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Insect and Mite Pests in Food

Many kinds of flies are attracted to perishable foods on which they feed and deposit their eggs or larvae (maggots). Feeding by the larvae often hastens further decay by fostering growth of secondary decomposers such as bacteria and fungi. Larvae may develop rapidly in some media. For example, blow fly larvae (Calliphoridae) may reach full growth in three days under optimal conditions. Some larvae feed inside plant tissues and therefore often go unnoticed when the plants are bought for food or prepared for storage.

The keys given here to some common flies or groups of

flies often associated with food are designed to separate taxa at least to family level and in some cases to generic or specific level. Most of the structures referred to in the keys are visible to the unaided eye or require no more than a hand lens; others require the use of a dissecting microscope. The key characters and the descriptive notes used to separate larvae pertain to full-grown larvae.

This key is compiled from several sources (1, 2, 4, 5). More complete, technical keys to family and generic levels for adult flies (and, in many cases, larvae) may be found in McAlpine *et al.* (3).

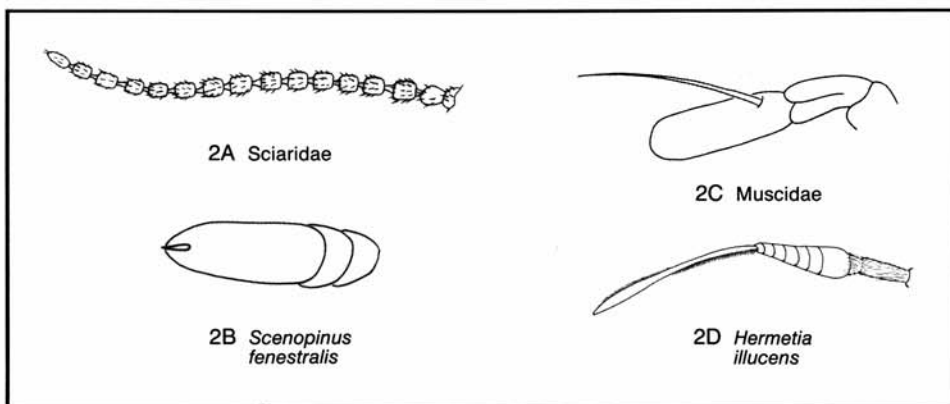
KEY

Drawings by C. Feller
unless otherwise noted.

Adults

- | | |
|--|----|
| 1 Adult specimen----- | 2 |
| Larval specimen----- | 32 |
| | |
| 2 Antenna with 7 to 16 segments, each segment discrete, more or less similar, and freely articulated (2A)----- | 3 |
| Antenna with 3, often dissimilar, segments (2B, 2C)----- | 5 |

The third segment may be annulate (2D) or aristate (2B, 2C).

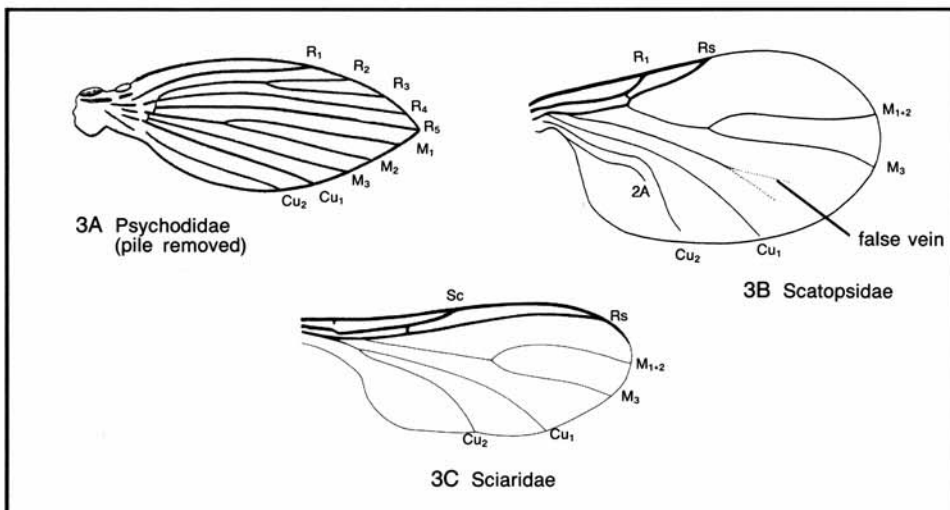


- 3 Mothlike; body and wings densely haired, with wings held rooflike over body (pl. 121C); wing veins evenly distributed, not stronger anteriorly than elsewhere (3A)-----**moth flies, Psychodidae**

Drawing 3A from 2.

- Not mothlike; much of the body smooth and shining; wings held flat or erect over body (see 4A, 4B); wing veins stronger and concentrated in anterior part of wing (3B, 3C)-----

4

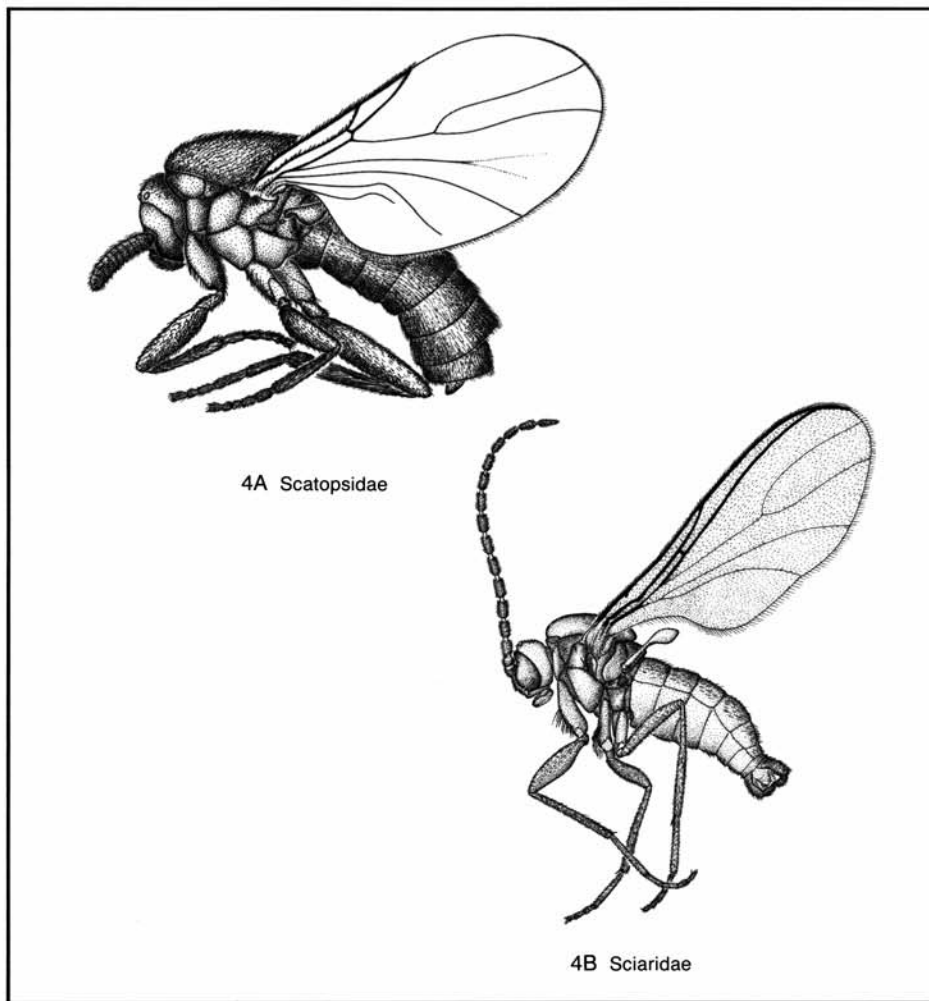


4 Antenna clublike, with 7 to 12 segments; antennal length much shorter than thorax (4A)
-----minute black scavenger flies, Scatopsidae

Species of the cecidomyiid genera *Heteropeza*, *Henria*, and *Mycophila* infesting cultivated mushrooms would also key out at this point (the adults of these genera have 10 or fewer antennal segments). In Sciaridae, the costal vein ends just beyond the last branch of R; in Cecidomyiidae, the costal vein continues beyond the wing tip. It would be unusual to find the adults of these mushroom pests anywhere but in mushroom houses. Even there cecids would be associated with the edible portions of mushrooms only as accidental contaminants. See also 3B.

Antenna elongate and flexible, with 16 segments; antennal length longer than thorax (4B)-----darkwinged fungus gnats, Sciaridae

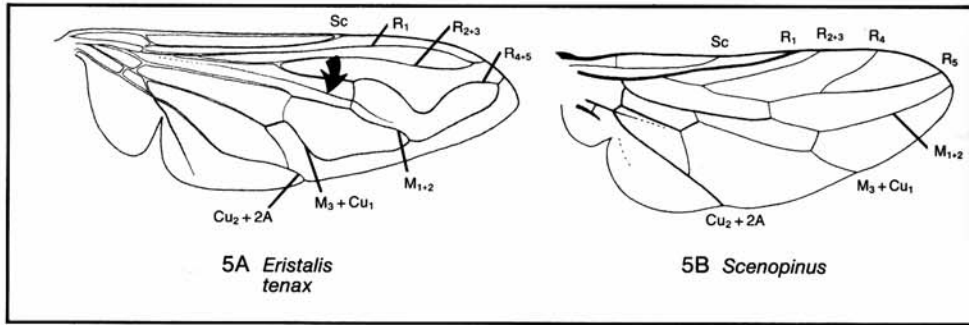
See also 2A, 3C.



5 Wing with spurious vein (5A); body beelike; pl. 122A. Syrphidae (**flower flies**)
 ----- **drone fly, *Eristalis tenax***

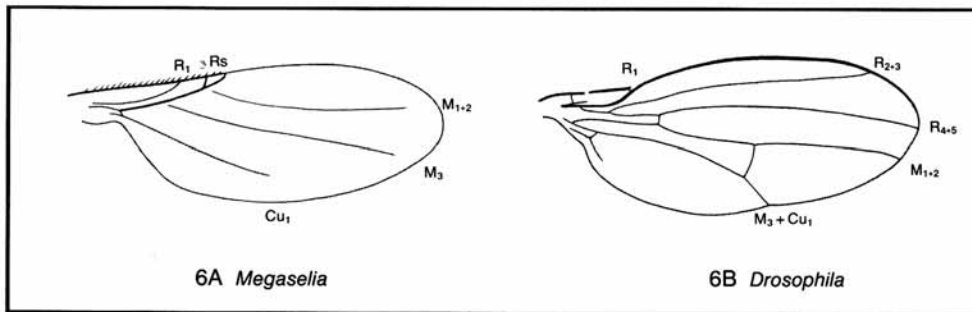
This is one of several similar species likely to be found.

Wing without spurious vein (5B); body not beelike ----- 6



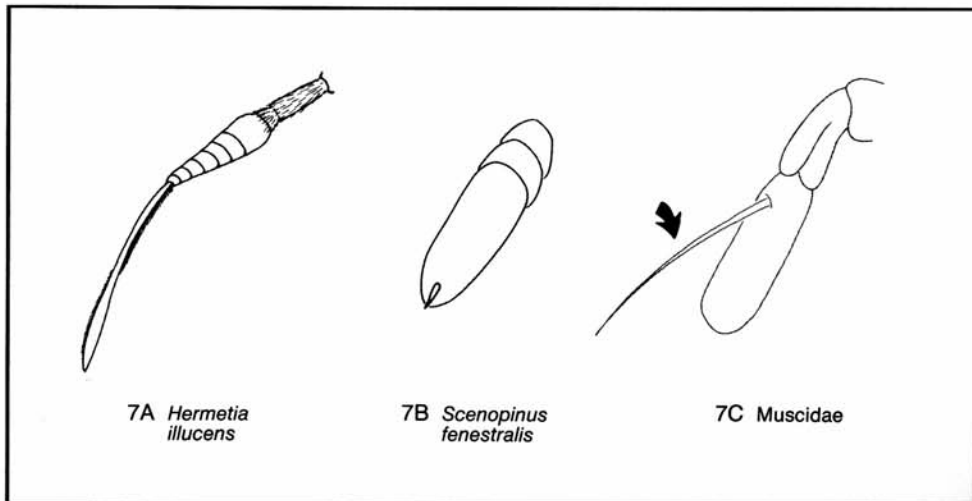
6 Wing with strong veins anteriorly and weak, oblique veins posteriorly (6A); pl. 123C&D
 ----- **humpbacked flies, Phoridae**

Wing veins not appreciably stronger anteriorly than elsewhere (6B) ----- 7



7 Antenna without a long, dorsal arista (7A, 7B) ----- 8

Antenna with a long, dorsal arista (7C) ----- 9

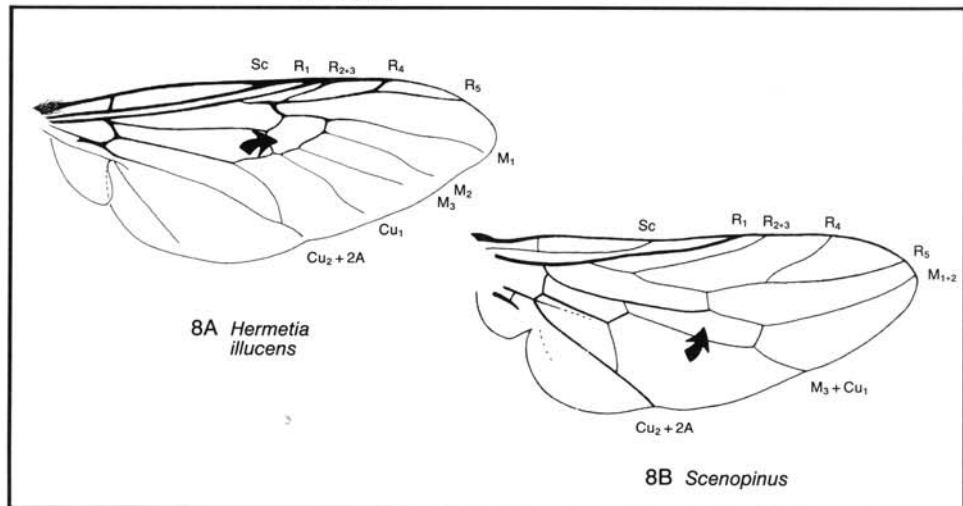


8 Discal (central) cell rounded with several veins issuing from it (8A); pl. 124B&C.
 Stratiomyidae (**soldier flies**)-----**black soldier fly, *Hermetia illucens***

This is one of several similar species likely to be found.
 See also 7A.

Discal cell long, with only 2 veins issuing from it (8B); pl. 125A. Scenopinidae (win-
 dow flies)-----***Scenopinus* spp.**

See also 7B.

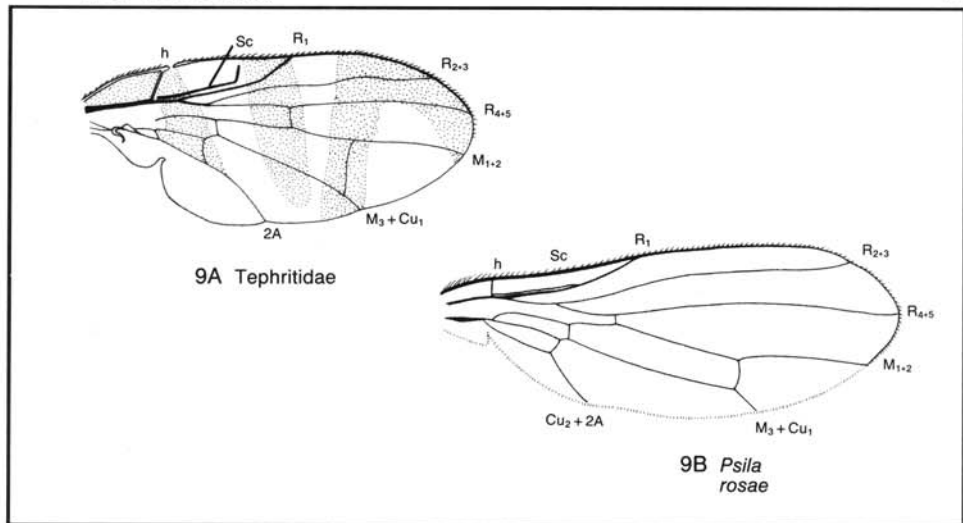


9 Thorax, abdomen, and wing (9A) patterned -----**fruit flies, Tephritidae**

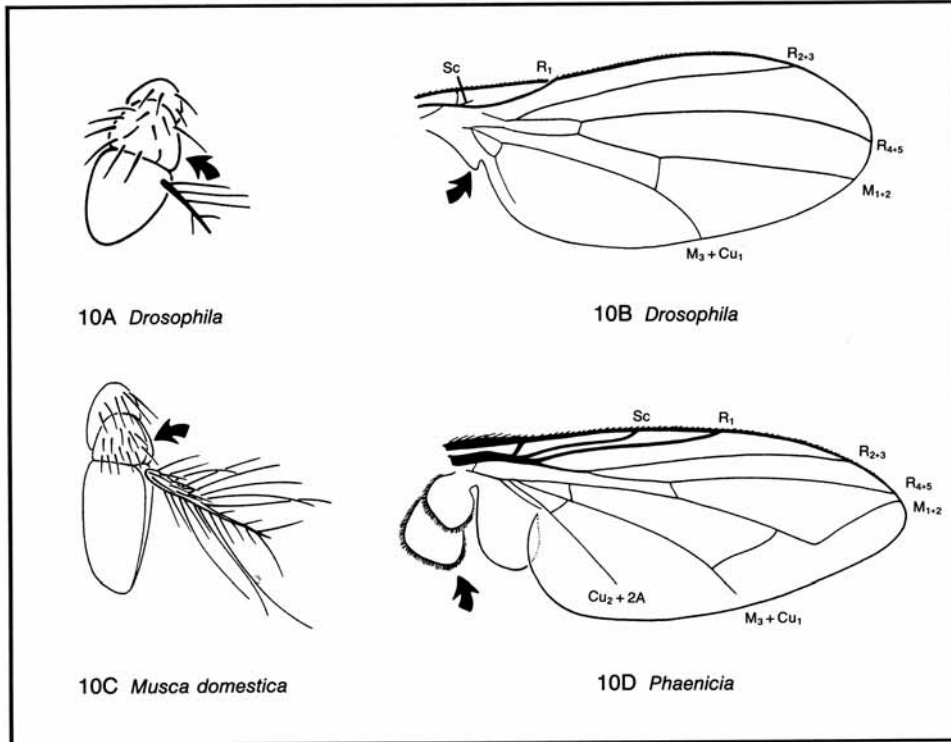
Tephritids likely to occur in fruit products include
Anastrepha spp., *Rhagoletis* spp., and *Ceratitis capitata*.

Thorax and abdomen usually brown to black; wing not patterned (9B) (may be a spot
 near apex of R₂₊₃)-----

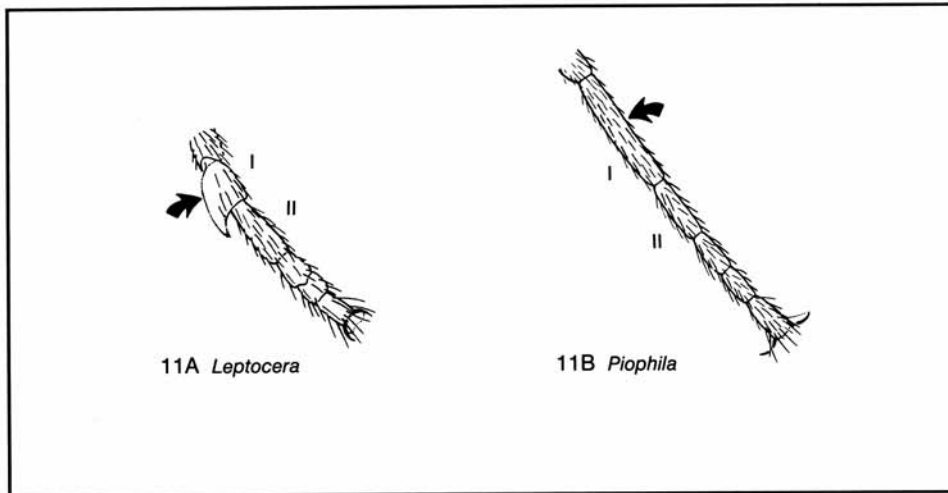
10



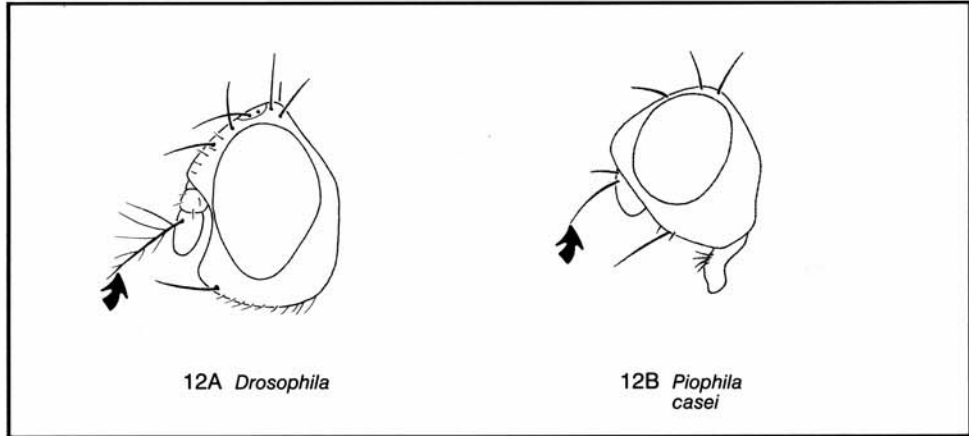
- 10 Antennal segment II without longitudinal suture (10A); calypteres of wing absent or inconspicuous (10B)----- 11
 Antennal segment II with longitudinal suture (10C); wing with large calypteres (10D)----- 15



- 11 First segment of tarsus III wider and shorter than segment II (11A); pl. 125B.
 Sphaeroceridae (small dung flies)-----*Leptocera* spp.
 First segment of tarsus III longer but not wider than segment II (11B)----- 12

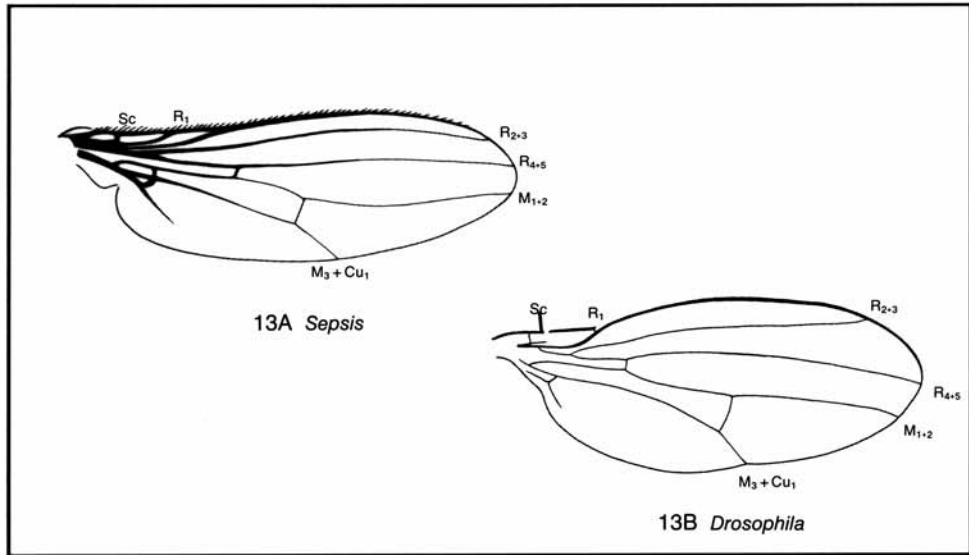


- 12 Arista plumose (12A)----- 13
 Arista simple or with inconspicuous hairs (12B)----- 14



- 13 Abdomen conspicuously narrowed at base (pl. 126A&B); subcostal vein complete (13A)
 ----- black scavenger flies, Sepsidae
 Abdomen not conspicuously narrowed at base (pl. 126C); subcostal vein incomplete
 (13B). Drosophilidae (**small fruit flies**)-----*Drosophila*

See also 10A, 12A.

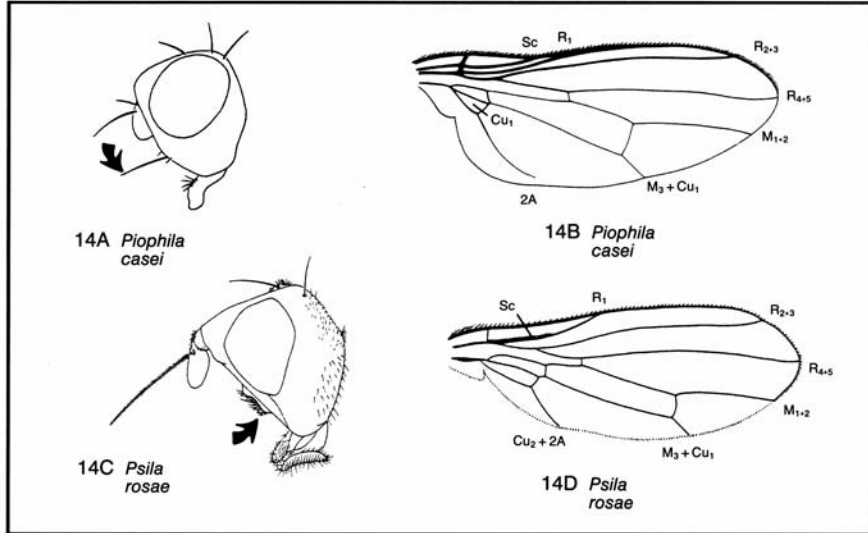


- 14 Strong oral bristle present (14A); subcostal vein ending in costa (14B); pl. 127A.
 Piophilidae (**skipper flies**)-----**cheese skipper, *Piophilidae casei***

See also 11B.

- Strong oral bristle absent (14C); subcostal vein ending in radius (14D); pl. 127B.
 Psilidae (**rust flies**)-----**carrot rust fly, *Psila rosae***

This is one of several similar species likely to be found.

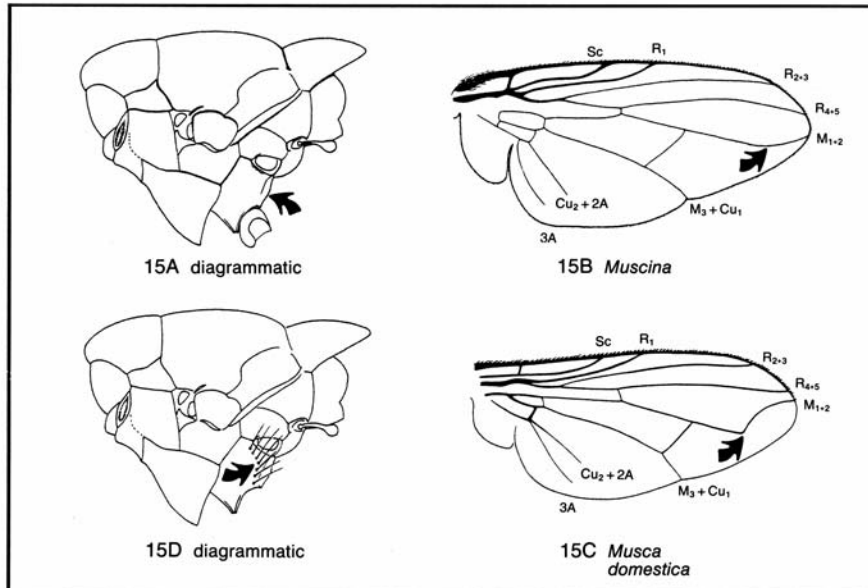


15 Hypopleuron bare (15A). Muscidae (muscid flies)----- 16

Median vein (M₁₋₂) straight or gently curved forward (15B), except in *Musca* spp. (15C).

Hypopleuron with a row of strong setae (15D)----- 21

Median vein (M₁₋₂) strongly bent forward near apex (as in 15C).

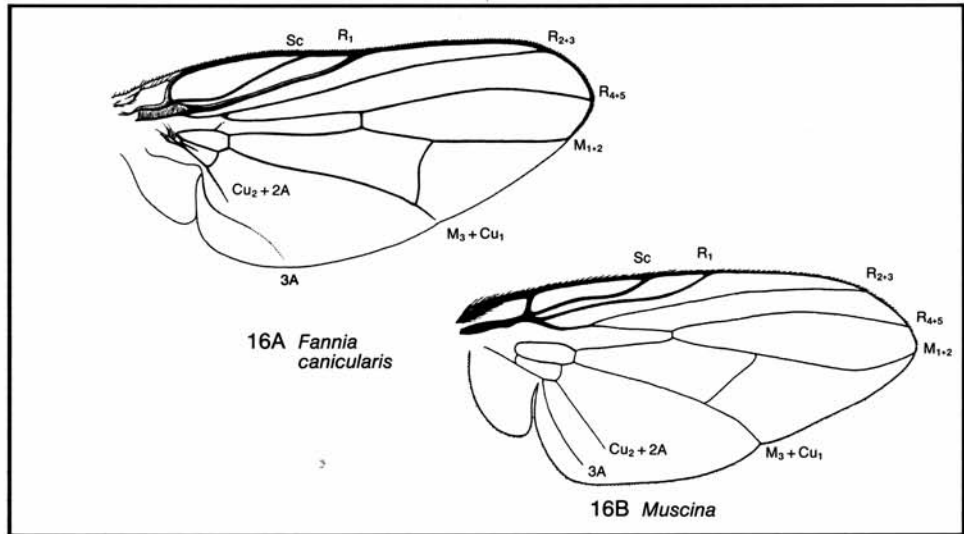


16 Vein 3A so strongly curved forward that it would intersect with a hypothetical extension of $Cu_2 + 2A$ well before wing margin (16A); pl. 128B

-----little house fly, *Fannia canicularis*

This is one of several species likely to be found.

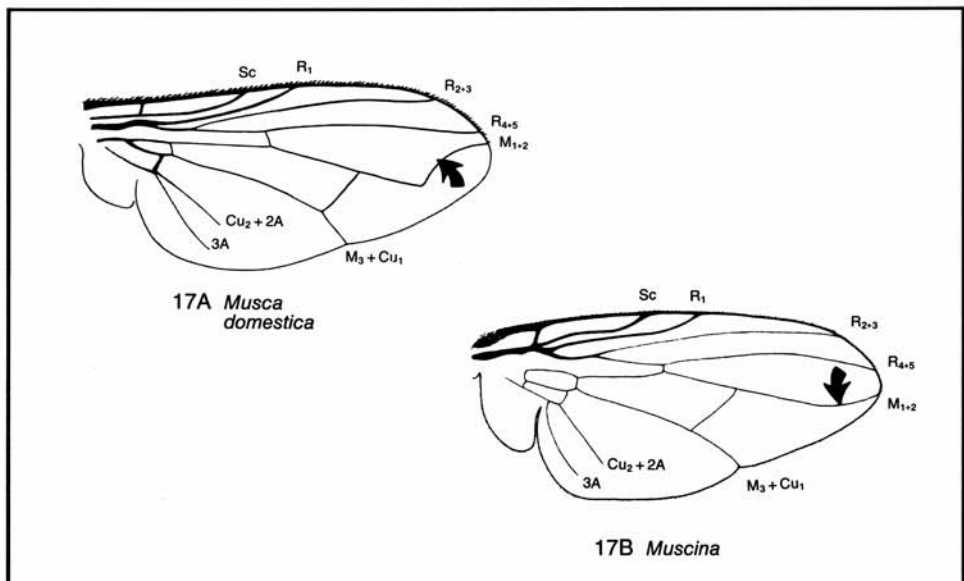
Vein 3A straight or only weakly curved (16B) ----- 17



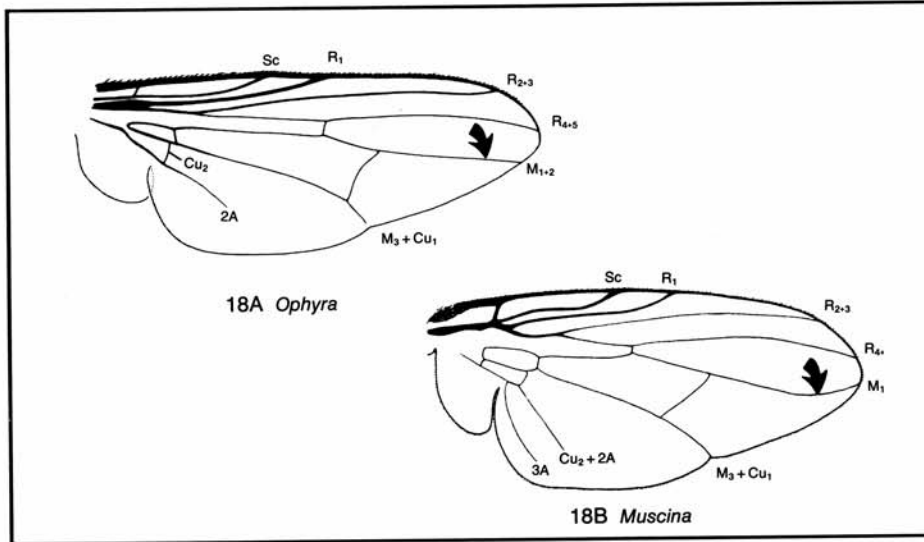
17 Vein M_{1+2} strongly bent forward apically (17A); pl. 129B -----house fly, *Musca domestica*

See also 10C.

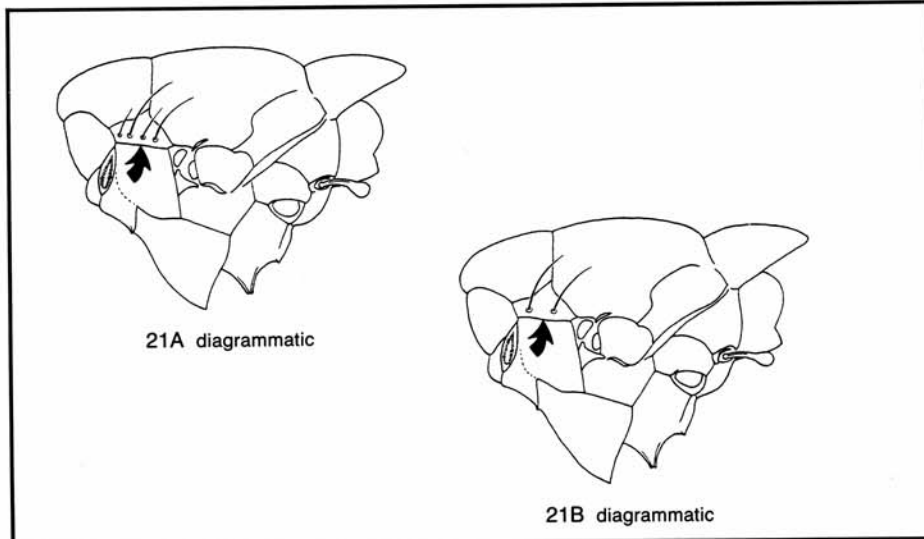
Vein M_{1+2} straight or weakly curved apically (17B) ----- 18



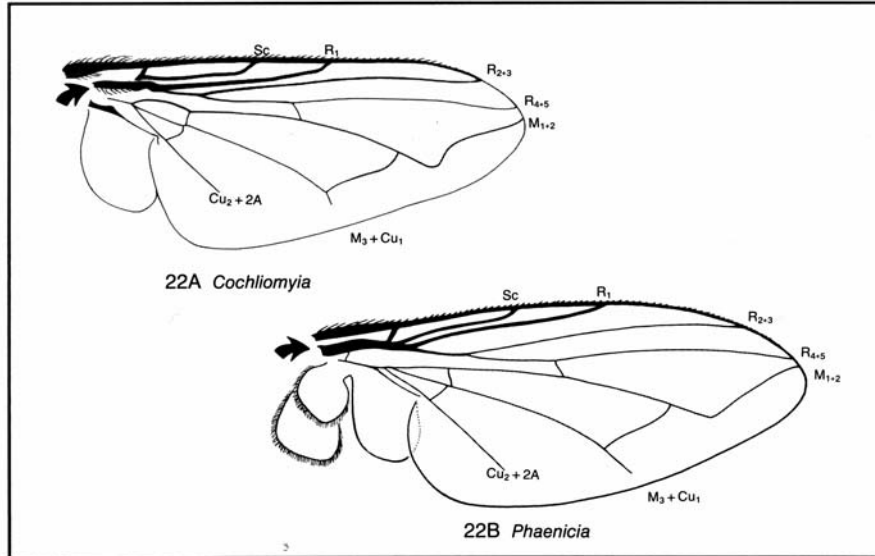
- 18 Median vein straight (18A); body shining, black. Genus *Ophyra*----- 19
 Median vein curved apically (18B); body dull, grayish-black, with tip of scutellum red-
 dish. Genus *Muscina*----- 20



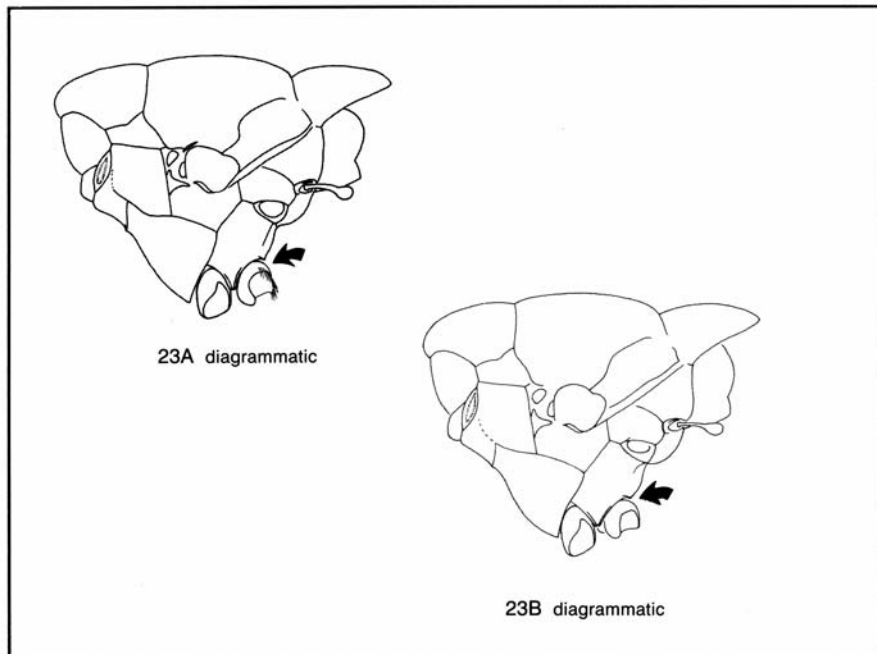
- 19 Palpus yellow; pl. 130A -----bronze dump fly, *Ophyra aenescens*
 Palpus black-----dump fly, *Ophyra leucostoma*
- 20 Legs predominantly red; pl. 130B-----**false stable fly**, *Muscina stabulans*
 Legs black-----*Muscina assimilis*
- 21 Notopleuron with 3 or 4 setae (21A); body dull colored, the abdomen with checkered
 pattern; pl. 131B. Sarcophagidae (**flesh flies**)-----*Sarcophaga* spp.
- Notopleuron with 2 setae (21B); body shining green, bronze, or blue. Calliphoridae
 (**blow flies**)----- 22



22 Base of stem vein (R) ciliate (22A)	23
Base of stem vein (R) bare (22B)	26



23 Coxa III pilose posteriorly (23A)	24
Coxa III bare posteriorly (23B)	25

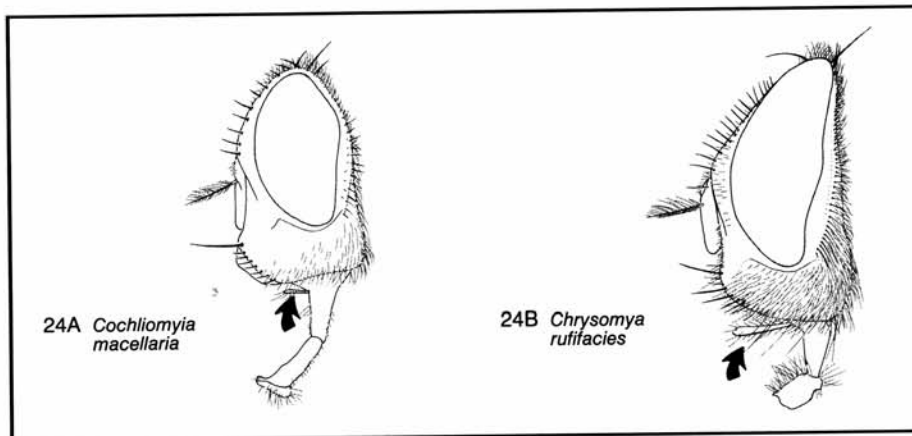


24 Palpus short, filiform (24A); pl. 132B-----**secondary screwworm, *Cochliomyia macellaria***

See also 22A.

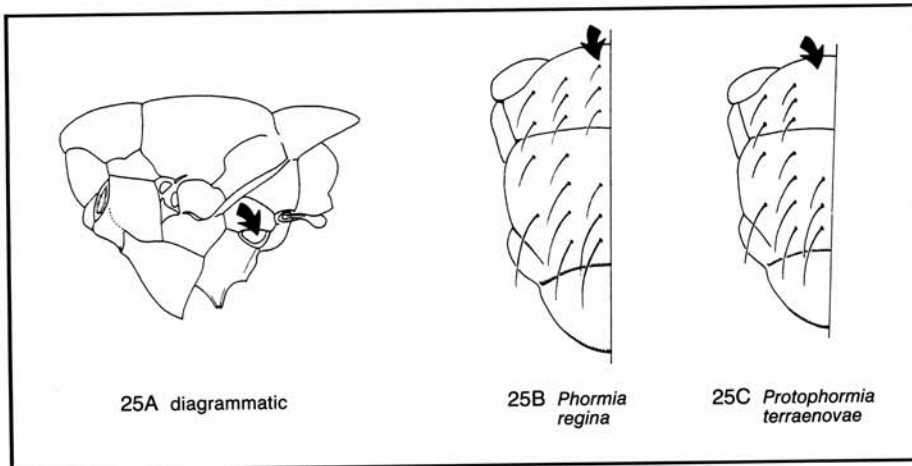
Palpus long, clavate (24B); pl. 133E&F-----Old World screwworm flies, *Chrysomya* spp.

Body length: 8-12 mm. Members of the genus *Chrysomya*, widely distributed in the Old World, commonly lay eggs on meat and fish (2). Four species are now established in the New World. The **hairy maggot blow fly, *C. rufifacies***, appeared in Costa Rica shortly before 1978 and has since spread through Mexico to Texas and Oklahoma. *C. albiceps*, *C. megacephala*, and *C. chloropyga* have been collected in South America (Brazil, Peru) since 1975.

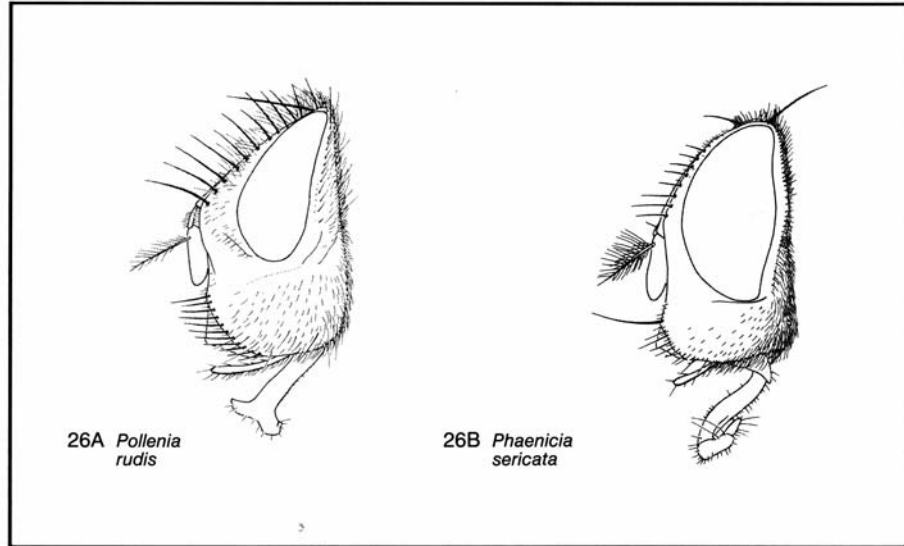


25 Mesothoracic spiracle (25A) with orange hair; presutural acrostical bristles well developed (25B)-----**black blow fly, *Phormia regina***

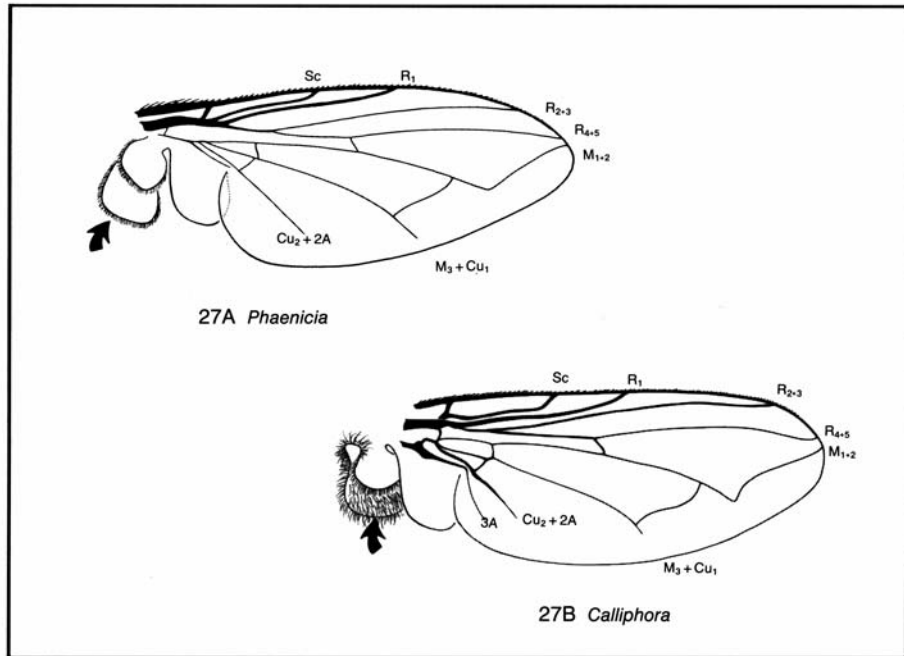
Mesothoracic spiracle (25A) with black hair; presutural acrostical bristles vestigial, not differentiated from surrounding hairs (25C)
-----Holarctic blow fly, *Protophormia terraenovae*



- 26 Eye comparatively small in relation to head (26A); thorax with crinkly yellow hair among the bristles ----- **cluster fly, *Pollenia rudis***
 Eye comparatively large in relation to head (26B); thorax without crinkly hair ----- 27



- 27 Lower (proximal) calypter bare (27A). Genus *Phaenicia*----- 28
 Lower calypter with long, dark pile (27B)----- 29

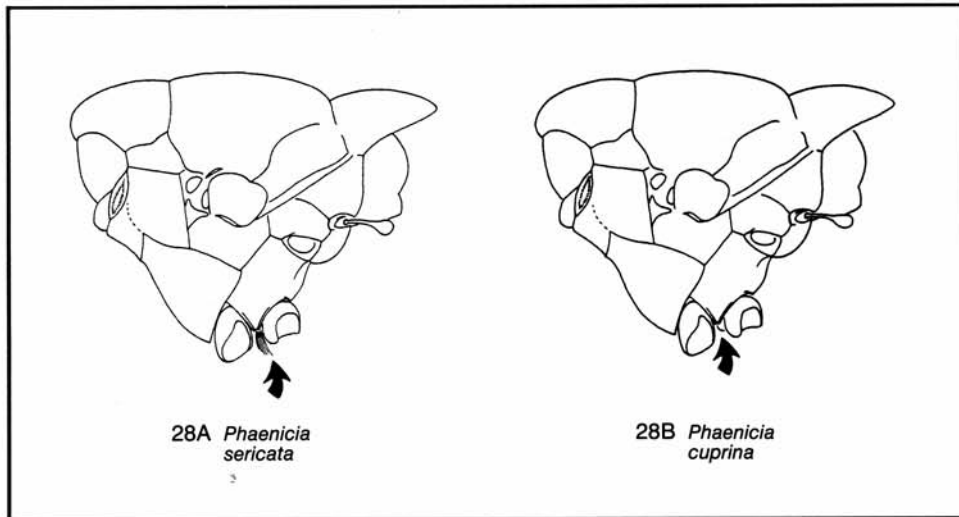


28 Metasternum setose (28A)-----green bottle fly, *Phaenicia sericata*

Body length: 6-9.5 mm. See also 26B.

Metasternum bare (28B)-----bronze bottle fly, *Phaenicia cuprina*

Body length: 5-8.5 mm.



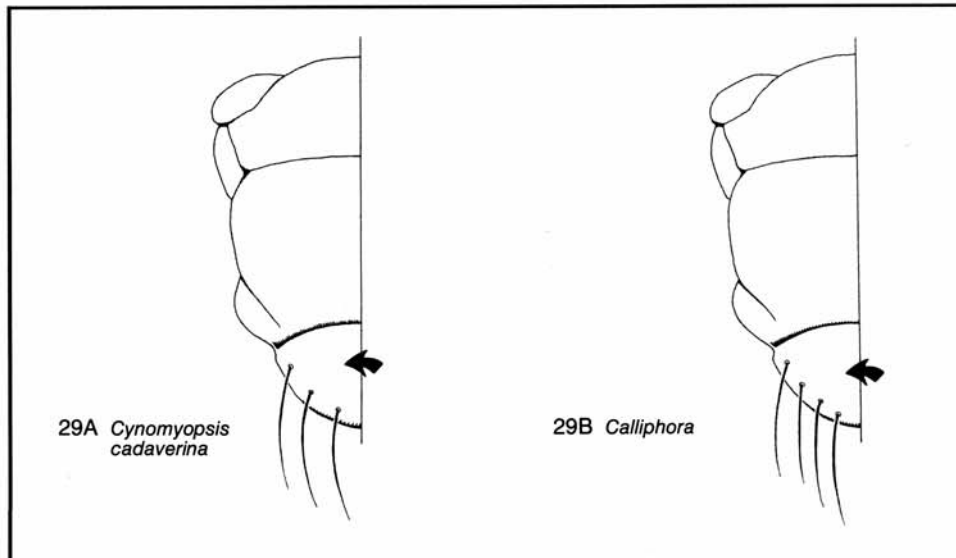
29 Scutellum with 3 strong lateral bristles on each side (29A)

-----blue bottle fly, *Cynomyopsis cadaverina*

Body length: 9-14 mm.

Scutellum with 4 strong lateral bristles on each side (29B). Genus *Calliphora*----- 30

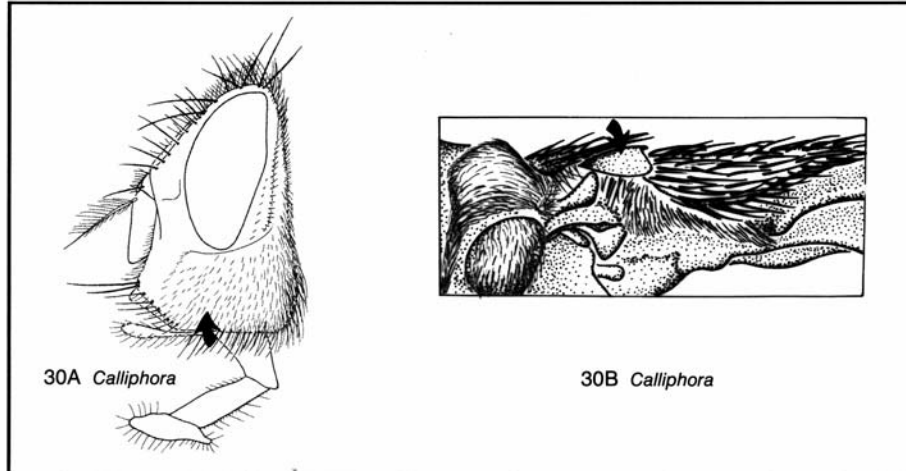
See also 27B.



30 Integument of bucca (30A) reddish on anterior half; basicosta (30B) yellow to orange
 ----- cosmopolitan blue bottle fly, *Calliphora vicina*

Body length: 6-12 mm.

Buccal integument (30A) black; basicosta (30B) black----- 31

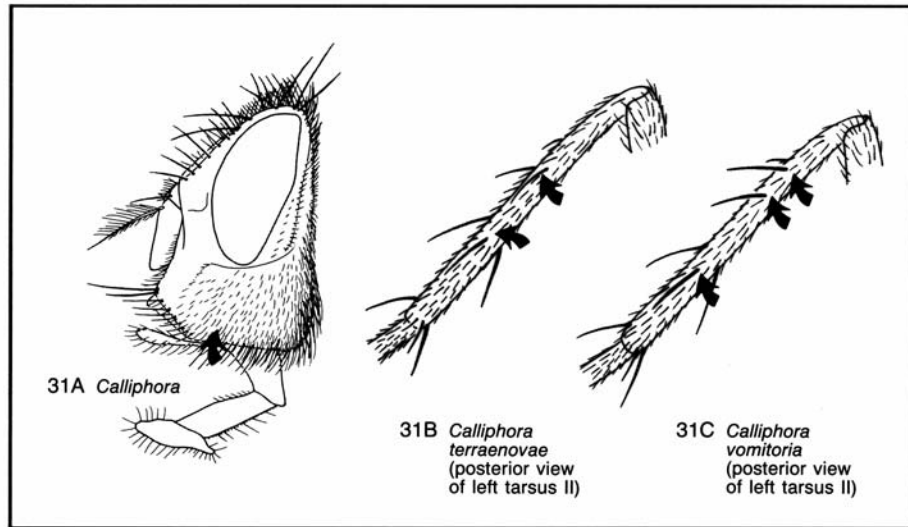


31 Buccal hairs (31A) mostly black; tibia II with 2 posterior bristles (31B)
 ----- Nearctic blow fly, *Calliphora terraenovae*

Body length: 9-13 mm.

Buccal hairs (31A) mostly reddish orange; tibia II with 3 posterior bristles (31C)
 ----- Holarctic blue bottle fly, *Calliphora vomitoria*

Body length: 10-14 mm.

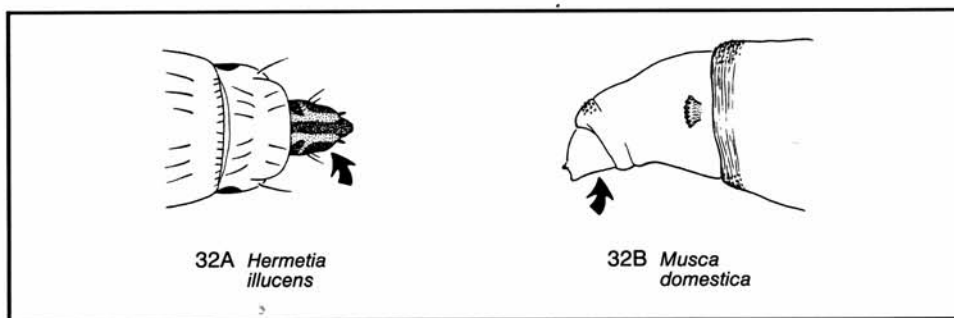


Larvae

32 Larva with a definite, sclerotized head capsule (32A)----- 33

Cecid larvae (Cecidomyiidae) would key out at this point. These larvae are less than 5 mm long and have a tiny, lightly-sclerotized head capsule. The most distinctive character is the sternal spatula, a clove-shaped "breast bone" located ventrally on the prothorax. Most of the mushroom-infesting species have minute, whitish larvae that are inconspicuous against the white color of their hosts, but if members of the genus *Mycophila* are present, their bright orange color renders the mushrooms unmarketable.

Larva without a definite, sclerotized head capsule (mouth hooks may or may not be visible) (32B)----- 37

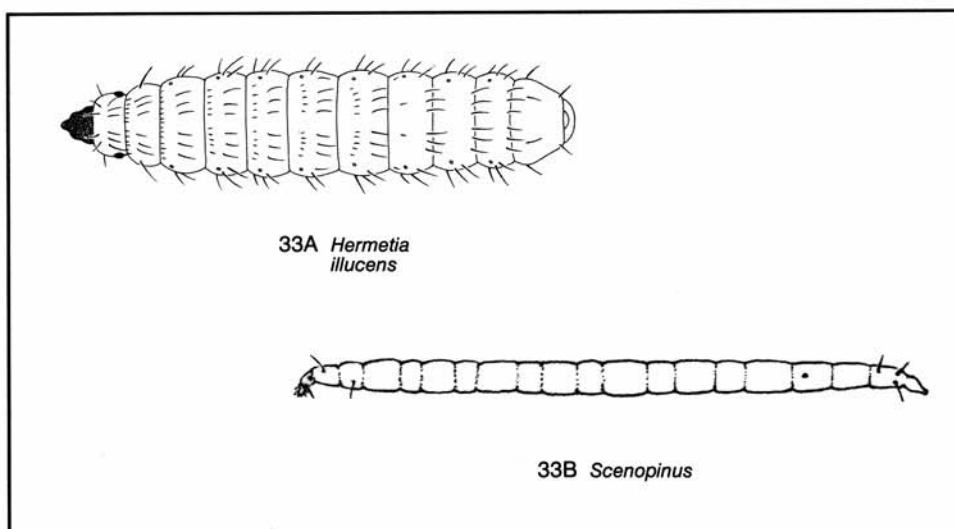


33 Large larva (15 to 20 mm) with long, conspicuous setae on all body segments (33A).
Stratiomyidae (**soldier flies**); pl. 124A ----- **black soldier fly, *Hermetia illucens***

This is one of several similar species likely to be found.
See also 32A.

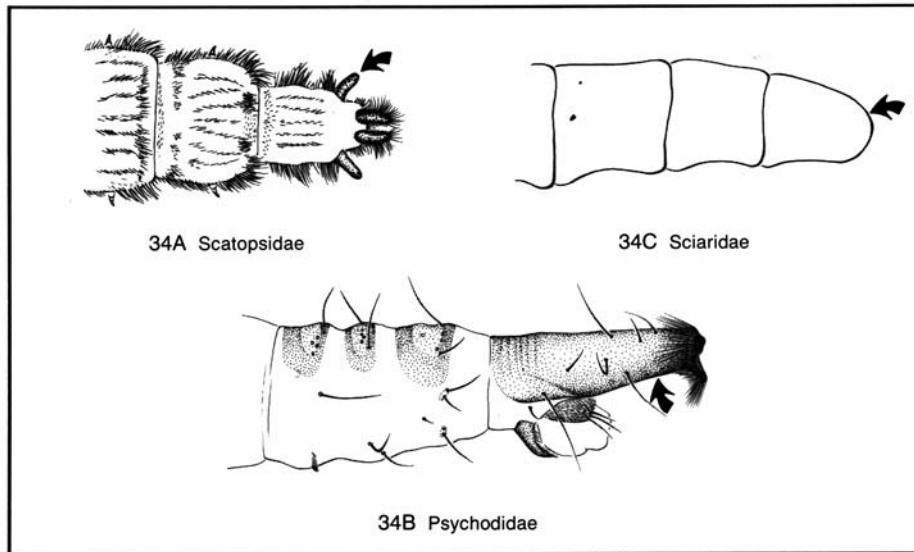
Small larva (less than 8 mm), either mostly glabrous or pubescent (31B) ----- 34

Drawing 33B by A.D. Cushman.



- 34 Body fuzzy; posterior spiracles at tips of long, membranous processes (34A) or at tip of a sclerotized tube (34B)----- 35
 Body smooth; posterior spiracles flush with body wall (34C)----- 36

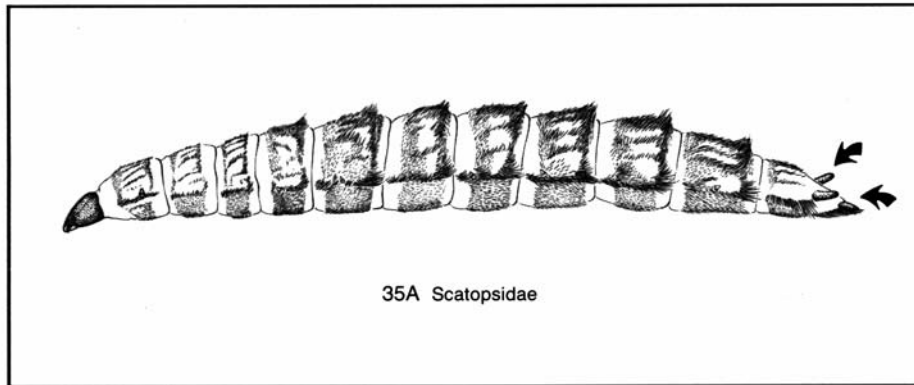
Larval chironomid midges (Chironomidae [Tendipedidae]) would key out at this point. Midge larvae have a complete head capsule, usually have prominent anterior and posterior prolegs, and have no functional spiracles. Midge larvae occasionally appear in foods that have been washed with unfiltered water from storage tanks or ponds.



- 35 Posterior spiracles at ends of long, dorsolateral tubes (35A)
 ----- minute black scavenger flies, Scatopsidae

Body length: 3-5 mm.

- Posterior spiracles at end of long median tube (see 34B); pl. 121A&B
 ----- moth flies, Psychodidae

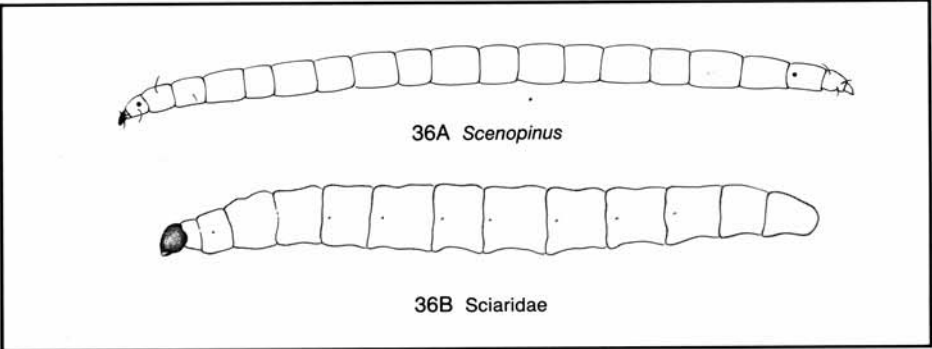


36 Larva eellike, with diminutive, conelike, brown head capsule (36A); short but conspicuous setae present on first 3 segments and on last segment. Scenopinidae (window flies)-----*Scenopinus* spp.

Body length: about 22 mm.

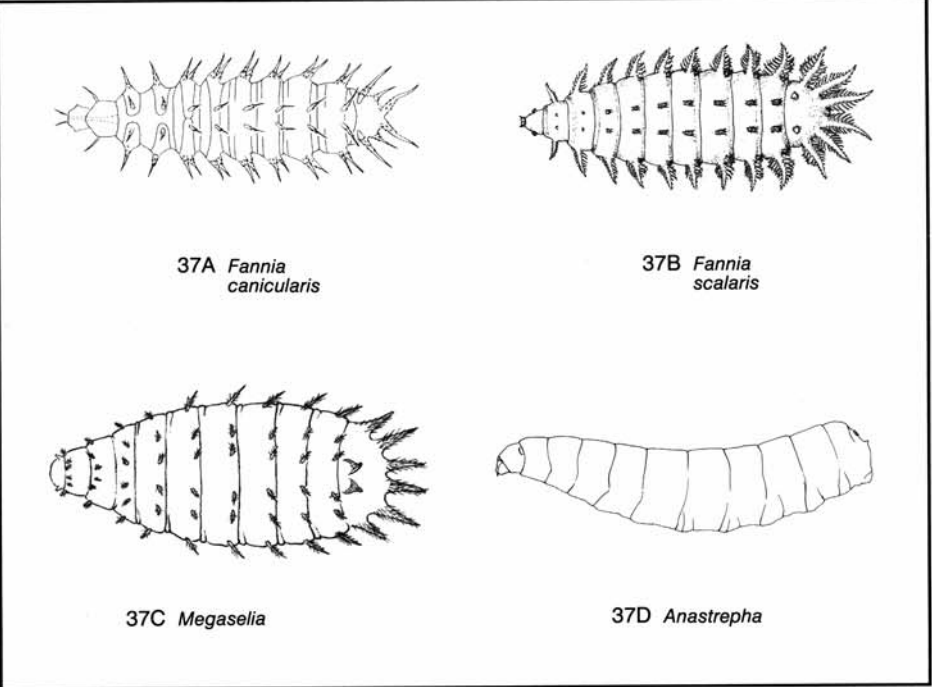
Larva more robust, with a large black head capsule (36B); conspicuous setae absent -----**darkwinged fungus gnats**, Sciaridae

Body length: 6-11 mm.



37 Body more or less depressed, with long, often feathery lobes on most segments (37A, 37B, 37C)----- 38
 Body cylindrical, without conspicuous lobes on each segment (37D) ----- 39

Drawing 37B from 2; 37C by A.D. Cushman.

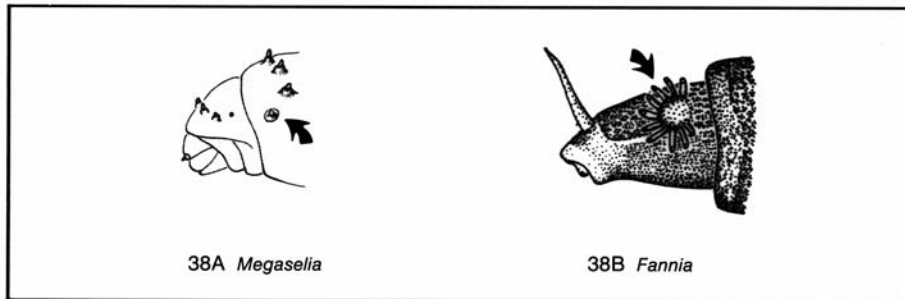


38 Body about 5 mm long; anterior spiracle simple (38A); pl. 123A&B
 ----- **humpbacked flies**, Phoridae (in part)

See also 37C, 45A.

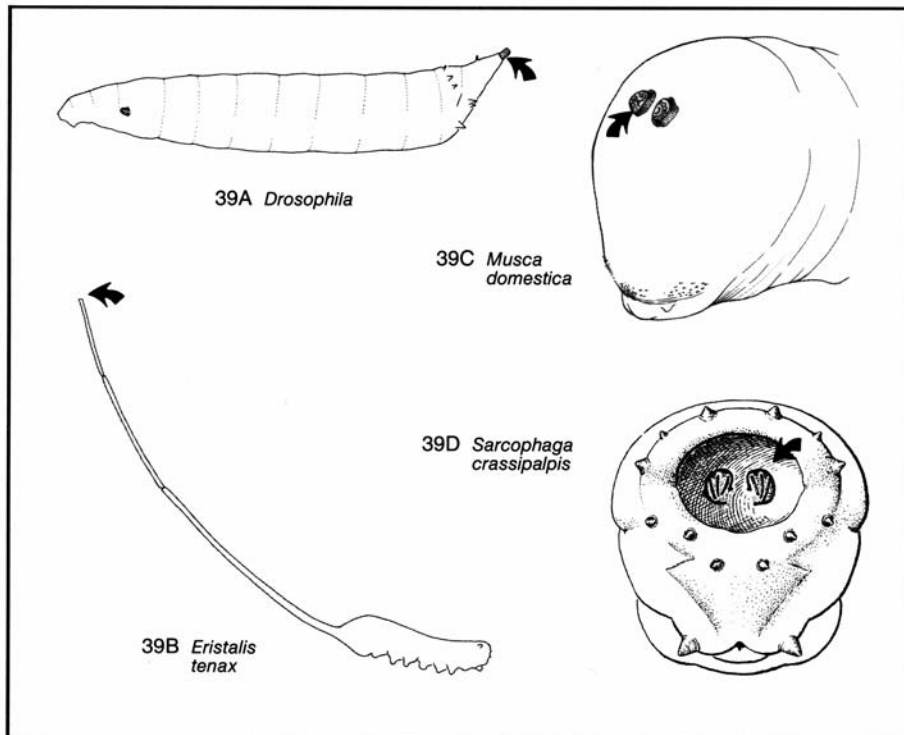
Body about 10 mm long; anterior spiracle branched (38B); pl. 128A. Muscidae (muscid flies) (in part) ----- *Fannia* spp.

See also 37A&B.



39 Posterior spiracles small, located either on peglike tubercles or cones (39A) or at the end of a long tail (39B) ----- 40
 Posterior spiracles large, more or less flush with body surface (39C, 39D) ----- 46

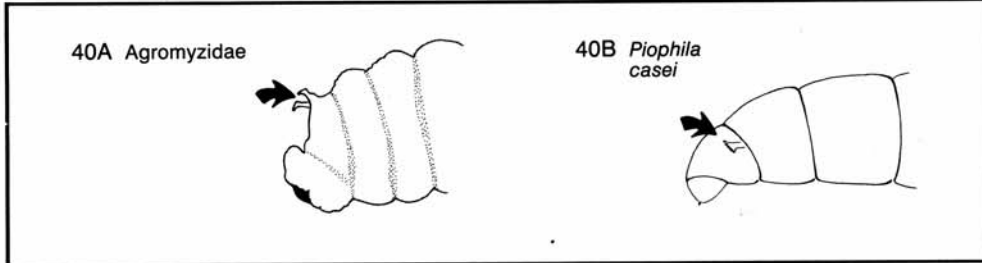
Drawing 39D by A.D. Cushman.



40 Anterior spiracles located on dorsal surface of body (40A) -**leafminer flies**, Agromyzidae

Body length: 5 mm.

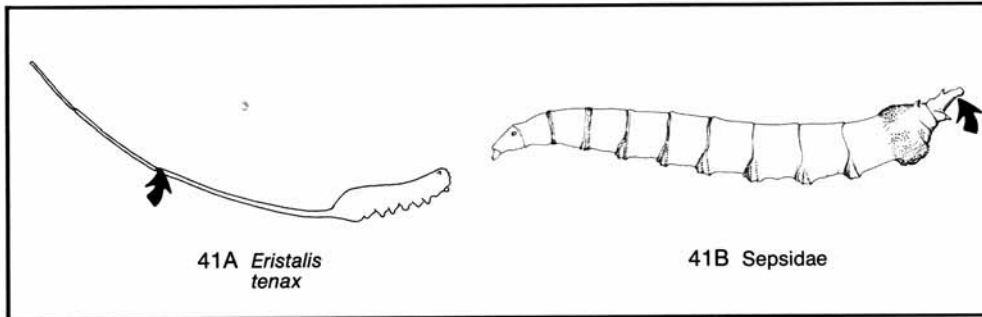
Anterior spiracles located on sides of body (40B)----- 41



41 Posterior end of body extended as a long, telescoping tail (41A); pl. 122B. Syrphidae
(flower flies)-----**drone fly**, *Eristalis tenax*

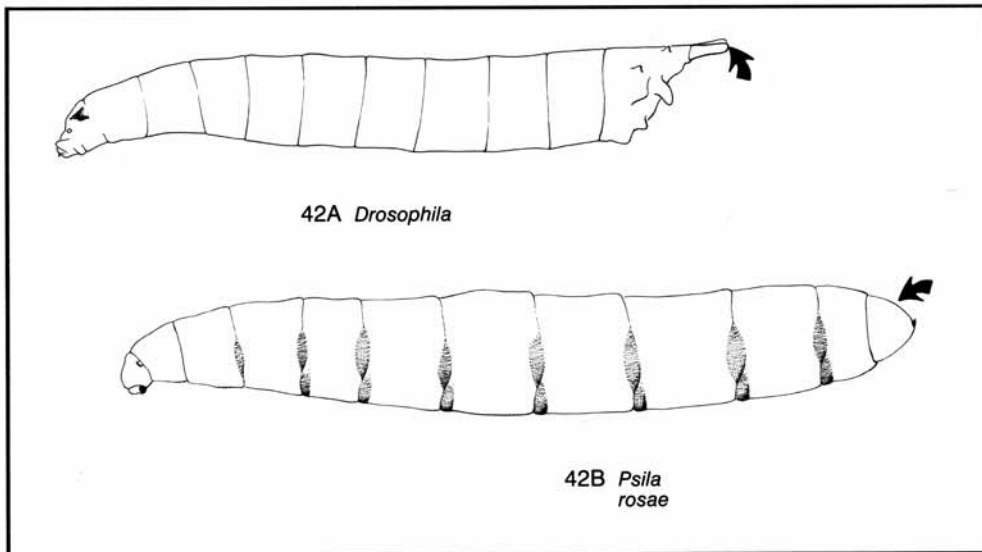
This is one of several similar species likely to be found.

Posterior end of body never more than slightly extended (41B) ----- 42



42 Posterior spiracles located at apex of long tubercles (42A)----- 43

Posterior spiracles located at apex of short cones (42B)----- 44



43 Anterior spiracle a tube with many retractable branches protruding from tip (43A)
----- **small fruit flies**, Drosophilidae

Body length: 5 mm. See also 42A.

Anterior spiracle branched from base (43B)-----**black scavenger flies**, Sepsidae

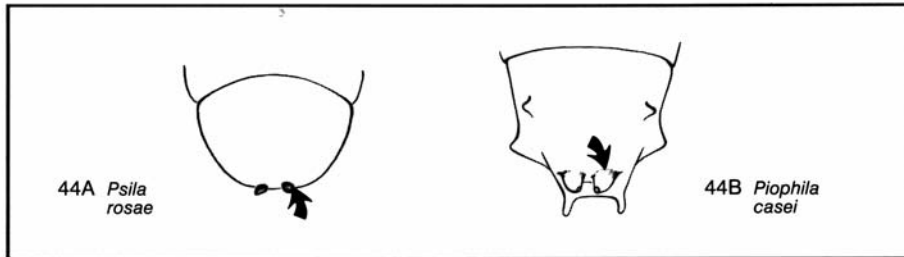
Body length: 5-6 mm. See also 41B.



44 Posterior spiracles located on sclerotized, pigmented cones; last abdominal segment without lobes (44A). Psilidae (rust flies)----- **carrot rust fly**, *Psila rosae*

Body length: 8 mm. This is one of several similar species likely to be found. See also 42B.

Posterior spiracles located on membranous cones; last abdominal segment with lobes (44B)----- 45

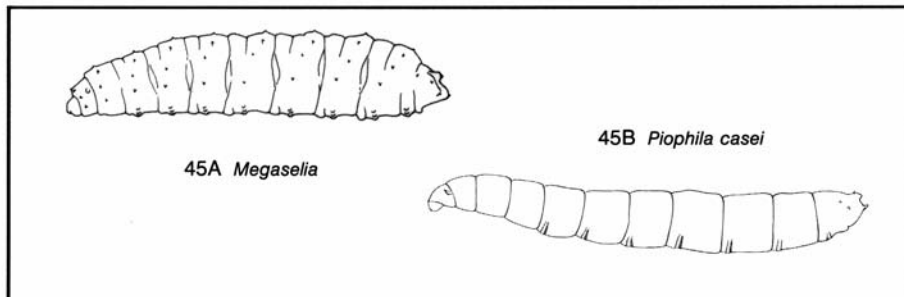


45 Larva with lobes on most segments (45A); pl. 123A&B
----- **humpbacked flies**, Phoridae (in part)

See also 37C, 38A.

Larva with lobes only on last segment (45B). Piophilidae (**skipper flies**)
----- **cheese skipper**, *Piophilidae casei*

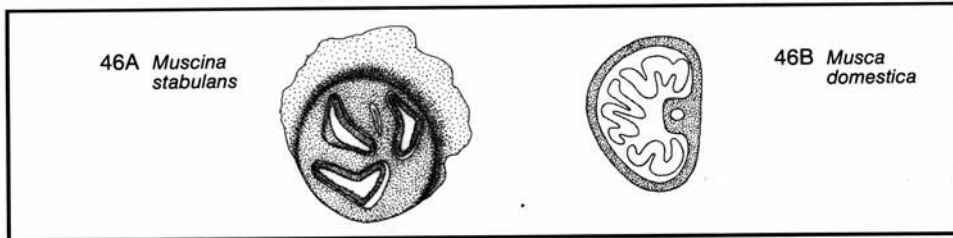
Body length: 6-9 mm. See also 40B, 44B



46 Posterior spiracular plate completely pigmented (except for openings and button, when present) (46A). Muscidae (muscid flies) (in part)-----*Muscina* spp.

Body length: 10-12 mm.

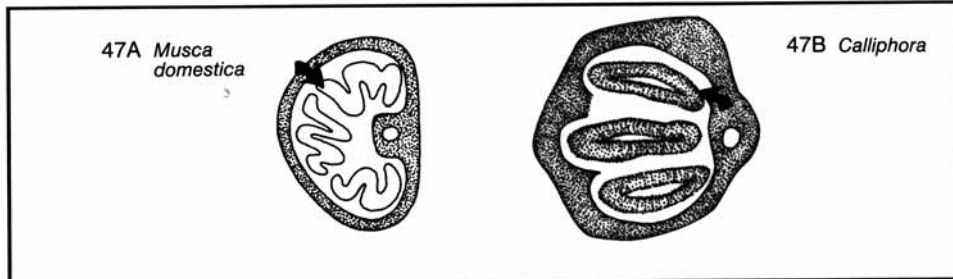
Posterior spiracular plate unpigmented (except for peritreme, if present) (46B)----- 47



47 Posterior spiracles with sinuous slits (47A); pl. 129A. Muscidae (muscid flies) (in part)-----**house fly, *Musca domestica***

See also 32B, 39C.

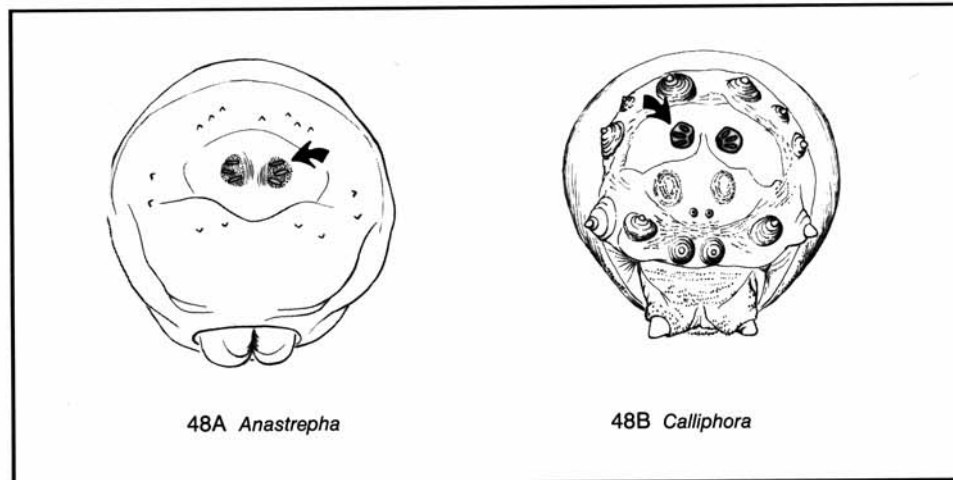
Posterior spiracles with straight slits (47B)----- 48



48 Peritreme absent from posterior spiracular plate (48A)-----**fruit flies, Tephritidae**

Body length: 9-10 mm. See also 37D.

Peritreme present around posterior spiracular plate (48B)----- 49

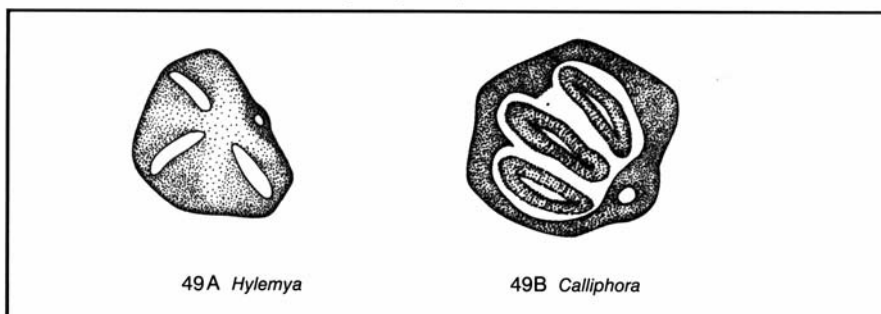


49 Posterior spiracles with 3 short slits positioned almost perpendicular to one another (49A); pl. 134E. Anthomyiidae (**anthomyiid flies**)-----*Hylemya* spp.

Spiracular button, if present, located near the upper medial margin of spiracular plate.

Posterior spiracles with slits approximately parallel (49B)----- 50

Spiracular button located near the medial or lower medial edge of spiracular plate.

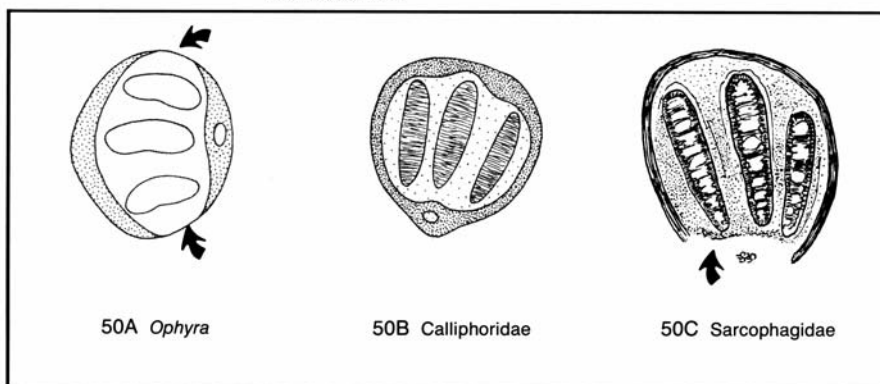


50 Peritreme of posterior spiracle with 2 unsclerotized areas (50A). Muscidae (muscid flies) (in part)-----*Ophyra* spp.

Body length: 9-10 mm.

Peritreme of posterior spiracle complete (50B) or with only 1 weakly sclerotized area (50C)----- 51

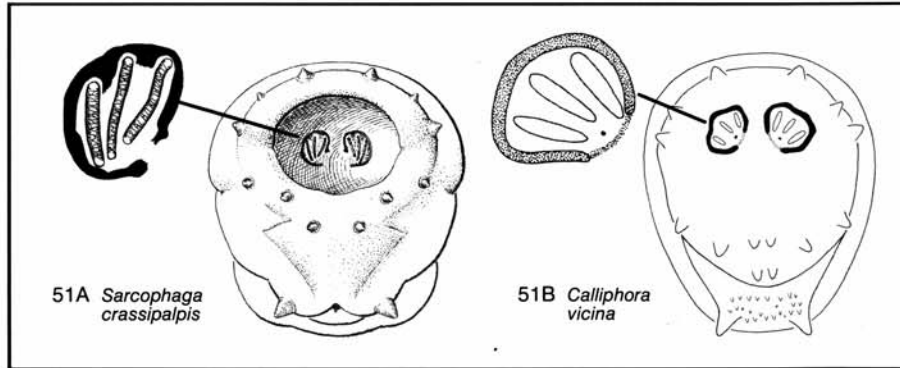
Drawing 50C from 2.



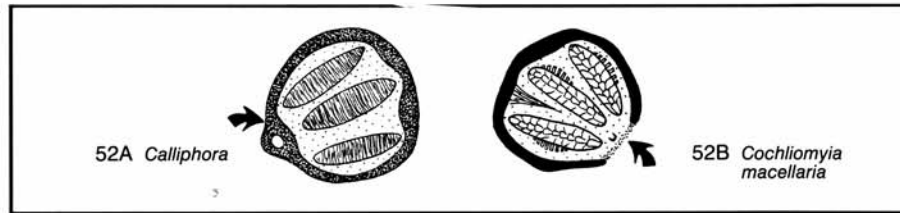
51 Posterior spiracular plates set in a cavity; spiracular slits essentially vertical in orientation (51A); pl. 131A-----**flesh flies**, Sarcophagidae

See also 50C.
Drawing 51A from 2.

Posterior spiracles not set in a cavity; spiracular slits directed towards midventral line (51B). Calliphoridae (**blow flies**)----- 52



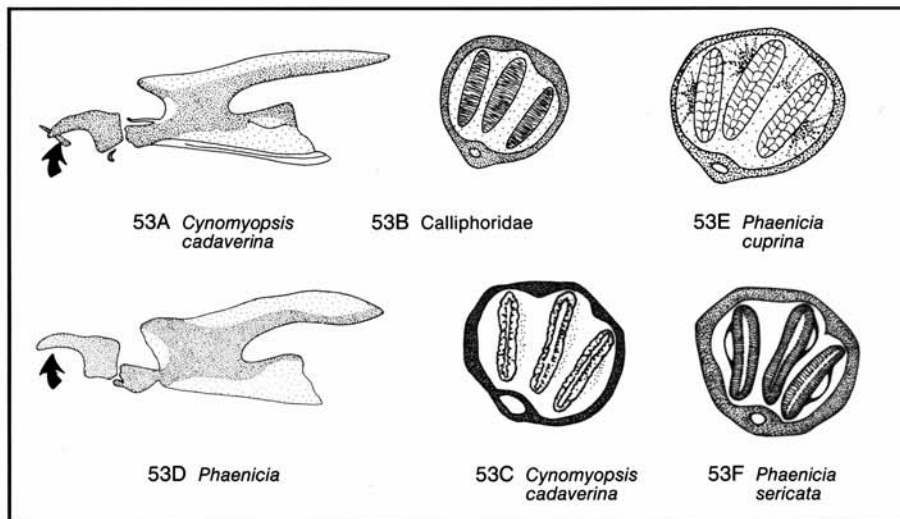
52 Posterior spiracles with complete peritreme (52A) 53
 Posterior spiracles with incomplete peritreme (52B) 54



53 Accessory sclerite of cephalopharyngeal skeleton present (53A); peritreme of posterior spiracles strongly sclerotized (53B, 53C) *Calliphora* spp.
 blue bottle fly, *Cynomyopsis cadaverina*

Body length of *Calliphora* spp.: 6.8-18 mm.; of *C. cadaverina*: 18-22 mm. See also 47B, 48B, 51B.

Accessory sclerite absent (53D); peritreme less strongly sclerotized (53E, 53F); pl. 134A-D *Phaenicia* spp.

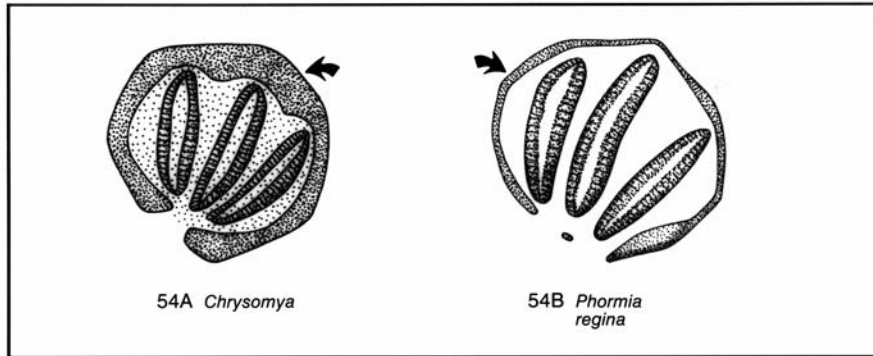


54 Peritreme of posterior spiracle very thick (54A); pl. 133A-D
 -----Old World screwworm flies, *Chrysomya* spp.

Body length: 12-18 mm. Body segments sometimes with dorsal lobes.

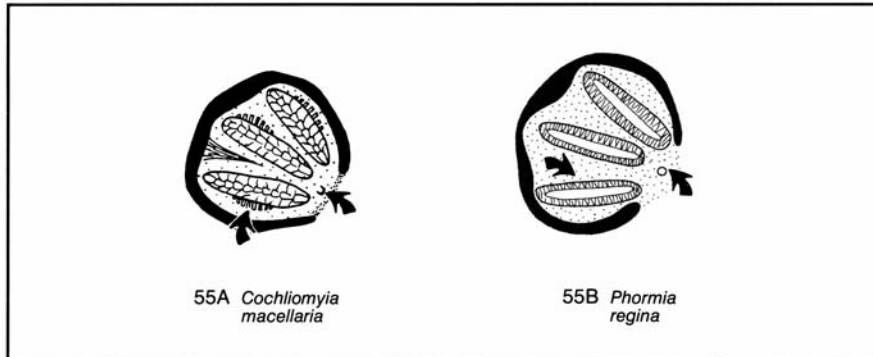
Peritreme of posterior spiracle only moderately thick (54B)----- 55

Body segments without dorsal lobes.



55 Button absent or indistinct on posterior spiracles; walls of posterior spiracular slits with lateral swellings (55A); pl. 132A--**secondary screwworm**, *Cochliomyia macellaria*

Button distinct on posterior spiracles; spiracular slits without lateral swellings (55B)
 ----- **black blow fly**, *Phormia regina*



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