

KEYS TO THE GENERA AND SPECIES OF BLOW FLIES (DIPTERA: CALLIPHORIDAE) OF AMERICA NORTH OF MEXICO

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Abstract.—A Key separating Calliphoridae from similar Diptera families in North America is given. Keys to 17 genera and 54 species of North American calliphorids north of Mexico are provided. The distribution and key characters for each species are discussed and 100 illustrations are included. *Calliphora montana* Shannon is redescribed.

Key Words: Calliphoridae, Diptera, genera, keys, North America, species

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, *Bufo lucilia* 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 *Melanomyia* 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.

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 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 48 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 genitalia proved useful to confirm species when external characters were 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.

Terminology differences in the calliphorid literature can be confusing. For North American terminology workers should see the *Manual of Nearctic Diptera* (McAlpine 1981), while for European terminology they should refer to the *Manual of Palearctic Diptera*

(Papp and Darvis 1998). I have primarily followed McAlpine (1981) except as noted below.

Figs. 1–5 from Rognes (1991) 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 callosity; 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), 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.

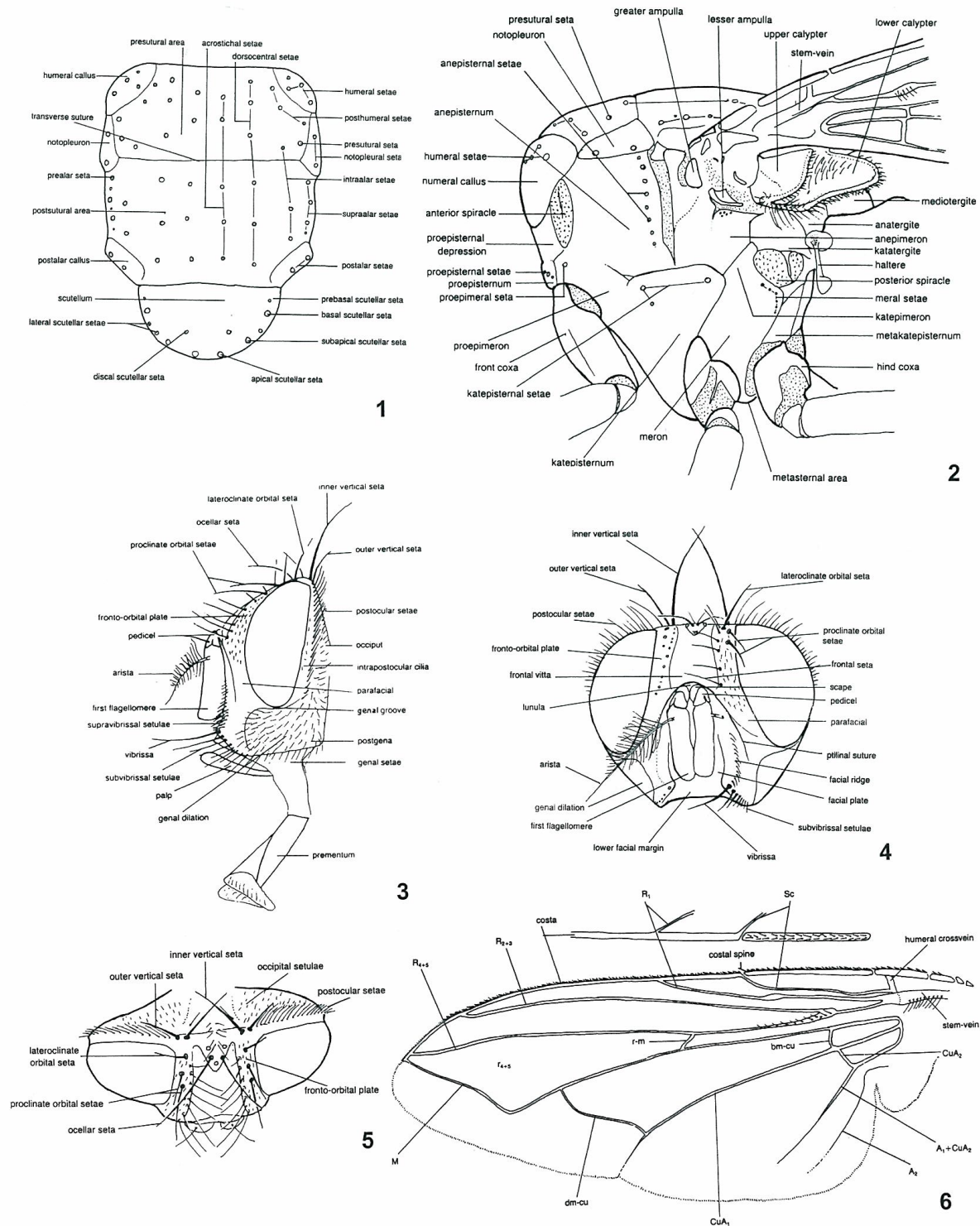
Historically many terms have been used to describe the hairs and fine dusting observed in adult flies. I use the

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 *Protophormia* are provided to be integrated with existing keys in Sabrosky et al. (1989). The keys include 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



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).

and species keys are therefore not included.

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 the 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.

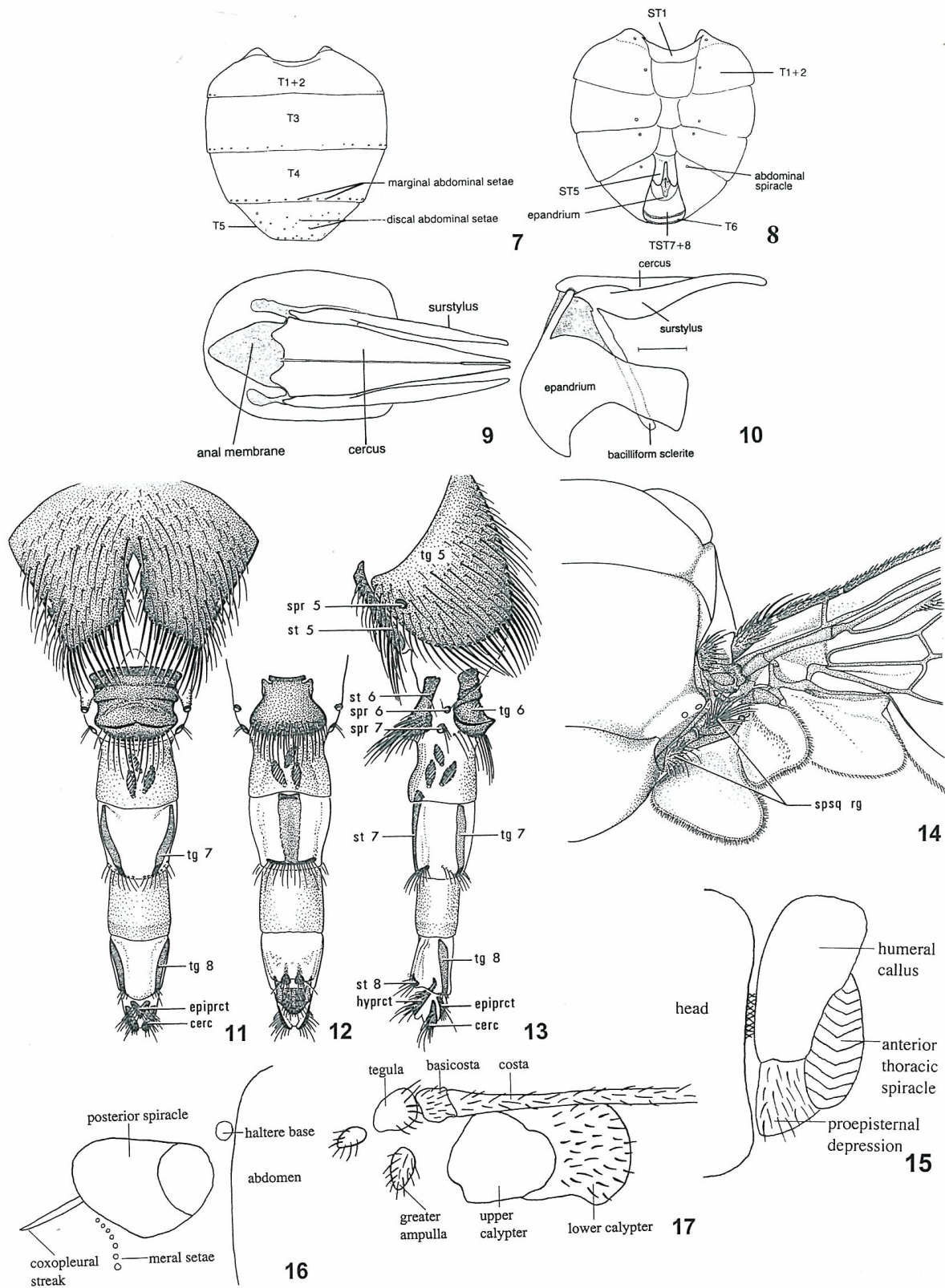
KEY TO SEPARATE CALLIPHORIDS FROM SIMILAR FAMILIES

1. Meron without row of setae, sometimes scattered weak setulae. Muscidae, Anthomyidae, Scathophagidae
- Meron with distinct row of setae (Figs. 2, 16). 2
2. Subscutellum strongly developed; arista often bare (not in Dexiini and some other taxa). Tachinidae
- Subscutellum absent or weak; arista usually setose (Fig. 3) [except *Angioneura* 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. Sarcophagidae
- Scutum without black stripes; dorsum of abdomen usually not checkered; notopleuron usually with only 2 setae (as in Fig. 1) (except *Trypocalliphora*). 6
6. Coxopleural streak absent. Calliphoridae, in part (*Melanomyia*, 2 genera, 9 species)
- Coxopleural streak present (Fig. 16). 7
7. Middle of proepisternal depression bare or with a few sparse setae; posterior thoracic spiracle small. Calliphoridae in part (*Melanodexia*, 8 species)
- Middle of proepisternal depression setose (Fig. 15), posterior thoracic spiracle larger (as in Fig. 16). Rhinophoridae (*Bezzimyia*), and some Sarcophagidae (Miltogramminae)

KEY TO SUBFAMILIES AND GENERA OF CALLIPHORIDAE

1. Basal section of stem vein setose above (Fig. 6) Chrysomyinae 2
- Basal section of stem vein bare above (Fig. 14) 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* (2 spp.)
- 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* (1 sp.)

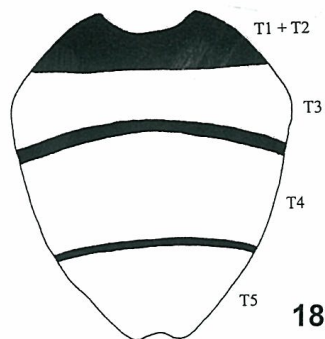


Figs. 7–17. 7–8, *Pollenia rudis*. 7, Dorsal view of abdomen. 8, Ventral view of abdomen (from Rognes 1991). 9–10, *Lucilia magnicornis*, male postabdomen. 9, Posterior view. 10, Left lateral view (from Rognes 1991). 11–13, *Calliphora stelviana*, female postabdomen. 11, Dorsal view. 12, Ventral view. 13, Left lateral view (from Shewell 1987). cerc = cercus; epiprct = epiproct; hypcrct = hypoproct; spr = spiracle; st =

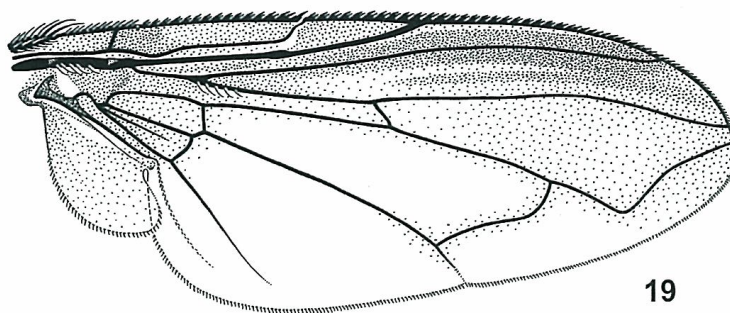
- Mesonotum with distinct dark vittae; lower calypter with upper half setose; wing not clouded along C (Fig. 6); parafacial with pale or dark setulae (may be inconspicuous). 5
- 5. Setae on posterior margin of hind coxa pale; palp filiform (Fig. 20); calypter whitish; Bend in M closer to wing margin than dm-cu crossvein (as in Fig. 42). Three species, one widespread (*C. macellaria*). *Cochliomyia* (4 spp.)
- 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 spp.)
- 6. Presutural acrostichal seta weak or absent; upper calypter with black setae; body metallic, shining very dark blue green without microtrichia. *Protophormia* (2 spp.)
- 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; anterior acrostichal seta moderate; scutum convex centrally. Scavenger species, not parasitic. *Phormia* (1 sp.)
- Three or four postsutural intra-alar setae; anterior thoracic spiracle usually with white to dark brown setae; anterior acrostichal seta strong; scutum often more or less flattened centrally. Obligate parasites of nestling birds. 8
- 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) 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 lateroclinate orbital setae absent (see Figs. 3–5 for location); thorax & 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 nestling birds. *Trypocalliphora* (1 sp.)
- 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 lateroclinate 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 nesting birds. *Protocalliphora* (28 spp.)
- 9. Middle of proepisternal depression bare, 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* (6 spp.)
- Thorax without long, crinkly yellowish setae; preapical posterodorsal seta on hind tibia present, almost as long as preapical dorsal seta (Fig. 28). *Melanodexia* (8 spp.)
- 12. Arista plumose (as in Fig. 27). Apical scutellar setae long (Fig. 29). *Opsodexia* (4 spp.)

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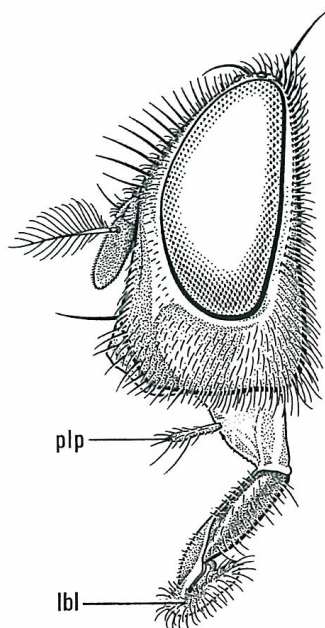
sternite; tg = tergite. 14, *Lucilia sericata*, dorsal view of wing base showing suprasquamal ridge (spsq rg) (from Shewell 1987). 15, Diagrammatic left lateral view of anterior portion of thorax, showing setose proepisternal depression. 16, *Lucilia coeruleiviridis*, left lateral view of posterior thoracic spiracle and coxopleural streak. 17, *Chrysomya rufifacies*, left lateral view of wing base showing setose greater ampulla.



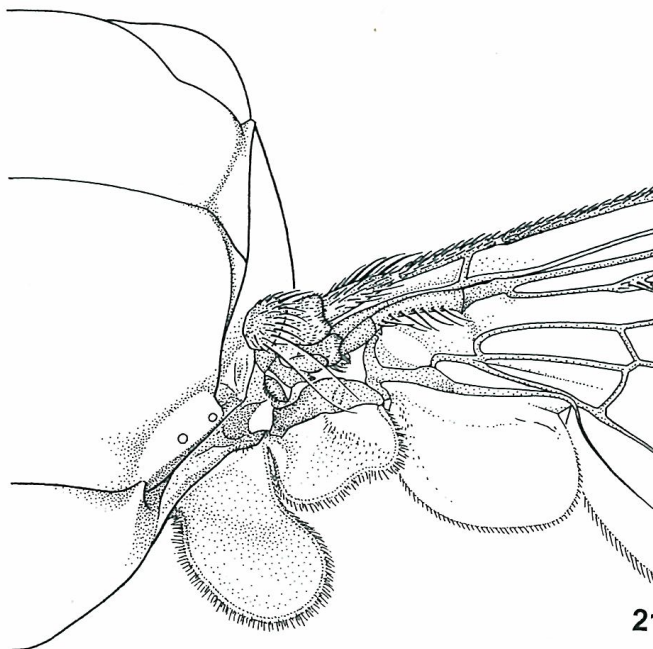
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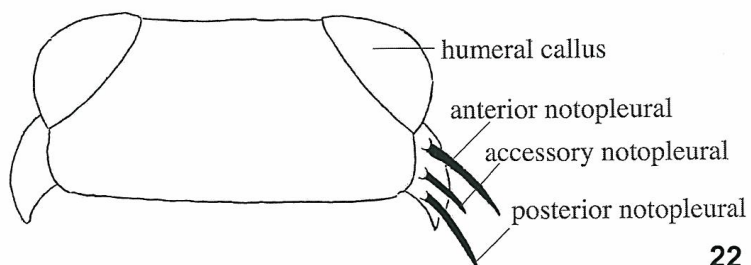
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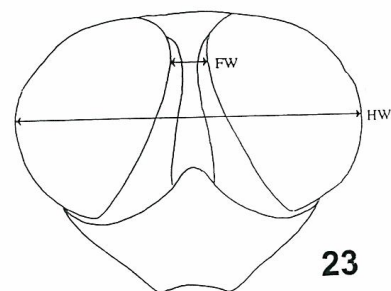
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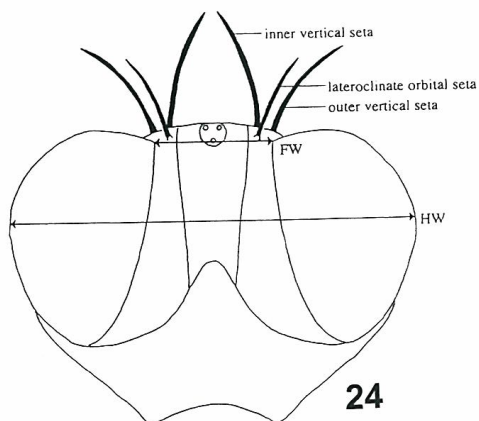
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- Arista with fine pubescence. Apical scutellar setae usually short (Fig. 30). *Angioneura* (5 spp.)
- 13. Thorax and abdomen shining green, blue, or bronze. Suprasquamal ridge with conspicuous cluster of setae near the base of scutellum (Fig. 14); lower calypter bare above (Fig. 14). Luciliinae *Lucilia* (11 spp.)
- Thorax dull, microtomentose; abdomen usually metallic blue with whitish microtomentum. Suprasquamal ridge bare or with inconspicuous fine setae (Fig. 31); lower calypter setose above (Fig. 31). Calliphorinae 14
- 14. Bend of M obtuse (as in Fig. 32), curvature of apical section even; first flagellomere, at most, twice the length of pedicel; costa usually setulose below only to junction with subcosta, as in inset Fig. 6; abdomen blue or olive green; known only from northeastern North America in the Nearctic Region. *Bellardia* (2 spp.)
- Bend of M acute or right angled (Fig. 42), curvature of apical section greatest just beyond bend; first flagellomere more than twice length of pedicel; costa usually setulose below to junction with R1; abdomen bluish. 15
- 15. Upper and lower calypter white. 16
- Upper and lower calypter light to dark brown, margin may be white. *Calliphora*, in part (11 spp.)
- 16. Presutural intra-alar seta absent; abdomen shining, no microtomentum visible when viewed posteriorly. *Cynomya* (2 spp.)
- Presutural intra-alar seta present (Fig. 1), abdomen microtomentose 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* (1 sp.)
- 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 spp.)

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; suprasquamal ridge bare or with only a few inconspicuous setae.

Bellardia Robineau-Desvoidy, 1863

This Palearctic genus is a recent immigrant to North America and known only from the northeastern U.S. It was very rare in my search of collections. The genus can be identified by the obtuse bend in vein M (Fig. 32). 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).

KEY TO SPECIES OF *BELLARDIA*

- 1. Upper parafacial with dark brown spots which do not disappear when viewed from above; lower calypter evenly darkened, light tan; male genitalia tiny, cercus longer than surstylus as in Rognes (1991: figs. 79, 80); a small fly. *bayeri*
- Upper parafacial without spots; lower calypter white, margins yellowish or light tan; male genitalia larger, cercus shorter than surstylus as in Rognes (1991: figs. 68, 69); a larger fly. *vulgaris*

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.

Table 1. Species in order they are discussed and comparison of names used in the current paper with names used by Hall (1948).

Whitworth (2006)	Hall (1948)	Page Number
CALLIPHORINAE		
<i>Bellardia</i>	Not included	698
<i>bayeri</i>		
<i>Bellardia</i>	Not included	698
<i>vulgaris</i>		
<i>Calliphora</i>	<i>Acronesia alaskensis</i>	700
<i>alaskensis</i>		
<i>Calliphora</i>	<i>Acronesia aldrichia</i>	701
<i>aldrichia</i>		
<i>Calliphora</i>	<i>Calliphora</i>	701
<i>coloradensis</i>	<i>coloradensis</i>	
<i>Calliphora</i>	<i>Acronesia collini</i> ,	701
<i>genarum</i>	<i>A. popoffana</i>	
<i>Calliphora</i>	<i>Aldrichina grahami</i>	703
<i>grahami</i>		
<i>Calliphora</i>	<i>Eucalliphora arta</i> ,	703
<i>latifrons</i>	<i>E. lilaea</i>	
<i>Calliphora</i>	<i>Calliphora livida</i>	703
<i>livida</i>		
<i>Calliphora</i>	<i>Calliphora mortica</i>	703
<i>loewi</i>		
<i>Calliphora</i>	<i>Acronesia montana</i>	703
<i>montana</i>		
<i>Calliphora</i>	<i>Acronesia abina</i> ,	704
<i>stelviana</i>	<i>A. anana</i>	
<i>Calliphora</i>	<i>Calliphora vicina</i>	707
<i>vicina</i>		
<i>Calliphora</i>	<i>Calliphora</i>	707
<i>terraenovae</i>	<i>terrae-novae</i>	
<i>Calliphora</i>	<i>Calliphora vomitoria</i>	707
<i>vomitoria</i>		
<i>Cyanus</i>	<i>Cyanus elongata</i>	707
<i>elongata</i>		
<i>Cynomya</i>	<i>Cynomyopsis</i>	709
<i>cadaverina</i>	<i>cadaverina</i>	
<i>Cynomya</i>	<i>Cynomya mortuorum</i> ,	709
<i>mortuorum</i>	<i>C. hirta</i>	
CHRYSOMYINAE		
<i>Chloroprocta</i>	<i>Chloroprocta</i>	709
<i>idioidea</i>	<i>idioidea</i>	
	<i>C. fuscipennis</i>	
<i>Chrysomya</i>	Not included	709
<i>megacephala</i>		
<i>Chrysomya</i>	Not included	710
<i>rufifacies</i>		
<i>Cochliomyia</i>	<i>Callitroga aldrichi</i>	710
<i>aldrichi</i>		
<i>Cochliomyia</i>	<i>Callitroga americana</i>	710
<i>hominivorax</i>		
<i>Cochliomyia</i>	<i>Callitroga macellaria</i>	712
<i>macellaria</i>		
<i>Cochliomyia</i>	<i>Callitroga minima</i>	712
<i>minima</i>		

Table 1. Continued.

Whitworth (2006)	Hall (1948)	Page Number
<i>Compsomyiops</i>	<i>Paralucilia wheeleri</i>	712
<i>callipes</i>		
<i>Phormia regina</i>	<i>Phormia regina</i>	712
<i>Protocalliphora</i>	<i>Apaulina</i>	712
<i>Protophormia</i>	<i>Boreellus atriceps</i>	717
<i>atriceps</i>		
<i>Protophormia</i>	<i>Protophormia</i>	717
<i>terraenovae</i>	<i>terrae-novae</i>	
<i>Trypocalliphora</i>	<i>Apaulina hirudo</i>	718
<i>braueri</i>		
LUCILIINAE		
<i>Lucilia cluvia</i>	<i>Phaenicia cluvia</i>	720
<i>Lucilia</i>	<i>Phaenicia</i>	720
<i>coeruleiviridis</i>	<i>coeruleiviridis</i>	
<i>Lucilia cuprina</i>	<i>Phaenicia pallescens</i>	720
<i>Lucilia elongata</i>	<i>Bufolucilia elongata</i>	720
<i>Lucilia eximia</i>	<i>Phaenicia eximia</i>	720
<i>Lucilia illustris</i>	<i>Lucilia illustris</i>	721
<i>Lucilia</i>	<i>Francilia alaskensis</i>	721
<i>magnicornis</i>		
<i>Lucilia mexicana</i>	<i>Phaenicia mexicana</i>	721
<i>Lucilia sericata</i>	<i>Phaenicia sericata</i>	721
<i>Lucilia silvarum</i>	<i>Bufolucilia silvarum</i>	721
<i>Lucilia thatuna</i>	<i>Phaenicia thatuna</i>	721
POLLENIINAE		
<i>Melanodexia</i>	<i>Melanodexia</i>	721
	<i>Melanodexiopsis</i>	
<i>Pollenia</i>	Not included	722
<i>angustigena</i>		
<i>Pollenia</i>	Not included	722
<i>griseotomentosa</i>		
<i>Pollenia labialis</i>	Not included	723
<i>Pollenia</i>	Not included	723
<i>pediculata</i>		
<i>Pollenia rudis</i>	<i>Pollenia rudis</i>	723
<i>Pollenia</i>	Not included	723
<i>vagabunda</i>		
MELANOMYINAE		
<i>Angioneura</i>	Not included	723
<i>Opsodexia</i>	Not included	723

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 tend to 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 blue or dark green with white microtomentum; male epandrium large, cerci curve sharply under abdomen with horn-like prominences at each base (Fig. 33). Western, Alaska to California and Colorado. *grahami*
- Presutural intra-alar seta present (Fig. 1); anterior thoracic spiracle usually with brown setae; abdomen usually metallic bluish with or without white microtomentum; cerci and surstyli not as above (as in Fig. 34). 2
2. Calypter wholly white; frons of male broad, at narrowest, usually 0.15–0.21 head width; primarily northern Canada and Alaska or high elevations. 3
- Calypter brown, margin often white; frons of male narrower, 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). Alaska, northern Canada, to Quebec and Labrador. *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 shorter median marginal setae, always less than half the length of those on fourth tergite; tip of surstylus pointed (see Rognes 1991: fig. 173). Alaska, Quebec, 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). Male genitalia shorter, with a chisel-shaped point (Fig. 38). Frons of male broad, at narrowest, almost 2× 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 western, east to Colorado and Wisconsin. *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; 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. 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). Alaska to Ontario and Indiana, 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, usually black (except front half often reddish in *C. terraenovae*); 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 subgena and 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. *vomitioria*
- 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
10. Bend in M much closer to wing margin than length of M from cross vein dm-cu to bend (as in Fig. 42); usually 4 (3–5) strong lateral scutellar setae besides apical pair (Fig. 43); male frons, at narrowest, 0.04–0.07 head width; surstylus curves anteriorly or is straight (Figs. 34, 38, 39). 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); usually 2 or 3 (occasionally a fourth on one side) strong lateral scutellar setae besides apical pair (Fig. 45); male frons, at narrowest, 0.06–0.14 head width; surstylus curves posteriorly (Fig. 46a). 12
10. Genal groove usually reddish or orange; anterior 1/3–1/2 of genal dilation usually reddish when viewed from above; first flagellomere often orange along lower inside edge; parafacial golden or silvery tan when viewed from above; surstylus long and slender with gentle anterior curve (Fig. 47). Widespread from Alaska to Newfoundland, south to southern California, and Texas; usually at higher elevations in the West. *terraenovae*
- Genal groove usually black or dark brown (rarely reddish or reddish brown); anterior portion of genal dilation entirely black or dark brown; first flagellomere uniformly gray; parafacial silvery black; surstylus not as above (Fig. 48). 11
11. Surstylus 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. Alaska, British Columbia, Yukon Territory. *loewi*
- 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, b), profile not tent-like. Widespread from Alaska to Oregon and east to North Carolina, primarily at high elevations in southern locations. *alaskensis*
12. Two or 3 lateral scutellar setae in addition to apical pair (Fig. 45). When a third seta is present, in the prebasal position (see Fig. 1), it is usually weak. Bend in M vein usually farther from wing margin and closer to crossvein dm-cu (as in Fig. 44). Sometimes the bend is equal distance between wing margin and crossvein. Male frons, at narrowest, 0.11 (0.08–0.14)/15 head width. Cercus of male usually shorter (Fig. 46b). Western south from Alaska through British Columbia to California and Colorado. *aldrichia*
- Three or sometimes 4 lateral scutellar setae in addition to the apical pair, the seta in the prebasal position usually stronger (as in Fig. 43). Bend in M vein usually slightly closer to wing margin or equal distance between wing margin and dm-cu crossvein (similar to Fig. 42, but the bend is shown much closer to the wing margin). Male frons at narrowest, 0.07 (0.06–0.08)/18 head width. Cercus of male usually longer (Fig. 52b). Primarily east of the Rockies, ranging southeast from northwestern Canada (where it overlaps with *C. aldrichia*) east through the Canadian provinces to Ontario and Labrador. *montana*
- Calliphora alaskensis* Shannon, 1923. This species is widespread but rare, found only at high elevations in the southern portions of its range. Hall (1948) listed specimens from Alaska, Wyoming and Colorado. I also found this species from 7 locations in Canada (3 in British Columbia and 4 in Quebec), from 10 locations in the U.S. (2 in Oregon, 2 in Utah, 4 in Colorado and, surprisingly, one each from mountains in Tennessee and North Carolina). This

species is normally rare, but I examined about 25 females of this species that were bait trapped in the vicinity of Vancouver, British Columbia. These flies were attracted to both beef and chicken liver in second growth timber (K. Needham, in litt.). In 7 of 50 specimens examined (6 males, 1 female), the genal groove was reddish to reddish brown which would place them with *C. terraenovae*. Genitalia will separate males, but females with reddish genal grooves will be difficult to separate.

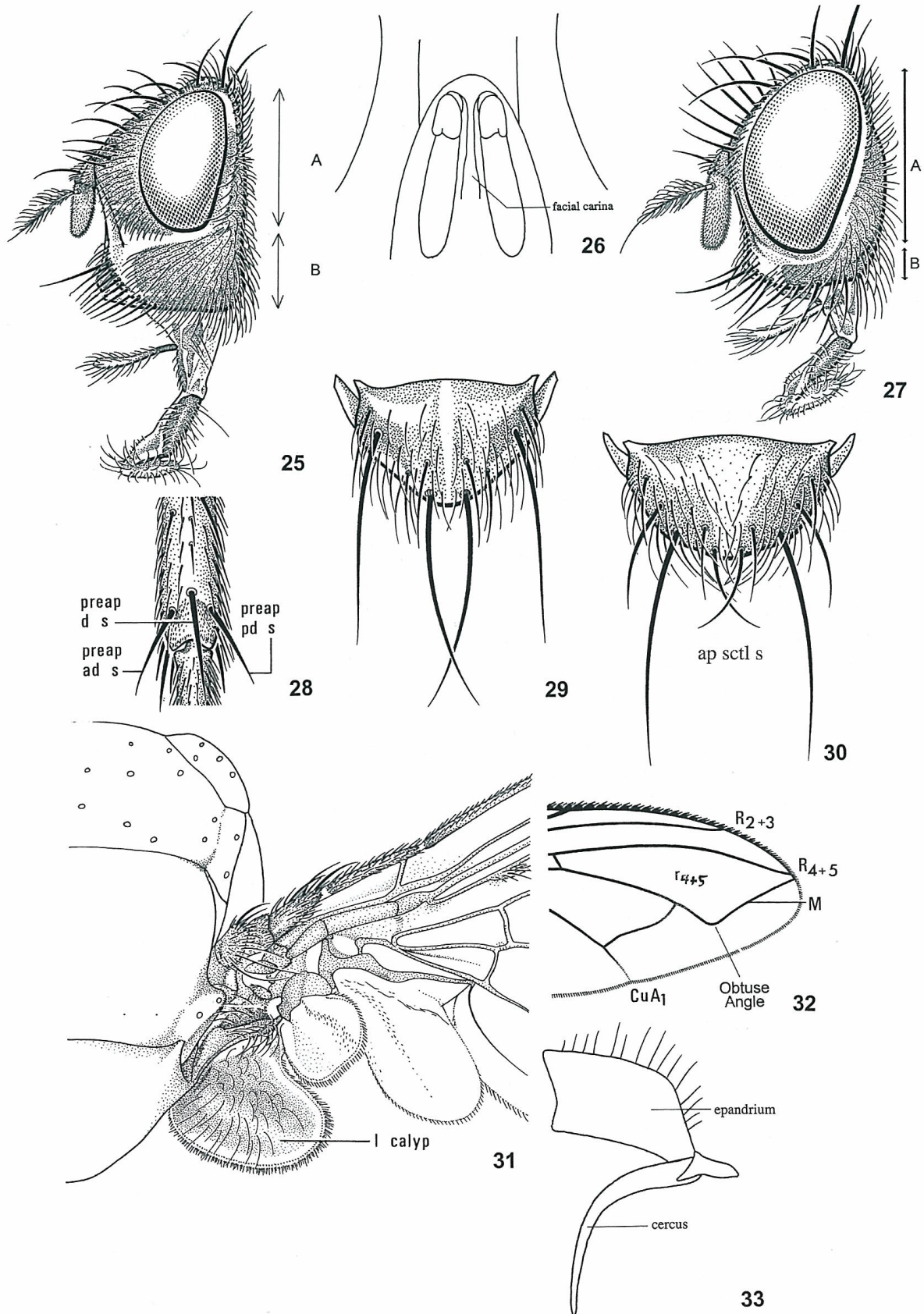
Calliphora aldrichia Shannon, 1923. Hall (1948) gave records from British Columbia and Quebec, Alaska, Colorado, Wyoming, Montana, and Washington. (I believe the Quebec record was likely *C. Montana*). I also examined specimens from western Alberta, California, and Oregon. This species is morphologically very close to *C. montana*, the two appear to be sibling species. Males share distinctive surstyli which curve posteriorly (Fig. 46a), unlike other *Calliphora*. The most obvious difference between the two species is that males of *C. aldrichia* have, on average, a much wider frons (0.11 of head width at narrowest) than *C. montana* (0.07 of head width, at narrowest). The term lateral scutellar setae is used in the key in a broad sense to include all stronger setae on the margin of the scutellum other than the apical pair (as in Figs. 43, 45). Other authors assign separate names to these setae, as in Fig. 1.

The two species appear to have formed as a result of geographical isolation. *Calliphora aldrichia* is found west of the Rocky Mountains from Alaska to California and Colorado, while *C. montana* is found primarily east of the Rockies from Northwest Territories and Alberta east to Labrador. Their ranges overlap in northern British Columbia, and southern Yukon where specimens with intermediate characters were found. 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 through lower elevations to the east. The area where the species converge is lower elevation at the northern edge of the Rockies. Separating females of these species, based on morphology, will be problematic. Outside the zone where populations converge, distribution appears to be the best way to separate females. As more specimens become available, species distinctions should be reevaluated.

Calliphora coloradensis Hough, 1899. This species is generally rare, but appeared to be locally abundant in areas around Flagstaff, Arizona, and Uvalde, Texas. I also examined specimens from California, New Mexico, Oregon, Wyoming, and South Dakota. Hall (1948) reported its range from Mexico north to Alaska, and east to Ontario and Indiana. Most specimens that I examined were from the southwestern U.S. 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.

Calliphora genarum Zetterstedt, 1838. This species and *Calliphora stelviana* (Brewer and Bergenstamm, 1891) would key to *Acrophaga* in Shewell (1987). I saw few specimens of this species. Hall (1948) gave its range as Alaska and northern Canada, Manitoba, and Labrador. I examined specimens from Yukon, Northwest Territories, and Manitoba. 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. Characters are illustrated in Rognes (1991: figs. 149–158).

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. It lacks a presutural intra-alar seta, which distinguishes it from other *Calliphora*, and is a character shared with the genus *Cynomya*. The large, curved cerci (Fig. 33) of the male are unlike those of any other *Calliphora* in North America.

Calliphora latifrons Hough, 1899. I examined specimens from California to Washington, and Colorado to Wisconsin. Hall (1965) reported that he found the species in the north, from Alaska to Ontario. It is primarily a western species, though found occasionally in the East. It can be recognized by a combination of several characters including short, stout supravibrissal setae and a second set of strong divergent ocellar setae. 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. Hall (1948) reported this species only in Alaska, but I examined specimens from Kulane Lake in the Yukon, from Terrace and the Queen Charlotte Islands in central British Columbia, Kootenay National Park in southeastern British Columbia and the Vancouver area in southwestern British Columbia. It is a rare species that 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, in females the shape of the fifth tergite and the presence of a posterior incision separate them from similar species. Characters are illustrated in Rognes (1991: figs. 159–168).

Calliphora montana (Shannon 1926) (Figs. 45, 52).

Sterigomyia montana Shannon 1926: 135 (♂, ♀).

Acronesia montana: Hall 1948: 280.

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Figs. 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 d s = preapical dorsal seta; preap ad s = preapical anterodorsal seta; preap pd 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 grahami* male, left lateral view of postabdomen.

Hall (1948) commented that he could not find the type of this species in the U.S. National Museum, I borrowed a male labeled type and a female labeled allotype from the Canadian National Collection. The male genitalia are similar to those of *C. aldrichia*, but the characters are variable enough that the two species can be difficult to separate. Normally the narrower frons will distinguish males. Because Shannon's description included few details, I redescribe this species below.

Diagnosis.—Bend in M usually closer to wing margin or equal distance between wing margin and cross vein dm-cu (Fig. 44). Usually 3, or occasionally 4, lateral scutellar setae in addition to the apical pair (see Fig. 45 for location). Male frons, at narrowest, about 0.07 head width; cerci long (Fig. 52), longer than in *C. aldrichia* (Fig. 46).

Male.—Head ground color black, with silvery microtomentum, genal groove black, preocellar area triangular, shining to subshining black. Thorax subshining black with white microtomentum. Abdomen metallic blue with silvery microtomentum when viewed from an angle. Frons narrow, at narrowest, 0.072 (0.06–0.08)/18 head width, the holotype male ratio is 0.065. Usually 3 pair lateral scutellar setae in addition to apical pair, sometimes 4 on one or both sides. Bend in M usually slightly closer to wing margin, occasionally equidistant between wing margin and dm-cu crossvein or closer to crossvein. Surstyli curve posteriorly, as in *C. aldrichia* and unlike all other North American *Calliphora*. Cerci longer than those of *C. aldrichia*.

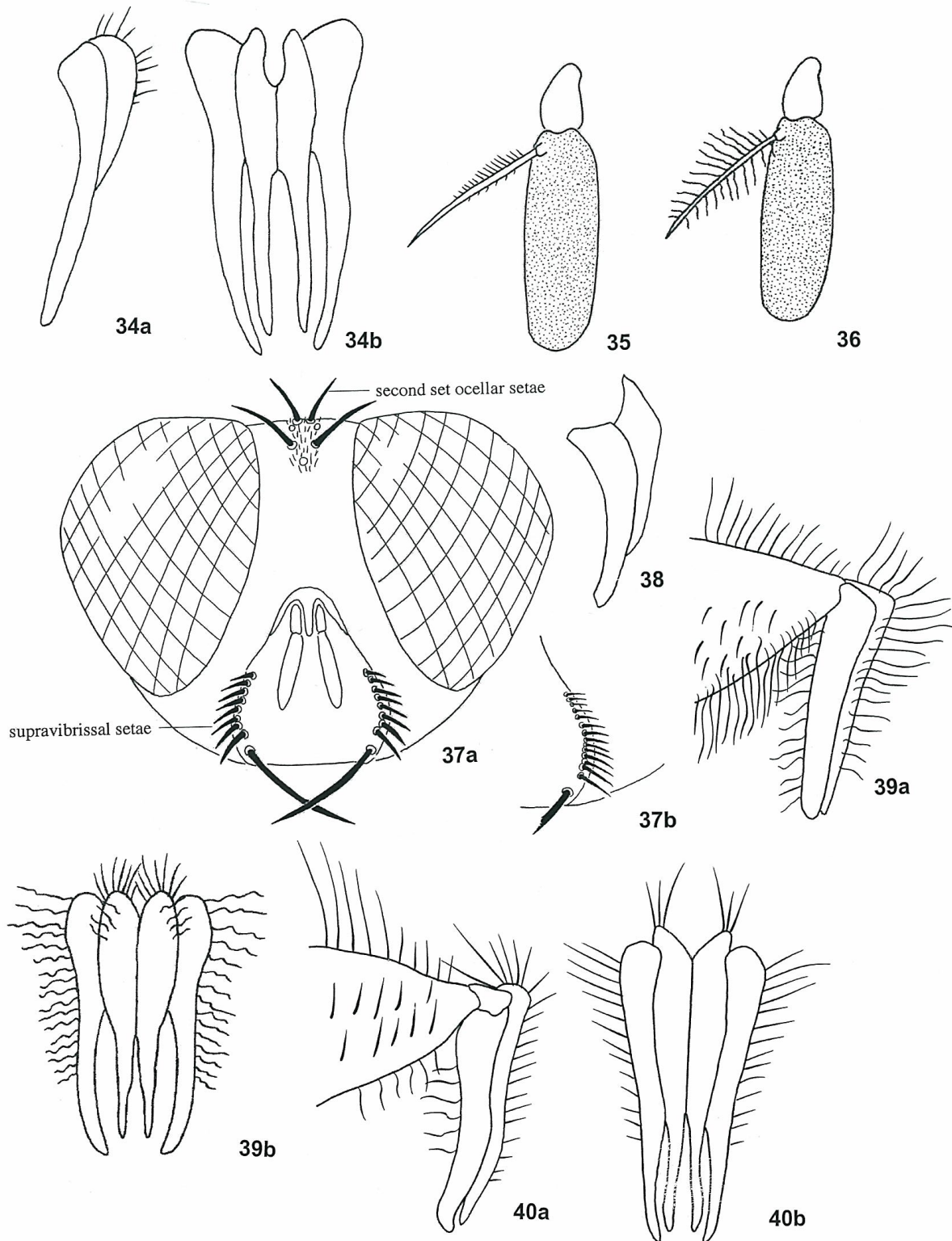
Female.—Color of head as in male, preocellar area unmarked. Thorax and abdomen as in male. Frons, at narrowest, 0.34(0.32–0.36)/8 head width; other characters as in male.

Types.—Type male, allotype female, no paratypes designated. Both specimens labeled *Steringomyia montana*, from Ed-

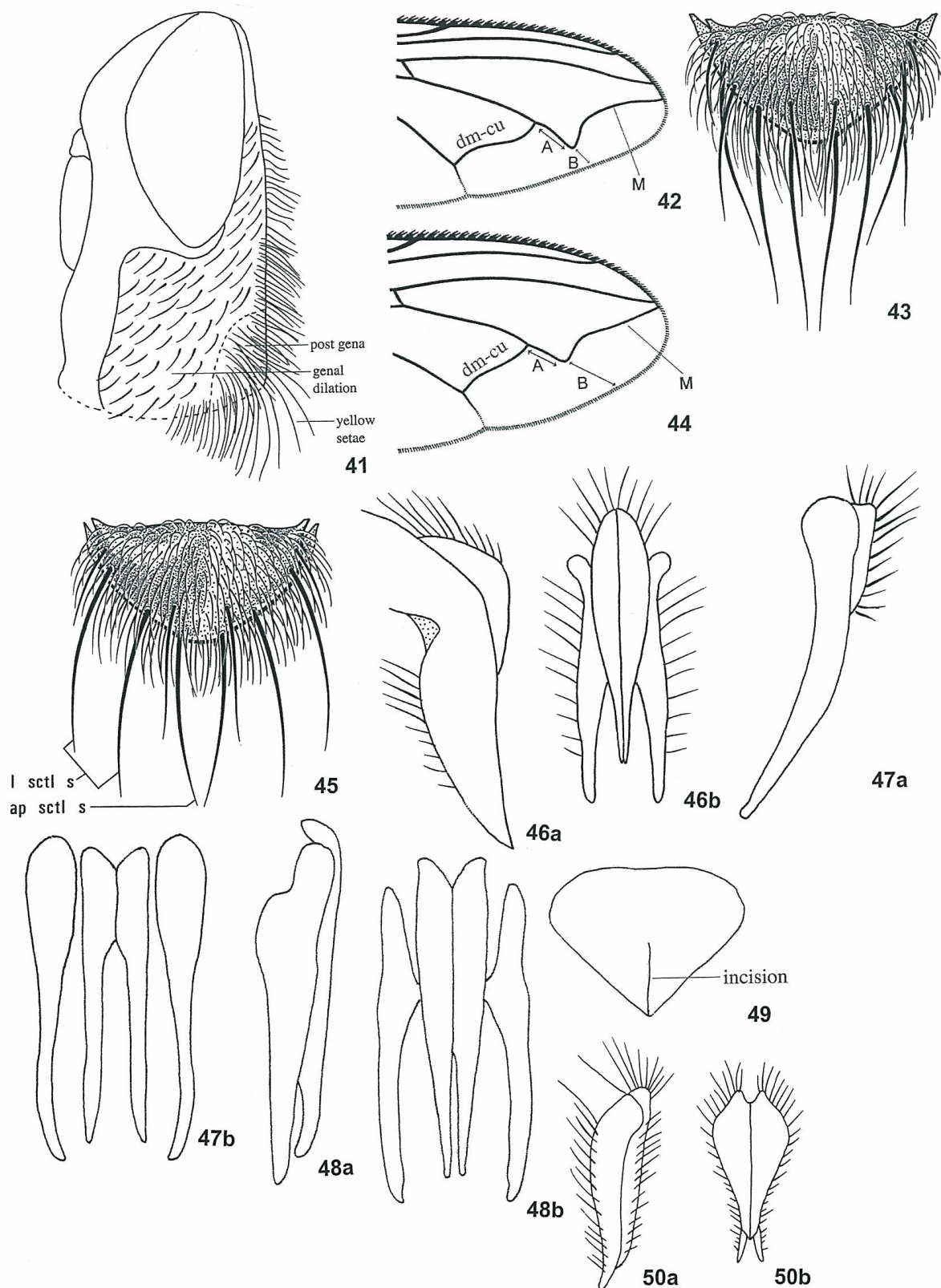
monton, Alberta, Canada, August 19, 1923, collector E.H. Strickland label numbered 2444. Male genitalia had been dissected and are in a vial with the specimen.

Additional specimens examined in this study.—CANADA, BRITISH COLUMBIA: Haines Highway. Mile 45, 7/25/1963, G.C. and D.M. Wood, 1 male. Stone Mountain Provincial Park, 8/2/1989, Paul Arnaud, 1 male. LABRADOR: Cartwright, 8/21/1955, E.F. Cashman, 1 male; Churchill Rd., 10 miles from Goose Bay, 7/28/1987, K.F. Paraday, 1 male. MANITOBA: Churchill, 8/5/1955, D.M. Wood, 1 male. NOVA SCOTIA: Cape Breton Highlands National Park, Mackenzie Mountain, 8/29/1983, M. Sharkey, 1 female. NORTHWEST TERRITORIES: Norman Wells, 8/16/1969, G.E. Shewell, 1 female. ONTARIO: Ogoki, 8/28/1952 J.B. Wallis, 1 female, 8/18/52, 1 male; 8/20/1963, D.M. Wood, 1 male; Temagami, 8/20/1963, G. Taylor and M. Wood, 1 male. QUEBEC: Cascapedia River, Gaspé, 30 miles north of New Richmond, 8/1/1983, W. Middlekauff, 1 male; Grand Valley, 7/30/1963, G.S. Walley, 1 male; Laurentides Park, Barriere Ste. Anne, 8/15/1971, D.M. Wood, 1 male; 8/16/1956, R.W. Hodges, 2 males; La Verendrye Provincial Park, 8/19, 8/20, 8/21 1965, D.M. Wood, 2 males, 1 female. SASKATCHEWAN: Prince Albert, 8/14/1953, W.J. Turnock, 1 female. YUKON TERRITORIES: Gravel Lake, 63°48'N 137°53'W, 6/16/1981, C.S. Guppy, 1 male; Kulane Lake, 8/1/1963, G.C. and D.M. Wood, 2 males; Wolf Creek, mile 907 Alaska Hwy, 8/24/1963, G.C. and D.M. Wood, 1 female.

Calliphora stelviana (Brauer and Bergenstamm, 1891). This species would key to *Acrophaga* in Shewell (1987). Hall (1948) listed it from Alaska to northern Quebec, and Labrador, also at high elevations in Colorado. I examined specimens from Alaska, Yukon, Northwest



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



Figs. 41–50. 41, *Calliphora vomitoria* female, left lateral view of head. 42, *C. vomitoria* female, dorsal view of right wing; a) bend in M to crossvein; b) bend to wing margin (after Shewell 1987). 43, *C. terraenovae* male, scutellar setae (from Shewell 1987). 44, *C. genarum* female, dorsal view of right wing; a)

Territories, and Quebec. This species and *C. genarum* are the only North American *Calliphora* with white calypters. Characters illustrated in Rognes (1991: figs. 169–182).

Calliphora terraenovae Macquart, 1851. This species is widespread from Alaska south to California, and east to Greenland, also known from Wisconsin, Colorado, and New Mexico. Hall (1965) reported it from Florida, and James (1955) reported it from New York. I never saw this species from eastern localities despite examining many specimens of *Calliphora* from there. The Florida record is likely a misidentification. This species lacks any single distinctive character, but can be recognized by a combination of characters.

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).

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 rear and lower portion of the postgena, genal dilation, and back of the head. Characters are illustrated in Rognes (1991: figs. 207–216).

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. 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 4,000' elevation. One each of the other specimens was caught in Malaise traps on Stein's mountain at 4,500 feet, 6,000 feet, and 8,500 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, b).

Cynomya Robineau-Desvoidy, 1830

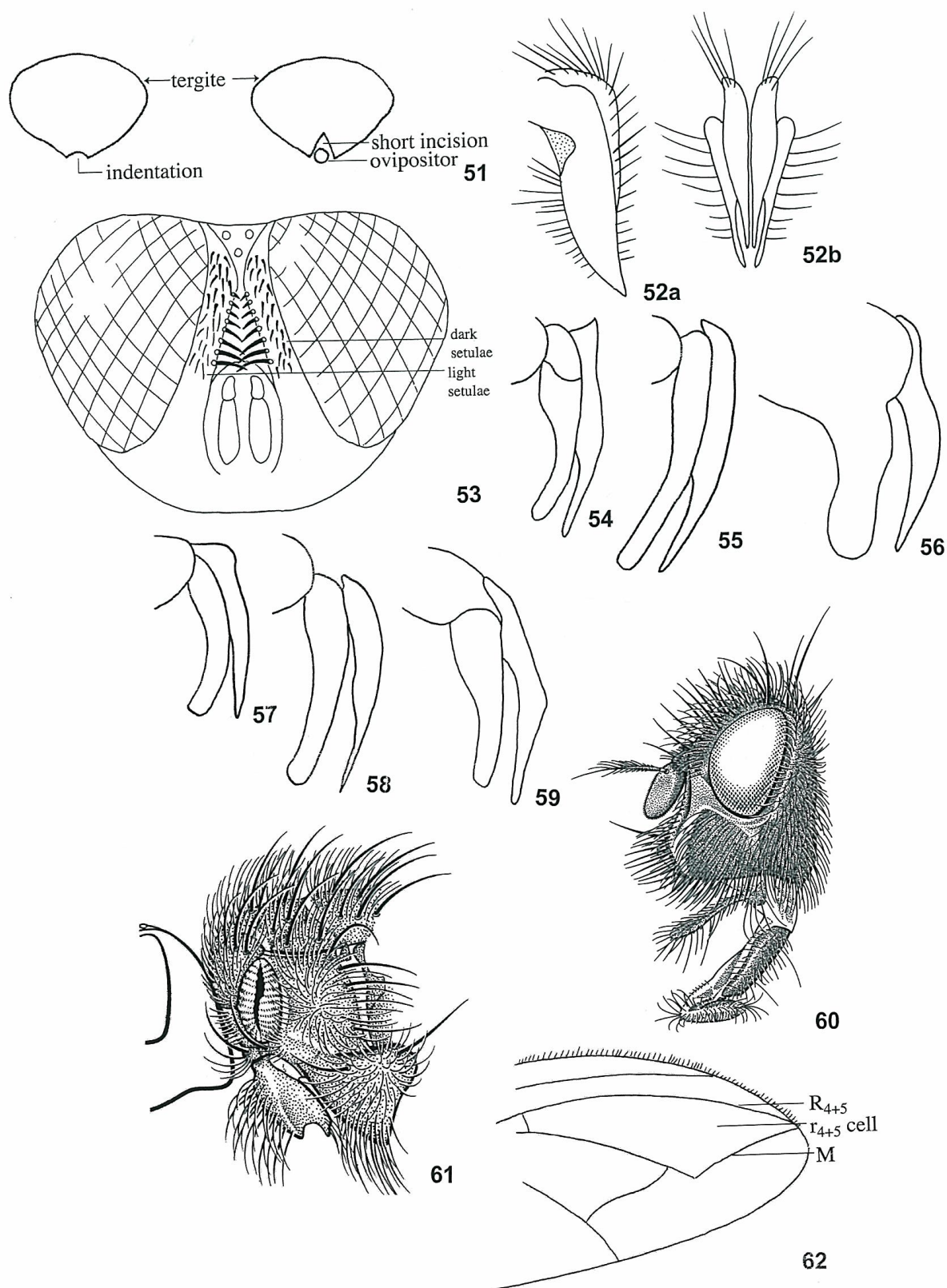
The genus has 2 species which have white calypters, lack the presutural intralar seta, and have a brilliant, shining blue abdomen.

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. Holarctic, 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 microtri-

←

bend in M to crossvein; b) bend to wing margin (after Shewell 1987). 45, *C. montana* male, scutellar setae; l sclt s = lateral scutellar setae; ap sclt s = apical scutellar setae (after Shewell 1987). 46, *C. aldrichia* male, cerci and surstyli; a) left lateral view; b) posterior view. 47, *C. terraenovae* male, cerci and surstyli; a) left lateral view; b) posterior view. 48, *C. loewi* male, cerci and surstyli; a) left lateral view; b) posterior view. 49, *C. loewi* female, dorsal view of tergite 5. 50, *C. alaskensis* male, cerci and surstyli; a) left lateral view; b) posterior view.



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, *C. montana* male, cerci and surstyli, a) left lateral view; b) posterior view. 53, *Cochliomyia*, anterior view of head; left side

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

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. I rarely found it from the southern U.S. 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*, *Compsoimyops*, *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 mesonotal vittae, and has dusky wings.

Chrysomya Robineau-Desvoidy, 1830

Species of this Old World genus recently have 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).

KEY TO SPECIES OF *CHRYSOMYA*

1. Vestiture 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 Zumpt (1965: fig. 113); male frons very narrow, eyes nearly touching, frons, at narrowest, 0.01/5 head width; female frons, at narrowest, 0.32/6 (0.31–0.33) head width *megacephala*
- Vestiture 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 (0.04–0.05) head width; female frons, at narrowest, 0.29/6 (0.28–0.30) head width. *rufifacies*

Chrysomya megacephala (Fabricius, 1794). This species is rarely found in the southern U.S. and I examined specimens from Florida only. This species also has been recorded from Alabama, California, Georgia, New Mexico, South Carolina, and Texas (Tomberlin et al. 2001). 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 of the eyes being much smaller.

←

C. hominivorax; right side *C. macellaria*. 54–59, *Protocalliphora*, 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, *P. atriceps* female, left lateral view of prothorax (after Shewell 1987). 62, *P. atriceps*, female, dorsal view of right wing.

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 four species in North America. The genal dilation has orange ground color and yellow setae, with pale setae on posterior margin of hind coxa; palp filiform.

KEYS TO SPECIES OF *COCHLIOMYIA*

1. Upper anterior portion of genal dialation with few to many short black setulae; fifth tergite cupreous, contrasting in color with preceeding tergites; dorsum of thorax with predominately metallic black and grey colors; postgenal setulae white. Rare in southern Florida.
- Genal dialation with setulae entirely yellow; fifth tergite blue to green, concolorous with preceeding tergites; dorsum of thorax with predominantly metallic blue or green colors; postgenal setulae yellow.
2. Fifth tergite with a pair of median dorsal silvery microtomentose spots; occiput with 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; surstylus and cercus long and slender, similar to those in Fig. 55 (also see Dear 1985: figs. 39, 40 and Hall 1948: figs. 17 E, F). *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; surstylus and cercus short, surstylus digitate, similar to those in Fig. 56 (also see Dear 1985: figs. 37, 38 and Hall 1948: figs. 18C, D, E). *minima*

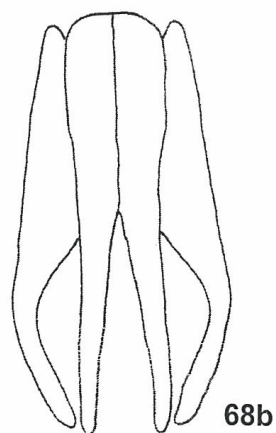
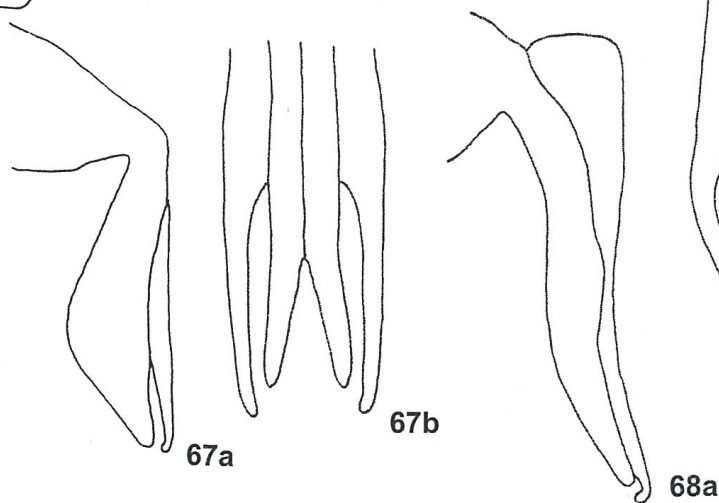
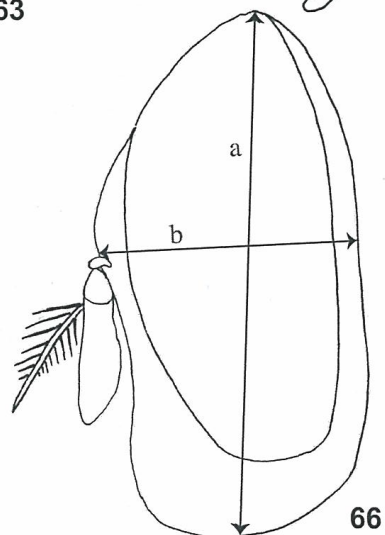
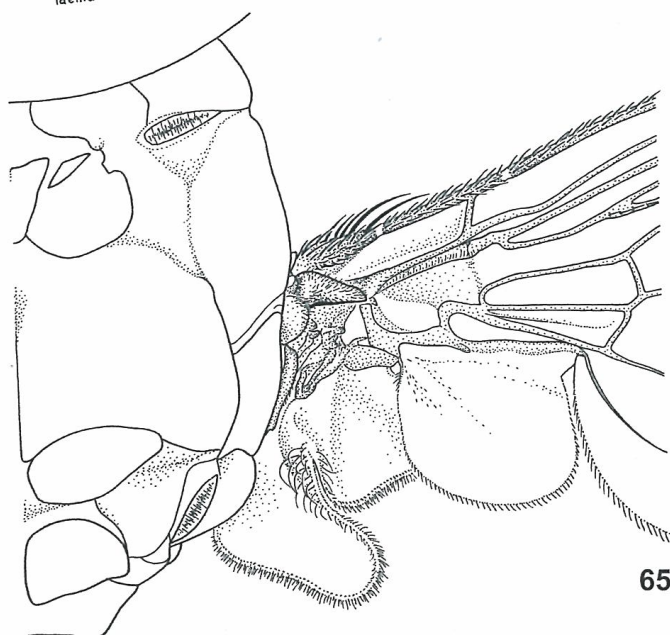
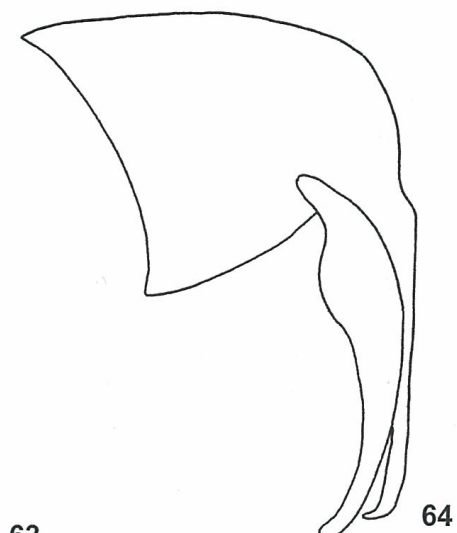
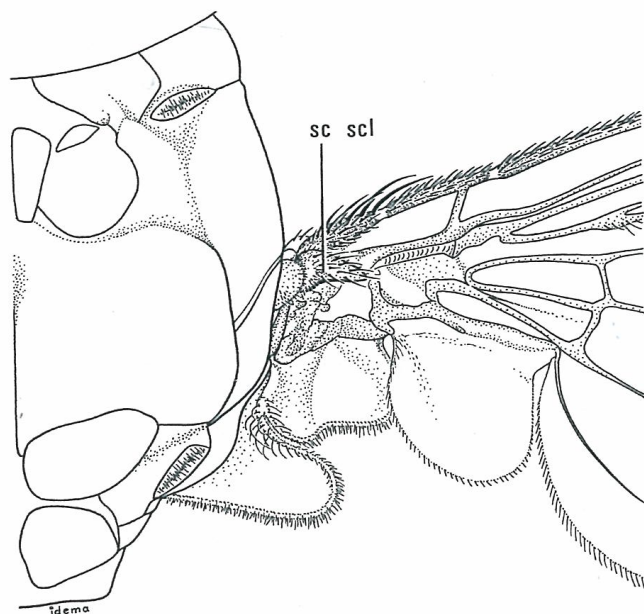
3. Fronto-orbital plate with dark setulae outside row of frontal setae (Fig. 53, right side); lateral areas of fifth tergite without pronounced silvery microtomentum; postgenal setae usually golden yellow; female with dark basicosta; proclinate orbital setae absent. Not found in North America since 1966 due to eradication efforts, found in parts of Mexico, Central, and South America. *hominivorax*
- Lower $\frac{1}{2}$ – $\frac{1}{3}$ of fronto-orbital plate with pale setulae outside row of frontal setae (Fig. 53, left side); 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.

Cochliomyia hominivorax (Coquerel, 1858). This species is 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

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



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 many *Cochliomyia* from the Keys and never found this species. Dear (1985) also 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 they are easily damaged and 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 in-

terpret. Some *C. aldrichi* have only a few dark setulae to separate them from *C. minima* with all pale setulae.

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

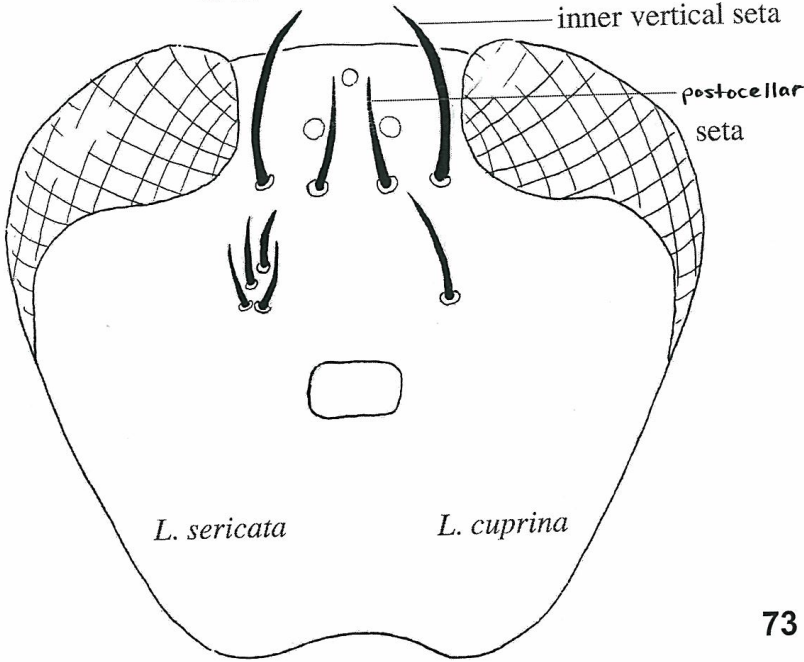
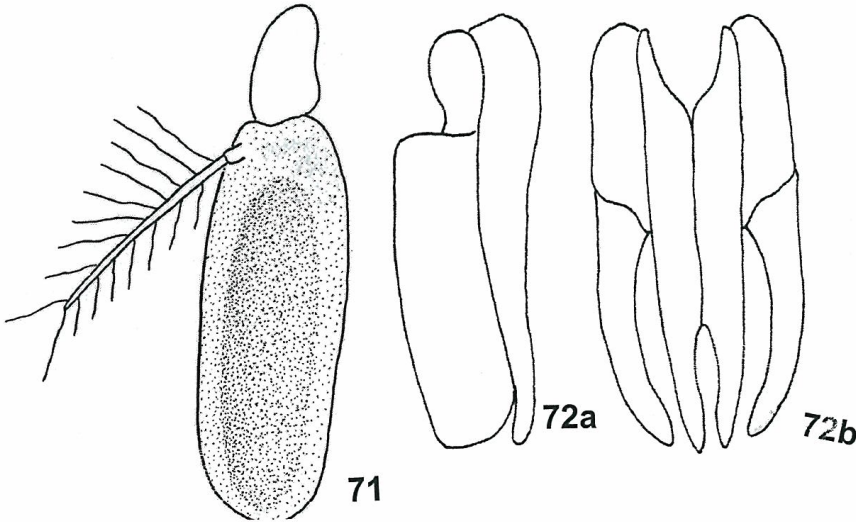
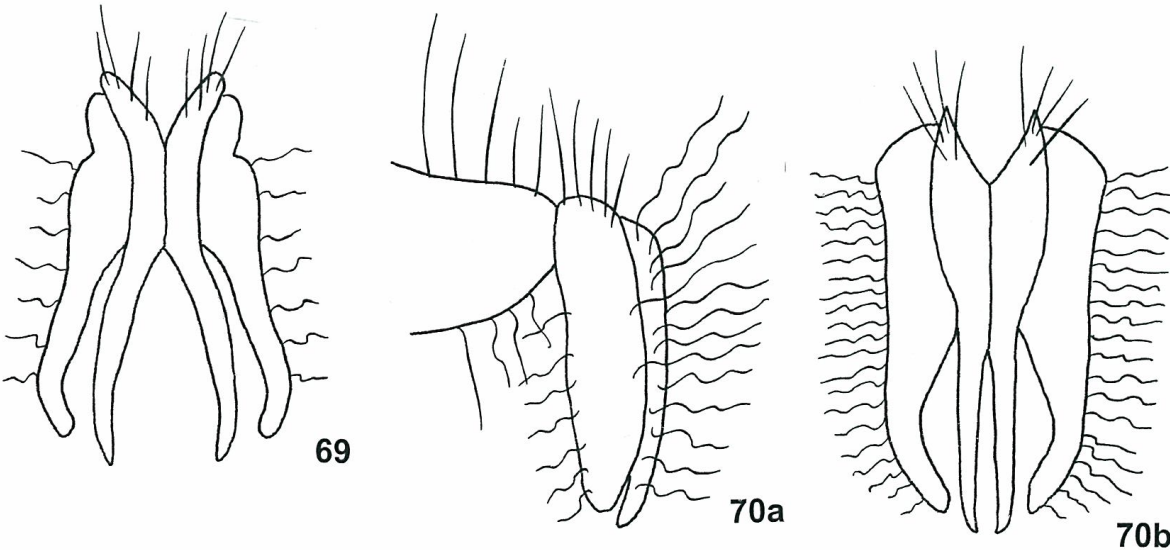
A single species.

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 by Rognes (1991: figs. 247–258).

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.

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



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*.

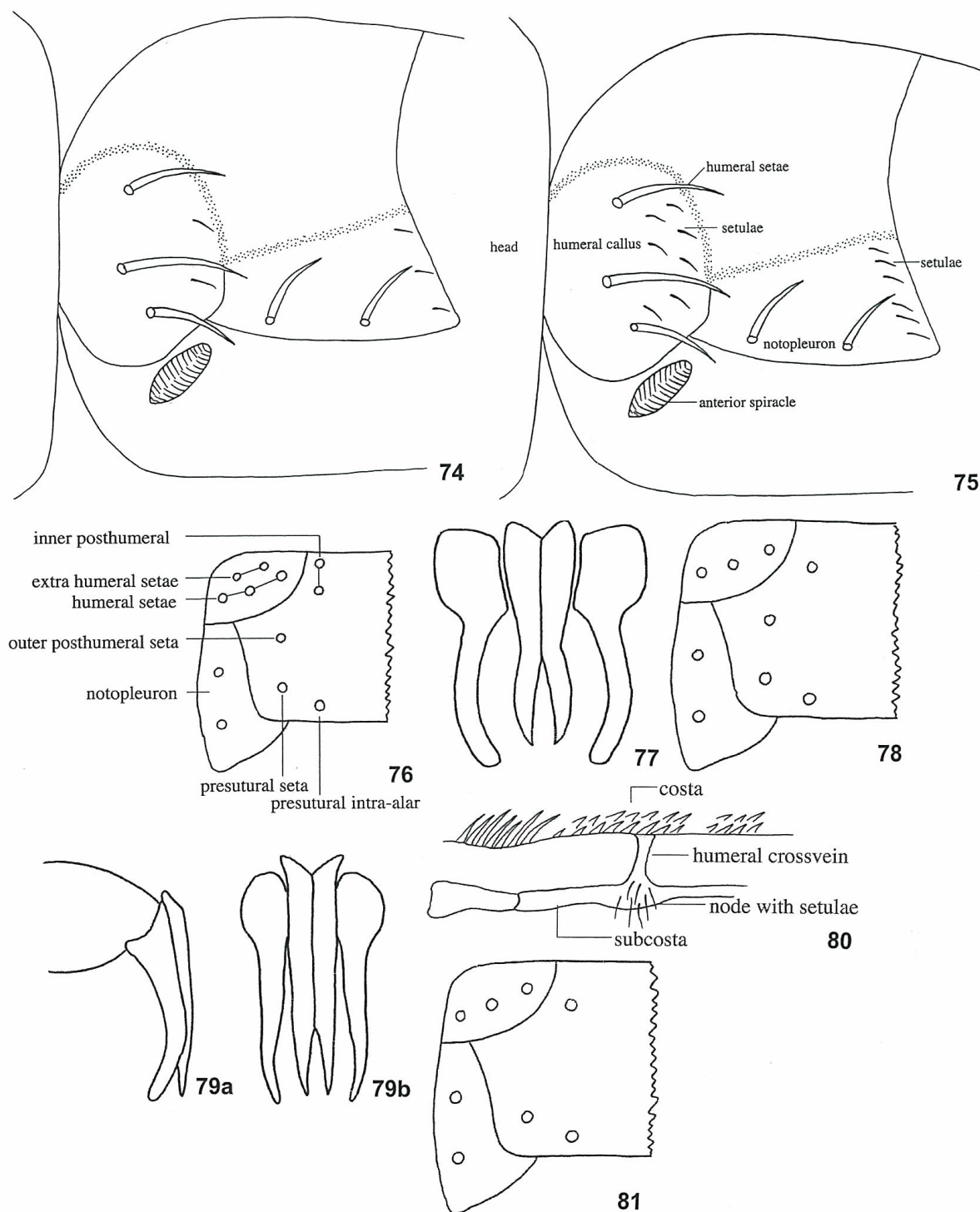
The keys to species relying on adult and puparial *Protocalliphora* in Sabrosky et al. (1989) work well for reared series with matched males, females, and puparia for the 26 North American species known at the time of publication (*Trypocalliphora braueri* was included under *Protocalliphora*). The key 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.*

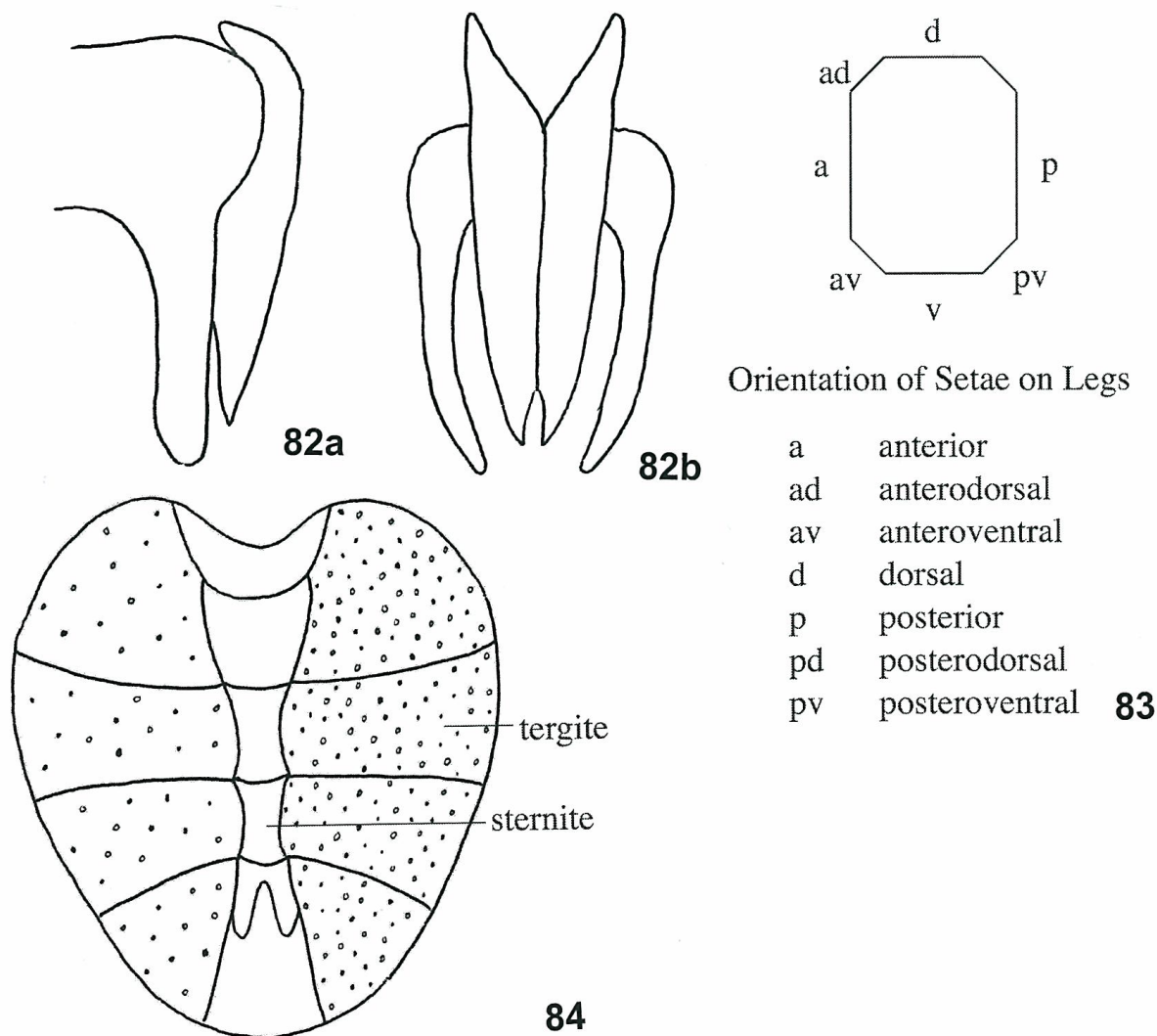
salia into an eastern and western component. *Protocalliphora salia* Shannon and Dobrosky is the form found in the Midwest and East while *P. occidentalis* Whitworth is the western form.

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 surstyli 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. salia* 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 revised key (Whitworth 2003b) for the puparia of 27 North American species. To date I have examined over 8000 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, *L. sericata*, setae at rear of humeral callus and notopleuron. 76, *Pollenia vagabunda*, dorsal view of left side of prothorax. 77, *P. vagabunda* male, cerci and surstyli, posterior view. 78, *P. rudis*, dorsal view of left side of prothorax. 79, *P. griseotomentosa* male, cerci and surstyli; a) left lateral view; b) posterior view. 80, *P. pediculata*, ventral view of junction of humeral crossvein and subcosta showing bundle of pale setulae. 81, *P. griseotomentosa*, dorsal view of left side of thorax.



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; *P. angustigena*, left side, *P. 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.
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. *P. 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 faint or absent, or if pronounced, found only east of a line from Alaska to Kentucky. 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. Pupa-
rium 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. Pupa-
rium 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. Pupa-
rium 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). 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. 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). 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) 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 shining, green, blue or bronze thorax and abdomen, suprasquamal ridge with a cluster of setae, and bare lower calypter. The genus includes 11 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); 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); basicosta orange or black; palp orange or black; surstylus and cercus of male not as above; ocellar triangle of female small, not reaching halfway to lunule. 2
2. Palp black or brown; 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 orange to yellow, not darkened apically; 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). 5
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 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. Two postsutural acrostichal setae, occasionally 3 on one side; male frons, at narrowest, 0.13/4 (0.12–0.14) head width; surstylus triangular in lateral view; cerci with short inverted V shape in posterior view (Fig. 67b); fifth sternite of male prominent, as long as fifth tergite; female frons, at narrowest, 0.35/5 (0.33–0.36) head width. Western only, rare in California, Colorado, Oregon, and Washington. *elongata*
- Three postsutural acrostichal setae; male frons, at narrowest, 0.07/6 (0.07–0.09) head width; surstylus slender in lateral view;

- cerci longer inverted V in posterior view (Fig. 68b). Fifth sternite of male shorter than fifth tergite. Female frons, at narrowest, $0.32/5$ ($0.32-0.34$) head width. Widespread, common. *silvarum*
5. Two postsutural acrostichal setae; abdomen usually uniformly metallic or microtomentose. 6
 - 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*). 9
 6. Basicosta usually black or dark brown, sometimes lighter ground color, but always with dusky shading; mostly southern distribution. 7
 - Basicosta yellow or orange; primarily eastern. 8
 7. Two or more complete rows of black postocular setae (Figs. 3-5 for location); genal dilation and parafacial mostly black, with black vestiture; frontal vitta wider in male, frontal plates separated, frons, at narrowest, 0.055 ($0.05-0.06$)/8 head width; distal end of cercus Y-shaped when viewed from rear, surstylus with sparse wavy setae (Fig. 69); female frons broader, $0.28(0.26-0.30)/6$ head width, at narrowest. Primarily southwestern U.S. into Mexico. *mexicana*
 - One complete row of black postocular setae; genal dilation and parafacial mostly tan to orange, with vestiture reddish to light brown; frontal vitta in male very narrow, frontal plates touching, or nearly so, frons, at narrowest, 0.035 ($0.03-0.04$)/10 head width; distal end of cercus almost parallel when viewed from rear, surstylus with dense wavy setae (Fig. 70); female frons narrower 0.25 ($0.24-0.28$)/9 head width, at narrowest. Subtropical, occasionally found in Texas and Florida. *eximia*
 8. Frons of male with frontal plates almost touching, frons width, at narrowest, much less than breadth of first flagellomere, frons $0.023/8$ ($0.015-0.030$) head width; male with one lateroocline orbital seta slightly anterior to median ocellus (see Figs. 3-5 for seta location); female with black setulae outside row of frontal setae on frontal plate; fifth abdominal tergite highly polished, tinged with red or purple in both sexes; mature specimens usually larger, 8.0-9.5 mm 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*
 - Frons of male with frontal plates well separated, frons width, at narrowest, more than width of first flagellomere, frons $0.11/7$ ($0.10-0.12$) head width; male with lateroocline orbital seta opposite median ocellus, or seta absent; female with pale setulae outside row of frontal setae on frontal plate; fifth abdominal tergite generally not more polished than other tergites, usually without reddish or purple cast; mature specimens usually smaller, 8.0 mm length or less. Florida north to North Carolina and west to southern Mississippi. *chuvia*
 9. 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; frons of male, 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; frons of female, at narrowest, $0.30/12$ ($0.27-0.32$). 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); frons of male, at narrowest, with frontal plates widely separated, frons $0.12-0.21$ head width; frons of female, at narrowest, $0.35-0.40$ of head width. 10
 10. 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. Southern, 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. Wide-spread. *sericata*

Lucilia chuvia (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. chuvia* males can be distinguished by their much broader frons. Females of *L. chuvia* are difficult to separate with confidence from those of *L. coeruleiviridis*, the primary distinction being the color of the fine setulae outside the row of frontal bristles. This character is often variable, damaged, or difficult to see. The difference in the shininess of the fifth tergite is subjective and variable, but can be useful with practice. Based on the material I examined *L. chuvia* tends to be smaller than *L. coeruleiviridis*. Excluding 3 obviously undersized specimens, 20 specimens of the former were 7.5–8 mm in length. For *L. coeruleiviridis*, excluding 5 undersized specimens, 51 ranged from 7.75–9.5 mm in length. Better characters are needed for females distinctions, perhaps a study of ovipositors would reveal useful characters to separate the two species.

Lucilia coeruleiviridis Macquart, 1855. This species is 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. chuvia*. 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.

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 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. I examined specimens from California, including San Mateo County, Mendocino County, Tehama County, and Yolo County; Washington, Pierce County; Oregon, Washington County, and Klamath County. James (1955) recorded this species from Orcas Island, Washington, as well as California and possibly Colorado. 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*. A few females and one male were seen with 2 setae on one side and 3 on the other. J. O'Hara (in litt.) reports the Canadian National Collection has 15 specimens of *L. elongata*, 6 from various areas in British Columbia have 2 postsutural acrostichals each side, 9 from Whatcom County, Washington, include several males with 3 postsutural acrostichals on one side.

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. It has only one row of black postocular setae, and an orange genal dilation. By contrast, its close relative, *L. mexicana*, has two complete rows of postocular setae and a dark genal dilation. The postocular seta char-

acter can be confusing, the row of black postocular setae may be incomplete in *L. eximia*.

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. It has a brown basicosta, like *L. eximia*, but two complete rows of postocular setae 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 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). I examined specimens from Washington to California in the West and Maine, south to South Carolina and Louisiana in the East. A common, widespread species, Hall (1948) also recorded it from southern Canada. Specimens have 3 postacrostichal setae and black palps, the male frons is much broader than in the similar *L. elongata*. Various characters are illustrated in Rognes (1991: 376, 466–476).

Lucilia thatuna Shannon, 1926. This is an uncommon species; I examined specimens from 10 counties in California, most in the northern coastal areas; also Pullman, Washington; Baker Co. Oregon; and Cache Co. Utah. James (1955) recorded it from many localities in California, and also Montana, Idaho, and Colorado. The presence of three postacrostichal setae and the first flagellomere being broader than the parafacials separate 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*. Males are distinctive as their frons is much narrower than those of *L. cuprina* and *L. sericata*.

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 diffi-

cult 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 1997). 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).

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). Northeastern and northwestern U.S. and Canada. *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. Northern U.S. and southeastern Canada. *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 northern portions of the U.S. *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, northeastern and northwestern U.S. and Wisconsin. *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 too 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 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 (1991) listed this species from Ontario, Canada. I have seen specimens from Maine, Washington, and Wisconsin. 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 from Michigan, Maine, New Hampshire, Oregon, and Washington. 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 examined specimens of this species from Washington to Wisconsin and New York and south to North Carolina. I also found it in Utah, Oregon, and California. Rognes (1991) recorded it from New Mexico. 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. *Pollenia* specimens in most 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). Rognes (1991) listed this species from British Columbia, Nova Scotia, and

Prince Edward Island, and Greenberg (1998) listed it from New York. I also examined specimens from Massachusetts, New Hampshire, and Washington. 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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