wingspans of 7.5–13 mm. They share a ubiquitous character of Gelechioidea, i.e. the basally scaled haustellum. The lack of tympanal organs differentiates them from Pyraloidea. The placement of Coelopoetinae as belonging to Gelechioidea is also confirmed by molecular studies (see Introduction). In the majority of gelechioid taxa, the adult moths have long and upcurved labial palpi. In Coelopoetinae, however, the labial palpi are relatively short (usually shorter than diameter of head), often porrect, or the second segment is only weakly ascending and not significantly longer than the third segment (Figs. 2, 3).



FIGURES 2–4. 2. Head of *Coelopoeta glutinosi* Walsingham; **3.** Head of *Coelopoeta phaceliae* Kaila; **4.** Abdominal skin of *Coelopoeta aurora* (L. Kaila prep. 6374) showing the shape of sternum 2 and the spine bands of tergal segments.

The head is smooth-scaled; the antenna is about 3/4 as long as the forewing, the scape bears a pecten, the pedicel is reduced and hardly visible, the flagellum is not ciliate, in the male sometimes at least partly weakly serrate, usually in the distal third, and is often annulated with distinct white and dark-grey rings (Figs. 2, 3). The forewing is usually rather narrow and the hindwing is lanceolate, narrower than its fringe scales. The forewing ground colour is usually unicolourous white to brown or occasionally grey; in several species there is a pale spot of varying shape and distinctiveness at about distal 3/5 of the dorsal margin; sometimes darker scales are scattered over the wing or condensed to form an indistinct patch in the middle of it in species/specimens with pale wing colour. Venation is as follows in *C. glutinosi* (no species of the *C. fissurina* species group examined): forewing R_1–R_5 present, directed costad of apex, R_5 stalked with M_1, M_1–M_3 and CuA_1–$_2$ present, all separate and directed ventrad of apex. Hindwing

R_S with a costal-directed vein in slide USNM 10.738, but not in Pl. 1, Fig. 1. in Braun (1948), nor in slide 10.737 (both wing slides examined); RS+M1 stalked, either separate from or fused with M2+M3; CuA1 and CuA2 present, separate from M veins. Regarding venation, see also Remarks below. The tergal segments of the abdomen have conspicuous transverse bands of spines (Fig. 4). The male genitalia are capsule-shaped; the uncus is distinctive, either bilobed or undivided and hook-shaped; the gnathos is articulated from the tegumen, curved, hook-shaped, without scobination, The ventral margins of the valvae are connected to each other with membrane; the valvae are undivided, with somewhat varying shape distally. The juxta is a simple sclerotized plate, laterally bent towards the dorsal side supporting the valva both ventrally and laterally, without lateral or distal lobes. The vinculum is tapered into an elongate and broad saccus. The phallus is not differentiated apart from occasionally having scobination near the apex in the *C. glutinosi* species group, markedly inflated in basal half in the *C. fissurina* species group; there are no cornuti in the vesica in species of the *C. glutinosi* species group, but one or two dense groups of scobinations in vesica of species of the *E. fissurina* group. The papillae anales of the female genitalia are covered by long setae, otherwise not differentiated; the ovipositor is not telescopic; the posterior margin of segment 8 is markedly setose, and sternum 8 is ventrolaterally with setose areas that are sometimes shaped as lobes; on the dorsal side of the ostium bursae there is a sclerotized plate; the ostium bursae+antrum is funnel-shaped, separated from the rest of the sclerotized ductus by a somewhat membranous zone. The ductus seminalis is situated near the inception of the ductus and the corpus bursae. The corpus bursae contains one or two signa. One of them is almost rounded, dentate; the other, when present, is formed by a dense group of scobinations.

Remarks. The hindwing venation of the three *C. glutinosi* specimens examined shows marked variation, even exceeding the considerable variation reported by Albrecht & Kaila (1997) in Elachistidae (Gelechioidea).

Genus *Coelopoeta* Walsingham, 1907

Coelopoeta Walsingham, 1907: 217. Type species: *Coelopoeta glutinosi* Walsingham, 1907, by monotypy.

Diagnosis. As for the diagnosis of Coelopoetinae.

Taxonomy. Morphology (wing pattern, male genitalia) as well as differences in DNA barcodes separate the *Coelopoeta glutinosi* and *C. fissurina* species groups. Eight of the species here recognized belong to the morphologically uniform *C. glutinosi* species group. The remaining two species, *C. fissurina* and *C. valalbui*, are markedly different from *C. glutinosi* and its relatives, in external appearance, male genitalia and DNA barcodes, yet they are similar to each other. The differences between these species groups are so significant that the *C. fissurina* species group will likely merit its own genus, to be consistent with other gelechioid genera. In the present context a new genus is not described to denote the *C. fissurina* species group as only adult males are known of the two species.

In general, the differences among of the species of the *C. glutinosi* species group are minor, with only *C. maiadella*, both male and female of *C. aprica*, and female of *C. fulminea* being quite straightforward (see the key and the diagnoses of the species below). The males of most other species differ from each other by the shape of the termen of the valva, in combination with one or another character. The examination of the male genitalia is challenging because of their capsule-like shape that requires examination from different orientations before mounting them in permanent slides, as well as of their very small size compared to many other Lepidoptera. In the present work, the male genitalia are shown in ventral aspect with the phallus omitted, and in lateral aspect with the juxta and one of the valvae omitted. For purposes of illustrations, this is done to avoid clutter caused by multiple layers of structures on top of each other. Certainly, this leads to compromises, especially regarding the shape of the phallus as it is shown only in lateral aspect. However, it seems that few diagnostic characters are lost when applying this practice. The permanent slides of the males were mounted in lateral position, as the present author considers this projection to display the diagnostic features best. Nevertheless, permanent mounting will inevitably cause the loss of visibility of some potentially diagnostic characters, unless viewed with special equipment such as a CT scanner.

The characters of the whole subfamily, as diagnosed above, are not repeated in species diagnoses and descriptions unless relevant in context.

Keys to the species

Keys to males

0 Uncus bifurcate; base of phallus markedly swollen (Figs. 37, 38) 1
- Uncus formed as undivided hook; base of phallus not swollen (Figs. 29–36) 2
1. Forewing colour off-white, peppered with grey-tipped scales; termen of valva produced medially; in ventral view apex of valva level with apex of uncus; a few stout teeth at apex of phallus (Figs. 28, 38) . . . . . *C. valalbui*
- Forewing ground colour formed of intermixed white and grey scales; termen of valva straight; in ventral view apex of valva level with base of uncus; apex of phallus without teeth (Figs. 27, 37) . . . . . *C. fissurina*
2. Phallus nearly two times as long as valva (Fig. 30) . . . . . *C. aprica*
- Phallus at most 1.5 times as long as valva 3
3. Forewing with varying amount of distally narrowly dark brown - nearly black scales giving a peppered appearance (Figs. 5–10); valva distally distinctly narrower than basally (Fig. 29) . . . . . *C. glutinosi*
- Forewing without distally narrowly dark brown - nearly black scales; valva entirely or nearly parallel-sided 4
4. Scales of forewing unicolorous, or their distal part ochreous to brown, this darker part occupying at least half of the scales; termen of valva laterally with folds or swellings; caecum of phallus without projection of manica 5
- Forewing ground colour leaden grey; termen of valva without folds or swellings; caecum of phallus distally with a projection of manica (Figs. 26, 36) . . . . . *C. maiadella*
5. Forewing ground colour white to orange brown; termen of valva with folds or swellings laterally 6
6. Tegumen subspherical, in lateral view as high as width of valva (Fig. 34) . . . . . *C. alboflava*
- In lateral view tegumen lower than width of valva 7
7. Tegumen longer than uncus as measured from dorsoposterior corner of tegumen (Fig. 33) . . . . . *C. fulminea*
- Tegumen at most as long as uncus as measured from dorsoposterior corner of tegumen 8
8. Uncus apically curved; termen of valva costally with a small extension (Fig. 35) . . . . . *C. sariae*
- Apex of uncus apically nearly evenly bent; termen of valva without extension 9
9. Phallus straight, caecum not dilated; termen of valva with distinctive foldings and dilation (Fig. 31) . . . . . *C. phaceliae*
- Phallus bent at basal 1/3, caecum bulbous; termen of valva with only a weak oblique fold (Fig. 32) . . . . . *C. aurora*

Key to females based on genitalia

The female of only five species are known, all of them belonging to the *C. glutinosi* group. For further characters useful in distinguishing the known species their diagnoses should be consulted.

1. Colliculum bulbous (Fig. 39) . . . . . *C. glutinosi*
- Colliculum more or less tubular 2
2. Sternum 8 with pair of setose lobes (Fig. 40) . . . . . *C. aprica*
- Posterior margin of sternum 8 setose but without distinct lobes 3
3. Antrum only narrowly sclerotized along posterior margin (Fig. 42) . . . . . *C. aurora*
- Antrum entirely sclerotized, funnel-shaped 4
4. Two signa in corpus bursae; border between antrum and colliculum constricted (Fig. 43) . . . . . *C. fulminea*
- One signum in corpus bursae; border between antrum and colliculum not constricted (Fig. 41) . . . . . *C. phaceliae*

Species

Coelopoeta glutinosi Walsingham, 1907

Figs. 2, 5–10, 29, 39, 44

Coelopoeta glutinosi Walsingham, 1907: 218
Coelopoeta baldella Barnes & Busck, 1920: 248. Synonymized by Braun (1948).

Type material: *Coelopoeta glutinosi*: ♂ No. 90511, ♀ No. 9512 in Mus. Walsingham (NHMUK), U.S.A., California, Mendocino County, Coal Creek Cañon, Potter's Valley, 14.vi.1871, larvae in galls on *Eriodycteon* [now *Eriodictyon*] *glutinosum,* issued middle of june to middle of July, 1871 Walsingham leg. (NHMUK), labelled as "types" (examined). The male, numbered as 90511 is here designated as the **lectotype.** The female specimen indicated also as "type" is here interpreted as a paralectotype.

In addition, Walsingham gives a mention: "paratype, male and female, No.10350, U.S.N.M., 11 specimens. Four specimens examined, [one of them actually *C. phaceliae*; for its data see under that species]: U.S.A., California, Mendocino County, Coal Creek Cañon, 1 ♀; "gallmine fol. 14.vi. *Eriodycteon glutinous*[*um*], ex. m[iddle] vi.–

m[iddle] vii.1871 Wlsm, numbered as 1607 WLSM. 1907; Type 10350 U.S.N.M; *Coelopoeta glutinosi* ♀ Wlsm. PARATYPE 69/71; Wing slide ♀ by A[ugust] B[usck] 10.7387; USNMENT 01200017 (USNM);1 ♂ with the same collection data as in lectotype except date 14.vi.1871, numbered as Wlsm. 90470; 1602 Wls. 1907; Type no. 10350; *Coelopoeta glutinosi* ♂ paratype Wlsm 20/71; ♂ genitalia on slide A[ugust] B[usck] april/12/1901; Genitalia slide by AB ♂ USNM 10.734; Wing slide by AB USNM 10.736; USNMENT 01200019 (USNM); California, Lake Co, Scott's Valley, 17.–19.vi.1871 1 ♀, Wlsm. 90479; 1603 Wlsm. 1907; Type 10350 U.S.N.M.; *Coelopoeta glutinosi* Paratype 29/71; Wing slide ♀ by AB USNM 10737; USNMENT 01200018 (USNM).

Coelopoeta baldella: Holotype ♀ and 1 paratype ♀ [originally as co-type] of *Coelopoeta baldella*, labelled: June/24–30; Camp Baldy/ San Bern[ardino] Mts. / Calif; *Coelopoeta /baldella* /Type. Busck.; L. Kaila prep. nro 1183 (USNM) [examined].

Other material (all from California) (see Remarks).

Kern Co., Pine Mts., 10.vi.1936 1 ex., E. C. Johnston leg. (USNM); Los Angeles Co., Wrightwood, 14.vi.1948 20 exx., larvae as leaf miners on *Eriodictyon trichocalyx*, C. M. Dammers leg., USNMENT 01200024–27. (USNM); Los Angeles Co., San Francisquito Canyon, 6.vii.1937 2 exx., [collector not given] (USNM); San Benito Co., Pinnacles, 11.vi.l936 1 ex., E. C. Johnston leg. (USNM); Los Angeles Co., San Fernando Valley, 25.vi.1913 1 ♂ Grinnell leg., ♂ genitalia on slide AB 2.ii.1927, Genitalia slide ♂ by AB USNM 10733, USNMENT 01200014 (USNM); 1 ♂ with same collecting data, with genitalia preserved in glycerol vial on the pin, USNMENT 01200015 (USNM); Los Angeles Co., San Fernando Valley, Monte Cristo CG, 15.vii.1997 1 ♂ 1 ♀ HW. Vd. Wolf leg., ♀ L. Kaila prep. 6027 (MZH); Los Angeles Co, issued 17.vi.1938 1 ♂ with genitalia preserved in glycerol vial on the pin, 2 ♀ C. Dammers leg., gall-maker in leaves of *Eriodictyon trichocalyx*, USNMENT 01200020, USNMENT 01200022, USNMENT 01200023 (USNM); Marin Co., Mt. Tamalpais, 15.vi.l960, J. Powell 60E5, reared from *Eriodictyon californicum*, 3 exx. emerged 6.–13.vii.1960 J. Powell leg. L. Kaila prep. 6362 (EME, MZH,); Monterey Co., Horse Bridge, 1.5 air mi SW Arroyo Seco G. Sta., 1300', 3–7.v.1975 3 exx., J. Powell 75E8, reared from *Eriodictyon californicum*, J. Powell leg.; San Bernardino Co., San Bernardino Mts., Camp Baldy, 24.vi.1930 6 exx., 16.vii.l923 7 exx.; San Bernardino Co., 24.viii.l931 2 exx. [collector not given] (USNM); Santa Barbara County, 2 mi. N Refugio Beach, 28.vi.1986 1 ♀ J.S. Buckett leg. (BME); Solano Co., G.L. Stebbins Cold Canyon reserve, 28.v.2009 1 ♀, 1.vi.2009 1 ♀ J.A. De Benedictis leg. (BME); Ventura Co., Hungry Valley, 5 mi S Gorman, 4.v.1959 2 exx., J. Powell 69E3, reared from *Eriodictyon crassifolium*, emerged 1.vi.l959; Tuolumne Co., Big Oak Flat, 12.vi.1962 3 ♂ 2 ♀ C.D. MacNeill leg. (CAS); Yolo Co., Davis, 2010 1 ♂ J.A De Benedictis leg (BME). In addition, there is one female that is externally indistinguishable from *C. glutinosi* but with slightly different barcode, collected from California, San Diego Co., Miller Valley, 1.vi.2013 N. Bloomfield leg. barcode sample ID: BIOUG06951-E08 (genitalia not examined) (CBG).

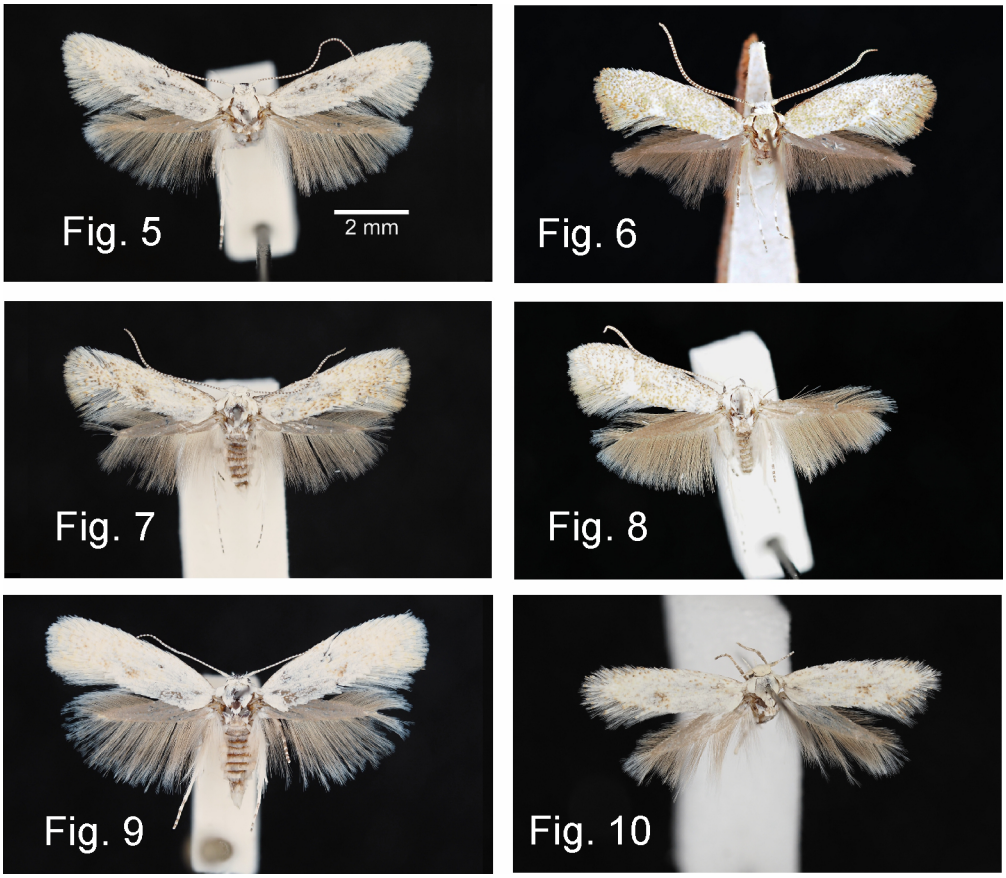
Diagnosis. *C. glutinosi* is a relatively large and rather broad-winged species. Usually the ground colour of the forewing is white or off-white, and it is typically peppered with scattered ochreous brown and/or black-tipped scales that are also present in the fringe scales. This character distinguishes this species from others. There is often an indistinct spot in the middle of the forewing formed by grey- or brown-tipped scales. The male genitalia are characterized by the distally somewhat tapered valva, similar to *C. aprica*, *C. alboflava* and to a lesser extent *C. phaceliae*. *C. aprica* is readily distinguished from *C. glutinosi* and all other species by its considerably longer phallus. *C. alboflava* can be separated by the shape of its tegumen which is more spherical and in lateral view as high as the width of the valva. The saccus is usually significantly larger than in other species apart from *C. alboflava*. This and the distally tapered valva are perhaps the best diagnostic traits in the male genitalia of *C. glutinosi*, which are otherwise little differentiated. The female genitalia are characterized by the bulbous colliculum which differentiates *C. glutinosi* from other species with known females.

Redescription. Forewing length 5–6 mm. Labial palpus porrect or slightly upcurved, length half the diameter of head; labial palpus, head, neck tuft, scape and pecten varying from pure to creamy white or pale brown, thorax sometimes mottled with darker tips of scales. Flagellum off-white, annulated with grey rings, not serrate. Fore- and midleg outwardly varying white with scattered grey scales to unicolourous grey creamy white, inwardly ochreous, tarsal articles distally white. Hindleg outwardly white or creamy white, inwardly creamy white, tarsal articles distally weakly darker.

Male genitalia: Uncus undivided, hook-shaped, evenly tapered, approximately as long as tegumen. Gnathos as long as uncus, evenly tapered towards apex, somewhat bent dorsad. Tegumen half as long as valva, 0.7 x as high as width of valva in lateral view. Valva over twice as long as wide at its widest point, distal half narrower than basal

half, inwardly bent in distal 1/3, termen distolaterally without clear swellings. Juxta bent, broadest in the middle, tapered to somewhat concave posterior margin, anterior margin evenly convex. Saccus somewhat bent dorsad, twice as long as its width at its narrowest point in middle, apex broadly rounded. Phallus as long as valva, basal opening dorsally directed, with distinct carina along distal opening.

Female genitalia. Apophyses slender, apophysis anterioris as long as apophysis posterioris; as long as papilla analis + sternum 8. Sternum 8 ventrolaterally with setose areas not formed as lobes; plate dorsad of ostium bursae rather small, wider than long; ostium bursae about 1/3 as wide as sternum 8, ventral margin concave, antrum funnel-shaped, laterally distinctly sclerotized, abruptly separated from bulbous and sclerotized colliculum, ductus bursae otherwise short, joining corpus bursae without distinct border. Ductus seminalis incepted slightly posteriorly to inception of ductus and corpus bursae. Corpus bursae membranous, without internal spines, with small, oval-shaped and dentate signum.



FIGURES 5–10. Habitus of *Coelopoeta glutinosi* Walsingham. All images at the same scale as the first image. Figure 5: ♂, California, Marin County; Figure 6: ♂, California, Los Angeles County; Figure 7: ♀, California, Solano County; Figure 8: ♂, California, Ventura County; Figure 9: ♀, California, Monterey County; Figure 10: ♀, California, Los Angeles County.

Variation. Forewing maculation of *C. glutinosi* varies extensively, from only a few brown or black-tipped scales on white ground colour to maculated overall, giving a pale brown appearance. Barnes & Busck (1920) described *C. baldella* on the basis of a paler forewing colour than in 'typical' *C. glutinosi*, with no other evidence but a vague expression that genitalia, without any specifics, are "without much specific differentiation but sufficient to indicate that the two species are distinct and not merely varieties". Braun (1948) carried out extensive rearings from the type locality of *C. baldella* which showed that specimens emerging later in season are darker than those emerging earlier, and she subsequently synonymized *C. baldella* with *C. glutinosi.* This interpretation is supported by the present material, and *C. baldella* is retained in synonymy of *C. glutinosi*. The size of the saccus is somewhat more variable in *C. glutinosi* and *C. phaceliae* than indicated by Kaila (1995). Even though the saccus usually is clearly larger in *C. glutinosi* than in *C. phaceliae*, it should not be used as a decisive character in separating these species.

Biology. *C. glutinosi* is a gall-inducer on the leaves of *Eriodictyon* spp. (Boraginaceae) (Fig. 44). There are rearing records from *E. californicum* (including *E. glutinosum* which is now considered a synonym), *E. crassifolium*,

and *E. trichocalyx*. Braun (1948) gives the following description of the gall and larval biology. "The gall-like mine extends on each side of the midrib on the upper side of the leaf, usually occupying the width of the leaf; the epidermis is so wrinkled that the leaf is curled at the sides and end, and the mine becomes almost hemispherical and gall-like in appearance. Within the mine or gall, the frass is pushed to the roof and separated from the roomy lower part by a thin sheet of silk. In this lower part, the thin cocoon is spun, an elongate-ovate affair, with its anterior end prolonged into a tube which opens outwardly through a semicircular slit in the epidermis". The only altitude reported is 1300 ft (400 m a.s.l.). The flight period ranges from May to mid-July.

Distribution. From around San Francisco in central California south to around Los Angeles and the San Diego regions. The southernmost records, though, require verification.

Remarks. The material examined for this study includes also the specimens examined by the present author in his 1995 publication, without re-examination of some of them.

In addition to the two type specimens, there is a series of 57 specimens identified as *C. glutinosi* in Coll. Walsingham, NHMUK. This series, not further detailed here, is mixed with *C. phaceliae* (L. Kaila, note added in 2000 in the drawer).

There is a *C. glutinosi* specimen labelled as "Campo Co., 26.v.1947, 1 ♂ E.D. Algert leg., 47-8702, reared from *Salvia*, USNMENT 01200021". There is no Campo Co. in California, but a Campo locality in South-Western San Diego County. The label probably refers to this locality. The locality is somewhat outside the otherwise known range of *C. glutinosi*, and the stated host plant *Salvia* would be a unique record. The possibility of mislabelling cannot be excluded.

Coelopoeta aprica Kaila, sp. nov.

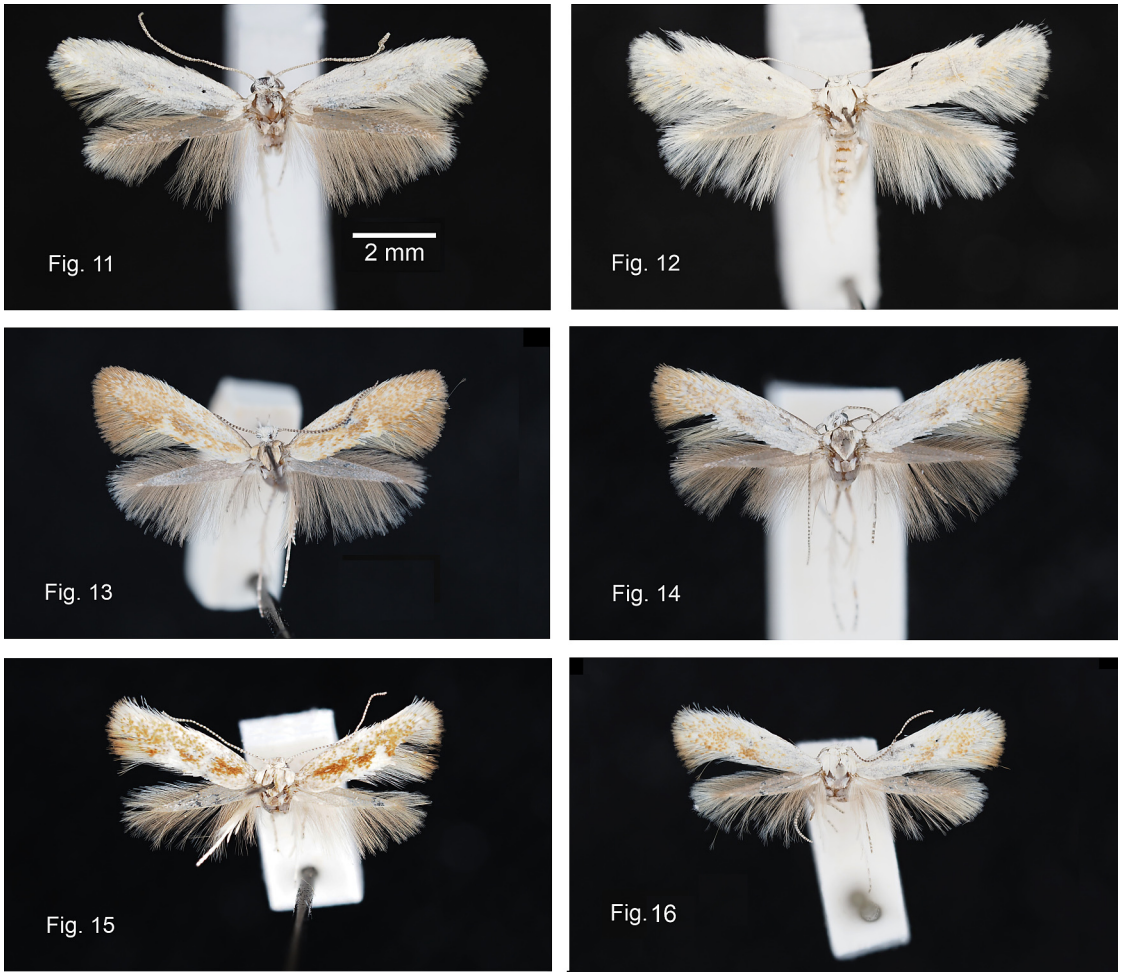
Figs. 11, 12, 30, 40

Holotype ♂: U.S.A., California, San Diego Co., Laguna Mts., 1800 m, *Pinus/Quercus/*meadow, 18.vii.1998, black light, L. Kaila & S. Timonen leg.; L. Kaila prep. 6366; DNA voucher FinBol 2019 http://id.luomus.fi/KZ.7710) (MZH). Paratypes: 3 ♀ with the same collecting data as in the holotype, except collecting dates 15.–18.vii.1998; females L. Kaila prep. 6025, 6029 (MZH); U.S.A. California, Kern Co., 5 km SW Tehachapi, 1900 m, Tehachapi Mountain Park, 11.vi.1997 1 ♂ 1 ♀ H. van der Wolf leg. Male genitalia preserved in glycerol vial on the pin, female genitalia mounted on slide, L. Kaila prep. 6161 (MZH).

Diagnosis. Forewings of *C. aprica* are silky white, sparsely scattered with yellowish ochre scales especially in the distal part and forming a yellowish patch in the middle of wing at costal side of fold. Unlike other species apart from *C. alboflava* the flagellum is only weakly annulated with pale grey scales. In the male the fringe scales at the apex of the forewing are narrowly grey. The male genitalia of *C. aprica* are readily distinguishable from other *Coelopoeta* species by the significantly longer phallus and saccus (see the key). The female genitalia of *C. aprica* are distinguishable from other *Coelopoeta* species by the colliculum being longer in relation to antrum than in other species except *C. phaceliae*, in which the ratio is similar. However, in *C. phaceliae* ostium + antrum is markedly shorter than in *C. aprica*. In *C. aprica* there are distinctive setose lobes ventrolaterally in sternum 8. The known males of *C. aprica* are similarly coloured as females, thus much paler and shinier than the males of *C. phaceliae*.

Description. Forewing length 5–6.5 mm. Labial palpus slightly upcurved, length half the diameter of head; labial palpus, head, neck tuft, tegula, thorax, scape of antenna and pecten white. Flagellum of male slightly serrate, off-white, weakly annulated by pale grey rings; female antenna not serrate, unicolourous off-white. Fore- and midleg inwardly off-white, outwardly grey, tarsal articles distally narrowly white; hindleg white. Forewing silky white, sparsely scattered with yellowish ochre scales especially in distal part of wing, and forming patch in the middle of wing length at costal side of fold; fringe white, in males apically narrowly grey. Hindwing grey with concolorous fringe. Underside of forewing grey to dark grey, distally sometimes with irregular white scales, fringe white; hindwing grey, fringe varying from white to pale grey.

Male genitalia. Uncus undivided, hook-shaped, evenly tapered and bent ventrad, as long as tegumen. Gnathos as long as uncus, evenly tapered. Tegumen in lateral view not as high as width of valva. Valva nearly parallel-sided, half as wide as long, in ventral view weakly bent inwardly in distal third, termen not swollen. Juxta distally slightly concave, broadest in the middle, evenly tapered to convex anterior margin. Saccus slightly bent dorsad, almost 5 x as long as its width at its narrowest point in middle, apex broadly rounded. Phallus 1.7 times as long as valva, basal opening dorsally directed, without carina near apex.



FIGURES 11–16. Habitus of *Coelopoeta* spp. All images at the same scale as the first image. Figure 11: *C. aprica* sp. nov, ♂, holotype; Figure 12: *C. aprica* **sp. nov.**, ♀, paratype, California, San Diego County; Figure 13: *C. phaceliae* Kaila, ♂, California, Plumas County; Figure 14: *C. phaceliae*, ♂, California, Solano County; Figure 15: *C. phaceliae*, ♂, paratype, California, San Mateo County; Figure 16: *C. phaceliae*, ♂, paratype, California, Siskiyou County.

Female genitalia. Apophyses slender, apophysis anterioris as long as apophysis posterioris; as long as papilla analis + sternum 8. Sternum 8 ventrolaterally with setose areas formed as lobes; plate dorsad of ostium bursae square; ostium bursae about 1/3 as wide as wide as sternum 8, ventral margin concave, antrum funnel-shaped, laterally distinctly sclerotized, abruptly separated from elongate, sclerotized and granulose colliculum, length of which is 1.5 x that of antrum, ductus bursae otherwise almost nonexistent, abruptly joining corpus bursae. Ductus seminalis incepted at posterior margin of corpus bursae. Corpus bursae membranous, without internal spines, with one distinct and another very faint small, round and dentate signa.

Variation. Not known.

Remarks. The barcode is within the small range of variation seen in the morphologically distinct *C. glutinosi*, suggesting recent speciation.

Coelopoeta phaceliae **Kaila, 1995**

Figs. 3, 13–18, 31, 41

Coelopoeta phaceliae Kaila, 1995: 176

Material examined: Holotype ♂: U.S.A, California: Modoc Co., Fandango Pass, 6100', 12.–13.vi.l970, J. Powell 70F95, emerged 7.vii.1970, reared from *Phacelia hastata*, R.E. Dietz & P.A. Opler; "Holotype *Coelopoeta phaceliae*

Kaila" [red]. Genitalia preserved in glycerol vial on the pin (EME). Paratypes (23 ex): Modoc Co., Fandango Pass, 6100', larva 12.–13.vi.1970, 1 ♂ J. Powell 70F95, emerged 30.vi.l970, reared from *Phacelia hastata*; same collecting data, 2 ♂ R.E. Dietz & P.A. Opler leg. (EME); San Mateo Co., San Bruno Mts., J. Powell 62D3, emerged 7.v.1962, reared from *Phacelia californica* 2 ♂ J.A. Powell leg. (EME, USNM); same site, J.A. De Benedictis 81137-A, 2 ♂ 2 ♀ emerged 10.vi.l981, reared from *Phacelia californica*, J.A. De Benedictis leg. (1 ♂ 2 ♀ in EME, 1 ♂ in MZH) (♂ genitalia figured by L. Kaila 1995); Siskiyou Co., Ash Creek Rgr. Sta., 9 mi E McCloud, 3500', 7.–9.vi.1974, J. Powell 74F17, 2 ♀ emerged 5.vii.1974, reared from *Phacelia mutabilis*, J.A. Powell leg. (EME, MZH); Plumas Co., Humbug Cr., 5100', 3 mi NW Portola, 7.vii.1982, J. Powell 82G7, 1 ♂ 1 ♀ emerged 23.vii.1982, reared from *Phacelia hastata* x *mutabilis*, J.A. Powell leg. (MZH, EME); Plumas Co., 1 mi S Meadow Valley, 22.v.1982, J. Powell 82G2, 82G3, 82E98, 3 ♂ 8 ♀ reared from *Phacelia procera*, J.A. Powell leg. (2 ♂ 8 ♀ in EME, 1 ♂ in MZH).

Other material. Nevada Co., Sagehen Creek, 1920 m, 11.–15.vii.1984 1 ♂ J.A. De Benedictis leg.; male genitalia preserved in glycerol vial on the pin (BME). Shasta Co., Bear Creek, 27.–28.vii.1871 Wlsm; 90498; 1610 WLSM 1907; Type no. 10350; *Coelopoeta glutinosi* WLSM ♂ paratype 48/71; *glutinosi* Wlsm. ♂ genitalia on slide AB Jun 16 1907; Genitalia slide by AB ♂ USNM 10.735; USNMENT 01200016; *Coelopoeta phaceliae* Kaila, L. Kaila det. 2023 (USNM); Solano Co., G.L. Stebbins Cold Cyn. Reserve, 29.iv.1989 2 ♂ 1 ♀, 21.v.1989 1 ♀, 26.vi.1996 2 ♂ 1 ♀; ♂ L. Kaila prep. 6363; ♀: DNA voucher FinBOL 2019; http://id.luomus.fi/KZ.7708), 15.vi.1996 1 ♀, 5.vi.2006 1 ♀, 31.v.2012 1 ♀ (BME, MZH).

Diagnosis. *Coelopoeta phaceliae* is a medium-sized species with forewing length 4.5–5 mm. The forewing colouration varies from nearly white with only a slight hue of ochre as a blotch in the middle of the wing, as well as in the distal third of the forewing, to ochreous and variably covered with broadly pale brown scales, giving a more or less evenly pale-brown appearance, without peppering by narrowly darker-tipped scales typical of *C. glutinosi* whose forewing ground colour is usually nearly white; in the distal 2/3 of dorsal margin there is a variably and indistinctly delineated white to yellow spot or area. *C. aurora* is more broad-winged, with the tornal spot brighter white, rounded.

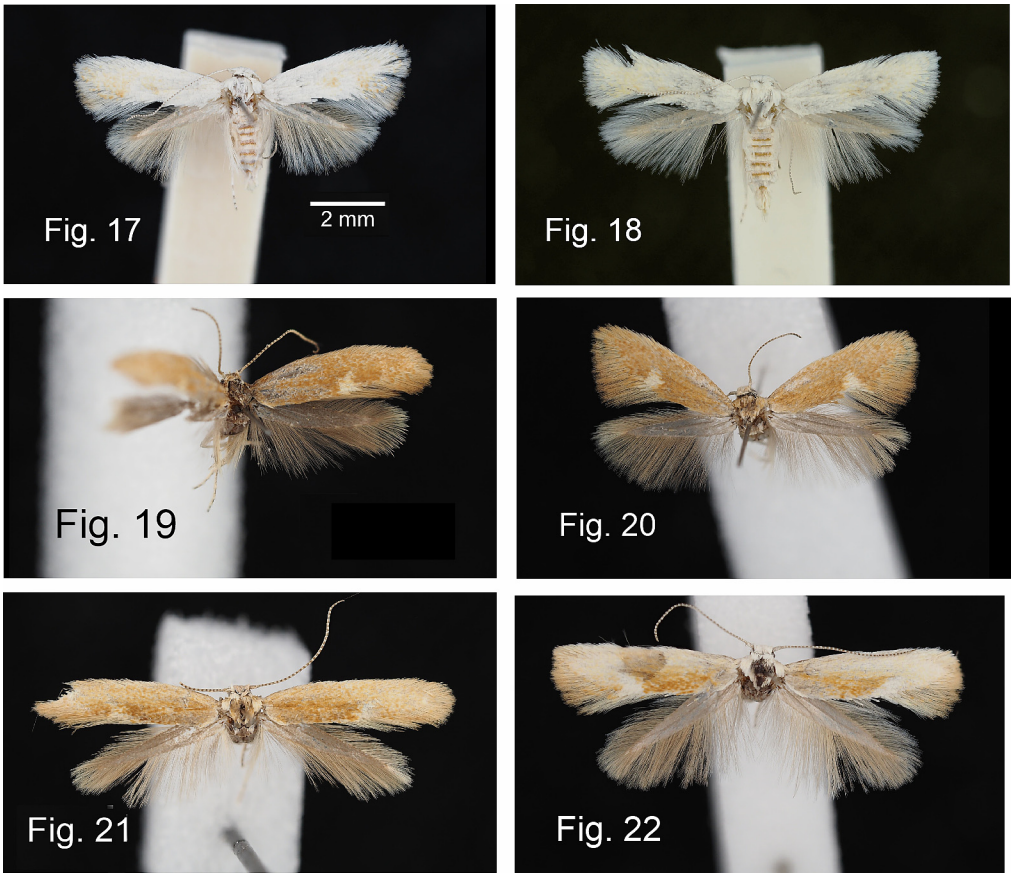
The valva is parallel-sided, bent inward in the distal half, almost half as wide as long; the distal margin is almost straight in lateral view, the termen lacks the prominent distal swelling unlike *C. sariae* and *C. fulminea*; the length of the saccus is usually less than its width, though there is some variation; the phallus is as long as the valva, with a fine carina along its distal opening. *Coelopoeta sariae* and *C. fulminea* are similar in forewing colouration; *C. sariae* is smaller, and *C. fulminea* larger and more narrow-winged. *C. aurora* is similar to *C. phaceliae*, but more broad-winged, and the tornal spot is brighter white, rounded. In the male genitalia *C. fulminea* differs from other species by the shorter uncus, in the female genitalia as having two signa unlike other species with known female; however, in *C. aprica* there is a very faint trace of a similar second signum. The phallus of *C. aurora* is basally bent, and the termen of its valva with only a weak fold, unlike in *C. phaceliae*. The female genitalia are characterized by the non-bulbous antrum and the coarse setae on the posterior margin of sternum 8.

Redescription.

Forewing length 4.5–5 mm. Length of labial palpus 1/3 to 1/2 of diameter of head, slightly upcurved; labial palpus, head, neck tuft, tegula and thorax varying from white to ochreous or pale brown, scape of antenna white or grey, with pecten consisting of white or ochreous coloured scales. Fore-and midleg varying from off-white to grey, with white spot in tibia, tarsal articles basally white; hindleg pale ochreous, slightly darker above.

Forewing ground colour from nearly white with only a slight hue of ochre in the distal part, to consisting of ochreous scales, variably overlaid by broadly pale brown scales, giving a more or less pale-brown appearance; in darker specimens indistinctly delineated white or yellow area in distal 3/5 of dorsal margin; fringe concolorous with ground colour. Hindwing grey with concolorous fringe. Underside of forewing grey, distally sometimes irregularly white, fringe varying from off-white to ochreous; hindwing grey, fringe varying from grey to ochreous grey.

Male genitalia. Uncus undivided, hook-shaped, evenly tapered and curved, slightly shorter than tegumen, apical fourth somewhat bent ventrad. Gnathos as long as uncus, distally tapered. Tegumen in lateral view not as high as width of valva. Valva nearly parallel-sided, weakly concave distally and almost half as wide as long in lateral view, in ventral view inwardly bent in its distal half, termen slightly swollen distolaterally. Juxta broadest at distal third, distally slightly concave, evenly tapered toward the convex anterior margin. Saccus slightly bent dorsad, about 2 x as long as its width in its narrowest point in middle, apex broadly rounded. Phallus as long as valva, basal opening dorsally directed, with fine carina along distal opening.



FIGURES 17–22. Habitus of *Coelopoeta* spp. All images at the same scale as the first image. Figure 17: *C. phaceliae* Kaila, ♀, California, Solano County; Figure 18: *C. phaceliae*, ♀, California, Solano County; Figure 19: *C. aurora* **sp. nov.**, ♂, holotype; Figure 20: *C. aurora* **sp. nov.**, ♀, paratype, U.S.A. Colorado, Gilpin County; Figure 21: *C. fulminea* **sp. nov.**, ♂, holotype; Figure 22: *C. fulminea* **sp. nov.**, ♂, paratype, Canada, British Columbia, Lilloeet Pow, Kirby Flats.

Female genitalia. Apophyses stout, apophysis anterioris as long as apophysis posterioris; as long as papilla analis + sternum 8. Plate dorsad of ostium bursae triangular; ostium bursae about 1/4 as wide as sternum 8, ventral margin weakly concave, antrum funnel-shaped, laterally distinctly sclerotized, between antrum and colliculum a narrow membranous zone; colliculum elongate and sclerotized, granulose, length 1.5 x that of antrum, ductus bursae otherwise almost nonexistent, joining corpus bursae without distinct border. Ductus seminalis incepted at posterior margin of corpus bursae. Corpus bursae membranous, without internal spines, with one distinct and another very faint small, round and dentate signa.

Biology. *C. phaceliae* is a gall-inducer on the leaves of *Phacelia* spp. (Boraginaceae). According to Powell & Opler (2009) the larvae cause the leaves to curl, concealing the mines, which are found from April to May on the coast, late May to early July in the mountains. There are rearing records from *P. californica*, *P. hastata*, *P. mutabilis* and *P. procera*. Reported altitudes range from 2500 to 6100 ft. a.s.l.; *C. phaceliae* is a more northern species than *C. glutinosi*, apparently preferring higher altitudes. Their distribution areas, however, overlap and these two species have been found sympatrically in at least Solano County.

Distribution. Mid to northern California, from coast (for instance San Bruno Mountain in San Francisco Bay area) to northeastern California.

Variation. The forewing ground colour varies more than indicated by Kaila (1995); in females it can be nearly white with only a slight hue of ochre in the distal part. The size of the saccus is more variable in *C. phaceliae* than suggested as a diagnostic character by Kaila (1995), and its size sometimes overlaps that of some specimens of *C. glutinosi*.

Remarks. The material examined for this study includes also the specimens examined by the present author in his 1995 publication, without re-examination of some of them for the present publication.

***Coelopoeta aurora* Kaila, sp. nov.**
Figs. 4, 19, 20, 32, 42

Holotype ♂: U.S.A. Colorado, Gilpin County, 2538 Golden Gate Canyon Road (State highway 46, 2674 m/8774 ft. a.s.l. at MV light black light, 29.vi.2014 leg. Barbara K. Bartell, don. Barbara K. Bartell DMNS Donation Accession # 2018-119; DMNS ZE.132509, L. Kaila prep. 6374 (DMNS).

Paratypes: U.S.A. Colorado, 39.841260°N, 105.456411°W Gilpin County, 2538 Golden Gate Canyon Road (State highway 46, 2674 a.s.l./8774 ft at MV light black light, 24.vii.2014 1 ♀ leg. Barbara K. Bartell, L. Kaila prep. 6369; don. Barbara K. Bartell DMNS Accession # 2014-244: DMNS ZE.132508 (DMNS); 1 ♀ with same collection data except the date 10.vii.2018; *Coelopoeta phaceliae* det. Chris Grinter 2023; L. Kaila prep. 6367 (2024) CASENT 8580900 (CAS).

Diagnosis. *C. aurora* is a rather large and broad-winged species with forewing length 6 mm. The forewing colouration seems uniformly ochreous brown with a creamy white triangular spot at 2/3 length of the dorsal margin. The valva is parallel-sided, the termen of the valva is only with a weak fold, not markedly swollen unlike *C. sariae* and *C. fulminea*; the aedeagus is as long as valva, basally bent, with bulbous caecum. The female genitalia are characterized by the stout apophyses, apophyses anteriores being shorter than apophyses posteriores; the antrum is anteriorly largely membranous, unlike in other species.

Description. Forewing length 6 mm. Labial palpus almost as long as diameter of head, porrect; labial palpus, head, neck tuft, tegula, thorax, scape and pecten of antenna ochreous, flagellum ochreous, annulated with dark grey rings. Fore- and midleg grey, tibia with cream-coloured white spot medially, tibia and tarsal articles distally cream-coloured, varying from off-white to grey, with white spot on tibia, tarsal articles basally white; hindleg cream-coloured, tibia and tarsal articles faintly darker distally.

Forewing ground colour ochreous brown; at 2/3 length of dorsal margin a distinctive and clearly delineated creamy white triangular spot; fringe concolorous with ground colour. Hindwing grey with concolorous or slightly more ochreous fringe. Underside of forewing grey, fringe variably ochreous; hindwing grey, fringe varying from grey to ochreous grey.

Male genitalia. Uncus undivided, hook-shaped, curved and evenly tapered to pointed apex, apical half somewhat bent ventrad; slightly shorter than tegumen. Gnathos as long as uncus, distally tapered, somewhat bent dorsad. Tegumen in lateral view as high as width of valva. Valva parallel-sided, 3.5 times as long as wide in lateral view. Saccus bent dorsad, twice as long as its width in its narrowest point in middle, apex broadly rounded. Phallus as long as valva, bent at basal 1/3, caecum bulbous, basal opening dorsally directed, without carina along distal opening.

Female genitalia. Apophyses stout, apophysis posterioris 1.5 x as long as apophysis anterioris. Plate dorsad of ostium bursae square; ostium bursae about 1/4 as wide as sternum 8, ventral margin weakly concave, antrum only posteriorly narrowly sclerotized, otherwise membranous and funnel-shaped; colliculum parallel-sided, slightly longer than antrum, sclerotized, granulose; ductus bursae otherwise nonexistent, joining corpus bursae without distinct border. Ductus seminalis incepted at border of colliculum and corpus bursae. Corpus bursae membranous, without internal spines, with one distinct, dentate signum consisting of two symmetrical, medially joined parts.

Biology. The known specimens have been collected at black light, the site is at an altitude of 2674 m, = 8774 ft. a.s.l.; otherwise the biology is unknown.

Distribution. Known only from the type locality in central Colorado, west of Denver.

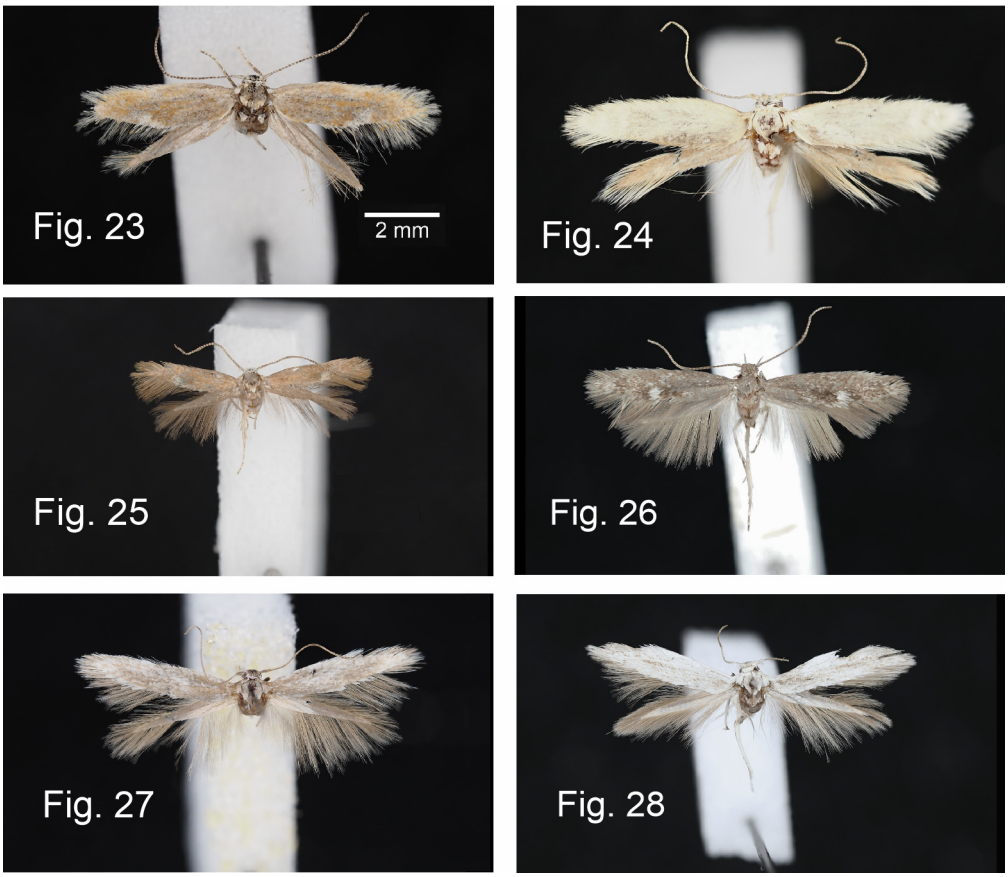
***Coelopoeta fulminea* Kaila, sp. nov.**
Figs. 21–23, 33, 43

Holotype ♂: Canada, B.C., 49.070841°N, 120.790136°W, Manning Park, 1385 m, 10.viii.2020, leg. Dave G. Holden. L. Kaila prep. 6376; DNA sample http://tun.fi/MZH_NJ.17 (CNC).

Paratypes: Canada, B.C., 50.533405°N, 121.744247°W, Lilloeet Pow, Kirby Flats, 442 m, 19.vi.2018, UV, 1 ♂ leg. Dave G. Holden, L. Kaila prep. 6375; DNA sample http://tun.fi/MZH_NJ.16 (RCDH); Canada, B.C., 49.097248°N, 120.766530°W, Manning Park, 1968 m, 27.vii.2022 1 ♂ 1 ♀, L. Kaila prep. 6357 (♀), in RCDH; 49.070841°N, 790331°W, Manning Park, 1385 m, 24.viii.2022 1 ♂ leg. Dave G. Holden (MZH).

Diagnosis. *C. fulminea* is a large and narrow-winged species. The ground colour of forewing is brown; an

early-summer specimen is widely pale cream-coloured (Fig. 22). There is an indistinctly and variably delineated yellowish white spot at distal 2/3 of the dorsal margin. The male antennae are slightly serrate in distal 1/4. The male genitalia can be distinguished from other *Coelopoeta* species by the size of the uncus that is shorter than the tegumen. The female genitalia are characteristic with the presence of two distinct signa, whereas females of other known species have only one signum; although in *C. aprica* there is a very faint trace of a second signum.



FIGURES 23–28. Habitus of *Coelopoeta* spp. All images at the same scale as the first image. Figure 23: *C. fulminea* **sp. nov.**, ♀, paratype, Canada, British Columbia, Manning Park; Figure 24: *C. alboflava* **sp. nov.**, ♂, holotype; Figure 25: *C. sariae* **sp. nov.** ♂, holotype; Figure 26: *C. maiadella* Kaila, ♂, holotype; Figure 27: *C. fissurina* **sp. nov.**, ♂, holotype; Figure 28. *C. valalbui*, ♂, holotype.

Description. Forewing length 5–6 mm. Labial palpus 1/3 to half the diameter of head, porrect or slightly upcurved; labial palpus, head, neck tuft, tegula, thorax and scape of antenna varying from white to pale brown, pecten concolorous with scape. Flagellum filiform, except distal 1/4 which is slightly serrate, leaden grey, annulated with pale grey rings. Fore- and midleg grey, with white spot on tibia, tarsal articles basally white; hindleg off-white, slightly darker above. Forewing ground colour pale brown, sometimes widely creamy-coloured, with white to yellow, oblique patch in the middle of dorsal margin, directed towards apex; fringe concolorous with ground colour. Hindwing grey, fringe pale grey with yellowish hue. Underside of wings grey, fringe along apex of forewing yellow, otherwise grey.

Male genitalia. Uncus undivided, evenly tapered, curved as ventrally directed hook in distal 1/4, about 2/3 as long as tegumen. Gnathos as long as uncus, evenly tapered towards apex, straight. Tegumen in lateral view not as high as width of valva. Valva parallel-sided in lateral view, 2/3 as wide as long, somewhat inwardly bent in the distal half in ventral view, almost half as wide as long; termen distolaterally bulbous. Juxta broadest in the middle distally straight, evenly tapered to convex anterior margin. Saccus slightly bent dorsad, 2 x as long as its width at its narrowest point in middle, apex broadly rounded. Phallus slightly longer than valva, basal opening dorsally directed, without distinct carina along distal opening.

Female genitalia. Apophyses stout, apophysis posterioris 1.3 x as long as apophysis anterioris. Plate dorsad of ostium bursae square; ostium bursae about 1/4 as wide as sternum 8, ventral margin weakly concave, antrum widely

funnel-shaped, border between antrum and colliculum narrow, colliculum parallel-sided, slightly longer than wide, sclerotized, granulose; ductus bursae otherwise nonexistent, joining corpus bursae without distinct border. Ductus seminalis incepted at border of colliculum and corpus bursae. Corpus bursae membranous, without internal spines, with one distinct, dentate signum consisting of two symmetric, medially joined parts.

Variation. The area of white-creamy white colour on forewing varies extensively.

Biology. Specimens have been caught at UV light from June through August at altitudes ranging from about 450 to 1968 m, otherwise the biology is unknown.

Distribution. Known from south-western British Columbia, Canada.

Coelopoeta alboflava Kaila, sp. nov.

Figs. 24, 34

Holotype ♂: U.S.A., Montana, Hamilton, 17.viii.1928 J. McDunnough leg.; *Coelopoeta* sp. det. A.F.B.; Specimen ID CNCLEP00116752; Barcode of Life Project, Leg(s) removed, DNA extracted [barcoding unsuccessful]; L. Kaila prep. 6373 (CNC).

Diagnosis. *C. alboflava* is a large and narrow-winged species. The forewing, head and thorax are creamy-white. The male antennae are slightly serrate in distal 1/4, and unlike other species, almost white and only indistinctly annulated with pale grey rings. The male genitalia most closely resemble those of *C. glutinosi* and *C. phaceliae* in not having the termen of valva distally dilated. This, in combination with the short saccus and phallus separates it from *C. aprica*. The shape of the tegumen differentiates *C. alboflava* from all other species in being more spherical and about as high as long as seen in lateral view. The female is unknown.

Description. Forewing length 6 mm. Labial palpus half the diameter of head; labial palpus, head, neck tuft, scape and pecten creamy white. Flagellum white, weakly annulated with pale grey rings, slightly serrate in distal 1/4. Fore- and midleg outwardly creamy white, inward ochreous, tarsal articles basally ochreous, distally pale grey. Hindleg outwardly creamy white, inwardly pale ochreous, tarsal articles distally slightly darker.

Male genitalia: Uncus undivided, hook-shaped, evenly tapered, approximately as long as tegumen. Gnathos as long as uncus, tapered from middle to apex, straight. Tegumen spherical, as high as long and 4/5 as long as valva in lateral view. Distal half of valva slightly narrower than basal half, twice as long as wide, distinctly inwardly bent in distal half, termen distally not markedly bulbous. Juxta bent, broadest in the middle, distal margin almost straight, anterior margin evenly convex. Saccus half the length of valva, bent dorsad, twice as long as its width at its narrowest point in middle, apex broadly rounded. Phallus slightly longer than valva, basal opening dorsally directed, without distinct carina along distal opening.

Female unknown.

Biology. Unknown. The single known specimen was collected in mid-August.

Distribution. Known only from the type locality in western Montana, U.S.A.

Coelopoeta sariae Kaila, sp. nov.

Figs. 25, 35

Holotype ♂: U.S.A., California, 32.87°N, 116.41°W, San Diego Co., Laguna Mts., *Pinus/Quercus/*meadow, 18.vii.1998, black light, L. Kaila & S. Timonen leg., L. Kaila prep. 6364; DNA-voucher FinBOL 2019; http://id.luomus.fi/KZ7709 (MZH).

Diagnosis. *C. sariae* is a very small and narrow-winged species. With the pale brown forewing colour it resembles *C. phaceliae* and *C. aurora.* The white spot in the distal 3/5 of the dorsal margin of the forewing is brighter than in *C. phaceliae*, more reminiscent of *C. aurora*. The flagellum of the antenna is distinctly serrate in *C. sariae*, unlike *C. phaceliae* or *C. aurora. C. aurora* is more broad-winged than *C. sariae*. The male genitalia of these species are distinguished by the following characteristics of *C. sariae*: dorsal part of the apex of the valva is markedly produced, and the uncus is apically inwardly bent as a small hook. The female is unknown.

Description. Forewing length 3.5 mm. Labial palpus 1/3 diameter of head, porrect; labial palpus, head and neck tuft white, tegula and thorax intermixed with white and pale brown scales; scape of antenna grey above, white

below, with pecten consisting of white scales; pedicel grey. Flagellum thick, serrate, grey, annulated with white rings. Fore-and midleg grey, with white spot on tibia, tarsal articles basally white; hindleg off-white, slightly darker above. Forewing pale brown; white spot in distal 3/5 of dorsal margin; fringe concolorous with ground colour. Hindwing grey with concolorous fringe. Underside of fore- and hindwing dark grey.

Male genitalia. Uncus undivided, evenly tapered and curved as ventrally directed hook in distal 1/4, slightly shorter than tegumen. Gnathos as long as uncus, distally tapered and slightly bent towards uncus. Tegumen in lateral view not as high as width of valva. Valva parallel-sided in both lateral and ventral views, almost half as wide as long; apex costally with small extension, termen distolaterally bulbous. Juxta broadest at distal third, distally concave, evenly tapered to rounded anterior margin. Saccus slightly bent dorsad, twice as long as its width at its narrowest point in middle, apex broadly rounded. Phallus as long as valva, basal opening dorsally directed, with coarse carina along distal opening.

Female unknown.

Biology. The single specimen has been caught at black light in a meadow with *Pinus* and *Quercus*, in mid-July; otherwise the biology is unknown.

Distribution. Known only from the type locality in California, Laguna Mountains, in San Diego County.

Remarks. The barcode is within the small range of variation seen in the morphologically distinct *C. glutinosi*, suggesting recent speciation.

Coelopoeta maiadella **Kaila, 1995**

Figs. 26, 36

Coelopoeta maiadella Kaila, 1995: 177

Material examined. Type material. Holotype ♂: Canada, Yukon Territory, 60.75°N, 134.66°W, 20 km SE Whitehorse, light trap, 16.vii.1985 K. Mikkola leg. L. Kaila prep. 6387; DNA voucher FinBOL 2019; http://id.luomus.fi/KZ7712 (MZH). Other material. Canada, Yukon, 60.9631°N 138.3875°W, Kluane National Park Reserve, north-facing slope of Outpost Mtn., wet tundra, 1625–1775 m a.s.l., 24.vi.2017, afternoon vegetation sweeping, 1 ♂ G.R. Pohl leg., BOLD sample ID: NFRC-2017-01516 (CNC).

Diagnosis. *C. maiadella* is a mottled dark grey species with a distinctive white spot at about 2/3 length of the dorsal margin of the forewing. The dark grey forewing ground colour is unique among *Coelopoeta* species, in others being white to brown. The male genitalia are characterized by the phallus being 1.3 x as long as the valva; basal opening at 0.25 length of phallus from base, directed ventrad, with a lobe of the manica; distal opening without carina. The termen of the valva is simple, without swellings or folds. The female is unknown.

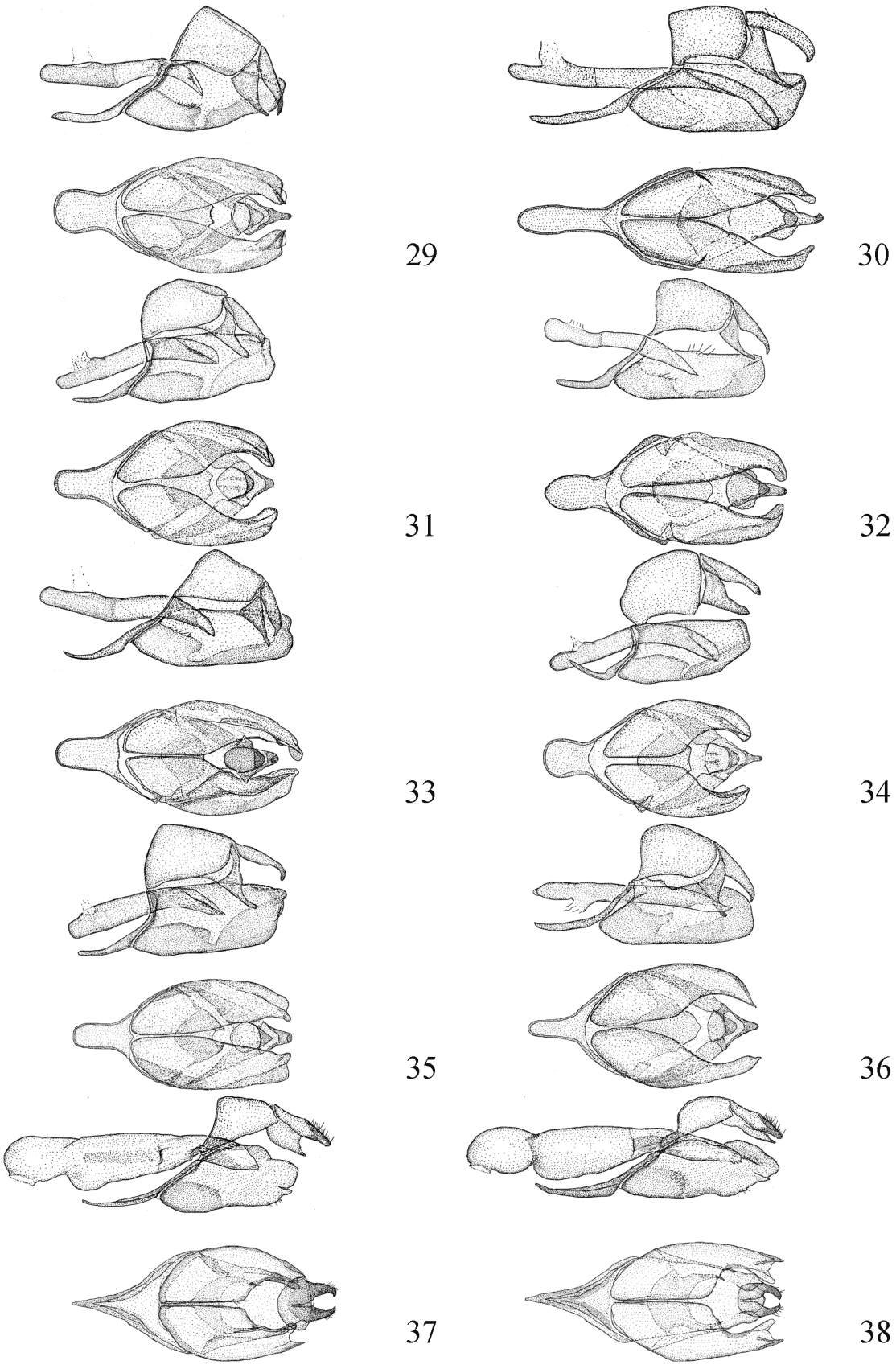
Redescription. Forewing length 4.5 mm. Labial palpus as long as diameter of head, ascending; labial palpus, head, neck tuft, tegula and thorax grey. Scape of antenna grey above, off-white below, pecten off-white. Flagellum grey, annulated with indistinctly darker-grey rings. Legs grey, tibia and tarsal articles of fore- and midleg distally paler. Forewing and hindwing grey with concolorous fringe; at 2/3 of length of dorsal margin a white spot. Underside of forewing dark grey with concolorous fringe; hindwing grey, fringe varying from white to pale grey.

Male genitalia. Uncus undivided, hook-shaped, evenly tapered and bent dorsad, as long as tegumen. Gnathos as long as uncus, evenly tapered. Height of tegumen a little less than width of valva as seen in lateral view. Valva parallel-sided, a little wider than long. In ventral view weakly bent inwardly in distal third, termen not swollen, without folds. Juxta distally slightly concave, broadest in the middle, evenly tapered to convex anterior margin. Saccus slightly bent dorsad, 3.5 x as long as its width at its narrowest point in middle, apex broadly rounded. Phallus 1.3 times as long as valva, abruptly widening near basal opening that is projected ventrad. Caecum well discernible, manica forming lobe at apex of basal part of phallus. No carina along distal opening.

Female unknown.

Biology. The known habitat is a north-facing slope in wet tundra. One specimen was caught at black light in July, the other swept during afternoon in June. Otherwise the biology is unknown.

Distribution. Known from two localities in Canada: Yukon Territory.



FIGURES 29–38. Male genitalia of *Coelopoeta* spp. Above lateral view with juxta and one valva excluded; below ventral view, with phallus excluded. Figure 29. *C. glutinosi* Walsingham. Figure 30: *C. aprica* **sp. nov.**, holotype; Figure 31: *C. phaceliae* Kaila, California, Nevada Co.; Figure 32: *C. aurora* **sp. nov.**, holotype; Figure 33: *C. fulminea* **sp. nov.**, holotype; Figure 34: *C. alboflava* **sp. nov.**, holotype; Figure 35: *C. sariae* **sp. nov.**, holotype; Figure 36: *C. maiadella* **sp. nov.**, holotype; Figure 37: *C. fissurina* **sp. nov.**, holotype; 38: *C. valalbui* **sp. nov.**, holotype.

***Coelopoeta fissurina* Kaila, sp. nov.**
Figs. 27, 37

Holotype ♂: U.S.A., Arizona, 31.93°N, 109.20°W, Cochise Co., Chiricahua Mts., Portal–Paradise cyn. road, 2 mi. N. Portal, 1300 m, grass/*Opuntia*, 24.iv.1996, ad luc. L. Kaila & J. Kullberg leg. L. Kaila prep. 6372; Database # MZH-LEO 00000294; *Coelopoeta* sp. det. J.-F. Landry 2016; DNA-voucher FinBOL 2019; http://id.luomus.fi/KZ7707 (MZH).

Diagnosis. *C. fissurina* is a mottled pale grey species, with forewing colour formed of white and grey scales. The male genitalia are characterized by the bilobed uncus lobes and the basally inflated phallus. With these genital characters it is readily distinguished from all other *Coelopoeta* apart from *C. valalbui.* These species are distinguished from each other by the shorter valva with a distally blunt apex in *C. fissurina*. The uncus of *C. fissurina* far exceeds the length of the valva in ventral view (Fig. 37). The female is unknown.

Description. Forewing length 5 mm. Labial palpus porrect, length 2/3 of diameter of head, brownish grey. Head, neck tuft, tegula, thorax, scape and pecten of antenna white. Flagellum unicolourous grey, not serrate. Legs grey. Forewing ground colour formed of unicolourous, white and pale brownish grey scales, hindwing grey with concolorous fringe. Underside of wings grey with concolorous fringe apart from forewing costa where fringe is white.

Male genitalia. Uncus bilobed, lobes horn-shaped, bent inward, tapered towards curved and acute apex, as long as tegumen. Gnathos 3/4 as long as uncus, tapered in distal third to pointed apex. Tegumen triangular-shaped in lateral view, twice as long as high at its highest point; height half of width of valva in lateral view. Valva as wide as long when measured in the middle where valva is broadest, forming swelling; weakly bent inwards in distal half. Termen somewhat produced in costal part, blunt; sacculus apically separated into small, sharp-tipped lobe. Juxta distally markedly concave, laterally tapered into hook, tapered to convex anterior margin. Saccus slightly bent dorsad, evenly tapered to pointed apex, as long as its width basally. Phallus twice as long as valva, gradually widened from apex to basal 3/4; followed by abrupt narrowing and then dilating in a rounded basal part with basal opening ventrally directed; vesica with two groups of scobinations: one in the middle of phallus, another near apex; apex without carina or teeth.

Female unknown.

Biology. The habitat is rocky submontane prairie-like habitat with low vegetation and dense stands of *Opuntia*, at altitude 1300 m.

Distribution. Known only from the type locality in the Chiricahua Mountains in SE Arizona.

***Coelopoeta valalbui* sp. nov.**
Figs. 28, 38

Holotype ♂: U.S.A., 34.52°N, 112.38°W, Arizona, Yavapai Co., Lynx Lake recreation area, Prescott, 22.vii.2011 V. Albu leg. L. Kaila prep. 6371; DNA-voucher FinBOL 2019; http://id.luomus.fi, KZ7713 (USNM). Paratype, 1 ♂: same collecting data as in holotype (MZH).

Diagnosis. *C. valalbui* is a white species, the forewings peppered with grey-tipped scales. The male genitalia are similar to those of *C. fissurina.* See the diagnosis of *C. fissurina* for the separation of these species.

Description. Forewing length 5.5 mm. Labial palpus porrect, length 2/3 of the diameter of head, off-white, tip of second segment narrowly grey, underside of second segment off-white in one specimen, mixed with grey scales in other specimen. Head, neck tuft, tegula, thorax, scape and pecten of antenna off-white. Flagellum unicolourous grey, not serrate. Legs off-white. Forewing ground colour off-white, with indistinctly delineated stripes of grey scales; such scales irregularly scattered over distal part of wing; fringe white along costa and apex, grey along dorsal margin, hindwing silky, pale grey, fringe darker grey. Underside of forewing dark grey with scattered cream-coloured scales; fringe along costa cream-coloured, otherwise grey.

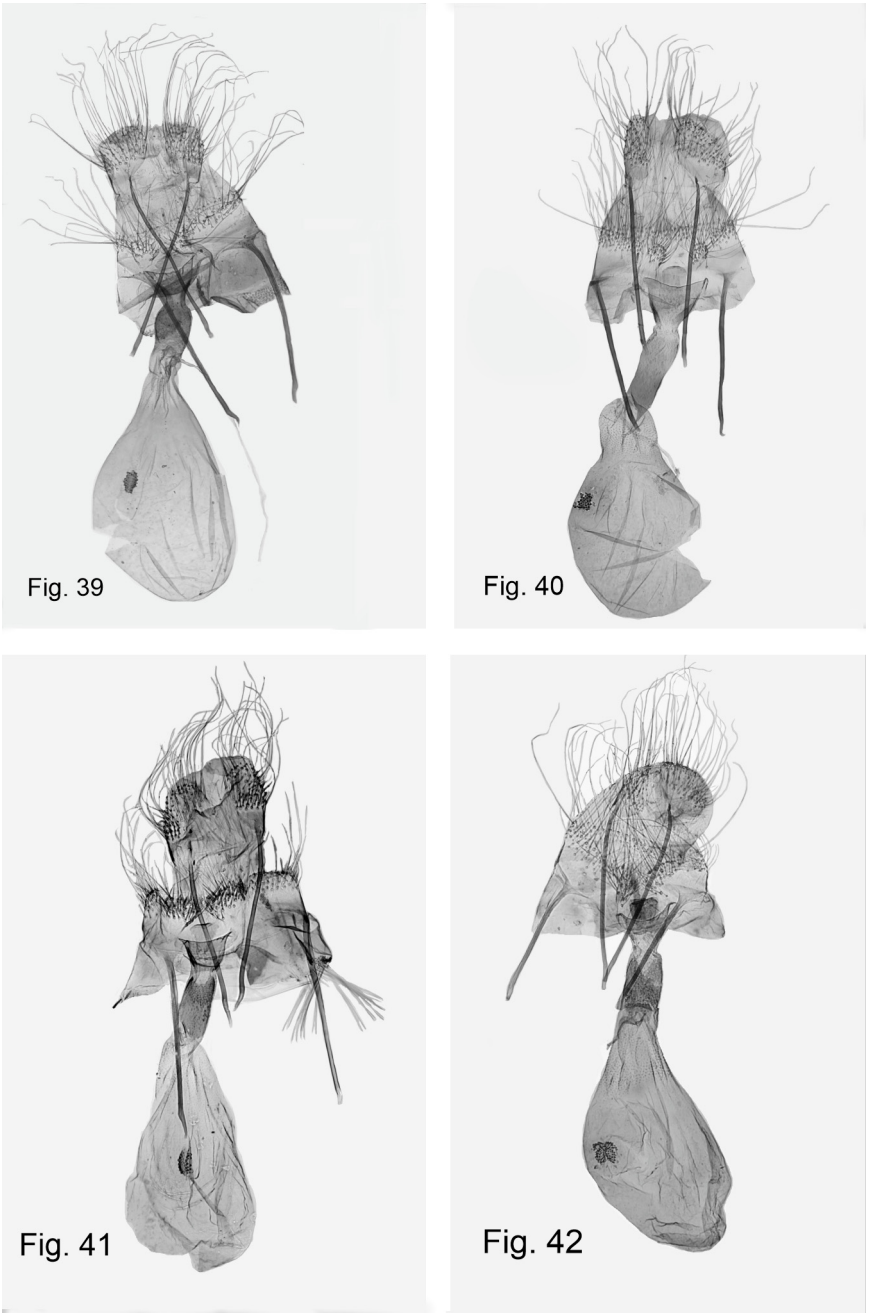
Male genitalia. Uncus bilobed, lobes horn-shaped, bent inward, tapered towards curved and acute apex, as long as tegumen. Gnathos as long as uncus, tapered in distal third to its pointed apex. Tegumen hemispherical in lateral view, 3 x as long as high at its highest point; height a little less than half of width of valva in lateral view. Valva 1/3 as wide in the middle where it is broadest, forming a swelling ; distinctly bent inwardly in distal half; costa concave in

distal 2/3, tapered into blunt apex; sacculus apically separated into small, acute-tipped lobe. Juxta distally markedly concave, laterally tapered into hook, tapered to convex anterior margin. Saccus slightly bent dorsad, evenly tapered to pointed apex, as long as its width basally. Phallus twice as long as valva, from apex gradually widened to basal 3/4; there abruptly narrowed and then dilated as rounded basal part where basal opening ventral directed with a few stout teeth along distal apex; vesica with one group of scobinations in the middle of phallus.

Female unknown.

Biology. The collecting site, at altitude of approximately 5000–6000 ft. (=1500–2000 m), was a trail surrounded by pines and cypresses, sparsely intermixed with oaks, and clearings with small bushes, flowers and abundant cacti. (Valeriu Albu, personal communication).

Distribution. Known only from the type locality in central Arizona north of Phoenix.



FIGURES 39–42. Female genitalia of *Coelopoeta* spp., in ventral view. Figure 39: *C. glutinosi* Walsingham, Los Angeles County, L. Kaila prep. 6027; Figure 40: *C. aprica* **sp. nov.**, paratype, California, San Diego County, L. Kaila prep. 6029; Figure 41: *C. phaceliae* Kaila, paratype, California, San Mateo County, L. Kaila prep. 6026; Figure 42: *C. aurora* **sp. nov.**, paratype, Colorado, Gilpin County, L. Kaila prep. 6734.

FIGURE 43. Female genitalia of C. fulminea **sp. nov.**, in ventral view. British Columbia, Manning, L. Kaila prep. 6357.

Discussion

The BOLDSystems engine recognizes three BINs in the barcodes of *Coelopoeta*. The *C. fissurina* cluster consisting of two species differs by about 11.5% from the rest of *Coelopoeta*, which opens to question the close relationship of these species to other *Coelopoeta*. The magnitude of this difference more likely highlights the deficiency of current, underrepresented barcode data available for Gelechioidea than spuriousness of barcode data in Lepidoptera in general. There are noteworthy differences in the morphology between the *C. fissurina* and *C. glutinosi* groups. Thus the barcode and morphology data agree, but at the same time there are morphological characters that suggest a relationship between these groups. The remaining two *Coelopoeta* BINs consist of two discrete groups, *C. maiadella* with 4.5 % difference to the closest match to the third, the "*C. glutinosi* BIN" that consists of several species here considered valid. Within the *C. glutinosi* BIN the barcode differences between the species are small if not negligible, with the maximum magnitude of 1.6 %. This might render the recognition of several species questionable. It has been shown that barcodes can reliably recognize about 90% of European Gracillariidae, likely representing a more general pattern in Lepidoptera (Lopez-Vaamonde *et al.* 2021). Despite the lack of significant barcode dissimilarities the differences in external appearance and genitalia support the *Coelopoeta* species recognized here as valid. This view is further supported by the observation that some of the taxa grouped most closely together by barcodes, viz. *C. aprica*, *C. aurora*, *C. glutinosi* and *C. sariae*, are among the morphologically most distinctive species, several of which are also known to be sympatric. The reason for the discrepancy between morphology and barcodes can only be guessed. The most likely possibilities are incorrect morphology-based taxonomy, or recent speciation not yet reflected in DNA barcodes; see the general review by Vogler & Monaghan (2007), or Kekkonen *et al.* (2015), which demonstrated differences in consistency between barcodes and morphology in different lepidopteran groups. The present author opts for the reliability of morphology over barcode evidence.

FIGURE 44. Gall made by the larva of *C. glutinosi* on *Eriodictyon californicum*. Photo, courtesy of Valeriu Albu with permission to use.

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