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KEYS TO THE GENERA AND SPECIES OF BLOW FLIES

(DIPTERA: CALLIPHORIDAE) OF AMERICA, NORTH OF MEXICO

UPDATES AND EDITS AS OF SPRING 2017

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Total number of species in Nearctic-93

Abstract

A key separating Calliphoridae from similar Diptera families in North America is given. Keys to 16 genera and 53 species of North American calliphorids north of Mexico are provided. The distribution and key characters for each species are discussed and 84 illustrations are included. *Calliphora montana* Shannon is redescribed.

Author’s note: These keys were first published in 2006. Since then, numerous researchers have used them and provided me feedback on issues they encountered with them. This document provides updates and revisions to make the keys easier to use. I welcome further feedback from key users. Terry Whitworth

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Introduction

The most recent revision of North American blow flies was by Hall (1948); however, Hall’s keys have proven to be difficult to use because of his heavy reliance on proportional measurements of characters and the fact that he measured no more than five to ten specimens per species. He also chose specimens representing size extremes rather than “average” individuals (Sabrosky *et al.* 1989). Subsequently,

James (1953, 1955) and Hall and Townsend (1977) provided revised keys, which clarified the identification of regionally selected species. James addressed the western species of blow flies, while Hall and Townsend provided keys to blow flies found in Virginia. Shewell (1987) provided a key to the genera of North American calliphorids, but did not key species. Rognes (1991) reviewed Palearctic and Holarctic species and recommended numerous changes in blow fly taxonomy. Many of his name changes affected taxa found in North America.

Downes (1965) reduced the North American genera *Angioneura* Brauer and Bergenstamm and *Opsodexia* Townsend to subgenera under the Palearctic genus *Melanomya* Rondani. Later Downes (1986) revised species he had placed within *Melanomya* describing one new species. Shewell (1987) resurrected *Angioneura* and *Opsodexia* as genera. Dear's (1985) revision of the New World Chrysomyini resulted in *Paralucilia wheeleri* (Hough) being synonymized with *Compsomyiops callipes* Bigot, and *Chloroprocta fuscanipennis* (Macquart) with *C. idioidea* (Robineau-Desvoidy).

Sabrosky *et al.* (1989) revised the genus *Protocalliphora* Hough in North America and described 15 new species. Subsequently, Whitworth (2002, 2003a) described three additional species. Rognes (1985) synonymized the North American *Protocalliphora hirudo* (Shannon and Dobrosky) and the Palearctic *Trypocalliphora lindneri* Peus with *Trypocalliphora braueri* (Hendel). Sabrosky *et al.* (1989) agreed with this, but reduced *Trypocalliphora* Peus to a subgenus of *Protocalliphora*. Whitworth (2003b) re-evaluated the status of *Trypocalliphora* and agreed with Rognes (1985) that it should be a separate genus.

Rognes (1991) combined Hall's (1948) tribes Phormiini and Chrysomyini under the subfamily Chrysomyinae. Rognes (1991) also proposed the following synonymies: *Boreellus* Aldrich and Shannon = *Protophormia* Townsend (Chrysomyinae); *Phaenicia* Robineau-Desvoidy, *BufoLucilia* Townsend, and *Francilia* Shannon = *Lucilia* Robineau-Desvoidy (Luciliinae); *Acrophaga* Brauer and Bergenstamm, *Acronesia* Hall, *Aldrichina* Townsend, and *Eucalliphora* Townsend = *Calliphora* Robineau-Desvoidy and *Bellardia agilis* (Meigen) = *B. vulgaris* (Robineau-Desvoidy) (Calliphorinae). He disagreed with Shewell's (1987) revival of the genus *Acrophaga* which Zumpt (1956) had synonymized with *Calliphora*. Shewell had included three species in this genus, *genarum*, *stelviana*

and the Palearctic *subalpina*. Rognes (1991) retained these species in *Calliphora*. He followed Shewell (1987) in retaining *Angioneura* and *Opsodexia* (Melanomyiinae) as genera. Thus *Melanomya* is a Palearctic genus that does not occur in North America. *Angioneura* is a Holarctic genus represented by five species in North America while *Opsodexia* is a Nearctic genus with four species in North America. I have adopted all of Rognes' (1991) changes.

Recently, interest in blow flies has increased, along with studies in forensic entomology. Smith (1986) published keys to adult blow flies of Britain while Greenberg and Kunich (2002) provided keys for Oriental, Australian, South American, and Holarctic species. These keys include some species shared with the Nearctic Region, but omit species found only in North America. The lack of any comprehensive species keys for North American blow flies prompted this study.

Materials and Methods

Specimens for this project were obtained from various entomological collections throughout North America and my personal collection. A complete list of my sources for specimens is under acknowledgments. Many blow flies were personally collected with the aid of bait traps baited with carrion. See Whitworth 2010, 2014 for details on traps and trapping techniques.

The keys are written for the identification of dry, pinned specimens. With the advent of DNA analysis, many specimens are now collected in alcohol, or other liquids, which discolors and warps specimens often making identification more difficult. To use these keys it's best to pin and dry out specimens in liquids. Soaking specimens in ethyl acetate or xylene before drying completely helps restore cuticle color and "liven up" matted setae, making identification easier.

Characters used in my keys are usually visible with the aid of a quality stereomicroscope and a good light. An ocular micrometer will assist in making proportional measurements. It should be noted that fiberoptic and LED lights tend to "wash out" colors, such as yellow and orange, so workers using incandescent lights should consider that when interpreting color characters. Some specimens need to be

relaxed to reveal certain characters. Flies were relaxed over wet sand in shallow plastic containers with tight-fitting lids. Most specimens were sufficiently relaxed after 24 hours in a relaxing chamber so they could be handled without damage. Those left too long in the relaxing chamber were susceptible to mold or rot and could be ruined. If removed too soon, they were brittle and prone to breakage. Older specimens often had to be relaxed longer before they could be manipulated safely. The shape of the male and female genitalia are useful to confirm species when external characters are not distinctive. Male cerci and surstyli were drawn into view following techniques described by Hall (1948). I encountered problems using a bent insect pin, as recommended by Hall, because it tended to flex and sometimes would snap off the genitalia, damaging them. I had better results exposing genitalia using half of a pair of fine point tweezers bent to a 45-degree angle. Rognes (1991) has shown that female terminalia have characters useful to identify female specimens to species, however I did not rely on them in the keys. Since this work was published, I now regularly fully dissect both sexes for difficult to identify species. For some genera genitalia dissection is very important to confirm species identification (see Tantawi *et al.* 2017). To perform a complete dissection, break off the abdomen of a dry, pinned specimen by gently lifting under the end of the abdomen with fine tweezers to snap it off. Submerge the abdomen in a 10% potassium hydroxide solution for 12–24 hours, until it is sufficiently cleared and softened for full dissection. This clearing process takes longer for heavily sclerotized specimens and less time for weakly sclerotized specimens. Often abdomens have air trapped in them, making sinking them difficult. If they don't sink readily, allow them to soften for a few hours to relax the cuticle, then compress the abdomen to force out the air. Once softened and cleared, rinse in water to wash out the potassium hydroxide or tissue may become over cleared. I usually perform the initial dissection in water and separate the sternites and tergites by carefully tearing the pleural membrane. I then transfer the smaller parts to 95% ethyl alcohol for a few minutes, then into glycerol to dissect the smaller parts. Fine point tweezers, tiny scissors and tiny probes are needed for this stage. The genitalia for both sexes are found near the tip of the abdomen. For males, I separate the epandrium, surstyli and cerci, from the phallus (aedeagus), pre- and postgonites and ejaculatory sclerite. For females, I extend the ovipositor and separate it

from the abdomen between tergite and sternite 5 and 6. To study ovipositor sclerites, I split the ovipositor as in Tantawi *et al.* 2017. Once completed, I store dissected parts in a small genitalia vial with glycerol.

Terminology differences in the calliphorid literature can be confusing. For North American terminology see the Manual of Nearctic Diptera (McAlpine 1981); while for European terminology refer to the Manual of Palearctic Diptera (Papp and Darvis 1998). I have primarily followed McAlpine (1981) except as noted below. Figures 11–13 are reproduced from McAlpine (1981), and Figs. 14, 19–21, 25, 27–32, 42–43, 60–61, 63, 65 are from Shewell (1987) with permission of the Minister of Public Works and Government Services Canada, 2004.

Figures. 1–10 are reproduced with permission from Rognes (1991); they detail many of the characters used for blow fly identification. The names of some characters vary from common North American usage. The following are equivalent terms, with North American terms listed first: postpronotal lobe = humeral callus; postpronotal setae = posthumeral setae (inner and outer); posterior presutural supra-alar seta = presutural seta; propleuron = proepisternal depression; reclinate orbital seta = laterocline orbital seta (all are shown in Figs. 1,2).

Some changes to older terms are as follows, with the preferred term listed second: parafrontal = fronto-orbital plate; bucca = genal dilation; third antennal segment = first flagellomere (Figs. 3–5); inner and outer forceps = cerci and surstyli respectively (Figs. 9,10); and hypopleuron = meron (Fig. 2).

Some variation will be noted in spelling of the following, with the preferred spelling given second: acrostical = acrostichal, and intraalar = intra-alar. For hyphenated species names such as *terrae-novae*, a species of both *Calliphora* and *Protophormia*, the hyphen is dropped, as a result of a ruling by the International Commission on Zoological Nomenclature (ICZN 1999, Article 32.5.2.3.).

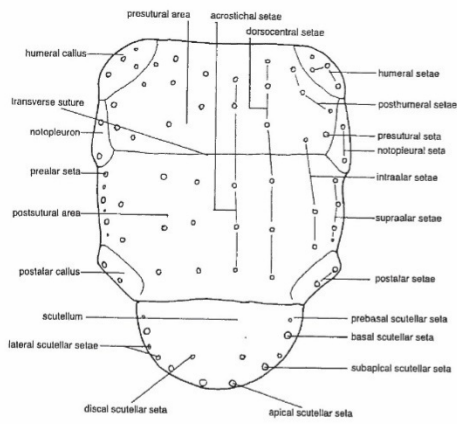
Several useful taxonomic characters are available on the wings (Fig. 6, 17), abdomen (Figs. 7, 8) and genitalia (males Figs. 9,10, females Figs. 11–13). Important characters which are species specific are illustrated separately. The ratio of head to frons widths are used throughout keys, see Figs. 23, 24 for how to measure. The average ratio is followed by the range and the total number of specimens measured.

Historically many terms have been used to describe the hairs and fine dusting observed in adult flies. I use the following convention: macrotrichia are larger hairs with nerves and sockets, microtrichia are cuticular extensions or dusting without sockets. Macrotrichia can be described as setae, setulae, hairs, or bristles. I will avoid the terms hairs and bristles and consider larger macrotrichia as setae and smaller macrotrichia as setulae. The term vestiture sometimes is used to describe patterns of macrotrichia. Microtrichia patterns have been called dusting, pubescence, pollinosity, microtomentum, or microtrichia. For purposes of this publication, the term microtomentum is used to describe this condition.

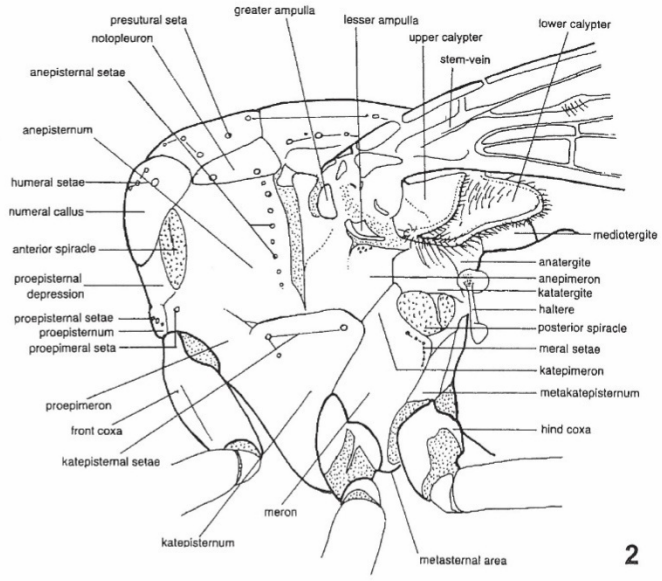
The scientific names used herein follow Rognes (1991). Where possible, characters used are readily observed with a good microscope and without dissection. The first character listed in a couplet is generally the most distinctive; characters listed after may not be as reliable or may be more difficult to distinguish. See Table 1 for a list of species in the order they are addressed and the names used by Hall (1948). The only synonyms given are for Hall's publication. This is not a complete list of synonyms for each species.

Partial keys to adult species of *Protocalliphora* are provided to be integrated with existing keys in Sabrosky *et al.* (1989). The key includes 3 new species I have described (Whitworth 2002, 2003a). I also have added revised illustrations and information to assist in the separation of species of this genus.

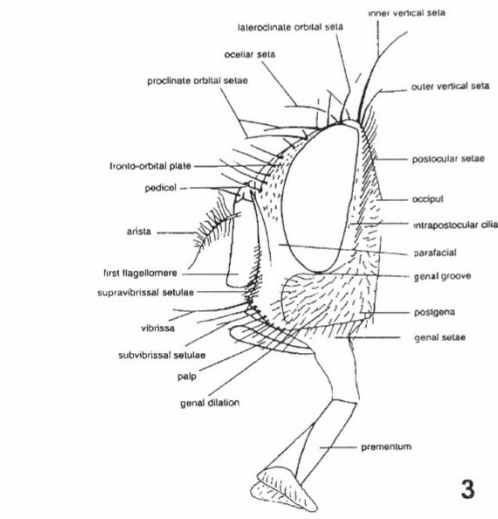
Species keys are not provided for *Melanodexia*, *Opsodexia*, or *Angioneura*. Both Hall (1948) and James (1955) provided species keys for *Melanodexia*, but they are difficult to use and in any case the genus needs revision, a task which is beyond the scope of this study. Downes (1986) provided keys to species of *Opsodexia* and *Angioneura* which are effective (N. Woodley, in litt.), but few specimens were available for this study and species keys are therefore not included. As of 2017, there are 93 species and 19 genera of Calliphoridae known in North America. The largest genera include *Protocalliphora* with 28 species, *Calliphora* with 18 species, and *Lucilia* with 12 species, see Table 1 for a list of species numbers.



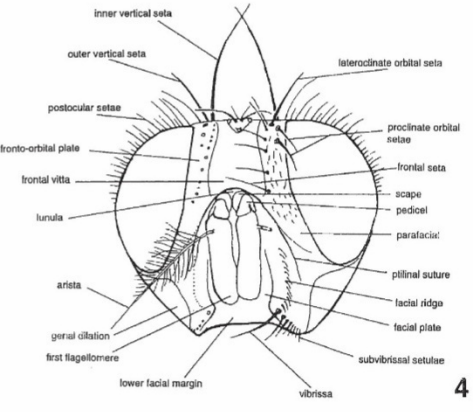
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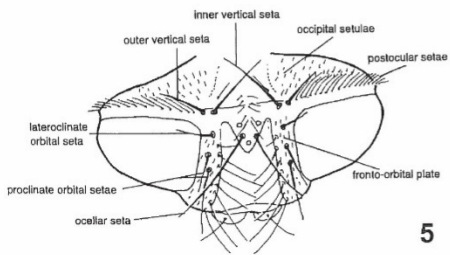
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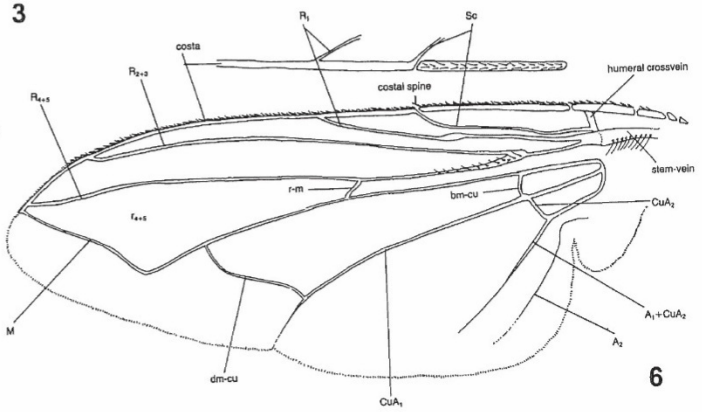
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4



5



6

Figs. 1–6. *Calliphora subalpina* (Ringdahl, 1931). 1, Dorsal view of thorax. 2, Left lateral view of thorax. 3, Left lateral view of head. 4, Anterior view of head. 5, Dorsal view of head. From Rognes (1991). 6, *Trypocalliphora braueri*, dorsal view of wing. Inset, portion of costa showing setulae on underside. From Rognes (1991).

Separating families

Most calliphorids are readily distinguished from other families by their metallic blue, green, or bronze color and the relatively large size of adults. Metallic muscids and tachinids are frequently found under Calliphoridae in collections because of these shared characters. Metallic muscids are readily separated from calliphorids by the absence of a row of setae on the meron. Metallic tachinids can be distinguished by their prominent subscutellum and bare arista.

The non-metallic calliphorid genus *Pollenia* Robineau-Desvoidy is common in North America. It can be recognized by a row of setae on the meron and an abundance of silky, crinkly hairs on the thorax. Other non-metallic calliphorids include the relatively rare *Angioneura*, *Opsodexia*, and *Melanodexia* which are more or less dull colored. Characters provided in the key should distinguish these genera. Non-metallic calliphorids are often found in collections with similar looking muscids, sarcophagids, and tachinids.

Key to separate calliphorids from similar families

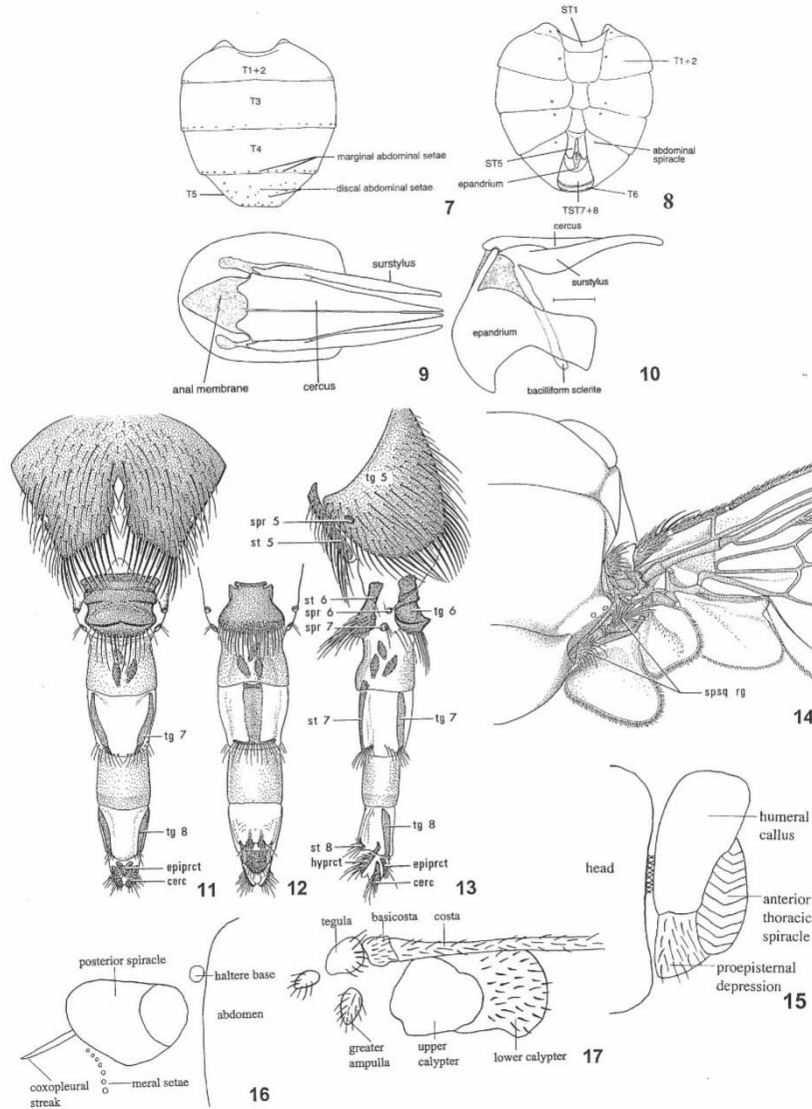
1. Meron without row of setae, sometimes scattered weak setulae. R4+5 and M with, at most, slight narrowing distally (this can be variable, but in most species, the difference is distinct)..... Muscidae, Anthomyiidae, Scathophagidae
 -Meron with distinct row of setae (Figs. 2,16). Veins R4+5 and M usually sharply converging distally (as in Fig. 5) 2
2. Subscutellum strongly developed (see fig. 2.66, McAlpine 1981); arista often bare (not in Dexiini and some other taxa)..... Tachinidae
 -Subscutellum absent or weak; arista usually setose (Fig. 3)[except *Angioneura* (Calliphoridae) and most Miltogramminae (Sarcophagidae)] 3
3. Abdomen, and usually thorax, shining metallic blue, green, or bronze luster: sometimes with darker vittae (e.g., *Cochliomyia*) most Calliphoridae
 -Abdomen and thorax dull gray, brown, or black, never shining metallic..... 4

4. Thorax with silky, crinkly, yellowish setae along with regular dark setae; proepisternal depression bare (Fig. 2) Calliphoridae, in part (*Pollenia*)
 -Thorax without silky, crinkly, yellowish setae along with regular dark setae; proepisternal depression setose (Fig. 15) or bare (*Melanodexia*)..... 5

5. Scutum with three conspicuous black stripes on a gray to gold background; dorsum of abdomen checkered dark and light; notopleuron usually with two large and two smaller setae; hind coxa usually with fine setae on posterior surface Sarcophagidae
 -Scutum without black stripes; dorsum of abdomen usually not checkered; notopleuron usually with only 2 setae (as in Fig. 1); hind coxa always without setae on posterior surface 6

6. Coxopleural streak absent
Calliphoridae, in part (Melanomyinae, 2 genera, 9 species)
 -Coxopleural streak present (Fig. 16)..... 7

7. Middle of proepisternal depression bare or with a few sparse setae (Fig. 2); posterior thoracic spiracle small..... Calliphoridae in part (*Melanodexia*, 8 species)
 -Middle of proepisternal depression setose (Fig.15) (see Fig. 2 for location), posterior thoracic spiracle larger (as in Fig. 16).
Rhinophoridae (*Bezzimyia*), and some Sarcophagidae (Miltogramminae).

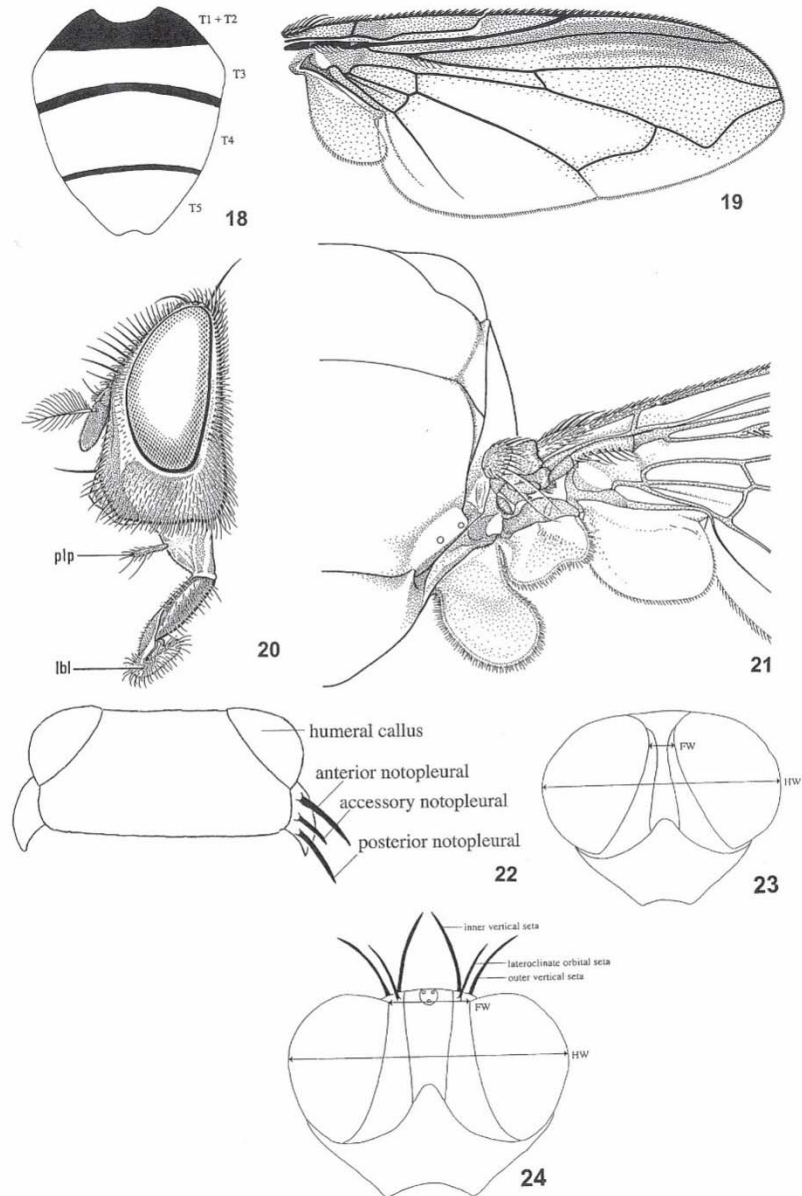


Figs. 7–17. 7–8, *Pollenia rudis*. 7, Dorsal view of abdomen. 8, Ventral view of abdomen. From Rognes (1991). 9–10, *Lucilia magnicornis*, male postabdomen. 9, Posterior view. 10, Left lateral view. From Rognes (1991). 11–13, *Calliphora stelviana*. Female postabdomen. 11, Dorsal view. 12, Ventral view. 13, Left lateral view. From Shewell (1987). cerc=cercus; epiprct=epiproct; hyprct=hypoproct; spr=spiracle; st=sternite; tg=tergite. 14, *Lucilia sericata*. Dorsal view of wing base showing suprasquamal ridge (spsqrg). From Shewell (1987). 15, Diagrammatic left lateral view of anterior portion of thorax, showing setose proepisternal depression. 16, *Lucilia coeruleiviridis*. Left lateral view of posterior thoracic spiracle and coxopleural streak. 17, *Chrysomya rufifacies*. Left lateral view of wing base showing setose greater ampulla.

Key to the subfamilies and genera of Calliphoridae

1. Basal section of stem vein setose above (Fig. 6). Subcostal sclerite setose (as in Fig. 63).....**Chrysomyinae** 2
 -Basal section of stem vein bare above (Fig. 14). Subcostal sclerite bare (except *Lucilia illustris*) 9
2. Greater ampulla with stiff erect setae (Fig. 17); dorsum of first and second abdominal tergites black, posterior margins of abdominal tergites 3 and 4 black (Fig. 18)..... *Chrysomya* Robineau-Desvoidy (2 species)
 -Greater ampulla bare or with fine, short setulae (Fig. 2); color pattern not as above. 3
3. Genal dilation yellow or orange with mostly yellow setae; head with predominantly yellow vestiture; posterior margin of hind coxa setose 4
 -Genal dilation usually black with dark setae; head with predominantly black vestiture; posterior margin of hind coxa bare or with weak setulae 6
4. Mesonotum without distinct dark vittae; lower calypter bare (as in Fig. 14); wing clouded along C (Fig. 19); parafacial bare; cerci, surstyli and other characters illustrated in Dear (1985: figs. 7–11); tropical, rare in Texas.....
 *Chloroprocta* Wulp (*idioidea*) (1 species)
 Mesonotum with distinct dark vittae; lower calypter with upper half setose; wing not clouded along C (Fig. 6); parafacial with pale or dark setulae (may be inconspicuous) 5
5. Setae on posterior margin of hind coxa pale; palp filiform (Fig. 20); calypter whitish; bend in M closer to wing margin than dm-cu crossvein (as in Fig. 42). Three species, one widespread (*C. macellaria*).....*Cochliomyia* Townsend (3 species)
 -Setae on posterior margin of hind coxa long and dark; palp clavate (as in Fig.3); calypter brown; bend in M closer to dm-cu crossvein or about equal distance between crossvein and wing margin (as in Fig. 44). Found primarily in the southwestern U.S.....*Compsomyiops* (*callipes*)(1 species)
6. Presutural acrostichal seta weak or absent; upper calypter with black setae; body metallic, shining very dark blue green without microtrichia.
 *Protophormia* (2 species)
 -Presutural acrostichal seta moderate to strong; upper calypter bare or with pale setae (Fig. 21); body metallic with whitish microtomentum 7
7. Two postsutural intra-alar setae; anterior thoracic spiracle with bright orange setae; basicosta orange (see Fig. 17 for location) ; 3 or 4 notopleurals present; anterior acrostichal seta moderate; scutum convex centrally. Scavenger species, not parasitic *Phormia*Robineau-Desvoidy *regina* (1 species)

-Three or four postsutural intra-alar setae; anterior thoracic spiracle usually with white to dark brown setae; usually only 2 notopleurals; anterior acrostichal seta strong; scutum often more or less flattened centrally. Obligate parasite of nestling birds..... 8



Figs. 18–24. 18, *Chrysomya megacephala*. Dorsal view of abdominal, tergites. 19, *Chloroprocta idioidea*. Dorsal view of wing, from Shewell (1987). 20, *Cochliomyia macellaria*. Left lateral view of head, from Shewell (1987). plp=palp; lbl=labellum. 21, *Phormia regina*. Dorsal view of right wing base, from Shewell (1987). 22, *Trypocalliphora braueri*. Dorsal view of prothorax. 23, Measuring male head to frons ratio. fw=frons width at narrowest; hw=head width at widest. 24, Measuring female head to frons ratio. fw=frons width at narrowest; hw=head width at narrowest.

8. One or more accessory notopleural setae between the usual anterior and posterior notopleural seta (Fig. 22); calypter yellowish to brown; frons of male narrow, at narrowest 0.05 (0.04–0.07/25) of head width (see Fig. 23 for how to measure); fronto-orbital plates touching, or nearly so; surstylus, cercus, and aedeagus distinctive (See Figs. in Sabrosky *et al.* 1989: 272, 273). Female laterocline orbital setae absent (see Figs. 3–5 for location); thorax and abdomen bronze-green; frons to head ratio 0.22 (0.21–0.25/25) (see Fig. 24 for how to measure). Puparia appear bare, with sparse spines; prothoracic fringe absent; larvae are obligate subcutaneous parasites of nesting birds *Trypocalliphora braueri* (1 species)
- Two notopleural setae (as in Fig. 1); calypter usually whitish, if brown, other characters vary; male frons usually broader, fronto-orbital plates well separated, frons at narrowest 0.06 or more head width (0.06–0.16, one species 0.34), surstylus, cercus, and aedeagus variable. Female, with laterocline orbital setae present (Figs. 3-5); thorax bluish (female *Protocalliphora aenea* and some *P. interrupta* have an aeneous thorax); frons to head ratio 0.24 or more (0.25–0.35). Puparia usually heavily spined; distinct prothoracic fringe (250–800 μ in diameter); normally an ectoparasite, sometimes found in nestling nares, ears, or at the base of feather sheaths of nestling birds *Protocalliphora* (28 species)
9. Middle of proepisternal depression bare (Fig. 2), or if setose, then body dull black, subshining, not metallic blue or green 10
- Middle of proepisternal depression setose (Fig. 15); body shining metallic blue-green, or bronze, sheen sometimes dulled by microtomentum 13
10. Gena usually half height of eye or more (Fig. 25); coxopleural streak present (as in Fig. 16); parafacial setose to lower eye margin; facial carina usually present (Fig. 26) **Polleniinae** 11
- Gena about one fourth height of eye (Fig. 27); coxopleural streak absent; parafacial bare on lower half or more; facial carina absent **Melanomyinae** 12
11. Thorax with long, crinkly yellowish setae; preapical posterodorsal seta on hind tibia absent or weak *Pollenia*
- Thorax without long, crinkly yellowish setae; preapical posterodorsal seta on hind tibia present, almost as long as preapical dorsal seta (Fig. 28). *Melanodexia* (8 species)
12. Arista plumose (as in Fig. 27). Apical scutellar setae long (Fig. 29). *Opsodexia* (4 species)
- Arista with fine pubescence. Apical scutellar setae usually short (Fig. 30). *Angioneura* (5 species)
13. Thorax and abdomen usually shining green, blue, or bronze with microtomentum weak. Suprasquamal ridge with conspicuous cluster of setae near the base of scutellum (Fig. 14); lower calypter bare above (Fig. 14). **Luciliinae** (1 genus, *Lucilia*)

- Thorax usually dull, with more distinct microtomentum; abdomen usually metallic blue with whitish microtomentum (except *Cynomya* and *Cyanus*). Suprasquamal ridge bare or with inconspicuous fine setae (Fig. 31); lower calypter setose above (Fig. 31).....**Calliphorinae** 14
14. First flagellomere, at most, twice the length of pedicel (see Rognes 1991, figs. 46, 47); costa usually setulose below only to junction with subcosta; abdomen blue or olive green; known only from northeastern North America in the Nearctic Region.
..... *Bellardia* Robineau-Desvoidy (2 species)
-First flagellomere more than twice length of pedicel (Figs. 3, 4); costa usually setulose below to junction with R1; abdomen bluish..... 15
15. Disc of upper and lower calypter white; rim of upper calypter usually tan; rim of lower calypter usually pale 16
-Disc of upper and lower calypter light to dark brown, rim of calypter pale or dark.
..... *Calliphora*, in part (11 species)
16. Presutural intra-alar seta absent; abdomen shining, at most, faint microtomentum visible when viewed posteriorly *Cynomya* Robineau-Desvoidy (2 species)
-Presutural intra-alar seta present (often tiny in *Cyanus*) (Fig. 1); abdomen with more distinct microtomentum when viewed posteriorly 17
17. Orange basicosta; abdomen elongate, longer than length of dorsum of thorax; abdomen with light microtomentum when viewed from rear. California to Washington, Colorado to Alberta, usually at higher elevations.
..... *Cyanus* Hall (*elongata*) (1 species)
-Black basicosta; abdomen no longer than dorsum of thorax; abdomen with heavy microtomentum when viewed from rear. Northern Canada, Alaska or high elevation only *Calliphora*, in part (2 species)

Calliphorinae

This subfamily includes *Bellardia*, *Calliphora*, *Cyanus*, and *Cynomya*. It can be recognized by the following characters: stem vein bare above; lower calypter setose above; proepisternal depression setose; thorax dull, microtomentose; abdomen more or less shining blue with whitish microtomentum; suprasquamal ridge bare or with only a few inconspicuous setae.

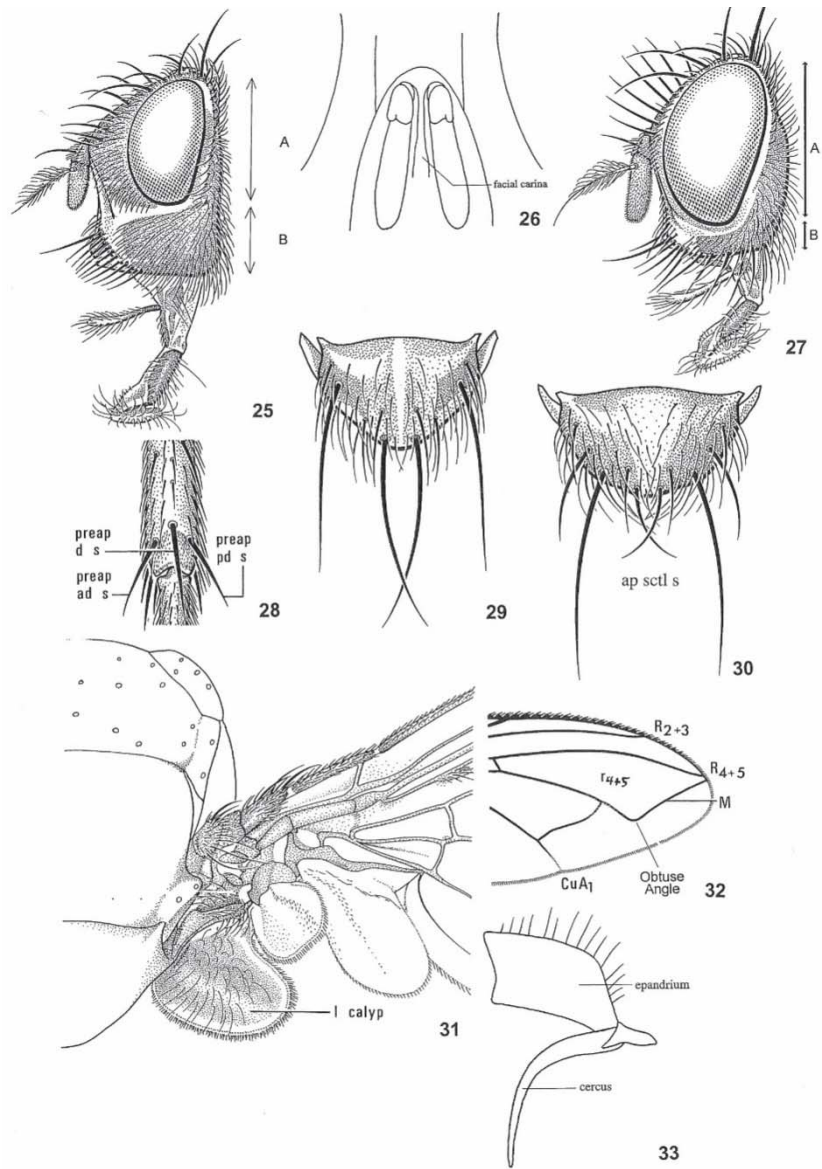


Fig. 25–33. 25, *Pollenia* sp. Female, left lateral view of head; A, eye height, B, gena height, after Shewell (1987). 26, *Pollenia rudis*. Anterior view of antennae and facial carina. 27, *Opsodexia* sp. Female, left lateral view of head; A, eye height, B, gena height, after Shewell (1987). 28, *Melanodexia grandis*. Distal end of hind tibia; preap ds=preapical dorsal seta; preap ad s=preapical anterodorsal seta; preappd s=preapical posterodorsal seta, from Shewell (1987). 29, *Opsodexia* sp. Female, scutellar setae, from Shewell (1987). 30, *Angioneura obscura*. Female, scutellar setae; ap sctl s=apical scutellar setae, after Shewell (1987). 31, *Calliphora* sp. Female, dorsal view of right wing base; l calyp=lower calypter, after Shewell (1987). 32, *Bellardia vulgaris* male. Dorsal view of right wing, after Shewell (1987). 33, *Calliphora grahmi*. Male, left lateral view of postabdomen.

Key to species

***Bellardia* Robineau-Desvoidy, 1863**

This Palearctic genus is a recent immigrant to North America and known only from the northeastern U.S., Massachusetts and New Jersey. It was very rare in my search of collections. This genus can be recognized by the first flagellomere which is, at most, twice the length of pedicel; costa usually setulose below only to junction with subcosta; abdomen blue or olive green. Other Calliphorinae have a longer first flagellomere and the costa is setulose below to R1. The species are believed to be earthworm parasites. They are the only North American blow flies which are viviparous (Shewell, 1987). Shewell noted that the terminalia of females are very short; he provided two illustrations (figs. 38, 39) and he labeled them *Bellardia agilis* (Meigen) which is a synonym of *B. vulgaris* (Robineau-Desvoidy).

1. Upper parafacial with dark brown spots which do not disappear when viewed from above; lower calypter evenly darkened, light tan. Male frons usually narrower, 0.05 (0.04–0.07) of head width at narrowest; genitalia tiny, cercus longer than surstylus as in Rognes (1991: figs. 79, 80); a small fly. Northeastern U.S. only *bayeri*

-Upper parafacial without spots; lower calypter white, margins yellowish or light tan; male frons usually wider, 0.09 (0.08–0.10) of head width at narrowest; genitalia larger, cercus shorter than surstylus as in Rognes (1991: figs. 68,69); a larger fly. Northeastern U.S. only *vulgaris*

Bellardia bayeri (Jacentkovsky, 1937). I examined specimens from Strafford Co., New Hampshire and Middlesex Co., Massachusetts. This species has dark calypters, and if generic characters are missed, it will key to *Calliphora terraenovae*.

Bellardia vulgaris (Robineau-Desvoidy, 1830). I examined a single specimen collected from Moorestown, New Jersey. Shewell (1987) reported it only from New Jersey. This species has pale calypters. Specimens key to *Calliphora genarum* or *C. stelviana* if generic characters are missed.

***Calliphora* Robineau-Desvoidy, 1830**

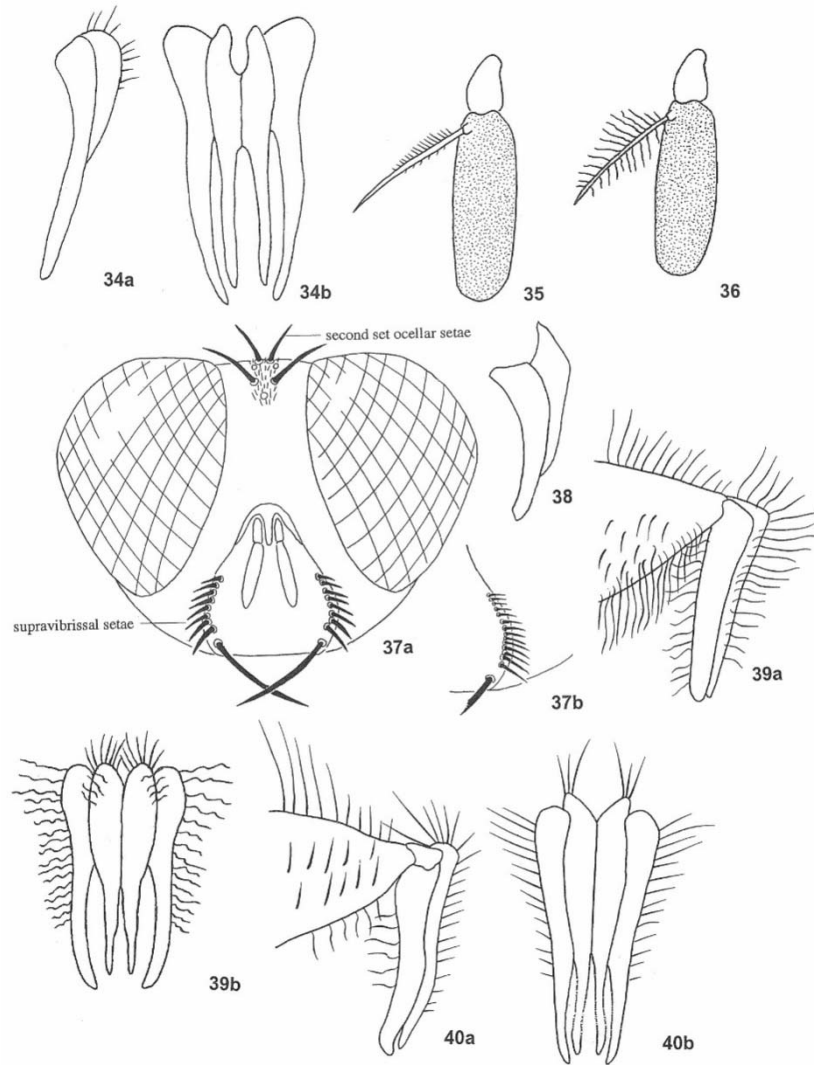
This genus now has 13 Nearctic species, since Rognes (1991) suggested the following generic names are synonyms: *Acronesia*, *Acrophaga*, *Aldrichina*, and *Eucalliphora*. Species have the stem vein bare, a dull, microtomentose thorax and bluish abdomen with whitish microtomentum.

Key to species of *Calliphora*

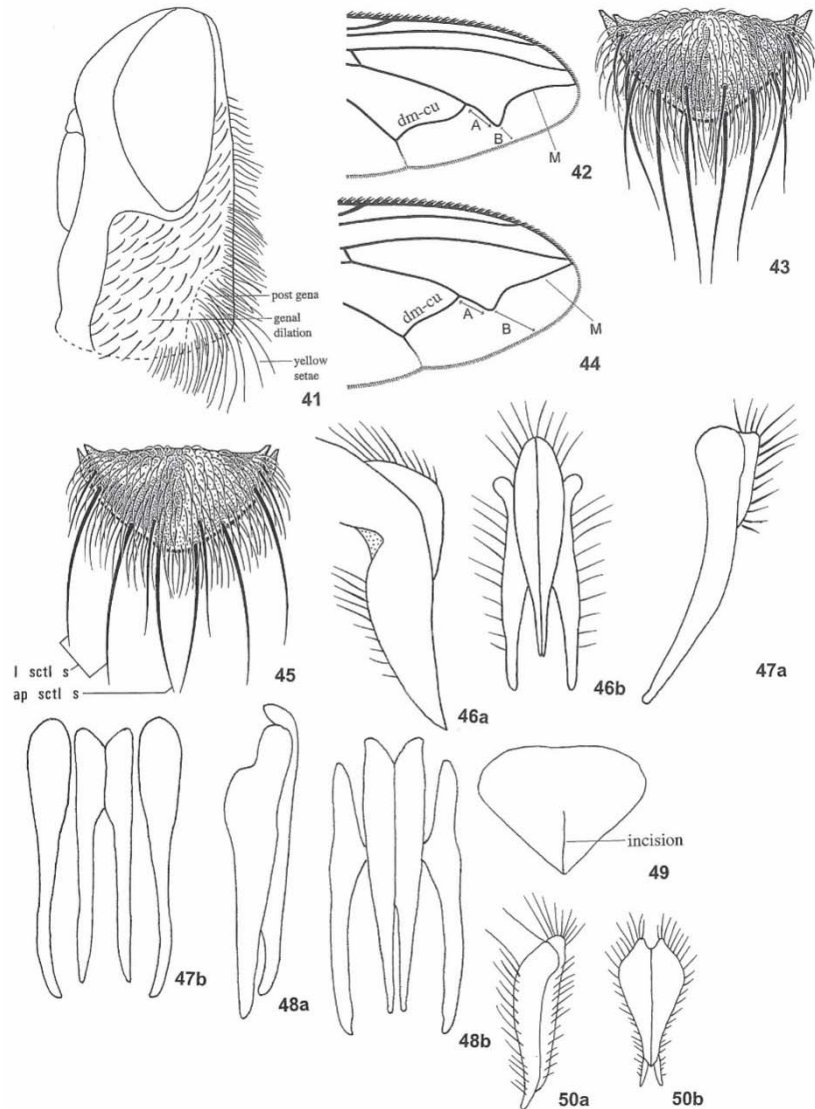
1. Presutural intra-alar seta absent; anterior thoracic spiracle with orange setae; abdomen dark blue or green with tessellated (checkerboard-like) whitish microtomentum; male epandrium large, cerci curve sharply under abdomen with horn-like prominences at each base (Fig. 33). Western; Alaska, California, Oregon, Washington and Montana. James 1953 also listed it from Colorado. *grahami*
 -Presutural intra-alar seta present (Fig. 1); anterior thoracic spiracle usually with brown setae; abdomen usually metallic bluish with moderate to heavy uniform whitish microtomentum; cerci and surstyli not as above (as in Fig. 34)..... 2
2. Disc of both calypters wholly white, rim brown or white; frons of male broad, at narrowest, usually 0.15–0.21 head width; primarily northern Canada and Alaska or high elevations 3
 -Disc of both calypters tan to dark brown; rim tan or white; frons of male narrow, at narrowest, usually 0.14 head width or less (*C. latifrons* averages 0.24, *C. coloradensis* averages 0.15); usually not restricted to northern or high elevation areas 4
3. Arista with short setae above, very short below (Fig. 35); parafacial with dark chestnut or black ground color; broad undusted stripe between presutural acrostichals usually extending past transverse suture; third abdominal tergite with long median marginal setae, usually more than half the length of those on the fourth tergite; tip of surstylus rounded (see Rognes 1991: fig.150). Found only in the far north of Canada and Alaska *genarum*
 -Arista with long setae above and below (Fig. 36); parafacial orange in ground color on lower half or more; undusted stripe faint, usually narrower and stopping at the transverse suture; third abdominal tergite with short median marginal setae, always less than half the length of those on fourth tergite; tip of surstylus pointed (see Rognes 1991: fig. 173). Canada. British Columbia to Newfoundland. U.S Alaska and high elevations in Colorado *stelviana*
4. Facial ridge with row of short, stout, supravibrissal setae, ascending from the vibrissae to a point almost halfway to antennal base (Fig. 37a); a second set of strong divergent ocellar setae about 2/3 the length of the anterior ocellars, surrounded by only a few sparse setae (Fig. 37a); anterior spiracle with orange setae. Male genitalia shorter, with a chisel-shaped point (Fig. 38). Frons of male broad, at narrowest, almost 2x width of parafacial at lunule, frons 0.24(0.22–0.26)/12

- head width; female frons 0.37 (0.36–0.39)/8 head width. Primarily a western species, from Alaska and Canada in the north, to Mexico in the south. Occasionally found in the Midwest or east coast. *latifrons*
- Facial ridge with row of slender supravibrissal setae (Fig. 37b); second set of ocellar setae weak or absent, if stronger (females of some species), surrounded by dense fine setae; anterior spiracle with brown to black seta; male genitalia usually longer and more slender, as in Fig. 34a; frons of male narrower, at narrowest, equal to or less than width of parafacial at lunule, frons 0.15 head width or less; frons of female variable..... 5
5. Three postsutural intra-alar setae..... 6
- Two postsutural intra-alar setae (as in Fig. 1) 7
6. Anterior half to two-thirds of genal dilation reddish; frons of male broad, broader than width of parafacial at lunule, 0.14 (0.12–0.16)/11 times head width; lower portion of surstylus and fifth abdominal segment with dense wavy setae (Figs. 39a,b). Primarily western, known from southern Canada throughout the west and south to Mexico *coloradensis*
- Genal dilation, when fully colored, black; frons of male much narrower, less than half width of parafacial at lunule, 0.06(0.05–0.07)/7 times head width; lower portion of surstylus and fifth abdominal segment with sparse, straighter setae (Figs. 40a,b). Widespread..... *livida*
7. Basicosta yellow to orange; genal dilation with reddish ground color on anterior half or more; frons of male, at narrowest, 0.075(0.07–0.08)/4 head width. Widespread. *vicina*
- Basicosta dark brown or black; genal dilation, when fully colored, black; frons of male, at narrowest, usually less than 0.07 head width..... 8
8. Postgena and lower posterior corner of genal dilation and back of head with long yellow-orange setae, sometimes extending forward along edge of lower genal dilation (Fig. 41); vestiture of the occiput below postocular setae primarily pale setae; genal groove reddish or orange. Frons of male, at narrowest, 0.044 (0.04–0.05)/10 head width; long, slender, curved surstyli (Figs. 34a,b); frons of female at narrowest 0.34(0.31–0.35)/10 head width. Widespread *vomitorea*
- Postgena and genal dilation with mostly dark or black setae, back of head and rear edge of postgena may have yellow setae; vestiture of the occiput below postocular setae with three or more rows of black setae; genal groove usually black or dark brown (except *C. terraenovae*); other characters vary 9
9. Bend in M much closer to wing margin than length of M from cross vein dm-cu to bend (as in Fig. 42). Male, surstylus curved anteriorly or straight (Figs. 47 a,b, 48 a,b, 50 a, b). Female ovipositor sclerites distinctive (See Tantawi *et al.* 2017, figs. 137–140, and 202) 10
- Bend in M about equal distance between wing margin and dm-cu cross vein (varies from slightly closer to wing margin to slightly closer to cross vein) (Fig. 44 shows the latter condition); male, surstylus curved posteriorly as in Figs. 46a and 52a; female ovipositor distinctive (See Tantawi *et al.* 2017, figs. 141–144) 12

10. Genal groove and parafacial usually reddish or orange; anterior 1/3–1/2 of genal dilation usually reddish when viewed from above (not always obvious). Male; surstylus long and slender with gentle anterior curve (Fig. 47). Female ovipositor. T6 broad and complete. (See Tantawi *et al.* 2017, fig. 137) Widespread from Alaska to Newfoundland, south to southern California, and Texas; usually found at higher elevations in the West. In the eastern U.S., it was found at higher elevations in Pennsylvania and North Carolina..... *terraenovae*
 -Genal groove usually black or dark brown (rarely reddish or reddish brown); anterior portion of genal dilation entirely black or dark brown genal dilation dark brown to black. Male; surstylus not as above (Fig. 48)..... 11
11. Male, surstylus and cercus long, straight, parallel-sided tapering to an obtuse point (Fig. 48a); cerci appearing slender when viewed posteriorly (Fig. 48b); frons of male, at narrowest, 0.043(0.035–0.055)/12 head width; fronto-orbital plates touching at narrowest; fifth abdominal tergite of female with posterior incision 1/3–1/2 length of segment(Fig. 49), lateral profile of tergite often tent-like. Widespread and locally common, Alaska, Canada, and northern Continental U.S.....*loewi*
 -Male, surstylus curved anteriorly at tips (Fig. 50a); cerci pear-shaped when viewed posteriorly (Fig. 50b); frons of male wider, at narrowest, 0.06 (0.05–0.07)/16 head width, fronto-orbital plates not touching; fifth abdominal tergite of female with short incision, or at most only a slight indentation (Figs. 51a), profile not tent-like. Widespread from Alaska to California and east to North Carolina, primarily at high elevation in southern locations..... *alaskensis*
12. Male frons, at narrowest, 0.11 (0.10–0.13)/16 head width (See Tantawi *et al.* 2017, fig. 48) Cercus of male usually shorter, distance between tip of cercus and tip of surstylus about twice the same distance in *C. montana* (Fig. 46b). Sternite 2 short and wide, more than twice as wide as long (See Tantawi *et al.* 2017, figs. 60–61); ST4 wide, about twice as wide as long. Female posterior half of T5 incised (See Tantawi *et al.* 2017, fig. 28) A rare species, known only from the northwestern United States and British Columbia, Canada*aldrichia*
 -Male frons, at narrowest, 0.07 (0.06–0.10)/15 head width (See Tantawi *et al.* 2017, figs. 51–52). Cercus of male longer, distance between tip of cercus and tip of surstylus about half the same distance in *C. aldrichia* (Fig. 52b). Sternite 2 quadrate (See Tantawi *et al.* 2017, figs. 62–63); ST4 about 1.5x as wide as long. Female, T5 not incised. Widespread throughout Alaska and Canada, higher elevations in the northern continental US *montana*



Figs. 34–40. 34, *Calliphora vomitoria*. Male, cerci and surstyli; a) left lateral view; b) posterior view. 35, *Calliphora genarum*. Male, left lateral view of antenna. 36, *Calliphora stelviana*. Male, left lateral view of antenna. 37, *Calliphora latifrons*. Male, a) anterior view of head; b) inset, *Calliphora terraenovae*, supravibrissal setae. 38, *Calliphora latifrons*. Male cercus and surstylus, left lateral view. 39, *Calliphora coloradensis*. Male cerci and surstyli; a) left lateral view; b) posterior view. 40, *Calliphora livida*. Male cerci and surstyli; a) left lateral view; b) posterior view.



Figs. 41–50. Fig. 41, *Calliphora vomitoria*. Female, left lateral view of head. 42, *Calliphora vomitoria*. Female, dorsal view of right wing; a) bend in M to crossvein; b) bend to wing margin; after Shewell (1987). 43, *Calliphora terraenovae*. Male, scutellar setae, from Shewell (1987). 44, *Calliphora genarum*. Female, dorsal view of right wing; a) bend in M to crossvein; b) bend to wing margin; after Shewell (1987). 45, *Calliphora montana*. Male, scutellar setae; l sctl s=lateral scutellar setae; ap sctl s=apical scutellar setae; after Shewell (1987). 46, *Calliphora aldrichia*. Male, cerci and surstyli; a) left lateral view; b) posterior view. 47, *Calliphora terraenovae*. Male, cerci and surstyli; a) left lateral view; b) posterior view. 48, *Calliphora loewi*. Male, cerci and surstyli; a) left lateral view; b) posterior view. 49, *Calliphora loewi*. Female, dorsal view of tergite 5. 50, *Calliphora alaskensis*. Male, cerci and surstyli; a) left lateral view; b) posterior view.

Calliphora alaskensis Shannon, 1923. This species is widespread but rare, found only at high elevations in the southern portions of its range. It is widespread in northern North America from Alaska through most of Canada and the northwestern U.S. I also found this species in two eastern U.S. locations, one each from mountains in Tennessee and North Carolina. It is rarely seen in museum collections. Genitalia will separate males, but females with reddish genal grooves can be difficult to separate. This species can be confused with other species with a dark genal dilation, the males have distinctive pear shaped cerci (Fig. 50b) while the female ovipositor has T5 complete (see Tantawi *et al.* 2017, fig. 27).

Calliphora aldrichia Shannon, 1923. *Author's note:* I have made major changes to this section based on our recent research on Nearctic *Calliphora* (Tantawi *et al.* 2017). This species is very similar to *C. montana* and until the recent revision, there was confusion about how to separate the two species. This species is very rare and is known only from British Columbia, California, Colorado, Washington, and Wyoming in the U.S. Males of both species share distinctive surstyli which curve posteriorly (Fig. 46a and 52a), unlike other *Calliphora*. Male frons, at narrowest, 0.11 (0.10–0.13)/16 head width at narrowest (See Tantawi *et al.* 2017, fig. 48) compared to a frons width of about 0.07 of head width at narrowest. Cercus of male usually shorter, distance between tip of cercus and tip of surstylus about twice the same distance in *C. montana* (Fig. 46b). Sternites. ST2 short and wide, more than twice as wide as long (See Tantawi *et al.* 2017, figs. 60–61); ST4 wide, about twice as wide as long. Female. posterior half of T5 incised (See Tantawi *et al.* 2017, fig. 28). The two species appear to have formed as a result of geographical isolation. *Calliphora aldrichia* is found west of the Rocky Mountains in British Columbia to California and Colorado, while *C. montana* is found primarily east of the Rockies from Alaska through Canada and east to Labrador. Their ranges overlap in British Columbia and Washington State. This may represent a range expansion of the more common and widespread *C. montana*. Since both species are associated with mountains or northern latitudes the mechanism of isolation is unclear. It appears that *C. aldrichia* is associated with higher elevations while *C. montana* is found at moderate to lower elevations in the east.

Calliphora coloradensis Hough, 1899. This species is generally uncommon, but appeared to be locally abundant in some areas such as around Flagstaff, Arizona and Uvalde, Texas. This species has been confirmed throughout the West in the U.S. as far east as Kansas. In Canada, it has been found from Alberta to Ontario. This species has 3 postsutural intra-alar setae, a character it shares only with *C. livida* and some *C. latifrons*. However, it has a reddish genal dilation which separates it from *C. livida*. The character is good in fully sclerotized specimens, but can be confusing in teneral individuals, which are fairly common in this species. The broad frons in males 0.14 (0.12–0.16)/11 of head width at narrowest readily distinguishes it from *C. livida* with a much narrower frons, 0.06 (0.05–0.07/7).

Calliphora genarum (Zetterstedt, 1838). This species and *Calliphora stelviana* (Brewer and Bergenstamm, 1891) would key to *Acrophaga* in Shewell (1987). It is found only in northern Canada and Alaska in North America, it is also found in the Palearctic Region. It shares white calypters with *C. stelviana*, which separates both species from other *Calliphora*. The differences in seta length on the arista are used to separate these two species from each other, but the fact that the setae are often damaged makes positive identification more difficult in some cases. Other useful characters to distinguish this species from *C. stelviana* include: dark parafacials; a broad undusted stripe between presutural acrostichals; and long median setae on the rear margin of the third abdominal tergite. If in doubt, examine the genitalia of both sexes. Characters are illustrated in Rognes (1991: figs. 149–158) and reproduced in Tantawi *et al.* 2017.

Calliphora grahami Aldrich, 1930. This species is indigenous to Asia and an immigrant to the western U.S. I saw specimens from California to Alaska. James (1953) also reported it from Colorado and New Mexico, but I have not confirmed this. It lacks a presutural intra-alar seta, which distinguishes it from other *Calliphora*, and is a character shared with the genus *Cynomya*. The broad frons in males (about 0.15 of head width at narrowest) are distinctive and the large, curved cerci (Fig. 33) of the male are unlike those of any other *Calliphora* in North America.

Calliphora latifrons Hough, 1899. Primarily a western species, from Alaska and Canada in the north, to Mexico in the south. Occasionally found in the Midwest or on the east coast. It can be recognized by a combination of several characters including short, stout supravibrissal setae (Fig. 37a) and a second set of strong divergent ocellar setae (Fig. 37a). Most *Calliphora* have much finer supravibrissal setae although *C. coloradensis* can be similar. In most *Calliphora* the second set of ocellar setae is weak or absent, but females of some species, like *C. alaskensis*, have stronger setae. However, the area around the second set of ocellars in *C. latifrons* is mostly bare, while in *C. alaskensis* it is setose. *Calliphora latifrons* sometimes has a small third postsutural intra-alar seta in front of the first strong postsutural intra-alar on one or both sides, which can cause confusion with *C. coloradensis* or *C. livida*.

Calliphora livida Hall, 1948. Widespread in North America. This species is similar to *C. coloradensis* but the genal dilation is black when fully sclerotized. It can be confused with *C. coloradensis* if the specimen is teneral, a fairly common condition.

Calliphora loewi Enderlein, 1903. Widespread and locally common, Alaska, Canada, and northern Continental U.S. This species can be confused with *C. terraenovae* because an occasional specimen may have a reddish genal groove. I examined many *C. loewi* from the Kola Peninsula in Russia and several had a bright orange genal groove. In males genitalia are distinctive (Figs. 48 a, b), in females the shape of the fifth tergite and the presence of a posterior incision (Fig. 49) separate them from similar species. Characters are illustrated in Rognes (1991: figs. 159–168) and reproduced in Tantawi *et al.* 2017.

Calliphora montana (Shannon, 1926). *Author's note:* I have made major changes to this section based on recent research on Nearctic *Calliphora* (Tantawi *et al.* 2017). See the differential diagnosis for how to distinguish *C. montana* and *C. aldrichia* under *C. aldrichia*. Males can be separated from *C. aldrichia* based on the shape of sternites 2 and 4 and the narrower width of the frons at narrowest (0.08, 0.06–0.10/15) and the

cercus being almost as long as the surstylus. For females, the fifth tergite is not incised and tergite 6 of the ovipositor is complete. This species is much more common than *C. aldrichia*; it is found throughout Canada and Alaska and has been found at high elevation in New York and Washington states.

Calliphora stelviana (Brauer and Bergenstamm, 1891). This species would key to *Acrophaga* in Shewell (1987). This species and *C. genarum* are the only North American *Calliphora* with white calypters. Characters are illustrated in Rognes (1991: figs. 169–182) and reproduced in Tantawi *et al.* 2017. This species is found throughout Alaska, Canada, and also has been found in Colorado.

Calliphora terraenovae Macquart, 1851. This species is widespread from Alaska, Canada and south to California, and east to Greenland, also known from Wisconsin, Colorado, and New Mexico. It also was found in higher elevations of New York and North Carolina. This species lacks any single distinctive character, but can be recognized by a combination of characters. With this species, it is best to examine genitalia to confirm identification.

Calliphora vicina Robineau-Desvoidy, 1830. This species is widespread and common. It is easily recognized, with a yellow to orange basicosta and the anterior half of genal dilation yellowish to reddish. Characters are illustrated in Rognes (1991: figs. 139–148) and reproduced in Tantawi *et al.* 2017.

Calliphora vomitoria (Linnaeus, 1758). This is a common species throughout North America. It is one of the largest *Calliphora* with bright yellow to orange setae on the postgena and lower posterior corner of the genal dilation, and back of the head. Characters are illustrated in Rognes (1991: figs. 207–216) and reproduced in Tantawi *et al.* 2017.

Cyanus Hall, 1948

Represented by a single species.

Cyanus elongata (Hough, 1898). This species is rarely found in collections. Hall (1948) lists it from South Dakota, Colorado, Oregon, and Alberta. James (1953) examined specimens from North Dakota, Nebraska, Colorado, Montana, Utah, Idaho, Washington, Oregon, and California, usually from higher elevations. I also have examined specimens from Alberta and Manitoba, Canada, and in the USA, Oregon, Utah, Washington, and Wyoming. A collecting trip to southeastern Oregon in August 2005 near the Malheur Wildlife Refuge in Harney County yielded 9 specimens of this species. Six came to a trap baited with a dead rabbit set in a swamp at around 4000' elevation. Three other specimens were caught in Malaise traps on Stein's Mountain at 4500 feet, 6000 feet, and 8500 feet elevation. It is a large fly with a long shining abdomen and bright orange basicosta. Male genitalia are illustrated in Shannon (1923: figs. 5a, 5b).

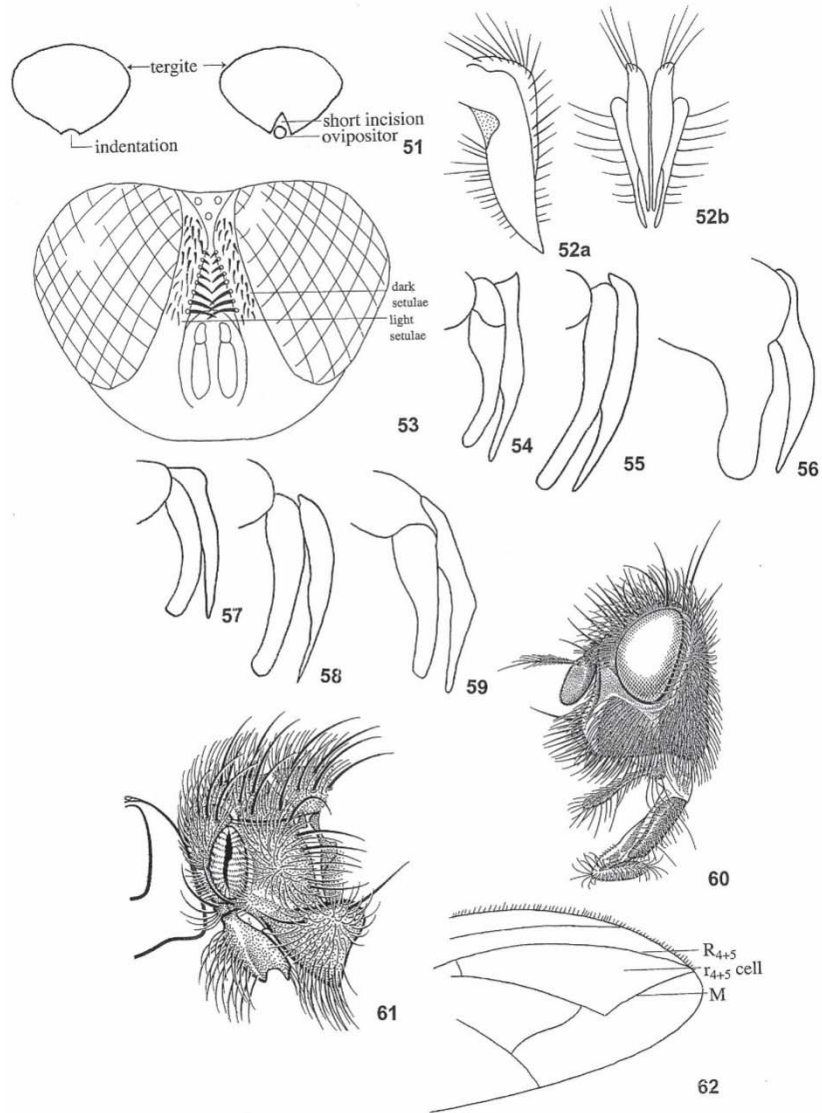
Cynomya Robineau-Desvoidy, 1830

The genus has 2 species which have white calypters, lack the presutural intra-alar seta, and have a brilliant, shining blue abdomen.

Key to Species of *Cynomya*

1. Parafacial with bright yellow to orange ground color and golden microtrichia; portions or all of fronto-orbital plate, frontal vitta, antenna, and genal dilation with bright yellow ground color and golden microtrichia; usually one postacrostichal seta; female with center of fifth abdominal tergite distinctly concave and with dense, stout setae. A Holarctic species in North America found only north of the Arctic Circle*mortuorum*
-Parafacial with black to reddish brown ground color and yellowish microtrichia when viewed from above; fronto-orbital plate, frontal vitta, antenna, and genal dilation with black to reddish brown ground color and yellowish microtrichia;

usually two postacrostichal setae; female with fifth abdominal tergite more or less straight in profile, setae sparser and weaker. Widespread in North America.
 *cadaverina*



Figs. 51–62. 51, *Calliphora alaskensis*. Female, dorsal view of tergite 5, two possible views of condition of tergite above ovipositor, a) slight indentation; b) small incision. 52, *Calliphora montana*. Male, cerci and surstyli, a) left lateral view; b) posterior view. 53, *Cochliomyia*. Anterior view of head; left side *C. hominivorax*; right side *C. macellaria*. 54–59, *Protophormia*. Male surstylus and cercus. 54. *P. beameri*. 55. *P. bicolor*. 56. *P. hirundo*. 57. *P. interrupta*. 58. *P. metallica*. 59. *P. parorum*. 60, *Protophormia atriceps*. Female, left lateral view of head, from Shewell (1987). 61, *Protophormia atriceps*. Female, left lateral view of prothorax; after Shewell (1987). 62, *Protophormia atriceps*. Female, dorsal view of right wing.

Cynomya cadaverina Robineau-Desvoidy, 1830. This species is fairly common and widespread throughout North America. Hall (1948) found it from northern Quebec to southern Texas, being most abundant along the Canadian-U.S. border. The parafacials and genal dilation are black or reddish brown. Male and female abdomens and male genitalia are illustrated in Hall (1948: figs. 29 C-F).

Cynomya mortuorum (Linnaeus, 1761). This species is found only in the far north in Alaska near the Arctic Circle. I did not see this species in the unidentified material that I examined from North America, but it was common in a group of blow flies I examined from the Kola Peninsula in Russia. The parafacials and genal dilation are bright yellow. Characters are illustrated in Rognes (1991: figs. 217–228).

Chrysomyinae

This subfamily is recognized by a setose stem vein and includes 8 genera:

Chloroprocta, *Chrysomya*, *Cochliomyia*, *Compsomyiops*, *Phormia*, *Protocalliphora*, *Protophormia*, and *Trypocalliphora*.

***Chloroprocta* Wulp, 1896**

The genus has a single species.

Chloroprocta idioidea (Robineau-Desvoidy, 1830). This species is occasionally found in southern Texas. It is a small fly that resembles *Cochliomyia*, but it lacks vittae on the mesonotum, and has dusky wings. It is fairly common in the Neotropical Region. See Whitworth 2010 for more information on this species.

***Chrysomya* Robineau-Desvoidy, 1830**

Species of this Old-World genus have recently become established in South America and the southern U.S. (Greenberg and Kunich 2002), and populations apparently are expanding their distribution. The genus is recognized by a setose greater ampulla (Fig. 17). See Whitworth 2010 for more information on this genus.

Key to species of *Chrysomya*

1. Lappets of anterior thoracic spiracle dark brown or dark orange; genal dilation with orange ground color with orange setae; eye of male with upper facets enlarged and sharply demarcated from facets in lower third, as in Whitworth 2010 (fig. 19); male frons very narrow, eyes nearly touching, frons, at narrowest, 0.01/5 (0.0075) head width; female frons, at narrowest, 0.32/6 (0.31–0.33) head width. Currently known only from southern states in the U.S *megacephala*

-Lappets of anterior thoracic spiracle pale or white; genal dilation with pale dusting and pale setae; eye of male with upper facets not enlarged, no demarcation in lower third; frons broader, at narrowest, 0.046/5 (.04–.05) head width; female frons, at narrowest, 0.29/6 (0.28–0.30) head width. Widespread but uncommon
.....*rufifacies*

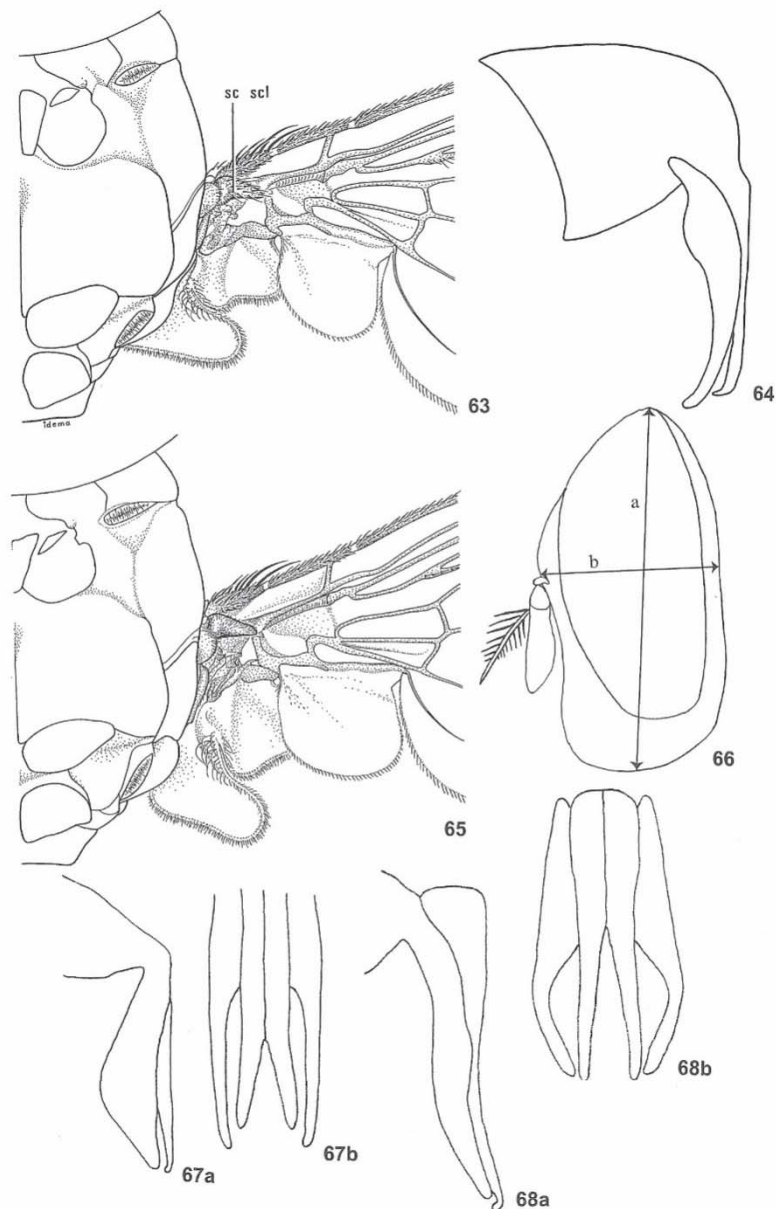
Chrysomya megacephala (Fabricius, 1794). This species is found in the southern U.S. Tomberlin *et al.* (2001) lists this species in Alabama, California, Georgia, New Mexico, South Carolina and Texas. The vestiture of the anterior thoracic spiracle is dark and the genal dilation has an orange ground color. Males have the upper facets of the eyes much enlarged, with lower facets being much smaller.

Chrysomya rufifacies (Macquart, 1843). Widespread but uncommon in southern California, Arizona, New Mexico, Louisiana, Florida, Illinois and Michigan (Shahid *et al.* 2000). Facets of eyes are uniform in size, vestiture of the anterior thoracic spiracle is pale in color, and the genal dilation is pale.

***Cochliomyia* Townsend, 1915**

This genus has three species in North America; *Cochliomyia minima* is found in the West Indies, but not confirmed in North America despite Dear (1985) listing it from there (see Whitworth 2010 and the discussion under that species below). It is included in the key because it has been confirmed in nearby Cuba. The genal dilation has orange ground color and yellow setae, with pale setae on posterior margin of hind coxa; palp filiform. This genus is unusual because all species have the aedeagus with a long, extended

paraphallus with a short complex hypophallus (Dear 1985). See a detailed discussion and illustrations of species in this genus in Dear (1985) and Whitworth (2010).



Figs. 63–68. 63, *Lucilia illustris*. Female, ventral view of right wing base; scscl=subcostal sclerite, from Shewell (1987). 64, *Lucilia illustris*. Male, left lateral view cercus and surstylus. 65, *Lucilia sericata*. Female, ventral view of right wing base, from Shewell (1987). 66, How to measure head proportions. (a) head height (b) head length. 67, *Lucilia elongata*. Male, cerci and surstyli; a) left lateral view; b) posterior view. 68, *Lucilia silvarum*. Male, cerci and surstyli; a) left lateral view; b) posterior view.

Keys to species of *Cochliomyia*

1. Upper anterior portion of genal dilation with few to many short black setulae; fifth tergite cupreous, contrasting in color with preceding tergites; dorsum of thorax with predominately metallic black and grey colors; postgenal setulae white. Rare in southern Florida 2
 -Genal dilation with setulae entirely yellow; fifth tergite blue to green, concolorous with preceding tergites; dorsum of thorax with predominantly metallic blue or green colors; postgenal setulae yellow. One species is common throughout North America (*C. macellaria*); the other species has been eradicated in North America (*C. hominivorax*) 3

2. Fifth tergite with a pair of median dorsal silvery microtomentose spots; occiput with a row of few to numerous dark setulae above, just below postocular setae; frons of male narrower, at narrowest, 0.06 (0.05–0.065/8) head width; male surstylus and cercus long and slender (see Whitworth 2010, figs. 31–32). Rare in southern Florida. *aldrichi*
 -Fifth tergite with uniform dusting of microtomentum; occiput with pale setulae only below postocular setae; frons of male broader, at narrowest, 0.083 (0.075–0.09/2) head width; male surstylus and cercus short, surstylus digitate, (see Whitworth 2010, figs. 33–34). Not known in North America, but found nearby in Cuba *minima*

3. Fronto-orbital plate with dark setulae outside row of frontal setae (Fig. 53, right side); polished central occipital area just below and behind the inner vertical setae reddish (see Fig. 73 for general location); central polished stripe on dorsum of thorax short, ending at about the transverse suture; lateral areas of fifth tergite without pronounced silvery microtomentum; postgenal setae usually golden yellow; female with dark basicosta; proclinate orbital setae absent. Not found in North America since 1966 due to eradication efforts, may still be found in parts of Mexico, Central and South America *hominivorax*
 - Lower 1/2–1/3 of fronto-orbital plate with pale setulae outside row of frontal setae (Fig. 53, left side); polished central occipital area just below and behind the inner vertical setae black; central polished stripe on dorsum of thorax long, extending beyond the transverse suture toward the anterior edge of the thorax; fifth tergite usually with pronounced lateral areas of silvery microtomentum; postgenal setae usually pale yellow; female usually with yellowish basicosta; usually with 2 pairs of proclinate orbital setae (sometimes one or both sides have only one). Widespread in North America *macellaria*

Cochliomyia aldrichi Del Ponte, 1938. This species is found occasionally in southern Florida. It is similar to *C. minima*, see discussion under that species. Male genitalia are illustrated in Whitworth 2010, figs. 31–32.

Cochliomyia hominivorax (Coquerel, 1858). This species can be difficult to separate from *C. macellaria* (see comments under that species). Male genitalia are illustrated in Hall (1948: figs.17 G–I). Not in North America north of Mexico, original range was the area south of central California east through Iowa and Indiana to South Carolina (Hall, 1948). This species has been the subject of an intensive eradication effort; most specimens collected in the U.S. are pre-1960. It was considered eradicated from North America by 1966 (Catts and Mullen 2002). Specimens collected in North America north of Mexico at later dates may be released sterile males. Overall color usually bluish, lower half of fronto-orbital plate with mostly dark setulae outside row of frontal setae, versus pale setulae in *C. macellaria*. Some specimens have pale setulae mixed with dark in the lower frontal plate. If any dark setulae are present, the specimen is *C. hominivorax*.

Cochliomyia macellaria (Fabricius, 1775). This is the most common *Cochliomyia* in North America, from the southern U.S. to southern Canada. In good specimens this species can be readily identified by the presence of pale setulae outside the row of frontal setae, and pronounced silvery microtomentum on the lateral areas of the fifth tergite. These characters may be difficult to see in old or damaged specimens. For females, the yellowish basicosta is distinctive. The number of proclinate orbital setae is variable; in a group of 16 females, 11 had two on each side while 5 had only one on each side. Male genitalia are illustrated in Hall (1948: figs.18 A,B).

Cochliomyia minima Shannon, 1926. Dear (1985) identified two females from the Florida Keys, one was from Key West and one was from Stock Island. I examined the specimen at USNM that Dear had identified as this species from the Florida Keys and it proved to be *C. aldrichia*. I examined many *Cochliomyia* from the Keys and never found this species. I included this species in this key because there is a chance it may be found in North America since it is in nearby Cuba. Dear (1985) listed this species from Cuba, the Dominican Republic, Jamaica, Puerto Rico, and the Virgin Islands. Male specimens are readily separated from the similar *Cochliomyia aldrichi* by the broader frons and distinctive genitalia. Characters for females are reliable for good specimens,

but problematic in poor specimens. The pattern of microtomentum on the fifth tergite is sometimes readily visible but is somewhat subjective in many specimens. The color of setulae on the occiput can be difficult to interpret. Some *C. aldrichi* have only a few dark setulae to separate them from *C. minima* with all pale setulae. Male genitalia are illustrated in Whitworth 2010, figs. 33–34.

***Compsomyiops* Townsend, 1918**

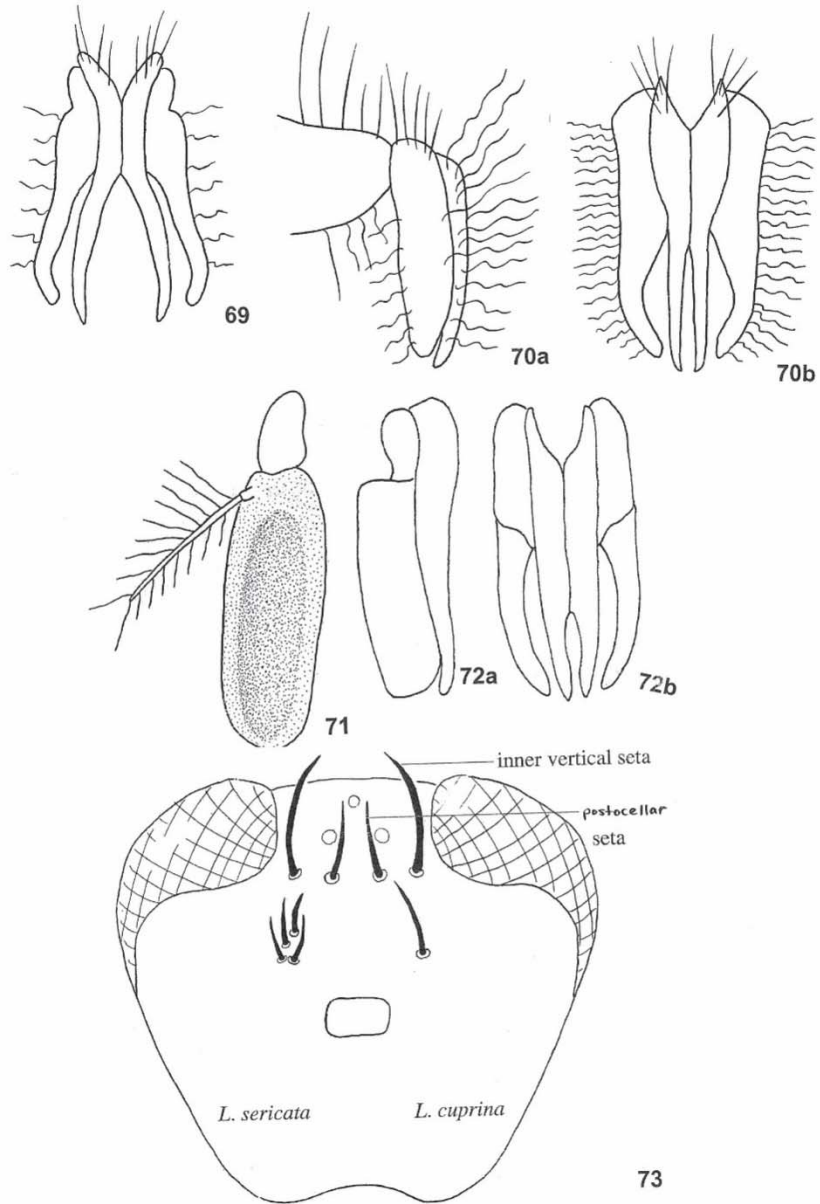
A single species.

Compsomyiops callipes (Bigot, 1877) is found primarily in the southwestern U.S. I examined specimens from California, Arizona, New Mexico and Texas. It can be separated from *Cochliomyia* by the clavate palps, long dark setae on the hind coxa, and dark calypter. It is a large bluish fly. Male genitalia are illustrated in Hall (1948: figs. 19A-D); female ovipositor illustrated in Dear (1985: figs. 47, 48).

***Phormia* Robineau-Desvoidy, 1830**

A single species.

Phormia regina (Meigen, 1826) is very common throughout North America. It is a shining metallic blue or green fly with bright orange setae around the anterior thoracic spiracle. Characters are illustrated in Rognes (1991: figs. 247–258).



Figs. 69–73. 69, *Lucilia mexicana*. Male, cerci and surstyli; posterior view. 70, *Lucilia eximia*. Male, cerci and surstyli; a) left lateral view; b) posterior view. 71, *Lucilia thatuna*. Female, antenna, left lateral view. 72, *Lucilia thatuna*. Male, cerci and surstyli; a) left lateral view; b) posterior view. 73, *Lucilia sericata*. Posterior view of head showing setae below inner vertical setae, left side; *Lucilia sericata*, *L. cuprina*.

***Protocalliphora* Hough, 1899**

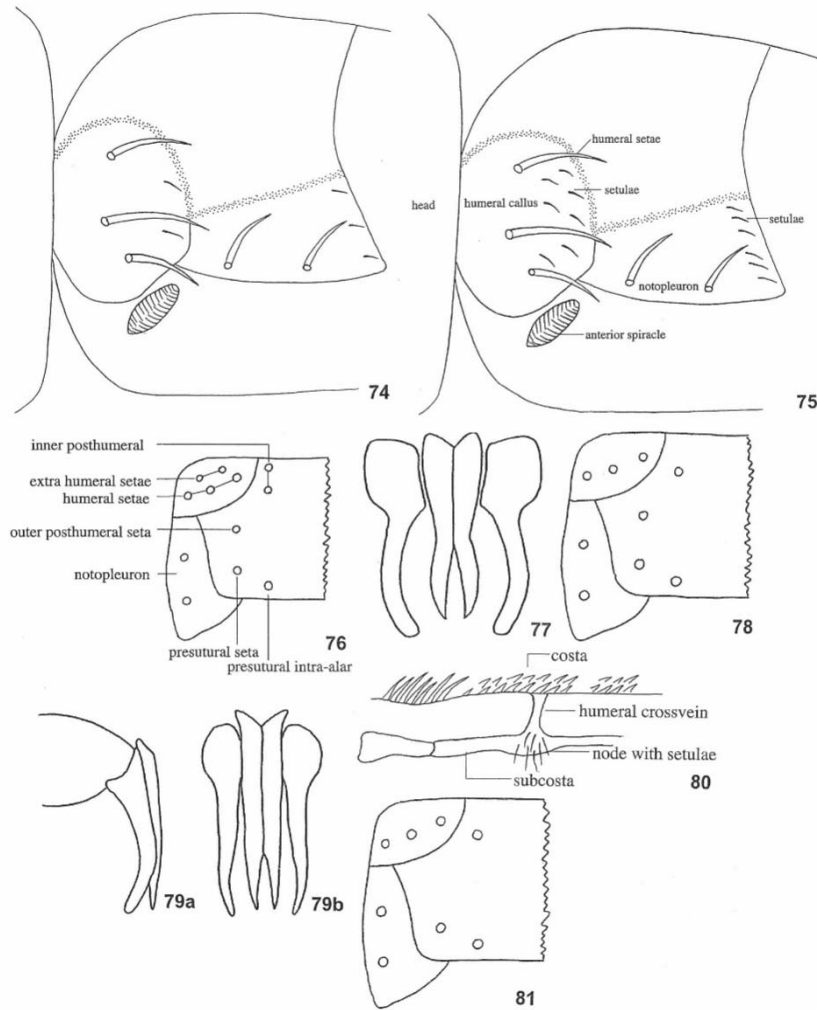
Protocalliphora is a large genus with 28 species known in North America. It is most diverse in temperate regions of the Intermountain West, less common farther south. Sixteen species are found only in the West, 6 only in the East, while 6 are widespread in both areas. This genus has been found in 46 of the lower 48 states and Alaska, but it has not been recorded from Florida or Louisiana. It is uncommon in collections, but common in the nests of many altricial birds. Species of this genus are bird nest parasites whose larvae suck the blood of nestling birds. Characters include 3 or 4 postsutural intra-alar setae, 2 notopleural setae, strong anterior acrostichals, scutum usually flattened on center, puparium usually heavily spined, with a strong prothoracic fringe. This genus is closest to *Trypocalliphora*.

..... The keys to species relying on adult and puparial *Protocalliphora* in Sabrosky *et al.* (1989) work well for reared series with matched males, females, and puparia for the 26 North American species known at the time of publication (*Trypocalliphora braueri* was included under *Protocalliphora*). The key to males permits the identification of lone males in good condition and the key to females permits the identification of about 15 species of lone females in good condition. For males, the shape of the surstyli is a critical character and some of the sketches provided in Sabrosky *et al.* (1989) are misleading. I have redrawn the surstyli for *P. beameri* Sabrosky, Bennett, and Whitworth, 1989; *P. bicolor* Sabrosky, Bennett, and Whitworth, 1989; *P. hirundo* Shannon and Dobrosky, 1924; *P. interrupta* Sabrosky, Bennett, and Whitworth, 1989; *P. metallica* Townsend, 1919, and *P. parorum* Sabrosky, Bennett, and Whitworth, 1989 (Figs. 54–59) to better reflect distinctions for each species. Lone females are often difficult to identify because they have few distinctive characters. Perhaps a detailed study of female genitalia will produce some distinguishing characters in the future, but preliminary examinations have not provided any good characters. Since the publication of Sabrosky *et al.* (1989), I have identified three additional North American species of *Protocalliphora* (Whitworth 2002, 2003a). The former publication describes two new

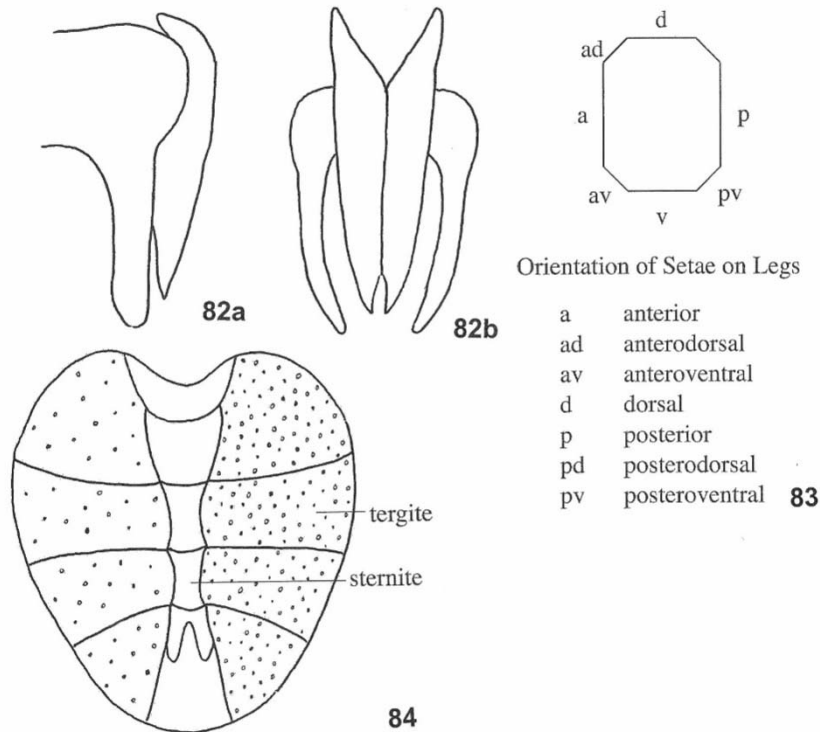
species (*P. bennetti* Whitworth and *P. rugosa* Whitworth), the latter splits *P. sialia* into an eastern and western component. *P. sialia* Shannon and Dobrosky is the form found in the Midwest and East while *P. occidentalis* Whitworth is the western form.

I have provided a key to assist with identification of these new species and it can be integrated with the adult and puparial key in Sabrosky *et al.* (1989) starting at couplet 7, p. 77. The unifying character in this group is the digitate surstylus in males. Lone adult females will be difficult to key, but the key is useful to separate females of species in mixed infestations in bird nests. Common mixes in the west included *P. bennetti*, *P. occidentalis*, *P. rugosa*, and occasionally *P. hirundo*. In the east *P. sialia* and *P. bennetti* are commonly found in the same nest.

Adults in this genus are difficult to collect, though their empty puparia are relatively easy to find in old bird nests. I developed a key (Whitworth 2003b) for the puparia of 27 North American species. To date I have examined over 9000 bird nests, about half of which were infested with one or more of 27 of the 28 known species of this genus. One species, *P. sapphira* Hall, has not been collected from a nest and is known primarily from a single distinctive male. Three females matched to the male may not be the same species. I have examined many *Protocalliphora* from the same area in Alaska where *P. sapphira* was collected and have found nothing resembling the male holotype. Until recently, *P. beameri* had never been collected from a bird nest. However, in 2004 I received an adult *P. beameri* and matched puparium from a black-throated gray warbler nest. The specimens were provided by Piotr Jablonski, who found the nest in the Chiricahua Mountains in Arizona. The puparium matches those of a previously unidentified species I examined from a barn swallow nest near Ft. Davis, west Texas.



Figs. 74–81. 74, *Lucilia cuprina*. Setae at rear of humeral callus and notopleuron. 75, *Lucilia sericata*. Setae at rear of humeral callus and notopleuron. 76, *Pollenia vagabunda*. Dorsal view of left side of prothorax. 77, *Pollenia vagabunda*. Male, cerci and surstyli, posterior view. 78, *Pollenia rudis*. Dorsal view of left side of prothorax; outer posthumeral seta is present. 79, *Pollenia griseotomentosa*. Male, cerci and surstyli; a) left lateral view; b) posterior view. 80, *Pollenia pediculata*. Ventral view of junction of humeral crossvein and subcosta showing bundle of pale setulae. 81, *Pollenia griseotomentosa*. Dorsal view of left side of thorax, outer posthumeral seta is absent.



Figs. 82–84. 82, *Pollenia rudis*. Male, cerci and surstyli, a) left lateral view; b) posterior view. 83, Diagrammatic sketch of seta orientation on legs; a=anterior; ad=anterodorsal; av=anteroventral; d=dorsal; p=posterior; pd=posterodorsal; pv=posteroventral; v=ventral. 84. Ventral view of vestiture on abdomen. *Pollenia angustigena*, left side (setae should be about twice as dense as shown, still less dense than in *P. rudis*), *Pollenia rudis*, right side.

Key to male *Protocalliphora* with digitate surstyli, and white calypters, with notes on females and puparia

1. Male surstylus digitate (as in Fig. 56), not appreciably curved 2
 - Male surstylus distinctly curved (Figs. 54, 55, 57–59), usually slender, or short and broad as in Sabrosky *et al.* (1989: figs. 7–9) 15 species of *Protocalliphora*

2. Calypter white in both sexes, primarily parasites of birds which nest in cavities 3
 - Calypter brown, except calypter white in female *P. cuprina* and *P. halli*. Female *P. cuprina* have fifth tergite cupreous, female *P. halli* are found almost exclusively in barn swallow and phoebe nests. Usually in birds with open nests. *cuprina*, *halli*, *hesperia*, *hesperioides*

3. Male and female with postalar wall and tympanic pit bare or with a few pale setae, see Sabrosky *et al.* (1989: fig. 3b) for location; fore tibia usually with one posterior seta 4
 -Male and female with postalar wall and tympanic pit with a conspicuous tuft of black setae; fore tibia with two posterior setae. Found almost exclusively in bank swallow nests *rognesi*

4. Male and female with preocellar area polished just anterior to median ocellus, polished area varies from small to large and irregular (see Sabrosky *et al.* 1989: figs. 1, 2a for location); frons of female, at narrowest, averages 0.25 (0.22–0.28) head width. Dorsum of puparium with cuticular ridges usually faint or absent 5
 -Male and female with preocellar area dull colored, microtomentose (rarely a small polished area); frons of female, at narrowest, averages 0.28 (0.26–0.31) head width. Dorsum of puparium with pronounced cuticular ridges (see Whitworth 2003b for an explanation of puparial characters). Found primarily in the West, one species, *P. hirundo*, may be found in the East primarily in bank and cliff swallow nests 7

5. Male and female with parafacial relatively broad, width at lunule obviously much wider than width of first flagellomere; male frons wider, at narrowest, averaging 0.075–0.10 head width. Puparium with hyperstigmatal spines longer, averaging 25 μ or more; posterior ventral spine bands not reduced to rear 6
 -Male and female with parafacial narrow, equal to or barely wider than first flagellomere; male frons narrower, at narrowest, averaging 0.06 (0.05–0.07) head width. Puparium with hyperstigmatal spines short, averaging 12.5 μ in length; posterior ventral spine bands reduced to rear *shannoni*

6. Male frons, at narrowest, 0.075 (0.065–0.08) head width; about equal to width of first flagellomere; female with large, triangular polished area encompassing ocellar triangle which tapers to a point in preocellar area when viewed from below. Puparium with shorter prothoracic fringe averaging 350 μ ; dorsal cuticular folds faint. Alaska to northern Idaho, east to northern Minnesota and southeast to Virginia. *bennetti*
 -Male frons broader, at narrowest, 0.10 (0.09–0.12) head width; frons of male clearly wider than first flagellomere; female with smaller irregular polished preocellar area, not encompassing ocellar triangle, or if extending upward, not uniformly shining when viewed from below. Puparium with exceptionally long prothoracic fringe, 500 μ or more in diameter; dorsal cuticular folds pronounced. East of a line from Alaska through Saskatchewan and Minnesota to Kentucky. *sialia*

7. Basicosta orange to reddish brown 8
 -Basicosta black or dark brown *occidentalis*

8. Upper portion of fronto-orbital plate in male significantly narrowed as in Whitworth (2002: fig. 7). Dorsal cuticular ridges of puparium narrower, less than 50 μ wide, ridges abundant and close together. Primarily in tree, and violet-green swallows, and purple martins *rugosa*

-Upper portion of fronto-orbital plate in male not significantly narrowed as in Whitworth (2002: fig. 8). Dorsal cuticular ridges of puparium broader, 50 μ or more, ridges usually widely spaced. Primarily in cliff and bank swallows *hirundo*

***Protophormia* Townsend, 1908**

This genus is represented by only two species in North America. Both have a flattened scutum, like *Protocalliphora*, but the anterior acrostichals are weak or absent.

Key to Species of *Protophormia*

1. Lower part of face strongly protruding (Fig.60); arista almost bare below (Fig.60); antenna entirely black; two pairs of marginal scutellar setae in addition to the apical pair; anterior spiracle much enlarged (Fig.61), almost as large as humeral callus in lateral view; cell r₄₊₅ closed, or nearly so at wing margin (Fig.62); eye small, about two-thirds of head height (Fig.60). Typically, a small fly, 6–8 mm. Rare, found only north of 80° N..... *atriceps*

-Lower part of face not strongly protruding (as in Fig.3); arista plumose (as in Fig.3); tip of pedicel and basal part of first flagellomere reddish; 3–4 pairs of marginal scutellar setae in addition to the apical pair; anterior spiracle smaller, much smaller than humeral callus (as in Fig. 2); cell r₄₊₅ open at wing margin; eye larger, three-fourths of head height. Typically, a larger fly, 10–11 mm. Common, in the northern U.S., Canada and Alaska..... *terraenovae*

Protophormia atriceps (Zetterstedt, 1845). This is a rare species found north of 80°N in North America (Rognes 1991). It can be recognized by its protruding lower face (Fig. 60) and large anterior spiracle (Fig. 61). Typically, this species is much smaller than *P. terraenovae*. Various characters are illustrated in Rognes (1991: figs. 311, 313, 315–326).

Protophormia terraenovae (Robineau-Desvoidy, 1830). This species is common throughout the northern U.S., Canada, and Alaska. I examined specimens from Washington to Ohio and Alaska to California. The face is not protruding and it has a smaller anterior spiracle. Various characters are illustrated in Rognes (1991: figs. 310, 312, 314, 327–337)

***Trypocalliphora* Peus 1960**

Rognes (1985) considered *Trypocalliphora* a valid genus, while Sabrosky *et al.* (1989) considered it a subgenus of *Protocalliphora*. As a result of my studies of puparia (Whitworth 2003b), I concluded that *Trypocalliphora* deserves generic status. It is represented by a single Holarctic species.

Trypocalliphora braueri (Hendel, 1901) is widespread, but uncommon throughout most of the U.S., Canada, and Alaska; relatively common in the Northwest (Whitworth, 2003b). Closest to *Protocalliphora*, this species has one or more accessory notopleural setae (Fig.22). Larvae are obligate subcutaneous parasites of nesting birds. Puparia have very few spines and lack a prothoracic fringe. Various characters are illustrated in Rognes (1991: figs. 338–349).

Luciliinae

This subfamily includes one genus, *Lucilia* Robineau-Desvoidy, 1830. The genera *Phaenicia*, *BufoLucilia*, and *Francilia* were synonymized with *Lucilia* by Rognes (1991). It can be recognized by its bare stem vein; sclerite on the suprasquamal ridge with a conspicuous cluster of setae near the base of the scutellum, and bare lower calypter. They typically have a shining, green, blue or bronze thorax and abdomen. The genus includes 12 species in North America. When measuring the head to frons ratios in females, note that the frons is not narrowest at the vertex as in most female calliphorids.

***Lucilia* Robineau-Desvoidy, 1830.**

Key to *Lucilia* species

1. Subcostal sclerite on venter of wing with wiry black setulae (Fig. 63); only 2 postsutural acrostichal setae; basicosta tan, dark brown or black; palp orange; surstylus and cercus of male (as in Fig. 64); ocellar triangle of female large, reaching at least halfway to lunule. Widespread in the northern U.S. and Canada.
..... *illustris*
-Subcostal sclerite on venter of wing with pubescence only (Fig. 65); 2 or 3 postsutural acrostichal setae; basicosta orange or black; palp pale or dark; surstylus and cercus of male not as above; ocellar triangle of female small, not reaching halfway to lunule 2

2. Palp dark brown to tan (only tip may be dark); length of head at level of lunule more than half head height (see Fig. 66 for how to measure); third abdominal tergite with 1 or 2 pairs of long, erect median marginal setae (see Fig. 7 for location); basicosta dark brown or black..... 3
 -Palp pale orange to yellow (except dark in *L. cuprina*), not darkened apically (palps of specimens that have been in liquid or stored improperly may be darkened); length of head at level of lunule less than half head height (except in *L. thatuna* and some *L. sericata*); third abdominal tergite with marginal setae not especially strong or erect (except male *L. thatuna*); basicosta usually yellow or orange (*L. mexicana* and *L. eximia* have brown basicostas)..... 6
3. Three postsutural intra-alar setae with anterior one weak; presutural intra-alar setae absent; arista with short setae, usually much shorter than width of first flagellomere as in Rognes (1991: fig. 411); first flagellomere long, more than half eye length in profile. Male frons broad, 0.13–0.16 of head width, at narrowest; cercus parallel-sided, tip of surstylus straight (Figs. 9,10); Northern, Alaska to Labrador.
*magnicornis*
 -Two postsutural intra-alar setae; presutural intra-alar setae present; arista normal, with setae longer than width of first flagellomere; first flagellomere shorter, less than half eye length in profile; male cercus Y-shaped when viewed from rear, tip of surstylus with sharp bend to rear (Figs. 67,68); widespread..... 4
4. Three postsutural acrostichal setae, rarely reduced to two setae on one or both sides (only 6 of 200 specimens examined). Male frons at narrowest, 0.07/6 (0.07–0.09) head width, about equal to the width of the parafacial at lunule; lower calypter tan; surstylus slender in lateral view, cercus with apical hook (Fig. 68a); cerci longer inverted V in posterior view (Fig. 68b), fifth sternite of male shorter than fifth tergite. Female ovipositor as in figs. 40, 41 (Tantawi and Whitworth 2014). Widespread, common throughout North America*silvarum*
 -Two postsutural acrostichal setae, occasionally 3 on one or both sides. Male: frons broader 0.09–0.16 of head width at narrowest; lower calypter pale; surstylus broader in lateral view, cercus without apical hook (as in Fig. 67a); rare species, known only from the northwestern U.S. and western and central Canada 5
5. Male frons, at narrowest, 0.13 (0.12–0.16/11) head width, about twice the width of the first flagellomere; surstylus triangular, curved posteriorly in lateral view, apical end tapered to a point; cerci with short inverted V shape in posterior view (Fig. 67b); fifth sternite of male prominent, as long as fifth tergite. Female: ovipositor as in figs. 44, 45 (Tantawi and Whitworth 2014). Rare species, western only, Alberta, British Columbia, California, Colorado, Idaho, Oregon, and Washington..... *elongata*
 -Male frons, at narrowest, 0.094 (0.09–0.10/7) of head width, frons narrower than width of parafacial at level of lunule, as in fig. 3, Tantawi and Whitworth 2014; surstylus digitate, parallel sided, apical end blunt; cerci in posterior view parallel, as in figs. 21, 22 (Tantawi and Whitworth 2014); fifth sternite normal, shorter than fifth tergite. Female: ovipositor as in figs. 44, 45 (Tantawi and Whitworth 2014). Rare,

- known only from southern Canada, Alberta, British Columbia, Manitoba, Saskatchewan..... *bufonivora*
6. Two post sutural acrostichal setae; abdomen usually uniformly metallic or microtomentose 7
 - Three postsutural acrostichal setae; abdomen with apparent mesal division in which one-half is microtomentose, the other half is shining (except not in *L. thatuna*)..... 10
 7. Basicosta dark brown to tan, mostly southern distribution..... 8
 - Basicosta yellow or orange; primarily eastern 9
 8. A second set of stout setae below and behind the postocular row (as in Whitworth 2014, fig. 4); (see Figs. 3–5 for general location); genal dilation and parafacial mostly black, with black vestiture. Male frons, at narrowest, 0.055 (0.05–0.06)/8 head width; frontal vitta wide, fronto-orbitals well separated; only rear half of fifth tergite polished; distal end of cercus Y-shaped when viewed from rear, surstylus with sparse wavy setae (Fig. 69). Female frons broad, 0.28(.26–.30)/6 head width, at narrowest; all of fifth tergite polished in female. Primarily southwestern U.S. into Mexico *mexicana*
 - Setae below and behind postocular row pale and weak (as in Whitworth 2014, fig. 3); genal dilation and parafacial mostly tan to orange, with vestiture reddish to light brown. Tergite 4 with real half to rear third and all of the tergite 5 polished. Male frons, at narrowest, 0.035 (0.03–0.04)/10 head width; frontal vitta very narrow, fronto-orbital plates touching, or nearly so; distal end of cercus almost parallel when viewed from rear, surstylus with dense wavy setae (Fig. 70). Female frons narrow 0.25 (0.24–0.28)/9 head width, at narrowest. Subtropical, occasionally found in Texas and Florida *eximia*
 9. Genal dilation with dark setae. Frons of male with fronto-orbital plates almost touching, frons width, at narrowest, 0.023/8 (0.015–0.030) head width; much less than width of first flagellomere; lower calypter tan; genitalia as in Hall 1948, figs. 24 A–C. Female with black setulae outside row of frontal setae on frontal plate; mature specimens usually larger, 8–9.5mm in length. Maryland south to Florida, north to Michigan and Wisconsin, most common in the southeast, less abundant west of the Mississippi River, but westward to California *coeruleiviridis*
 - Rear half of genal dilation with pale setae. Frons of male with fronto-orbital plates well separated; frons width, at narrowest, 0.11/7 (0.10 – 0.12) head width; frons wider than the width of first flagellomere; lower calypter pale; genitalia as in Whitworth 2010, figs. 38, 39. Mature specimens usually smaller, 8mm length or less. Florida north to North Carolina and west to southern Mississippi *cluvia*
 10. First flagellomere broader than width of parafacial at level of lunule, often cupped inward, inner margin often reddish, especially in female (Fig. 71), sometimes not so cupped in male, still broader than parafacial. Male frons, at narrowest, with frontal plates almost touching, frons 0.044 (0.04–0.05)/9 of head width; male surstylus and cercus as in Fig. 72; lower calypter tan color. Female frons, at narrowest, 0.30/12 (0.27–0.32) of head width at narrowest. Rare, known only from California, Colorado, Idaho, Oregon, Utah, and Washington..... *thatuna*

-First flagellomere narrower than width of parafacial at level of lunule, usually not cupped or with reddish margin (similar to Fig. 36). Male frons, at narrowest, with frontal plates widely separated, frons 0.12–0.21 head width; lower calypter pale. Female frons, at narrowest, 0.35–0.40 of head width 11

11. Central occipital area with single seta below inner vertical seta (Fig.73, right side); metasternum bare; abdomen dull coppery; humeral callus with 2 or 3 small setulae along posterior margin; notopleuron with only 2 or 3 small setulae on posterior border (Fig. 74); frons of male broader, at narrowest obviously much broader than width of the parafacial at level of the lunule, 0.20/7 (0.19–0.21) of head width; frons of female at narrowest 0.39/5(0.38–0.40) head width. Primarily a southern species, Virginia west through Missouri to California *cuprina*
 -Central occipital area with group of 2–5 setae below inner vertical seta (Fig. 73, left side); metasternum setose; abdomen usually bright green, occasionally shining coppery; humeral callus with 6–8 small setulae along posterior margin; notopleuron usually with 5 or more setulae on rear border (Fig. 75); frons of male narrower, at narrowest about equal to width of parafacial at level of lunule, 0.13/6 (0.12–0.14) of head width; frons of female at narrowest 0.37/8 (0.35–0.40) head width. Widespread..... *sericata*

Lucilia bufonivora Moniez, 1876. This Palearctic species was recently discovered in southern Canada (Tantawi and Whitworth 2014). Several specimens of *L. bufonivora* were found in the Canadian National Collection identified as *L. silvarum*. This species is very similar to *L. silvarum* and *L. elongata* and females can be especially difficult to identify without dissection. See a differential diagnosis comparing the three similar species, *L. elongata*, *L. bufonivora* and *L. silvarum* under *L. silvarum*. This species is only known from four provinces in Canada, Alberta, British Columbia, Manitoba, and Saskatchewan.

Lucilia cluvia (Walker, 1849). This species is found primarily in the Southeast; I examined specimens from Arkansas to Florida to South Carolina. It is uncommon and very close to *L.coeruleiviridis* in appearance, but *L. cluvia* can be distinguished by the pale setae on the lower gena. Males also have a broader frons, 0.11/7 (0.10–12) of head width at narrowest versus about 0.02 of head width in *L. coeruleiviridis*. Based on the material I examined, *L. cluvia* tends to be smaller than *L. coeruleiviridis*.

Lucilia coeruleiviridis Macquart, 1855. This species is common in the southeastern U.S., but it may be found in the Northeast and Midwest. It is uncommon in the West, and is generally much more commonly encountered than *L. cluvia* in the East. I examined specimens from California to Florida, from Nebraska and Wisconsin to Pennsylvania and most states south. I did not find it in the Northwest. Despite the morphological differences between *L. coeruleiviridis* and *L. mexicana*, barcodes do not distinguish them (see Whitworth 2014).

Lucilia cuprina Wiedemann, 1826. This species is uncommon throughout the south, from Virginia to Florida west to Missouri and Texas and California. It is usually can be recognized by its dull coppery sheen, but color alone is not reliable. Some *L. sericata* are quite coppery, though usually more shining. The wider frons in *L. cuprina* readily separates males of each species. A single seta below the inner vertical seta (Fig.73, right side) versus 2–5 setae in *L. sericata* (Fig.73, left side) will distinguish specimens of both sexes. This character sometimes varies, or can be hard to see due to the condition of the specimen. The presence or absence of setae on the metasternum (absent in *L. cuprina*) is also useful, but often is difficult to see.

Lucilia elongata Shannon, 1924. This species is rarely found in collections. It is only known from the West, in Alberta, British Columbia, California, Colorado, Idaho, Oregon, and Washington. This species is close to *L. silvarum*, but it normally has only 2 postsutural acrostichal setae, while *L. silvarum* has 3. The frons of males, at narrowest, is much broader, averaging 0.13 of head width in *L. elongata* versus 0.07 in *L. silvarum*. See a differential diagnosis comparing the three similar species, *L. elongata*, *L. bufonivora* and *L. silvarum* under *L. silvarum*. See a detailed discussion of this species in Tantawi and Whitworth 2014.

Lucilia eximia (Wiedemann, 1819). This species is rare, found occasionally only in Texas and Florida. Hall (1948) noted that this is a common fly in market places of Central America. This is one of only 2 species with yellow palps and a dark basicosta. This species has pale, weak setae below and behind the postocular row, and an orange

genal dilation. By contrast, its close relative, *L. mexicana*, has a stout row of dark setae below and behind the postocular row and a dark genal dilation.

Lucilia illustris (Meigen, 1826). This species is widespread and common in the northern U.S. and Canada. I examined specimens from as far south as southern California and Arizona in the West, but in the Midwest I did not find it south of Missouri to Indiana, while on the East coast I did not find it south of South Carolina. Various characters are illustrated in Rognes (1991: figs. 371, 411–422).

Lucilia magnicornis (Siebke, 1863). This species is uncommon in the far north, from Alaska to Labrador. I examined specimens from Alaska, Northwest Territories, and northern Manitoba. This species has brown palps, 3 postsutural intra-alar setae, and the length of the first flagellomere is more than half the eye length. Various characters are illustrated in Rognes (1991: figs. 371, 411–422).

Lucilia mexicana Macquart, 1843. This species is common in the southwestern U.S. I examined specimens from California to Texas, Utah and Oklahoma. Hall (1948) stated that this species extends as far south as Brazil; this was clearly a mistake (see Whitworth 2014). It has a brown basicosta, like *L. eximia*, but a row of stout dark setae below and behind the postocular row and a dark genal dilation. Its range overlaps with that of *L. eximia* in Texas.

Lucilia sericata (Meigen, 1826). This species is one of the most common *Lucilia*, and is widespread in the U.S. and southern Canada. It is one of 3 species with 3 postsutural acrostichal setae. It can be separated from *L. cuprina* by the presence of 2–5 setae on the central occipital area below the inner vertical setae. Specimens tend to be green, but some are so coppery that they can be confused with *L. cuprina*. It also has a setose metasternum, which is often hidden and very difficult to see. This species can be separated from *L. thatuna* by the width of the first flagellomere and the much broader frons of the male. Various characters are illustrated in Rognes (1991: figs. 375, 455–465).

Lucilia silvarum (Meigen, 1826). This is a common and widespread species in the Nearctic Region. This species can be confused with two rare species, *L. bufonivora* and *L. elongata* since they share dark palps and a dark basicosta. The latter two species are rare and only known from the northwestern US and western and west central Canada (Tantawi and Whitworth 2014). Most *L. silvarum* have three postsutural acrostichal setae, though *L. bufonivora* and *L. elongata*, which normally have only two setae, occasionally have three setae on one or both sides. The male frons in *L. silvarum* is narrower (0.07, 0.06–0.09/8) than in *L. elongata* and *L. bufonivora* which is broader (0.09–0.16). In males, good specimens of *L. silvarum* have a tan lower calypter, while it is pale in *L. bufonivora* and *L. elongata*. The male genitalia of these three species are distinctive, in lateral view, the cercus of *L. silvarum* has a distinct hook (Fig. 68 a), while in the other species there is no hook. Male genitalia for all three species are distinctive, to compare genitalia, see Figs. 68a, b for *L. silvarum*, figs. 21, 22 (Tantawi and Whitworth 2014) for *L. bufonivora*; and Figs. 67a, b for *L. elongata*. To compare ovipositors of female specimens, see Tantawi and Whitworth (2014) figs. 40, 41 for *Lucilia silvarum*; figs. 42, 43 for *L. bufonivora*; figs. 44, 45 for *L. elongata*. Various characters for this species are also illustrated in Rognes (1991: 376, 466–476). This is a Holarctic species, it is widespread in the Nearctic and Palearctic Regions and also found in the Neotropical Region around Mexico City.

Lucilia thatuna Shannon, 1926. The first flagellomere is broader than the parafacial (Fig. 71) which separates it from *L. cuprina* and *L. sericata*. Specimens are often bluish which separates them from the green or coppery *L. sericata* or the coppery *L. cuprina*. The male frons is much narrower than in *L. cuprina* and *L. sericata* (about 0.04 of head width at narrowest versus 0.12–0.22). The male genitalia (Figs. 72a, b) are distinctive, see Tantawi and Whitworth (2014) for illustrations of a variety of characters for this species. This is an uncommon species known from British Columbia, California, Oregon, Utah, Washington, and Wyoming. James (1955) recorded it from many localities in California, and also Montana, Idaho, and Colorado.

Polleniinae

Species in this subfamily are dull colored unlike most calliphorids and there are two genera, *Melanodexia* and *Pollenia*.

***Melanodexia* Williston, 1893**

This genus is uncommon in the West; few specimens were encountered in this study and no attempt was made to sort them to individual species. Both Hall (1948) and James (1955) studied this genus, but species distinctions are difficult and the genus needs further study. Hall listed three species under this genus and five more under the name *Melanodexiopsis*, a synonym of *Melanodexia*.

***Pollenia* Robineau-Desvoidy, 1830**

This genus is widespread in North America. It was thought to be represented by a single species, *P. rudis*, until recently (Rognes, 1991). Six species are now recognized in North America. Species of this genus are dull colored calliphorids with distinctive, crinkly yellow setae on the thorax. The key herein was adapted from the one developed by Knut Rognes for Greenberg (1998). For a pictorial key of the Nearctic *Pollenia*, see Jewiss-Gaines *et al.* 2012.

Key to Species of *Pollenia*

1. Thorax with dark median undusted vitta between presutural acrostichal setae, usually extending forward to extreme anterior slope of thorax and back to the rear of the scutum; usually 2 or more extra setae in front of the regular row of 3 (2–4) humeral setae (Fig. 76); 2 inner posthumeral setae (Fig. 76); male cercus broad and flattened when viewed from rear (Fig. 77). Specimens were examined from Washington State, and in the northeastern U.S. and southeastern Canada. It was also found at high elevation in New Mexico *P. vagabunda*
-No median undusted vitta; no extra humeral setae in front of the regular setae (Fig. 78); 1 inner posthumeral seta (Fig. 78); cercus not as above (Fig 79b)..... 2

2. Lappets of posterior thoracic spiracle dark brown; facial carina reduced and indistinct; basicosta usually dark brown to black. Found in the northern U.S. and southeastern Canada, also found at high elevation in New Mexico.
.....*P. labialis*
-Lappets of posterior thoracic spiracle pale yellow to orange; facial carina usually distinct (Fig. 26) (except *P. griseotomentosa*); basicosta yellowish, orange, or light tan 3

3. Node at junction of humeral crossvein and subcosta of wing with a bundle of pale setulae below (Fig. 80); palpus dark brown or black. Widespread in the northern U.S. from California through West Virginia and the southern half of Canada.
..... *P. pediculata*
-Node without setulae; palpus usually lighter brown or orange (except some *P. rudis*) 4

4. Outer posthumeral seta absent (Fig. 81); femur of mid- and hind leg with mostly black vestiture on posteroventral surface (see Fig. 83 for orientation); facial carina absent or much reduced; male surstyli distinctly curved and slender (Fig. 79a); frons of male exceptionally narrow, at narrowest, 0.032 (0.025 – 0.04)/3 head width. Rare, currently known only from British Columbia, Ontario, Newfoundland, New York, Pennsylvania and Colorado *P. griseotomentosa*
-Outer posthumeral seta usually present (Fig. 78); if absent (some *P. angustigena*) femur of mid-and hind leg with mostly yellow vestiture on posteroventral surface; facial carina distinct (Fig. 27); male surstyli less curved and broader (Fig. 82); frons of male slightly to much broader 5

5. Tibia of midleg with one anterodorsal seta (see Fig. 83 for orientation); mid- and hind femora with yellow or orange posteroventral vestiture; ventral abdominal vestiture in males normal, not particularly fine, dense, or erect (Fig. 84, left side); male frons narrower, frons 0.038 (0.03 – 0.04)/6 head width. Locally common in Washington, California, Wisconsin and northeastern U.S..... *P. angustigena*
-Tibia of midleg usually with 2–3 anterodorsal setae; mid-and hind femora with black or dark posteroventral vestiture; ventral abdominal vestiture in males fine, erect, and dense (Fig. 84, right side); male frons broader, frons 0.06 (0.055 – 0.065)/7 head width. Widespread in North America *P. rudis*

Pollenia angustigena Wainwright, 1940. Until this study, this species was known only from northeastern North America. I have examined specimens from California to Washington, Idaho to Wisconsin, Ohio to New Jersey and south to Virginia. It is similar to *P. rudis*, but males are usually distinctive. Females of this species can be confused with *P. griseotomentosa*. Females are difficult to distinguish since the only good

character known is the number of anterodorsal setae on the midtibia. If legs are missing or the setae damaged, then identification of females is difficult. Various characters are illustrated in Rognes (1991: figs. 562, 579, 594–603).

Pollenia griseotomentosa (Jacentkovsky, 1944). Rognes has verified this species from Ontario, Canada (pers. comm.) I have seen specimens from British Columbia, and Newfoundland, Canada, and in the U.S. in Colorado, Pennsylvania, and New York. I originally listed this species from Wisconsin and Washington, but further study revealed the specimens were *P. angustigena*. It is the only North American *Pollenia* lacking an outer posthumeral seta. Various characters are illustrated in Rognes (1991: figs. 563, 604–611).

Pollenia labialis Robineau-Desvoidy, 1863. Rognes (1991) recorded this species from Ontario, and Greenberg (1998) listed it from Indiana. I found it in the northern U.S. and southeastern Canada, also at high elevation in New Mexico. The lappets of the posterior spiracle are dark brown, which distinguishes it from other species. Discolored specimens of other species can be confused with it, although the reduced facial carina separates it from most similar species. Various characters are illustrated in Rognes (1991: figs. 565, 622–628).

Pollenia pediculata Macquart, 1834. I found this species widespread in the northern U.S. from California through West Virginia and the southern half of Canada. I did not find it in the southeastern U.S. This is the second most common *Pollenia* I found, next to *P. rudis*. It is readily identified by a distinctive bundle of setae on the venter of the wing, at the junction of the humeral crossvein and subcosta. Various characters are illustrated in Rognes (1991: figs. 557, 559, 581, 583, 640–650).

Pollenia rudis (Fabricius, 1794). This species is widespread in North America and was once thought to be the only *Pollenia* species present in North America. *Pollenia* specimens in most museum collections are identified as this species, but I have found that half or more are other species. It is similar to *P. angustigena*, but males have a

broader frons and a denser vestiture on the venter of the abdomen. Female characters are limited to setae on the mid tibia. Various characters are illustrated in Rognes (1991: figs. 582, 651–661).

Pollenia vagabunda (Meigen, 1826). Specimens were examined from Washington State, and in the northeastern U.S. and southeastern Canada. It was also found at high elevation in New Mexico. In specimens in good condition, a dark median stripe between the presutural acrostichal setae is a distinctive character. Accessory humeral setae and 2 inner posthumeral setae will further confirm its identity. Various characters are illustrated in Rognes (1991: figs. 569, 662–669). In one sample of 12 *Pollenia* collected from a home in Tacoma, Washington on April 1, 2005, 8 were *P. vagabunda*, 3 were *P. angustigena*, and one was *P. rudis*.

Melanomyinae

Downes (1986) synonymized *Angioneura* and *Opsodexia* under *Melanomya*. Shewell (1987) concluded these should be separate genera, an opinion with which Rognes (1991) concurred. Species of both genera are rarely encountered in collections, so keys to species are not provided here. The keys in Downes (1986) are useful in making accurate identifications (N. Woodley, in litt.). Species of both genera are dull colored and nondescript. Their biology is poorly known, but Downes (1986) suspects all might be snail parasites.

***Angioneura* Brauer and Bergenstamm, 1893**

This genus includes 5 species which have relict populations primarily in the East and Midwest.

***Opsodexia* Townsend, 1915**

This genus includes 4 species which apparently have habits and distributions similar to *Angioneura*.

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