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Revision of the Nearctic *Calliphora* Robineau-Desvoidy (Diptera: Calliphoridae)

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Abstract

The Nearctic species of *Calliphora* Robineau-Desvoidy are revised and all species are redescribed and/or diagnosed. Diagnostic characters to permit reliable identification of both sexes of *Calliphora aldrichia* (Shannon) and *C. montana* (Shannon) and detailed distributional records for both species are provided for the first time. A lectotype is designated for *Calliphora loewi* Enderlein, 1903. A revised key to the 13 species of Nearctic *Calliphora* is also included. The key is based on examination of over 1,000 specimens from across North America and the structure of the terminalia of both sexes of each species. Complete illustrations of the terminalia of both sexes are provided for all species, including those of eight poorly known species: *Calliphora alaskensis* (Shannon), *C. aldrichia* (Shannon), *C. coloradensis* Hough, *C. grahami* Aldrich, *C. latifrons* Hough, *C. livida* Hall, *C. montana* (Shannon) and *C. terraenovae* Macquart. The female terminalia of *C. alaskensis*, *C. aldrichia*, *C. coloradensis*, *C. livida* and *C. montana* are illustrated for the first time. Barcode data for all 13 species of Nearctic *Calliphora* are provided, several for the first time. Results support current species concepts but barcodes failed to distinguish *C. aldrichia* and *C. montana*.

Key words: taxonomic key, *Calliphora aldrichia*, *C. montana*, barcodes, North America

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Introduction

Calliphora Robineau-Desvoidy, 1830 (Diptera: Calliphoridae: Calliphorinae) is a cosmopolitan genus comprising about 76 species, with highest species richness in the Holarctic and Australasian Regions with about 26 and 36 species, respectively (Zumpt 1965; Norris 1973; Pont 1980; Schumann 1986; Rognes 1991; Schumann & Ozerov 1992; Norris 1994; Fan *et al*. 1997; Wallman & Adams 1997; Rognes 1997, 1998; Kurahashi & Selomo 1998; Wallman 2001; Rognes 2002; Verves 2002, 2005; Whitworth 2006; Bharti 2011; Whitworth 2012; Kurahashi 2014, 2016; Rognes 2016). Most species of *Calliphora* are well known because of their medical and forensic importance (James 1947; Nuorteva 1963; Zumpt 1965; Greenberg 1971; Smith 1986; Greenberg & Kunich 2002; Graczyk *et al.* 2005; Sawabe *et al.* 2006; Stevens & Wallman 2006; Stevens *et al.* 2006; Förster *et al.* 2007; Byrd & Castner 2010; Salvetti *et al*. 2012).

In North America there are 13 species of *Calliphora* of which five are endemic to this region, namely: *Calliphora alaskensis* (Shannon, 1923), *C. aldrichia* (Shannon, 1923), *C. coloradensis* Hough, 1899, *C. livida* Hall, 1948 and *C. montana* (Shannon, 1926) (Hall 1948, 1965; Whitworth 2006). *Calliphora genarum* (Zetterstedt, 1838), *C. stelviana* (Brauer & Bergenstamm, 1891) and *C. terraenovae* Macquart, 1851 are exclusively Holarctic (Schumann 1986), while *C. grahami* Aldrich, 1930, *C. latifrons* Hough, 1899, *C. loewi* Enderlein 1903, *C. vicina* Robineau-Desvoidy, 1830 and *C. vomitoria* (Linnaeus, 1758) are also found in several other regions (see Pont 1980; Verves 2005; Kurahashi 2016). Despite the recently published keys to species of Nearctic *Calliphora* by Whitworth (2006, 2010), several species still required further study, especially of the male and female terminalia, to facilitate accurate identification. The publication of Whitworth (2006) resolved many of the problems with blow fly taxonomy in Hall (1948). However, in Whitworth (2006), male terminalia were not illustrated in detail, female terminalia were not studied and the status of *C. aldrichia* and *C. montana* as possible synonyms was left unconfirmed.

The primary original goal of this study was to resolve the taxonomy and distribution of the two rare boreo-montane species *C. aldrichia* and *C. montana*, based on the work of Whitworth (2006). As our work progressed, we realized we needed to re-evaluate the whole genus in the Nearctic Region. We illustrated the terminalia of both sexes of eight poorly known species (*Calliphora alaskensis*, *C. aldrichia*, *C. coloradensis*, *C. grahami*, *C. latifrons*, C. *livida*, *C. montana* and *C. terraenovae*), since information about them was scattered in publications, lacked detail and was not very effective for identification. The one exception was *C. grahami*, the terminalia of both sexes of which were studied more carefully by Thomas (1951); however, he did not illustrate the male bacilliform sclerites and the phallic structures were not illustrated in detail. Moreover, the female terminalia of *C. alaskensis*, *C. aldrichia*, *C. coloradensis*, *C. livida* and *C. montana* had never been illustrated. Finally, we have included, for completeness, figures previously published by Rognes (1991) of the five Holarctic species, i.e. *C. genarum*, *C. loewi*, *C. stelviana*, *C. vicina* and *C. vomitoria*.

Material and methods

We examined about 1,000 specimens representing all 13 Nearctic *Calliphora* species and dissected the terminalia of over 100 of those specimens. We also examined the primary type specimens of *Calliphora alaskensis, C. aldrichia*, *C. coloradensis*, *C. latifrons* and *C. montana*. Identifications were primarily based on Hall (1948), Rognes (1991) and Whitworth (2006), with additional data gathered from the following literature sources: Hough (1899), Shannon (1923, 1926), Thomas (1951), Emden (1954), James (1953, 1955), Zumpt (1956, 1965), Kano & Shinonaga (1968), Grunin (1970), Kurahashi (1971), Lobanov (1976), Hall & Townsend (1977), Hardy (1981), Smith (1986), Grunin (1988), and Fan *et al.* (1997).

We conducted a thorough search of museum collections, visiting some and obtaining loans from others, and had the opportunity to examine more specimens of *C. aldrichia* and *C. montana* to clarify the previously existing confusion in the taxonomy and distribution of these two species. The specimens examined were borrowed from or are deposited in the following collections: BIOUG—Biodiversity Institute of Ontario, University of Guelph, Guelph, Ontario, Canada; CAS—California Academy of Sciences, San Francisco, California, USA; CNC —Canadian National Collection of Insects, Agriculture and Agri-Food Canada, Ottawa, Ontario, Canada; CSU—Colorado State University, Fort Collins, Colorado, USA; DEBU—University of Guelph, Guelph, Ontario, Canada; FMNH—Field Museum of Natural History, Chicago, Illinois, USA; FSCA—Florida State Collection of Arthropods, Gainesville, Florida, USA; KR—Knut Rognes private collection, Oslo, Norway; LACM—Los Angeles County Museum of Natural History, Los Angeles, California, USA; MEM—Mississippi State University, Starkville, Mississippi, USA; OUMNH—Oxford University Museum of Natural History, Oxford, UK; TAMU—Texas A&M University, College Station, Texas, USA; TW—Terry Whitworth private collection, Tacoma, Washington, USA; UBCZ—University of British Columbia, Spencer Museum, Vancouver, British Columbia, Canada; USNM—National Museum of Natural History (formerly United States National Museum), Smithsonian Institution, Washington, District of Columbia, USA; WSUP—M.T. James Entomological Collection, Washington State University, Pullman, Washington, USA; ZMHB—Zoologisches Museum, Museum für Naturkunde der Humboldt-Universität zu Berlin, Berlin, Germany. Type data from specimens in the following collections are listed, but the specimens were not examined: MNHN—Museum National d'Histoire Naturelle, Paris, France; MZLU—Museum of Zoology, Lund, Sweden; NMW—Naturhistorisches Museum Wien, Vienna, Austria; SDEI—Senckenberg Deutsches Entomologische Institut, Müncheberg, Germany. The information entered in the "material examined" sections under each species is taken directly from the labels on the specimens. Many collectors used a variety of abbreviations or only provided fragmentary information on their labels; for clarification, we occasionally provide additional information in square brackets. Label data of primary types are cited from the top of the pin downward, with the data from each label in quotation marks. Labels are cited in full, with original spelling, punctuation and date, and label lines are delimited by a slash (/). The repository of each type is given in parentheses.

In addition to the examination of museum material, extensive collecting during warmer months (usually April–September) was performed throughout North America by TW to obtain specimens for study and to document species' distributions. Collecting trips were made throughout western North America, including trips to high elevation locations in Alberta and British Columbia, Alaska, Colorado, New Mexico, Washington and Utah, in a search for uncommon species (i.e., *C. alaskensis*, *C. aldrichia*, *C. genarum*, *C. loewi*, *C. montana*, *C. stelviana* and *C. terraenovae*). Other collection sites in the United States included Missouri, Virginia, Florida and Texas. The primary method used to collect specimens was the use of traps baited with decaying fish; however, other types of decaying flesh were also successfully used to attract blow flies. Most blow flies were collected with a "Pop-up Butterfly Bait Trap" available from BugDorm Store (http://bugdorm.megaview.com.tw/pop-up-butterfly-bait-trap-cone-type-pack-of-6-p-143.html). The fabric of the upper portion of the trap was sprayed with a residual insecticide containing permethrin. The insecticide killed the trapped flies quickly, avoiding damage to specimens. The best specimens were obtained when traps were emptied daily and specimens were pinned immediately. Some live flies were captured and killed in 95% ethyl alcohol for future use in molecular analyses.

Frons to head ratios (frons width/head width) were measured in both sexes of all species and presented, following Whitworth (2006), as follows: "frons 0.05 (0.04–0.07/12) of head width", where the average ratio (rounded off) is followed, in parentheses, by the range of frons widths and the number of specimens measured. Proportional measurements were made with the aid of an ocular micrometer, with frons and head widths measured at the narrowest point of the frons. The male frons is usually narrowest about midway, while the female frons is usually narrowest at the vertex. Figure 19 shows how to measure the wing character "position of the bend in M in relation to the dm-cu crossvein and wing margin". The male and female terminalia of eight species (*C. alaskensis*, *C. aldrichia*, *C. coloradensis*, *C. livida*, *C. montana*, *C. grahami*, *C. latifrons* and *C. terraenovae*) were dissected and illustrated. For the remaining five species (*C. vicina*, *C. vomitoria*, *C. stelviana*, *C. genarum* and *C. loewi*), the terminalia were well illustrated in Rognes (1991) and are reproduced here with permission.

Terminalia dissections were performed in both sexes by snapping off abdomens and macerating them overnight in 20% NaOH or 10% KOH solutions, neutralizing in 10% glacial acetic acid, and rinsing twice in distilled water. The terminalia were then examined in glycerol under a stereomicroscope. For males, the sternites were separated from the tergites and the epandrium. The phallus, bacilliform sclerites, pre- and postgonites, and ejaculatory apodemes were separated from the epandrium, surstyli and cerci for photographing. After photographing, the dissected parts were placed in glycerol in a terminalia vial, which was pinned together with the specimen. For females, the ovipositor was split into two halves to clearly show the dorsal and ventral sides; dissected ovipositors were placed in terminalia vials and pinned together with the specimens. Abdomens were glued to a piece of card and pinned with the specimen, or glued back on to the specimen. We recommend that researchers extend the telescopic ovipositor of recently killed female specimens with fine forceps. Examination of the ovipositor can help confirm species identity of poor or non-typical specimens that are hard to positively identify. Extending the ovipositor of fresh specimens saves the time required for maceration and dissection, and facilitates quick and accurate identification. For photography, the dissected parts were placed in a mixture of hand sanitizer gel and glycerol. The hand sanitizer gel keeps the specimen in the desired position while the glycerol prevents the gel from rapidly drying and coagulating, and increases the refractive index of the medium. Photography was performed with a Leica camera (model DFC425C) controlled by a Leica Digital Imaging System. The Zerene Stacker software was used to view and assemble the final images from multiple images taken at single focal planes.

Morphological terminology follows Rognes (1991) and Whitworth (2006), except "phallus" and "ejaculatory apodeme", which are used in place of "aedeagus" and "ejaculatory sclerite", respectively. Synonymies for the Holarctic species are based largely on Rognes (1991). The following abbreviations are used in the text: T = abdominal tergite, ST = abdominal sternite. Under material examined, specimens the abdominal sternites and/or terminalia of which were examined are marked "*".

The following province and state abbreviations are used: Canada—AB Alberta, BC British Columbia, MB Manitoba, NB New Brunswick, NL Newfoundland & Labrador, NS Nova Scotia, NT Northwest Territories, NU Nunavut, ON Ontario, PE Prince Edward Island, QC Quebec, SK Saskatchewan, YT Yukon; USA—AK Alaska, AL Alabama, AR Arkansas, AZ Arizona, CA California, CO Colorado, CT Connecticut, DE Delaware, FL Florida, GA Georgia, HI Hawaii, IA Iowa, ID Idaho, IL Illinois, IN Indiana, KS Kansas, KY Kentucky, LA Louisiana, MA Massachusetts, MD Maryland, ME Maine, MI Michigan, MN Minnesota, MO Missouri, MS Mississippi, MT Montana, NC North Carolina, ND North Dakota, NE Nebraska, NH New Hampshire, NJ New Jersey, NM New Mexico, NV Nevada, NY New York, OH Ohio, OK Oklahoma, OR Oregon, PA Pennsylvania, RI Rhode Island, SC South Carolina, SD South Dakota, TN Tennessee, TX Texas, UT Utah, VA Virginia, VT Vermont, WA Washington, WI Wisconsin, WV West Virginia, WY Wyoming.

To further clarify and evaluate species' identities, selected specimens of the 13 Nearctic *Calliphora* species were submitted for barcoding to the Biodiversity Institute of Ontario in Guelph, ON, Canada. The right hind leg was detached from each specimen to obtain mitochondrial DNA barcodes (658 base pairs from the 5′ end of *COI*) using standard high throughput methods (Ivanova *et al*. 2006). Analysis of the *COI* sequences produced the neighbor-joining tree in Figure 211, created in the Barcode of Life Data Systems (BOLD) using the BOLD Aligner (Amino Acid based HMM) (Ratnasingham & Herbert 2007). Information on the sequences associated with each individual specimen (including GenBank and BOLD accession numbers) can be retrieved from the BOLD website (http://www.boldsystems.org) via the publicly available dataset on Nearctic *Calliphora* (Calliphoridae) (dx.doi.org/10.5883/DS-CALLINEA), which is part of the ongoing BNNR (Blow flies of the Nearctic and Neotropical Regions) project.

Calliphora Robineau-Desvoidy

Calliphora Robineau-Desvoidy, 1830: 433. Type-species: *Musca vomitoria* Linnaeus, 1758: 595, by original designation.

Steringomyia Pokorny, 1889: 568. Type-species: *Steringomyia stylifera* Pokorny, 1889: 569, by original designation and monotypy.

Abonesia Villeneuve, 1927: 357. Type-species: *Musca genarum* Zetterstedt, 1838: 658, by original designation and monotypy.

Acrophaga Brauer & Bergenstamm, 1891: 367 [67]. Type-species: *Acrophaga stelviana* Brauer & Bergenstamm, 1891: 367 [67], by designation of Brauer (1893: 500 [54]).

Acronesia Hall, 1948: 272. Type-species: *Steringomyia aldrichia* Shannon, 1923: 112, by original designation.

Eucalliphora Townsend, 1908: 118. Type-species: *Calliphora latifrons* Hough, 1899: 286, by original designation.

Aldrichiella Rohdendorf, 1931: 177. Type-species: *Calliphora grahami* Aldrich, 1930: 1, by original designation and monotypy. Junior homonym of *Aldrichiella* Vaughan, 1903 and *Aldrichiella* Hendel, 1911.

Stobbeola Enderlein, 1933: 126. Type-species: *Stobbeola norwegica* Enderlein, 1933: 126, by original designation and monotypy (= *Acrophaga stelviana* Brauer & Bergenstamm, 1891).

Aldrichina Townsend, 1934: 111, replacement name for *Aldrichiella* Rohdendorf, 1931. Type-species: *Calliphora grahami* Aldrich, 1930: 1.

Diagnosis. The genus *Calliphora* belongs to the subfamily Calliphorinae. Adults in this subfamily share the following diagnostic synapomorphies: outer posthumeral seta outside (laterad to) a line passing parallel to a median line through the presutural seta; lower half of anterior part of anepimeron usually with numerous setae; coxopleural streak absent; underside of costa bare beyond junction with vein R_1; lower calypter setose dorsally; ST8 of ovipositor with bifid or bilobed apex (Rognes 1991). In North America, three other genera belong to the subfamily Calliphorinae: *Bellardia* Robineau-Desvoidy, 1863 [represented by *Bellardia vulgaris* (Robineau-Desvoidy, 1830) and *B. bayeri* (Jacentkovský, 1937)]; *Cyanus* Hall, 1948 [a monotypic genus represented by *Cyanus elongata* (Hough, 1898)]; and *Cynomya* Robineau-Desvoidy, 1830 [represented by *Cynomya cadaverina* Robineau-Desvoidy, 1830 and *Cyn. mortuorum* (Linnaeus, 1761)] (Whitworth 2006).

In North America, species of *Calliphora* are separable from other species of Calliphorinae by the following combination of character states: first flagellomere more than twice as long as pedicel vs. at most twice as long as pedicel in *Bellardia*; presutural intra-alar seta present (except in *Calliphora grahami*) vs. absent in *Cynomya cadaverina* and *Cyn. mortuorum*; abdomen no longer than thorax and basicosta dark (except orange in *C. vicina*) vs. abdomen longer than thorax and basicosta orange in *Cyanus elongata* (Whitworth 2006). The genus includes some of the largest blow flies in North America, which are a common sight around carrion and are often the first to arrive at a fresh animal kill.

Taxonomy. Shewell (1987) revived *Acronesia* and *Acrophaga*, which had already been sunk into synonymy with *Calliphora* by Zumpt (1956). Rognes (1991) synonymized the genera *Steringomyia*, *Acronesia* and *Acrophaga* with the genus *Calliphora* and we agree with his conclusion based on the structure of the male and female terminalia.

Key to adults of *Calliphora* in the Nearctic Region

The present key separates adults of all 13 species of *Calliphora* known from North America and represents a revision of the key of Whitworth (2006). For separating members of the genus *Calliphora* from other North American genera of Calliphoridae, see Whitworth (2006).

Specimens in good condition, with all important characters intact, can usually be identified with external morphology alone. However, in specimens in poor condition and especially in females of *C. livida*, *C. alaskensis*, *C. aldrichia*, *C. loewi*, *C. montana* and *C. terraenovae*, the terminalia should be examined.

1 Upper and lower calypters wholly white (Fig. 5); basal three humeral setae arranged in almost a right-angled triangle (Fig. 8). Male: frons broad, usually 0.15–0.20 of head width at narrowest; terminalia as in Figures 162–163 and 166–167. Female: terminalia as in Figures 201 and 208; primarily northern Canada and Alaska or high elevations above 3,000 m further south . 2

\- Upper and lower calypters with a dark brown disc, margin often white (Figs 6–7); basal three humeral setae arranged in a gently curved (Fig. 9) or strongly curved line (in *C. alaskensis*, *C. latifrons*, *C. aldrichia* and *C. montana* only) (Figs 10–12). Male: frons narrow, usually 0.03–0.13 of head width at narrowest [except in *C. latifrons* where frons width averages 0.24 (0.22–0.26/12) of head width at narrowest, in *C. coloradensis* where it averages 0.14 (0.12–0.16/11), and in *C. grahami* where it averages 0.15 (0.14–0.16/5)]; usually not restricted to northern areas in Canada or Alaska or high-elevation areas over 3,000 m in the continental United States 3

2 Arista with short setae above and very short setae below (Fig. 13); parafacial of dark chestnut or black ground color; broad undusted stripe between presutural acrostichals usually extending past transverse suture; T3 with long median marginal setae, usually more than half the length of those on T4. Male: frons 0.17 (0.16–0.20/6) of head width at narrowest; postabdomen not swollen, normal in appearance; lobes of ST5 small, not expanded laterally (Fig. 157); epandrium normal, not longer than surstylus and cercus; terminalia as in Figures 162–163, 172–174 and 186–188. Female: frons 0.32 (0.31–0.35/8) of head width at narrowest; T4 with rather sparse and mostly decumbent setae; T5 shorter than T4, with weak and inconspicuous marginal setae with a short posterior incision; terminalia as in Figure 201. Found only in the far north of Canada and Alaska . . ***C. genarum***

\- Arista with long setae above and below (Fig. 14); parafacial orange in ground color on lower half or more; undusted stripe faint, usually narrower and stopping at the transverse suture; T3 with shorter median marginal setae, always less than half the length of those on T4. Male: frons 0.15 (0.15–0.17/10) of head width at narrowest; lobes of ST5 large and strongly expanded laterally (Fig. 159); postabdomen large and swollen; epandrium longer than length of surstylus and cercus (Figs 15, 166); rest of terminalia as in Figures 166–167, 178–179 and 192–194. Female: frons 0.40 (0.38–0.43/7) of head width at narrowest; T4 with densely set and rather erect setae; T5 about as long as T4, strongly convex in lateral view, with numerous closely-set and very strong marginal setae forming a conspicuous comb (Fig. 23), and with a conspicuous posterior mid-dorsal incision reaching almost halfway to anterior edge (Fig. 24); terminalia as in Figure 203. Found primarily in mountains of the northwestern United States and Canada . . . . ***C. stelviana***

3 Basicosta yellow to orange (Fig. 18), but if darker, then never all black; genal dilation with reddish ground color on anterior half or more; anterior thoracic spiracle orange (Fig. 6). Male: frons 0.08 (0.07–0.12/9) of head width at narrowest, about half the width of the parafacial at level of lunule; terminalia as in Figures 168–169, 180–182 and 195–197. Female: frons 0.35 (0.33–0.38/14) of head width at narrowest; terminalia as in Figure 204. Widespread in North America . . . . ***C. vicina***

- Basicosta dark brown or black (Fig. 17); genal dilation usually brown or black (Fig. 7); anterior spiracle usually brown or black (except orange in *C. grahami* and *C. latifrons*) (Fig. 7) 4

4 Facial ridge with a row of stout supravibrissal setae, ascending from the vibrissa to a point almost halfway to antennal base (Figs 30–32); a second set of strong divergent ocellar setae present, about 2/3 the length of the anterior ocellars and surrounded by only a few sparse setae (Figs 31–32); anterior thoracic spiracle with mostly orange setae; a small third postsutural intra-alar seta anterior to the first strong postsutural intra-alar on one or both sides sometimes present. Male: frons broad, 0.24 (0.22–0.26/12) of head width at narrowest, almost two times the width of parafacial at lunule (Fig. 30); terminalia as in Figures 64–65. Female: frons 0.37 (0.36–0.39/8) of head width at narrowest (Fig. 32); terminalia as in Figures 128–129. Primarily a western North American species, occurring from Canada in the north to Mexico in the south, occasionally reaching the east coast . . . . ***C. latifrons***

- Facial ridge usually with a row of more slender supravibrissal setae (Figs 33–35); second set of ocellar setae usually weak (Fig. 35), if stronger (females of some species), then surrounded by dense fine setae; anterior spiracle usually with all dark brown setae (except *C. grahami*) 5

5 Presutural intra-alar seta absent (Fig. 17); anterior thoracic spiracle with orange setae (as in Fig. 6); abdomen with microtomentum forming a distinctly tessellated pattern; male frons broad, 0.15 (0.14–0.16/5) of head width at narrowest (Fig. 33). Male: external terminalia remarkably large; surstylus in the form of a strong, long and curved rod with a horn-shaped base (Fig. 66). Female: frons 0.36 (0.34–0.39/8) of head width at narrowest (Fig. 35); terminalia as in Figures 66–67. Western North America, from Alaska to California . . . . ***C. grahami***

- Presutural intra-alar seta present (Fig. 18); anterior thoracic spiracle dark, with brown to black setae (Fig. 7); abdomen with microtomentum not forming as distinct a tessellated pattern as above. Male: frons usually narrower, 0.04–0.14 of head width at narrowest; male external terminalia much smaller; surstylus not as above. Female: frons width variable 6

6 Three postsutural intra-alar setae. Note: the anteriormost seta may occasionally be hard to see because it is tiny or it may be broken off (see Fig. 16) 7

- Two postsutural intra-alar setae (Figs 17–18) 8

7 Anterior 1/2 to 2/3 of genal dilation reddish (Fig. 38). Male: frons broad, 0.14 (0.12–0.16/11) of head width at narrowest, fronto-orbitals widely separated by frontal vitta (Fig. 36); surstylus, in lateral view, parallel-sided, tapering to a blunt tip (Fig. 68). Female ovipositor: T6 with a translucent cuticular area dividing the tergite into two sclerotized halves fused at the anterior end, with a large circular area of translucent cuticle dividing the rest of the sclerite (Fig. 132). Primarily western, from Ontario to Washington State and south into Mexico; occasionally found farther east . . . . ***C. coloradensis***

- Genal dilation, when fully colored, entirely black (Fig. 41). Male: frons much narrower, 0.06 (0.05–0.07/7) of head width at narrowest, frontal vitta nearly obliterated midway, fronto-orbitals almost touching (Fig. 39); surstylus, in lateral view, gently S-curved, ending in a posterior-directed, pointed tip (Fig. 70). Female ovipositor: T6 complete in most specimens examined (Fig. 134); in some specimens there is a small oval translucent area in the middle of T6 (Fig. 136). Widespread in Canada and the lower United States . . . . ***C. livida***

8 Postgena, lower posterior corner of genal dilation and back of head with long, yellow-orange setae, sometimes extending forward along edge of the lower genal dilation (Fig. 7); genal groove reddish or orange (Fig. 7). Male: frons 0.04 (0.04–0.05/10) of head width at narrowest; terminalia as in Figures 170–171, 183–185 and 198–200. Female: frons 0.34 (0.31–0.35/10) of head width at narrowest; terminalia as in Figure 205. Widespread in North America . . . . ***C. vomitoria***

- Postgena and genal dilation with mostly dark or black setae (Figs 47, 50), sometimes back of head and rear edge of postgena with yellow setae; genal groove usually black or dark brown (except in *C. terraenovae*) 9

9 Bend of M usually much closer to wing margin than to crossvein dm-cu (Figs 19–20). Male: surstylus curved anteriorly or straight (Figs 72, 74). Female: sclerites of ovipositor distinctive, as in Figures 137–140 and 202 10

- Bend of M closer to dm-cu (Fig. 21) or about equidistant from wing margin and crossvein dm-cu (Fig. 22) (can vary from slightly closer to margin to slightly closer to crossvein). Male: surstylus curved posteriorly (Figs 76, 78). Female: sclerites of ovipositor distinctive, as in Figures 141–144 12

10 Genal groove and lower parafacial usually reddish or orange (Fig. 44); anterior 1/3–2/3 of gena usually reddish when viewed from above (Fig. 44) (not always obvious). Male: surstylus, in lateral view, with distal end gently curved anteriorly; in posterior view tip of surstylus directed medially (Figs 72–73). Female: ovipositor: T6 broad and complete (Fig. 137). Western, from Alaska through Canada to the southwestern United States; at higher elevations in southern part of range . . . . ***C. terraenovae***

- Genal groove and lower parafacial usually reddish (Fig. 47) (except rarely reddish in *C. loewi* and *C. alaskensis*; if so, anterior portion of genal dilation darker); genal dilation dark brown to black. Male: surstylus straight (Fig. 164) or sinuous (S-shaped) (Fig. 74). Female: ovipositor: rear margin of T6 with a deep vertical incision extending anteriorly over half the length of the sclerite (Figs 139, 202) 11

11 Male: in posterior view, surstylus and cercus long and straight (Fig. 165); in lateral view, surstylus and cercus slightly curved anteriorly (Fig. 164). Female: T5 tent-like in lateral view (Fig. 25) with posterior incision at 1/3–1/2 of length (Fig. 28); ovipositor: T6 long, with narrow, inverted V-shaped translucent cuticle (Fig. 202). From Alaska to the northern continental United States . . . . ***C. loewi***

- Male: cercus pear-shaped when viewed posteriorly (Fig. 75); surstylus, in lateral view, S-shaped with a blunt tip directed anteriorly (Fig. 74). Female: T5 with a slight indentation only (Fig. 27), not tent-like in profile; ovipositor: T6 short with a wide, inverted U-shaped translucent cuticle in middle (Fig. 139). From Alaska to California, usually at higher elevations, with isolated populations at high elevations in the eastern United States . . . . ***C. alaskensis***

12 Male: frons broad, 0.11 (0.10–0.13/16) of head width at narrowest (Fig. 48); sternites: ST2 short and wide, more than twice as wide as long (Figs 60–61); ST4 wide, about twice as wide as long; ST5 with large lobes; cercus short, distance between tip of cercus and tip of surstylus about twice the same distance in *C. montana* (Fig. 77). Female: posterior half of T5 incised (Fig.

28); ovipositor: T6 with a distinct mid-dorsal area of translucent cuticle in posterior 2/3 (Fig. 141). A rare species, known only from the northwestern United States and British Columbia, Canada . . . . ***C. aldrichia***

- Male: frons narrow, 0.07 (0.06–0.10/15) of head width at narrowest (Figs 51–52); sternites: ST2 quadrate (Figs 62–63); ST4 about 1.5x as wide as long; ST5 with normal-sized lobes; cercus longer, reaching closer to the tip of the surstylus, distance between tip of cercus and tip of surstylus about half the same distance in *C. aldrichia* (Fig. 79). Female: T5 without an incision (Fig. 29); ovipositor: T6 complete, without weak areas (Fig. 143). Widespread throughout Alaska and Canada, occasionally at higher elevations (3,000 m or more) in the northern continental United States . . . . ***C. montana***

Species redescriptions

1. *Calliphora alaskensis* (Shannon, 1923)

(Figs 10, 20, 27, 45–47, 59, 74–75, 95–97, 119–121, 139–140, 150, 211)

Steringomyia alaskensis Shannon, 1923: 108 (in key), 112. Holotype male, examined (USNM, Cat. No. 26164). Type locality: Seward, Alaska, USA. (Note: the holotype is in good condition; the abdomen is detached and mounted on a point under the specimen, the terminalia are drawn into view.). Other references: Shannon (1926: 134).
Acronesia alaskensis: Hall (1948: 275, 1965: 928); Sailer & Lienk (1951: 209).
Calliphora alaskensis: Poole (1996: 77); Whitworth (2006: 700).

Diagnosis. This species groups with three other species (*C. aldrichia*, *C. loewi* and *C. montana*) with a dark genal dilation, parafacial and frons. Males have distinctive pear-shaped cerci when viewed posteriorly (Fig. 75). Females lack an incision in T5 (Fig. 27), similarly to *C. montana*. Females of these two species can be distinguished by the condition of T6 in the ovipositor: in *C. alaskensis* T6 is divided (Fig. 139), in *C. montana* it is complete (Fig. 143).
Redescription. Male: frons wide, 0.06 (0.05–0.07/16) of head width at narrowest (Fig. 45); abdomen: ST3 and ST4 trapezoid-shaped (Fig. 59); ST5 large, with projecting lobes (Fig. 59); cercus pear-shaped when viewed posteriorly (Fig. 75); surstylus, in lateral view, sinusoid, with blunt tip directed anteriorly (Fig. 74); epiphallus short (Fig. 95); ventral plate small and narrowed dorsally; pregonite with wide base and characteristic, very short apical process (Fig. 120). **Female:** frons 0.33 (0.31–0.35/913) of head width at narrowest (Fig. 46); T5 with a slight indentation only (Fig. 27), not tent-like in profile; T6 short with a wide, inverted U-shaped translucent cuticle in middle (Fig. 139); T7 completely divided into 2 sclerotized halves by an unsclerotized membrane; ST6 of characteristic shape: with a long, broad stalk proximally and a broad semi-circle distally; ST7 short, broad and ending distally with a distinct horseshoe-shaped and small median process (Fig. 140).

Type material examined. HOLOTYPE ♂, labeled: "Sterinogomyia/ alaskensis/ Shannon"; Seward Alsk [Alaska]/ "VII 26 '21"; "JM Aldrich/ coll [collection]"; "Type No./ 26164/ U.S.N.M. [red label]" [the specimen is in good condition; the abdomen is detached and mounted on a point under the specimen] (USNM).

Additional material examined. Canada. **AB** *38 ♂ [terminalia exposed], *48 ♀ [T6 exposed], Spray Lake Rd., 51°05′06″N 115°24′03″W, 11.viii.2012, 5034 ft, bait trap, T.L. Whitworth (TW); *2 ♀ [ovipositors dissected], 4 ♀, near Crow's Nest, 49°32′25″N 114°18′30″W, 5.viii.2014, 4149 ft, bait trap, T.L. Whitworth (TW). **BC** 1 ♀, Lemon Creek, 117°16′N 40°30′W, [no date], J.H. Shepard (LACM); 2 ♀, Robson, 26.ix.1961, H.R. Foxlee (UBCZ); 4 ♀, Vancouver, 1.ix.2002, bait trap, A. Stjernberg (UBCZ); 1 ♀, same data except 6.ix.2002; 1 ♀, same data except 10.ix.2002; 1 ♀, same data except 13.ix.2002; 6 ♀, same data except 16.ix.2002; 4 ♀, same data except 18.ix.2002; *1 ♂, Mt. Thornhill, near Terrace, 8.viii.1960, B. Heming (CNC); 1 ♂, 32 mi SW Terrace, 11.vi.1960, R. Pilfrey; *1 ♂, Terrace, 3 mi S Lakelse Rd, 19.viii.1960, C.H. Mann (CNC); *1 ♂, Kitsequecla River, 76 mi E Terrace, 675 ft, 16.vii.1960, C.H. Mann (CNC); 1 ♀, mi 45, Haines Hwy, 25.vii.1963, G.C. & D.M. Wood [dissected by G.E. Shewell]. **NS** *1 ♀, Cape Breton Highlands NP, Mack Fire Tower, 15.vii.1983, D.M. Wood (CNC). **QC** 1 ♂, Cap Bon Ami, 17.vii.1968, D.M. Wood (CNC); *1 ♂, La Verendrye, mi 61 Rte 58, Prov. Pk, 21.viii.1965, D.M. Wood (CNC). USA. **AK** 1 ♀, Ketchikan, 1954, in light fixture, F. Baker (WSUP); 1 ♀, same data except 5.ix.1955; 1 ♂, Thane, 15.vii.1958, [collector name illegible] (WSUP); 1 ♀, Seward, 9.viii.1951, W.J. Brown (CNC); *1 ♀, Glacier Hwy, mi 12, 2.ix.1962, D.C. Schmiege (CNC); *1 ♀, Fairbanks, 15.viii.2008, bait trap, T.L. Whitworth (TW). **CO** 1 ♂, Gunnison Co., Lake Irwin, 15.viii.1974, R. Lincoln, R. Moldenke (CAS); 1 ♀, San Juan Co., Site 3, 2–31.viii.2002, M. Allaire (TW); 1 ♀, same data except 17.vi.–26.vii.2002 (TW); 2 ♂, 1 ♀, Doolittle Ranch, 9800 ft, Mt. Evans, 23.vii.–5.viii.1961, W.R.M. Mason [1 ♂ dissected by G.E. Shewell] (CNC). **ME** *1 ♀, Mt. Katahdin, South Basin, 3000 ft, 20.vii.1959, H.C. Huckett (CNC). **NC** *1 ♂, Mt. Mitchell, 6800 ft, 12.viii.1957, J.G. Chillcott (CNC). **OR** *1 ♂, Union Co., Jordon Ck, 28 mi SSW La Grande, 19–22.vi.1977, 4840 ft, Malaise trap baited with CO_2, [no collector listed] (TW); 1 ♂, same data except 31.vii.–viii.1977; 1 ♀, same data except 21–23.viii.1977; *1 ♀, same data except 17–23.viii.1975; 1 ♀, same data except 7–9.vii.1977; *1 ♂, Union Co., Whiskey Ck, 23 mi SSW La Grande, 7–9.vii.1977, Malaise trap baited with CO_2, [no collector listed] (WSUP). **UT** 1 ♀, Rich Co., 2.ix.1976, Spruce Fir Project, D.M. Bowers (TW).

Remarks. This species is scarce in museum collections and has a limited distribution, but it can be locally common. It was attracted to carrion (spoiled chicken) bait in significant numbers near Vancouver, BC, and also in several locations in southwestern Alberta at around 1,500 m and in the peaks of north central Colorado at around 3,000 m. Surprisingly, in the Colorado collecting trip (see "Material and methods"), it was less common around high alpine peaks over 3,300 m.

Distribution. Canada: AB, BC, NB, NL, NS, QC, SK. USA: AK, CA, CO, ME, NC, NY, OR, TN, UT, WA.

2. *Calliphora aldrichia* (Shannon, 1923)

(Figs 1–2, 11, 21, 28, 48–50, 60–61, 76–77, 98–100, 122–124, 141–142, 151, 211)

Steringomyia aldrichia Shannon, 1923: 108 (in key); 112. Holotype male, examined (USNM, Cat. No. 26163) (Figs 1–2). Type locality: Tennessee Pass, Colorado, USA. (The male paratype from Seward, Alaska is a misidentification = *C. montana*.)

Steringomyia aldrichi: Shannon (1926: 134). Incorrect subsequent spelling of *aldrichia*.

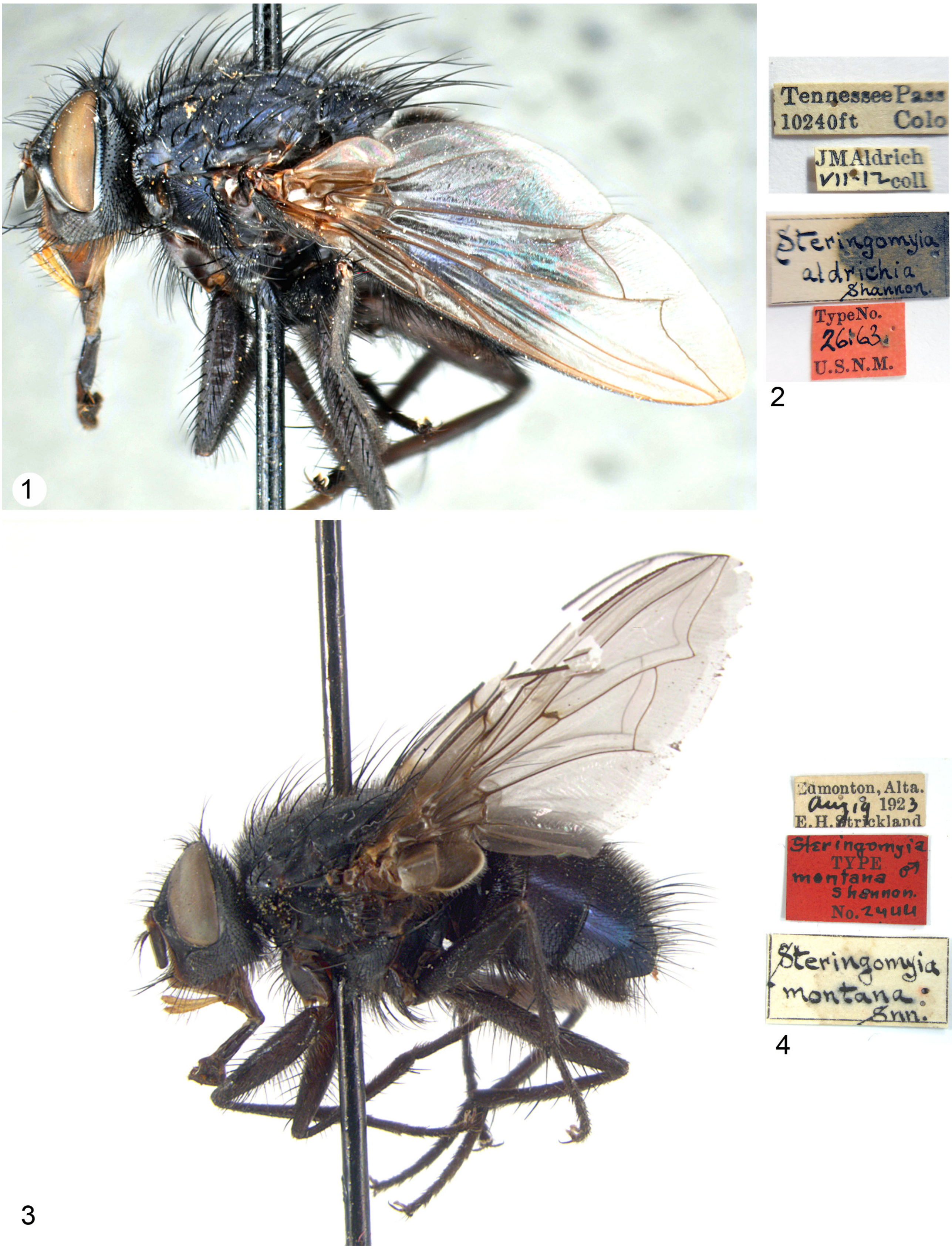
Acronesia aldrichia: Hall (1948: 277, 1965: 928; records from Alaska and Quebec are misidentifications = *C. montana*); Sailer & Lienk (1951: 209; records from Seward, Naknek Lake, Alaska and Quebec are misidentifications = *C. montana*); James (1953: 144; male record from Cameron Pass, Colorado); James (1953: 145; records of males and females from Savonoski, Naknek Lake, Alaska are misidentifications = *C. montana*); Gill (1955: 651; records from Galena, Alaska are misidentifications = *C. montana*); Peris & Gonzáles-Mora (1989: 174, figs 10a and 10b; records from Savonoski, Alaska are misidentifications = *C. montana*); De Jong (1994: 382); De Jong & Chadwick (1997: 47).

Calliphora aldrichia: Poole (1996: 77); Whitworth (2006: 700) (records from Alaska are misidentifications = *C. montana*).

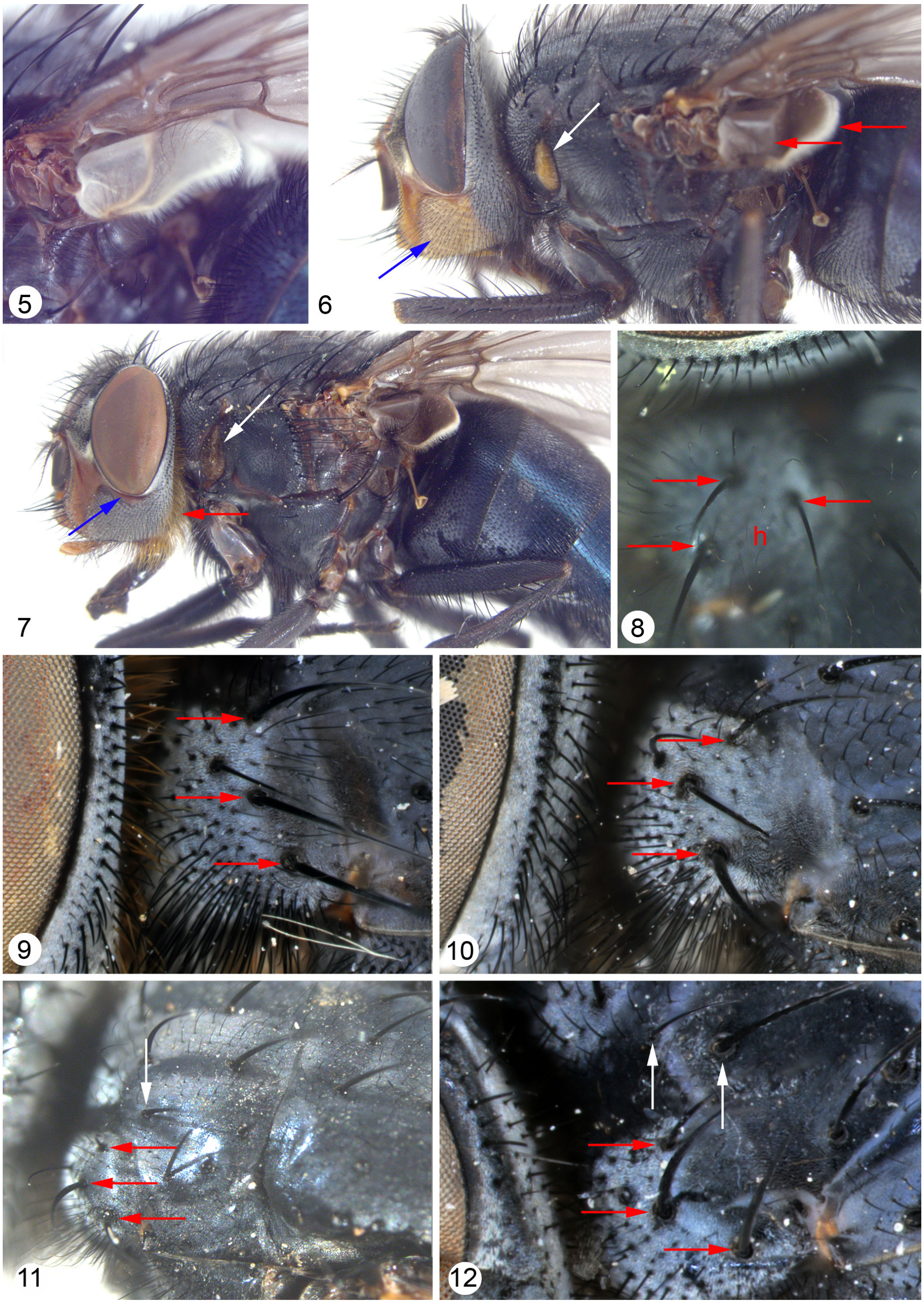
Diagnosis. Males of *C. aldrichia* and *C. montana* are very similar; in *C. aldrichia* ST2 is over twice as wide as long and ST4 is about twice as long as wide (Figs 60–61), while in *C. montana* ST2 is almost a perfect square and ST4 is less than 1.5x as long as wide (Figs 62–63). The male frons of *C. aldrichia* is typically much wider [0.11 (0.10–0.13)/16] than in *C. montana* [0.08 (0.06–0.10/15)]. In *C. aldrichia*, the male cercus is much shorter than the surstylus (Fig. 77) when viewed posteriorly, while in *C. montana* the male cercus is about twice as long, almost as long as the surstylus (Fig. 79). Females can be distinguished by the presence (in *C. aldrichia*) or absence (in *C. montana*) of an incision on the posterior margin of T5 (Figs 28 and 29, respectively). T6 of the ovipositor is divided by a mid-dorsal area of transparent cuticle in *C. aldrichia* (Fig. 141), while in *C. montana* it is complete (Fig. 143).

Redescription. Usually one pair of inner posthumeral setae (Fig. 11); bend in M usually closer to dm-cu crossvein than to wing margin (Fig. 21). **Male:** frons broad, 0.11 (0.10–0.13/16) of head width at narrowest (Fig. 48); ST2 shorter than wide (Figs 60–61); ST4 wide, trapezoid-like, with a slightly curved apical edge; ST5 with large lobes; cercus short, distance between tip and tip of surstylus about twice the same distance in *C. montana* (Fig. 77). **Female:** frons 0.37 (0.35– 0.38/10) of head width at narrowest (Fig. 49); T5 incised (Fig. 28); T6 with a distinct mid-dorsal area of translucent cuticle on posterior 2/3 (Fig. 141); ST6 long and narrowed apically with stout, long setae at apex (Fig. 142); ST7 long and strongly narrowed apically into a characteristic long neck, ending with a small rounded head with stout setae.

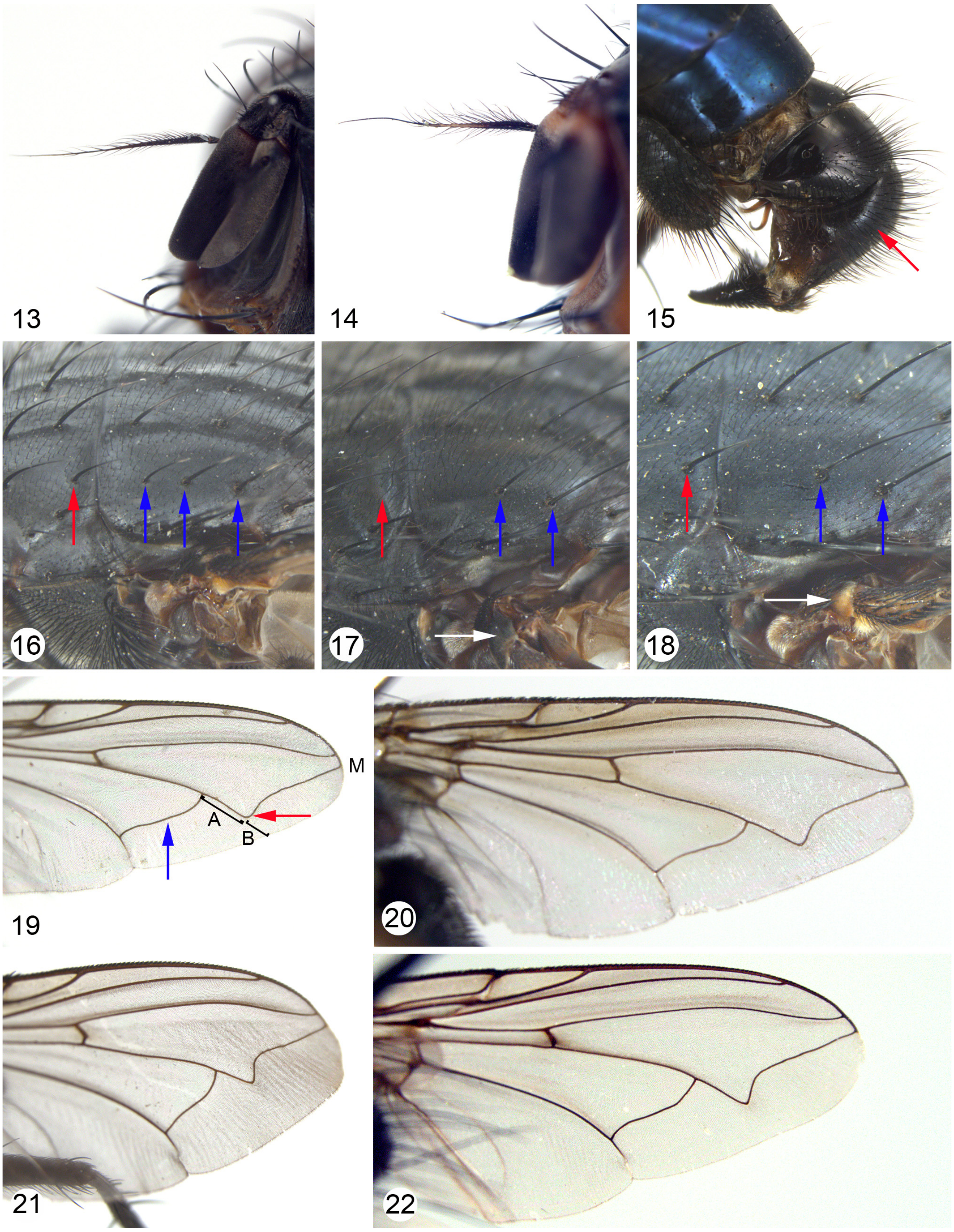
Type material examined. HOLOTYPE ♂, labeled: "Tennessee Pass/ 10240 ft [feet] Colo [Colorado]"; "JM Aldrich/ VII. 12 coll [year not given, a female collected in the same area was labeled 1917]"; "Steringomyia/ aldrichia/ Shannon. [handwritten by R.C. Shannon]"; "Type No./ 26163/ U.S.N.M [red label]" [terminalia in vial on pin had been previously dissected and were examined] (USNM) (Figs 1–2). PARATYPES (all USNM): 1 ♀ (terminalia dissected and examined), same data as holotype except 24.vii.1917-JMA, paratype number 26163 [dissected by authors, ovipositor in vial under specimen]; 1 ♂ (cerci and surstyli examined), same data as holotype except 7.vii, labeled "*Acronesia aldrichia*"; 1 ♂ (cerci and surstyli examined), same data as holotype except 10.vii [no *Acronesia* label]; 1 ♂ (cerci and surstyli examined), same data as holotype except 12.vii; 1 ♂ (abdominal sternites examined), British Columbia, Bear Lake, London Hill Mine [handwritten], 29.7.03, 7000 ft, paratype no. 26163, R.P. Currie [genitalia glued on label]. Note: the male paratype from Seward, Alaska is a misidentification, = *C. montana*. For label data of this specimen, see under *C. montana*.



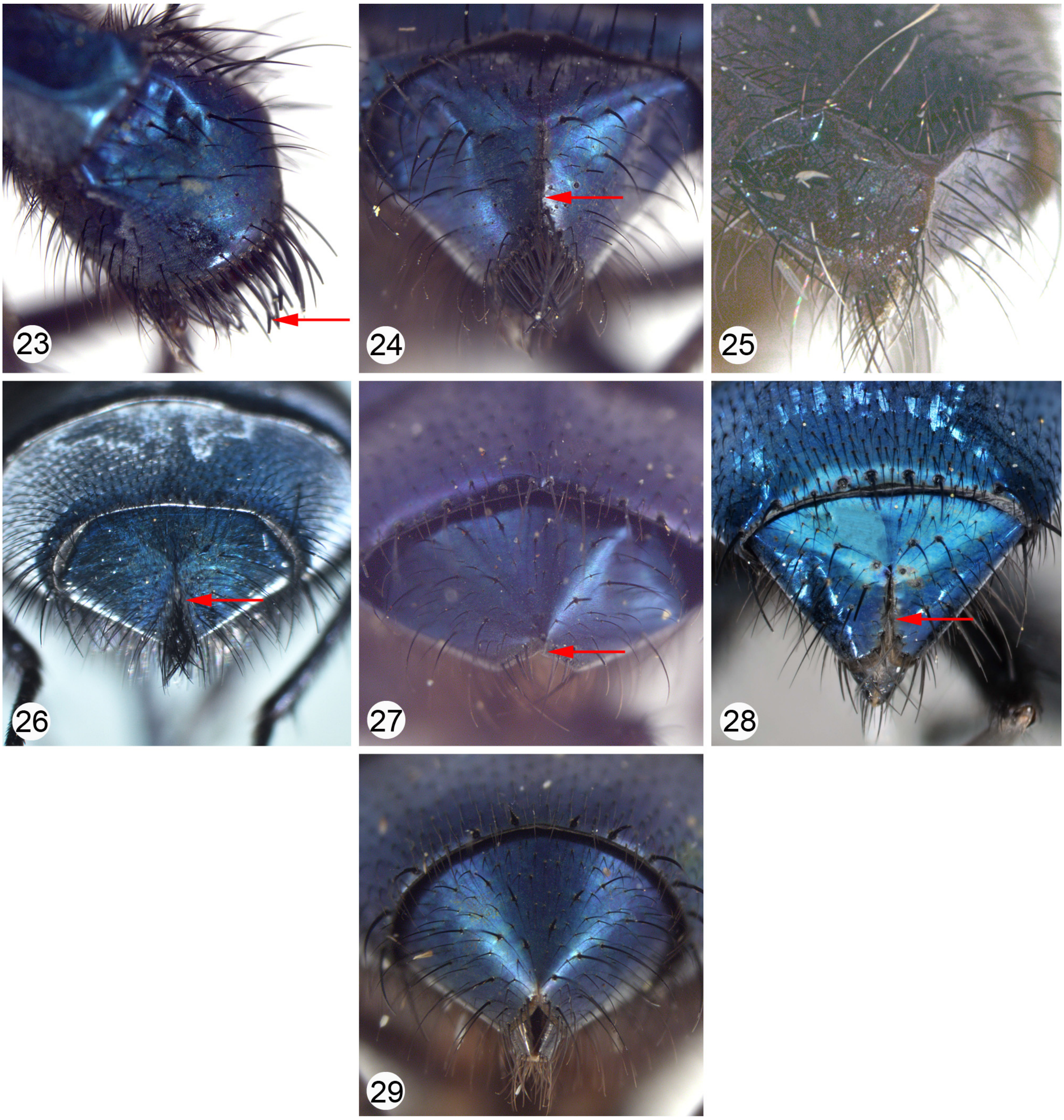
FIGURES 1–4. *Calliphora* spp., type specimens. **1–2.** *Calliphora aldrichia*, holotype male. **1.** Habitus. **2.** Labels. **3–4.** *Calliphora montana*, holotype male. **3.** Habitus. **4.** Labels.



FIGURES 5–12. *Calliphora* spp., heads, thoracic regions and calypters. **5.** *Calliphora stelviana*, male, upper and lower calypters, left lateral view. **6.** *Calliphora vicina*, male, head and thorax, left lateral view; the blue arrow points to the genal dilation; the red arrows point to the dark brown upper and lower calypters; the white arrow points to the yellow anterior spiracle. **7.** *Calliphora vomitoria*, female, head and thorax, left lateral view; the blue arrow points to the orange genal groove; the red arrow points to the yellow setae on the postgena and lower genal dilation; the white arrow point to the dark brown anterior spiracle. **8.** *Calliphora stelviana*, female, humeral callus, dorsal view; the red arrows point to the three basal humeral setae arranged in almost a right-angled triangle. **9.** *Calliphora vomitoria*, female, pronotum, dorsal view; the red arrows point to the three basal humeral setae arranged in a gently curved line. **10.** *Calliphora alaskensis*, male, pronotum, dorsal view; the red arrows point to the three basal humeral setae arranged in a strongly curved line. **11.** *Calliphora aldrichia*, male, pronotum, dorsal view; the red arrows point to the three basal humeral setae arranged in a strongly curved line; the white arrow points to the single inner posthumeral seta. **12.** *Calliphora montana*, male, pronotum, dorsal view; the red arrows point to the three basal humeral setae arranged in a strongly curved line; the white arrows point to the two inner posthumeral setae. Abbreviations: h = humeral callus.



FIGURES 13–22. Antennae, male terminalia, thoracic regions and wings. **13–14.** Arista, left lateral view. **13.** *Calliphora genarum*, female; showing short setae above and very short setae below. **14.** *Calliphora stelviana*, female; showing long setae above and below. **15.** *Calliphora stelviana*, male terminalia, left lateral view; the red arrow points to the long epandrium. **16–18.** Thorax, dorsolateral view. **16.** *Calliphora coloradensis*, female; the blue arrows point to the three postsutural intra-alar setae; the red arrow points to the presutural intra-alar seta. **17.** *Calliphora grahami*, male; the blue arrows point to the two postsutural setae; the red arrow highlights the absence of a presutural intra-alar seta; the white arrow points to the black basicosta. **18.** *Calliphora vicina*, female; the blue arrows point to the two postsutural setae; the red arrow points to the presutural intra-alar seta; the white arrow points to the yellow basicosta. **19–22.** Wing venation. **19.** *Calliphora loewi*, male; showing bend of M closer to wing margin; the blue arrow points to the dm-cu crossvein; the red arrow points to the bend of M. A = distance between bend of M and dm-cu crossvein; B = distance between bend of M and wing margin. **20.** *Calliphora alaskensis*, male; same as in Fig. 19. **21.** *Calliphora aldrichia*, female; showing bend of M close to dm-cu crossvein. **22.** *Calliphora montana*, male; showing bend of M midway between wing margin and dm-cu crossvein. Abbrevations: M = media.



FIGURES 23–29. *Calliphora* spp., females, fifth abdominal tergites. **23–24.** *Calliphora stelviana*. **23.** Left lateral view, showing strong marginal setae (red arrow). **24.** Posterior view, showing incision (red arrow). **25–26.** *Calliphora loewi*. **25.** Posterolateral view, showing tent-like appearance. **26.** Posterior view; red arrow points to incision. **27.** *Calliphora alaskensis*, posterior view; T5 with slight indentation; red arrow. **28.** *Calliphora aldrichia*, posterior view, showing incision (red arrow). **29.** *Calliphora montana*, posterior view, showing no incision.

Additional material examined. Canada. **BC** 1 ♂, Apex Mt., summit, Keremeos, 3.viii.1987, S.G. Cannings (TW); *1 ♂, same data except 6500 ft, Penticton, 26.vii.1967, J.R. Vockeroth (CNC); *1 ♂, Eureka Mt., 6000 ft, Monashee, 22.vii.1955, G.P. Holland (CNC); *1 ♂, Jesmond, 11.ix.1938, J.K. Jacob (WSUP). USA. **CA** *1 ♂, Mono Co., Twin Lakes, SW Mammoth Lakes, 2620 m, 21.vii.1966, P.H. Arnaud, Jr. (CAS); *1 ♂, Yuba Pass, Sierra Co., 9.vii.1968, R.L. Brumley (TW); *1 ♂, Inyo Co., Mosquito Flat, E side Mono Pass, 10000 ft, 17.vii.1966, P.A. Arnaud, Jr. (USNM). **CO** *1 ♂, Tennessee Pass, 10240 ft, 17.vii.1930, J.M. Aldrich (CNC); *1 ♀, same data except 16.vii.1930 (CNC); *1 ♂, 12 ♀, same data except 39°21′80″N 106°21′80″W, 10443 ft, bait trap-fish, 16.viii.2015, T.L. Whitworth (TW); *1 ♂, Mt. Evans, 11300 ft, 10.viii.1961, C.H. Mann (CNC); *2 ♂, same data except marshy clearing, J.G. Chillcott; *1 ♀, same data except Doolittle Ranch, 9800 ft, 14.viii.1961, W.R.M. Mason; *1 ♀, San Juan NF, CR 648 off Hwy 160, 37°26.45′N 106°53.3′W, 7820 ft, 31.viii.2014, J.E. O'Hara (CNC); *1 ♂, Jackson Co., Cameron Pass, 11.viii.1955, M.T. James (WSUP); *1 ♂, Rio Grande Co., 11000 ft, Beaver Creek, Malaise trap, 23.vi.1972, W.W. Wirth (USNM); 3 ♀, Hwy 24, mi 174, 39°96′45″N 106°18′58″W, 10105 ft, bait trap-fish, 16.viii.2015, T.L. Whitworth (TW); 5 ♀, Hwy 91, mi 7, 39°20′20″N 106°13′25″W, 10315 ft, bait trap-fish, 16.viii.2015, T.L. Whitworth (TW); 1 ♀, Hwy 91, mi 20, 39°28′38″N 106°07′87″W, 10015 ft, bait trap-fish, 16.viii.2015, T.L. Whitworth (TW); *3 ♂, 3 ♀, Clinton Reservoir, 39°24′94″N 106°10′29″W, 11212 ft, bait trap-fish, 16.viii.2015, T.L. Whitworth (TW). **WA** (all USNM) *1 ♂, Mt. Rainier, Berkeley Park, 23.viii.1934, A.L. Melander; *1 ♂, same data except Burroughs Mt., 21.viii.1934; *1 ♂, same data except White River, *Heracleum*, 19.vii.1924. **WY** (all USNM) *1 ♂, Yellowstone NP, 28.viii.1924, R. Spoler; *1 ♂, same data except Old Faithful, 12.viii.1927, J.M. Aldrich; *1 ♂, Dunraven Pass, 26.vii.1956, A.L. Melander.

Remarks. This very rare species is so similar to *C. montana* that it has been questioned whether it was a separate species (Whitworth 2006). We searched numerous North American museums (see list in "Material and methods") for both these species and found very few specimens. Prior to this project, we had never collected either of these species in the field. Initially, we were only able to locate 20 male (5 from the type series) and 4 female specimens (two from the type series) of *C. aldrichia*. In a week-long trip to the peaks of northern Colorado in August 2015, TW collected numerous blow flies in the Tennessee Pass area, which is the type locality of *C. aldrichia*. All were caught in carrion-baited traps in the area of the Pass and in nearby mountainous areas. *Calliphora aldrichia* proved to be very rare there compared to most other species of *Calliphora*, but 3 males and 25 females were caught. The few females we examined prior to this field trip were not in very good condition, so these additional females allowed us to better characterize the female of this species.

Males of both *C. aldrichia* and *C. montana* can be readily separated from males of *C. alaskensis* and *C. loewi* (as well as all other Nearctic *Calliphora*) based on the unique shape of the terminalia. The surstyli in both species are curved posteriorly (Figs 76, 78), a character state separating them from males of *C. loewi* and *C. alaskensis*, which have straight surstyli (Fig. 164) and surstyli curved anteriorly (Fig. 74), respectively. Females of these four species can be difficult to separate. Females of both *C. aldrichia* (Fig. 28) and *C. loewi* (Fig. 26) have a conspicuous incision on T5 reaching to about the middle of the segment, a feature that is lacking in *C. alaskensis* (Fig. 27) and *C. montana* (Fig. 29). The ovipositors of *C. aldrichia* and *C. loewi* are very similar, but the anterior end of ST6 in *C. aldrichia* (Fig. 142) is narrow and the posterior end is broad, while in *C. loewi* this condition is reversed (Fig. 202). Females of *C. alaskensis* and *C. montana* can be separated by the presence of a large oval division in the posterior half of T6 (Fig. 139) in the former and its absence in the latter, where T6 is complete (Fig. 142). In *C. alaskensis* this character can be readily seen by extending the ovipositor in freshly caught specimens.

In Whitworth (2006), *C. aldrichia* and *C. montana* were separated from *C. terraenovae*, *C. alaskensis* and *C. loewi* primarily by using two characters: the location of the bend in vein M (Fig. 21) and the number of lateral scutellar setae (Whitworth 2006, figs 43, 45). We have noted variation in these characters and have decided to evaluate their reliability. To test the character "bend in M closer to dm-cu crossvein or closer to wing margin", we measured 51 specimens of *C. aldrichia* and found that in 90% of specimens the bend was closer to the crossvein (as in Fig. 19), in 6% it was equidistant from the crossvein and wing margin and in 4% it was slightly closer to the wing margin. For *C. montana*, in 16% of the 124 specimens the bend was closer to the crossvein, in 70% it was equidistant (Fig. 22), and in 14% it was slightly closer to the wing margin. These results indicate that this character is generally reliable to separate these two groups, since we have found that *C. terraenovae*, *C. alaskensis* and *C. loewi* consistently have the bend closer or much closer to the wing margin. However, Whitworth (2006) used the character "bend in M closer to crossvein" for *C. aldrichia* and "usually equidistant or slightly closer to wing margin" for *C. montana* to separate these two species, but this character only works for about 75% of the specimens and cannot be relied upon. As for the number of lateral scutellar setae, out of 54 specimens of *C. aldrichia* examined, 68.5% were 2x2, 20.4% were 3x3, 9.2% were 2x3 or 3x2 and 1.9% were 4x4. In *C. montana*, 124 specimens were examined and 74.2% were 2x2, 16.1% were 3x3, 7.3% were 3x2 or 2x3, 1.6% were 3x4 or 4x3, and 0.8% were 4x4. Based on these results, we conclude that this character is problematic because *C. terraenovae*, *C. alaskensis* and *C. loewi* typically have 3–5 pairs of lateral scutellar setae, and that it is too variable to be used as a primary diagnostic character. However, specimens with 2x2 setae will almost certainly be either *C. aldrichia* or *C. montana.* The number of lateral scutellars was also used to separate *C. aldrichia* from *C. montana*; the former was thought to have 2–3 pairs of lateral scutellar setae, while the latter was thought to have 3–4 pairs. Based on our results, the number of lateral scutellar setae does not reliably separate these two species. Another character, cited by Shannon (1926), is the number of posthumeral setae, which he used to separate *C. aldrichia* and *C. montana*, the former possessing one seta (Fig. 11) and the latter two (Fig. 12). We examined these setae in 54 specimens of *C. aldrichia* and 86% were 1x1, 7% were 2x2 and 7% were 1x2 or 2x1; in *C. montana* 22.5% were 1x1, 63.8% were 2x2 and 13.7% were 2x1 or 2x2. Because these character states overlap in the two species, they are only useful as secondary diagnostic characters.

Distribution. *Calliphora aldrichia* is a western species known from BC in Canada and CA, CO, WA and WY in the USA. This narrower distribution range compared to that of *C. montana* can assist with species separation in difficult specimens. Both species appear to overlap only in a narrow area from British Columbia south to California. All previous records of this species from Alaska and Quebec are actually misidentifications of *C. montana* (see above). As mentioned earlier, careful examination of the male paratype of *C. aldrichia* from Seward, Alaska revealed that it actually belongs to *C. montana*. Peris & Gonzáles-Mora (1989: 174, fig. 10a) illustrated the cerci and surstyli in posterior view of what they thought was a male specimen of *C. aldrichia* from Savonoski, Alaska. This specimen is actually *C. montana* as the cerci and surstyli are nearly equal in length. Clearly, *C. montana* has a much wider distribution than *C. aldrichia* as specimens have been collected from coast to coast, but it is primarily found east of the Rocky Mountains. Whitworth (2006) was mostly correct when he concluded "*Calliphora aldrichia* is found primarily west of the Rocky Mountains, from Alaska to California and Colorado, while *C. montana* is found primarily east of the Rockies, from Northwest Territories and Alberta east to Labrador". It is of interest to note that in this study, male specimens of both species have been found to co-occur in British Columbia, even in the same locality and on the same collection date: Apex Mt., summit, Keremeos, 3.viii.1987 (see "Additional material examined" under both species). This co-occurrence highlights the importance of careful examination of specimens for accurate identification. See discussion under "Barcoding of Nearctic *Calliphora*".

3. *Calliphora coloradensis* Hough, 1899

(Figs 16, 36–38, 56, 68–69, 86–88, 110–112, 132–133, 147, 153–154, 211)

Calliphora coloradensis Hough, 1899: 286. Lectotype male, examined (FMNH) (Figs 153–154). Type locality: Colorado, USA (without further detail). Other references: Shannon (1923: 109, 1926: 135); Hall (1948: 294); James (1953: 144, 1955: 4); Hall (1965: 929); Poole (1996: 77); Whitworth (2006: 699).

Diagnosis. One of two species with three postsutural intra-alar setae, the other being *C. livida*; anterior half to two-thirds of genal dilation reddish, versus all black in *C. livida*. In teneral *C. livida* specimens the gena may resemble that of this species; consequently, other characters must be checked. Male frons broad, 0.14 (0.12–16)/11 of head width at narrowest (Fig. 36), broader than width of parafacial at level of lunule; terminalia distinctive as in Figs 68–69, frons much narrower, 0.06 (0.05–0.07/7), in *C. livida*. Female ovipositor with T6 broadly divided (Fig. 132), versus complete in *C. livida.*

Redescription. Anterior 1/2 to 2/3 of genal dilation reddish (Fig. 38). Parafacial at level of lunule wide, about equal to distance between two strongest vibrissal setae and much wider than width of first flagellomere (Fig. 37); parafacial, in lateral view, with two, fusing silvery spots (Fig. 38). **Male:** surstylus, in lateral view, with a broad base, tapering to a narrow, blunt tip (Fig. 68); pregonite broad, with a short process (Fig. 111). **Female:** frons wide, 0.39 (0.37–0.41/11) of head width at narrowest (Fig. 37); T6 with translucent cuticular area dividing tergite into two sclerotized halves, fused at anterior end with T7, with oval membranous area broader proximally and narrowly joined distally (Figs 132–133).

Type material examined. LECTOTYPE ♂, labeled: "Colo/ 1611"; "Univ.of Chicago/ G.N.Hough/ Diptera Colln."; "Lectotype/ Calliphora coloradensis Hough/ Fixation by D.G. Hall, 1948/ (labeled: T.L. Whitworth, 2016)" (FMNH) (Fig. 154). PARALECTOTYPES: 2 ♀, No. 1567, Univ. of Chicago G.N. Hough Diptera Collection (FMNH); 1 ♀, No. 1567, Collection J.M. Aldrich (USNM); 1 ♂, No. 1611, Univ. of Chicago G.N. Hough Diptera Collection (FMNH).

Additional material examined. Canada. **AB** 1 ♂, 1 ♀, Suffield, 1.viii.1949, F. Snyder (TW); 1 ♂, 1 ♀, 13 mi E Canmore, 4300 ft, 6.viii.2012, T.L. Whitworth (TW). USA. **AZ** 1 ♀, Canon, 2.i.1937, C.C. Deomier. **CA** 1 ♂, Trinity Co., Shasta-Trinity NF, Ironside Mt., summit, N Hwy 299, 40°49.9′N 123°27.1′W, 5250 ft, 31.v.2009, J.E. O'Hara (CNC). **CO** 1 ♂, 2 ♀, Tennessee Pass, 10443 ft, 16.viii.2015, bait trap, T.L. Whitworth (TW). **NM** 1 ♂, Grant Co., N Silver City, Eighty Mtn., hilltop, 7460 ft, 32°50.9′N 108°18.0′W, 26.viii.2006, J.E. O'Hara (CNC); 1 ♀, Grant Co., ca. 24 mi N Silver City, Signal Peak, 32°55.5′N 108°10.8′W, 8900 ft, hilltop, 25.v.2013, J.E. O'Hara

(CNC); 1 ♀, Torrance Co., 34°16′26″N 105°43′28″W, ca. 9 mi S Cedarvale, North Peak, hilltop, ca. 6700 ft, 12.ix.1994, J.E. O'Hara (CNC); 1 ♂, Torrance Co., 34°16.4′N 105°43.5′W, ca. 9 mi S Cedarvale, North Peak, hilltop, ca. 6700 ft, 2.viii.1999, J.E. O'Hara (CNC); *1 ♂, Grant Co., Tyrone, 15.viii.2007, 5659 ft, bait trap, T.L. Whitworth (TW). **OR** 1 ♀, Harney Co., Kiger Gorge Overlook, 9400 ft, 42°42.5′N 118°34.2′W, 8.viii.2005, G. & M. Wood (CNC); 1 ♀, Harney Co., Page Springs, 28.vii.2005, Malaise trap, T.L. Whitworth (TW). **SD** *1 m#, Badlands Nat'l Mon., Sage Ck Basin, S. Wolf (TW). **TX** 1 ♀, Kerrville, 29.iii.1959, J.F. McAlpine (CNC); 1 ♂, Uvalde, 16.xii.1933, C.C. Deomier (TW). **UT** 1 ♂, San Juan Co., 7 mi W Monticello, 13.vi.2011, 8300 ft, bait trap, T.L. Whitworth (TW); 7 ♂, 2 ♀, Grand Co., 12 mi SE Moab, 1.vi.2011, bait trap, T.L. Whitworth (TW).

Remarks. Hough (1899) indicated that the type series consisted of two males and four females from Colorado, collected by C.F. Baker, but no holotype was designated. Hall (1948) revised this species and stated: "Type, male from Colorado, in the Field Museum of Natural History", but nothing labeled "type" was found and only four specimens, one male and three females, are presently located in FMNH. We consider this statement a fixation of a lectotype (see O'Hara *&* Cerretti 2016). A single female specimen was located at USNM in the general collection and would appear to be the fourth female from the type series (Norm Woodley, pers. comm. 2016). However, the second male from the original type series has not been found at either FMNH or USNM. In order to avoid confusion for future workers, we added a lectotype label to the male specimen in FMNH. The lectotype, which is slightly undersized for the species at 8 mm long, is in good condition (Fig. 153), with a broad frons, 0.14 of head width at narrowest, and the anterior half of the genal dilation orange to reddish in color. The terminalia, which were already extended, are also typical of *C. coloradensis* as treated by previous authors (Hall 1948; Whitworth 2006).

Distribution. Canada: AB, MB, ON, SK. Mexico: Durango, Morelos; near Tehuacan in the State of Puebla. USA: AZ, CA, CO, KS, NM, NV, OK, OR, SD, TX, UT, WA, WY. Hall (1948) listed this species from AK but we suspect this is an error.

This species was found in most western museums in small numbers. It is usually rarely collected but is widespread throughout the western United States from Washington to Kansas, Texas and California, and is also found from Alberta to Ontario. It may be locally common, as a number of specimens have been examined from several locations in Texas. It has been collected from low elevations, but also from above 3,300 m in Colorado.

4. *Calliphora genarum* (Zetterstedt, 1838)

(Figs 13, 157, 162–163, 172–174, 186–188, 201, 206, 211)

Musca genarum Zetterstedt, 1838: 658. Lectotype male, not examined (MZLU). Type locality: Torne Lappmark, Sweden (see Rognes 1986: 352).

Sarcophaga alpina Zetterstedt, 1838: 651 (Rognes 1986: 352, as synonym of *genarum*).

Calliphora popoffana Townsend, 1908: 117. Holotype female, examined (USNM, Cat. No. 10885). Type locality: Popoff Island, Alaska (see Rognes 1986: 352, as synonoym of *genarum*).

Cynomyopsis popoffana: Townsend (1915: 118).

Steringomyia popoffana: Shannon (1923: 110, 1926: 134).

Steringomyia alpina: Shannon (1923: 108).

Acronesia collini Hall, 1948: 279. Holotype male, examined (OUMNH). Type locality: Akpotok Island, Ungava Bay, Canada (see Shewell *in* Danks 1981: 491; Rognes 1986: 352; in both as synonym of *genarum*).

Acronesia popoffana: Hall (1948: 280); Sailer & Lienk (1951: 209); Gill (1955: 651); Hall (1965: 928); Shewell *in* Danks (1981: 491; as synonym of *genarum*).

Abonesia genarum: Shewell *in* Danks (1981: 491).

Calliphora genarum: Rognes (1986: 352, 1991: 68); Poole (1996: 77); Whitworth (2006: 699); Marshall *et al.* (2011: 51).

Diagnosis. The white calypters of this species are distinctive, and are similar only in *C. stelviana*. Arista with short setae above and very short setae below (Fig. 13); parafacial of dark chestnut or black ground color; broad undusted stripe between presutural acrostichals usually extending past transverse suture; T3 with long median marginal setae, usually more than half the length of homologous setae on T4. Male: frons broad, 0.18 (0.16–0.2/6) of head width at narrowest. Female: frons 0.33 (0.31–0.35/8) of head width at narrowest.

Type material examined. *Calliphora popoffana*: HOLOTYPE ♀, labeled: "Popoff Island/ Alaska, July 16 '99"; "Harriman Expedition '99/ T. Kincaid Collector"; "Type/ No. 10885/ U.S.N.M. [red label]"; "Calliphora/ ♀ popoffana/ Type Towns."; "Cynomya/ popoffana/ CHTT [C.H.T. Townsend] T."; "USNMENT/ 01288299" (USNM).

Acronesia collini: HOLOTYPE ♂, labeled: "289/ Herbaceous/ valley slope./ 6 Sept 1931./ O.U.Exp.1931/ SE Akpotok I./ Ungava Bay./ N.Canada./ N.H.S.Davis/ d.d.1931."; "A288"; "Steringom-/ yia popfana./ Tug./ Det 1935./ J.E. Collin./ Ann. Mag./ Nat. Hist./ (10) 15 369-81."; "Lectotype [red label]"; "Acronesia/ collini n.sp./ Hall 1948"; "HOLOTYPE/ Acronesia/ collini Hall [red label]"; "TYPE Dip: 455?/ Acronesia/ collini Hall/ HOPE DEPT.OXFORD" (OUMNH).

Additional material examined. Canada. **NT** *1 ♂, Inuvik, 13.vii.1982, D.M. Wood (CNC). **MB** *1 ♂, Churchill, 18.vii.1954, H.M. Graham (TW); 1 ♂, Horton River, 68°32′N 123°58″W, 23.vii.2000, B.V. Brown (LACM). **QC** *1 ♂ [dissected by G.E. Shewell], Payne Bay, 9.vii.1958, E.E. MacDougall (CNC). **YT** 1 ♂, Dempster Hwy, km 155, 950 m, 16–18.vii.1981, Lafontaine & G. & M. Wood (CNC), 1 ♂, Dempster Hwy, mi 87, 1–4.vii.1973, G. & D.M. Wood (CNC); 1 ♂, same data except 8–12.vii.1973; 1 ♀, Dempster Hwy, mi 51, 7–12.vii.1973, G. & D.M. Wood (CNC); 1 ♀, North Fork Crossing, mi 42, Peel Plt. Rd, 3500 ft, 30.vi.1962, P.J. Skitsko (CNC); 1 ♀, Blackstone R., Dempster Hwy, km 141, 65°01′N 138°12′W, 19.vi.1981, C. Guppy (UBCZ). USA. **AK** *1 ♂, Savonoski, Naknek Lk., vii.1919, Katmai Exped., A.J. Basinger (TW).

Remarks. See Rognes (1991) for a detailed description of this species. This is a rare species known only from far northern Canada and Alaska in North America. It is scarce in museum collections, though about 75 specimens were collected using mice-baited traps in a cooperative project conducted on the Kola Peninsula in Russia. Specimens of this species from the Russian study (unpublished) were shared with a number of major museums including CNC and USNM.

Distribution (Nearctic). Canada: BC, MB, NL, NT, NU, QC, YT. USA: AK.

5. *Calliphora grahami* Aldrich, 1930

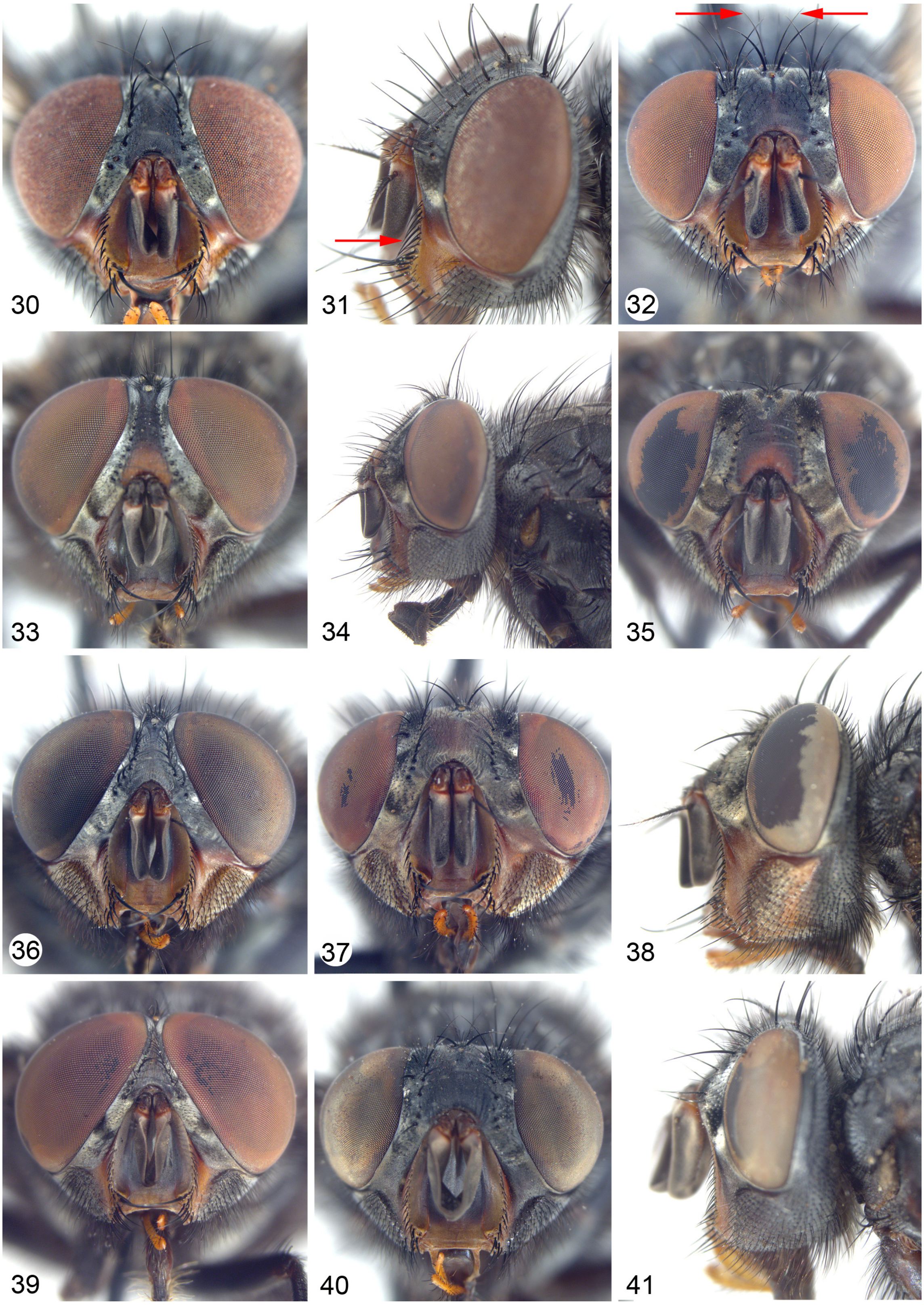
(Figs 17, 33–35, 55, 66–67, 83–85, 107–109, 130–131, 146, 211)

Calliphora grahami Aldrich, 1930: 1. Holotype male, not examined (USNM, Cat. No. 26865). Type locality: Sichuan Province, China. Other references: Thomas (1951: 181); Poole (1996: 77); Whitworth (2006: 699).
Aldrichina grahami: Hall (1948: 290, 1965: 929); James (1953: 144, 1955: 10).

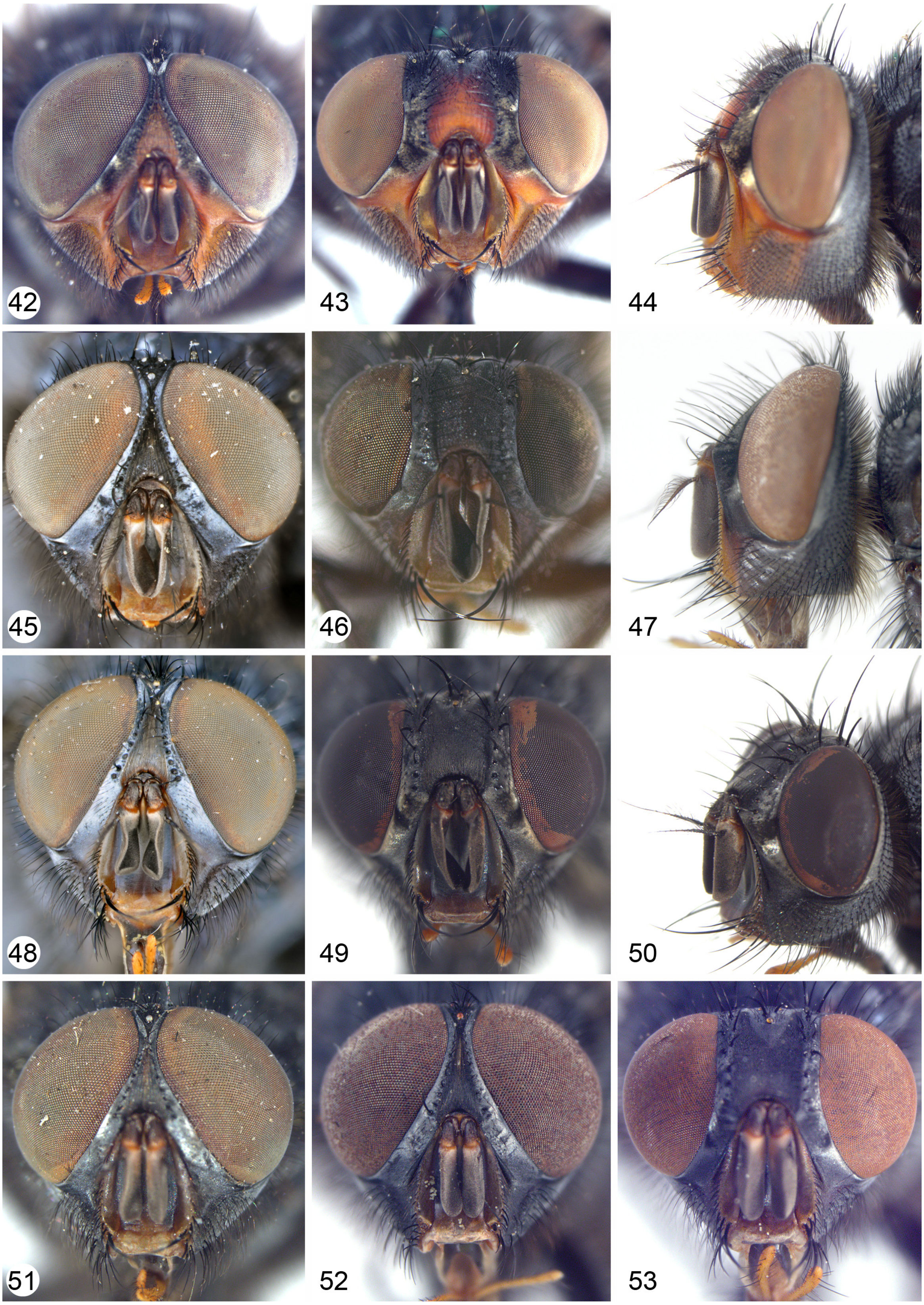
Diagnosis. This is a distinctive species with a greenish abdomen clothed in heavy whitish microtomentum and lacking the intra-alar seta (Fig. 17). Males have large, distinctive terminalia as in Figure 66. T6 of the ovipositor has a sclerotized W shape in the middle, not enclosing the spiracles, unlike any other Nearctic *Calliphora* (Fig. 130).

Redescription. Male: frons broad, 0.15 (0.15–0.20/6) of head width at narrowest. ST5 enlarged, with a strong pair of brush-like setae midway and a deep median concavity between the lobes and bearing two long, parallel horns of soft structure, with tips directed posteriorly and curving outward (Fig. 55); surstylus rod-like in lateral view, black, long, slender and curved, with base horn-shaped (Fig. 66); cercus very much reduced, less than 1/4 of length of surstylus (Fig. 67); basiphallus elongate (Fig. 83); ventral plate triangular, hypophallic lobe with distinct serration on ventral edge; acrophallus with slender lateral ducts, outer wall with small, backward-pointing cuticular denticles (Fig. 85); paraphallus with a characteristically bifid apex and with a serrated dorsal margin (Figs 84–85); bacilliform sclerites long, V-shaped, with a membrane near base of V (Fig. 107); pregonite broad, shoe-like, with a subapical seta and 5 setae near base (Fig. 108); postgonite rod-like, slightly curved posteriorly, with a blunt apex (Fig. 108). **Female:** frons 0.36 (0.34–0.39/8) of head width at narrowest. T6 with characteristic sclerotized W shape in middle, not enclosing the spiracles (Fig. 130); T7 with two lateral, broad sclerotized bars, equal in size, converging distally, completely separated by area of unsclerotized cuticular membrane; T8 completely divided into two lateral sclerotized halves by unsclerotized cuticular membrane, each half with a medial projection proximally; ST6 anchor-shaped, surrounded by a membranous area (Fig. 131); ST7 wedge-shaped, with separate, paired sclerotized areas situated distally and each armed with setae.

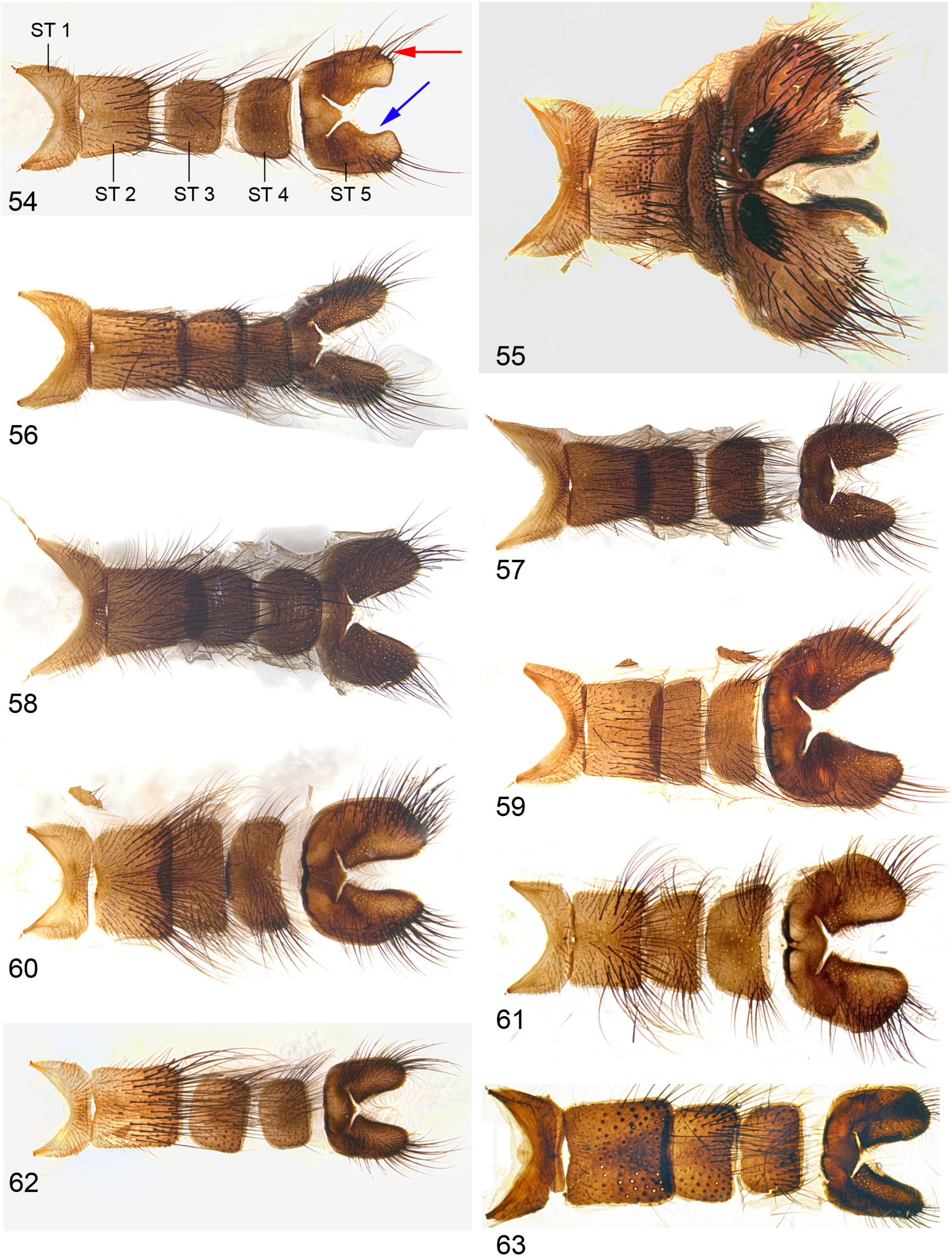
Material examined. USA. **AK** 1 ♀, Ketchikan, 28.vii.1958, F. Baker (TW). **CA** 1 ♂, Contra Costa Co., Mt. Diablo, summit, 3849 ft, 4.vi.2005, M. Wood (CNC); 1 ♀, Sonoma Co., Poultry Ranch, 10.xii.1965, J.H. Peck (CNC); *1 ♂, Sonoma Co., Poultry Ranch, 20.ii.1966, J.H. Peck (CNC); *1 ♂, San Luis Obispo Co., Oceana, 6.v.1963, D.D. Linsdale (CAS); 1 ♀, Yolo Co., Davis, 18.iv.1975, N.J. Smith (TW). **OR** 1 ♀, Union Co., 23 mi SSW La Grande, 13–19.vii.1975, E.J. Davis, Malaise trap (WSUP). **WA** 1 ♂, Orcas Is., Mt. Constitution, viii.1958, A. Kamel (TW); *1 ♂, 2 ♀, Jefferson Co., Neah Bay, 29.vii.2010, bait trap, T.L. Whitworth (TW); *1 ♂, Pierce Co., Tacoma, 2.vi.1982, Malaise trap, T.L. Whitworth (TW); *1 ♂, Ocean Park, 21.vii.1973, M.T. James (WSUP).



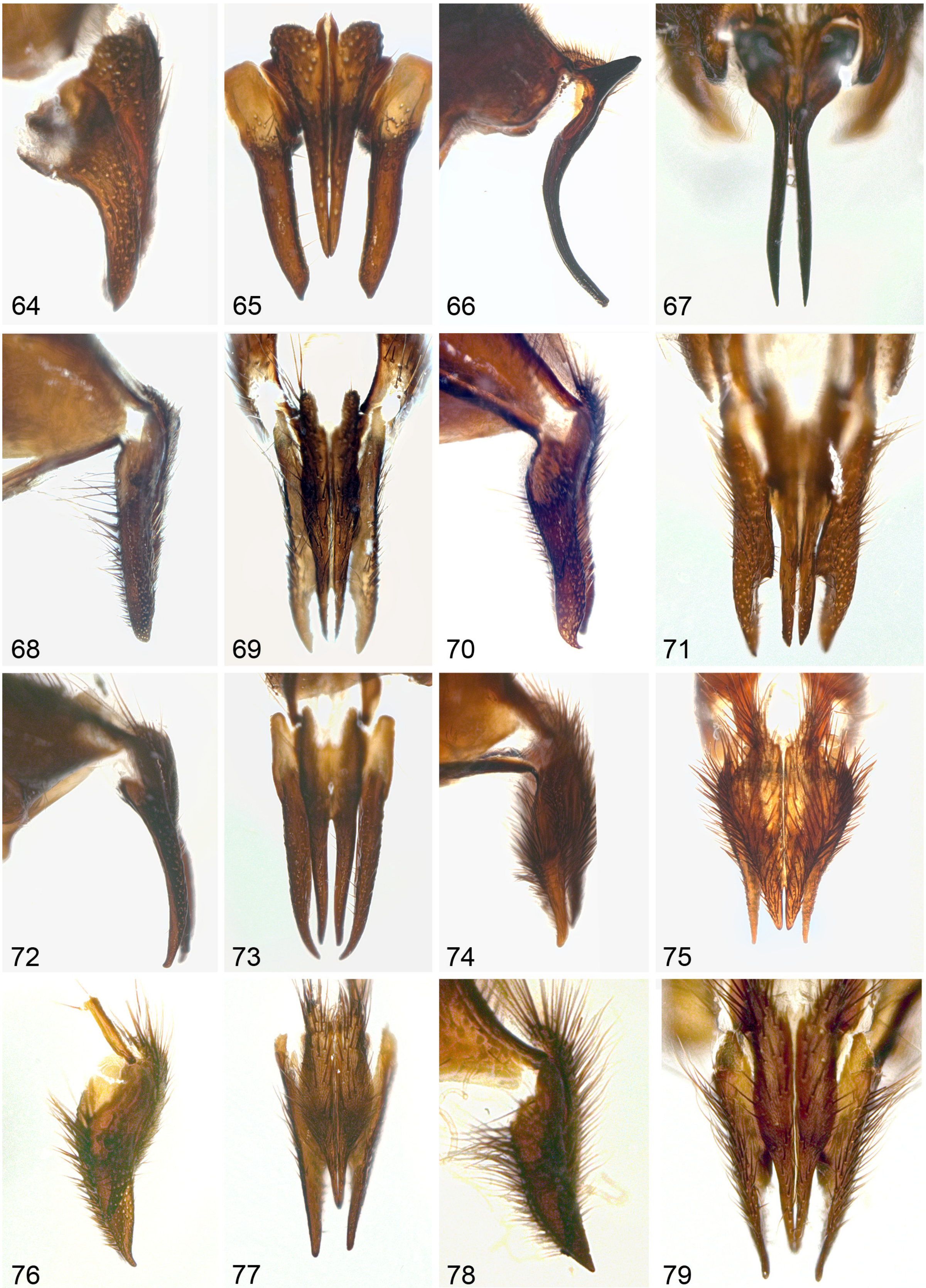
FIGURES 30–41. *Calliphora* spp., heads. **30–32.** *Calliphora latifrons*. **30–31.** Male. **30.** Anterior view. **31.** Lateral view; the red arrow points to the stout supravibrissal setae. **32.** Female, anterior view; the red arrows point to the strong posterior ocellar setae. **33–35.** *Calliphora grahami*. **33–34.** Male. **33.** Anterior view. **34.** Lateral view. **35.** Female, anterior view. **36–38.** *Calliphora coloradensis*. **36.** Male, anterior view, showing broad frons. **37–38.** Female. **37.** Anterior view. **38.** Lateral view, showing reddish anterior area of genal dilation. **39–41.** *Calliphora livida*. **39.** Male, anterior view. **40–41.** Female. **40.** Anterior view. **41.** Lateral view, showing entirely dark genal dilation.



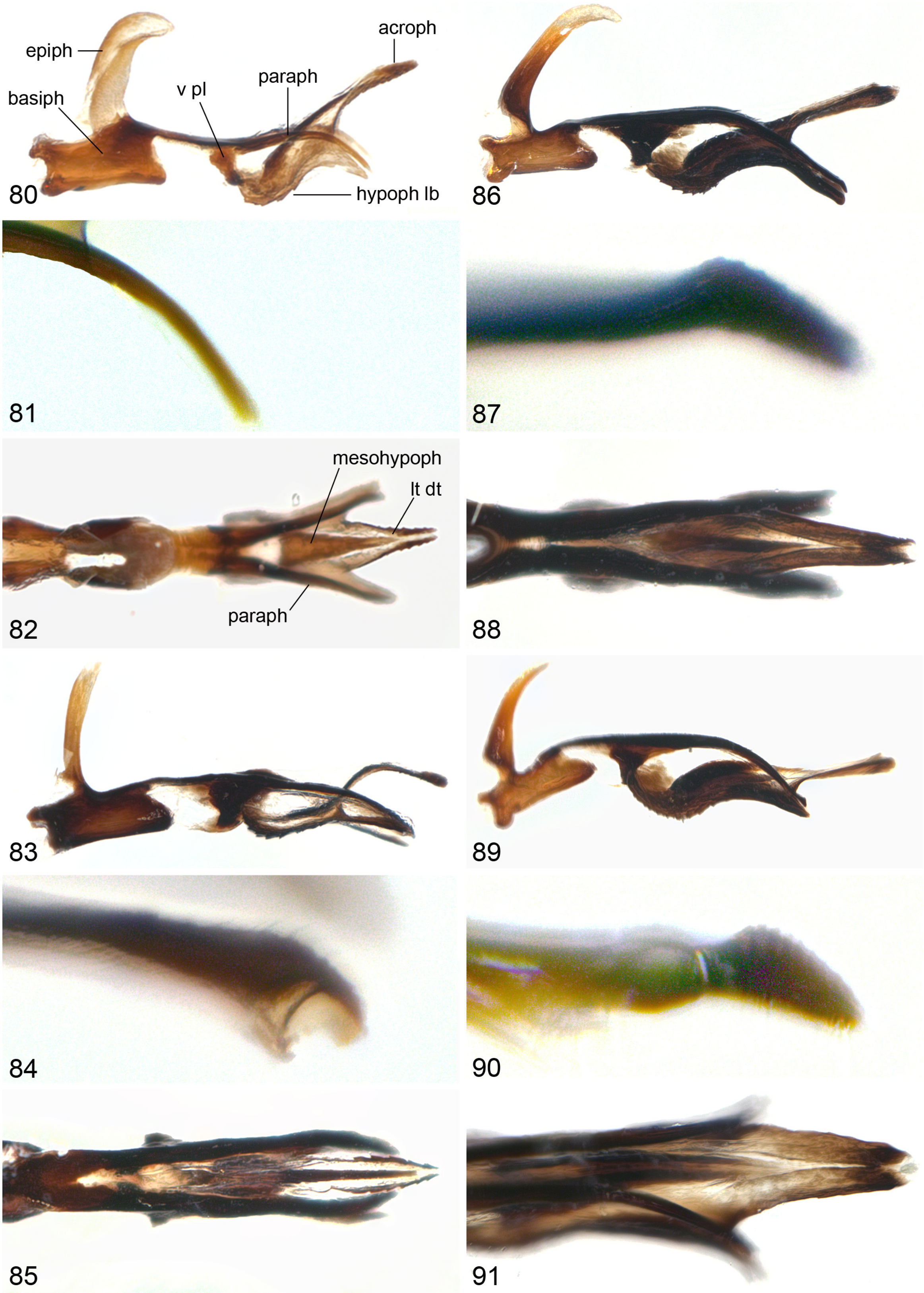
FIGURES 42–53. *Calliphora* spp., heads. **42–44.** *Calliphora terraenovae*, showing reddish frons, parafacial and anterior area of genal dilation. **42.** Male, anterior view. **43–44.** Female. **43.** Anterior view. **44.** Lateral view. **45–47.** *Calliphora alaskensis*, showing dark frons, parafacial and anterior area of genal dilation. **45.** Holotype male, anterior view. **46–47.** Female. **46.** Anterior view. **47.** Lateral view. **48–50.** *Calliphora aldrichia*. **48.** Holotype male, anterior view. **49–50.** Female. **49.** Anterior view. **50.** Antero-lateral view. **51–53.** *Calliphora montana*. **51.** Holotype male, anterior view. **52.** Male from British Columbia, anterior view. **53.** Female, anterior view.



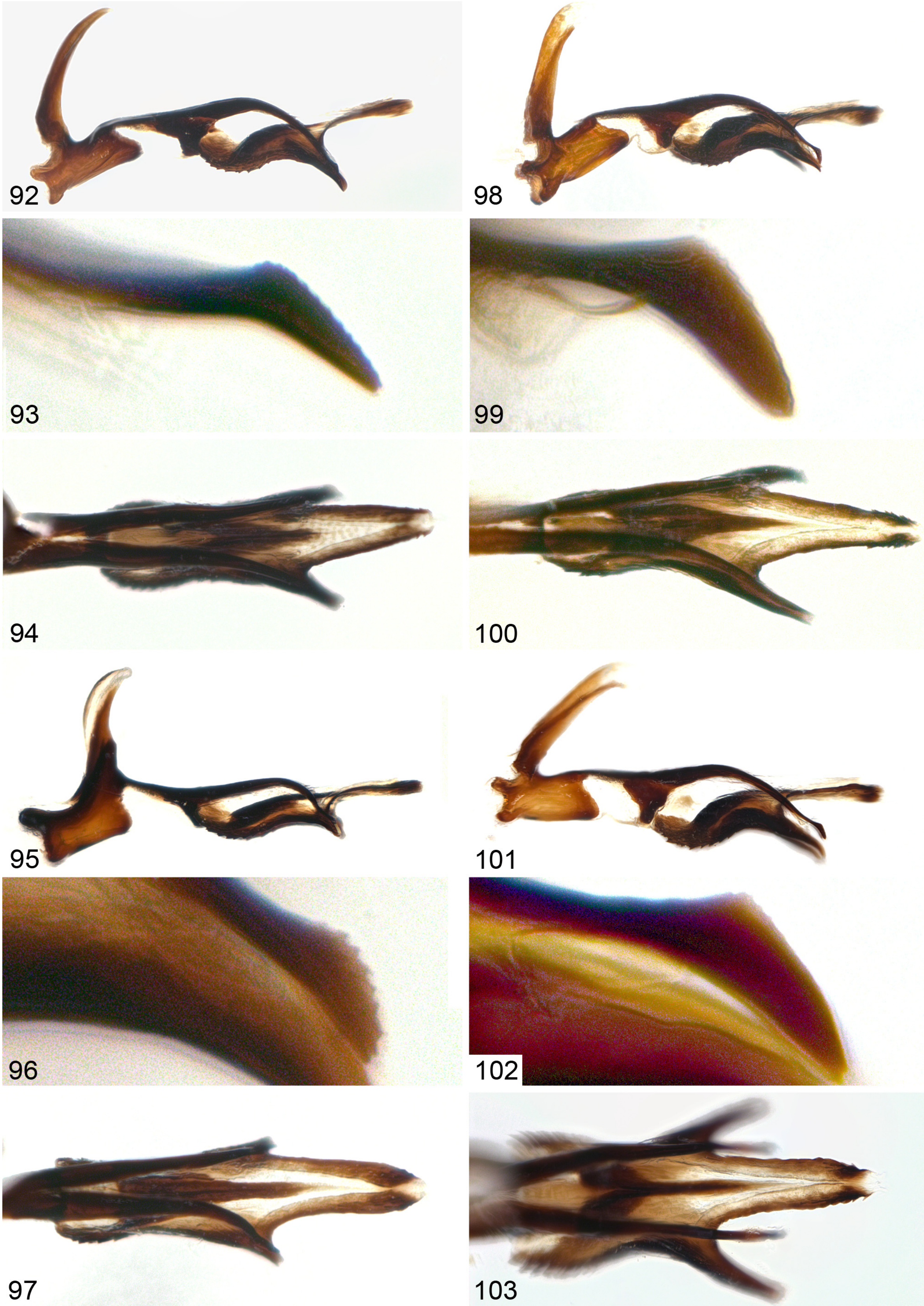
FIGURES 54–63. *Calliphora* spp., male abdominal sternites, ventral view. **54.** *Calliphora latifrons*; the blue arrow points to the medial concavity; the red arrow points to the apical notch. **55.** *Calliphora grahami*. **56.** *Calliphora coloradensis*. **57.** *Calliphora livida*. **58.** *Calliphora terraenovae*. **59.** *Calliphora alaskensis*. **60–61.** *Calliphora aldrichia*, showing ST2 wider than long and ST4 about twice as wide as long. **60.** Specimen from Colorado. **61.** Specimen from British Columbia. **62–63.** *Calliphora montana*, showing ST2 subquadrate and ST4 1.5x as wide as long. **62.** Specimen from Quebec. **63.** Specimen from Alberta. Abbreviations: ST = abdominal sternite.



FIGURES 64–79. *Calliphora* spp., cerci and surstyli. **64–65.** *Calliphora latifrons*. **64.** Left lateral view. **65.** Posterior view. **66–67.** *Calliphora grahami*. **66.** Left lateral view. **67.** Posterior view. **68–69.** *Calliphora coloradensis*. **68.** Left lateral view. **69.** Posterior view. **70–71.** *Calliphora livida*. **70.** Left lateral view. **71.** Posterior view. **72–73.** *Calliphora terraenovae*. **72.** Left lateral view. **73.** Posterior view. **74–75.** *Calliphora alaskensis*. **74.** Left lateral view. **75.** Posterior view. **76–77.** *Calliphora aldrichia*. **76.** Left lateral view. **77.** Posterior view. **78–79.** *Calliphora montana*. **78.** Left lateral view. **79.** Posterior view.



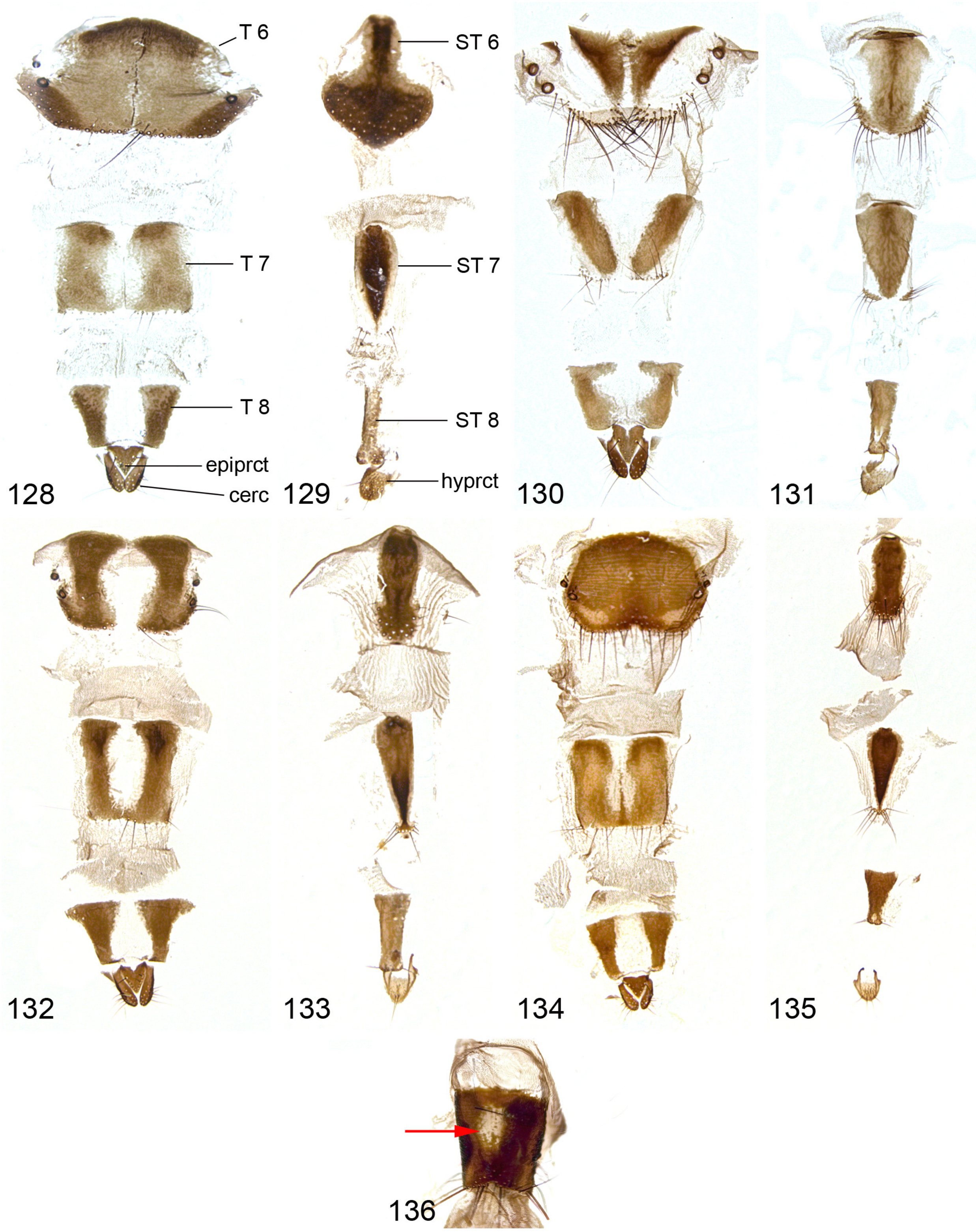
FIGURES 80–91. *Calliphora* spp., phalli. **80–82.** *Calliphora latifrons*. **80.** Left lateral view. **81.** Tip of paraphallus, left lateral view. **82.** Dorsal view. **83–85.** *Calliphora grahami*. **83.** Left lateral view. **84.** Tip of paraphallus, left lateral view. **85.** Distiphallus, dorsal view. **86–88.** *Calliphora coloradensis*. **86.** Left lateral view. **87.** Tip of paraphallus, left lateral view. **88.** Distiphallus, dorsal view. **89–91.** *Calliphora livida*. **89.** Left lateral view. **90.** Tip of paraphallus, left lateral view. **91.** Distiphallus, dorsal view. Abbreviations: acroph = acrophallus; basiph = basiphallus; epiph = epiphallus; hypoph lb = hypophallic lobe; lt dt = lateral duct; mesohypoph = mesohypophallus; paraph = paraphallus; v pl = ventral plate.



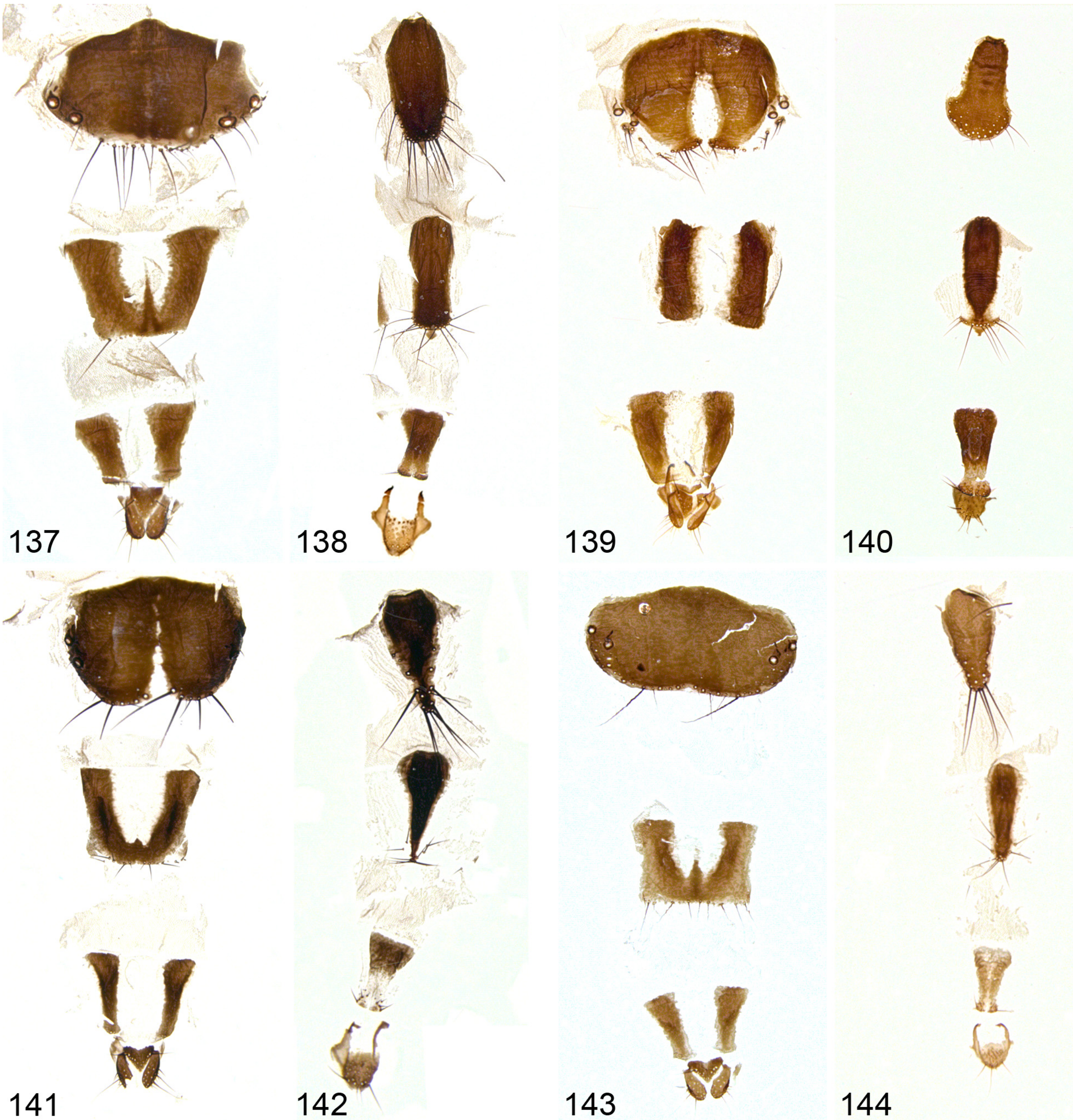
FIGURES 92–103. *Calliphora* spp., phalli. **92–94.** *Calliphora terraenovae*. **92.** Left lateral view. **93.** Tip of paraphallus, left lateral view. **94.** Distiphallus, dorsal view. **95–97.** *Calliphora alaskensis*. **95.** Left lateral view. **96.** Tip of paraphallus, left lateral view. **97.** Distiphallus, dorsal view. **98–100.** *Calliphora aldrichia*. **98.** Left lateral view. **99.** Tip of paraphallus, left lateral view. **100.** Distiphallus, dorsal view. **101–103.** *Calliphora montana*. **101.** Left lateral view. **102.** Tip of paraphallus, left lateral view. **103.** Distiphallus, dorsal view.

FIGURES 104–115. *Calliphora* spp., bacilliform sclerites, gonites and ejaculatory apodemes. **104–106.** *Calliphora latifrons*. **104.** Bacilliform sclerites. **105.** Pre- and postgonites (setae broken off on pregonite). **106.** Ejaculatory apodeme. **107–109.** *Calliphora grahami*. **107.** Bacilliform sclerites. **108.** Pre- and postgonites. **109.** Ejaculatory apodeme. **110–112.** *Calliphora coloradensis*. **110.** Bacilliform sclerites. **111.** Pre- and postgonites. **112.** Ejaculatory apodeme. **113–115.** C*alliphora. livida*. **113.** Bacilliform sclerites. **114.** Pre- and postgonites. **115.** Ejaculatory apodeme. Abbreviations: pgt = postgonite; pregt = pregonite.

FIGURES 116–127. *Calliphora* spp., bacilliform sclerites, gonites and ejaculatory apodemes. **116–118.** *Calliphora terraenovae*. **116.** Bacilliform sclerites. **117.** Pre- and postgonites. **118.** Ejaculatory apodeme. **119–121.** *Calliphora alaskensis*. **119.** Bacilliform sclerites. **120.** Pre- and postgonites. **121.** Ejaculatory apodeme. **122–124.** *Calliphora aldrichia*. **122.** Bacilliform sclerites. **123.** Pre- and postgonites. **124.** Ejaculatory apodeme. **125–127.** *Calliphora montana*. **125.** Bacilliform sclerites. **126.** Pre- and postgonites. **127.** Ejaculatory apodeme.



FIGURES 128–136. *Calliphora* spp., ovipositors. **128–129.** *Calliphora latifrons*. **128.** Dorsal view. **129.** Ventral view. **130–131.** *Calliphora grahami*. **130.** Dorsal view. **131.** Ventral view. **132–133.** *Calliphora coloradensis*. **132.** Dorsal view. **133.** Ventral view. **134–136.** *Calliphora livida*. **134.** Dorsal view. **135.** Ventral view. **136.** T6, intact; the red arrow points to an oval area of translucent cuticle (the sclerite is not flattened). Abbreviations: cerc = cercus; epiprct = epiproct; hyprct = hypoproct; ST = abdominal sternite; T = abdominal tergite.



FIGURES 137–144. *Calliphora* spp., ovipositors. **137–138.** *Calliphora terraenovae*. **137.** Dorsal view. **138.** Ventral view. **139–140.** *Calliphora alaskensis*. **139.** Dorsal view. **140.** Ventral view. **141–142.** *Calliphora aldrichia*. **141.** Dorsal view. **142.** Ventral view. **143–144.** *Calliphora montana*. **143.** Dorsal view. **144.** Ventral view.

Distribution. Canada: BC. Mexico: Durango, Hidalgo. USA: AK, CA, MT, OR, WA. James (1953) also reported this species from Colorado and New Mexico, but these state records have not been confirmed in this study. Whitworth (2012) reported this species from the mountains north of Mexico City, Mexico. This species is indigenous to Asia and an immigrant to western North America (Whitworth 2006). It is locally common in a few locations such as the northwest coast of Washington, but is not found in most of North America.

6. *Calliphora latifrons* Hough, 1899
(Figs 30–32, 54, 64–65, 80–82, 104–106, 128–129, 145, 155–156, 211)

Calliphora latifrons Hough, 1899: 286. Lectotype male, by fixation of Hall (1948: 286), examined (FMNH) (Figs 155–156).

Type locality: Moscow, Idaho. Other references: Shannon (1923: 109, 1926: 134); Whitworth (2006: 703).

Eucalliphora latifrons: Townsend (1908: 118).

Eucalliphora arta Hall, 1948: 287. Holotype male, examined (USNM, Cat. No. 54933). Type locality: San Luis Potosi, Mexico. James (1970: 12).

Eucalliphora lilaea: Hall (1948: 284, 1965: 928); James (1955: 15). Misidentifications, not *Musca lilaea* Walker (= *Cynomya cadaverina* Robineau-Desvoidy, *teste* Thompson & Pont 1994).

Calliphora arta: Whitworth (2006: 698); Rognes (2016: 195), as synonym of *latifrons*.

Calliphora bezzii Zumpt, 1956: 16. Holotype male, not examined (SDEI). Type locality: Ruta, Italy (see Rognes 2016: 195, as synonym of *latifrons*).

Diagnosis. Male frons exceptionally broad, 0.24 (0.22–0.26/12) times head width at narrowest, frons almost twice as wide as parafacial (Fig. 30). Facial ridge with a row of stout supravibrissal setae (Fig. 31); second pair of strong, divergent ocellar setae present (Fig. 32). Male terminalia distinctive, with a broad surstylus with chisel-like tip (Figs 64–65). Females can be confused with several species; with their dark frons, they look similar to *C. terraenovae*, *C. loewi*, *C.alaskensis*, *C. aldrichia* and *C. montana*; the ovipositor, with ST6 of a characteristic inverted spade-like shape with a long proximal stalk (Figs 128–129), distinguishes females of *C. latifrons* from those of similar species.

Redescription. Male: frons broad, 0.24 (0.22–0.26/12) of head width at narrowest. Lobes of ST5 with an apical, lateral notch and medial concavity (Fig. 54). Cercus and surstylus short (Figs 64–65); cercus straight and shorter than surstylus; surstylus broad and apically with chisel-like tip; phallus: epiphallus short (Fig. 80), broad and apically hooked; basiphallus well developed; ventral plate small; hypophallic lobe bulged ventrally, with a serrated edge; acrophallus wall with small backward-pointing denticles, acrophallus with lateral ducts; paraphallus tube-like throughout entire length and not serrated apically (Figs 81–82); bacilliform sclerites short, with inner edges strongly projecting or bulging medially throughout most of their length but not touching, fused with interlying membrane throughout most of their length (Fig. 104); pregonite not strongly narrowed apically (Fig. 105); postgonite smoothly curved posteriorly, with blunt apex; ejaculatory apodeme relatively large (Fig. 106). **Female:** frons 0.37 (0.36–0.39/8) of head width at narrowest. T6 broad (Fig. 128); T7 with two broad, sclerotized vertical bands with concave inner edges, completely separated by a narrow median area of unsclerotized cuticular membrane; T8 with two lateral and longitudinal narrow bands completely and widely separated by unsclerotized cuticular membrane; ST6 of a characteristic inverted spade-like shape, with a long proximal stalk (Fig. 129); ST7 with a sclerotized and elongate, wedge-like proximal area, narrowed distally into a faint, slender, transverse crescent-like area of translucent cuticle with a row of fine setae.

Type material examined. *Calliphora latifrons*: LECTOTYPE ♂, labeled: "Moscow/ Idaho"; "var… a"; "Univ.of Chicago/ G.N.Hough/ Diptera Colln."; "Prob. Lectotype/ fide D.G. Hall/ Blowflies of N.Amer./ 1948—P. 286/ M. Drokop 1970"; "FMNHINS/ 3130707/ FIELD MUSEUM/ Pinned"; "PHOTOGRAPHED/ Allie Stone 2015/ Emu Catalog"; "Lectotype/ Calliphora latifrons Hough/ Fixation by D.G. Hall, 1948/ (labeled: T.L. Whitworth, 2016)" (FMNH) (Fig. 156).

Eucalliphora arta: HOLOTYPE ♂, labeled: "Bishopp/ No. 17216"; "SanLuisPotosi/ Mex. 4-23-[19]31"; "R.A. Roberta/ Collector"; "♂"; "TypeNo/ 54933/ U.S.N.M. [red label]; "Eucalliphora/ arta/ Hall/ det/ DGHall"; "USNMENT/ 01288290" (USNM).

Additional material examined. Canada. **AB** *1 ♂ [dissected by G.E. Shewell], Lethbridge, 5.vii.1956, E.E. Sterns (CNC). **BC** *1 ♂, Terrace, 4.vii.1960, G.E. Shewell (CNC); 1 ♂, Mt. Revelstoke, 6.vii.1952, 5800 ft, G.J. Spencer (CNC); 1 ♀, Mt. Revelstoke, 15.vii.1952, 6000 ft, G.P. Holland (CNC). **YK** *1 ♀, Khuane NP, base Mt. Wallace, 14–15.vii.1980, 1050 m, Wood & Lafontaine (CNC). USA. **AZ** 1 ♂, Pima Co., Sta. Catalina Mtns, Molino Basin, 4000 ft, 26.ii.1995, J.F. Burger (TW). **CA** 1 ♂, 1 ♀, Nevada Co., Sagehen Ck, 21.vii.1976, D.A. Poirier (TW); 1 ♀, Davis, 21.iv.1965, E.E. Grissell (TW); 1 ♂, Plumas Co., Butterfly Valley, 29.v.1976, R.B. Kimsey, M.L. Siri (TW). **CO** *1 ♂, Jackson Co., S Walden, 40°40.9′N 106°14.3′W, 8135 ft, 26.viii.2014, J.E. O'Hara (CNC). **HI** 3 ♀, Island of Hawaii, Kona, 14.iii.2013, bait trap, T.L. Whitworth (TW). **ID** 1 ♀, Chatcolet, 2.vii.1961, M.T. James (WSUP). **OR** *1 ♂, Union Co., Ladd Cyn. 14 mi S La Grande, 4280 ft, 29.vi.1977, Malaise trap, E.J. Davis (WSUP). **PA** 1 ♀, Forest Co., 1.ix.1996, 1500 ft, [no collector listed] (TW). **UT** 1 ♂, Logan, 1.vii.1951, L.D. Haws (TW). **WA** *2 ♂, 3 ♀, Pierce Co., Tacoma, 1.vii.1999, T.L. Whitworth (TW); 1 ♀, Mt. Baker Lodge, 4360 ft, Hwy 542, 24.vii.1968, B.V. Peterson (CNC). **WI** 1 ♀, Monroe Co., Fort McCoy, 17.vii.1997, J.A. Maxell (TW).

FIGURES 145–152. *Calliphora* spp., spermathecae. **145.** *Calliphora latifrons*. **146.** *Calliphora grahami*. **147.** *Calliphora coloradensis*. **148.** *Calliphora livida*. **149.** *Calliphora terraenovae***. 150.** *Calliphora alaskensis*. **151.** *Calliphora aldrichia*. **152.** *Calliphora montana*.

Remarks. The type series of Hough (1899) was composed of 8 male and 28 female syntypes. It appears that some of the specimens from the type series went to USNM and others to FMNH (Crystal Maier, pers. comm.). USNM has one male and one female from Moscow (Idaho) and one female from Mexico labeled as "cotypes" (Norm Woodley, pers. comm.). Hall (1948) stated that he selected a male from Moscow, Idaho housed in FMNH as the lectotype, although it was not labeled as such (Figs 155–156). In order to avoid confusion for future workers, a lectotype label has been added to the male specimen designated by Hall (1948).

Hall (1948) synonymized *Calliphora latifrons* with *Eucalliphora lilaea* (Walker). Thompson & Pont (1994) examined the type specimen of *Musca lilea* Walker and identified it as *Cynomya cadaverina* Robineau-Desvoidy; thus, the name *lilaea* cannot be used for Hough's taxon*.* Shannon (1923) rejected Townsend's (1908) erection of the genus *Eucalliphora* for *Calliphora latifrons* based on the lack of sufficient distinctive characters. Rognes (1991) placed this genus in synonymy with *Calliphora.*

Males of *C. latifrons* can be readily recognized by their exceptionally broad frons and short, stout, chisel-like surstylus. However, females can be difficult to separate from those of similar species unless ovipositors are dissected. With practice, they can be recognized by the stout setae on the facial ridge and the strong second pair of divergent ocellar setae. Some specimens of this species have an additional small postsutural intra-alar seta anterior to the first strong postsutural intra-alar seta, which can cause readers to key specimens to *C. coloradensis* or *C. livida*.

Distribution. *Calliphora latifrons* is a common species in western North America, found occasionally in eastern North America. Canada: AB, BC, MB, QC, SK, YT. Mexico: Baja California, Chiapas, Durango, Federal District, Mexico, Puebla, Tabasco (La Venta). USA: AZ, CA, CO, HI, ID, MT, NM, NV, OR, PA, TX, UT, WA, WI, WV, WY. Whitworth (2012) reported it from the State of Puebla near Tehuacán and in scattered locations northward, and it is likely to occur throughout most of Mexico. We believe this species is endemic to North America, but human activity is likely responsible for dispersing it elsewhere. It is established in Hawaii (Hardy

1981), and Rognes (2016) notes that it has been found near Genova, Italy where it was described as a new species, *Calliphora bezzii* Zumpt, 1956. He also notes that it has been found in southern China in Guangzhou Province. But in both Italy and China, *C. latifrons* has apparently not become established, with records only from international ports.

7. *Calliphora livida* Hall, 1948

(Figs 39–41, 57, 70–71, 89–91, 113–115, 134–136, 148, 211)

Calliphora livida Hall, 1948: 296. Holotype male, not examined (USNM, Cat. No. 54934). Type locality: Savannah, Georgia, USA. Other references: James (1953: 144, 1955: 4); Hall (1965: 929); Hall & Townsend (1977: 27); Poole (1996: 77); Whitworth (2006: 699); Marshall *et al.* (2011: 61).

Calliphora viridescens of authors (e.g., Hough 1899: 286), not Robineau-Desvoidy, 1830. Misidentifications (see Hall 1948: 297).

Diagnosis. One of two species with three postsutural intra-alar setae (as in Fig. 16), genal dilation dark when fully colored (Fig. 41). Male frons narrow, 0.06 (0.05–0.07/7) of head width at narrowest, compared to 0.14 (0.12–0.16/11) in *C. coloradensis.* In the female, T6 of ovipositor is normally complete, rarely with a weak area in the center (Figs 134–136), versus divided in *C. coloradensis*.

Redescription. Male: frons narrow, 0.06 (0.05–0.07/7) of head width at narrowest, less than half the width of parafacial at lunule (Fig. 39). Surstylus, in lateral view, with base curved anteriorly and smoothly curved posteriorly midway, lower edge smoothly curved anteriorly above, then smoothly curved posteriorly below, apically hooked, with pointed tip directed posteriorly (Fig. 70); pregonite narrow with a long process (Fig. 114). **Female:** frons 0.35 (0.34–0.38/12) of head width at narrowest (Fig. 40). Width of parafacial at level of lunule about half the distance between the two strongest vibrissal setae, nearly equal to width of first flagellomere (Fig. 40); parafacial, in lateral view, with two silvery spots completely separated by a black band (Fig. 39). T7 almost divided with a slender, vertical, incomplete sclerotized partition extending from fused distal end to about midway between the two sclerotized halves (Fig. 134).

Material examined. Canada. **AB** *1 ♀, *1 ♀, Spray Lakes Rd, 51°05′06″N 115°24′03″W, 11.viii.2012, T.L. Whitworth (TW). **NB** 1 ♀, Kouchibouguac NP, 25.vi.1977, D.M. Wood (CNC). **ON** 1 ♀, Algonquin Pk., Swan Lake, 13.v.1975, G. & M. Wood (CNC); *1 ♂, Toronto, 13.ix.1958, D.M. Wood (CNC). **QC** *1 ♀, North Ck, Mt. St. Hilaire, 3–6.v.1982, B.M. Nelson (CNC). **YT** *2 ♂, Kluane NP, base Mt. Wallace, 1050 m, 6.viii.1980, Wood & Lafontaine (CNC). USA. **AL** 1 ♀, Baldwin Co., Stapelton, 30°73′N 87°80′W, 15.xii.2004, E. Benton (TW). **AZ** *1 ♂, Coconino NF, Kinder Crossing, 6460 ft, 34°33.94′N 111°08.7′W, 10.ix.2014, J.E. O'Hara (CNC). **CA** *1 ♂, El Dorado Co., Echo Lake, 7400 ft, 6.vii.1964, W.W. Middlekauff (TW); *1 ♂, Sierra Co., Independence Lk., 1.vii.1976, M.A. Rabel (TW); 1 ♀, Nevada Co., Sagehen Ck, 25.vi.1968, C.J. Horning (TW). **MO** *3 ♂, *1 ♀, Putnam Co., Martinstown, 20.iv.2007, bait trap, T.L. Whitworth (TW). **NJ** *2 ♀, Sussex Co., 27.vii.2012, Lauren Weidner (TW); *2 ♀, Hunterdon Co., 16.v.2012, Lauren Weidner (TW). **NM** 1 ♀, Torrance Co., Manzano Mts., 8 mi W Tajique, 7500 ft, 4th of July Campground, 34°47.4′N 106°22.8′W, 21.viii.1999, J.E. O'Hara (CNC); 1 ♀, Grant Co., Cherry Ck CG, 15.viii.2007, 6767 ft, bait trap, T.L. Whitworth (TW). **OH** 1 ♀, Hamilton Co., Cincinnati, 9.v.1988, E. Eaton (TW). **OR** *2 ♂, Wheeler Co., 10 mi E of Fossil, 29.vi.2007, bait trap, T.L. Whitworth (TW).

Remarks. This is a fairly common species throughout North America, occurring from sea level to high elevations. Like *C. coloradensis*, it has three postsutural intra-alar setae but the gena is normally all dark (Fig. 41); teneral specimens with a pale area on the anterior portion of the gena can be confused with *C. coloradensis* (Figs 37–38). The dark frons, parafacial and gena in females of this species (Figs 39–41) can create confusion with several other species with similar characters, especially if the anteriormost intra-alar seta is broken off or tiny. Similar species are *C. alaskensis*, *C. latifrons* and *C. loewi*. During this project, several female specimens were found that appeared to have only two intra-alar setae, and they did not key properly. Once they were dissected, they were determined to be *C. livida.* Some were in poor condition, but others simply lacked the extra, anteriormost seta since no empty socket could be found (see Figs 17 and 18 for examples of presence and absence of this seta). It is critical to examine the terminalia of both sexes in this species if there is any doubt about its identity.

Distribution. Canada: AB, BC, MB, NB, NS, ON, QC, YT. USA: AZ, CO, DE, FL, KS, LA, MD, ME, MI, MS, MT, NC, NJ, NM, NY, OH, OR, PA, SD, SC, TN, TX, UT, VA, WA, WI.

FIGURES 153–156. *Calliphora* spp., type specimens. **153–154.** *Calliphora coloradensis*, lectotype male. **153.** Habitus. **154.** Labels. **155–156.** *Calliphora latifrons*, lectotype male. **155**. Habitus. **156**. Labels.

8. *Calliphora loewi* Enderlein, 1903

(Figs 19, 25–26, 158, 164–165, 175–177, 189–191, 202, 207, 211)

Calliphora loewi Enderlein, 1903: 254. Lectotype male, examined (ZMHB). Type locality: Schneeberg, near Vienna. Other references: Rognes (1991: 71); Poole (1996: 77); Whitworth (2006: 700); Marshall *et al*. (2011: 72).

Calliphora morticia Shannon, 1923: 110 (in key), 116. Holotype male, not examined (USNM, Cat. No. 26126). Type locality: Kodiak, Alaska (see Rognes 1991: 71). Other references: Shannon (1926: 134); James (1953: 144); Hall (1965: 929); Rognes (1991: 71; as synonym of *loewi*).

Calliphora mortica: Hall (1948: 299); Sailer & Lienk (1951: 151). Incorrect subsequent spelling of *morticia*.

Diagnosis. This is another species with a dark frons, parafacial and gena that can be confused with several similar species (as in Figs 48–53). Rarely, specimens have an orange genal groove that can cause confusion with *C. terraenovae*. The long, straight and slender surstylus and cercus in males are distinctive (Figs 164–165); in females, the posterior half of T5 with an incision and the distinctive sclerites of the ovipositor help confirm identification (Fig. 202).

Redescription. The detailed description provided by Rognes (1991) is here supplemented by the following information. **Male:** frons narrow, 0.04 (0.03–0.05/12) of head width at narrowest; ST3 and ST4 quadrate (Fig. 158), ST5 normal (Fig. 158); cercus long and slender when viewed posteriorly (Fig. 165); surstylus long, straight, parallel-sided, and apically pointed (Figs 164–165); epiphallus long (Fig. 176); ventral plate of phallus prominent and broader dorsally; pregonite with a narrow base and narrow, long apical process (Fig. 190). **Female:** frons 0.35 (0.34–0.36/9) of head width at narrowest; T5 tent-like in lateral view (Fig. 25), with a dorsal incision on posterior 1/3–1/2 (Fig. 26); T6 long, with a narrow, inverted V-shaped translucent area of cuticle (Fig. 202); T7 almost divided, with a small sclerotized partition arising distally; ST6 broad; ST7 elongate, slender, distinctly narrowed distally, ending as a small semi-circle (Fig. 202).

Type material examined. *Calliphora loewi*: LECTOTYPE ♂, here designated, labeled: "nov. sp. [hand written]"; "Coll./ H.Loew"; "Type [red label]"; "Schneeb/ ?[1].8.58"; "Caliphora [sic]/ vomitoria/ var. Loewi/ nov. ♂/ det. Dr. Enderlein"; "LECTOTYPE/ Calliphora loewi/ des. Tantawi, Whitworth/ & Sinclair 2016 [red label]" (ZMHB).

Additional material examined. Canada. **AB** 2 ♂, Highwood Pass, Kananaskis Rd, 30.vii.1989, M. Polak & M. Wood (CNC). **BC** 1 ♀ (dissected by G.E. Shewell), Terrace, 30.vi.1960, R.J. Pilfrey (CNC); 2 ♂ (1 dissected, labeled as "homotype" by G.E. Shewell), same data except 3 mi S Lakelse Rd, 19.viii.1960, C.H. Mann (CNC); *1 ♂, Shames, 18 mi SW Terrace, 23.vi.1960, C.H. Mann (CNC); *1 ♂, Mt. Revelstoke, 5400 ft, 7.vii.1952, G.J. Spencer; 1 ♀, Floe Lake, Kootenay NP, 6500 ft, 9.viii.1955, J.R.W. McGillis (CNC); 1 ♂, Lakelse bog, S Terrace, 5.viii.1960, W.R. Richards (CNC); 1 ♀, King Salmon Lake, 1750 ft, 58°43′N 132°54′W, W.W. Moss (CNC); *1 ♀ (dissected by G.E. Shewell), Lac Le Jeune, 27.vi.1973, H.J. Teskey (CNC); 1 ♂, 50 mi Terrace, 9.vii.1960, B. Heming (CNC). **NT** 1 ♀, Reindeer Depot, Mackenzie Delta, 14.viii.1948, J.R. Vockeroth (CNC). **YT** *2 ♂, Dempster Hwy, km 140.5, 900 m, 21–23.vii.1980, G. & M. Wood (CNC); *1 ♂, same data except 27–29.vii.1980, Wood & Lafontaine (CNC); *1 ♂, 1 ♀, same data except km 155, 950 m, 29.vi.–3.vii.1980 (CNC); *1 ♂, *2 ♀, same data except mi 87, 4–8.viii.1973, G. & D.M. Wood (CNC); *1 ♂, same data except km 140.5, 900 m, 11–13.vii.1981, Lafontaine & G. & M. Wood (CNC); 2 ♂ [*1 specimen], 4 ♀, same data except km 155, 950 m, 11–18.vii.1981; *1 ♂, 3 ♀, Kluane NP, base Mt. Wallace, 1050 m, 6.viii.1980, Wood & Lafontaine (CNC); *1 ♂, Kluane Lake, 1.viii.1963, G.C. & D.M. Wood (CNC). USA. **AK** 1 ♀, Glacier Hwy, mi 12, 25.viii.1962, D.C. Schmiege (CNC); 4 ♀, Denali Park, Nenana River, 10.viii.2008, bait trap, T.L. Whitworth (TW); *4 ♂, Fairbanks, 15.viii.2008, bait trap, T.L. Whitworth (TW); 1 ♀, Ketchikan, 28.x.1957, F. Baker (TW); 1 ♀, Galena, 24.vii.1953, [no collector listed] (TW). **ME** 1 ♂, 1 ♀, Mt. Katahdin, 14.vii.1959, 2950 ft, H.C. Huckett (TW). **NY** 2 ♂, Mt. Marcy, Phelphs Trail, 4.vii.1962, 4200 ft, H.C. Huckett (USNM). **WA** 1 ♂, Pierce Co., Mt. Rainier-Yakima Trail, 22.vii.1924, A.L. Melander (USNM).

Remarks. Although the two syntypes (1 ♂, 1 ♀) of *C. loewi* were not examined physically, digital images of the habitus and male terminalia of the male syntype (J. Ziegler, pers. comm.) allowed us to confirm the identification and here designate the male specimen as lectotype, in order to fix the identity of the species. Schneeberg is the highest mountain in Lower Austria and the male specimen appears to have been collected by Loew during a trip on 1 August 1858 (see Loew 1861: 384) (J. Ziegler, pers. comm.). Although Enderlein (1903) interpreted the collection date as 8 August 1858, the first number on the label is unreadable. According to the det. label, Zumpt identified the female syntype as *C. terraenovae*; we cannot verify this determination.

This species is uncommon in the northern continental United States, but it is locally common in parts of Canada, where it occurs from the West to the East coasts. During a collecting trip around Fairbanks, Alaska in 2008, *C. loewi was* commonly collected and is likely found throughout most of the state. It also was fairly common in the mountains of southwestern Alberta. Marshall *et al.* (2011) published the "first record" of *C. loewi* from eastern North America based on a male specimen collected in northern Quebec. However, *C. loewi* had already been reported from northern Newfoundland by Rognes (1991: 71).

Distribution. Canada: AB, BC, NL, NT, QC, YT. USA: AK, ME, NL, NY, WA.

9. *Calliphora montana* (Shannon, 1926)

(Figs 3–4, 12, 22, 29, 51–53, 62–63, 78–79, 101–103, 125–127, 143–144, 152, 211)

Steringomyia montana Shannon, 1926: 135. Holotype male, examined (CNC, No. 2444) (Figs 3–4). Type locality: Edmonton, Alberta, Canada. Other references: Cooper & Cumming (2000: 48).

Acronesia montana: Hall (1948: 280, 1965: 928); Shewell (1987: 1139).

Calliphora montana: Poole (1996: 77); Whitworth (2006: 703); Marshall *et al.* (2011: 74).

Diagnosis. See diagnosis of *C. aldrichia* for a comparison of these two very similar species. Males can be distinguished by the shape of ST2 and ST4 (Figs 62–63), the narrower frons width, 0.08 (0.06–0.10/15) of head width at narrowest, and cercus almost as long as surstylus (Fig. 79). Females: T5 not incised (Fig. 29); ovipositor withT6 complete (Fig. 143).

Redescription. See comparison of characters of *C. montana* with those of *C. aldrichia* under that species. Usually 2 pairs of inner posthumeral setae (Fig. 12) present; bend in M usually midway between wing margin and dm-cu crossvein (Fig. 22). **Male:** frons narrow, 0.08 (0.06–0.10/15) of head width at narrowest (Figs 51–52); ST2 long and narrow (Figs 62–63); ST4 small, quadrate, with apical margin straight; ST5 with small, normal lobes; cercus long, ending close to tip of surstylus, distance between tip of cercus and tip of surstylus about half the same distance in *C. aldrichia* (Fig. 79). **Female:** frons 0.33 (0.32–0.36/17) of head width at narrowest (Fig. 53); T5 without an incision (Fig. 29); T6 complete, without weak areas (Fig. 143); ST6 short with a broad apex with normal setae (Fig. 144); ST7 short, without a long neck and with a broad apex with normal setae.

Type material examined. HOLOTYPE ♂, labeled: “Edmonton, Alta./ Aug. 19 1923/ E.H. Strickland”; “Steringomyia/ TYPE/ montana ♂/ Shannon/ No. 2444 [red label]”; “Steringomyia/ montana/ Snn.” [terminalia stored in glycerol in a glass microvial pinned below the specimen] (CNC) (Figs 3–4). PARATYPE: 1 ♀, same data as holotype (CNC) [labeled as “allotype”].

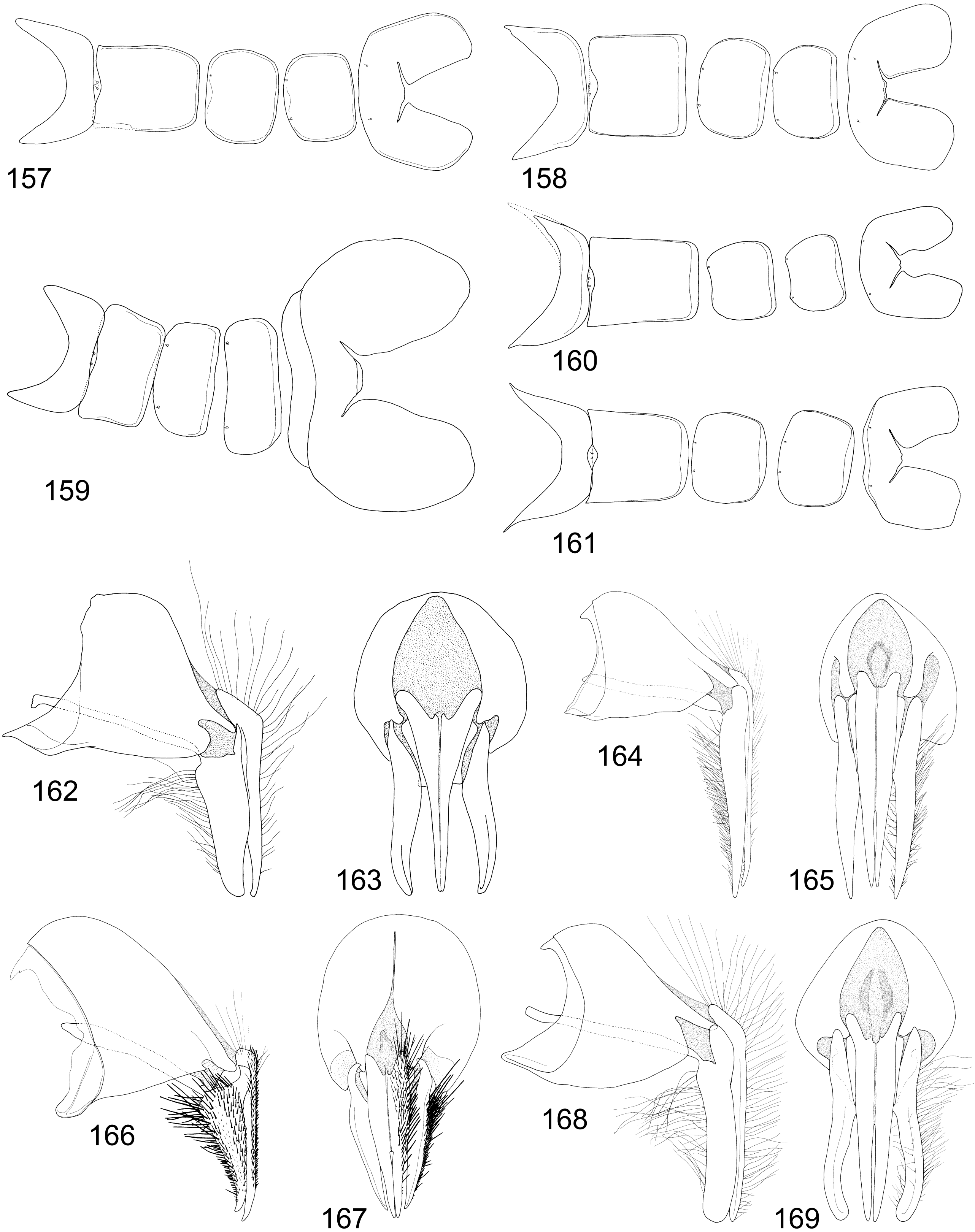
Additional material examined. Canada. **AB** 1 ♀, Rocky Mountains, Banff NP, Sunshine Meadows, Alpine meadows, 51.061°N 115.784°W [51°3′39.6″N 115°47′2.4″W], 2245 m, 2.viii.2008, J. Straka & J. Cossey (BIOUG); 1 ♂, 1 ♀, 15 mi E Canmore, 51°05′06″N 152°46′40″W, 6.viii.2012, bait trap, T.L. Whitworth (TW); 8 ♂, 15 ♀ [*6 specimens, T6 exposed in 6 other specimens], Spray Lake Rd, 11.viii.2012, bait trap, T.L. Whitworth (TW); *1 ♀, 10 mi E Hinton, 12.viii.1980, S.A. Marshall (DEBU). **BC** *1 ♂, 5 ♀ [*2 specimens, T6 exposed in 2 other specimens], mi 45, Haines Hwy, 25.vii.1963, G.C. & D.M. Wood (CNC); *1 ♀, 40 km E Enderby, 10.vii.1992, A. Borkent (CNC); *2 ♂, Eva Lake Trail, 31.vii.1952, G.P. Holland (CNC); *1 ♂, same data except G.J. Spencer (CNC); *1 ♀, Squamish, Diamond Head Trail, 4000 ft, 17.viii.1953, W.R.M. Mason (CNC); *1 ♂, Mt. Revelstoke, 15.viii.1952, G.J. Spencer (CNC); *1 ♂, Lakelse Lk., near Terrace, 300 ft, 27.vi.1960, R. Pilfrey (CNC); *1 ♂, Mount Harry, 6200 ft, Mt. Revelstoke NP, 20.viii.1952, G.J. Spencer (CNC); *2 ♂, 1 ♀, Apex Mt., summit, Keremeos, 3.viii.1987, S. Cannings (TW); *1 ♂, *1 ♀, same data except D.L. Sanford; 1 ♂, same data except (UBCZ); *2 ♂, Yoho NP, Takakkaw Falls, 51.4996°N 116.4728°W [51°29′58.56″N 115°47′2.4″W], 23.vii.2010, BIObus 2010 (BIOUG); 1 ♂, Alaska Hwy, Stone Mountain Provincial Pk at E end Summit Lk., 373.6 mi from Dawson Ck, 2.vii.1989, P.H. Arnaud, Jr. (CAS). **MB** *1 ♀, AtiKaml’s Lake [Atikameg Lake], 14.viii.1949, J.B. Wallis (CNC); *1 ♂, Churchill, 25.viii.1950, J.R. Vockeroth (CNC); *1 ♂, same data except 5.viii.1955, D.M. Wood; 1 ♀, same data except 20.viii.1955; 1 ♂, Churchill River, 20 mi S Churchill; 5–6.viii.1937, D.G. Denning (USNM). **NB** *1 ♂, Wayerton, 12.vii.1950, W.W. Moss (CNC). **NL** *3 ♀, Sir Richard Squires Memorial Prov. Pk, near Humber River, 3.viii.1983, K. Rognes (KR); *1 ♂, 7 ♀ [*one specimen, T6 exposed in 6 specimens], 34.8–39.7 km, Grand Lake Rd., 21.vii–5.viii.1992, K. Perrault (CNC); 1 ♂, Churchill Rd., 10 km Goose Bay, 28.vii.1987, R.F. Pardy (CNC); 4 ♀, Cartwright, 23–28.vii.1955, E.F. Cashman (CNC); *1 ♂, 2 ♀ [*one specimen], same data except 7–9.viii.1955, E.E. Sterns; 1 ♀, same data except 11.viii.1955, E.F. Cashman (CNC). **NS** *2 ♂, Cape Breton Highlands NP, Cheticamp Rd, 14.vii.1983, D.M. Wood (CNC); *3 ♂, same data except French Lake bog, 11.vii.1983, G. & M. Wood; *3 ♂, *1 ♀, same data except D.M. Wood; *2 ♂, 2 ♀ [T6 exposed in one specimen, abdomen missing in other specimen], same data except 15.vii.1983, G. & M.

Wood; *1 ♂, same data except Mack. Fire Tower, 11.vii.1983, D.M. Wood; 1 ♀ (T6 exposed), same data except Mackenzie Mountain, 29.viii.1983, M. Sharkey (CNC); *1 ♀, Cape Breton, Victoria Co., Highland Rd, mi 15, 11–13.vii.1983, [no collector listed] (CNC); *1 ♂, same data except 4–5.vii.1983, B. Wright; *1 ♂, same data except Big Barren, 27.vii.1983; 1 ♂, Victoria Co., Baddeck, 21.vii.1985, flight trap, B. Bhreagh (FSCA). **NT** *2 ♂, Norman Wells, 14.viii.1969, G.E. Shewell (CNC); 2 ♀, same data except 16.viii.1969 (CNC); *1 ♀, Fort Wrigley, McKenzie River, 17.vii.1922, C.H. Crickmay (USNM). **ON** *1 ♂, Temagami, 20.viii.1963, G. Taylor & M. Wood (CNC); *6 ♂, 3 ♀ [one specimen dissected], Ogoki, 11–29.viii.1952, J.B. Wallis (CNC); 1 ♀, Algonquin Prov. Pk, Wildlife Res. Stn., Chit Lk. Trail, 18–24.viii.1996, pan traps, J.M. Dow & G. Perry (DEBU); 1 ♀, White Otter Lk., Sp 3, lot 40, vii.1984, A.P. Applejohn (DEBU); 1 ♀, Rushbrook Lk., UTM 17T3115770, SP2, plot 29, vii.1984, A.P. Applejohn (DEBU); 1 ♀, Ice Water Creek, 72 km NW of STE [Sault Ste. Marie], mixed forest, 23.viii.1994, Malaise trap, D. Allen (CNC). **QC** *12 ♂, 6 ♀ [*2 specimens, T6 exposed in 3 specimens], La Verendrye Prov. Pk, mi 61, 139, 142, Route 58, 18–21.viii.1965, D.M. Wood (CNC); *2 ♂, Grande Vallée, 30.vii.1963, G.S. Walley (CNC); *1 ♀, Cascapedia R., Gaspe, 30 mi N New Richmond, 1–6.viii.1983, W. Middlekauff (CAS); 1 ♂, 1 ♀, same data except (CNC); 2 ♂, Laurentides Park, 16.viii.1956, R.W. Hodges (WSUP); 1 ♂, same data except Barrier Ste. Anne, 15.viii.1971, D.M. Wood (CNC), 1 ♂, Parc Natl. Gaspésie, Mount Auclair summit, 49°04′36″N 65°95′26″W, 1113 m, alpine tundra, yellow pan trap, 9–16.vii.2008, L. Jolicoeur (DEBU); 1 ♂, same data except summit, 2 km E Mt. Rolland-Germain, 49°02′69″N 65°92′39″W, 1041 m, alpine tundra, yellow pan traps, 8–15.vii.2008, J.-F. Jette (DEBU); 4 ♂, James Bay Rte. km 307, Pontax II River, 51°46′31″N 77°25′27″W, open black spruce, yellow pans, 8–16.vii.2001, M. & B. Buck (DEBU); 3 ♂, same data except km 398.8, 52°21′25″N 77°06′25″W, 8–15.vii.2001, boggy black spruce, white pans (DEBU); 2 ♂, same data except km 603, 53°43′28″N 77°43′10″W, 10–14.vii.2001 (DEBU); 3 ♂, same data except km 204.5, 50°56′59″N 77°38′20″W, 7–16.vii.2001, Malaise trap (DEBU); 1 ♂, same data except km 217.1, 51°40′29″N 77°32′58″W, sphagnum bog, yellow pans (DEBU); 1 ♂, same data except km 567.3, 53°28′22″N 77°35′31″W, 9–15.vii.2001 (DEBU); 1 ♀, same data except km 570.3, 53°29′39″N 77°37′15″W, black spruce nr. lake shore, Malaise trap (DEBU). **SK** *1 ♂, 1 ♀, Lk. Athabasca, Yakow Lake dunes, 21–29.vi.1988, M. Polak & M. Wood (CNC); 1 ♀, Pr. Albert, 3.viii.1953, W.J. Turnock (CNC). **YK** *1 ♀, 14 mi E Dawson, 1300 ft, 3.viii.1962, R.E. Leech (CNC); 1 ♀ [terminalia missing], same data except P.J. Skitsko; *1 ♀, same data except 1.viii.1962; *1 ♀, same data except 4.viii.1962; *1 ♂, Kluane Lake, 1.viii.1963, G.C. & D.M. Wood (CNC); 1 ♀ [T6 exposed], same data except NP base Mt. Wallace, 14–15.vii.1980, 1050 m, Wood & Lafontane; 1 ♀, Wolf Creek, mi 907, Alaska Hwy, 24.viii.1963, G.C. & D.M. Wood (CNC). USA. **AK** 1 ♀ [ovipositor exposed], Soldotna, 6.5 km E, 60°30′50″N 150°55′60″W, 1.viii.2002, D. & W.N. Mathis (USNM); 12 ♂ [*11 specimens], *1 ♀, Nogahabara dunes, 65 mi N Galena, 25–30.vi.1989, M. Polak & D.M. Wood (CNC); 1 ♂, Galena, 24.vii.1953, [no collector listed] (WSUP); *1 ♂, *1 ♀, Savonoski, Naknek Lk., vi.1919, J.S. Hinae (CNC); *1 ♂, same data except viii.1919 (USNM); *1 ♂, same data except Nat. Geo. Soc., Katmai Exped., 12.viii.1919, A.J. Basinger (CAS); 3 ♂, same data except 14.viii.1919 (WSUP); 1 ♂, same data except 18.viii.1919 (WSUP); *1 ♂, *2 ♀, Katmai, vii–viii.1917, J.S. Hine (USNM); *1 ♀, Seldovia, 21.vii.1899, Harriman Exped., 1899, T.K. Kincaid (USNM); *1 ♂, Seward, 24.vii.1921, J.M. Aldrich [misidentified as paratype ♂ of *C. aldrichia* by Shannon (1923: 112)] (USNM). **NY** (all USNM) 1 ♂, Adirondack Mts., 2.vii.1963, H.C. Huckett; *1 ♂, same data except Mt. Haystack, Snowbird Trail AMR, 4000 ft, 7.vii.1964; 2 ♂, Phelps Trail, 4200 ft, 10.vii.1962, H.C. Huckett; 1 ♂, same data except 1.vii.1962; 1 ♂, same data except Mt. Marcy, 10.vii.1962; 2 ♂, same data except 3.vii.1962, 2500–3000 ft. **WA** (all USNM) *1 ♀, Mt. Rainier, Summerland, 24.vii.1924, A.L. Melander; 1 ♀, same data except Mazama Ridge, 23.vii.1922.

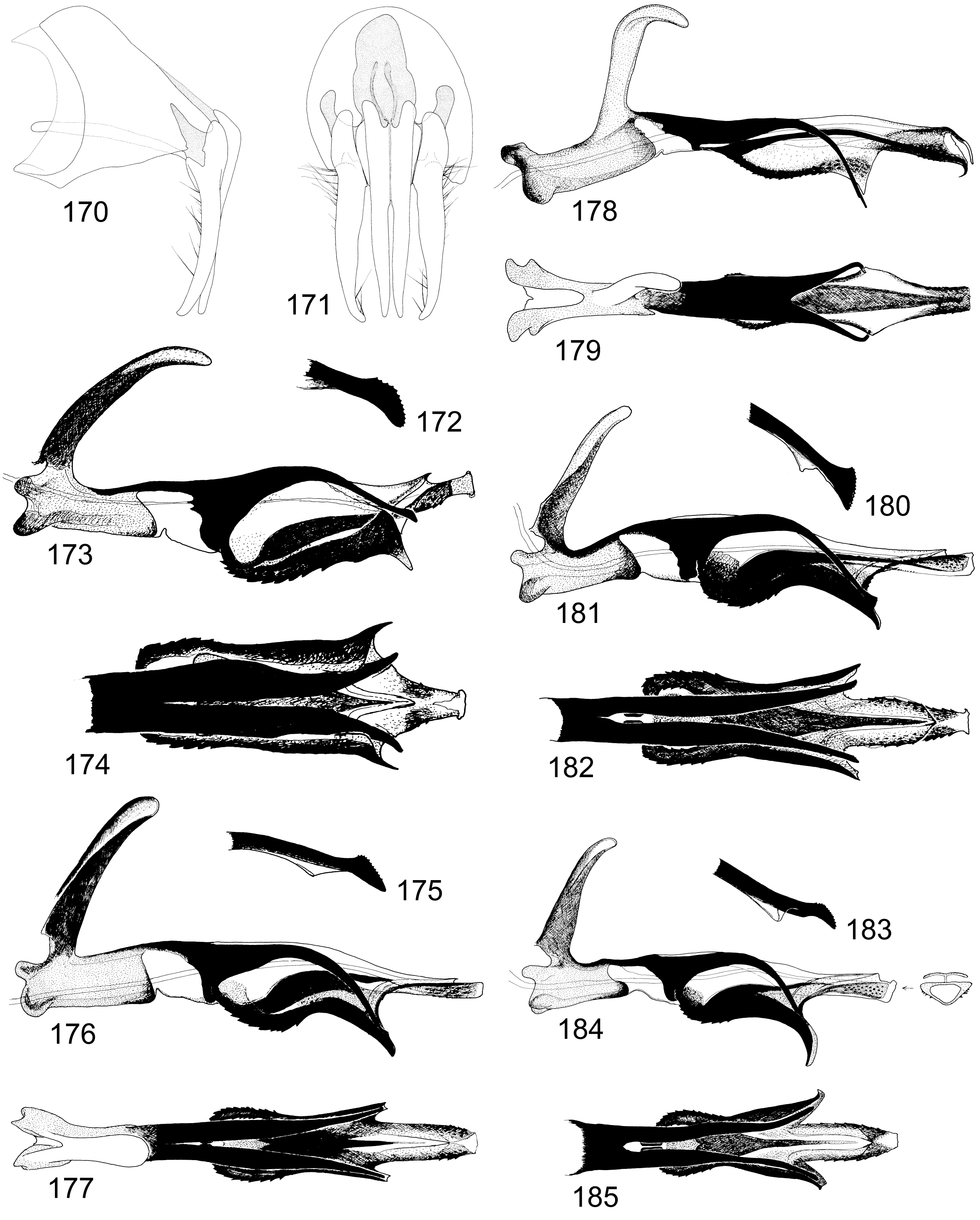
Remarks. Shannon (1926) erroneously stated that the type specimens were deposited in the USNM (Cat. No. 28,895). Hall (1948) was not able to locate these specimens in the USNM because they are housed in the CNC (Cooper & Cumming 2000). Whitworth (2006) redescribed the holotype male in detail. See discussion under "Barcoding of Nearctic *Calliphora*".

This species is much more common and widespread than its sister species, *C. aldrichia*. It was relatively common above 1,500 m in the mountains near Canmore, Alberta. In eastern Canada it is found at lower elevations, to near sea level.

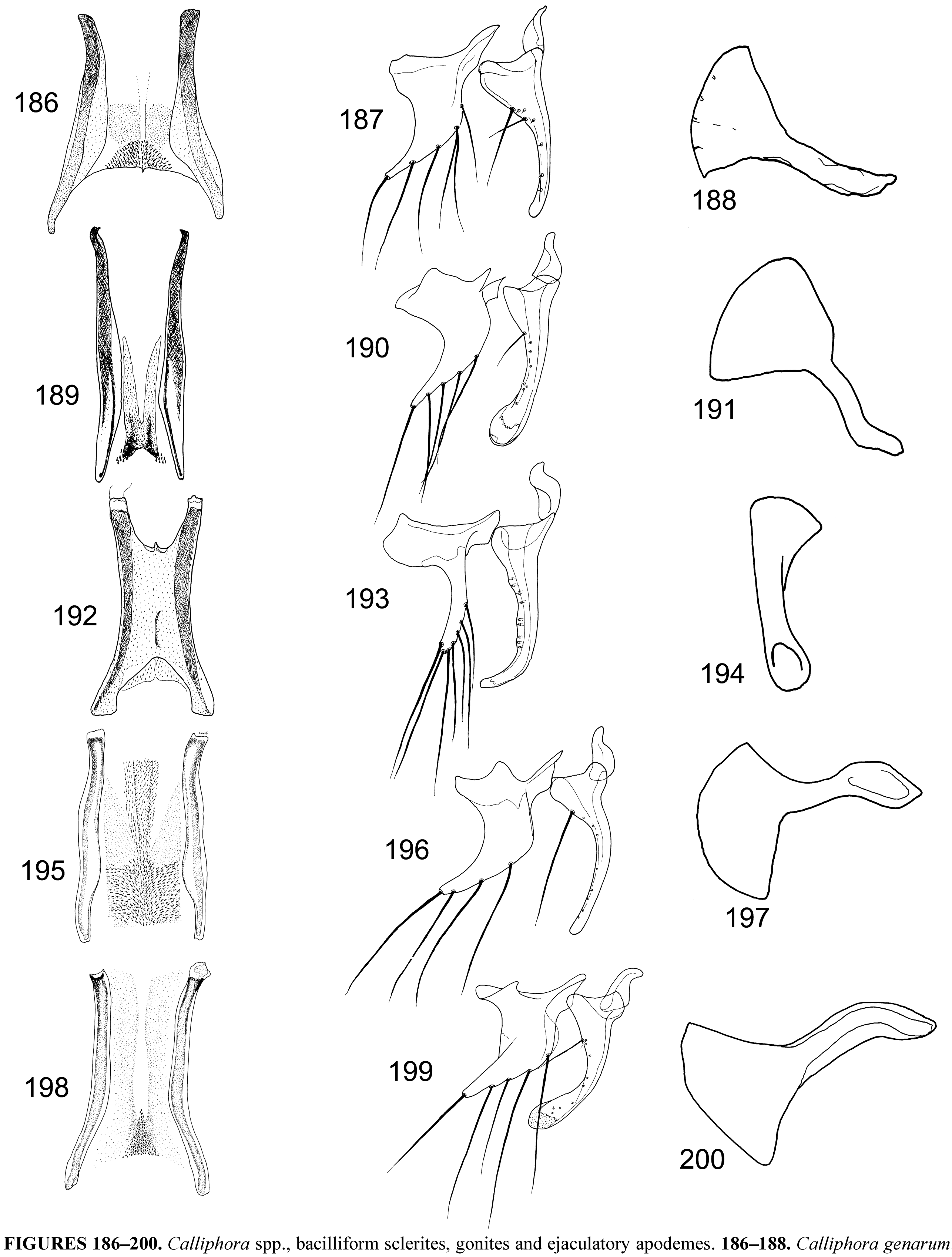
Distribution. Canada: AB, BC, MB, NB, NL, NS, NT, ON, QC, SK, YT. USA: AK, NY, WA. Most populations of *C. montana* and *C. aldrichia* are well separated; the two species overlap only in a narrow range from British Columbia south to Washington, where a few *C. montana* have been found.



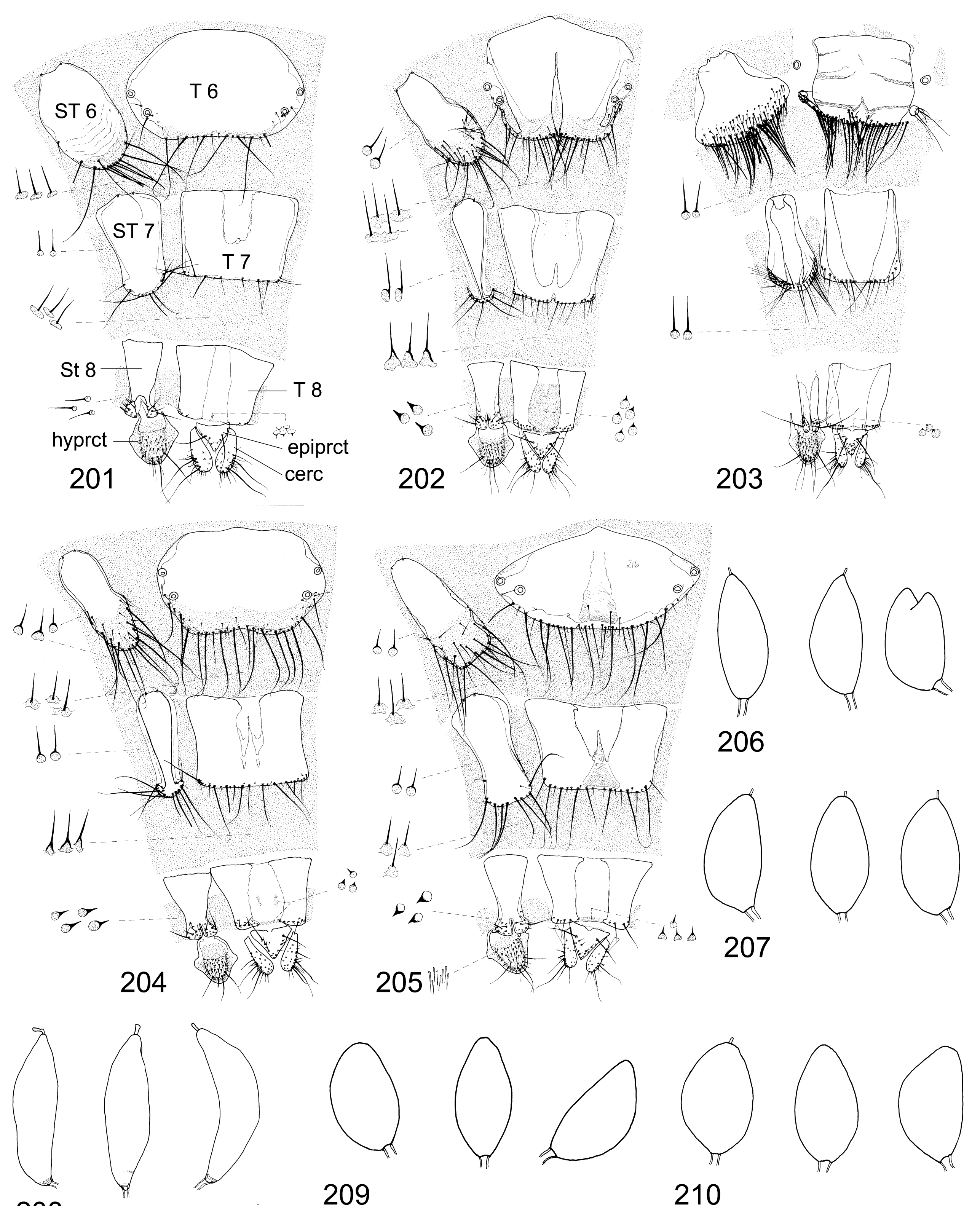
FIGURES 157–169. *Calliphora* spp., male abdominal sternites (ventral view) and male cerci and surstyli. **157.** *Calliphora genarum*. **158.** *Calliphora loewi*. **159.** *Calliphora stelviana*. **160.** *Calliphora vicina*. **161.** *Calliphora vomitoria*. **162–163.** *Calliphora genarum*. **162.** Lateral view. **163.** Posterior view. **164–165.** *Calliphora loewi*. **164.** Lateral view. **165**. Posterior view. **166–167.** *Calliphora stelviana*. **166.** Lateral view. **167.** Posterior view. **168–169.** *Calliphora vicina*. **168.** Lateral view. **169**. Posterior view.



FIGURES 170–185. *Calliphora* spp., cerci, surstyli and phalli. **170–171.** *Calliphora vomitoria*, cerci and surstyli. **170.** Lateral view. **171.** Posterior view. **172–174.** *Calliphora genarum*. **172.** Tip of paraphallus, lateral view. **173.** Phallus, lateral view. **174.** Distiphallus, dorsal view. **175–177.** *Calliphora loewi*. **175.** Tip of paraphallus, lateral view. **176.** Phallus, lateral view. **177.** Phallus, dorsal view. **178–179.** *Calliphora stelviana*. **178.** Phallus, lateral view. **179.** Phallus, dorsal view. **180–182.** *Calliphora vicina*. **180.** Tip of paraphallus, lateral view. **181.** Phallus, lateral view. **182.** Distiphallus, dorsal view. **183–185.** *Calliphora vomitoria*. **183.** Tip of paraphallus, lateral view. **184.** Phallus, lateral view. Inset: apex of acrophallus with opening of sperm duct and opening of lateral ducts above it. **185.** Distiphallus, dorsal view.



FIGURES 186–200. *Calliphora* spp., bacilliform sclerites, gonites and ejaculatory apodemes. **186–188.** *Calliphora genarum*. **186.** Bacilliform sclerites. **187.** Pre- and postgonites. **188.** Ejaculatory apodeme. **189–191.** *Calliphora loewi*. **189.** Bacilliform sclerites. **190.** Pre- and postgonites. **191.** Ejaculatory apodeme. **192–194.** *Calliphora stelviana*. **192.** Bacilliform sclerites. **193.** Pre- and postgonites. **194.** Ejaculatory apodeme. **195–197.** *Calliphora vicina*. **195.** Bacilliform sclerites. **196.** Pre- and postgonites. **197.** Ejaculatory apodeme. **198–200.** *Calliphora vomitoria*. **198.** Bacilliform sclerites. **199.** Pre- and postgonites. **200.** Ejaculatory apodeme.



FIGURES 201–210. *Calliphora* spp., ovipositors (ventral and dorsal views) and spermathecae. **201–205.** Ovipositors. **201.** *Calliphora genarum*. **202.** *Calliphora loewi*. **203.** *Calliphora stelviana*. **204.** *Calliphora vicina*. **205.** *Calliphora vomitoria*. **206–210.** Spermathecae. **206.** *Calliphora genarum*. **207.** *Calliphora loewi*. **208.** *Calliphora stelviana*. **209.** *Calliphora vicina*. **210.** *Calliphora vomitoria*. Abbreviations: cerc = cercus, epiprct = epiproct; hyprct = hypoproct; ST = abdominal sternite; T = abdominal tergite.

10. *Calliphora stelviana* (Brauer & Bergenstamm, 1891)

(Figs 5, 8, 14–15, 23–24, 159, 166–167, 178–179, 192–194, 203, 208, 211)

Acrophaga stelviana Brauer & Bergenstamm, 1891: 367. Lectotype male (not examined) (NMW). Type locality: Tyrol, Austria (see Rognes 1986: 352).
Acronesia abina Hall, 1948: 274. Hall (1965: 928); Rognes (1991: 75, 80; as synonym of *stelviana*).
Acronesia anana Hall, 1948: 278. Hall (1965: 928); Sailer & Lienk (1951: 209); Rognes (1991: 75; as synonym of *stelviana*).
Calliphora stelviana: Rognes (1986: 352, 1991: 75); Poole (1996: 77); Whitworth (2006: 698); Marshall *et al.* (2011: 52).

Diagnosis. The calypters of *C. stelviana* are wholly white (Fig. 5), a character shared only with *C. genarum*. The arista has long setae above and below (Fig. 14). The surstylus is distinctive (Fig. 166) and there is a comb of strong marginal setae on the female T5 (Figs 23–24, 203). Male frons 0.16 (0.15–0.17/10) of head width at narrowest. Female frons 0.40 (0.38–0.42/7) of head width at narrowest.

Material examined. Canada. **AB** *1 ♂, Laggan [Lk. Louise], 24.viii.1902, R.C. Osburn (USNM). **NT** 1 ♀, 21 mi E Tuktoyaktuk, 8–12.vii.1971, D.M. Wood (CNC); 1 ♂, 21 mi E Tuktoyaktuk, 17–21.vii.1971, D.M. Wood (CNC). **NU** 1 ♀, Bathurst Inlet, 8–12.vi.1952, G.J. Spencer (UBCZ). **YT** 1 ♂, Dempster Hwy, km 465, 800 m, 5–7.vii.1980, Wood & Lafontaine (CNC); 1 ♀, Dempster Hwy, mi 51, 1–8.vii.1973, G. & D.M. Wood (CNC) 1 ♂, Richardson Mt., 720 m, 67°58′N 136°29′W, 1–5.vii.1987, M. Polak & M. Wood (CNC); 1 ♀, Kluane, 27.viii.1990, Malaise trap, S.G. Cannings (UBCZ). USA. **CO** 3 ♀, Hwy 91, mi 7, 39°20′20″N 106°13′25″W, 10315 ft, bait trap-fish, 16.viii.2015, T.L. Whitworth (TW); 2 ♀, Hwy 91, mi 20, 39°28′38″N 106°07′87″W, 10015 ft, bait trap-fish, 16.viii.2015, T.L. Whitworth (TW); *1 ♂, 8 ♀, Clinton Reservoir, 39°24′94″N 106°10′29″W, 11212 ft, bait trap-fish, 16.viii.2015, T.L. Whitworth (TW).

Remarks. See Rognes (1991) for a detailed description of this species. This species is more abundant in museum collections than its sister species, *C. genarum.* It occurs farther south, from southern Canada to Colorado. In a recent collecting trip to northern Colorado (2014), 22 specimens were collected in one week in five bait traps on mountain peaks from 3,000 to 3,300 m. All but one *C. stelviana* collected lacked one or both presutural intra-alar setae. Of four specimens from Alberta, two males lacked a pair of presutural setae and two females had a presutural seta on one side only. Of a few specimens examined from British Columbia, most had a pair of presutural intra-alar setae; only one male lacked these setae. Rognes (1991) stated that Scandinavian *C. stelviana* have a pair of presutural intra-alar setae, while they were either present or absent among North American specimens.

The illustration of the male terminalia in Shewell (1987, fig. 29) is of *C. stelviana.*

Distribution (Nearctic). Canada: AB, BC, MB, NL, NT, NU, QC, YT. USA: AK, CO.

11. *Calliphora terraenovae* Macquart, 1851

(Figs 42–44, 58, 72–73, 92–94, 116–118, 137–138, 149, 211)

Calliphora terrae-novae Macquart, 1851: 217. Holotype female, not examined (MNHN). Type locality: Newfoundland, Canada. Other references: James (1953: 145, 1955: 4).
Calliphora vomitoria nigribarba Shannon, 1923: 109 (in key), 116 (as *vomitoria* var.). Lectotype male, not examined (USNM, Cat. No. 26165). Type locality: New York. Other references: Shannon (1926: 134); Hall (1948: 303; lectotype designation); Hall (1965: 929; as synonym of *vomitoria*).
Calliphora terraenovae: Hall (1948: 303, 1965: 929); Hall & Townsend (1977: 27); Rognes (1991: 88); Poole (1996: 77); Whitworth (2006: 700); Marshall *et al.* (2011: 68).

Diagnosis. This species can be distinguished by the reddish or orange genal groove (Fig. 44), which similar species lack; anterior 1/3–1/2 of genal dilation reddish (Fig. 44). Male terminalia as in Figures 72–73; female ovipositor as in Figures 137–138.

Redescription. Genal groove usually reddish or orange (Fig. 44) (rarely found also in *C. loewi*, *C. montana* and *C. alaskensis*); anterior 1/3–2/3 of genal dilation usually reddish when viewed from above (Fig. 44) (not always obvious); parafacial golden or silvery-tanned when viewed from above; upper basal half of first flagellomere usually orange, occasionally darkened. **Male:** frons 0.04 (0.04–0.05/7) of head width at narrowest (Fig. 42); cercus and surstylus long, slender and nearly equal in length (Figs 72–73); cercus, in lateral view, with base distinctly bulged upwards (Fig. 72); surstylus, in lateral view, gently curved anteriorly; tip directed medially in posterior view. **Female:** frons 0.36 (0.35–0.38/10) of head width at narrowest (Fig. 43); T4 longer than T5, T5 with short posterior incision; T6 broad and complete (Fig. 137); proximal 2/3 of T7 divided midway, with a small, arrow-shaped, sclerotized partition arising from mid-distal end and extending anteriorly to about midway; ST6 and ST7 broad, each with a digit-like extension medially on distal margin (Fig. 138).

Material examined. Canada. **AB** *1 ♂, Spray Lakes Rd, 51°05′06″N 115°24′03″W, 11.viii.2012, bait trap, T.L Whitworth (TW). **BC** 1 ♂, 32 mi SW Terrace, 100 ft, 4.vi.1960, B. Heming (CNC); 1 ♂, 32 mi SW Terrace, 50 ft, 6.vi.1960, R. Pilfrey (CNC); 1 ♀, 32 mi SW Terrace, 6.vi.1960, J.G. Chillcott (CNC); 1 ♀, Ketchum, 58°22′N 131°45′W, 3600 ft, 23.viii.1960, W.W. Moss (CNC). **NL** 1 ♀, Northern Pen., Pistolet Bay Prov. Park, 31.vii.–1.viii.1983, K. Rognes & fam. (TW). **YK** *1 ♀, Whitehorse, 28.viii.1959, R. Madge (CNC). USA. **AK** *1 ♂, Auke Bay, 22.vii.1952, [collector illegible] (WSUP); *1 ♂, Ketchikan, 9.ix.1955; F. Baker (WSUP); 1 ♀, Denali Park, Nenana River, 10.viii.2008, T.L. Whitworth (TW). **AZ** 1 ♂, Kaibab NF, West Side Rd (FR 22), 36°27.6′N 112°14.4′W, 8520 ft, 2.ix.2014, J.E. O'Hara (CNC); 1 ♀, Coconino NF, Kinder Crossing, 34°33.94′N 111°08.7′W, 6460 ft, 9.ix.2014, J.E. O'Hara (CNC). **CO** *1 ♂, Doolittle Ranch, 9800 ft, Mt. Evans, 22.vii.1961, W.R.M. Mason (CNC). **NM** 1 ♀, Grant Co., Signal Peak, 8896 ft, 15.viii.2007, bait trap, T.L. Whitworth (TW). **TX** 1 ♀, Jeff Davis Co., upper Limpia Ck, 12–14.iv.2002, 6180 ft, E. Riley (TAMU). **UT** *1 ♂, Grand Co., 12 mi SE Moab, 8500 ft, 1.vi.2011, bait trap, T.L. Whitworth (TW). **WA** *1 ♂, Pullman, x.1953, A. Kamal (WSUP); 1 ♀, Alpental, 47°26′55″N 121°25′40″W, 2.ix.2013, T.L. Whitworth (TW). **WY** *1 ♂, Washakie Co., HighPark abv Meadowlark Lk., 44°09′53″N 107°13′70″W, 25.vii.1998, pan trap, F. Parker (LACM).

Remarks. *Calliphora terraenovae* is a fairly common and widespread species in Western North America, at higher elevations in the southern part of its range, at lower elevations farther north. It is occasionally found in eastern Canada and the northeastern United States. It can be difficult to separate from similar species, especially *C. loewi* and *C. alaskensis*; the terminalia of both sexes should be dissected to confirm identification.

Distribution. Canada: AB, BC, MB, NB, NL, NS, ON, QC, SK, YT. USA: AK, AZ, CA, CO, ID, MT, NC, NM, NV, NY, OR, UT, WA, WI, WY.

12. *Calliphora vicina* Robineau-Desvoidy, 1830

(Figs 6, 18, 160, 168–169, 180–182, 195–197, 204, 209, 211)

Calliphora vicina Robineau-Desvoidy, 1830: 435. Holotype female, not examined (OUMNH). Type locality: Philadelphia, USA (see Dear 1986: 26; Rognes 1991: 68). Other references: Hall (1948: 307); Sailer & Lienk (1951: 210); James (1953: 144, 1955: 14); Hall & Townsend (1977: 27); Rognes (1991: 63); Poole (1996: 77); Whitworth (2006: 699); Marshall *et al.* (2011: 65).

Musca carnivora Fabricius, 1794: 313. Name suppressed, see International Commission on Zoological Nomenclature (1992 [Opinion 1670]).

Musca erythrocephala Meigen, 1826. Junior primary homonym of *Musca erythrocephala* De Geer, 1776. Name suppressed, see International Commission on Zoological Nomenclature (1992 [Opinion 1670]).

Calliphora rufifacies Macquart, 1851: 216. Holotype male, not examined (MNHN) (see Rognes 1991: 68).

Diagnosis. This species can be identified by its yellow basicosta, and anterior half of genal dilation and anterior spiracle of yellow-orange color (Fig. 6). Male frons 0.09 (0.07–0.12/9) of head width at narrowest (about 2/3 width of parafacial at lunule). Female frons 0.35 (0.33–0.35/8) of head width at narrowest.

Material examined. Canada. **BC** 1 ♂, Terrace, 4.vii.1960, G.E. Shewell (CNC); 1 ♂, Terrace, 4.vii.1960, J.G. Chillcott (CNC); 1 ♀, Deep Bay nr Bowser, 21.vi.1955, R. Coyles (CNC); 1 ♀, Terrace, 8.vii.1960, W.R. Richards (CNC). **ON** 1 ♂, Mt. Nemo Conservation Area, 12.vi.2011, O. Lonsdale (CNC). **NL** 1 ♂, 2 ♀, St. John's, Agric. Exp. Sta., 3.viii.1967, J.F. McAlpine (CNC). **SK** *1 ♂ [dissected by G.E. Shewell], Saskatoon, 16.ix.1952, A.R. Brooks (CNC). USA. **OH** 1 ♂, Hamilton Co., Cincinnati, Price Hill, 25.v.1996, E. Eaton (TW). USA. **GA** 1 ♀, Lawrence Co., Dublin, 11.x.1975, J. Beall (TW). **TN** 1 ♀, Great Smoky Mts. NP, Cerulean Knob, 35°37′45″N 83°47′03″W, 1134 m, hilltopping, 3.vi.2001, J. Skevington (CNC). **WA** *2 ♂, Pierce Co., Tacoma, 13.vii.1998, T.L. Whitworth (TW). **WI** *1 ♂, Florence Co., Spread Eagle, 28.vi.1988, R.H. Roberts (TW); 2 ♀, Jefferson Co., Neah Bay, 29.vii.2010, bait trap, T.L. Whitworth (TW).

Remarks. See Rognes (1991) for a detailed description of this species. Most *C. vicina* have a yellow basicosta; we have seen a few specimens of this species with an entirely black basicosta, though most variant specimens had the posterior edge of the basicosta pale. The terminalia of these aberrant specimens were examined and they were positively identified as *C. vicina*.

Distribution (Nearctic). Canada: AB, BC, MB, NL, NS, ON, QC, SK. Mexico: Mexico City. USA: CA, CO, DE, FL, GA, IA, IL, IN, KS, MA, ME, MI, MO, NC, NH, NJ, NM, OH, OK, OR, PA, SC, TN, TX, UT, VA, WA, WI, WV. A common and widespread species that tends to be synanthropic. It is rarely found in remote wild areas, but is common near cities.

13. *Calliphora vomitoria* (Linnaeus, 1758)

(Figs 7, 9, 161, 170–171, 183–185, 198–200, 205, 210–211)

Musca vomitoria Linnaeus, 1758: 595. Type, sex unspecified, not examined. Type locality: Sweden (see Hall 1948: 313; Thompson & Pont 1994: 134).

Calliphora vomitoria: Shannon (1923: 116, 1926: 134); Hall (1948: 313, 1965: 930); Sailer & Lienk (1951: 210); Gill (1955: 651); Hall & Townsend (1977: 27); Rognes (1991: 88); De Jong (1994: 383); Poole (1996: 77); Whitworth (2006: 700); Marshall *et al.* (2011: 55).

Diagnosis. This species is readily recognized by the presence of long, yellow-orange setae on the postgena, lower posterior corner of the genal dilation and back of head, sometimes extending anteriorly along lower edge of genal dilation (Fig. 7). Male frons 0.04 (0.04–0.05/10) of head width at narrowest. Female frons 0.34 (0.31–0.035/10) of head width at narrowest.

Material examined. Canada. **BC** 1 ♂, Vancouver, 24.viii.1972, J.R. Vockeroth (CNC); 1 ♂, Mission City, 13.vi.1953, G.J. Spencer (CNC); 1 ♀, Terrace, Spring Ck, 220 ft, 3.vi.1960, R. Pilfrey (CNC). **NL** 1 ♀, Carbonear, 15.viii.1962, R.F. Morris (CNC). **NS** 1 ♂, Cape Breton NP, French Lk. Bog, PG633770, 15.vii.1983, G. & M. Wood (CNC). **QC** 1 ♂, Rigaud, hilltop, 45°28′N 74°18′W, 9.v.2006, J.E. O'Hara (CNC). USA. **AK** *2 ♂, Ketchikan, 11.ix.1956, F. Baker (LACM). **AZ** 1 ♀, Coconino NF, East Clear Ck at FR 95, 34°33.0′N 111°09.8′W, 6500 ft, 10.ix.2014, J.E. O'Hara (CNC). **CA** *2 ♂, 3 ♀, Del Norte Co., Botanical Trail, 41°51′06″N 123°54′43″W, bait trap, T.L. Whitworth (TW). **ID** *1 ♂, Latah Co., 6 mi N Moscow, 21.iv.1971, W.J. Turner (WSUP). **NH** *1 ♂, Rock Co., Exeter Riv., 1 mi S Exeter, 29.v.1991, D.S. Chandler & S. Durley (TW). **OR** 1 ♂, Wheeler Co., 10 mi E Fossil, 29.vi.2009, bait trap, T.L. Whitworth (TW). **WA** *1 ♂, vi.1921, W. Clarkston (LACM); *1 ♂, Pierce Co., Tacoma, 17.viii.1998, T.L. Whitworth (TW). **WI** 1 ♂, Bayfield Co., Copper Range, Brule River, 15.vi.1993, D. Young (TW).

Remarks. See Rognes (1991) for a detailed description of this species. A common, widespread species, especially in northern North America or at higher elevations farther south in the United States. It is the dominant species of *Calliphora* in some locations. Most specimens are exceptionally large, larger than most other Nearctic *Calliphora*.

Distribution (Nearctic). Widespread. Canada: AB, BC, MB, NB, NL, NS, NT, ON, QC, SK, YT. USA: AK, AZ, CA, CO, GA, HI, ID, KS, MA, ME, MI, MN, MS, NC, NH, NJ, NM, NV, NY, OR, PA, SC, TN, UT, VA, VT, WA, WI, WV.

Unrecognized species

Calliphora viridescens Robineau-Desvoidy, 1830

Calliphora viridescens Robineau-Desvoidy, 1830: 437. Holotype female, not examined (?MHNM). Type locality: Carolina. *Nomen dubium* (see Hall 1965: 929).

Remarks. Hall (1948) discussed the history of this unrecognized species. *Calliphora viridescens* was described on the basis of a single female specimen. Hough (1899) applied this name to Nearctic specimens and provided an identification key to species that was followed by all subsequent authors. Hall (1948) reported that Aldrich had examined the type in 1928 and had determined that it was not conspecific with *viridescens sensu* Hough (1899). Aldrich was unable to determine to which other North American species the name *viridescens* should be applied because of the poor condition of the type. Consequently, it is viewed as a *nomen dubium* or an unrecognized species (Hall 1965).

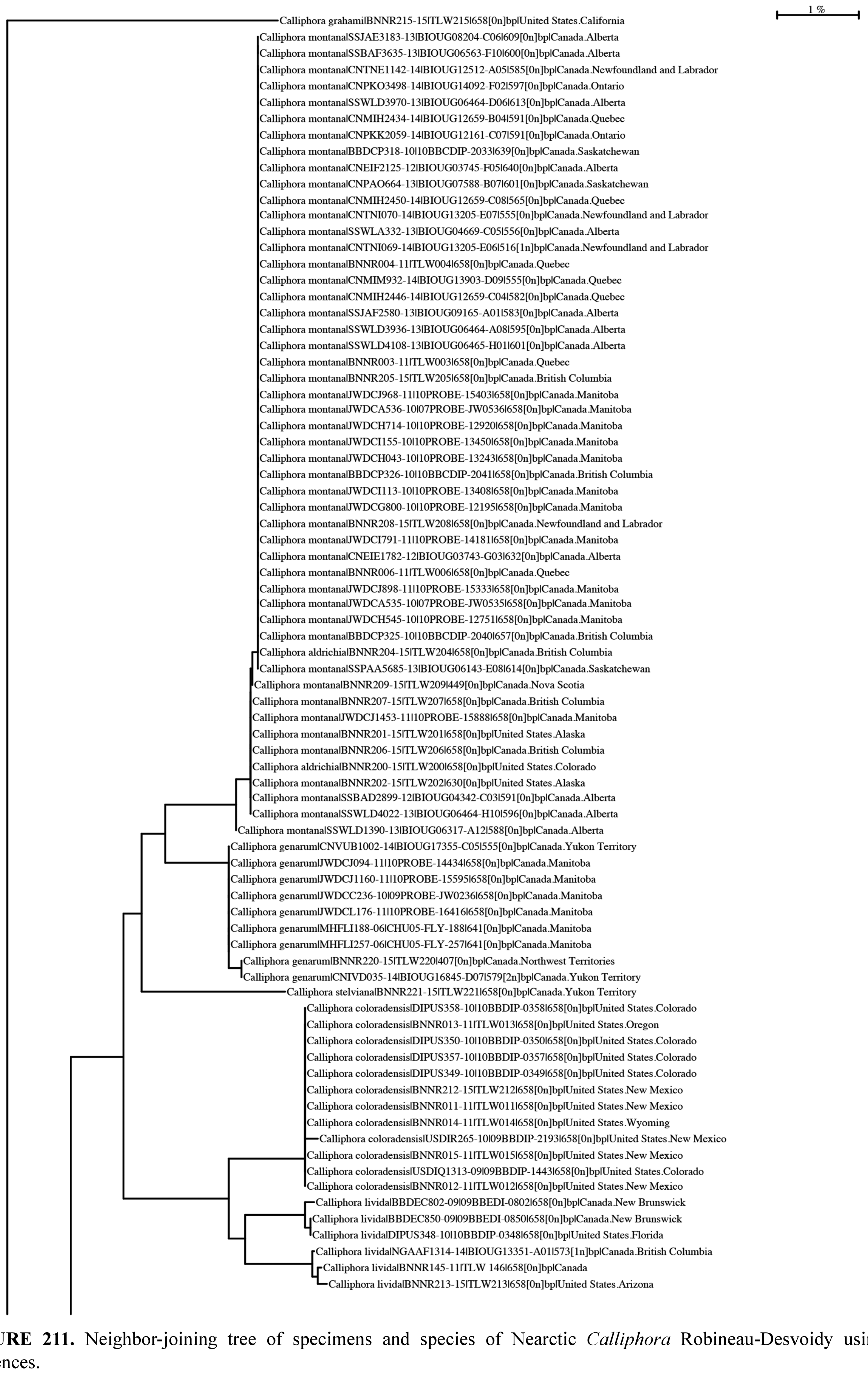


FIGURE 211. Neighbor-joining tree of specimens and species of Nearctic *Calliphora* Robineau-Desvoidy using *COI* sequences.

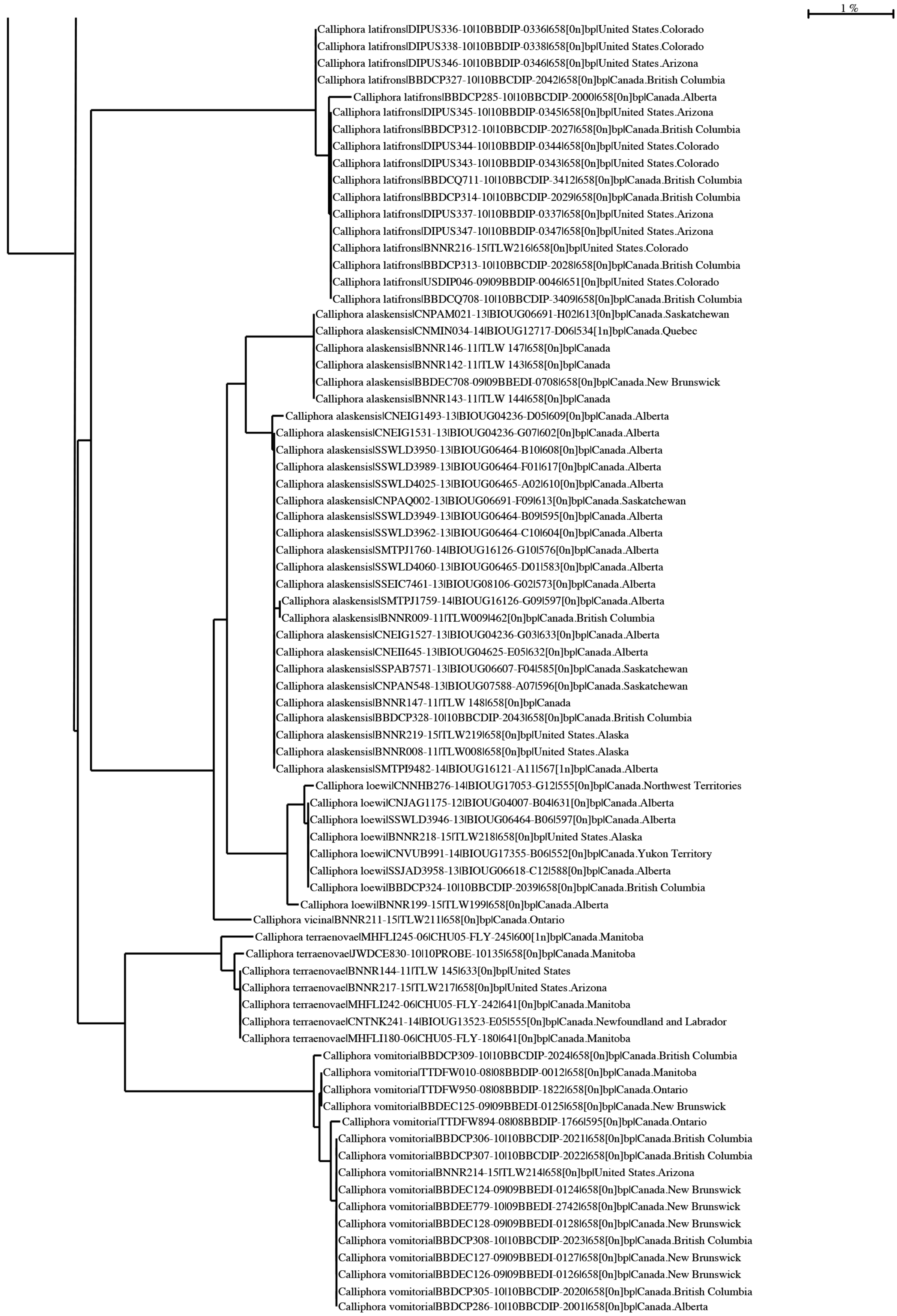


FIGURE 211. (Continued)

Barcoding of Nearctic *Calliphora*

In this study, 156 specimens representing all 13 species of Nearctic *Calliphora* were DNA-barcoded (Fig. 211). Generally, specimens belonging to the same species clustered together, confirming our morphological identifications. The specimens were examined morphologically before and after barcoding to confirm or correct species' identities.

Two specimens of *C. aldrichia*, one from Colorado and one from British Columbia (BC), and 49 specimens of *C. montana* from AK, AB, BC, MB, NL, NS, ON, QC and SK, were successfully barcoded (Fig. 211). In the resulting neighbor-joining tree, *C. aldrichia* and *C. montana* clustered together, but morphologically they are clearly two separate species (see Diagnosis for *C. aldrichia*). Additional specimens of *C. aldrichia* are required to further investigate the lack of resolution. Barcoding also does not separate other calliphorid species; in North America, for example, it does not separate *Lucilia coeruleiviridis* Macquart and *L. mexicana* Macquart (DeBry *et al*. 2013). Whitworth (2014) barcoded both *Lucilia* species and confirmed this problem with the specimens he studied.

Calliphora livida is divided into eastern and western North American clusters in the NJ tree, but analysis of additional specimens from across North America is required to investigate this further. *Calliphora alaskensis* also formed eastern and western North American clusters, with overlap of the populations occurring in Saskatchewan. The Saskatchewan specimens present in both clusters are from the same collection locality and the percent difference between clusters is just over 1%. This is possibly indicative of two different genetic populations. As with *C. livida*, barcodes from additional specimens of these species from across North America are required to evaluate the significance of these apparent geographical clusters.

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