

The Diptera Families of British Columbia

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Introduction

Many insects that usually are seen flying have long been called “flies” of various sorts – dragonflies, mayflies, fireflies, caddisflies, butterflies and so on. But these all belong to different orders of insects, only distantly related to each other. In entomology, none of these are flies proper, insects of the Order Diptera, which are often referred to as “true flies” or “two-winged flies” because they never have more than one pair of wings, those on the middle segment of the thorax. Some insects in other orders have lost a pair of wings, sometimes the front pair, sometimes the back one -- but none of these, except some male scale insects, have the hind wings reduced to halter-like structures. We follow convention in writing the English names of Diptera as two words (crane fly, house fly) and those called flies in other orders as a single word (dragonfly, stonefly).

Structure of Diptera

- When describing fly structure, we use the terminology of McAlpine (1981).
- Terms and diagrams.

Classification

The higher classification of the Diptera is in flux. That used here is from Wood and Borkent (1989) for the suborder Nematocera (lower Diptera) and from Yeates and Weigmann (2005) for the suborder Brachycera (higher Diptera). While Yeates and Weigmann (2005) indicate that the suborder Nematocera is a paraphyletic grouping, the exact relationship of the lower fly families is not certain. Thus we have deferred to the older higher classification of Wood and Borkent (1989) for this group. This amalgam of higher classification schemes is also being followed for the Manual of Central American Diptera, which is being developed (B.V. Brown, pers. com.). There is also some controversy as to whether some of the families are monophyletic. In such cases we have followed, in large part, the family classification presented in the Manual of Nearctic Diptera to allow for the use of its generic level keys, but noted the controversy in the discussion of the respective families. As well, we have used some traditional artificial higher groupings, such as Aschiza, in the development of the family keys to make the keys more user-friendly. This is because many of the characters that indicate the true evolutionary relationships of some fly families are genitalic and/or molecular, both of which would make a key unnecessarily awkward to use.

Table, Appendices, and Glossary Figures A and B

Table 1 lists figure details. All except two of these illustrations are reproduced with the permission of the Minister of Public Works and Government Services Canada, 2006, and taken from the *Manual of Nearctic Diptera, Volume 1*, Research Branch, Agriculture & Agri-food Canada, Monograph No. 27, 1981, and *Manual of Nearctic Diptera, Volume 2*, Research Branch, Agriculture & Agri-food Canada, Monograph No. 28, 1987.

The exceptions to the above are families Oreoleptidae and Asilidae. Family Oreoleptidae is reproduced with the permission of J. Zloty, and originates from Zloty, J.,

Sinclair, B., and Pritchard, G. 2005. Discovered in our backyard: a new genus and species of a new family from the Rocky Mountains of North America (Diptera: Tabanomorpha). *Systematic Entomology* 30(2), 248-266.

Family Asilidae is reproduced with permission by R.A. Cannings, and was originally published in *Insects of the Yukon*. 1997. (Eds. H.V. Danks and J.A. Downes). Biological Survey of Canada (Terrestrial Arthropods), Ottawa, ON. Robber Flies (Diptera: Asilidae) of the Yukon by R.A. Cannings.

Appendix I is a Checklist for the Order Diptera in British Columbia, Appendix II lists the Diptera families in alphabetical order, and Appendix III contains illustrations of Diptera families (Figures 1-94).

Glossary Figures A and B provide nomenclature of the Diptera wing (also see the terms and definitions of 'cells' and 'crossveins' in the glossary). The figures have been redrawn from the *Manual of Nearctic Diptera, Volume 1*, Research Branch, Agriculture & Agri-food Canada, Monograph No. 27, 1981, (Figures 2.67 and 2.69).

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Order Diptera Description

Order DIPTERA (Flies)

From the Greek *di* = two and *ptera* = wings. Flies have only one pair of wings -- the front pair, on the mesothorax.

Flies are minute to large insects (about 0.5 to 60 mm long), extremely variable in form and colour, but are mostly rather soft bodied, flying forms. The compound eyes are usually large, often occupying most of the head. They may meet on the top of the head or may be well separated; often, in the same species, the males show the former condition, the females the latter one. Typically, three ocelli occur, but these are reduced or lost in many groups, such as the aquatic families of Nematocera. The antennae are extremely variable in form and consist of three to forty segments. The simplest, basic nematoceran type is thread-like and 16-segmented; the basic number of segments in the Brachycera is eight, but is reduced to four in the higher Diptera. In most of the latter flies, the third segment is enlarged and the more apical segments are reduced to an appendage -- called a stylus when rigid and an arista when bristle-like. Mouthparts are modified and combined into a sucking proboscis, which is highly variable in structure. The ancestral condition is evidently the piercing and sucking type proboscis, more modified proboscis' forms rasp or sponge fluids. Some species have non-functional mouthparts. No flies bite in the true sense of cutting food between mandibles; biting flies pierce the skin of their victims and suck or lap up blood.

Diptera are primarily aerial insects and the mesothorax, which bears the only pair of wings, has come to dominate the thorax -- the prothorax and metathorax are greatly reduced. The legs are normally rather simple and are used primarily for perching; in some groups they are modified for prey capture or for signaling during courtship. The tarsi are nearly always 5-segmented. The functional wings are membranous and their pattern of veins is critical in fly classification and identification. During the evolution of flies there has been a trend towards a reduction in veins, especially in the rear half of the wing -- changes that evidently relate to improvements in two-winged flight. The hind wings, present in most other insects, are reduced in Diptera to small, club-like organs, called halteres, used for stabilizing flight.

Flies are holometabolous insects and the larvae typically live completely different lives than the adult insects do. The larvae eat to grow and to provide reserves for adult activity; the adult is primarily a reproductive and dispersal stage. The larvae never have jointed thoracic legs, but sometimes have fleshy prolegs or pseudopods that allow them to move by pushing against surfaces around them. Nematoceran species usually have a complete, well-sclerotized head capsule, but this is reduced drastically in the maggots of higher Diptera to an internal skeleton supporting the hooked mandibles and pharynx. The pupa is usually immobile, although those of some aquatic Nematocera (e.g. mosquitoes) actively swim. In some flies, larvae are deposited after they hatch inside the female; in others, notably the bird and bat parasites in the families Hippoboscidae, Nycteribiidae and Streblidae (but also in the tsetse flies (*Glossina*)), there are no free-living larvae -- the

larvae are fed glandular secretions inside the adult female and are dropped only when ready to pupate. At the other extreme, the larvae of some gall midges (Cecidomyiidae) give birth to other larvae (paedogenesis).

The Order Diptera is usually divided into two suborders, the Nematocera and the Brachycera. Among the main differences are the structure of the antennae, maxillary palps and larval mandibles. The basic number of segments in the antennal flagellum of the most ancestral Brachycera is eight. Most nematocerans have more than eight segments in the flagellum and having fewer is considered a secondary reduction. All Brachycera have two or fewer segments in the maxillary palp while the basic number in the Nematocera is five. The mandibles of brachyceran larvae lie parallel and move vertically; those of the Nematocera are opposable and move horizontally. The Brachycera are further divided by major evolutionary steps such as the development of a puparium (pupation within the hardened final larval skin) and the subsequent evolution of an eversible sac (ptilinum), which is extruded through sutures above and beside the antennae and forces the top of the puparium open, allowing the adult fly to emerge.

About 150,000 species of living Diptera have been described in approximately 10,000 genera and 150 families; this is about 14% of the world's known insect fauna. The true number of fly species is probably many times more than this. Many species of flies are cool or cold adapted and the relative abundance of Diptera in the total insect fauna is higher in northern countries such as Canada than in the world as a whole. In high arctic sites, the number of fly species is greater than that of all other insects.

The astounding success of flies is owing to their great versatility in the exploitation of habitats and their ability to utilize every possible sort of food. The larvae of the earliest flies probably fed on damp, decaying plant material, a ubiquitous food source over much of the Earth. Flies then colonized both wetter and drier habitats, leading to life in aquatic and terrestrial environments. Many are predators, parasites and parasitoids, feeding on everything from microscopic animals to mammals; many eat decaying organic matter and plant material. Unlike the adult stages of many beetles and bugs, adult Diptera have not successfully colonized underwater habitats, but many aquatic or semiaquatic larvae are common in fly families. They live from the intertidal waters of the ocean shores to the salt-encrusted margins of desert alkaline lakes, from rushing glacial torrents to the bottom of deep lakes. Many of these larvae, such as those of mosquitoes, horse flies and soldier flies, breathe atmospheric air through open spiracles and must come to the surface periodically. Others, such as chironomid midges and black flies, take oxygen from the water through their integument. Still others live in wet mud or sand or under thin films of water. Those groups, mostly in the higher Diptera, that evolved towards drier habitats live in soil and sand, in leaf litter, under bark, in wood and fungi, in decomposing material or inside growing plant tissues such as roots, stems, fruits and leaves. Some live as ectoparasites on the skin of vertebrates. Secondarily, many returned to a more fluid habitat, such as those in the syrphid, subfamily Eristalinae, where rat-tailed maggots live in semi-liquid, decaying material; in the Ephydriidae, where larvae of one species live in crude petroleum; and in the Oestridae that are obligate parasites inside the bodies of mammals.

Adult flies feed on a wide variety of substances although some have non-functional mouthparts and do not feed as adults. Most eat liquid food: water; decomposing organic matter; animal and plant secretions such as insect honeydew and flower nectar; animal tissue fluids, including vertebrate blood; soluble solids liquefied by saliva.

Flies are ubiquitous and are abundant in individuals as well as in species number. They are important food for other animals. Many are parasitic or predatory on other insects and help keep their populations under control. Some herbivorous flies have been successfully used to control weeds. Many are probably important pollinators of plants; certainly a few important crops such as cacao and rubber depend on pollination by ceratopogonids. Many are invaluable as scavengers and are vital in aiding the never-ending decomposition of plant and animal material. The flies of *Drosophila*, readily raised in the laboratory and sporting huge salivary chromosomes, provided much of our early understanding of genetics. On the negative side of the ledger, flies are famous. They are far and away the most important insects vectoring diseases in humans and domesticated animals. Blood-sucking flies transmit many diseases, including malaria, yellow fever, filariasis, leishmaniasis, and sleeping sickness. Some flies are important pests of crops -- tephritid fruit flies are serious pests of fruit; leaf miners, stem borers and other flies destroy our garden plants and crops; others carry plant diseases. Swarming flies can be a nuisance just because they are so numerous.

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Keys to Order Diptera and Families

The following keys to Diptera families is modified from the *Manual of Nearctic Diptera* in an appropriate manner for the British Columbia fauna.

Key I: Key to Order DIPTERA in British Columbia

1. Wings well-developed, extending at least to midpoint of abdomen, and of normal shape2
- Wings absent or greatly reduced WINGLESS DIPTERA (Key VII)
- 2 (1). Antennal flagellum with 4 or more flagellomeres which are usually uniform in shape and size, apical segments not modified into a stylus or arista. Palpus usually with 3-5 segments, rarely with one or two segments NEMATOCERA (Key II)
- Antennal flagellum usually more compact than Nematocera, very rarely more than 8 segments, apical segments often modified into a stylus or arista those with 4 or more flagellomeres have non-uniform sized and shaped segments. Palpus never with more than 2 segments3
- 3 (2). Ptilinal suture and lunule present4
- Ptilinal suture and lunule absent ORTHORRHAPHOUS BRACHYCERA and MUSCOMORPHA, ASCHIZA (Key III)
- 4(3). Thorax usually strongly flattened, hind coxa widely separated, tarsal claws large, strongly recurved, often toothed. Adults ectoparasitic on mammals or birds CALYPTRATAE, HIPPOBOSCOIDEA (Key IV)
- Thorax not overly flattened hind coxa close together, tarsal claws small, somewhat curved, never toothed. With very few exceptions (some members of the family Carnidae) adults not ectoparasitic on mammals or birds5
- 5 (4). Greater ampulla present as a distinct bulbous swelling below wing base and fused to the anepimeron. Vibrissae usually present. Antennal pedicel always with an entire dorsal seam CALYPTRATAE, OESTROIDEA and MUSCOIDEA (Key V)
- Greater ampulla usually absent, but if present (some Tephritidae, Psilidae and Periscelididae) then the vibrissae are absent (some Milichiidae with vibrissae have a bulbous swelling – the lesser ampulla, near the wing base and the anepimeron however in these cases there is a distinct white, membranous area between the anepimeron and the lesser ampulla).

Antennal pedicel usually with dorsal seam incomplete or absent.....
ACALYPTRATAE (Key VI)

Key II: Key to Families of NEMATOCERA

1. Wing with a network of delicate crease-like lines between the main veins, and with the number of main veins fully or partially reduced; anal lobe strongly projected towards the base of the wing.....2
- Wing lacking a network of delicate crease-like lines between the main veins, number of main veins sometimes reduced; anal region of wing usually not as strongly projecting towards base of wing as above3
- 2 (1). Antennal flagellum with 11-13 flagellomeres, apical flagellomere approximately equal in length to preceding segments; wing relatively long and narrow.....Blephariceridae
- Antennal flagellum with 4 flagellomeres, apical segment greatly elongated in males; wing broad and fan-like..... Deuterophlebiidae
- 3 (1). Halter with a basal appendage (prehalter).....Ptychopteridae
- Halter lacking a basal appendage.....4
- 4 (3). Wing with veins A₁ and A₂ reaching wing margin as distinct veins.....5
- Wing with at least vein A₂ absent or fading out before reaching wing margin6
- 5 (4). Vein A₂ usually more than ½ length of vein A₁ and fairly straight. Ocelli absent or greatly reduced.....Tipulidae
- Vein A₂ usually much less than ½ length of vein A₁ and strongly curved at apex. Ocelli present, distinct.....Trichoceridae
- 6 (4). Radial vein with 5 separate branches reaching the wing margin; discal cell present; anal lobe usually well developed.....Tanyderidae
- Radial vein usually with fewer than 5 branches reaching the wing margin; if 5 separate branches reaching the margin then discal cell absent and anal lobe poorly developed.....7
- 7 (6). Costa continuing around the wing onto the hind margin (often weaker beyond wing tip), well beyond the last radial vein.....8

- Costa ending near last branch of radial vein, near wing tip; if costal character indistinct (Pachyneuridae) then radial vein with 3 branches and a crossvein, r-r, which forms a closed cell between R_{2+3} and R_{4+5} 14
- 8 (7). First tarsomere much shorter than second and both more or less fused giving the appearance of 4 tarsal segmentsCecidomyiidae (in part)
- First tarsomere longer than the second, with distinctly 5 tarsal segments9
- 9 (8). Ocelli always absent; costa without a break beyond the insertion of R_{4+5} ...10
- Ocelli usually present, if absent the costa has a break just beyond the insertion of R_{4+5} Cecidomyiidae (in part)
- 10 (9). Wing with 6 or 7 veins reaching margin; antennae about as long as head, flagellum short and slender with 2 or 3 bristles at apex..... Thaumaleidae
- Wing with 9 to 11 veins reaching margin; antennae at least twice length of head, flagellum not reduced and usually with rings of setae on all flagellomeres11
- 11 (10). Medial vein with 3 branches; subcosta incomplete or ending in costa or R_1 before middle of wing; very setose, moth-like flies.....Psychodidae
- Medial vein with 2 branches; subcosta complete, ending at costa at or beyond midpoint of wing; flies at most moderately setose, mosquito-like...12
- 12 (11). Flattened scales present on wing veins, head legs, and often other parts of body. Proboscis long, extending well beyond clypeus.....Culicidae
- Scales absent from wing veins, head, legs, and other body parts although narrow setae often present. Proboscis short, at most extending to just beyond clypeus.....13
- 13 (12). Wing veins with dense covering of long narrow setae; base of vein R_{2+3} straight. Antennal flagellomeres with long setae in distinct rings Chaoboridae
- Wing veins with sparse covering of very short; base of vein R_{2+3} strongly curved forward. Antennal flagellomeres with short sparse indistinctly arranged setae..... Dixidae
- 14 (7). Ocelli absent15
- Ocelli present.....17

- 15 (14). Antennae short, about as long as head; flagellum with short setae in both sexes. Wing relatively broad with weakened posterior veinsSimuliidae
- Antennae long, much longer than head; flagellum with distinct long setae especially in males. Wing relatively narrow, with posterior veins usually prominent16
- 16 (15). Medial vein almost always forked, with M_2 sometimes weakened at base, rarely faint over entire length; never more than 2 branches of the radial vein reaching the wing margin. Postnotum usually without a longitudinal groove. Females' mouthparts usually with blade-like mandiblesCeratopogonidae
- Medial vein never forked, always lacking M_2 ; usually with 3 branches of radial vein reaching the wing margin. Postnotum usually with a longitudinal groove. Neither sex's mouthparts with functional mandibles ...Chironomidae
- 17 (14). Wing with radial vein 3 branched and with crossvein r-r forming a closed cell between R_{2+3} and R_{4+5} Pachyneuridae
- Wing with radial vein sometimes having 3 branches, but never with crossvein r-r forming a closed cell between R_{2+3} and R_{4+5} 18
- 18 (17). Wing with discal cell present, medial vein with 3 branchesAnisopodidae
- Wing lacking a discal cell, medial vein with never more than 2 branches...19
- 19 (18). Radius with 4 branches; R_2 and R_3 appearing as 2 separate veins, with R_2 short forming an oblique angle with R_3 and joining R_1 at costa; pair of shiny oval spots near middle of scutum..... Axymyiidae
- Radius with 3 or fewer branches; R_2 and R_3 never appearing as 2 separate veins20
- 20 (19). Wing with 2 closed basal cells – br and bm, that are separate and closed on their distal ends. Pulvilli and empodium well and equally developed; acropod with 3 similar pads Bibionidae
- Wing almost always (few exceptions in the family Mycetophilidae) with only one closed basal cell -- either cells br and bm fused or with cell bm open distally. Pulvilli at most weakly developed; acropod never with 3 similar pads21
- 21 (20). Compound eyes nearly meeting below the antennae, and holoptic above..... Canthyloscelidae

- Compound eyes widely separated below antennae with or without a narrow eye bridge above the antennae22
- 22 (21). Tibiae without apical spurs. Wing with costa ending well before apex of wing and usually with only costa and radial veins darkly pigmented..... Scatopsidae
- Tibiae with apical spurs. Wing with costa ending at or near the apex of the wing and usually with all veins darkly pigmented.....23
- 23 (22). Compound eyes meeting narrowly above antennae. Wing with base and forked portion of M subequal in length and with fork bell-shaped....Sciaridae
- Compound eyes never meeting above antennae. Wing usually with fork of M much longer than base and lanceolate in shape.....Mycetophilidae

Key III: Key to Families of ORTHORRHAPHOUS BRACHYCERA and MUSCOMORPHA, ASCHIZA

- 1. Empodia pulvilliform; each acropod with 3 similar shaped flattened pads below tarsal claws. Vein CuA₂ free or forming an acute angle with vein A₁ near the wing margin.....2
- Empodia usually setiform or absent; if acropod with 3 pads then empodium much narrower and more tapered than pulvilli; if empodia somewhat pulvilliform then CuA₂ joining A₁ at an obtuse angle far from the wing margin.....13
- 2 (1). Head unusually small, rarely exceeding ½ width of thorax; compound eyes of both sexes nearly, to entirely, holoptic. Lower calypter extremely large, wider than head Acroceridae
- Head more than ½ width of thorax; compound eyes never holoptic in females. Lower calypter smaller, not as wide as head3
- 3 (2). Branches of radius and medial veins converging towards wing apex; branches of medial vein curved forward and ending near apex of wing, and with a diagonal vein running from distal end of cell br to posterior margin of wing.....Nemestrinidae
- Branches of radius and medial vein diverging to wing apex; branches of medial vein meeting wing margin behind apex and lacking a diagonal vein..4
- 4 (3). Costa ending near wing apex.....5

- Costa continuing beyond wing apex, usually weaker along posterior margin of wing.....7
- 5 (4). Costa usually ending well before, rarely nearly at, wing apex; branches of R more or less crowded anteriorly, and all ending in margin well before wing apex; cell d short, usually little longer than wide. Tibial spurs usually absent. Stratiomyidae (in part)
- Costa extending to wing apex or slightly beyond; branches of R not crowded anteriorly, with R₅ ending at or beyond wing apex; cell d at least two times as long as broad. Tibial spurs present on at least middle and hind tibiae6
- 6 (5). Fore tibia with a ventral apical spur..... Xylophagidae (in part)
- Fore tibia without a ventral apical spur Xylomyidae
- 7 (4). Scutellum always setulose and with 4 prominent spines on margin..... Stratiomyidae (in part)
- Scutellum sometimes setulose, but never with 4 prominent spines8
- 8 (7). Subscutellum strongly developed; posterior thoracic spiracle with a scale-like elevation immediately behind it9
- Subscutellum absent or poorly developed.....12
- 9 (8). Antennal flagellum with a slender non-annulated arista. Wing with cell r₁ closed by vein R₂₊₃ meeting costa at end of R₁..... Athericidae
- Antennal flagellum with a coarse annulated stylus.....10
- 10 (9). Both upper and lower calypteres large, subequal in size. First abdominal tergite deeply notched in the middle of the posterior margin, and with a median suture Tabanidae
- Upper calypter moderately large, lower one scarcely developed. First abdominal tergite without a median notch or suture.....11
- 11 (10). Proscutellum (a small swelling between the scutellum and the mesonotum) present; aedeagal tines of male terminalia absent; female with a well developed postabdomen, clearly separated from the preabdomen..... Pelecorhynchidae
- Proscutellum absent; aedeagal tines of male terminalia present; female with postabdomen not clearly separated from preabdomen..... Oreoleptidae

- 12 (8). Clypeus exposed and strongly convex, in profile with anterior surface bulging beyond parafacial, and usually reaching dorsally to bases of antennae. Flagellum usually with not more than 7 flagellomeres, and with distal ones frequently forming a slender stylus or arista.....Rhagionidae
- Clypeus recessed in a deep facial groove and more or less flattened, in profile with anterior surface depressed below level of parafacial, and not reaching dorsally to bases of antennae. Flagellum usually with at least eight gradually smaller flagellomeres, and with apical ones not forming a slender stylus or arista except in the genus *Dialysis*..... Xylophagidae (in part)
- 13 (1). CuA₂ reaching wing margin near A₁ or joining A₁ near wing; if joining A₁, then CuA₂ at least 1.5 times longer than apical section of A₁, except in a few Bombyliidae
.....14
- CuA₂ absent or vestigial, or joining A₁ far from wing margin; if joining A₁, then CuA₂ at most scarcely longer than apical section of A₁, except in a few Empididae and a few Platypezidae.....21
- 14 (13). Branches of M peculiarly curved forward, more or less parallel to posterior wing margin at least M₁ ending freely in wing margin before wing apex....15
- Branches of M not curved as above, but if somewhat bent forward then not ending freely in wing margin16
- 15 (14). Flagellum unusually long with a slender stalk-like base and strongly clubbed apex; stalk at least twice as long as combined length of scape and pedicel. Only one ocellus presentMydidae
- Flagellum shorter than head, without a stalk-like base; entire flagellum not much longer than combined length of scape and pedicel. Three ocelli present Apioceridae
- 16 (14). Spurious vein evident as a strong vein-like fold between Rs and M; M₁ curved forward roughly in line with crossvein dm-cu and joining unbranched R₄₊₅ in a crossvein-like mannerSyrphidae
- Spurious vein undeveloped; M₁ usually not curved forward in a crossvein-like manner, but if curved forward then joining a furcated R₄₊₅
.....17
- 17 (16). Head strongly hemispherical, with compound eyes abnormally large and almost meeting both above and below antennae. Flagellum with a dorsal arista. R₄₊₅ is unbranched; costa ends at wing apex.....Pipunculidae

- Head usually not hemispherical, but if so then flagellum without a dorsal arista. R_{4+5} usually furcated: costa usually continuing around wing.....18
- 18 (17). Vertex usually distinctly excavated between eyes; ocellar tubercle below dorsal level of compound eyes; compound eyes never holoptic. Face relatively long, with a cluster or row of long bristles, the mystax. Proboscis stout, polished; labella reduced and inconspicuous; hypopharynx protrusible, strongly developed for piercing.....Asilidae
- Vertex not or only slightly concave; ocellar tubercle usually elevated above the dorsal level of the compound eyes; compound eyes usually holoptic in males. Face relatively short, sometimes setulose, but without a mystax. Proboscis short and stout to long and thin, usually dull pruinose; labella usually well-developed and conspicuous; hypopharynx not protrusible, not developed for piercing.....19
- 19 (18). Wing with cell bm truncate distally and with four corners from which arise four separate veins (M_{1+2} , M_3 , CuA_1 , CuA_2) base of cell m_3 truncate Therevidae
- Wing with cell bm , when present, pointed distally and with three corners from which arise three separate veins (M_{1+2} , M_3+CuA_1 and CuA_2); base of cell m_3 , when present, pointed20
- 20 (19). Wing with cell dm absent, and with R_{4+5} and M_{1+2} rather similarly forked, each fork not longer than its base..... Hilarimorphidae
- Wing with cell dm usually present, but if not the R_{4+5} and M_{1+2} not similarly forked Bombyliidae
- 21 (13). Antennal flagellum with a minute stylus concealed in a subapical pit. Crossvein $r-m$ at or beyond middle of wing; M unbranched and curved forwards, joining R_{4+5} or closely approaching it in the wing margin..... Scenopinidae
- Antennal flagellum with an elongate, fully exposed stylus or arista. Crossvein $r-m$ well before middle of wing or absent; M branched or unbranched, sometimes curved forward, but not as above22
- 22 (21). Wing pointed at apex with peculiar linear venation; main veins except subcosta and R_3 with black setulae above. Antennal flagellum rounded, with a terminal arista. Slender brownish or yellowish flies, 2-5 mm long..... Lonchopteridae

- Wing rounded at apex, and with radiating venation; veins at least in posterior half of wing not setose. Antennal flagellum, body size, and colour variable23
- 23 (22). Wing with branches of R strongly thickened and crowded into anterior base, and with four other weak and peculiarly aligned veins in remainder of wing blade; costa ending near middle of anterior margin.....Phoridae
- Wing with branches of R not strongly thickened and crowded anterobasally, and with other veins normal; costa extending at least to wing apex.....24
- 24 (23). Antenna with pedicel much longer than flagellum; flagellum with a dorsal three-segmented arista. Mid coxal prong strongly developed.....
.....SCHIZOPHORA
..... (exception lacking a ptilinal suture) Sciomyzidae: genus *Sepodon*
- Antenna with pedicel not or scarcely as long as flagellum; if arista three-segmented, then terminally situated. Mid coxal prong often absent25
- 25 (24). Wing with both A_1 and subcosta reaching wing margin, and with cell cu_p acute at posterior apex. Hind tarsus, at least in male, with one or more basal tarsomeres expanded and flattened. Arista three-segmented, terminally situated Platypezidae
- Wing rarely with A_1 reaching wing margin, but if so either subcosta incomplete or cell cu_p obtuse or rounded at posterior apex. Hind tarsus not modified as above. Arista or stylus two-segmented, terminally or dorsally situated26
- 26 (25). R_s originating at or near level of crossvein h, distal to crossvein h by, at most, length of crossvein h; crossvein r-m in basal fourth of wing; cells bm and dm confluent, that is, crossvein bm-cu absent; subcosta usually abruptly curved posteriorly and fused with R_1 , except in the subfamily Hydrophorinae..... Dolichopodidae
- R_s originating well distal to level of crossvein h, usually distal to it by more than length of crossvein h; crossvein r-m distal to basal fourth of wing; cell bm usually separated from cell dm (when cell dm is present) by crossvein bm-cu; subcosta usually joining costa or ending freely, never abruptly joining R_1 Empididae

Key IV: Key to Families of HIPPOBOSCOIDEA

1. Compound eyes large, horizontally oval, at least $\frac{3}{4}$ as high as head, with at least 100 very small facets. Posterior wing veins weaker than anterior veins. Ectoparasitic on birds and mammals except bats.....Hippoboscidae
- Compound eyes, if present, small, round, never more than $\frac{1}{2}$ as high as head, and with less than 40 relatively large bead-like facets. Wing veins relatively uniform in strength. Ectoparasitic on bats.....Streblidae

Key V: Key to Families of OESTROIDEA and MUSCOIDEA

1. Large (9-25 mm long) heavy-bodied, finely setulose flies which lack large setae and resembling honeybees, bumblebees or carpenter bees. Head bulbous with greatly reduced or atrophied mouthparts, no vibrissae, and small recessed antennae. Meron usually with a cluster of long setae. All larvae obligate parasites of mammalsOestridae
- Usually smaller (1-15mm long) normally setose flies. Head usually with well-developed mouthparts, vibrissae, and normal-sized antennae. Meron bare or with a row of bristles, sometimes with additional scattered fine setulae. Larvae rarely parasites of mammals2
- 2 (1). Meron bare8
- Meron with a row of bristles, sometimes with additional scattered fine setulae3
- 3 (2). Subscutellum strongly developed..... Tachinidae
- Subscutellum absent or weakly developed.....4
- 4 (3). Abdomen and usually thorax with a distinct metallic blue or green sheen. Palpus usually orange-yellow..... Calliphoridae (in part)
- Abdomen usually mostly dull, variegated gray, brown or black, sometimes shiny black, but never metallic blue or green. Palpus blackish to yellowish. .5
- 5 (4). Thorax with silky wavy yellowish setulae as well as normal black bristles and setulae..... Calliphoridae (in part)
- Thorax without silky yellowish setulae.....6
- 6 (5). Scutum usually with three conspicuous black stripes on a gray background. Notopleuron usually with 3 or 4 bristles. Hind coxa usually with setulae on posterior surface. Arista usually plumose Sarcophagidae (in part)

- Scutum with or without black stripes. Notopleuron always with only 2 bristles. Hind coxa always without setulae on posterior surface. Arista plumose to bare7
- 7 (6). Coxopleural streak present..... Sarcophagidae (in part)
- Coxopleural streak absent Calliphoridae (in part)
- 8 (2). A₂ curved forward beyond tip of A₁, with course of A₁ (if extended) intersecting A₂ before wing margin; subcosta always nearly straight on apical 2/3. Hind tibia always with a strong bristle near middle of dorsal surface as well as a preapical dorsal bristle... Muscidae (Subfamily Fanninae)
- A₂ not curved forward beyond tip of A₁, with course of A₁ not intersecting A₂ before wing margin; subcosta usually distinctly curved forward on apical half or less. Hind tibia rarely with a strong bristle near middle of dorsal surface as well as a preapical dorsal bristle (sometimes a similar bristle- the calcar, present on posterodorsal surface)9
- 9 (8). Palpus absent. Crossveins r-m and dm-cu separated by a distance not or scarcely greater than length of crossvein dm-cu; crossvein bm-cu partially atrophied..... Anthomyiidae (in part)
- Palpus present. Crossveins r-m and dm-cu usually more widely separated; crossvein bm-cu usually complete10
- 10 (9). A₁ never reaching wing margin even as a fold; lower calypter broad, never linear..... Muscidae (in part)
- A₁ usually reaching wing margin at least as a fold, if not then lower calypter linear.....11
- 11 (10). Scutellum usually with fine pale setae on apicoventral surface; frons usually narrower in male than in female; if scutellum bare on apicoventral surface and frons wide in male then frons with strong interfrontal bristles. Occiput never with fine pale setulae, only with black bristles and setulae. Katepisternum usually with 2 to 4 bristles; lower calypter linear to broad..... Anthomyiidae (in part)
- Scutellum bare on ventral surface; frons wide in both sexes and lacking interfrontal bristles. Occiput usually with numerous fine pale setulae, sometimes between black bristles and setulae. Katepisternum usually with 1 bristle. Lower calypter always linearScathophagidae

Key VI: Key to Families of ACALYPTRATAE

1. Proboscis usually very long and slender, frequently 2 or more times longer than head; pedicel usually longer than first flagellomere. Crossvein sc-r present or cell cup distinctly longer than cell bm, or with both characters present simultaneously; M joining R_{4+5} or closely approaching it...Conopidae
- Proboscis usually shorter and stouter, not longer than head except in some Milichiidae and Chloropidae where it is elbowed; pedicel usually shorter than first flagellomere, but if longer then crossvein sc-r absent and cell cup shorter than cell bm; M approaching R_{4+5} or not.....2
- 2 (1). Ocelli and mid coxal prong absent; medium to large flies with heavily marked wingsPyrgotidae
- Ocelli usually present; if absent, mid coxal prong present; size variable, wings marked or unmarked.....3
- 3 (2). Hind tarsus with first tarsomere distinctly swollen and usually shorter than second tarsomere. Subcosta always incomplete; CuA_1 usually incompleteSphaeroceridae
- Hind tarsus with first tarsomere not swollen and longer than second tarsomere. Subcosta complete or incomplete; CuA_1 usually complete.....4
- 4 (3). Subcosta abruptly bent forward at almost 90° , weakened beyond the bend and ending at subcostal break; wing almost always with markings. Pedicel with a dorsal cleft. Vibrissae absent. Greater ampulla usually weakly distinguishable and anepimeron always with bristles or setulae or both.....Tephritidae
- Subcosta less abruptly bent. Not agreeing with one or more of the remaining characters.....5
- 5 (4). Slender bodied flies with long slender legs. R_{4+5} and M meeting or strongly converging at wing margin; subcosta always complete.....6
- Usually stouter flies with shorter heavier legs. R_{4+5} and M usually subparallel or divergent at wing margin; subcosta complete or incomplete...7
- 6 (5). Eyes very large, distinctly higher than long, and closer together in male than female. Ocellar bristles present. R_1 setose above. Katepisternum evenly pilose, but without large bristlesTanypezidae

- Eyes smaller than above, not much higher than long, and equidistant in both sexes. Ocellar bristles absent. R_1 not setose. Katepisternum never evenly pilose, always with one or more large bristlesMicropezidae
- 7 (5). Subcosta complete or nearly so, ending at costa or just short of it and free from R_1 distally.....8
- Subcosta incomplete, not reaching costa, often fusing with R_1 distally.....29
- 8 (7). Costa without a subcostal break.....9
- Costa with a subcostal break18
- 9 (8). Posterior thoracic spiracle with one or more fine bristles on lower margin. Form usually ant-like; head subspherical; palpus usually vestigial; abdomen usually elongate and basally constrictedSepsidae
- Posterior thoracic spiracle without bristles or outstanding setulae. Form usually not ant-like; palpus usually well-developed10
- 10 (9). Metepisternum setose below posterior thoracic spiracle; thorax distinctly flattened. Squatty and strongly bristled fliesCoelopidae
- Metepisternum bare; thorax not very flattened. Form and bristling variable11
- 11 (10). Face broadly membranous and sunken in middle; vibrissa present.....12
- Face uniformly sclerotized and convex in middle; vibrissa absent.....13
- 12 (11). Arista subapical; frons with a pair of cruciate interfrontal bristles. Costa without humeral break. All tibiae with a preapical dorsal bristleClusiidae (in part)
- Arista dorsobasal. Frons without cruciate interfrontal bristles. Costa with humeral break. All tibiae without a preapical dorsal bristleAcartophthalmidae
- 13 (11). Some or all tibiae with a preapical dorsal bristle14
- All tibiae without a preapical dorsal bristle16
- 14 (13). Postocellar bristles distinctly convergentLauxaniidae
- Postocellar bristles almost parallel, divergent, or absent15

- 15 (14). Clypeus large and prominent, in profile distinctly bulging beyond lower margin of face. Pedicel always short.....Dryomyzidae
- Clypeus small and withdrawn, in profile more or less concealed under lower margin of face. Pedicel usually elongate.....Sciomyzidae
- 16 (13). Postocellar bristles convergent or absent. Clypeus small and withdrawn. Female with a flexible tubular ovipositorChamaemyiidae (in part)
- Postocellar bristles divergent or absent. Clypeus large and prominent. Female with rigid shaft-like ovipositor17
- 17 (16). Postocellar bristles distinctly developed, divergent. Katepisternal bristle presentOtitidae (in part)
- Postocellar bristles absent or very weakly developed. Katepisternal bristles absent, though setulae or pile commonly presentPlatystomatidae
- 18 (8). Vibrissae present, but sometimes weak in the family Tethinidae.....19
- Vibrissae absent, but subvibrissal bristles sometimes vibrissae-like26
- 19 (18). Costa with a distinct humeral break as well as a subcostal break.....20
- Costa without a humeral humeral break, with a subcostal break only.....21
- 20 (19). Gena broad, with a row of bristles in the middle. Proboscis with a stout bulbous prementum and short inconspicuous labella.....Carnidae (in part)
- Gena usually narrow, but if broad then bristles confined to lower margin. Proboscis with slender prementum and long conspicuous labels folded back along prementum.....Milichiidae (in part)
- 21 (19). Pedicel with an angular though sometimes weak projection on outer side. Arista subapical. Frons with 2 to 5 strong more or less equally spaced mostly reclinate fronto-orbital bristles, with at most only the lowest one inclinateClusiidae (in part)
- Pedicel without an angular projection. Arista dorsobasal. Frons usually with fewer more or less equally spaced fronto-orbital bristles, but if with 2-5 (Agromyzidae and some Otitidae), then 2-3 of the lower ones are strongly inclinate22
- 22 (21). Postocellar bristles divergent23
- Postocellar bristles convergent or absent24

- 23 (22). Frons always with 3-5 strong inclinate frontal bristles that are relatively similar to the two reclinate orbital bristles in size and spacing..... Agromyzidae (in part)
- Frons seldom with any strong inclinate frontal bristles, but if one or two present then these positioned distant from and inclined oppositely to the two lateroclininate orbital bristlesPiophilidae
- 24 (22). All tibiae without a preapical dorsal bristle. Costa not spinose; A_1 fading out on apical third or more, never traceable to wing margin. Vibrissae and postocellar bristles weakly differentiated to virtually absent..... Tethinidae (in part)
- All tibiae with a preapical dorsal bristle. Costa spinose, except in some Heleomyzidae in which A_1 is traceable to wing margin. Vibrissae and postocellar bristles strong.....25
- 25 (24). Ocellar bristles arising on ocellar triangle above anterior ocellus Heleomyzidae
- Ocellar bristles arising just outside ocellar triangle beside or slightly below anterior ocellus Trixoscelididae
- 26 (18). Halter black. Anepisternum with a row of strong bristles posteriorly. Frons, face, thorax, abdomen, and legs (excluding tarsi) black, usually with metallic reflections. Stout bristly flies with broad flat abdomen; female with lance-like ovipositor..... Lonchaeidae
- Halter usually whitish, but if halter blackish, then anepisternum without a row of strong bristles, and/or head, thorax, abdomen, and legs not as extensively black. Form variable27
- 27 (26). Postocellar bristles convergent Chyromyidae (in part)
- Postocellar bristles divergent or absent28
- 28 (27). Scutum with one or more presutural dorsocentral bristles. Cell *cup* without an angular extension at posterior apex. Disc of proepisternum always bare Pallopteridae
- Scutum usually without presutural dorsocentral bristles, but if present then cell *cup* with an angular extension at posterior apex or disc of proepisternum setose, or both.....Otitidae (in part)
- 29 (7). Costa without subcostal or humeral break30

- Costa with at least a subcostal break present32
- 30 (29). CuA₂ and A₁ strong; cell *cup* complete. Arista bare or micropubescent
.....Chamaemyiidae (in part)
- CuA₂ and A₁ atrophied; cell *cup* incomplete or absent. Arista bare to
plumose31
- 31 (30). R₁ joining costa in basal third of wing; R₄₊₅ and M distinctly convergent
distally. Postocellar setae weak or absentAsteiidae
- R₁ joining costa near middle of wing; R₄₊₅ and M not convergent.
Postocellar setae strong..... Periscelididae
- 32 (29). CuA₂ and A₁ absent or vestigial, never forming a closed cell *cup*; crossvein
bm-cu absent, making cells bm and dm confluent.....33
- CuA₂ and A₁ present, always forming a closed cell *cup*; crossvein bm-cu
usually present, making cells bm and dm usually separate.....35
- 33 (32). Costa with a subcostal break only, without a humeral break; CuA₁ usually
with a kink marking the position of atrophied crossvein bm-cu. Arista bare
or micropubescent, never plumose..... Chloropidae
- Costa with both a subcostal and a humeral break; CuA₁ without a kink.
Arista bare to long plumose34
- 34 (33). Face strongly convex; subcranial cavity usually very large. Postocellar
bristles absent; pseudopostocellar bristles, if present, divergent ... Ephrydriidae
- Face concave; subcranial cavity normal. Postocellar bristles present,
convergent or subparallel..... Carnidae (in part)
- 35 (32). Katepisternum without an outstanding bristle, though frequently setulose.
Vibrissae absent and gena without a vibrissa-like bristle36
- Katepisternum always has one or more enlarged bristles. Vibrissae present
or absent; gena with or without a vibrissa-like bristle37
- 36 (35). Notopleuron usually with two bristles; anepisternum with an enlarged
bristle, in addition to fine setulae. Ocelli situated far forward, with the
anterior one about midway between the vertex and antennae.....
.....Strongylophthalmyiidae

- Notopleuron with one bristle, the posterior one; anepisternum without a bristle, with fine setulae only. Ocelli situated near vertex, with the anterior one on dorsal third of frons Psilidae
- 37 (35). Costa with both a humeral and a subcostal break38
- Costa without a humeral break, with a subcostal break only41
- 38 (37). Long axis of antenna strongly elbowed, with flagellum distinctly decumbent; arista frequently long plumose38
- Long axis of antenna nearly straight, with flagellum more or less porrect. Arista bare or shortly pubescent40
- 39 (38). Costa with small evenly spaced erect spinules beyond subcostal break. Proclinate orbital bristle arising dorsolaterally to lowermost reclinate orbital bristle..... Diastatidae
- Costa without erect spinules, with ordinary reclinate setulae only. Proclinate orbital bristle usually arising ventromedially to reclinate orbital bristle; if arising above reclinate orbital bristle then dorsomedially to it.. Drosophilidae
- 40 (38). Gena broad, with a row of bristles in middle. Proboscis with stout bulbous prementum and short inconspicuous labella Carnidae (in part)
- Gena usually narrow, but if broad, then bristles confined to lower margin. Proboscis with slender prementum and long conspicuous labella folded back along prementum..... Milichiidae (in part)
- 41 (37). All tibiae with a preapical dorsal bristle. Frons with two reclinate orbital bristles above and one inclinate frontal bristle below..... Odiniidae
- All tibiae without a preapical dorsal bristle. Fronto-orbital bristles not as above42
- 42 (41). Anepimeron setulose. Frons with a single orbital bristle..... Opomyzidae
- Anepimeron usually bare, but if setulose, then frons with more than one orbital bristle43
- 43 (42). Postocellar bristles always present and divergent..... Agromyzidae (in part)
- Postocellar bristles convergent or absent (there are a pair of pseudopostocellar setulae are present in some Tethinidae and are easy to confuse with true postocellars which are absent in all Tethinidae).....44

- 44 (43). Anepisternum bare. Fore femur usually with a strongly developed ctenidial spine Anthomyzidae
- Anepisternum setulose. Fore femur usually without a distinct ctenidial spine45
- 45 (44). Proepisternal and proepimeral bristles present.....Tethinidae (in part)
- Proepisternal bristle always absent; proepimeral bristle absent; except in some *Aphaniosoma* Chyromyidae (in part)

Key VII: Key to Families of wingless Diptera

1. Antennal flagellum with two or more distinctly separate flagellomeres, exclusive of stylus or arista2
- Flagellum with a single consolidated segment, exclusive of stylus or arista..8
- 2 (1). Ocelli absent3
- At least one ocellus present5
- 3 (2). Mesoscutum with a complete V-shaped suture.....Tipulidae (in part)
- Mesoscutum without a complete V-shaped suture.....4
- 4 (3). Compound eye minute, reduced to one facetCecidomyiidae (in part)
- Compound eye large, multifaceted.....Tipulidae (in part)
- 5 (2). Tibiae without apical spursCecidomyiidae (in part)
- Tibiae with apical spurs, although sometimes very short6
- 6 (5). Eye bridge presentSciaridae (in part)
- Eye bridge absent7
- 7 (6). Palpus one-segmented. Body about 2 mm longSciaridae (in part)
- Palpus with three or more segments. Body at least 4 mm longMycetophilidae

- 8 (1). Antennal pedicel swollen; flagellum at least twice as long as broad and with a minute apical setae. Remnant of larval eye strongly apparent. Abdomen about three times as long as remainder of body.....Chironomidae
- Antennal pedicel not swollen; flagellum less than twice as long as broad and usually with an elongate stylus or arista. Remnant of larval eye not apparent. Abdomen less than twice as long as remainder of body.....9
- 9 (8). Middle and hind coxae widely separated ventromedially; tarsal claws strongly recurved and toothed. Ectoparasites of bats, birds or mammals.....10
- Coxae not widely separated ventromedially; tarsal claws simple. Usually not ectoparasites of bats or mammals, sometimes associated with nesting birds ...
.....12
- 10 (9). Head vertically oriented, folded back into groove on mesoscutum. First tarsomere of each tarsus very elongate, at least as long as remainder of tarsus. Ectoparasites of batsNycteribiidae
- Head horizontally oriented, not folded back. First tarsomere of each tarsus short, subequal to second tarsomere. Parasites of bats, birds or mammals...11
- 11 (10). Compound eyes always present, large, horizontally oval, at least $\frac{3}{4}$ as high as head, with at least 100 very small facets. Ectoparasitic on birds and mammals except batsHippoboscidae
- Compound eyes sometimes absent, if present, small, round, never more than $\frac{1}{2}$ as high as head, and with less than 40 relatively large bead-like facets. Ectoparasitic on bats.....Streblidae
- 12 (9). Lunule absent13
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- 13 (12). Arista with 3 aristomeres.....Phoridae
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- 14 (13). Proboscis short and retracted. Vertex excavated. Compound eye pubescent ...
.....Dolichopodidae
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- 15 (12). First tarsomere of hindleg swollen, shorter than second tarsomere
.....Sphaeroceridae

- First tarsomere of hindleg not swollen, longer than second tarsomere.....16
- 16 (15). Propleuron with a vertical ridge..... Chloropidae
- Propleuron without a vertical ridge17
- 17 (16). Face strongly convex; subcranial cavity unusually large..... Ephydriidae
- Face concave; subcranial cavity normal.....18
- 18 (17). Postocellar bristles absent; frons with a single reclinate orbital bristle.
Reduced wing with an apical spot..... Opomyzidae
- Postocellar bristles present; frons with at least two orbital bristles. Reduced
wing, if present, without an apical spot.....19
- 19 (18). Postocellar bristles subparallel; gena with a row of strong bristles in middle.
Associated with nesting birds..... Carnidae
- Postocellar bristles convergent; gena without a row of strong bristles in
middle. Not associated with nesting birds.....20
- 20 (19). All tibiae without a preapical dorsal bristle; fore femur with a strong
ctenidial bristles. Frons with two strong reclinate fronto-orbital bristles on
lower half..... Anthomyzidae
- Some or all tibiae with a preapical dorsal bristle; fore femur without a
ctenidial bristle. Frons without strong fronto-orbital bristles on lower half.21
- 21 (20). Frons with a proclinate orbital bristle. Arista plumose Drosophilidae
- Frons without a proclinate fronto-orbital bristle. Arista bare or
micropubescent Heleomyzidae

Family Descriptions

Suborder NEMATOCERA

Infraorder TIPULOMORPHA

Family TANYDERIDAE (Primitive Crane Flies) [Fig. 1]

Considered by some the most archaic of living Diptera, the Tanyderidae is a family of medium to large-sized flies with long legs, no ocelli, and dark-patterned wings with a well-developed anal angle. The 5-branched radius is a hypothetically primitive condition rarely found in real flies. The antenna has 15 to 25 segments; North American species usually have 16 antennal segments with the last segment being shorter than the second last segment. The compound eyes bear erect setae between the ommatidia.

Little is known of the biology of the family. Adults are mostly collected in forests and the larvae are mostly aquatic. One Australian species bores in the surface of rotten logs submerged in mountain streams; known larvae of North American species burrow in the sandy sediments along the margins of streams.

The primitive crane fly family is a relict group, scattered in the temperate areas of the Northern and Southern hemispheres – the southern tips of Africa and South America, central and eastern Asia, Australasia and North America. The family contains 38 species in 10 genera. There are two genera and four species in North America; the sole eastern species is *Protoplasa fitchii* Osten Sacken (Fig. 1). The only western genus is *Protanyderus* with three species, one of which, *P. margarita* Alexander, occurs in BC.

Family TIPULIDAE (Crane Flies) [Fig. 2]

Crane flies are normally slender, very long-legged flies with wingspans ranging from 5 to 85 mm. The head is variable in shape, often expanded forward into a snout-like rostrum. The antenna is usually short or moderately long, but sometimes extremely long in males, reaching four times the body length in some species. The number of antennal segments range from 5 (some *Chionea*) to 39 (some exotic species), but usually there are 13 in the subfamily Tipulinae and 14 to 16 in the subfamily Limoniinae; antennal segments are sometimes branched in males, but rarely branched in both sexes (*Ctenophora*). The eyes are large, usually separated above, but sometimes joined (*Limonia*); ocelli are absent. Thorax with distinctive V-shaped transverse metanotal suture. The long legs are unusually brittle, easily breaking between the trochanter and femur. The wings are elongate, rather narrow, reduced or lost in females of some groups, sometimes in both sexes (*Chionea*). The venation is normally characterized by two anal veins, 9 to 12 veins reaching the wing margin, the basal cells extending at least half the length of the wing, and a distinctive region near the outer third of the wing where the branching points of Rs, M and CuA often occur together in a transverse line.

Crane flies occur almost everywhere insects live, from lowland deserts and tropical forests to the high Arctic islands and high mountain tops. Most live in moist temperate forests, especially in cool, damp places near water. Larvae develop in fresh water, especially fast streams, in the intertidal zone, in mosses, decayed wood, wet leaf litter, organic soils and mud, dry soils, fungi, vertebrate nests and in the leaves of terrestrial plants. They are herbivorous, saprophagous or carnivorous.

Crane flies comprise the most speciose family of Diptera – approximately 15,270 species are described. *Tipula*, with well over 2000 named species and *Limonia*, with about 200, are among the most speciose genera of Tipulidae. In Canada 593 described species are arranged in 73 genera. There are 171 described species in 52 genera record in BC. The province's most diverse genera are *Tipula* (35+ species), *Dicranomyia* (15+ species), *Tricyphona* (11+ species), *Ormonia* (10+), and *Nephrotoma* (10+). The family includes our largest flies, at least in wingspan with BC's largest, *Holorusia hespera* Arnaud & Byers, measuring up to 85 mm. This huge rusty-coloured fly ranges from BC to Arizona and California. *Pedicia magnifica* Hine was first described from Vancouver Island; it, and others of the genus, have a striking brown triangular mark on the wings, which span at least 50 mm. Larvae develop in wet organic soil along streams and seeps. Males of the orange and black *Phorocentria vittata* (Meigen) have feathery antennae; larvae of *P. vittata* burrow in decaying hardwood stumps and logs. Population levels of *Tipula paludosa* Meigen (Marsh Crane Fly), an introduction from Europe, exploded on the south coast in the 1960s; the root-eating larvae, called leatherjackets, damage lawns while the adults can be common in houses in September. Throughout BC from late autumn to early spring adults of several species of wingless crane flies of the genus *Chionea* frequently are found striding purposefully over the snow, especially when the temperature hovers around freezing. Larvae live in the nests of small mammals. Perhaps the most common and widespread is *C. alexandriana* Garrett.

Infraorder BLEPHARICEROMORPHA

Family BLEPHARICERIDAE (Net-winged Midges) [Fig. 3]

Net-winged midges are delicate, slender, long-legged flies, about 3 to 13 mm long. They are usually uniformly coloured grey or dull yellow-brown. The eyes are large, finely pubescent and divided into an upper and lower portion; the upper part normally is reddish in life and is made up of larger facets than the lower part, which is black in life. Males' eyes usually meet on top of the head. The three ocelli are borne on a tubercle. The antennae are short, with 11 to 13, usually barrel-shaped segments. Most females have slender, serrated rasping mandibles. The wings are broad with a prominent anal angle; the radius has only three or fewer branches reaching the wing margin in North American species; M_2 is completely detached basally. There is a net-like pattern of fine folds throughout the wing membrane, hence the family's common name.

Distinctive and highly specialized, net-winged midges are denizens of mountain streams, where the larvae cling to rocks in rapids and waterfalls, scraping diatoms and other algae, bacteria, and other organic matter from the rock surfaces. The larvae are well-adapted to fast-flowing water, having a cephalothorax composed of the fused head,

thorax and first abdominal segment; six ventral suctional discs attach strongly to smooth surfaces. The pupae are also attached to rocks, often in the hundreds, all aligned in the same direction. Wings are fully developed within the pupal case and adults usually emerge to the water surface in an air bubble. Adults usually live near streamside rocks or in riparian vegetation and survive only a week or two. Female adults of many species are predators of soft-bodied insects such as mayflies, stoneflies and chironomid midges. Feeding habits of males, and females lacking mandibles, are unknown but it is thought they might feed on nectar. Eggs are cemented to streamside rocks although some species oviposit while entirely submerged in the water.

Net-winged midges are distributed worldwide; the 300 described species are placed in 27 genera. The family is usually divided into two subfamilies – the Edwardsiniinae in the southern hemisphere and the Blepharicerinae in both northern and southern hemispheres. The relationships of groups within the latter subfamily are not well understood. There are 27 species in five genera in North America north of Mexico, all in the Tribe Blepharicerini. BC has four species in two genera: *Agathon aylmeri* (Garrett) was first described from the Rockies; *A. comstocki* (Kellogg) (Fig. 3) ranges in coastal mountains south to California; *A. markii* (Garrett) is recorded from Southeastern BC, near Cranbrook. *Bibliocephala grandis* Osten Sacken ranges from the Yukon south to New Mexico; it is recorded in BC from the Coast range east to the Rockies.

Family DEUTEROPHLEBIIDAE (Mountain Midges) [Fig. 4]

Mountain midges are delicate flies, approximately 3 mm long, with unusually broad, silvery-blue wings, and reduced mouthparts. The thorax is dark brown or black, broad and arched, projecting over the head; the tapered abdomen is pale brown in the male and dark green in the female. The head is small, transverse and rather flattened, with the small eyes below the antennae. The eyes lack pubescence and ocelli are absent. The antennae have only six segments, but the terminal segment is greatly elongated in males, making the antenna about four times the length of the body. The wing veins are much reduced however, a fan-like network of vein-like lines, the result of wing-folding, is striking. The legs are slender; the empodia of males are flattened, circular discs with long, yellow-knobbed setae; one tarsal claw is slender, the other is reduced; the empodia of females are linear and shorter than the two stout claws.

Mountain midges live along rapidly running streams where the larvae cling (with seven pairs of finely-clawed abdominal prolegs) to smooth, light-coloured rocks near the water surface. Pupae prefer depressions and cracks in dark-coloured rocks. High-altitude species have a single generation a year whereas some species at lower elevations may produce several; species probably overwinter in the egg. Adults live only a few hours.

The Deuterophlebiidae contains the single genus *Deuterophlebia*, found in widely separated regions of the temperate northern hemisphere. North America has six described extant species, all western. The known species in BC are *Deuterophlebia personata* Courtney, known from the Hope region, *Deuterophlebia inyoensis* Kennedy and *Deuterophlebia coloradensis* Pennak, both known from several areas of BC.

Infraorder AXYMIOMORPHA

Family AXYMYIIDAE (Axymyiid Flies) [Figs.5]

Axymyiids are medium-sized (5 to 6 mm long), rather stout flies with the general appearance of *Biblio* (Bibionidae), with which they can be confused. However, axymyiids have four branches of the radial vein, versus 3 or less in bibionids, and 2 shiny spots on the scutum, which are absent in bibionids. The large head bears compound eyes divided into upper and lower sections by a line or groove; the eyes in males meet dorsally, but are widely separate in females. There are three large ocelli on a strong convex tubercle. The antennae are rather short, composed of 16 small segments. The mouthparts are vestigial. The thorax is strongly arched and bears a pair of shiny oval spots near the middle of the scutum. The thorax has short pale setae; bristles or long erect setae are absent. The legs are short and lack spines or long setae. The wing is longer than the body and, in some species, has a faint pterostigma. Vein R_2 is short, nearly perpendicular to R_{2+3} , ending in C at, or just past, the end of R_1 . The medial vein is two-branched. The stem of the halter is very long.

Little is known about the biology of the family; adults are seldom collected. The larvae live head-down in cavities that they excavate in waterlogged, bark-free logs that are continuously in contact with water or wet mud, apparently feeding on micro-organisms living within the cavity.

The Axymyiidae is restricted to the temperate northern hemisphere, where there are five described extant species in three genera. In North America, *Axymyia* contains one described eastern and one described western species. The western species, known from Oregon, as well as an undescribed new species from Alaska may occur in BC.

Infraorder BIBIONOMORPHA

Family PACHYNEURIDAE (Pachyneurid Gnats) [Fig. 6]

Pachyneurid gnats are slender, long-legged, long-winged flies. The head is small and globose with more or less spherical eyes clothed in short setae; there are three ocelli, each on its own tubercle. The antennae, comprised of 15 to 17 cylindrical or bead-like segments, are shorter than the thorax, except in the males of *Cramptonomyia*, where the antennae are as long as the abdomen. Thorax with the mesoscutum shallowly convex; transverse suture weak; dorsocentral setae pronounced. The wing has a distinct pterostigma. Vein R_s branches near the r-m crossvein; R_{2+3} is branched in *Pachyneura*, but is unbranched and connected to R_{4+5} by an extra radial crossvein in other genera; discal cell usually present. The abdomen is slender and longer than the wing.

Known larvae of pachyneurid gnats bore in rotting wood. For example, larvae of the genus *Cramptonomyia* develop in logs of Red Alder along the Pacific coast; larvae tunnel under the bark or just below the surface of bare wood, taking at least a year to mature. Adults fly from February to April.

The Pachyneuridae contains four described extant species in four genera. The Japanese genus, *Haruka*, the eastern Siberian one, *Pergratospes*, and the North American genus, *Cramptonomyia*, are more closely related to each other than they are to the fourth genus, *Pachyneura*, from Europe and Asia and are sometimes placed in a separate family, the Cramptonomyiidae. *Cramptonomyia spenceri* Alexander (Fig. 6) lives in wet coastal forests from southern BC to Oregon. It is named after its discoverer, George Spencer, the first entomology professor at the University of BC.

Family BIBIONIDAE (March Flies) [Fig. 7]

March flies are dark, stocky, somewhat setose flies, about 5 to 12 mm long. Females' heads are rather flattened, more elongate than males; the eyes are small and widely separated. The compound eyes of males meet on top of the head, often covering much of it; the upper two-thirds have large facets, the lower third has smaller ones. Ocelli are present and prominent. The antennae are usually short with 9 to 12, normally rounded, compact segments; *Hesperinus* is the exception; the antennae are long with elongate segments. The scutum is prominent, domed. Femurs often swollen, especially the front pair; front tibiae with apical spurs or rings of spines in *Bibio*, *Bibiodes* and *Dilophus*. In the wing, R₁ ends just beyond the end of Sc; Rs simple or forked; crossvein r-m at or beyond the middle of the wing. Medial vein is two-branched, CuA₁ and CuA₂ reach the wing margin and A₁ is usually weak. There is frequently a pterostigma.

In North America, bibionids usually emerge in late winter or spring (thus the name March flies); mating swarms can be enormous. The adult flies live only a few days; many visit flowers and may be important pollinators, especially of fruit trees. Females, aided by spurs or spines on the fore tibiae, burrow into moist earth to lay eggs. Larvae scavenge in decaying organic material, rich soils and forest litter. They often eat the roots of grasses and other plants and are frequently numerous enough to damage cereal crops, vegetables, grass and other plant seedlings.

The Bibionidae is a common, worldwide family, with about 700 described extant species in six genera. All genera occur in North America; the predominant genus is *Bibio*, with 53 extant species north of Mexico. BC has 21 extant described species in five genera. *Hesperinus brevifrons* Walker, the sole member of its genus, is boreal, ranging south to Colorado; it is unusually slender, with long antennae. *Bibio* is the most speciose genus in the province, with 14+ species. *B. xanthopus* Wiedemann is common; adults emerge in February from grassy meadows in Garry Oak woodland at Victoria. *Bibiodes aestivus* Melander is a western species; it flies in June and July, later than many other species of March flies. Five species of *Dilophus* are reported from the province. *D. caurinus* is a widespread one, ranging across the south; it is distributed across the continent. The family apparently reached its zenith in the Tertiary Period; *Plecia* is now predominantly tropical in distribution, but in the Eocene, 50 to 60 million years ago, it was abundant in what is now BC. The 21 named fossil species of *Plecia* in BC represent the vast majority of insect fossils in Eocene shales from the interior of the province.

Reference

Rice, H.M.A. 1959. Fossil Bibionidae (Diptera) from British Columbia. Bulletin of the Geological Survey of Canada 55: 1-24.

Family MYCETOPHILIDAE (Fungus Gnats) [Fig. 8]

Fungus gnats are slender to moderately robust flies, 2.2 to 13.3 mm long. Body usually dull yellow, brown or black, but sometimes brightly coloured. Head usually flattened front to back, and inserted well below level of upper margin of strongly arched thorax; eyes usually densely setose, usually situated on lower part of head, and never meeting above antennae; usually with three ocelli; frons between ocelli and antennal bases usually bare; antennae inserted at middle of head, and with length varying from scarcely longer than head to several times length of body; antennae beyond basal two segments usually cylindrical, sometimes thickened basally and tapering to apex, and usually composed of 14 segments; labella usually large and fleshy. Thorax varying from compressed and deep to depressed and low; thoracic vestiture variable, consisting of moderately strong bristles with apex bifid or otherwise modified, scale-like setae, or very fine appressed or erect setae; setae or bristles always present on pronotum, scutum and scutellum but only occasionally present on other thoracic sclerites. Wing veins often with setae; membranes usually densely clothed with microtrichia, and often also with many macrotrichia; R with three or fewer branches; usually with fork of M much longer than stem, and lanceolate rather than bell-shaped. Legs with coxae long and stout; femora usually slender, sometimes swollen, with variable vestiture; tibiae usually slender, with variable vestiture, short setae arranged irregularly or in regular rows, and with bristles variable; tibiae usually with long, strong apical spurs; tarsi usually slender, sometimes with modified setae ventrally, or with some segments swollen below in female; tarsal claws rarely simple, usually with one or more teeth below. Abdomen usually broadest in middle; terga and sterna 1-6, 1-7 or 1-8 in male, and 1-7 in female well developed, but sternum 1 often reduced in size. Male with sclerites of segments 7 and 8 short and telescoped into segment 6; terminalia usually symmetrical.

Mycetophilids are usually found to be most abundant in humid or moist habitats in wooded areas. Many larvae live in fleshly or woody fungi, on or in dead wood, under bark, or in nests of birds or squirrels. Most or all of these are probably myctophagous, hence the common name, but some members of the subfamily Keroplatinae seem to be predominantly predaceous.

The family Mycetophilidae, is now generally thought to be paraphyletic with respect to the Sciaridae. This treatment of the families has been followed to allow for ease identification of BC specimens to the generic level in McAlpine *et al.* (1981) There are approximately 4300 described extant species in over 225 genera worldwide of which about 825 species in 77 genera occur in north America. Over 200 species of fungus gnats occur in British Columbia, with many apparently endemic.

Family SCIARIDAE (Dark-winged Fungus Gnats) [Fig. 9]

Dark-winged fungus gnats are small delicate flies, 1.0 to 11 mm long, usually blackish, brownish or yellowish in colour. Head usually ovoid in shape, higher than long; compound eyes usually forming a dorsal bridge above antennal bases; frons with three ocelli; basal two segments of antenna globular, rest of antenna with 14 segments which are cylindrical, sessile or stalked; palps of one to three segments, the basal segment usually reduced in size; first distinct segment often with a sensory pit or with a group of sensory setae. Thorax with anterior pronotum setose; posterior pronotum sometimes with a few setae; scutum with bristles of variable length. Wings hyaline or smoky, sometimes reduced or absent; costal vein ending between apices of R_5 and M_1 . Tibiae with one or two apical spurs; tarsal claws simple or toothed. Abdomen cylindrical, in females, usually strongly tapered posteriorly. Male terminalia exposed, often broader than rest of abdomen, and not usually rotated, but sometimes rotated up to 180° during copulation.

Adult dark-winged fungus gnats are usually found in moist places wherever fungus grows. Larvae generally feed on decaying plant material, animal excreta, or fungus. The family is worldwide in distribution with the exception of Antarctica. Some cosmopolitan species appear to have been spread synanthropically. There are over 1800 described extant species in about 90 genera worldwide with about 170 species in 18 genera known from the Nearctic.

Family CECIDOMYIIDAE (Gall Midges) [Fig. 10]

Gall midges are very small fragile flies, usually 1.0 to 5.0 mm long. Head with large eyes, holoptic or nearly so in both sexes; antennae usually long, usually with 12 or 14 segments beyond the basal scape and pedicel; mouth parts with generally fleshy labella, one to four segmented palps and labrum, the labrum and labella occasionally enlarged and styliform. Thorax about as long as high; mesonotum convex, usually with two median and two lateral rows of setae. Wing with microtrichia, often as scales, and occasionally with macrotrichia; wing veins generally weak, reduced in number, costal vein usually continuous around wing, usually with a break just beyond insertion of R_5 ; R_5 unforked. Legs usually long with coxae conspicuous; tibial spurs absent; claws toothed or untoothed. Abdomen elongate-cylindrical in male, elongate-ovoid in female; posterior end of female abdomen often protrusible, sometimes very long, and in some groups variously modified for piercing plant tissue.

Adults of the subfamily Lestremiinae often fly in cool weather, and can be found at lighted windows at night. The larvae are terrestrial and mycetophagous, usually found in decaying vegetation and wood, in plant wounds, and in mushrooms.

The subfamily Cecidomyiinae contains numerous gall-makers, hence the family's common name. However, other species are phytophagous in flower-heads or stems, without making a gall. Some other species are mycetophagous, and there are some larvae that are predaceous or parasitoids. As predators, species of this family feed on mites, aphids, coccoids and other arthropods. Aphids and psyllids are usually the insects attacked by the internal parasitoid cecidomyiids. There are over 5000 described extant

species of gall midges worldwide with approximately 1200 species in about 170 genera occurring in North America

Infraorder PSYCHODOMORPHA

Family PSYCHODIDAE (Moth and Sand Flies) [Fig. 11]

Moth flies are small, densely setose flies, with a rather moth-like in appearance, and with characteristic short and erratic flight. Head with antennae longer than the head, and sometimes longer than the body; antennae with 12 to 16 segments, each segment usually with dense cupuliform whorls of setae, and with membranous thin-walled sensilla that may be broad or slender, and that may be unbranched or with two to many branches; eye bridge absent or incomplete; mouth part palps with 3 to 5 segments, the next to last segment with a sensory pit or a compact group of sensoria; proboscis usually very short, but in blood-sucking species can be as long as height of head. Thorax with pronotum bare or setose; postnotum bare; pleural sclerites variously setose or bare; transverse suture of scutum not V-shaped; metanotum usually large and projecting over abdomen. Wings usually broad, and held roof-like or flat over abdomen when at rest; longitudinal veins of wings usually well developed; crossveins absent or restricted to basal half of wing; costal vein continuing around wing. Abdomen with sternum 1 sometimes unsclerotized; sternum 2 entire and divided into several sclerites, or unsclerotized. Males with terminalia permanently inverted.

Adult flies are usually to be found in moist protected areas, and are mainly active nocturnally. During the day, adults usually rest in shaded habitats. Adult food habits are unknown, except for the blood-sucking habit of female *Phlebotomus*. In the tropics, species in this genus are the vectors of several diseases, such as leishmaniasis. Blood-sucking adults, commonly called sand-flies, in North America are usually associated with reptiles or small burrowing mammals.

Larvae of the subfamily Psychodinae live in moist or subaquatic habitats, with a few species often found in compost heaps and sewage disposal systems. Larvae of the subfamily Phlebotominae live in soil, often in semi-desert areas. Other subfamilies have larvae associated with fast streams and waterfalls, but these do not occur in Canada.

There are several thousand described extant species of moth flies worldwide of which 112 species in 21 genera are recorded from North America.

Family TRICHOCERIDAE (Winter Crane Flies) [Fig. 12]

Winter crane flies are small to medium sized, fragile flies with long slender legs. Head with three ocelli, but with labrum reduced; antenna beyond basal two segments, elongate and setaceous, with 16 segments, but segmentation obscure in distal segments. Thorax with scutum flat, and with a V-shaped suture, incompletely developed in middle. Wings with two strong anal veins that reach the wing margin, A_2 much less than half as long as A_1 , and strongly curved at apex. Legs with tibial spurs present or absent.

Members of the Trichoceridae are very similar to species of Tipulidae. However, in the latter, the ocelli are absent or rudimentary, the scutum has a complete V-shaped suture complete in the middle, and vein A_2 in the wing is usually more than half the length of A_1 , and relatively straight. In the Trichoceridae, the legs do not fall off readily as in the Tipulidae, and females if they have an elongate cercus associated with the ovipositor, this is curved downward, whereas in the Tipulidae it is normally bent downwards.

As the common name suggests, adults of Trichoceridae are found in the colder months of spring and fall. On sunny days swarms of mostly male flies may be seen, but otherwise adults often occur in dark places such as caves, mine shafts, cellars, hollow trees and compost containers.

Larvae are scavengers, and found in a wide variety of habitats, especially those with decaying leaves and vegetables. They also occur in manure, fungi, stored roots and tubers, as well as burrows of rodents.

The family is composed of approximately 120 described extant species in four genera worldwide. Three genera are recorded from North America, all of which occur in Canada and British Columbia. The single species of *Paracladura*, *P. trichoptera* (Osten Sacken) is confined to western North America, and has the basal tarsal segment very short, and only about one-eighth the length of the second. There is also only one species of *Diazosma*, *D. hirtipennis* (Siebke). This is a transcontinental species with a basal tarsal segment as long as the second, and with glabrous eyes, but without tibial spurs. Several species of *Trichocera* occur in this province, of the 26 species recorded from North America. These have the basal tarsal segment as long as the second, but the compound eyes have setae between the facets, and tibial spurs are present.

Family ANISOPODIDAE (Wood Gnats) [Fig. 13]

Wood gnats are small to medium sized flies, 2.0 to 10.0 mm long. Body slender and elongate, with long slender legs. Head small, rounded and usually somewhat flattened; eyes moderately large, rounded to ovoid, bare or setose; males with eyes separate or meeting dorsally; frons with three ocelli, glabrous or with a few short, fine setae; antennae about as long as combined length of head and thorax; scape and pedicel short, but rest of antenna composed of 14 uniformly cylindrical segments; mouth parts with palps short and 3 or 4-segmented. Thorax convex, with pronotum greatly reduced. Wings moderately large and broad, lying flat over abdomen when at rest; costal vein ending just beyond insertion of last branch of R, usually near wing tip; M with two or three branches; anal lobe well developed. Legs without strong spines; fore coxae long; tibia with apical spurs; claws simple. Abdomen elongate and cylindrical, slightly convex dorsally, but flattened ventrally. Male terminalia with rotation up to 180°.

Adults can commonly be found on near larval habitats, often on bleeding tree trunks. They feed on nectar and other liquids, and frequently occur at windows. Males can form small to large mating swarms to attract females. Females oviposit on moist

surfaces. Larvae occur in decaying organic matter, and are common in fermenting sap and mammal manure.

There are about 100 described extant species in six genera worldwide of which nine species in three genera are reported in North America. There are 5 described species in 2 genera known from collections of BC Diptera.

Family SCATOPSIDAE (Minute Black Scavenger Flies) [Fig. 14]

Scatopsids are small and rather robust flies, 0.6 to 4.1 mm long. Usually black, dark gray or brown in colour, dull or shiny. Head laterally compressed, convex behind eyes and setose; eyes occupying anterior half of head, usually holoptic, and with sparse or dense setae; frons with three ocelli; antennae with scape and pedicel short, rest of 5 to 10 antennal segments short, often wider than long, usually pedicellate, covered with setae and microtrichia; mouth parts reduced, with single-segmented palp, but with larger labella. Thorax usually rather elongate and laterally compressed; scutum with sparse short setae. Wings with rather reduced venation; R_5 usually unbranched, and veins posterior to R faint; wing membranes covered with microtrichia, sometimes thickly; membrane and veins sometimes with obvious setae. Tibial spurs absent on legs. Abdomen with seven obvious pregenital segments; male terminalia sometimes rotated through 180° .

Little is known about the biology of the Scatopsidae. The larvae of *Scatopse notata* (Linnaeus) (Fig. 14) have been found in decaying plant and animal matter. Adults are often found on flowers as well as on decaying plant and animal matter.

There are about 250 described extant species of scatopsids worldwide of which about 75 species in 19 genera have been recorded from North America. There are 15 species in 7 genera known to occur in BC based on the published literature and collections of BC scatopsids.

Family CANTHYLOSCELIDAE (Canthyloscelid Flies) [Fig. 15]

The family Canthyloscelidae, includes the flies formerly referred to as the family Synneuridae. Nearctic canthyloscelids are small slender and heavily sclerotized flies, 2.0 to 3.5 mm long. Shiny and dark brown to black in colour. Head with eyes meeting dorsally, ventrally narrowly separate to almost contiguous; frons with three ocelli; antennae beyond basal two segments, 10 to 14-segmented, bead-like, increasing distally with apical largest; mouth parts reduced, but palps 4-segmented. Thorax rather slender, longer than high; pronotum reduced medially, but with conspicuous postpronotal lobes; scutum narrow, strongly arched, slightly tapering and more narrow anteriorly, sparsely covered with short stiff setae; scutellum triangular and sparsely covered with short setae. Wings long and slender, with anal lobe at most scarcely developed; membrane and veins covered with microtrichia; costal vein strong, not reaching tip of wing, but extending beyond posterior branch of R_5 . Legs moderately long and stout; fore tibia with a small, but distinct spur; middle and hind tibia with two short spurs; claws small and simple, at

most with a basal tooth. Abdomen long and slender, somewhat flattened dorsally, narrower anteriorly and widening posteriorly.

Little is known about the biology of these flies in North America. Elsewhere larvae have been found living in various kinds of decaying wood permeated by mycelia of various fungi.

Two genera, each with a single species, have been reported from North America. *Exiliscelis californiensis* Hutson is reported from California and Oregon, while *Synneuron decipiens* Hutson (Fig. 15) is more widely distributed being recorded from British Columbia to Quebec, and Alaska to Colorado.

Infraorder PTYCHOPTEROMORPHA

Family PTYCHOPTERIDAE (Phantom Crane Flies) [Fig. 16]

The Ptychopteridae contains moderately sized, slender, long-legged flies with long abdomens. The head is transverse, tightly held against the thorax and the antennae are long, with 15 (*Ptychoptera*) to 20 or 21 segments (*Bittacomorpha*, *Bittacomorphella*). The mesonotum has the transverse suture forming a strong loop rearward. The tibiae are spurred. The wings have Rs short and R_{2+3} very close to R_1 ; R_4 and R_5 present. M_{1+2} forked in Ptychopterinae, but not in Bittacomorphinae; outer part of CuA_2 strongly sinuous; only one anal vein present. The halter has an unusual prehalter.

The most striking members of the family are the two species of *Bittacomorpha*, the so-called 'phantom crane flies', which have the first segment of the tarsi inflated and filled with tracheae. This feature enables the flies to sail on the breeze, black and white banded legs outstretched. The striking habit gives them a ghost-like appearance, especially when seen in the dappled shade of the forest. The larvae live in wet mud and organic debris at the edges of forest streams and pools; they have long, posterior breathing siphon.

The Ptychopteridae consists of over 60 described extant species in only three genera. There are two distinct subfamilies. The Ptychopterinae occurs in all regions except the Australian and Neotropical; its sole genus, *Ptychoptera*, has many species, including 11 in North America. The Bittacomorphinae contains *Bittacomorpha*, with two Nearctic species, and *Bittacomorphella* with four Nearctic and three eastern Asian species. BC has seven species in the three genera: *Ptychoptera lenis* Osten Sacken, *P. pendula* Alexander, *P. townesi* Alexander, *Bittacomorphella fenderiana* Alexander, *B. pacifica* Alexander, *B. sackenni* (Röder), and *Bittacomorpha occidentalis* Aldrich.

Infraorder CULICOMORPHA

Family DIXIDAE (Dixid Midges) [Fig. 17]

Dixid midges are fragile, slender, yellow, brown or black, flies. Unlike their close relatives, the mosquitoes, they have no scales on the wings or body. The compound eyes

are more widely separated above than below; ocelli are absent. The antennae are long, 16-segmented, with the second segment large and globose; the male's antennae are not plumose. The wings are large, with variable markings or hyaline; R_{2+3} is strongly arched before it forks. The legs are long and slender; the hind tibia is usually somewhat expanded apically and some tarsal segments often have a small spine at the tip.

Dixid midge adults do not bite, and it is not certain that they eat anything. They are short-lived. During the day they rest, vertically and head up, on vegetation or the ground. Males form swarms at dusk near vegetation along the edges of streams or ponds and females fly into the swarms to mate; mating can also occur in daytime without swarming. The slender larvae strain diatoms and other micro-organisms from the water with complex mouthparts. They typically rest in a U-shaped position at the surface film, usually against some substrate or plant near the water's edge; they swim by jerking the front half of the body from side to side.

The family consists of approximately 200 described extant species worldwide; in North America 45 species are described in 3 genera. *Dixa* (8 species) and *Dixella* (7 species) are recorded in BC; the third genus, *Meringodixa* has one species known only from California.

Family CHAOBORIDAE (Phantom Midges) [Fig. 18]

Phantom midges are closely related to mosquitoes, but most do not bite. Adults are delicate flies, measuring from about 1.5 mm to 10 mm long; they are usually pale yellow, grey or brown. The compound eyes are separated in both male and female; there are no ocelli. In males the antennae are strongly plumose; the second segment is large and globose. The proboscis is short, extending only slightly past the clypeus. In the wing, the radius has four branches, the three branches of vein R_s are almost straight and parallel; M and Cu are two-branched. The wing's hind margin and most veins have scale-like setae; light and dark setae or pigment in the membrane sometimes pattern the wings.

The family is aquatic and adults are usually found around water, often in large mating swarms. They do not bite. Most larvae (and all North American ones) are predators of other small aquatic animals, including immature mosquitoes and members of their own family. The antennae are prehensile and are used to grab prey. The larvae of *Chaoborus* are transparent (and thus called phantom midges); gas-filled air sacs at each end of the body help them maintain their position in the water of lakes and ponds.

The Chaoboridae is a small cosmopolitan family, represented by 50 described extant species in six genera.

There are three genera and 15 species in North America; all three genera are recorded in BC. The closely related family Corethrellidae is mainly tropical, but extends into southern and eastern North America; it is unknown in BC. *Chaoborus* has six species in the province; *Eucoethra* contains a single species, *E. underwoodi* Underwood, which ranges across boreal North America and extends south in the West to California and New

Mexico. The two species of *Mochlonyx* are also boreal and range into BC: *M. velutinus* Ruthe, and *M. cinctipes* (Coquillett).

Family CULICIDAE (Mosquitoes) [Fig. 19]

Mosquitoes are delicate, long-legged, slender flies, 3 to 9 mm long and with scales usually clothing most of the body, legs and the veins and hind margin of the wings. These scales vary in colour and often form patterns that are useful in species identification. The head is globose and the compound eyes are concave medially where they meet the bases of the antennae. Ocelli are absent. The first segment of the antenna is small, the second large and spherical and the other 13 are slender and bear a whorl of setae; these setae are longer and more abundant in males than in females. The mouthparts are elongate, stylet-like and enclosed in a sheath formed by the labium. In the male, the maxillary palp is about as long as the proboscis. The wings are narrow, long and lie flat above the abdomen when at rest; there is no discal cell and the single vein R_{4+5} lies between two branched veins – R_2 and R_3 in front and M_1 and M_2 behind.

Mosquitoes are common, widespread and well-known insects. Few insect groups have been studied so much. Females of most species bite and feed on the blood of vertebrates, but males do not, and not all biting species feed on humans. Some mosquitoes transmit disease organisms to humans and other animals – malaria, filariasis, yellow fever, dengue, encephalitis and West Nile virus. Adult mosquitoes also pollinate many of the plants that they visit, especially various native orchids. Larvae and pupae are aquatic and live in marshes, ponds, pools, water-filled tree holes, man-made containers, and other places where water collects. They come to the water surface to breathe; most larvae eat organic debris and micro-organisms; a few are predators of invertebrates.

The Culicidae is a large cosmopolitan family of about 3560 described extant species in 42 genera; approximately 190 species in 13 genera live in North America. BC has five genera and 46 species. *Anopheles* contains three species in the province, *Anopheles earlei* Vargas, *A. freeborni* Aitken and *A. punctipennis* (Say). The adults, with dark-spotted wings, take the typical anopheline resting stance -- head-down, tail-up. The larvae, lacking a long respiratory siphon, rest horizontally at the surface when breathing. The largest BC genus is *Aedes*, with 33 species; females have a pointed abdomen; Species overwinter as eggs. *A. vexans* (Meigen) is a widespread species in Eurasia as well as North America; it is a mean biter and probably the most annoying mosquito in Canada, at least in settled areas. In southern BC it ranges from sea level to alpine. *A. campestris* Dyar and Knab is a yellow-brown species breeding in the alkaline ponds of Interior grasslands; it is a strong biter, even at midday. *A. togoi* (Theobald), probably introduced from Japan, lives in rock pools just above high tide along the coasts of southern BC; it was first found in Canada in the early 1970s. The three species of *Culex* overwinter as female adults. *Culex pipiens* Linnaeus, small and dull brown, is common in houses and breeds in many aquatic habitats, the more polluted the better. *C. tarsalis* Coquillett is common in southern BC, but was rare before the 1950s; it is the principal vector of western equine encephalitis. It habitually bites birds and is one of the potential vectors of West Nile virus in BC. *C. territans* Walker prefers to feed on amphibians. Females of the six *Culiseta* species in BC also overwinter. *Culiseta incidens* (Thomson) is a large,

brown, spotted-winged species that often lives around humans; the females are often found in houses in the spring. There is only one species of *Mansonia* in the province, *M. perturbans* (Walker). The larvae develop in marshes where they pierce the stems of aquatic plants such as cat-tails with the respiratory siphon and take air from the plant tissues.

Belton, P 1983. The Mosquitoes of British Columbia. British Columbia Provincial Museum Handbook No. 41. Victoria, BC. 189 pp.

Wood, D.M., P.T. Dang and R.A. Ellis. 1979. The Mosquitoes of Canada (Diptera: Culicidae). Insects and Arachnids of Canada, Part 6. Research Branch, Agriculture Canada. Ottawa, On 390 pp.

Family THAUMALEIDAE (Solitary Midges) [Fig. 20]

Thaumaleids are small, stocky flies, about 2 to 3 mm long, mostly shiny yellow to dark brown in colour. The head is small and globose, with the eyes meeting above in both sexes. Ocelli are absent. The antennae are short, about as long as the head, and project forward. The first two segments are large and spherical compared to the next three, which are small and almost square; the last seven are linear. The thorax is robust; the scutum is strongly arched dorsally and lacks a transverse suture. The scutellum is large and pointed. The wing is broad, with the membrane covered with macrotrichia in *Trichothaumalea*, these setae only on the veins in *Thaumalea*. C reaches the wingtip; Rs usually forked to produce very short, nearly vertical R_{2+3} (meeting R_1) and a long, curving R_{4+5} reaching the margin. M_1 , M_2 , CuA_1 and CuA_2 normally strong and reaching margin. The legs are rather slender and lack tibial spurs; empodia are minute and pulvilli are absent.

Adult flies are seldom seen; they live around streamside vegetation. Larvae live on wet rocks (usually on vertical surfaces in the shade) in cold streams. They scrape diatoms off the rocks where the water flows as a film not thick enough to cover their bodies. Pupae are collected in moss, wet leaves and mud on the stream margins.

Five genera containing about 120 described extant species are placed in the Thaumaleidae worldwide. Most of the species are Holarctic; two of the genera and 8 species live in the temperate parts of the southern hemisphere. There are two North American genera – *Thaumalea*, with 23 species and *Trichothaumalea*, containing three species. There are 5 species of thaumaleids in BC based on the known literature and collections of BC Diptera. Of these species, *Trichothaumaleia pluvialis* (Dyar and Shannon) is known only from BC.

Family SIMULIIDAE (Black Flies) [Fig. 21]

Black flies are small stocky insects, about 1.2 to 5.5 mm long. They usually are black or dark brown, but colours also range to grey, rust, orange or yellow. The head is rather large and round, with eyes meeting on top of the head in males, separated in females. There are no ocelli. The antennae are short and thick, with 9 to 11 bead-like

segments. The thorax is often strongly arched dorsally, especially in males; it is usually covered with short, dense, recumbent setae. The scutellum is also prominent, more or less triangular and densely clothed in long setae. The legs are short and rather stout; the front tibia has an apical spur, the others have two. The first segment of the tarsus is elongate, that of the hindleg is often swollen in males. The wing is broad with strong anterior veins and weak posterior ones. Vein Rs is simple or has a long fork; rarely the fork is short and obscure. There is a characteristic false vein (m-cu fold) that is usually forked apically, but is unbranched in *Parasimulium*. Vein CuA2 normally is strongly sinuate.

Black fly females usually have mouthparts structured to cut skin and suck blood, but in some females and all males they are weak and only usable for imbibing fluids such as water and nectar. However, not all species bite humans and some eat no blood at all. Those that do bite can be serious pests of man, other mammals, and birds. Simuliid bites are irritating and often cause infection and allergic reactions. Through blood feeding, many species transmit parasitic disease organisms among birds and mammals; the worst is the filarial nematode that causes human onchocerciasis in the tropics of Africa and the New World. Larvae live in flowing water, attaching themselves by the tip of the abdomen to a pad of silk they fix to submerged objects. Most feed by filtering food out of the water with fan-like mouthparts; some lack these labral fans (e.g., *Gymnopais*, *Twinnia*) and graze off the substrate.

The Simuliidae is a relatively small, homogeneous family of almost 1800 described living species; 254 species in 13 genera are known from North America. Ten of these genera occur in BC and contain 79 species, but a number more are recorded just outside the provincial borders. Because of its wealth of ecological diversity, BC has, by far, the greatest species richness of black flies of any province or territory in Canada. The largest genus is *Simulium*, with 40 species. *S. baffinense* Twinn is one of those black flies whose mouthparts are not able to cut skin; it is a species of the far North and the Rockies, but the only BC record is from the Atlin area. About 10 per cent of North American black flies cannot bite; such species are mostly found at high latitudes or elevations. Almost 40 per cent of blood-feeding American species primarily attack birds. For example, *S. annulus* (Lundström), a holarctic fly, is known to feed only on the Common Loon and is the only species known to regularly do so. It is not yet confirmed from BC, but almost certainly occurs, because photographs have been taken of black flies on loons in BC. Members of the *Simulium venustum* species complex, such as *S. venustum* Say, *S. irritatum* Lugger and *S. truncatum* (Lundström) can be distinguished from each other only by their chromosomes; they are the most fierce and abundant human biters in the province. Nevertheless, although many of BC's black flies bite people, we are spared the hordes that plague Eastern North America. *Prosimulium*, with 15 BC species, is also diverse; the larvae prefer cold waters. The large, orange females of *P. fulvum* (Coquillett) are conspicuous and are attracted to humans; the species is among the most widespread and common of the genus in BC. *P. esselbaughi* Sommerman is another widespread biter in the group. There are eight species of *Helodon* in the province; those that feed on blood mainly attack birds. *H. decemarticulatus* (Twinn), widespread in the BC interior, feeds on many species of woodland birds from Sharp-shinned Hawks to Common Ravens. The arctic-adapted species of *Gymnopais* do not bite. There are two species in BC -- *G. dichoticoides* Wood lives across northern BC and down the Rockies and *G.*

holopticooides Wood is known from the Northeast. On the other hand, *Twinnia nova* (Dyar & Shannon) is a vexatious biter in southern BC. The genus *Parasimulium* is endemic to the wet forests of the North America's Pacific coast and is the sole genus in the Subfamily Parasimuliinae; it is the most primitive of the black fly groups. Larvae live in subterranean waters such as underground springs and water flowing beneath streambeds. Adults do not bite. There are five species, but only two are known in BC, both recorded on Vancouver Island; *P. melanderi* Stone has been collected in a cave. Four other genera have two or three species each in BC: *Greniera*, *Stegopterna*, *Tlalocomyia* and *Metacnepia*; most of the biting species in these groups feed on birds.

Reference

Adler, P.H., D.C. Currie and D.M. Wood. 2004. The Black Flies (Simuliidae) of North America. Cornell University Press, Ithaca, NY.

Family CERATOPOGONIDAE (Biting Midges, No-See-Ums) [Fig. 22]

Flies of the family Ceratopogonidae are minute to small 1 to 6 mm long, (most in BC are about 2 mm long) and slender to rather stout. The compound eyes usually meet, or almost meet, on top of the head (but well separated in Leptoconopinae); they are usually bare, but sometimes are finely setose. There are no ocelli. The antennae have 8 to 15 segments, although vertebrate feeders have 13 to 14 (*Leptoconops*) or 15 (other genera); females have the last five segments elongated (in the Leptoconopinae only the last one is differentiated) and most males have plumose antennae. The proboscis is about as long as the head; most females have serrate mandibles. A pair of humeral pits often occur near the front edge of the mesonotum. The wing typically has one to three compacted radial veins close behind the front edge of the wing and reaching the wing margin before the wing tip; two median vein branches reach the wing margin; crossvein r-m usually strong. The wings overlap over the abdomen when at rest, often patterned with dark or light spots or patches. The females of predatory Ceratopogoninae usually have at least one pair of raptorial legs with swollen, spiny femora or with enlarged tarsal claws.

Biting midges live mainly in moist habitats around the aquatic or semi-aquatic environments where the larvae live. Most species of *Culicoides* fly at dusk, but those of some genera, such as *Leptoconops*, fly during the day. Females of many species suck blood to provide protein for egg maturation, and many are notorious for both their biting and for transmitting disease. Their small size enables most to crawl through the mesh of screens and, when large numbers of biting females are present, avoiding them outdoors is difficult. *Culicoides* species are vectors of filarial nematodes, blood protozoans and viruses such as bluetongue in livestock. *Culicoides*, *Leptoconops*, *Austroconops* and some *Forcipomyia* are the only genera that feed on vertebrates, usually mammals or birds, but also reptiles, amphibians and even the amphibious mud skipper fish of Southeast Asia. Many *Forcipomyia* drink the blood of large insects such as dragonflies, katydids and butterflies, usually feeding from wing veins. Other species kill small swarming flies and mayflies; some females eat males of their own species. *Dasyhelea* and some other genera feed only on nectar, and many others supplement their diet at flowers. Some are important pollinators of cacao (from which chocolate is derived), rubber trees

and other plants. The larvae of the most diverse subfamily, the Ceratopogoninae, run the gamut from burrowers in wet soil and manure to active swimmers in the waters of large lakes and rivers. Many are carnivorous. Those of the Leptoconopinae live in the soil and sand of arid habitats or the beaches of oceans and inland waters, feeding on microorganisms. Forcipomyiinae crawl in moist places such as moss mats or under bark, eating algae and fungi; Dasyheleinae wriggle in the fluids of sap flows, tree holes and other small, wet habitats.

The fossil record of the Ceratopogonidae is rich, especially in amber, and reveals that the family was abundant and diverse at least 120 million years ago. Today there are 5600 described extant species in 103 genera, but this is probably much less than half the actual total. There are 600 species in 39 genera known from North America with BC having 114 species in 23 genera. Some of the more notable species occurring in BC include, *Atrichopogon epicaudae* Wirth which feeds on the blood of meloid beetles, despite the fact that the blood contains the blistering defensive chemical cantharadin. *Forcipomyia bipunctata* (Linnaeus) is a setose, brown fly with a prominent yellow mark on the wing. The large biting genus *Culicoides* is diverse in BC. At least 30 species occur, including *C. occidentalis* Wirth and Jones, the main vector of bluetongue virus, which has infected cattle in the interior; it is especially abundant around saline ponds. Also common in the province are *C. obsoletus* (Meigen), a fierce biter of humans, and *C. crepuscularis* Malloch, primarily an attacker of birds.

Family CHIRONOMIDAE (Chironomid Midges) [Fig. 23]

Chironomid midges are delicate, small to medium-sized flies (1 to 10 mm long) with long, slender legs and narrow wings; some superficially resemble mosquitoes, but lack the long proboscis. Most are brown or black, but green, reddish and yellow species occur; many have the abdomen and legs banded and some have patterned wings. The compound eyes usually do not meet above; they may be bare or setose. Ocelli are absent, although the frontal tubercles on some species may be modified ocelli. The antennae are 3- to 17-segmented, usually with more segments in males than in females; the antennae are plumose in most males. The mouthparts are reduced, lack mandibles and are non-biting. The thorax is convex or flattened above, the scutellum is hemispherical; the postnotum is large and usually bare and marked with a median longitudinal furrow. The legs often have the tarsus of the foreleg elongate and sometimes strongly setose; the forelegs typically are held up off the substrate. The wings lie flat or roof-like over the abdomen when at rest. The costal vein usually is fused with R_{4+5} near the wingtip, but rarely reaches the wingtip. The subcosta usually ends before reaching the costa. The radius is three-branched, normally more strongly sclerotized than the posterior veins; R_{2+3} is often weak, sometimes absent, and branches into R_2 and R_3 in the Tanypodinae. The medial vein is straight and unbranched, meeting the wing margin near the wingtip. Vein CuA is forked at, or past, the r-m crossvein and crossvein m-cu is present or absent.

Chironomid midges are common and abundant – they are the most ubiquitous freshwater insects. Adults are most active at dusk or at night and at sundown they often form mating swarms that rise and fall over shrubs, rocks and other markers near water. Although they do not bite, their sometimes enormous numbers can be a severe nuisance,

especially around lakeside homes and resorts. As in many groups of flies, the immature stages of chironomids are more interesting than the adults. Larvae live mainly in the fresh water of ponds, lakes and streams, but many species occur in brackish habitats or the salty waters of desert and grassland alkaline lakes. A few develop in the marine intertidal zone. Others live in wet soil and leaf litter, in mammal dung and in pitcher plants. They are found from the mud in the deepest lakes to the surface of stones in shallow pools and springs; they tunnel in rotting wood and mine the tissues of aquatic plants; they live, sometimes parasitically, on the bodies of mayflies, stoneflies, molluscs and other organisms. Most chironomid larvae eat detritus and microscopic plants and animals; most live on or in the substrate, usually in tubes made from substrate particles bound with salivary secretions. Others, especially species in the subfamily Tanypodinae, prey on macroinvertebrates such as other chironomid larvae.

The major groups of midges generally prefer certain types of environments: thus, the Podonominae and some other subfamilies are cold-adapted, living mainly in rapid streams; species of the Orthocladiinae, too, mostly prefer cool waters, although some are common in warmer habitats and the subfamily contains the only terrestrial chironomids. The Chironominae and Tanypodinae are warm-adapted and most live in still waters, often where oxygen levels are depleted. Most species of the former subfamily live in or on the substrate and have oxygen-binding hemoglobin dissolved in their blood (the so-called “bloodworms”); the Tanypodinae are free-living predators and, when oxygen levels drop, they can swim to surface waters where oxygen is more abundant. Through detailed analyses of these groups and their preferred environmental conditions, species composition of chironomid larvae has been used to classify lakes ecologically, to determine levels of pollution and to examine the historical and prehistorical changes in lake systems.

The Chironomidae is a large and cosmopolitan family of over 5000 species. Even Antarctica supports two species and chironomids are among the most common and diverse insects in the high Arctic. North America has almost 1100 described extant species in 205 genera; BC records include 151 species in 78 genera. In small saline lakes in grasslands in the BC interior, chironomids can form distinct species assemblages. The freshest ponds at Riske Creek on the Chilcotin plateau support communities characterized by *Cricotopus abanus* Curran and *Procladius bellus* (Loew); in the most productive, medium-salinity lakes, *Einfeldia pagana* (Meigen) and *Glyptotendipes barbipes* (Staeger) predominate; in the saltiest lakes (salinity above 3 parts per thousand) a *Tanytarsus gracilentus* Holmgren and *Cryptotendipes ariel* (Sublette) association is typical. The large *Chironomus athalassicus* Cannings is typical of, and very abundant in, the most alkaline waters. In the province’s marine waters, *Paraclunio alaskensis* Coquillett, *Saundersia clavicornis* (Saunders), *S. marinus* (Saunders) and *S. pacificus* (Saunders) live in the intertidal zone. Plant-associated midges are also significant in BC. For example, *Cricotopus myriophylli* Oliver is an important grazer on the growing tips of *Myriophyllum spicatum*, a pernicious aquatic weed in BC lakes; the midge helps control the spread of the plant. *Brillia retifinis* Saether is a common member of the Orthocladiinae in coastal streams where it plays a major role in the decomposition of conifer leaves that fall into the water. The larvae mine in the needles of Douglas-fir and Western Yew, especially after fungi have attacked the tissues.

Reference

Oliver, D.R. and M.E. Roussel. 1983. The genera of larval midges of Canada (Diptera: Chironomidae). Insects and Arachnids of Canada, Part 11. Research Branch, Agriculture Canada. Ottawa, ON. 263 pp.

Suborder BRACHYCERA

Infraorder XYLOPHAGOMORPHA

Family XYLOPHAGIDAE (Xylophagid Flies) [Fig. 24]

Xylophagid flies vary in form, from stout and robust to slender and wasp-like, and range from 2 to 25 mm long. The body is often black, sometimes with yellow marks, but can be brown, reddish or yellow. Conspicuous setae are lacking, although the scutellum of *Coenomyia* bears two strong spines. The head is spherical to hemispherical; the compound eyes are broadly separated in females, but narrowly separated or meeting dorsally in males. The surfaces of the vertex and face are even with the compound eyes or only slightly depressed; in some species the latter is sunken deeply below the compound eyes. The antennal flagellum is 7- to 8- segmented in most genera, but has 20 to 36 saw-like or comb-like segments in *Rachicerus*. In *Dialysis* the flagellum, apical to the first segment, forms a thin arista. The legs are slender, each tibia has one or two spurs; the empodia are pad-like. The wings often have dark patches or spots. Except in *Rachicerus* the costal vein is continuous around the wing and cell m_3 is open. The medial vein is usually 3-branched and vein R_s arises before the base of the discal cell. The abdomen, with 7 to 9 visible segments, is tapered to the rear; the ovipositor is telescopic.

Xylophagids live in forest habitats where adults feed on sap, nectar and other liquids. The larvae are predators or scavengers in soil rich in organic matter (*Coenomyia*), under tree bark (*Xylophagus*) or in decaying logs (*Rachicerus*).

The Xylophagidae contains over 120 described, extant species world-wide, and 26 species in five genera in North America. The family, although small, is poorly known in BC; only two genera and four species are recorded. *Xylophagus decorus* Williston ranges across North America; *X. gracilis* Williston is known from southern BC south to California and Colorado. The former species is dark and slender, ichneumon-like, and up to 15 mm long. *Dialysis discolor* (Loew) and *D. disparilis* Bergroth range from BC to California along the Pacific coast. The latter has a shiny black thorax and a yellow-brown abdomen banded in dark brown.

Infraorder STRATIOMYOMORPHA

Family XYLOMYIDAE (Xylomyid Flies) [Fig. 25]

Xylomyids are slender, wasp-like or sawfly-like flies, 5 to 15 mm long, coloured in red, yellow and black or with pale markings on a dark background. The body has no bristles and is only inconspicuously setiferous. The head is hemispherical with the vertex and face more or less flush with the eyes. The eyes are bare of setae and are separate in both sexes. The antennae are 10-segmented, the eight segments of the flagellum tapering apically. The thorax is short, oval and rather flat. The legs are slender although the hind femur is sometimes thickened. The front tibia lacks apical spurs, the others have one or two; the empodia are pad-like. The wings are always clear and are folded flat over the abdomen when at rest. The costal vein does not extend past vein M_2 ; the medial vein is 3-branched and cell m_3 is closed.

Adults are seldom seen, but fly in wooded areas where they appear around rotting logs and stumps. The larvae live under loose bark and in decaying wood where they are scavengers or predators of small invertebrates. As in the Stratiomyidae, pupation occurs within the last larval skin.

The Xylomyidae is a small family closely related to the Stratiomyidae, with only about 130 described extant species in four genera worldwide. Two genera -- *Solva*, with three species, and *Xylomya*, with eight species, occur in North America. Only *Xylomya* is found in BC and the single known species in the province, *X. parens* (Williston) ranges along the Pacific coast from southern BC to California. The abdomen is reddish and the top of the thorax has crescent-shaped yellow marks on each side at the front.

Family STRATIOMYIDAE (Soldier Flies) [Fig. 26]

Both the scientific and English names of the Stratiomyidae come from the “armed” thorax – many species have spines, especially on the scutellum. The name is equally apt for other reasons -- the metallic sheen and colourful bodies of many of these flies are reminiscent of the armour and uniforms of soldiers. The adults are slender to robust, 2 to 18 mm long; the body ranges from rather bare to densely setose, but bristles are absent. These are often colourful flies – usually black, green, blue or yellow, and often patterned. The head is as broad or broader than the thorax, hemispherical to spherical, and sometimes protruding forward or downward. The head behind the compound eyes is often expanded, especially in females; ocelli are present. The compound eyes are bare to densely setose, widely separated in females, joined or narrowly separated in males; in males the upper eye has large facets. The antennae are variable; the second segment is often lengthened (often creating elbowed antennae) and the flagellum (5 to 8 segments) varies from simple and annulate to aristate. The proboscis is usually fleshy, sometimes elongate and sometimes atrophied. The thorax is often characterized by pairs of spines on the scutellum; occasionally spines also occur on the notum. The legs are simple, tibial spines are rare and the empodia are pad-like. The wing venation is distinctive. The small, short, sometimes almost circular, discal cell is associated with a crowding of the thick, short, radial veins toward the costa so that R_5 reaches the wing margin well before the

wing tip. The costa does not reach past the wing tip. The veins arising from, and posterior to, the discal cell are weak and tend to fade away. Viewed from above, the abdomen varies in shape from almost cylindrical or stalked to ovoid or almost round; it is always flattened, top to bottom, to some extent.

Adult soldier flies rest and feed on flowers (for example, willows, hawthorns and cow-parsnip) and are frequently found on grasses, sedges and other plants of wet habitats near marshes and the margins of streams and ponds. They love to bask in the sun. Some of the heavier flies, such as *Stratiomys*, can be sluggish and slow; others, specially the slender *Sargus*, often hover. Larvae of the subfamily Stratiomyinae (*Stratiomys*, *Odontomyia*, and others) are aquatic, living in a wide range of waters, including harsh habitats such as hot springs and saline pools. The Pachygastrinae (*Zabrachia* and other genera) live under tree bark; many apparently are predators of beetle larvae, but probably also scavenge in the wood. The other subfamilies develop in mostly terrestrial habitats and feed on rotting fruit and decaying vegetable matter, grass roots and vertebrate dung. The larvae are elongate and flattened; the cuticle contains small calcium carbonate plates, producing a shagreened surface. The pupa is enclosed within the final larval skin; this foreshadows the puparium of the Muscomorpha, but is actually an example of convergent evolution.

The Stratiomyidae is a widespread family, with over 2650 species described worldwide. North America has 40 genera containing 267 species; 18 of these genera and about 59 species are known to occur in BC based on published records and collections of BC Diptera. One of the largest American genera, *Stratiomys*, contains nine species in the province -- *S. barbata* Loew (Fig. 26), which lives over most of western North America, and *S. griseata* Curran, a species found in the dry southern interior of BC to Oregon and Utah, are among the more common ones. Species of *Stratiomys* have broad, strongly flattened, black abdomens with yellow markings. Seven of the 12 Nearctic species of *Caloparyphus* occur in BC; most, such as *C. crotchii* (Osten Sacken), *C. crucigerus* (Coquillett) and *C. mariposa* (James) are Cordilleran species, ranging into the Southwest. *Nemotelus*, most speciose of North American genera (40 species), has four species in the province; including *N. nigrinus* Fallén, which is Holarctic and Neotropical. The four species of *Sargus* in BC are small, elongate, metallic flies, conspicuous when sunning on vegetation or near the decaying fruits or dung where they lay their eggs. *Sargus bipunctatus* (Scopoli) is probably introduced from Europe, but *S. cuprarius* (Linnaeus) is apparently Holarctic. *S. decorus* Say and *S. viridis* Say are common transcontinental stratiomyids; the former has a green thorax and a yellow and black abdomen, the latter is metallic green or blue. *Neopachygaster* (1 species in BC) and *Zabrachia* (2 species in BC) develop under bark. *N. occidentalis* Kraft and Cook ranges from BC to Oregon; *Z. polita* Coquillett, a transcontinental species, is found in association with pine trees.

Infraorder TABANOMORPHA

Family RHAGIONIDAE (Snipe Flies) [Fig. 27]

Snipe flies are mostly medium-sized, 4 to 15 mm long, with an elongate, tapering abdomen and rather long, slender legs; the body is usually sparsely clothed in short

setulae, but rarely are there any enlarged bristles. Colours range from grey to brown to black, and sometimes yellow or orange markings occur. The head is hemispherical with the vertex usually on a plane with the compound eyes; the clypeus is strongly convex, margined by deep grooves. The compound eyes meet above or are narrowly separated in males, but are widely separated in females; they are bare, usually with the upper facets enlarged in males. The antennae vary in form; the primitively 8-segmented, tapering flagellum shows various reductions to an enlarged first segment bearing a slender, usually unsegmented stylus or seta-like arista. The proboscis is fleshy, but sometimes the mouthparts are developed for sucking blood. Legs lack spurs on the front tibia, but have them on the middle, and usually on the hind one; the empodium is pad-like. The wings are broad and elongate with strong venation and a small calypter; many species have spotted wings. Vein R_{2+3} is characteristically short, meeting the costa close to the tip of R_1 . In both sexes, the abdomen has seven visible segments; the ovipositor is telescopic.

Snipe flies are common in woods, especially near wet areas. Adults usually perch on foliage and grasses; the feeding habits of most are not well known, but presumably many are predators of small insects. Most do not bite people, but some species of *Symphoromyia* are biting pests in the western mountains and along the Pacific Coast. In these biting species is seen the last of the ancestral dipteran habit of blood-feeding with the help of blade-like mandibles and maxillae; vertebrate-biting habits that arose later in the evolutionary history of flies rely on modified structures of the labium. Rhagionidae larvae live in decaying wood and plant material, mosses, mud and debris where they eat small invertebrates.

The Rhagionidae is a cosmopolitan family still in need of considerable study with 22 extant genera and about 500 described species. In North America 105 described, extant species are placed in eight genera, with BC records for about 24 species in six genera. *Symphoromyia* species are small grey flies, and some of them are annoying biters, especially in subalpine habitats in BC. The first segment of the antennal flagellum is characteristically kidney-shaped. In North America, 29 species are known; six of these occur in BC. *S. johnsoni* Coquillett is a common species across the southern province. *Rhagio* contains at least five species in BC; they have a rather large head and thorax, tapering abdomen and broad wings. *R. dimidiata* (Loew) is black with a strong yellow band across the middle of the abdomen; *R. maculifera* (Bigot) has a yellow and black banded abdomen. *Chrysopilus quadratus* (Say) is one of about eight species of this large genus in the province; this transcontinental species is named after the rectangular brown wing spot. *Ptiolina alberta* Leonard is a Rocky Mountain species and *Bolbomyia wuorentausii* (Szilady) ranges on the coast from the Skeena Valley to southern Vancouver Island.

Family PELECORHYNCHIDAE (Pelecorhynchid Flies) [Fig. 28]

Pelecorhynchids are moderate-sized to large flies, 4 to 18 mm long. Mostly brown to black, the body is often prominently setulose, sometimes colourfully so in *Pelecorhynchus*. The head is large, with a strongly convex face; the compound eyes are large, unicolored, meeting above in males, separated in females. Three ocelli are present. The first two segments of the antennae are simple; the third (first of the flagellum) is the

largest and is sometimes elongate, and the others, up to seven in number, usually are reduced in size towards the apex. The scutum is broad, almost as wide as long; the wings are clear to smoky and have cell c_{up} narrowly open at the margin and vein A_1 somewhat sinuate. The calypter is large. The legs are strong; the empodium is pad-like.

Little is known of the biology of adults, although some have been found feeding at flowers. The larvae live in wet soil in swampy and marshy habitats where they eat earthworms and other invertebrates. At least some *Glutops* larvae live in the sandy bottoms of small, mountain streams.

The Family Pelecorhynchidae contains about 46 extant species in three genera. The largest genus is *Pelecorhynchus*, with 34 species confined to Australia and Chile. North America has eight species in two genera; the four BC species are western in distribution, ranging from the southern part of the province to California. The most distinctive is *Pseudoerinna jonesi* (Cresson), a velvety black fly with orange antennae and palps and smoky wings. *Bequaertomyia* is a synonym of this monotypic genus. *Glutops*, with seven Nearctic and four eastern Asian species, contains three species in BC: *G. bandus* Teskey, *G. punctatus* Wirth and *G. rossi* Pechuman.

Family OREOLEPTIDAE (Oreoleptid Flies) [Fig. 29]

First described in 2005 from the Canadian Rocky Mountains, the Oreoleptidae is a family closely related to the Athericidae and Tabanidae. Adults are dull grey pruinose flies, 5 to 7 mm long. The eyes meet on top of the head in males, but are widely separated in females; the upper two-thirds of the eyes have enlarged facets. The antenna is 6-segmented, the last three progressively narrower and comprising an apical stylus. The top of the thorax is covered with long, semi-erect setae; a prescutellum is absent, but the subscutellum is present. The hind coxa bears a blunt peg on the front face; in the wing, cell r_1 is open. The first abdominal tergite is undivided on the mid-line. In the female, the abdomen is telescoped, with the genitalic segments not clearly differentiated from the others; the cercus is 2-segmented, the first one strongly lobed below.

The few adult oreoleptids ever seen were reared from collected larvae and pupae, and nothing is known of the biology of the adult stage. The absence of mandibles in the female indicates that these flies are not blood-feeders. The larvae, which bear two pairs of long, slender prolegs on abdominal segments 2 to 7, are predators of immature aquatic insects. Their flexible bodies allow them to crawl through the abrasive substrates of torrential streams; they pupate in sand and gravel at the high water line after spring run-off.

The Oreoleptidae is known from a single genus, *Oreoleptis*, which lives in fast-flowing streams and groundwater wells in the mountains of western North America from the Yukon south to Montana and Idaho. A single species, *O. torrenticola* Zloty, Sinclair and Pritchard (Fig. 29), has been described from several sites in the Alberta Rockies. All other records are of immature stages; it is not known if these represent *O. torrenticola* or if additional species are also present. In BC, larvae have been collected in Kootenay and Yoho National Parks.

Family ANTHERICIDAE (Athericid Flies) [Fig. 30]

Athericids are medium-sized flies, 7 to 8 mm long, moderately setulose, but without enlarged bristles, yellowish to black, with spotted or banded abdomen and yellowish, faintly banded wings. Head dark, with the compound eyes widely separated in the female, almost meeting dorsally in the male; the three ocelli borne on a tubercle. The antennae have the first two segments globular, but the third is kidney-shaped and bears a thin, elongate arista. The wing is large and broad; vein R_{2+3} is short, ending together with R_1 ; the branches of R_{4+5} are splayed and enclose the wing tip; cell d is large, giving rise to three separate branches of M; cell cup is closed. The legs are yellowish; the middle and hind tibiae bear two apical spurs, but the front tibia has none. The empodia are pad-like.

Adults fly among streamside vegetation; *Atherix* apparently feeds on honeydew, but female *Suragina* eat blood from humans and other mammals. Female *Atherix* lay eggs on leaves and branches overhanging the water and the flies remain there and die; in some species, other females often lay eggs in the same mass, resulting in a bulky lump of eggs and dead flies. In parts of California, at least, aboriginal peoples collected and ate these rich sources of protein. Hatching larvae fall into the water, becoming fierce predators of midge and mayfly larvae in stream riffles and underwater vegetation.

The Athericidae is a small cosmopolitan family with eight genera and about 70 species worldwide. Athericids, until recently, were considered snipe flies, but are probably more closely related to the Tabanidae. In North America, two genera occur -- *Atherix* (four species) and *Suragina* (1 species), but only the former occurs in Canada. *A. variegata* Walker (Fig. 30) is the only described species known to occur in BC, but *A. pachypus* Bigot probably also occurs, at least in the southwest -- it is recorded from the mountains just south of the US border.

Family TABANIDAE (Horse Flies and Deer Flies) [Fig. 31]

Horse flies and deer flies are medium-sized to large (5 to 30 mm long), rather stout, large-headed flies, black, grey or brown, often coloured in orange or yellow; their bodies are more or less finely setulose, but lack enlarged bristles. The large compound eyes, often brightly coloured, iridescent, striped or spotted, are separated in females, but meet dorsally in males; the antennae are 5 to 11-segmented, the flagellum consisting of a large basal segment and 2 to 8 small annular segments apically. The proboscis is strong and rigid, with knife-like mandibles and maxillae in females of biting species. The large thorax bears stout legs; the front tibia lacks apical spurs, but these occur on the middle tibia and are present or absent on the hind one. The empodium is pad-like. The wing bears large calypters. The venation is rather primitive and uniform; the costa extends around the wing margin and the radius has four branches. A distinctive feature is the splayed veins R_4 and R_5 , which widely straddle the wingtip. The wings are often darkened and patterned distinctively. The abdomen is broad, often strikingly patterned; seven segments are visible.

Horse flies and deer flies, because of their fierce biting habit, are familiar to most people who spend time in the summer, outdoors, away from cities and towns. Indeed,

these flies are well studied because of their medical and veterinary significance. Apart from the annoyance and loss of blood suffered by humans, domestic and wild animals that the females bite, tabanids are also vectors of microorganisms that cause tularemia, anthrax, anaplasmosis and other diseases. Normally, adults are active only in bright sun on warm, windless days; both females and males visit flowers to feed on nectar. Some species require no blood meal to mature the eggs, but most females suck blood from warm-blooded animals, at least after the first batch of eggs is laid. The compact egg masses are laid on plant stems or leaves above the larval habitat. The larvae of most species live in the wet soil of marshes, fens, bogs, and along the margins of ponds and streams. A few live in the beds of fast flowing streams and some develop in dry soil. Apparently, most are predators of invertebrates, although *Chrysops* larvae may feed on plant matter in mud.

Worldwide in distribution, the family Tabanidae consists of about 4,200 named species in 201 genera; in North America these numbers are 316 and 25, respectively. BC has 62 species in eight genera. There are three subfamilies: the Chrysopsinae, with hind tibial spurs and an antennal flagellum with five or fewer segments; the Pangoniinae, with hind tibial spurs and eight or nine apparent segments in the flagellum; and the Tabaninae, lacking apical spurs on the hind femur. In BC the Chrysopsinae contains the genera *Silvius* (one species) and *Chrysops* (15 species). *S. gigantulus* Loew has a yellow-grey thorax and an orange abdomen; it occurs from southern BC to Baja California. *Chrysops* is a speciose and familiar genus. Deer flies are insects of open woodland, most diverse in north temperate regions, where members of the deer family are common. When biting people, they usually attack the head and neck. Most species in BC are about 1 cm long with golden or green eyes, brown-banded wings and orange abdomens marked with brown. *C. excitans* Walker, the most common species in boreal Canada, is abundant throughout BC. *C. ater* Macquart is also boreal, but is restricted to east of the Rockies in the province. *C. asbestos* Philip and *C. noctifer* Osten Sacken are common Cordilleran species and *C. discalis* Williston is abundant around the saline lakes of interior grasslands.

In BC the Pangoniinae contains *Apatolestes* and *Stonemyia*, both rather rare; the former is completely western in distribution, the latter has species in eastern as well as western North America. In Canada, *A. comastes* Williston is recorded in Canada only from Robson, BC and *S. californica* (Bigot) is restricted to the Okanagan Valley. The subfamily Tabaninae, in BC, is dominated by the speciose and physically large northern genus *Hybomitra* – the species are usually 10 to 20 mm long, black, and usually with orange or grey on the abdomen and green-banded eyes. Twenty-nine species of these horse flies are recorded in the province. *Hybomitra affinis* (Kirby), *H. frontalis* (Walker) and *H. zonalis* (Kirby) are abundant transcontinental flies, occurring throughout BC; *H. captonis* (Marten) is one of the most common Cordilleran species, ranging from BC to California. *H. sonomensis* (Osten Sacken) is restricted to the coast in BC, where it is abundant. The genus *Tabanus* contains our largest horse flies. The two biggest of the ten species in BC are *T. aegrotus* Osten Sacken and *T. punctifer* Osten Sacken, which reach 24 mm in length; the former is all black, the latter is black with the top of the thorax grey. Both are restricted to BC in Canada. *Haematopota* is a speciose genus of over 300 species that has evolved with the mammal family Bovidae – most occur in Africa and

Asia, and North America has only five species. Of these, only the western *H. americana* Osten Sacken lives in BC; the body is black marked with grey and the wings are speckled grey. *Atylotus calcar* Teskey is a denizen of saline habitats in grassland; *A. insuetus* (Osten Sacken) lives in forest wetlands. The golden haired *A. tingaureus* (Philip) is especially common in coastal BC peatlands.

Reference

Teskey, H.J. 1990. The horse flies and deer flies of Canada and Alaska (Diptera: Tabanidae). Part 16. The Insects and Arachnids of Canada. Publication 1838. Research Branch, Agriculture Canada, Ottawa, ON.

Infraorder MUSCOMORPHA

Superfamily NEMESTRINOIDEA

Family NEMESTRINIDAE (Tangle-veined Flies) [Fig. 32]

Tangle-veined flies are medium-sized to large, stocky flies, often strongly setulose and bee-like, but without enlarged bristles. The colours are variable, often black, brown, yellow or white and frequently the thorax and abdomen are striped and banded, respectively. The head is large, usually about as wide as the thorax; the compound eyes meet dorsally in most males, but are separated in females. In males, the upper compound eye facets are enlarged. Three ocelli are present. The antennae are small with the first three segments about equal in size and a terminal stylus, usually of three segments. The proboscis is vestigial, or short and fleshy (e.g., *Trichopsidea*), or longer than the head, slender and sclerotized for flower feeding (e.g. *Neorhynchocephalus*). The legs are slender and lack tibial spurs; the empodium is pad-like. The wings are rather narrow, sometimes tinged with brown; the complex venation gives the family its common name. The veins in the apical half of the wing are parallel to the front and hind margins of the wing and usually end at the wing margin before the wing tip. The so-called diagonal vein is present, obliquely crossing the middle of the wing; it consists of parts of Rs, R₄₊₅, crossvein r-m, M₁-M₃, and CuA₁. The abdomen is conical or widest near the middle; the ovipositor is either a telescoping tube or a sabre-shaped structure formed from the elongated cerci.

Adult tangle-veined flies are fast fliers and are most often seen at flowers or hovering, motionless, with a high-pitched hum. The adults of several tropical species are known to be pollinators of plants such as orchids. The few species that have been studied develop as parasites of grasshoppers and beetles. *Hirmoneura* species of the US Southwest attack the larvae of scarab beetles; elsewhere it also apparently feeds on long-horned beetles. The other two genera occurring in North America, *Neorhynchocephalus* and *Trichopsidea*, parasitize grasshoppers. Thousands of eggs are laid in crevices in posts and trees; these hatch into tiny, active larvae, which search for hosts. Apparently they are often dispersed by wind. Once the larva enters a host insect it develops into a maggot (hypermetamorphosis), producing a respiratory tube (lacking in *Hermoneura*) that links the spiracles at the larva's rear end to the outside air. The larvae parasitizing grasshoppers feed mainly on the fat body and ovaries of the host. Mature larvae overwinter in the soil.

The approximately 300 named species of Nemestrinidae worldwide are arranged in 23 genera. The majority of genera and species live in the southern hemisphere, and only six species in three genera are recorded in North America. Two species live in Canada; both occur in the grasslands of the Thompson and Okanagan valleys -- *Neorhynchocephalus sackenii* (Williston) (Fig. 32) and *Trichopsidea clausa* (Osten Sacken). The former has been recorded from Osoyoos to Kamloops, the latter from Kamloops to the Chilcotin. If not rare, they are, at least, seldom seen. Both species are clothed in pale yellow setae, which is long and dense in front, but shorter on the abdomen, where it forms a band on the rear margin of each segment. At Riske Creek in the Chilcotin, *T. clausa* is recorded laying eggs in the holes and cracks in old telephone poles that ran through an egg bed of *Camnula pellucida*, a common grasshopper of BC roadsides and probably the host of the flies. Green-eyed *N. sackenii*, with its long proboscis, probes in flowers for nectar.

Family ACROCERIDAE (Small-headed Flies) [Fig. 33]

Adult small-headed flies are bizarre often, as the common name suggests, with tiny heads dwarfed by a grotesquely inflated thorax and abdomen. There is significant variation, however; they range from 2.5 to 30 mm long and boast a range of colours from metallic blues, greens and purples to browns and blacks mixed with yellows and whites. The body can be nearly bare, but usually is covered with fine setulae; there are no enlarged bristles. The head is usually small and globose, fixed low on the thorax, and consisting mostly of the compound eyes, which meet dorsally in both sexes. There are normally three ocelli. The antennae are 3-segmented; the first two segments are short and round, the third (flagellum) varies from long and sword-shaped, awl-shaped or thread-like to short and spoon-shaped with long apical setae. The mouthparts are either vestigial, partly developed into a short tube, or well developed into a long sucking proboscis. The thorax is often humpbacked, sometimes flat; the legs are normally simple, but some species have swollen femora. The empodium is pad-like, but is sometimes reduced or absent. The wing is variable in shape and venation; it is usually clear, but sometimes is infused with brown. The lower calypter is unusually well developed. In the males of some taxa (especially *Pterodontia*) a striking costal thickening and projection occurs at the junction of Sc with R_1 and R_{2+3} . The Sc reaches the middle of the wing or farther; R_{2+3} , when present, usually ending in the wing margin; an extra crossvein r-m sometimes present, forming cells R_{4+5} and R_5 . The venation may be so reduced (as is often the case in *Ogcodes*) that there are no longitudinal veins behind R_1 . The abdomen is usually globose, but can be globose-elongate (for example, *Eulonchus*), tapered, laterally compressed or wasp-waisted.

Acrocerid genera that have a well-developed proboscis (e.g., *Eulonchus*, *Lasia*) visit flowers for nectar, and species of *Eulonchus* are important pollinators of some wild flowers. Acrocerid larvae are internal parasitoids of spiders. An adult female lays several thousand eggs in the vicinity of a host population – the oviposition site depends on the genus, for example, *Ogcodes* lays eggs on dead twigs, *Acrocera* on grass stems, *Eulonchus* on the ground. Like the first instar larvae of the Nemestrinidae, those of acrocerids crawl and jump around, searching for a host. Finding a spider, the larva burrows inside and takes up residence in the book lungs where it can breathe outside air.

Usually, the larva rests there until the spider is almost mature, then moults twice; the third and final larval stage is maggot-like and rapidly devours the liquid contents of the spider. Emerging, the larva pupates nearby, often in the host's web.

The Acroceridae contains about 520 described extant species in 50 genera; there are seven genera and 61 named species in North America. The 12 species recorded in BC are from five genera. The most diverse is *Ogcodes*, one of only two cosmopolitan genera and, with 90 species, the most speciose acrocerid genus in the world. Hosts include a wide range of spiders in families including the Lycosidae, Agelenidae, Thomisidae, and Clubionidae. BC reports five species, most of which are blackish with white bands on the abdominal segments. The most widespread is *O. eugonatus* Loew, which ranges from Canada to Mexico. *Acrocera* species are small black or brown flies, often with the abdomen coloured in orange or yellow. The four BC species range more or less transcontinentally: *A. bulla* Westwood is a very small acrocerid, some specimens being only 2.5 mm long; *A. convexa* Cole has a bright orange abdomen that gives it the appearance of a ladybird beetle when resting on a grass stem; *A. melanderi* Cole has broad yellow bands on a dark abdomen; *A. orbicula* (Fabricius) is Holarctic and has black bands on a yellow abdomen. *Turbopsebius diligens* Osten Sacken lives from BC to Mexico; males have clear wings, but those of females are usually darkened. *Pterodontia misella* Osten Sacken, a parasitoid of *Pardosa* wolf spiders, occurs across southern BC; it ranges south to California and Utah. Males have the abdomen patterned in yellow-orange, but the females are all black. *Eulonchus* is predominantly a western genus; members are easily recognized by their large size, colourful metallic body and long proboscis. The single BC species, metallic green or blue-green and 15 mm long, is usually named in collections as *E. tristis* Loew; this, BC's largest acrocerid, is undescribed.

Superfamily ASILOIDEA

Family THEREVIDAE (Stiletto Flies) [Fig. 34]

Stiletto flies are slender to rather robust, small to medium-sized flies (2.5 to 15 mm long); the English name perhaps relates to the pointed abdomen of many species. The colour of the integument ranges from black to yellow, but the body is partly, to completely, setulose and is often patterned with silvery or white tomentum. The wings are often banded or spotted. The head is hemispherical, without a depression between the compound eyes; the compound eyes are separate in females, but meet dorsally in most males. There are three prominent ocelli. The antennae sometimes arise from a prominent protuberance and the first segment is often enlarged (as in *Tabuda*); the first segment of the flagellum is the largest and one or two more form a small stylus, which bears a bristle, often tiny. Prominent bristles are usually present on the thorax and legs, which are usually long and slender; the empodium is bristle-like or absent. The wing venation is rather uniform; vein R_4 is long and usually sinuate; cell d is elongate with M_1 , M_2 and M_3 arising from the apex; cell m-cu present; pterostigma and calypter usually well developed. The 8-segmented abdomen tapers rearward and is convex to flattened above; acanthophorite spines are usually present in females.

Some therevids resemble small asilids in form and behaviour, although the structure of the head is distinctly different. The deep cleft between the eyes of robber flies is absent and, because the proboscis is built for sponging rather than piercing, stiletto flies do not prey on other insects. Other species look like rhagionids and some mimic wasps. Adults frequent a wide variety of habitats – forest openings, meadows, stream margins and dry areas such as beaches or sand dunes. They rest in the sun on different substrates, often depending on the species or genus – sand, rocks, logs, leaves, tree trunks, and so on. The elongate, snake-like larvae are predaceous in sand and loose soil, under dead tree bark and in decaying fruit or fungus where they attack invertebrates, especially the larvae of click, scarab and darkling beetles.

The Therevidae is a cosmopolitan family containing over 1000 described species; about 151 species are known in 28 genera in the Nearctic. The BC fauna is poorly known – there are about 16 species in nine genera recorded in the literature and known from collections of BC Diptera. With 29 described species in North America, *Thereva* is a genus of the mountains and boreal forests. *Thereva brunnea* Cole and *T. frontalis* Say are BC species that range south into the US northwestern states; *T. nigripilosa* Cole has been collected in BC only. Most *Pandivirilia* species live in the forests of the western mountains where some, at least, develop in conifer logs. *Pandivirilia limata* Coquillett is a large grey species, 12 mm long that lives from BC south to California and Colorado; *P. bussii* (James) ranges north to the Yukon. *Spiriverpa* contains some common species of sandy habitats – *S. cinerascens* Cole and *S. cockerelli* (Cole) are among them. *Tabuda planiceps* (Loew) has the base of the antenna prominently thick and setose, and the front edge of the wing darkened; it is mainly a coastal species, occurring from BC south to California. At least one species of the forest-inhabiting genus *Psilocephala* occurs in BC, but the group requires study in order to resolve the identity of the province's fauna.

Family SCENOPINIDAE (Window Flies) [Fig. 35]

Scenopinids are sturdy, small to medium-sized flies usually not much more than 5 mm long. The body is bare or setulose, but lacks enlarged bristles; it is usually dark in colour, but is sometimes marked with white or yellow. The head bears prominent compound eyes, which occupy most of the head and usually meet dorsally in males, but are separated in females. The upper facets of the compound eyes are enlarged in males. Three ocelli are present; the vertex is level with the compound eyes; a prominent flange is often present behind the eye, especially in some females. The three-segmented antennae arise close together; the third segment (flagellum) bears a peg-like stylus and varies from long and slender to short and oval, often with a slightly forked tip. The facial area around the mouthparts is deeply recessed. The thorax is long and moderately convex, pruinose and sparsely covered with short to long setulae or scale-like setulae. The scutellum has no bristles. The legs are short; empodia are absent. The wings have prominent radial veins, R_{2+3} is usually short, ending close to R_1 ; R_{4+5} forks and R_4 ends well before the wing tip; cell r_5 is open to the wing tip and is narrowed, or is closed and stalked. The abdomen is broad and flattened or cylindrical, with seven easily seen segments in the male, eight in the female; most segments are subdivided by a transverse groove.

Larvae are predators of insects. Those of window flies, a few species of *Scenopinus*, prey especially on the larvae of household pests of cloth, wood, stored food and pets, including clothes moths, dermestid beetles, powder-post beetles and fleas. After emergence, the adults appear on the windows of buildings, trying to escape to the outside. In more natural situations they probably live in bird and mammal nests. Other species are recorded in decaying wood, in fungi, in the galleries of wood-boring beetle larvae, in termite nests, and in the nests of woodrats and birds.

The Family Scenopinidae is world wide in distribution, with about 414 species described. Many of these (157 species in nine genera) are from North America, especially the arid southwest. The most diverse of these genera are *Scenopinus* (50 species), *Brevitrichia* (45 species) and *Pseudotrichia* (36 species). There are nine species in two genera known from the literature and from collections of BC Diptera to occur in the province. Perhaps the most familiar are *Scenopinus fenestralis* (Linnaeus) and *S. glabrifrons* Meigen, originally from Europe, but now widespread over much of the globe, having been distributed everywhere by commerce because of their association with household goods.

Family MYDIDAE (Mydid Flies) [Fig. 36]

Mydid flies are medium-sized to extremely large (*Mydas heros* of Brazil, with a length of 60 mm and a wingspan of 100 mm is probably the world's largest fly), sparsely covered in short setulae and lacking enlarged bristles except on the legs. Body colour is variable, and usually is some combination of black, yellow, red or white. The head is wider than high and the face is usually swollen and haired, but is flatter in the ancestral subfamilies. Most species have long, 4-segmented antennae with the two segments of the flagellum especially elongate; the second flagellar segment is normally clubbed and usually bears a tiny apical spine. The more ancestral species have a 1-segmented flagellum. The compound eyes are large, almost always with uniformly small facets; there are three ocelli. The proboscis is well-developed, usually short, but can be up to five times longer than the head (for example, in *Rhaphiomidas*). Compared to the other legs, the hind leg is frequently longer and stouter, with the femur usually swollen and bearing spines on the lower surface; the hind tibia often has an apical spur or bristles. Unlike in the Asilidae, there is no empodium and the pulvilli have one rib instead of two. The wings can be clear or washed with yellow, orange or brown. The wing venation is distinctive, with most veins usually ending in the front margin of the wing. Vein Rs is very short and cell br is extremely long; all radial veins, M_1 , and sometimes even M_2 end before the wing tip. Cells r_4 , r_5 and m_1 (when present) therefore curve forward, parallel to the hind edge of the wing tip; cell m_3 lies parallel to the hind margin of the wing. The abdomen is cylindrical and taper rearward in males, but in most females is widest in the middle. Male tergite 8 almost always has a deeply concave hind margin. In most females (except, for example, *Mydas*), tergite 10 is developed into acanthophorites bearing a circlet of strong blunt spines.

Mydids live mostly in warm habitats such as dry, open woodlands, grasslands and deserts. Adults, with their long antennae and colourful bodies, often resemble wasps and probably mimic them. They have been implicated as predators, but there is little evidence

for this habit; probably most feed at flowers and those with atrophied mouthparts may not feed at all. Although little is known about the larvae, some species are known to prey on beetle larvae in rotting wood and sandy soil.

The Family Mydidae is widely distributed, especially in dry tropical, subtropical and Mediterranean climates. It is an old and scattered family of about 360 species in 54 genera, long past its heyday, and has probably suffered much extinction. It dates back at least to the Jurassic, and like the Apioceridae, the ancestral subfamilies of the Mydidae (Raphiomidinae and Megascelinae) show relationships and geographical distributions related to the break-up of Gondwanaland. These ancestral groups have only recently been transferred from the Apioceridae to the Mydidae. There are 51 species in eight genera in North America. Two species barely range into Canada – *Mydas clavatus* Drury (Fig. 36) in southern Ontario and *Nemomydas pantherinus* Gerstaecker in BC's southern Okanagan Valley. The latter species, with its yellow and black-banded abdomen is easily mistaken for a wasp in the dry, sandy grasslands of Oliver and Osoyoos. It is distributed in the intermontane grasslands and dry forests south to California.

Family APIOCERIDAE (Flower-loving Flies) [Fig. 37]

Adult flower-loving flies are robust, medium sized flies, usually about 12 to 35 mm long. The body is bare to moderately setulose; the colour is black or brown, often with extensive grey or tan tomentum and pruinosity creating patterns, especially on the abdomen. The head is short and wide; the compound eyes in both sexes are widely separated by a shallow depression. There are three ocelli. The antennae are short and 4-segmented; the first segment of the flagellum is usually pear-shaped and the second is short, cylindrical and acute. The palps are 2-segmented; the proboscis is large and fleshy. The stout mesothorax bears bristles on the sides and rear. The legs are unspecialized, but usually there are a few bristles on all segments; the empodium is bristle-like. Apiocerid wings are relatively short with venation resembling that of mydid flies. Veins R_{2+3} join R_1 before the wing margin; R_5 and M_1 curve forward to join the margin before the wing tip. Crossvein r-m lies at about the midway point of the discal cell. The abdomen is elongate, tapering rearward, and has eight visible segments; the male genitalia are enlarged and club-like and the female has acanthoporphite spines.

Flower-loving flies are inhabitants of dry, hot places, especially where there is a nearby source of water. They especially like the edges of sand dunes where there is a sparse cover of plants. The best place in BC to find them is the extensive sandy habitat on the east side of Osoyoos Lake, but they occur at least as far north as the patches of grassland growing on sandy loam at Penticton. Females lay eggs in sandy soil at the base of plants. The term "flower-loving flies" is a misnomer, although it is firmly established in books – most of these insects seldom visit flowers. They spend much of their time walking or running on open sand or soil; when the temperature is high they make fast runs and short flights between shaded spots under plants. Flight is often noisy. The mouthparts are sponging -- the flies are attracted to water in the soil and imbibe honeydew from beneath aphid-infested plants. The slender larvae apparently prey on invertebrates in the soil.

The ancestral mydid subfamilies Raphiomidinae and Megascelinae have recently been transferred from the Apioceridae to the Mydidae, leaving *Apiocera*, with 137 described species, as the only apiocerid genus. This group is divided into four subgenera from four discrete geographical regions: western North America, southwestern South America, South Africa, and Australia. Evidence suggests that the family, like the Mydidae, arose in Pangaea before the middle of the Jurassic; its modern disjunct distribution resulted from the subsequent break-up and movement of the continental plates. The North American subgenus is the most ancestral; the region (including northern Mexico) has 58 named species. The single Canadian one, *Apiocera barri* Cazier, is known in the country only from the dry grassland and shrub-steppe of the southern Okanagan Valley. It ranges south to California.

Family ASILIDAE (Robber Flies) [Fig. 38]

Robber flies are named after their predatory habits – they attack and devour other insects. The body form varies widely, from delicate and slender to heavy and stout, from almost bare to bristly or setulose. Some are tiny flies only 3 mm long, but others are gigantic, over 50 mm long. Colours range from browns, greys, silvers and blacks to colourful patterns of contrasting blacks, yellows and reds. Males of some species have additional ornamentation such as the expanded silver abdominal tip in *Nicocles*, the striking white abdomens of *Efferia* and the decoration on the tarsi of many *Cyrtopogon* species. The compound eyes are large usually rather flattened from front to back; in most species the broad forward-facing area has enlarged facets. The compound eyes are well separated dorsally in both sexes by a distinctive hollow. The ocelli are prominent, usually placed on a tubercle. Varying from flat to strongly protuberant, the face bears a characteristic tuft of setulae or bristles, the mystax. The antennae are erect, usually 4-segmented. The first segment of the flagellum is elongate or oval, the stylus is normally 2-segmented, but may be 1-segmented or apparently absent; it is prominent and seta-like in the Asilinae. Both sexes have stabbing and sucking mouthparts developed into a proboscis -- paralyzing saliva is injected through the needle-like hypopharynx (tongue), which is sheathed in the prominent labium. The thorax is prominent and powerful and usually bears distinctively arranged bristles. The legs are strong and raptorial, frequently with numerous bristles; the empodium is bristle-like, but is lost in some Leptogastrinae; the pulvilli are also lost in the latter subfamily and a few other genera. The wings are sometimes coloured or spotted. The venation is not much modified and vein R always has four branches, with R_{2+3} unbranched. However, R_{2+3} joins R_1 before the wing margin in some subfamilies (e.g. Laphriinae, Asilinae), closing cell r_1 . Cells m_3 and cup are often closed. The abdomen varies from cylindrical and tapering to short, broad and rather flattened; in the Leptogastrinae the abdomen is slender, elongate and club-shaped. Acanthophorite spines are present in females of several subfamilies and a prominent knife-like ovipositor is formed from the terminal abdominal segments in many genera of the Subfamily Asilinae.

Robber flies are predators that as adults pursue other insects, seize them with powerful legs and kill them with a paralyzing stab of the hypopharynx. The liquefied contents of the prey are then sucked-up by the proboscis. They are mostly opportunistic predators, feeding upon any insect that they can subdue and kill. Some species, especially

in the subfamily Laphriinae, are effective mimics of bees and wasps. Robber flies usually hunt in open areas where there is plenty of light and warmth; grasslands, scrub, deserts and open woodland are the best places to find them. Larvae are predators of the eggs, larvae and pupae of other insects in the soil (most groups) or in rotting wood (subfamily Laphriinae), although in a few species studied the immature larvae, especially, are ectoparasitic on their hosts.

The Asilidae is a speciose family of about 6700 described extant species worldwide. North America has 1025 named species in 97 genera; in BC 33 of these genera contain 116 species, but it is certain that more remain to be recorded. This is 58% of the known Canadian asilid fauna. The subfamily Leptogastrinae is represented in BC by three species of *Leptogaster*. They are uncommon, extremely slender, long-legged, almost bare flies that hover among the grasses of grasslands and dry forests in the southern valleys. *L. arida* Cole is distributed from Vancouver Island east to the dry interior of BC. Species of Dasypogoninae are distinguished by an enlarged, or twisted spine at the apex of the fore tibia – BC has nine species in four genera. *Comantella pacifica* Curran, a species known only from grasslands in the Okanagan Valley, for a Canadian robber fly, is active unusually late in the autumn (late October) and early in the spring (late March) indicating that adults may overwinter in protected places. *Nicocles* is a genus of beautiful flies with brown-spotted wings and, in the male, with brilliant silver terminal abdominal segments; BC has five species. The asilids of the subfamily Laphriinae in BC are forest dwellers whose larvae develop in rotting wood. Many of the adults are large with colourful setulae and mimic bees and wasps. *Andrenosoma fulvicaudum* (Say) is a black and orange fly that ranges across the continent south of the northern forests. It is attracted to forest fires; the females lay eggs in burned trees where the larvae prey on buprestid beetle larvae. *Laphria* contains 22 species in BC; some are bumblebee mimics with bright fuzzy yellow and black or yellow, red and black bodies. Common Cordilleran species include *L. columbica* Walker and *L. fernaldi* (Back); *L. insignis* (Banks) and *L. posticata* Say are two of many boreal species.

The genus *Cyrtopogon*, with 23 species in BC (70 in North America) is the most diverse in the Subfamily Stenopogoninae. *C. willistoni* Curran is common on interior grasslands; like some other *Cyrtopogon* species, the males display to females by dancing in front of them, waving decorated tarsi. *Dicolonus simplex* Loew is restricted to the Garry Oak meadows of the south coastal islands; it ranges south to California. *Stenopogon inquinatus* Loew, physically big and varying from red to black, is one of the most common and conspicuous robber flies in the province; it hunts in habitats ranging from arid sagebrush steppe to open Douglas-fir forests. The subfamily Stichopogoninae is a small one in BC, mainly containing the genus *Lasiopogon*. These are small grey or brown flies that hunt from the bare ground or from rocks and logs. *L. willametti* Cole and Wilcox lives on ocean and river beaches on the south coast, *L. monticola* Melander is a common species of subalpine meadows and *L. quadrivittatus* Jones, a Great Plains species, inhabits the province east of the Rockies. *L. hinei* Cole and Wilcox (Fig. 38) is a Siberian fly that entered North America via the Bering land bridge; it has extended its range as far east as northern BC and central Alberta. The sole *Stichopogon* species in the province, *S. fragilis* Back, is a tiny silver fly from the sandy Okanagan grasslands at

Osoyoos. At 3 to 4 mm in length, this is BC's smallest asilid; only a single specimen has been collected in Canada.

In BC, the nine genera of the subfamily Asilinae contain mostly medium-sized to large, grey or brown, elongate flies. *Efferia* is the largest robber fly genus in North America with about 110 named species; seven occur in BC grasslands. The males have large club-shaped genitalia; the ovipositors of the females are long and sword-like. Males of all the species have some of the abdominal segments silver-white; one of the most common species, *E. benedicti* (Bromley) most of the segments are clothed with long, white setulae parted along the midline. *Megaphorus willistoni* (Cole), a rare little mimic of leaf-cutting bees, is known from only one specimen in Canada (from the southern Similkameen Valley). The two *Proctacanthus* species are the largest robber flies in BC; *P. milbertii* Macquart and *P. occidentalis* Hine are big, grey flies reaching a length of about 40 millimetres. *Rhadiurgus variabilis* (Zetterstedt) is one of only two Holarctic asilid species. It is one of the most northerly dwelling robber flies and one of the most common species in the spruce forests of the province.

Family BOMBYLIIDAE (Bee Flies) [Fig. 39]

Members of the Bombyliidae are called bee flies because many, in their setulation and flower-visiting habits, resemble bees in a vague sort of way. In addition, some species develop as parasitoids in the nests of solitary bees. Bee flies are small to large flies (1 to 25 mm long), with the usually stout body normally clothed in delicate setulae or scales, or both, ranging in colour from black and brown to white, silver and gold. The wings are often patterned and colourful. The compound eyes are globular to transverse, without setae, often meeting dorsally in males. In some groups, especially the subfamily Anthracinae, the hind margin of the compound eye is sharply indented, with a horizontal seam dividing the facets. There are three ocelli. The back of the head is flat, swollen or deeply concave (e.g. subfamily Anthracinae). The mouthparts are adapted to sucking from flowers: the proboscis is long and slender (e.g. Subfamily Bombyliidae) or short and with fleshy labella (e.g. subfamily Anthracinae). The antennae have 3 to 6 segments; the first segment of the flagellum is enlarged and the others, if present, form a stylus. The thorax is flattened or humped, with or without bristles; the latter are seldom strongly developed. The legs are slender, with or without bristles, but normally with bristles at the apex of the tibiae. The front legs are often thinner, shorter and weaker than the other two pairs, especially in anthracine genera such as *Exoprosopa* and *Poecilanthrax*. The wing venation is variable. Vein Rs normally has three branches (R_{2+3} , R_4 and R_5), with R_{2+3} usually ending in the wing margin toward the wing tip (and along with R_4 often bent sharply forward), but sometimes short and joining R_1 . Vein M usually with two branches reaching the wing margin; occasionally only one branch is complete because M_1 ends in R_5 or because M_2 is absent. Cell dm is usually present and cell cup is open or closed. The abdomen is short and broad, elongate or cylindrical, consisting of six to eight visible segments and seldom bearing bristles. The females of many bombyliid groups have acanthopores and spines on the tenth segment, but many have lost these egg-laying aids. Females in advanced groups, including the subfamilies Bombyliinae and Anthracinae, have a sand chamber, developed through modification of segment 8, in which eggs are coated with sand from the substrate before they are laid.

Bee flies are sun lovers and are most diverse in hot, dry climates where sand and stony ground prevails. They have a strong, hovering flight and usually are seen around flowers or hovering over, or resting on, bare patches of ground. They feed on nectar and, perhaps, some pollen from the flowers they visit. When perched, they hold their wings outstretched and swept back. Not much is known about the development of most species; those that have been studied are parasitoids of the immature stages of bees, wasps, moths, beetles, flies and other insects or they prey on the egg pods of grasshoppers. Eggs are laid near the host insects and the larvae are similar to those of the related Nemestrinidae and Acroceridae – an active first-instar larva seeks out the food source and moults to a grub-like form in subsequent instars to feed voraciously on the host.

The Bombyliidae is a speciose, worldwide family; about 4700 species are described in 230 genera. There are 893 species in 67 genera in North America and BC has at least 50 described species shared among 17 genera. Probably the most familiar species is *Bombylius major* Linnaeus, a fly that ranges throughout the northern hemisphere. Over most of the province this rotund, fuzzy fly with bicoloured wings hums around gardens in early spring, probing flowers with its long proboscis. The larvae are parasitic in the nests of bees such as *Andrena*, *Colletes* and *Halictus*. With a long proboscis and broad oval, abdomen, *Systoechus* species look like BC's approximately eight species of *Bombylius*; the larvae prey on grasshopper eggs. A common species is the white or pale yellow *S. oreas* Osten Sacken. *Anastoechus barbatus* Osten Sacken, the only species of the genus in the province, also attacks grasshopper egg-pods. Five species of the common genus *Conophorus* are recorded, including *C. nigripennis* (Loew) and *C. obesulus* (Loew), which are restricted to western North America. The Subfamily Bombyliinae in BC also contains the distinctive genus *Thevenemyia* – the four BC species are slender, black and setulose with a narrow head and prominent proboscis. They are usually found in coniferous forests, often sitting on fallen logs. The largest, *T. magnus* (Osten Sacken), is about 20 mm long and has the front of the wings dark.

Half the world's described bee flies are classified in the subfamily Anthracinae. Species of *Anthrax* mostly parasitize bees, wasps and tiger beetles. For example, the widespread, speckled-winged *A. irroratus* Say attacks bumblebees and eumenid wasps while *A. analis* (Say) feeds on various tiger beetles. The diverse genus *Villa*, with 52 North American species, parasitizes a wide range of flies, moths, sawflies, bees, wasps and beetles. There are about ten BC species; the wings are generally clear. *V. alternata* (Say) is named for the alternating dark and pale bands on the abdomen; it parasitizes noctuid moth caterpillars. *Hemipenthes* species have at least the basal half of the wings heavily marked with dark brown. *H. catulina* Coquillett was reared from the pupae of *Bessa harveyi* (Townsend), a tachinid parasite of the larch sawfly. *H. morio* Linnaeus, a common Holarctic species, attacks parasitic Hymenoptera such as *Ophion*. *Poecilanthrax* species are big and striking, with conical faces and wings boldly marked or shaded in brown. *P. tegminipennis* Say is covered in yellow pile and the wings are all pale brown; the wings of *P. willistonii* Coquillett are more mottled. There are at least four species of *Exoprosopa* in BC; one of the more common, *E. dorcadion* Osten Sacken, has wings beautifully patterned in dark brown.

Family HILARIMORPHIDAE (Hilarimorphid Flies) [Fig. 40]

Small, dark and robust flies, 1.8 to 7.2 mm long. The head is suboval, with a concave occiput; compound eyes bare, not emarginate laterally to the antennae. Males are holoptic, with the compound eyes contiguous from the vertex to the base of the antennae, and with the facets in the lower third of the compound eye smaller than those in the upper two-thirds. Females have compound eyes small and dichoptic, with facets of uniform size. Ocelli are present and appear prominent on a subtriangular vertex pad, usually with several short, fine, erect setae. The antennae have an apical 2-segmented stylus, and a short, subconical scape. The thorax dorsally is moderately arched, and usually with distinct vittae. The scutellum is short, relatively large, and subtriangular with short setae arranged in a row across the posterior margin. The wings are hyaline to pale brown, covered with microtrichia, and usually with a pterostigma. Veins are brown, with R_{4+5} and M_{1+2} similarly forked. Vein M_1 is not curved forward, and vein CuA_2 reaches the margin of the wing near A_1 . Legs are elongate, with tibiae lacking apical spurs. Tarsal claws are simple, the pulvilli are large and distinct, but empodia are absent. The male abdomen ends in swollen, globose terminalia, but the abdomen in the female is gradually tapering.

Immature stages are unknown, but adults have been collected on species of *Salix* growing along narrow gravel-bottomed streams. Published BC records indicate adults are active from mid-June to the end of July in the province.

The family contains a single, north temperate genus *Hilarimorpha*. Worldwide there are approximately 30 species, seven of which occur in Canada. There are four species known from BC: *H. ditissa* Webb (Fig. 40) from Pouce Coupe near Dawson Creek, *H. pitans* Webb collected near Chilliwack, *H. rivara* Webb from near Terrace, and *H. stena* from Yoho National Park.

Superfamily EMPIDOIDEA

Family EMPIDIDAE (Dance Flies) [Fig. 41]

Small to medium sized, elongate, predatory flies, 1 to 12 mm long. Usually dark coloured, but sometimes yellowish to pale brown. Head with large compound eyes, males often holoptic, females in the subfamily Hybotinae also holoptic; proboscis often elongate. The antennae have 3 or fewer segments, and usually have a stylus or arista. The thorax is usually somewhat rectangular in dorsal outline.

Wings have highly variable venation, but the costa extends to at least the apex of the wing. Vein Sc usually joins C or ending freely, never abruptly joining R_1 . Vein Rs originates well distal to the level of crossvein h, and with vein CuA_2 usually absent or vestigial. The posterior veins in the wing are not setose. Legs slender, usually rather long, and often exhibiting sexual dimorphism. If sexually dimorphic, males with basal one or two tarsal segments enlarged with silk glands. The femora may or may not be thickened, and the middle coxae lack a strongly developed prong. The hind tarsus also has the basal segments not expanded and flattened. The abdomen is usually more or less elongate and

cylindrical, with the terminalia in the male symmetrical or asymmetrical, much larger than preceding segments or turned forward over these segments.

Empidid larvae are either aquatic or terrestrial, living in soil, leaf-litter or rotten wood. Adults are often found on vegetation in moist habitats, on tree trunks, or on the surface of water. Both sexes of most species feed on protein sources and nectar. Empidids feed on live insects, especially swarming Diptera. Many species of empidids also swarm, in spring and early summer. Males in many species present nuptial gifts of food to females as part of the mating process. This food is either presented to the female as captured, or may be wrapped in silk by the male prior to presentation. Some males present a frothy "balloon" or ball of silk to the female without any insect inside. It is thought that such silk or silk-wrapped food, as well as insect food by itself serves to prolong the feeding response of the female, and so distract any predaceous attack by the female on the male.

The higher classification of this group is in flux, but it is generally thought that the Empididae, as currently defined, is a paraphyletic group with respect to the Dolichopodidae. As the limits of monophyletic groups within the paraphyletic Empididae are uncertain we have maintained the traditional definition of the family which is consistent with the Manual of Nearctic Diptera. Worldwide, there are some 4,000 described species, with about 800 reported in North America. At least 700 species apparently occur in Canada, with at least 87 of these species in 33 genera known from British Columbia.

Family DOLICHOPODIDAE (Long-legged Flies) [Fig. 42]

Long-legged flies are robust, about 1 to 9 mm long, typically shining metallic green in colour, but may be brown or black, and somewhat pruinose. Head with frons broad and narrower anteriorly. Arista or stylus 2-segmented, dorsal or terminal on antenna. Thorax with scutum usually strongly bristled. Wings oval in shape, with costa usually continuous to juncture with M. Vein R not strongly thickened, but Rs arising at or very near level of crossvein h, and R_{4+5} unbranched. Vein M often straight beyond crossvein dm-cu, the cells dm and bm united. Vein A_1 and cell cu_1 sometimes rudimentary or lacking. Legs usually with large bristles on tibiae. Male legs often highly modified, but never with one or more of basal tarsal segments of hind tarsus expanded. Middle coxae without a prong. Tarsi usually with bristle-like empodia and broad pulvilli. Male abdomen with tergum 5 sometimes modified. Female with usually posterior abdominal segments retracted into segment 5.

Most larvae are predaceous and occur under the bark of trees, or in decaying vegetation. A few are aquatic. Larvae pupate in a cocoon made by the larva from pieces of wood, sand or soil. Adults are also predaceous, and are found on foliage, tree trunks, or damp earth, usually in swamps or along partially shaded streams, where they prefer small areas of sunlight. Males of species of *Dolichopus* in particular have complex mating dances.

As noted in the discussion of Empididae, it is generally thought that the dolichopodids form a monophyletic group within the empidids in the broad sense. Worldwide there are over 6,600 described species in a total of over 200 described genera. Of these, approximately 1,300 species and 57 genera occur in North America north of Mexico and about 800 species occur in Canada. There are at least 98 described species in 25 genera known from BC based on published records and collections of BC Diptera.

Superfamily PLATYPEZOIDEA

Family PLATYPEZIDAE (Flat-footed Flies) [Fig. 43]

Flat-footed flies are slender to robust, 2 to 10 mm long, black, gray, yellow, orange or brown, or a combination of these colours, although sometimes marked with shining blue or green. Head as broad as thorax, and rounded in front. Antennae with 3-segmented bare arista situated terminally on flagellomere. Compound eyes of males holoptic, red, with upper facets large and lower facets small; females with compound eyes dichoptic, with facets small. Ocelli on prominent tubercle, especially in males. Mouthparts short and fleshy. Thorax with transverse sutures usually visible only at the sides. Wings clear or brownish, the veins in the posterior half of the wing not setose. Vein C extending to at least apex of wing; subcosta reaching wing margin; radial veins not strongly thickened. Characteristically, the wings of platypezids have a relatively large cup cell which always ends in an acute angle. Legs stout and with middle coxae lacking a prong. Often the hind tarsus of males, and in some genera also the females, are expanded or dilated, often appearing as flattened plates in dried specimens. The abdomen is elongate; and cylindrical or somewhat flattened.

Larvae of all flat-footed flies appear to feed in damp woods (on fungi), where the adults are often encountered running erratically in a zigzag, stop-and-go, fashion on leaves of bushes in filtered sunlight, likely feeding on honeydew and other deposits on the leaves. Adults may also be seen hovering or running across the damp sand of stream beds. Males can form aerial swarms, into which females enter to select mates. Adults of *Microsania* are attracted to smoke; *Microsania occidentalis* Malloch is a widespread western species in this genus that likely occurs in BC.

Worldwide there are about 20 described genera and 250 described species. Sixteen genera and 74 described species occur in North America, of these, nine genera and 16 species are known from BC collections.

Superfamily PHOROIDEA

Family LONCHOPTERIDAE (Pointed-wing Flies or spear-winged flies) [Fig. 44]

Pointed-wing or spear-winged flies are small and slender, yellowish to brown flies, 2 to 4 mm long. The head is as wide as or wider than the thorax. The compound eyes are broadly separated in both sexes. The frons is short and broad, and bare except for a pair of strong and divergent lower interfrontal bristles medially above antennae. Antennae short, with bases widely separated, and with all segments small. Scape and

pedicel each with a row of short bristles on the distal margin. The antennal arista is exposed, arises apically and has a short pubescence. The compound eyes are moderately large, bare, and prominent; the ocelli are small and equidistant from each other. The proboscis is short, with palps short and clavate. The thorax is subrectangular, and convex dorsally. The scutum is rather strongly arched anteriorly, and the scutellum is moderately large, triangular, and rounded posteriorly. The legs are large and slender, with claws and pulvilli small, but the empodia are evidently absent. The hind femora are slightly swollen, and the fore tarsi of the male are also slightly swollen. The wings are elongate, slender, and somewhat pointed apically, with linear venation which shows sexual dimorphism. The main veins except Sc and R₃ have black setulae on the dorsal surface, vein M is branched, and the crossvein r-m is situated near the base of the wing well before the middle of the wing. Vein CuA₂ does not reach the wing margin as a free vein, but in the male terminates as A₁+CuA₂. In the female it terminates as A₂+CuA₂+CuA₁. The abdomen is rather short, subcylindrical to oval.

Larvae live under leaves or in decaying vegetation, probably feeding in micro-organisms and fungal hyphae. Adults are found in moist, shady habitats, and have a characteristic jerky movement.

The family contains a single genus, *Lonchoptera*, with four Nearctic species, all of which occur in Canada. There are 35 described species worldwide. *Lonchoptera bifurcata* (Fallén) occurs worldwide and has both a bisexual and a parthenogenetic form. Besides *L. bifurcata*, *Lonchoptera borealis* Curran and *Lonchoptera uniseta* Curran are known to occur in BC.

Family PHORIDAE (Phorid Flies) [Fig. 45]

Minute to small, inconspicuous, blackish, brownish or yellowish flies, 0.5 to 6.0 mm long, with major bristles on head, legs and other parts of the body characteristically feathered. The head is small, sometimes rather short and flattened, with ocelli present except in apterous forms. The thorax has a characteristic hump-backed appearance. Legs are well developed with the hind femur often enlarged, and more or less laterally compressed. The tibiae have one or more apical bristles, with one or more seams often on the hind, and sometimes also on the middle tibia. The wings are usually large, usually hyaline to pale brown, and rarely with dark markings, but females are sometimes short-winged or apterous. Fully developed wings have the branches of R strongly thickened and crowded into the antero-basal portion of wing, but with four other weak and peculiarly defined veins in the remainder of the wing blade. The costa ends near the middle of the anterior margin of the wing, and the veins in the posterior half of the wing are not setose. The abdomen is somewhat conical, and more or less tapering posteriorly, but often it is membranous, especially in wingless forms.

Adults move about with a characteristic quick, jerky movement. They are common around decaying vegetation or animal matter, and sometimes in and around the nest of ants, termites and bees.

Larval habits are varied, with many having been reared from fleshy or woody fungi. Some are scavengers, and some are parasites. The parasitic forms are often found in the nest of ants, termites, bees and wasps, and on beetles, caterpillars, millipedes and land molluscs.

Worldwide there are about 245 described genera and over 3000 described species. There are over 50 genera and about 380 described species in the Nearctic; of these there are at least 50 described species in 18 genera known from BC based on published records and collections of BC flies.

Superfamily SYRPHOIDEA

Family SYRPHIDAE (Flower or Hover Flies) [Fig. 46]

Slender to robust flies, 4 to 25 mm long, with body usually black and strikingly marked with yellow or orange on the head, thorax and abdomen. Many such species are mimics of bees and wasps. Less commonly, species are brown, yellow or metallic green or blue, or with various combination of such colour. The integument is usually smooth, but sometimes is totally or partly punctate, sculptured or rugose, and may be somewhat pruinose. The body is usually covered with dense, short setae, but rarely may be almost bare, or with long setae or stout bristles. The setae are sometimes flattened or scale-like, forming a dense tomentum. The compound eyes are usually holoptic in males, but can be very narrowly or broadly dichoptic. Females are moderately to broadly dichoptic. Some or all of the facets in the upper part of the compound eye may be enlarged in the male. However, the eyes are usually unicolourous, but rarely can have dark spots or bands, or have irregular markings, and may be bare or setose, with short or long, sparse or dense, setae. Three ocelli are present, and the antennae are sometimes set on a short or long frontal prominence. The lower facial margin usually has a distinct median notch. The arrangement of thoracic bristles or setae is important taxonomically. The wings are usually hyaline, but sometimes are somewhat darkened or with distinct markings. Characteristically, these flies have the costa ending at the apex of R_{4+5} , and there is an unattached longitudinal vein, the spurious vein (*vena spurea*), running most of the length of cells br and r_{4+5} , posterior to Rs . The apex of vein M is bent strongly forward near the wing margin, and joins near the end of R_{4+5} , thus forming an apical crossvein. Cell cup in the wing is closed near the wing margin, and a pterostigma is usually present. The legs are usually slender, but can be somewhat modified, especially in males. The abdomen is usually suboval, but can be elongate or even petiolate.

Adults of the subfamilies Syrphinae and Eristalinae are habitual visitors of flowers for obtaining pollen, nectar and honeydew, and are important pollinators: they are often considered second only in importance to some bee species in cross-pollinating many economic plants. Males are often seen hovering, almost motionless in the air, but dart swiftly aside when disturbed.

Adults lay oval, chalky-white, sculptured eggs on or near the food of the larvae, those with aphidophagous larvae being laid singly, but others may lay eggs in masses of over 100. Larvae have a wide variety of habitats and food. Some are predaceous

(Syrphinae, Pipizini), but others are phytophagous (*Cheilosia*, Merodontini), saprophagous (most Eristalinae), or scavengers (*Volucella*, Microdontinae). The mouth parts of such larvae are thus quite different. Predaceous types have four stylets for piercing and sucking, while phytophagous forms have strong mandibles. Saphrophagous species have a complex comb-like mandibular lobe, and like the scavengers, have a muscular and contractile cibarial chamber.

The predaceous larvae of the Syrphinae feed primarily on aphids and other Homoptera, but some species have been reported to feed on immature thrips, beetle, or lepidopterous larvae. Larvae of the Pipizini feed on aphids, preferring woolly or root aphids with a waxy integument, and attack these living both above and below ground. Larvae of the Syrphinae and Pipizini are thus important in natural biological control. The phytophagous larvae of *Cheilosia* feed in fungi or vascular plants, while the larvae of the Merodontini live in monocotyledonous bulbs, and sometimes in other plants, and may cause considerable economic damage.

The saprophagous larvae of most species of Eristalinae live in tree holes, ulcerated tree wounds, or rotting wood, but larvae of species of the tribes Eristalini and Sericomyiini are aquatic, living in water with a high organic content. The larvae of the Eristalini are the rat-tailed maggots, so called because the end of the abdomen is drawn out into a protrusible rat-tail-like respiratory siphon. Among the scavengers, the larvae of the Microdontinae are known to live only in ant nests, and the larvae of *Volucella* likewise are scavengers in nests of colonial Hymenoptera.

One of the most common syrphids in British Columbia is the cosmopolitan *Eristalis tenax* (Linnaeus). Although larvae of this species are aquatic, they have also been found living in the urogenital opening of cows. Three species of Syrphinae, namely *Eupeodes perplexus* (Osburn), *E. venablesi* (Curran) and *Syrphus opinator* Osten Sacken have been reported as important predators in the natural control of the woolly aphid *Eriosoma langerum* (Hausmann) in British Columbia. The Narcissus bulb fly, *Merodon equestris* (Fabricius), is a pest of *Narcissus* and other bulbs, and most years causes considerable loss to some bulb growers. Larvae of *Heilosia* are called bark maggots, and cause a blemish in timber of western hemlock and other conifers, known in the lumber industry as "black check".

Worldwide there are some 180 recognized genera, and about 6000 species. In the Nearctic there are 87 described genera, and about 900 described species. Some 550 species are reported from Canada, with the Syrphinae monographed by Vockeroth (1992).

Reference

Vockeroth, J.R. 1992. The flower flies of the subfamily Syrphinae of Canada, Alaska, and Greenland. Diptera: Syrphidae. The Insects and Arachnids of Canada. Part 18. Research Branch Agriculture Canada Publ. 1867:456 pp.

Family PIPUNCULIDAE (Big-headed or Big-eyed Flies) [Fig. 47]

Big-headed flies are small, dark bodied, 3 to 15 mm long, with characteristic globose or semiglobose compound eyes, covering almost the entire head. The compound eyes of males are usually contiguous in front, but dichoptic in the subfamily Chalarinae. The occiput is very narrow in the Chalarinae, and has ocellar bristles. In the Pipunculinae the occiput is generally swollen, clearly visible and lacks ocellar bristles. The thorax is shiny black, and pruinose to a varying degree, but usually somewhat setose. The femora of the legs usually have rows of small spines ventrally towards the apex. The hind tibiae often have strongly, erect anterior setae medially. The claws and pulvilli are moderately large. The wings are typically long and slender, hyaline to faintly infusate, and iridescent in direct light. The costa ends at the wing apex, and R_{4+5} is unbranched. The abdomen is typically subcylindrical.

Adults are frequently found hovering in or over vegetation. Females search out immature leafhoppers and other Homoptera for oviposition. Females snatch the prey with their long legs and hold them in their strong tarsal claws. While in flight, females then insert an egg into the host through weak areas of the abdomen. The larvae are endoparasitic, and develop to maturity in the host. They then emerge, drop to the ground and pupate in the soil or ground litter.

Worldwide there are about 1,380 described species. In the Nearctic there are 12 to 14 described genera (depending on generic definitions) with about 175 described species; of these, nine genera and 35 described species are known from BC based on published records and collections of BC flies.

CALYPTRATAE

Superfamily MUSCOIDEA

Family SCATHOPHAGIDAE (Dung Flies) [Fig. 48]

Scathophagids are slender, small to medium-sized flies (about 3 to 11 mm long); bristling ranges from weak to strong and some species are densely setulose. The ground colour is usually black, brown or yellow, but some are strikingly bicoloured; some are densely grey or yellow pruinose. The head is normally higher than long, with the frons of equal width in males and females. There are 1 to 3 orbital bristles and 1 to 6 frontal bristles; the latter are curved inward. Also present are ocellar, postocellar and inner and outer vertical bristles. The parafacial area is bare; the vibrissa is weak or strong and there are few to many weaker bristles and setulae nearby. The compound eyes are bare. The second antennal segment has a distinct seam above; the third segment is two to five times longer than wide, usually rounded at the tip and sometimes with a long bristle near the base of the arista. The arista is three-segmented, straight or rarely elbowed, and bare or feathery. The bristles of the thorax are normally rather strong, but those on the disc of the scutum are sometimes short and setae-like. The postpronotum usually has one or two bristles; there are normally two presutural and three postsutural dorsocentral bristles. The scutellum rarely has more than two pairs of marginal bristles. The wing venation is rather

constant; the costa has costagial, humeral and subcostal breaks, the subcosta is complete and vein R_1 joins the costa before the middle of the wing. Vein R_{4+5} meets the costa at about the wing tip and the costa ends at vein M_1 . Vein A_1 is usually complete, but sometimes ends before the wing margin. The wings are normally clear, but sometimes spots or bands occur. The legs are slender; bristles vary from weak to strong. The front femur and tibia sometimes bear short black setae below and are sometimes highly modified in males. The abdomen is slender, but in males is frequently enlarged at the tip; the first and second tergites are fused.

Only some species of dung flies develop in dung. Larvae of the large and common genus *Scathophaga* Meigen mostly do so, although some larvae feed in rotting seaweed on ocean beaches. Other Scathophaginae feed in a wide range of plants, especially monocots including *Scirpus* Linneaus and *Juncus* Linneaus. Still others are predators in water, wet soil or plant tissues. Larvae of the subfamily Delininae mine in the leaves of plants in the lily and orchid families. Adults prey on insects and other small invertebrates.

The Family Scathophagidae has often been treated as part of the Anthomyiidae or Muscidae. Its approximately 260 named species are almost completely restricted to the Holarctic region -- about 35% of North American species also occur in the Old World and only about five species are known south of the equator. There are 37 genera and about 150 described species known from the Nearctic. It is, in general, the most northerly distributed of any fly family; about 25 North American species are confined to the arctic tundra. There are about 23 genera and 50 described species known to occur in BC based on published records and collections of BC Diptera. The most speciose genera in BC are *Cordilura* Fallén (12 species) and *Scatophaga* Meigen (10 species) in the Scathophaginae. In North America these genera have 42 and 29 species respectively. *Cordilura confusa* Loew, *C. fuscipes* Zetterstedt, *C. gracilipes* Loew and *C. latifrons* Loew are all boreal species and common in most of BC. The most familiar species of *Scathophaga* is *S. stercoraria* (Linnaeus), a large, golden species common around dung everywhere; it can be abundant in seabird colonies. *S. furcata* (Say) is also Holarctic and widespread. *S. frigida* Coquillett and *S. intermedia* Walker are common seabeach species. Other examples of BC species in the subfamily include *Brooksiella varicornis* (Curran), *Chaetosa punctipes* (Meigen), *Gimnomera tibialis* (Malloch), *Megaphthalma pallida* (Fallén), *Megaphthalmoides unilineata* (Zetterstedt), *Microprosopa diversipes* Curran and *Pogonota gilvipes* (Loew). The subfamily Delininae is represented in BC by at least six genera; of which five only have one species known from BC -- *Parallelomma vittatum* (Meigen), *Delina nigrita* (Fallén) and *Hexamitocera loxocerata* (Fallén) are Holarctic and boreal; *Synchysa tricincta* (Loew) is boreal and *Peratomyia vittata* (Coquillett) is western in distribution. In BC the genus *Nanna* contains at least three species including *N. pallidipes* (Malloch) and *N. similis* (Coquillett) which range transcontinentally in the boreal forest.

Family ANTHOMYIIDAE (Root-Maggot Flies) [Fig. 49]

Anthomyiids are small to medium-sized flies (2 to 12 mm long), usually yellow, brown, grey or black and without any metallic sheen. The compound eyes are usually

well-separated in females, often meeting above in males; they are bare to densely pilose. The frons bears frontal, vertical and ocellar bristles; flies with separated compound eyes normally also have orbital bristles. Vibrissae are present. The antenna has a quadrate or oblong third segment and the arista is bare to plumose. The scutum normally has paired postsutural acrostichal bristles, one or two pairs of presutural dorsocentral bristles and one to four pairs of postsutural dorsocentrals. There are always two notopleural bristles. The scutellum has a pair of basal and a pair of apical bristles; there are normally setulae on the underside. The costa reaches the tip of vein M_1 . Cell r_{4+5} is broadly open at the wingtip and vein A_1 is usually traceable to the wing margin. The legs are slender and bristly. The base of the first segment of the hind tarsus bears a strong bristle underneath. The abdomen is usually cylindrical and more or less conical. Sternite 5 in males is bilobed; the female ovipositor is usually tubular.

Adult root-maggot flies can be common on flowers; the larvae mostly feed in the roots, stems, leaves and flowers of living or decaying plants. The nonspeciose subfamily Fucelliinae contains marine beach species whose larvae feed on seaweed washed ashore; adults swarm in large numbers around these piles of wrack. The rest of the family comprises the subfamily Anthomyiinae, a diverse group living in many varied habitats. The most obviously economically important species are pests attacking crops. *Pegomya hyoscyami* (Panzer) (Spinach Leaf Miner), *Delia antiqua* (Meigen) (Onion Maggot), *D. platura* (Meigen) (Seed Corn Maggot) and *D. radicum* (Linnaeus) (Cabbage or Radish Maggot = *Hylemya brassicae* (Bouché)) are introduced European species now widespread across the northern temperate regions. Other species attack many cultivated plants. Many more species, however, are certainly important in pollination and in the recycling of organic matter. Some are scavengers living on the dung of mammals and birds, others are parasites or inquilines in the burrows of tortoises and rodents, and species of *Leucophora* Robineau-Desvoidy live in the nests of solitary bees and wasps, especially in dry, sandy habitats. Many species, such as some *Hydrophoria* Robineau-Desvoidy, are common in and around wetlands of all sorts and some larvae are aquatic. Still others breed in the fungi of forests and meadows.

The Family Anthomyiidae is cosmopolitan in distribution, but is especially diverse in the Holarctic region. The family often has been treated as a subfamily of the Muscidae and many authors include the Scathophagidae as a subfamily within the Anthomyiidae. There are 41 genera and over 700 described species in the Nearctic of which 30 genera and over 200 species are recorded in BC. The subfamily Fucelliinae (19 North American species) is represented in BC by several species of *Fucellia* along Pacific beaches, including *F. separata* Stein which is common on the sand beaches of western Vancouver Island. The Anthomyiinae contains a number of diverse genera in BC -- *Delia* Robineau-Desvoidy (77 species recorded in the province), *Pegomya* Robineau-Desvoidy (23 species), *Zaphne* Robineau-Desvoidy (14 species), and *Lasiomma* Stein (12 species) are among the most speciose. The principal introduced pests of vegetables are common in BC -- *Pegomya hyoscyami* (Panzer), *Delia antiqua* (Meigen), *D. platura* (Meigen) and *D. radicum* (Linnaeus). *Strobilomyia neanthracina* Michelsen, the Spiral Spruce-cone Borer, damages the seeds of White Spruce in northern and central BC, causing considerable losses in seed crops in some years. *Pegomya bicolor* (Wiedemann) is a Holarctic species that ranges over most of North America; it mines in the leaves of

species of *Rumex* Linnaeus. *P. carduorum* Hockett larvae mine in *Cirsium* P.Mill. (thistles). *Anthomyia pluvialis* (Linnaeus) is a widespread Holarctic species; the top of the thorax is pale grey marked with large dark spots. The larvae have been found in birds' nests. Nine species of *Leucophora*, bee and wasp parasites, are recorded in BC; these include *L. cinerea* Robineau-Desvoidy, a Holarctic species of the western mountains and the boreal *L. maculata* (Stein).

Family MUSCIDAE (Muscid Flies) [Fig. 50]

Muscid flies are slender to stocky, 2 to 14 mm long and usually bristly. Their colour ranges from yellow to grey or black, but some are metallic blue or green. In a few cases the flies are brightly setulose. The wings are usually unmarked, but some have clouded crossveins. The head is usually higher than long with the frons in males narrow to broad and its central plate sometimes strongly reduced; the frons in females is at least 25% as wide as the head with the central plate always distinct and normally wider than the fronto-orbital area. There are one to many frontal bristles curved inwards. The parafacial area is usually bare, but the vibrissa is normally strong and has associated bristles or setulae. The face is usually flat or concave, rarely with a medial ridge or tubercle on the upper part. The third antennal segment is at least twice as long as broad and usually rounded at the tip; the arista is 3-segmented, bare to plumose or rarely comb-shaped. The thoracic bristles are usually long and prominent; there are normally 1 to 2 presutural and 3 to 4 postsutural dorsocentral bristles. The scutellum usually bears two pairs of marginal bristles; there is rarely an isolated group of setulae on the underside of the apex. The costa has costagial, humeral and subcostal breaks; the costa usually ends where vein M_1 meets the margin. Vein M_1 is more or less parallel to vein R_{4+5} or is bent forward; vein A_1 never reaches the wing margin. The legs are usually slender with varied bristling; the base of the first tarsal segment of the hindleg lacks the distinctive ventral bristle characteristic of most anthomyiids. Both sexes have five exposed abdominal tergites usually bearing strong marginal bristles.

Larvae develop in many habitats, from dung and decaying plant matter to carrion and fungi. They are found in the nests of bees, wasps, birds, mammals and other animals. Others live in fresh water or soil of many sorts; a very few develop in living plant tissue. Most evidently feed on excrement, decaying organic matter and the micro-organisms that inhabit this material; some are known as predators of insect larvae or other invertebrates. A few species such as *Fannia canicularis* (Linnaeus) (Lesser House Fly) and *F. scalaris* (Fallén) (Latrine Fly) can invade the human body and cause intestinal and other myiasis. The food of adults is also varied. They feed on dung or decaying organic matter, plant sap, honeydew and pollen. Some are predators of insects; others suck vertebrate blood or feed on the exudates of mammals and other animals. Those species that feed on human feces and food, such as *Musca domestica* Linnaeus (House Fly) can spread human diseases such as typhoid fever, cholera and dysentery.

Muscid flies are widespread around the world, occurring on all continents and most oceanic islands. To conform to the generic level keys in the Manual of Nearctic Diptera we have maintained the broad definition of the family. Often now the subfamily Fanniinae is considered to be a separate family (Fanniidae). About 4300 species in about

180 genera are described with 4 genera and about 270 described species of those in the Fanniinae and the rest in the Muscidae in the strict sense. Many species live on the arctic tundra and about one quarter of the Nearctic species, especially the northern ranging ones, are naturally Holarctic in distribution. Fifty-three genera and 727 described species (of which 4 genera and 113 species are in the Fanniinae) occur in the Nearctic and 34 genera and about 210 species are recorded in BC. Of these BC records, 4 genera and 57 species are in the Fanninae. The genus *Fannia* Robineau-Desvoidy itself is the most diverse muscid genus in the province, with 53 known species, about half the North American *Fannia* fauna. The most familiar species of the genus is *F. canicularis* (Linnaeus); it is closely associated with humans, although it is less dependent on human habitations than is *Musca domestica* Linnaeus (the House Fly). It often replaces the latter species around houses in subarctic regions. As in other species of *Fannia*, the males hover in small swarms near the lower branches of trees; *F. canicularis* males also fly in circles under ceiling fixtures in houses. Although it is most commonly found breeding in excrement and decaying garbage around human dwellings, this species also breeds in bird and rodent nests and wasp and bumblebee colonies. Other *Fannia* species in the province develop in such habitats, too, but most commonly the genus breeds in mushrooms, leaf litter, decaying vegetation and animal carcasses.

Other speciose muscid genera in BC include *Spilogona* Schnabl (25 species), *Coenosia* Meigen (20 species), *Helina* Robineau-Desvoidy (27 species) and *Hydrotaea* Robineau-Desvoidy (16 species). *Hydrotaea* species, especially males, have a distinctive hovering and soaring flight; some species, in BC including *H. armipes* (Fallén), *H. meteorica* (Linnaeus) and *H. scambus* (Zetterstedt) annoy people by landing on them and feeding on perspiration and the secretions of the eyes, nose and mouth. *H. armipes* also often feeds from wounds on large mammals caused by horse fly bites. *Hydrotaea leucostoma* (Wiedemann), the so-called Dump Fly, can be common in urban areas; it breeds in garbage and dung and preys on housefly larvae in such habitats. Adults of the genus *Lispe* Latreille are predators of other insects and fly actively near water, often perching on rocks in streams. There are at least four species in BC; *L. tentaculata* (De Geer) is Holarctic and transcontinental in distribution while *L. salina* Aldrich is western. *Phaonia* has at least 8 described species in BC. *Phaonia pallidosa* Hockett is all orange while *P. caerulescens* (Stein) is metallic blue-black and superficially resembles a blow fly; both range from BC to California. The Holarctic and common *Neomyia cornicina* (Fabricius) is a striking, bright metallic green muscid that, at first glance, also can be mistaken for a calliphorid. Its larvae, an unusual blue colour, live mostly in cow dung. *Mesembrina latreillii* Robineau-Desvoidy is an easily recognized muscid, 10 to 12 mm long, metallic black and with bright yellow-orange wing bases. Its close relative, *M. solitaria* Knab also has golden wing bases, but is notable for its dense and colourful body setulae -- mostly golden on the top of the thorax and the rear half of the abdomen, black underneath and at the abdomen base. The former species ranges across the northern parts of the northern hemisphere, but the latter is restricted to North America; both develop in dung.

Musca domestica is the notorious House Fly, common now over much of the earth and certainly widespread in BC. *Musca autumnalis* De Geer is a European immigrant, first recorded in North America in 1952; it prefers moist shady pastureland

and breeds in cow dung, which the House Fly avoids. Called the Face Fly because it commonly feeds on fluids from the eyes and nostrils of cattle, *M. autumnalis* frequently gains notice for its habit of overwintering in buildings. *Muscina stabulans* (Fallén), which occurs throughout the province, acts a bit like a calliphorid fly, often entering houses and laying eggs in fresh or cooked meat. It can be a parasite of insect pupae and of nestling birds and is known to cause intestinal myiasis in humans. Several muscids suck the blood of vertebrates. In BC the main culprit is *Stomoxys calcitrans* (Linnaeus), the Stable Fly, a cosmopolitan pest that lays its eggs in mouldy hay bales and rotting vegetation of various sorts; it is a fierce biter of cattle and people. The other common biting muscid in BC is *Haematobia irritans* (Linnaeus), a common range species that breeds in cattle dung and feeds on the blood of these animals. Because the flies often rest at the base of the hosts' horns, the species has been dubbed the Horn Fly.

Superfamily OESTROIDEA

Family CALLIPHORIDAE (Blow Flies) [Fig. 51]

Most species of blow flies are stocky, medium-sized to large, 4.0 to 16 mm long, with bodies partly or completely metallic blue, green, black or brassy. Less frequently, they are small, slender and without metallic coloration. The sexes often differ distinctly in colour. The head is distinctly higher than long and the compound eyes in males rarely meet above, although the frons is narrower than in females. The lunule is bare and shining; the frontal setae reach forward to the second antennal segment; the frons usually is finely setulose. The vibrissa is strong and the gena is thickly setulose. Females have one backward-curving orbital bristle above and two forward-curving ones below. Ales lack frontal and outer vertical setae. The antenna has the arista long plumose on at least the basal two-thirds. Thorax with two notopleural setae; usually two or three anterior and posterior dorsocentral bristles are present. The scutellum has one to three pairs of lateral bristles; the apical pair is usually strong. The subscutellum is weakly developed or absent. The wing has the bend of vein M right-angled or acute; cell r_{4+5} is almost always open at the wing margin.

Blow flies are predominantly flesh-eaters as larvae. The most familiar blow flies, the common species called bluebottles and greenbottles, lay eggs on carcasses of all kinds and also are attracted to fresh and cooked meats and dairy products indoors. The restless flying around in rooms, so commonly seen, is mainly a search for places to lay eggs. The term "blown" refers to meat that has had blow fly eggs laid on it. The development of some species, such as *Phormia regina* (Meigen) and various species of *Calliphora* Robineau-Desvoidy, on human corpses is frequently monitored in establishing the time of death in murder cases. Some species are also attracted to excrement and can transmit digestive system pathogens. Most economically important are those species whose larvae are called screwworms (*Lucilia* Robineau-Desvoidy, *Phormia* Robineau-Desvoidy, *Protophormia* Townsend, *Cochliomyia* Townsend, and others). Eggs are laid in body orifices, on wounds or soiled hair and wool, especially on domestic animals. Cattle and sheep are particularly vulnerable and significant mortality can occur. Some species of *Lucilia* also attack amphibians, with often deadly results. The larvae of *Protocalliphora* Hough and *Trypocalliphora* Peus suck the blood of nestling birds of a huge range of

species from eagles and owls to swallows, bluebirds, warblers and sparrows; these parasites can be troublesome in nest boxes. Species of *Pollenia* Robineau-Desvoidy (cluster flies) often overwinter in the attics and outer walls of houses and other such places; large numbers often get trapped in the spring when they try to escape to the outside. Females lay eggs in the soil and the larvae attack earthworms. Some genera, such as *Angioneura* Brauer & Bergenstamm, are internal parasites of land snails. Adult blow flies visit flowers or rest on foliage, usually in the sun and, when attracted to carrion nearby, their buzzing can be loud and noticeable. Many calliphorids are easy to rear and some species are regularly used in laboratories studying insect physiology and other aspects of insect biology.

The Family Calliphoridae ranges worldwide, with about 1000 described species in 150 genera. About 80% of the species are from the Old World; Africa is especially diverse. There are only 17 genera and about 95 species known in North America, although there has been much lumping of species and genera. There are 11 genera and about 35 species known to occur in BC based on published records and collections of BC Diptera. About seven species of *Calliphora* are known in BC. The European *C. vicina* Robineau-Desvoidy and *C. vomitoria* (Linnaeus) are now widespread in many parts of the world and are common around many BC homes; *C. terraenovae* Macquart and *C. lilaea* (Walker) are found over much of North America, as is *Cynomya cadaverina* (Robineau-Desvoidy). The five species of *Lucilia* in the province are of two groups: the Holarctic *L. silvarum* (Meigen) and the western North American *L. elongata* (Shannon) and *L. thatuna* (Shannon) attack frogs and toads; the Holarctic *L. illustris* (Meigen) and the now cosmopolitan *L. sericata* (Meigen) are the well known greenbottles that breed in carrion and excrement, sores and wounds. *Phormia regina* (Meigen) is a very common fly around the temperate parts of the northern hemisphere; the dark green-black fly is abundant around carrion and corpses and is a frequent invader of living flesh in animals. *Protophormia terraenovae* (Robineau-Desvoidy) is widespread across the continent, but is especially abundant in the North where it is a pest of caribou. *Pollenia rudis* (Fabricius) is the most abundant cluster fly in BC, most obvious in early spring when it basks on the sunny sides of buildings. Fourteen of the 25 species of Nearctic *Protocalliphora* species develop in birds nests in BC. *Trypocalliphora braueri* (Hendel), widespread in BC on a great range of bird species, should probably be maintained in *Protocalliphora*. The latter species and *P. cuprina* (Hall), *P. halli* Sabrosky, Bennett and Whitworth and *P. hirundo* Shannon and Dobrosky were all found in Barn Swallow nests in a colony at Qualicum Beach. *P. chrysorrhoea* (Meigen) is known from northern BC only; apparently it is restricted to the tunnel nests of Bank Swallows. *P. sialia* Shannon and Dobrosky is common in nest boxes used by bluebirds and swallows, but also attacks many other species.

Family OESTRIDAE (Bot and Warble Flies) [Fig. 52]

The Family Oestridae contains medium-sized to large (9 to 25 mm long) flies with stout, bristleless but often thickly setulose bodies. They often resemble bumble or carpenter bees. The head is broad, higher than wide in side view and the flat face is either broad and shield-shaped or strongly narrowed below the antennae. The antennae are small and sunk deeply into pits; the third segment is globular and bears an arista. The

arista is either slender and bare with a thickened base or, in *Cuterebra* Clark, feather-like and lacking the broad base. The mouthparts are small and compact, or often atrophied. The thorax is covered in short setulae or is densely long-setulose; rarely there are some weak bristles present. The legs are short, stocky and setulose; the femora and tibiae often bear some weak bristles and the tips of the tibiae and the tarsal segments usually have short, spine-like bristles. Wings with vein M highly variable -- straight or weakly curved, ending at the wing margin well behind the wing tip, or curving forward to join vein R_{4+5} just before the wing margin, or meeting the wing margin immediately behind the tip of vein R_{4+5} , or strongly angled with a prominent stump vein beyond crossvein dm-cu. The abdomen is globose to conical with shiny cuticle and long, coloured setulae or is partly or completely pruinose.

The species of the Family Oestridae are obligate parasites of mammals and most are strongly host-specific. Adults have tiny or atrophied mouthparts and apparently do not feed on sugars or protein as do other calyptrate flies. They rely on fat reserves for energy, although some species of *Cephenemyia* Latreille and *Cuterebra* evidently drink fluids by pressing the underside of the head against a damp substrate. In the subfamily Cuterebrinae the eggs are usually laid in places frequented by the host mammals and the larva enters the host through any orifice, eventually migrating to subcutaneous tissues where it feeds in the warble, a pouch formed in the connective tissue of the skin. The larva breathes through the posterior spiracles, which communicate with the outside air through a small hole in the skin. The position of the warble is often predictable; those of *Cuterebra* in mice and chipmunks are usually on the belly while those in rabbits are normally on the neck. When mature the larva drops from the host and pupates in the soil. Females of *Dermatobia hominis* Linnaeus Jr., which attacks a wide range of hosts (including humans) in the Neotropics, first catches a blood-sucking fly (such as a mosquito), on which she lays her eggs and then releases. When the fly lands on a host to bite, the eggs hatch and the larvae burrow into the host's body.

Most species of the Subfamily Gasterophilinae lay eggs on hairs around the mouth or on the legs of the host – horses, zebras, elephants and rhinoceroses. The eggs hatch spontaneously or when licked, and the larvae feed in the mouth before moving to the stomach or intestines, where they complete development. In the Hypodermatinae, which attack rodents, lagomorphs and ungulates, eggs are placed on hairs of the host's legs or flanks. The larvae of *Hypoderma* Latreille burrow into the skin, migrate through the body by various routes to the skin of the back where warbles are formed. Larvae of the Oestrinae live in the respiratory passages of a wide range of hosts including ungulates, horses, elephants and kangaroos. The eggs are retained in the female until they hatch; the young larvae are expelled within droplets of fluid onto the face of the host. In some *Cephenemyia*, at least, the larvae crawl into the mouth and enter the sinuses and throat via the palate. Bot fly larvae feed on blood and mucous and can cause severe damage to the tissues; mature larvae are coughed out of the mouth or sneezed out of the nostrils. The Sheep Nostril Fly or Sheep Bot Fly, *Oestrus ovis* Linnaeus (Fig. 52), infests the noses, sinuses and throats of domestic sheep, but evidently has not transferred to native species. It also will attack goats, dogs and, sometimes, even humans. There are some cases of larvae living in the human eye where they can damage the cornea, but apparently there they are unable to develop past the first instar.

The Family Oestridae, containing over 150 species in 28 genera, is widespread on all the major continents but is most diverse in Africa and central Asia. The African Elephant alone supports five species. Although all the subfamilies except the Gasterophilinae have native representatives, the fauna of North America is much poorer, with six genera and 41 described species. The four subfamilies noted here sometimes have been treated as separate families. The Subfamily Cuterebrinae contains flies whose larvae form warbles under the skin of rodents, lagomorphs, monkeys, livestock and humans. The unusual *Dermatobia hominis* is sometimes brought back to BC as larvae, burrowed under the skin in various parts of the body, by unwitting tourists who have spent time in tropical America. The largest genus in the subfamily, and the family as a whole, is *Cuterebra*, with over 60 species that develop in rodents and lagomorphs. Six species of these big blackish flies are recorded in BC, including *C. fasciata* Swenk, which develops in squirrels and chipmunks, and the widespread *C. grisea* Coquillett, a common parasite of *Peromyscus* mice that ranges from BC to Nova Scotia south to New Jersey and Utah.

The horse bots of the Subfamily Gasterophilinae are Old World species, but three are now cosmopolitan, having been introduced with the horse to many regions. *Gasterophilus haemorrhoidalis* (Linnaeus), *G. intestinalis* (De Geer) and *G. nasalis* (Linnaeus) all are recorded in the digestive tracts of BC horses. The subfamily Hypodermatinae is represented in North America (and BC) by one native species, the Holarctic *Hypoderma tarandi* (Linnaeus), which attacks caribou, and the introduced and cosmopolitan *H. bovis* (Linnaeus) and *H. lineatus* (Villers), which are parasites of domestic cattle. The adults of these flies are setulose and bee-like with the base of the abdomen having black setulae and the apical half red setulae. The persistent attacks of *H. bovis* cause cattle to panic and stampede. In BC the Subfamily Oestrinae contains three species: *Oestrus ovis* Linnaeus, a grey, black-spotted fly introduced on domestic sheep; *Cephenemyia apicata* Bennett and Sabrosky, ranging from BC and Alberta south to Montana and California on Mule Deer; and *C. jellisoni* Townsend distributed from BC to Ontario south to Texas and California on Moose, Elk and Mule Deer.

Family SARCOPHAGIDAE (Flesh Flies) [Fig. 53]

Species of the family Sarcophagidae are robust, mostly grey flies ranging from 2.5 to 23 mm long. The thorax is usually has three dark stripes on top and the abdomen is striped, banded or spotted with markings that shift tones depending on the angle of the light. The abdomen is sometimes partly red. The head is wider than high and, in side view, usually a little higher than long. The compound eyes are bare. The fronto-orbital area usually has sparse setulae, but the central part of the frons is normally bare. There about 4 to 10 frontal setae and one to three orbital setae curving backward, two to four curving forward; these last setae are usually missing in males in the Sarcophaginae. The face is concave and lacks a central ridge. Vibrissae are present. The antennal arista is bare or finely setulose (most Miltogramminae) to plumose, especially on the basal half or two-thirds (most Sarcophaginae). On the thorax, there are normally 3 to 4 anterior and 3 to four posterior dorsocentral bristles. The scutellum has 2 to 3 pairs of lateral setae and one pair of discal setae; if a pair of apical setae occurs, they are small. The wing has the origin of vein R_{4+5} setulose above and below, with the setulae continuing toward

crossvein r-m above. Any extension at the bend in vein M is usually not developed, but is merely present as a short, darkened fold.

Flesh flies lay larvae or eggs that are ready to hatch. Larvae of the tribe Miltogrammini in the subfamily Miltogramminae are deposited by adult females at the entrance to the nests of burrowing solitary bees and wasps; the larvae feed on the provisions in the cell and sometimes kill the host's egg or larva. *Eumacronychia* attack lizard and turtle eggs and *Macronychia* parasitize adult tabanid flies. Species of the tribe Paramacronychiini (subfamily Miltogramminae) and the subfamily Sarcophaginae are obligate parasites or scavengers that become facultative parasites in a wide variety of animals, mostly arthropods – Orthoptera, Coleoptera, Lepidoptera and, to a lesser extent, Neuroptera, Hemiptera and Hymenoptera. Some attack scorpions, spiders, myriapods and snails. Others can develop in excrement. A few species are implicated in myiasis of the human flesh, but most are considered secondary invaders of wounds and sores. The exception is species of the genus *Wohlfahrtia* Brauer & Bergenstamm (including the BC species) which lay larvae on the skin of the young of healthy mammals, including human infants; the larva breaks the skin and feeds subcutaneously. The association of the family with humans is limited, however, and it has not gained the notoriety of the blow flies or some muscids, such as the House Fly. A few species are economically beneficial. *Sarcophaga aldrichi* Parker attacks the pupa of *Malacosoma disstria* Hübner (Forest Tent Caterpillar) and is a major control agent of this defoliating pest. Others are significant in the control of crop-damaging grasshoppers. Adults feed at sources of nectar, sap and honeydew; males, especially, often visit flowers. Males also often perch conspicuously on various surfaces waiting for females to fly by.

There are over 2500 named species of sarcophagids worldwide, placed in 108 genera. The number of genera cited for the family depends mostly on how the speciose genus *Sarcophaga* Meigen is subdivided; in its broad sense, *Sarcophaga* contains almost 800 known species. There are about 50 genera and 390 species described in the Nearctic; with 22 genera and about 90 described species known for BC from the published literature and collections of BC Diptera. Species of the tribe Miltogrammini, that parasites and live asinquilines in bee and solitary wasp nests, are common in BC. There are eight genera with numerous species recorded for BC with these habits. *Amobia oculata* Zetterstedt is Holarctic and widespread in North America; it develops in nests of sphecids wasps such as *Sceliphron* Klug and *Trypoxylon* Latreille and eumenid wasps such as *Symmorphus* Wesmael, and *Eumenes* Latreille. At least three species of *Metopia* Meigen are recorded in the province; one, *Metopia argyrocephala* (Meigen), which ranges over most of the continent as well as in Eurasia, attacks the underground cells of *Sphex* Linnaeus and the halictid bees of the genus *Lasioglossum* Curtis. *Senotainia trilineata* (Wulp) adults are often found on flowers; at least some populations develop in the nests of *Bembix* digger wasps. *Taxigramma hilaella* (Zetterstedt) deposits larvae in the nests of ground-nesting sphecids wasps where they feed on the noctuid moth caterpillars provisioning the cells.

In BC the subfamily Sarcophaginae is predominantly represented by three genera – *Sarcophaga* Meigen (with 18 species known), *Blaesoxipha* Loew (with 25 species known) and *Ravinia* Robineau-Desvoidy (with 8 species known). Species of *Ravinia*

mainly develop in excrement. For example, the common and widespread *R. lherminieri* Robineau-Desvoidy has been reared from cattle dung. Grasshoppers are the main targets of *Blaesoxipha*. In BC, *B. opifera* (Coquillett), a western species, is one of the most abundant flesh flies in the dry Interior, where it attacks species of *Melanoplus* Stål. Other species with the same hosts include *B. aculeata* (Aldrich), *B. atlanis* (Aldrich), *B. falciformis* Aldrich, *B. hunteri* (Hough) and *B. kellyi* (Aldrich). The females of the latter species strike grasshoppers in flight, depositing a larva under the open hindwing. *Melanoplus sanguinipes* (Fabricius) (Migratory Grasshopper), one of the most common grasshoppers in the province, is attacked by at least 14 different sarcophagid species. Species of *Blaesoxipha* parasitize insects other than Orthoptera; for example, *B. eleodis* (Aldrich), a widespread western fly, uses several species of the abundant tenebrionid beetle genus *Eleodes* Eschscholtz as hosts. *Sarcophaga aldrichi* Parker is common across the forests of Canada and the United States where the forest tent caterpillar is found; the fly sometimes occurs in outbreak numbers with its host and can become a pest around forest campsites. It places its larva on the moth's cocoon; it also attacks spruce budworms. *S. cooleyi* Parker is a scavenger that breeds in human excrement and much other garbage; the remains of fish are a favourite source of larval food. *S. sarracenioides* Aldrich is known to attack the huge wood-boring beetle, *Ergates spiculatus* LeConte, as is *Helicobia rapax* (Walker). Although it has been reared from a wide variety of hosts, this latter flesh fly is probably the main parasite of *Melanoplus sanguinipes* in BC.

Family TACHINIDAE (Tachinid Flies) [Fig. 54]

Tachinids are tiny to large flies, often strongly and densely bristled. The head takes many shapes – usually it is higher than long with a sloping frons and small antennae in holoptic males, but ranges to box-like with a horizontal frons, long face and long antennae. The frons of holoptic males is narrow and usually lacks any lower orbital bristles curving forward; almost always two pairs of such bristles occur in females and dichoptic males. Frontal bristles usually bend inward. Ocelli are rarely absent and the ocellar setae usually curve forward. The antennae range from tiny to as long as head height; the second segment bears setae on the front; the arista is normally bare, but sometimes is feather-like. The face is usually concave or flat, but sometimes convex; there is normally a strong vibrissa. In some species the labium is sometimes extremely long and slender. The postpronotum usually has four strong bristles, but there can be as few as two and as many as five. The scutum can be extensively bristled, especially in the subfamily Goniinae to almost devoid of them (many species in the subfamily Phasiinae); there are usually three presutural dorsocentral bristles and three or four postsutural ones. The scutellum usually bears three or four pairs of marginal bristles and one pair on the disc. The subscutellum is well-developed, in side view usually evenly convex from top to bottom. The meron always has a vertical row of bristles. The wings are normally transparent, but some are marked or spotted and others are all dark. Vein M is bent forward, ending in the wing margin just behind vein R_{4+5} or in vein R_{4+5} itself, thus closing cell r_{4+5} . The abdomen is variably shaped, from petiolate to broad, from convex above to flattened to globose. It is usually more or less covered with strong, erect bristles, but these are lacking in some species.

As far as is known, all the larvae of the Tachinidae are parasites of arthropods, and all except a few of these arthropod hosts are insects. The family plays a major role in the control of populations of other insect groups and many species have been used in the biological control of insect pests. Some tachinids, mostly in the subfamilies Phasiinae and Exoristinae stick a conspicuous, undeveloped egg directly on the cuticle of the host. This is considered the most primitive system of attack on an exposed host and modifications to speed up the penetration of the larvae into the host have developed. The females of most Phasiinae have abdominal structures for inserting eggs into the host's body. The vast majority of species in the Tachinidae, however, store the eggs in an ovisac (uterus) until embryonic development is complete. Unlike sarcophagids, which deposit active larvae that have hatched within the female, all tachinids lay eggs that hatch (but sometimes within seconds) after deposition. Most hosts avoid direct attack during the day while female flies are active; either the hosts are concealed in the soil, leaf litter or other substrates or are protected by silken webs, such as those produced by tent caterpillars. A female in the tribe Goniini lays thousands of minute eggs where the host will eat them along with its food; the larvae burrow into the host through the gut wall. However, most tachinids broadcast their eggs on damaged foodplants or other places likely to support their host; the larvae lie in wait for a suitable host to pass by, board it and burrow inside. Still others (tribe Dexiini) have larvae that burrow into the substrate where they hatched and actively search for the host in soil, rotten wood and other places. Most tachinids, including most species in the subfamilies Tachininae and Exoristinae, attack the larvae of Lepidoptera. The Phasiinae parasitize true bugs, especially the Pentatomidae, Coreidae, Nabidae and Lygaeidae. Beetle larvae of the families Scarabaeidae, Cerambycidae and Elateridae are hosts for the Dexiini in the subfamily Dexiinae; adult scarabs are attacked by species of *Cryptomeigenia* Brauer & Bergenstamm and adult carabids by those of *Zaira* Robineau-Desvoidy. Certain members of the tribe Blondeliini parasitize larval and adult chrysomelid beetles. The Orthoptera are hosts for several genera. The tachinine genus *Ormia* Robineau-Desvoidy is nocturnal and homes in on the songs of long-horned grasshoppers and crickets. Other genera attack stick insects, mantids, cockroaches and earwigs. A few flies are hosts – Tipulidae are parasitized by species of *Admontia* Brauer & Bergenstamm and *Siphona* Meigen and some tabanids are hosts to *Billaea* Robineau-Desvoidy. In the Hymenoptera, some leaf-feeding sawflies are known hosts, as are the adults of a few ants and some colonial wasps. There are a very few records of tachinids parasitizing centipedes, spiders and scorpions. Adult tachinids are active and eagerly search for sources of sugar; they are particularly attracted to honeydew. Some, in search of nectar, often visit flowers, especially those of the Asteraceae, and others feed on tree sap. Males of many species congregate on sunny hilltops and ridges to wait for females. Species aggregate at specific sites in these places.

In the Diptera, the Family Tachinidae is second only to the Tipulidae in the number of described species -- at least 8000 species are known worldwide. There are published records of about 303 tachinid genera containing 1345 described species in the Nearctic; with 152 genera and 393 species known from BC. The family is mainly tropical and southern parts of Canada have a more diverse fauna than regions farther north. The related family Rhinophoridae contains tachinid-like flies that share characters of primitive tachinids, calliphorids and sarcophagids; species parasitize woodlice (terrestrial isopods). There are no native North American rhinophorids, but two species, introduced

from Europe like their crustacean hosts, live in Canada. They have not been recorded in BC. Perhaps the most recognizable members of the subfamily Phasiinae in BC are the three species of *Gymnosoma* Meigen, rotund and almost bristleless flies that attack big, green *Chlorochroa* Stål stink bugs. *Gymnosoma fuliginosum* Robineau-Desvoidy is probably the most widespread species in the province. The four species of BC *Cylindromyia* Meigen are also distinctive parasites of pentatomid bugs; *C. intermedia* (Meigen) and *C. fumipennis* Bigot are the more common of these slender, red and black species. The subfamily Dexiinae includes *Uramya halisidotae* (Townsend), a black fly with grey bands on the abdomen; it has been reared from *Lophocampa argentata* (Packard) (Silverspotted Tiger Moth) and *Malacosoma californicum* (Packard) (Western Tent Caterpillar). In the Exoristinae, the genus *Gonia* Meigen (14 BC species) specializes in the speciose moth family Noctuidae; *G. porca* Williston is a widespread western species. *Compsilura concinnata* (Meigen) is considered the most polyphagous of all tachinids – it has over 200 different recorded hosts. It was introduced from Europe, mainly to control Gypsy Moth (*Lymantria dispar* (Linnaeus)) in eastern North America, but has spread west to the Pacific coast. It attacks many insects, from *Pissodes* German weevils to *Cimbex* Olivier sawflies, from *Limenitis* Schank butterflies to *Smerinthus* Latreille sphinx moths. There are eight species of *Winthemia* Robineau-Desvoidy in the province; the western-ranging *W. occidentis* Reinhard helps control *Lambdina fiscellaria* (Guenée) (Hemlock Looper). The Holarctic *W. quadripustulata* Fabricius parasitizes over 50 known moth species, including some of the most damaging cutworm moths. *Tachinomyia variata* Curran is big, black and grey and bristly; it is a major parasite the Western Tent Caterpillar. *Cyzenis albicans* (Fallén), another goniine, was introduced to southwestern BC to control Winter Moth, *Operophtera brumata* (Linnaeus), a pest of Garry Oak, fruit trees and many other plants. The subfamily Tachininae mainly has Lepidoptera hosts. The most speciose genera in BC are *Panzeria* Robineau-Desvoidy (18 species), *Tachina* Meigen (17 species) and *Peleteria* Robineau-Desvoidy (17 species).

Tachina algens Wiedemann is a particularly common BC representative of the genus *Tachina*; it is black with yellow wingbases and dense yellow setulae behind the head.

Peleteria iterans (Walker) is grey with an orange abdomen marked with black along the midline. *Adejeania vexatrix* (Osten Sacken), a western species ranging from BC to Mexico, is impressively big, orange and very bristly. *Hystericia abrupta* (Weidemann) could be described in the same way; it ranges all over North America. *Epalpus signifer* (Walker), a noctuid moth hunter, is distributed over much of North America; it is black with a prominent yellow patch at the tip of the abdomen. The three species of *Gymnocheta* Robineau-Desvoidy in the province, all restricted to the West, are strikingly metallic green or blue. The related *Chrysotachina alcedo* (Loew) also is metallic green. *Siphona*, with 11 species in the province, is a diverse group of small tachinids that mainly parasitizes microlepidoptera. *Siphona cristata* Fallén, however, attacks crane fly larvae.

Superfamily HIPPOBOSCOIDEA

Family HIPPOBOSCIDAE (Louse Flies and Keds) [Fig. 55]

Flies of the family Hippoboscidae are flattened, rather tough and leathery looking flies, ranging from 1.5 to 12.0 mm long. They are usually setulose. The head is broad and somewhat flattened; the mouthparts are thrust forward. The compound eyes are normally well developed and horizontally elongate; ocelli are either present, vestigial or absent. The inner vertical bristles are long, the outer ones are absent and the orbital bristles are few to many. The lunule is usually bare, shiny and conspicuous. The antennae are strongly modified and are more or less immovable; they lie in deep pits. The first segment is usually present, but sometimes is fused to the lunule and invisible; the rounded second segment is the largest and sometimes bears a third, flattened, segment or a spatulate or branching arista. The one-segmented palps form a sheath for the blood-sucking, retractile labium. The thorax is flattened; the scutellum is usually large, often broadly rectangular. The wings are usually fully developed, but in some genera that parasitize mammals, such as *Lipoptena* Nitzsch and *Neolipoptena* Bequaert, the wings break off after the fly settles on its host. In others, the wing is reduced to a small flap or, as in *Melophagus ovinus* (Linnaeus), which lives in the fleece of sheep, is a tiny knob. This species has lost its halteres, but they are normally present in other species. The wing veins are usually crowded forward with the posterior veins often fading towards the wing margin. Some species have greatly reduced venation. The legs are strong, rather short and often well-bristled. The coxae and femora are usually swollen; the apical tarsal segment is the largest. The tarsal claws are large and strong, simple or forked; the empodium is setulose or feathery and the pad-like pulvilli are often long and soft. The abdomen is largely membranous with tergites and sterna mostly reduced.

Hippoboscids are ectoparasites and feed on the blood of birds and mammals. The majority attack birds and are often called louse flies; those on mammals (mostly ungulates) are frequently called keds. The Sheep Ked (often erroneously called the sheep tick) is probably the only species in North America that causes any economic losses; heavy infestations of sheep sometimes result in anaemia and staining of the wool. This species was introduced from Eurasia to sheep-producing temperate environments worldwide and, apparently, no truly wild populations exist today. Those populations found on bighorn and thornhorn sheep are thought to have transferred from domestic sheep. Several species have been recorded biting humans, but this is a rare and accidental phenomenon. Most species are not host specific, but rather seem to inhabit a variety of hosts from a particular type of habitat.

Together, the Hippoboscidae, Nycteribiidae and Streblidae are sometimes called the Pupipara, because they appear to give birth to pupae. This is inaccurate, in that the fully grown larva is extruded by the female and immediately pupates afterwards. One at a time, an egg and then a larva develop in the female uterus, nourished by secretions from the so-called milk glands. A female can produce seven or eight or more mature larvae during her life.

The Family Hippoboscidae is cosmopolitan, but is most diverse in the tropics and subtropics; about 200 species are named in 21 genera. In North America, 13 genera contain 31 described species. At least 13 described species in 10 genera are known to occur in BC based on published records and collections of BC Diptera. Most are in the subfamily Ornithomyiinae and parasitize birds. *Icosta ardeae* (Macquart), a Holarctic

species, is common on various herons and bitterns and *I. nigra* (Perty) ranges from BC to Quebec and south to South America on hawks and falcons. *Ornithoica vicina* (Walker) is widespread in the New World and, on the Pacific Coast, is collected mostly on wading birds. Two species of *Ornithomyia* Latreille are recorded in the province. *O. fringillina* Curtis, widespread in the Northern Hemisphere, has been recorded on a wide range of forest birds, including Blue and Spruce grouse, Cedar Waxwing, Varied Thrush and Steller's Jay. *Ornithoctona erythrocephala* (Leach) ranges across Canada and into South America; it especially favours hawks and falcons. *Olfersia fumipennis* (Sahlberg) is a Holarctic species widespread over much of North America; it is collected regularly on Ospreys and Bald Eagles.

Species of the Subfamily Lipopteninae normally parasitize even-hooved mammals, such as deer and sheep. *Neolipotena ferrisi* (Baequert), from western North America, is the only member of its genus; it lives on deer in BC, mostly east of the Coast Mountains. *Lipoptena* has three Nearctic species, but only the western *L. depressa* (Say) occurs in the province; it is especially common on coastal deer. The introduced *Melophagus ovinus* does not fly at all. It can be a problem in BC sheep flocks and is also known from native wild sheep. *Hippobosca longipennis* Fabricius (Subfamily Hippoboscinae), an Old World species that attacks mammals of various types, including dogs, has been introduced to North America on zoo animals. Evidently, it has yet to be recorded in BC.

Family NYCTERIBIIDAE (Nycteribiid Bat Flies) [Fig. 56]

Nycteribiid bat flies are among the most specialized of all Diptera – they are wingless, dorsoventrally flattened, spider-like flies, about 1.5 to 5 mm long. The small head, when at rest, lies back on the mesonotum; during feeding it is rotated forward and downward. It is mostly a dorsally sclerotized, helmet-like capsule; much of the front and underside is membranous. The compound eye, which is sometimes absent, is usually reduced to two ocellus-like facets. The antenna appears as a single compound segment (evidently formed from the second and third segments), bearing a branching arista. The piercing-sucking proboscis is short; the palps are usually large and prominently bristled. The thorax is broad and flattened, mostly membranous above and strongly sclerotized below. The scutellum is absent but the postnotum is usually rounded and raised. Unique to the Nycteribiidae, a movable crescentic row of spines (thoracic ctenidium), is present in front of the middle coxa. The wings are absent but halteres are present, lying in a groove, which may be covered by a flap arising from the inner edge of the groove. The legs are rather long and stout, variously armed with setulae and bristles. The first segment of the tarsus is usually longer than the others combined; the last segment is usually the broadest. The claws are simple but large and stout; the empodia are absent. Normally, the abdomen has both the tergites and sterna bearing prominent rows of bristles and setulae on the hind margins.

Nycteribiids are blood-feeding ectoparasites of bats. Like species in the related Hippoboscidae and Streblidae, those of the Nycteribiidae are viviparous, giving birth to fully developed larvae. One mating produces multiple larvae; the sperm is stored in the two spermathecae -- the ovaries ovulate alternately, and one egg at a time enters the

uterus after fertilization. The larva is nourished from special glands and development takes about nine days. The female normally deposits the mature larva on the vertical surface of the bat roost, pressing it into place; the larva pupates immediately. Most species of nycterbiids are apparently bat species or genus specific although there may be considerable variation in host-parasite relationships over the range of a species of fly.

The family Nycteribiidae ranges worldwide except for the polar regions and contains about 260 described species in 13 genera. *Basilia* Ribeiro, the only genus known in North America, contains over 40 species but only five of these are recorded in North America. Almost all species of *Basilia* parasitize bats of the Family Vespertilionidae; all resident bat species in BC belong to this family. *Basilia forcipata* Ferris (Fig. 56) is the only known Canadian species; it was collected in BC on a Little Brown Myotis (*Myotis lucifugus* LeConte) in Midday Valley near Merritt. However, an apparently undescribed species of *Basilia* was collected in 1938 off a specimen of the Western Mastiff Bat (*Eumops perotis* (Schinz)) that showed up in Essondale, hundreds of kilometres north of its usual range in southern California and Arizona.

Family STREBLIDAE (Streblid Bat Flies) [Fig. 57]

Streblid bat flies are small, rather setose and bristly flies ranging from 0.75 to 5.0 mm long. They are either: compressed from side to side and flea-like, dorsoventrally flattened, or have a more typically dipteran convex body form. The head is normally small, often compressed laterally or flattened, and bearing conspicuous bristles and setulae. The compound eyes are reduced, the number of facets ranging from none to 36, but usually 7 to 11; ocelli are absent. The antennae are small, with the first segment fused to the head, the second with a furrow above and mostly concealing the oval third segment, which bears a comb-like arista. The mouthparts are piercing and sucking. The thorax varies from convex and globose (e.g. BC species in the Subfamily Trichobiinae) to slightly convex, laterally compressed or dorsally flattened; the pronotum is scarcely visible. The scutellum is normally obvious, its hind edge angulate in New World genera and bearing one to ten (usually four) long bristles. The legs are variable in length and thickness, but the hindleg is often much longer than the others. The tibiae lack apical spurs; the tarsal claws are large and adapted for clinging. Most species have fully developed wings, but some have shortened or narrowed wings and some lack them altogether. The wing veins usually have setae above and below. When well developed (as in most North American species), the veins run longitudinally; the costa ends at the apex of R_{4+5} ; the subcosta is faint, fused with R or absent. Vein R_s forks at about one-third the wing length, vein R_{2+3} ends just before the wing tip and vein R_{4+5} ends at the tip. Crossvein r-m is usually at about the midlength of the wing and dm-cu, which joins the unbranched vein M to vein CuA_1 , is near the wing tip. Veins CuA_1 and CuA_2 are fused for much of their lengths, with vein CuA_2 branching off at about two-thirds the wing length and joining A_1 near the wing margin. The abdomen is mostly membranous and sac-like, especially in egg-bearing females. Tergites 1 and 2 are fused, with strong lateral lobes bearing bristles and setulae.

Streblids are obligate, blood-feeding ectoparasites of bats; both sexes feed often and usually die quickly if deprived of blood. Females of one Old World genus,

Ascodipteron Adensamer, burrow in the host's skin and become sac-like endoparasites. Species of *Trichobius* Gervais sometimes bite humans. The larvae develop singly in the female's abdomen, where they feed on special glandular secretions. When fully grown, the larva is extruded and immediately pupates; large numbers of puparia often encrust the floors or walls of the bat roosts. Adults must feed before mating and, apparently, mating is required each time a new egg is produced. Streblids frequently parasitize colonial, cave-dwelling bats but most New World species occur on forest-roosting bats. Solitary bats are seldom attacked. Flightless streblids mostly inhabit bats that eat fish or fruit. The adults of most fully winged New World species, although highly mobile, stay close to their hosts; most are host specific or live on a few species of closely related bats.

The Family Streblidae ranges subtropically and tropically on all the main continents and oceanic islands, mostly between 40 degrees north and south. It contains about 220 species in 32 genera. There are six described species in three genera in the Nearctic. One species, *Trichobius corynorhini* Cockerell (Fig. 57), lives as far north as BC in the West and West Virginia in the East. This is the only known streblid species in Canada; it overwinters on bats hibernating in caves.

ACALPTRATAE

Superfamily CONOPOIDEA

Family CONOPIDAE (Thick-headed Flies) [Fig. 58]

Thick-headed flies are small to medium sized (3 to 20 mm long), usually rather elongate, wasp-like and lacking prominent setae or bristles. They are coloured black and yellow, black, or red-brown, frequently with pruinescence; the wings are often spotted or darkened along the front margin. The head is large, broader than the thorax; the bare compound eyes are widely separated in both sexes. Ocelli are absent in the Subfamily Conopinae but are present in other groups. The proboscis is long, elbowed at the base (Conopinae and the genus *Zodion*) or elbowed at both the base and in the middle of the proboscis. The antennae are variable: the first segment of the flagellum is elongate with a short 3-segmented stylus (Conopinae) or is short, bearing a 2- or 3-segmented arista on the upper surface. Wing with R_{4+5} and M_{1+2} strongly convergent and sometimes fused near the wing tip, closing cell R_{4+5} . A short crossvein joins Sc and R near the end of Sc in some genera. Sometimes a spurious vein occurs, running outwards from crossvein r-m. Cell cup is always closed and petiolate. The legs are almost bare and lack distinct bristles; they are rather uniform, although the femora are thickened in some genera. The abdomen is cylindrical and more or less club-shaped, broad or constricted at the base and often curving downward at the tip. In the female, the sterna of segment 5 and/or 6 are often enlarged and plate-like.

Adult conopids are frequently wasp-like in form and colour and apparently mimic various Hymenoptera. They are notorious for their variability, especially in coloration. They feed at flowers, especially of the aster, mint and carrot families. The known larvae of most genera (and all those found in BC) are internal parasitoids of aculeate Hymenoptera. Adult females deposit eggs on the hosts in flight. The Subfamily

Stylogasterinae, species of which are not known to occur in BC, parasitize cockroaches and calyptrate Diptera; females are known to hover over the front lines of army ant columns laying eggs as their hosts are flushed by the ants.

The Family Conopidae is small, with about 800 described species in 45 genera, but it is widespread over much of the Earth. In North America there are nine genera and 67 species described; many species range across the whole continent. BC has six genera and 24 described species. Perhaps the most readily seen genus in the province is *Physocephalus*, with its three rather large, red-brown species. *P. burgessi* (Williston) ranges across southern BC; and south to Texas and California; it attacks bumblebees such as *Bombus pennsylvanicus* (Degeer). *Physocephalus marginata* (Say) and *P. texana* (Williston) are transcontinental; the former is a known parasite of honeybees and latter has been found in the nests of the digger wasp, *Bembix americana* Fabricius and the bumblebee, *Bombus terricola* Kirby. *Physoconops obscuripennis* (Williston) is waspish, yellow and black, and about 1 cm long; it is known from the Thompson-Okanagan region. *Dalmannia picta* Williston, also yellow and black and from the Interior, is smaller. About six species of *Myopa* are known in BC; *M. rubida* (Bigot) is one of the more common ones, ranging south to Colorado and California. One of its hosts is the bee genus *Andrena*. *Zodion americanum* Wiedemann is a tiny (3.5 mm long) conopid distributed from sea to sea and south into southern South America. At least five other species in the genus live in BC; *Z. fulvifrons* Say, sometimes a parasite of honeybees, is known from the dry Interior. The six species of *Thecophora* recorded in BC are usually black and rather small, averaging 5mm long; *T. longicornis* (Say) ranges over most of North America.

Reference

Smith, K.G.V. 1959. The Conopidae (Diptera) of British Columbia. Proceedings of the Entomological Society of British Columbia 56: 54-56.

Superfamily TEPHRITOIDEA

Family LONCHAEIDAE (Lance Flies) [Fig. 59]

Lance flies are stout, setose, 3 to 6 mm long, with a large, wide head and a broad, flattened abdomen. The body is usually shining blue-black, sometimes dull brown; normally, the wings are clear, but often, clouded with yellow or brown. The halter is black. In lateral view the compound eyes are large and round to oval. The frons is setulose, narrower in male than in female; the lunule is large and exposed. One orbital bristle, one inner and one outer vertical bristle are present, and ocellar bristles are strong. No vibrissae are present, but some subvibrissal setae may be enlarged. Antenna with the third segment short or long and narrow, black to orange, often hanging vertically; the arista is bare, pubescent or plumose. Thorax with scutum arched, black or brown and pruinose to shining; the setulae and bristles are usually dense and strong. The scutellum has two pairs of bristles, one apical and one basal. The wing is normally strongly tapered from base to tip; C extends to M and is constricted or broken at the end of Sc; Sc is complete. Vein A₁ is short or continues toward wing margin as a sinuate fold. The upper calypter is prominent, with white to brown margins. The legs are stout and black; the tarsi

are often yellow. The femora often are strongly setose and bristled; the mid tibiae bear a bristle underneath at the tip.

Lance flies are commonly secondary invaders of injured or decaying vegetation. Larvae of *Lonchaea* and *Dasiops* often live under the bark of dead or dying trees (mainly conifers) or in damaged or rotting fruits and vegetables. Some are associated with plant-attacking insects such as bark beetles, weevils and fruit flies, where they scavenge or prey on larvae. Others may be primary invaders of plants; for example, most species of *Earomyia* infest the cones of conifer trees. Male adults of some species swarm in patches of light in woodland.

The Family Lonchaeidae contains ten genera and about 700 described species. There are six genera and about 120 named species in North America. In all, the province has about 44 species in five genera. *Lonchaea* is the most speciose genus, with about 70 Nearctic species; at least 31 of these live in BC. *Lonchaea chorea* (Fabricius), *L. flavipennis* Morge, *L. laxa* Collin and *L. zetterstedti* Becker are Holarctic; they range across the North American boreal forest. The latter preys on bark beetles in European conifers – it is widespread in BC and probably feeds on beetles in spruce trees. Some BC species restricted to the west include *L. atritarsus* Malloch, *L. foxleei* McAlpine, and *L. ursina* Malloch. Four species of *Earomyia* are recorded in BC, *E. aquilonia* McAlpine and *E. abietum* McAlpine are common; the former feeds in the cones of Subalpine Fir and Douglas Fir, the latter on Amabilis and Grand Fir. At least six *Dasiops* species live in BC. *Dasiops albiceps* (Malloch) is boreal; *D. obscurus* (Coquillett) is a western species. Also western in range is *Chaetolonchaea americana* McAlpine, the only species in the genus restricted to North America. *Protearomyia cordillerensis* McAlpine is a species of the western mountains and *P. trichopleura* McAlpine is transcontinental.

Family PALLOPTERIDAE (Flutter Flies) [Fig. 60]

Flutter flies are small to medium-sized (3 to 5 mm long), with grey or yellow bodies and brown-patterned wings. The head is higher than long with the frons broader than high and always yellow, at least on the front half. One pair of orbital bristles and strong ocellar and inner and outer vertical bristles present. The pair of post ocellar bristles is weaker and somewhat divergent. The yellow face is slightly convex, usually with a median ridge and lacks setae. There are no oral vibrissae. The small antenna has the second segment notched at the tip and bears a single bristle; the third segment is oval with a bare or short-setulose arista. The thorax is yellow to black and normally pruinose, but sometimes shining or patterned in yellow and black; thoracic bristles are prominent. The wing is rather long and narrow, usually with brown markings. Subcosta is complete; cell *sc* is always dark. The costa has three weakenings or breaks and ends just beyond its junction with *R*₄₊₅. Cell *cup* is convex at the tip; vein *A*₁ reaches or almost reaches the wing margin, at least as a fold. Tibiae and tarsi are usually yellow; the tibiae lack preapical dorsal bristles, but the middle tibia has an apicoventral bristle. The abdomen is elongate oval, yellow to dark brown and normally unpatterned.

Flutter fly larvae are apparently phytophagous or carnivorous. Some have been found in the flower buds and stems of plants in the aster and carrot families. Others live

under the bark of dead trees and prey on the larvae of long-horned and bark beetles. On Vancouver Island, *Palloptera claripennis* Malloch, has been reared from the cones of Douglas-fir, where the larvae fed on the larvae of *Contarinia* midges (Cecidomyiidae). Adults are usually seen on flowers or on the lower branches of trees and shrubs. Males vibrate their wings, giving the family its English name -- flutter flies.

The Pallopteridae is a small family, closely related to the Piophilidae and distributed in the north temperate region, temperate South America and New Zealand. Worldwide there are about 54 described extant species in 12 genera. All nine described North American species are now placed in the genus *Palloptera*; at least six of these live in BC. *P. claripennis* Malloch, *P. albertensis* Johnson, *P. subusta* Malloch and *P. terminalis* Loew range in the western mountains and valleys; *P. jucunda* Loew and *P. subarcuata* Johnson are transcontinental. There are several additional species in BC awaiting formal scientific descriptions.

Family PIOPHILIDAE (Skipper Flies) [Fig. 61]

Skipper flies are small (3 to 6 mm long) and vary in colour from metallic black or blue-black to pale brown or yellow. The head between the compound eyes, especially in front, is often yellow. Bristles are usually strong and black and the body is sometimes densely setulose. The wings are usually clear and iridescent, but some genera (eg, *Mycetaulus*) have brown-marked wings. Viewed from the side, the head is normally higher than long; the compound eyes are nearly round and lack setulae. The frons is parallel-sided, as broad as long in both sexes. There are two or three orbital bristles, the inner and outer vertical bristles are about the same size, the two ocellar bristles point forward and the postocellar bristles diverge. The oral vibrissae are usually prominent -- sometimes there are several and in *Amphipogon* they form a thick beard. The face is convex, with the antennae seated in grooves. The second antennal segment lacks a dorsal seam, but normally bears a dorsal bristle; the segment is about as long as wide, but is strikingly elongate in males of *Prochyliza xanthostoma* Walker. The third segment is oval with a bare or short-setulose arista arising near the base. The scutum normally is shiny, but is pruinose in some *Mycetaulus*; it is densely setulose to almost bare. The scutellum is sometimes flattened and occasionally bears a pair of tubercles; there are four bristles. In the wing, the costa has a subcostal break; all veins lack setae in BC species. Subcosta is complete and not fused with R; vein A₁ faintly reaches the wing margin or ends abruptly just before the edge. The tibiae lack preapical dorsal bristles, but often have other strong bristles, especially ventrally and laterally near the tip. The abdomen is shiny black to yellow and lacks a colour pattern.

Skipper flies usually develop in dead animal matter (especially dried carcasses advanced in decay) and rotting fungi. The larvae of one European species are ectoparasitic blood feeders on passerine bird nestlings. Perhaps the best-known species, *Piophilidae casei* (Linnaeus) (Cheese Skipper) infests cheeses, meats and hides and can be a serious pest in the food industry. This fly has also caused mild nasal and enteric myiasis when people have eaten maggot-infested cheese. The larvae are called skippers because they can flip into the air like little springs.

The Family Piophilidae contains 69 described species in 23 genera world wide, but is most diverse in the northern temperate regions. Over forty described North American species are placed in 14 genera, 11 of which contain Holarctic species. There are nine genera known in BC, all of which have Holarctic members, and at least 29 species including several that are awaiting formal scientific description. Described BC species include the cosmopolitan *Piophila casei* (Linnaeus), a pest of stored cheese and meat. *Actenoptera hilaella* (Zetterstedt) is Holarctic and, in North America, ranges transcontinentally; it is known from Vancouver Island. *Allopiophila testacea* Melander ranges across the western provinces; the bizarrely bearded *Amphipogon hyperboreus* (Green) is a boreal species. It develops in fungi, as do species of *Mycetaulus* such as *M. bipunctata* (Fallén), *M. nigrifellus* Melander and *M. polyperi* Melander. *Parapiophila* species are mostly shining black; *P. atrifrons* (Melander and Spuler) and *P. xanthopoda* (Melander and Spuler) are western species known from the BC Interior. *Parapiophila vulgaris* (Fallén), a Holarctic fly, has been found on the outer coast of Vancouver Island as has *Liopiophila varipes* Meigen, which, similarly, is transcontinental and Holarctic in distribution. *Prochyliza* contains at least four species in BC; *P. xanthostoma* Walker ranges across the continent and can be common around garbage. *P. brevicornis* Melander has been found on vertebrate cadavers. *Stearibia nigriceps* Meigen is Holarctic.

Family OTITIDAE (Picture-winged Flies) [Fig. 62]

The family Otitidae contains small to medium-sized flies (North American species are 3 to 12 mm long); the body is often brightly coloured and frequently metallic. The wings are banded or patterned with black, brown or yellow. The head in profile is normally higher than long; inner and outer vertical bristles, ocellar, postocellar and one or two orbital bristles usually present. Vibrissae are absent. The face is normally fully sclerotized, broad and convex. The size and shape of the antenna is variable; the third segment often has a sharp tip and the arista is long and bare to plumose. The wing has Sc complete, its tip gently curved; R_1 is bare or setulose. Cell cup usually has an acute projection at the postero-distal corner. Female has abdominal segment 7 flattened and more or less triangular; the ovipositor is sword-like.

The larvae of picture-winged flies live in decaying vegetable refuse and other organic material such as dung. Some feed under the bark of dead trees and others are phytophagous; a few, such as those attacking sugar beets and onions, are economically important. Adults can be common in moist places and meadows; they rest on low vegetation and visit flowers, fungi and tree wounds. Many vibrate their patterned wings during mating displays.

The family Otitidae consists of two subfamilies, the Otitinae and Ulidiinae, which are sometimes considered separate families. The family consists of about 800 described species in 50 genera of which 41 genera and 133 described species occur in North America. There are at least 15 genera and 23 species known from the published literature and collections of BC Diptera. The Ulidiinae is widespread in the tropics; in BC it contains the genera *Homalocephala* and *Physiphora*. The former genus contains four species in North America, all in the boreal or mountain forests; at least three, *H. albitarsis* Zetterstedt, *H. apicalis* (Wahlberg) and *H. similis* (Cresson) are recorded in

BC; the larvae are found in conifers such as pines. *Physiphora* contains two common scavenging flies, originally from Europe and now cosmopolitan -- *P. demandata* (Fabricius) develops in livestock dung in southern BC; *P. aenea* (Fabricius) also probably occurs in the province. The Otitinae is more diverse. *Ceroxys latiuscula* (Loew), the sole Nearctic species in its genus, is western, but has emigrated as far as Hawaii and Samoa. *Curranops apicalis* (Cole) ranges from BC to California. *Herina canadensis* (Johnson) is transcontinental; *H. nigribasis* McAlpine is western. *Melieria*, with barred and spotted wings, has four species in BC; one, *M. cana* (Loew), is Holarctic. *Seioptera vibrans* (Linnaeus) is Holarctic; the larvae feed on decaying potatoes and onions. *Tetanops myopaeformis* (Röder) is a pest of sugar beets in the West. Other BC genera include *Otites*, *Pseudotephritis*, *Psaeroterella* and *Tritoxa*.

Family PLATYSTOMATIDAE (Platystomatid flies) [Fig. 63]

Platystomatids are small to medium-sized flies (3 to 12 mm long), with bodies often brightly metallic and wings usually strongly banded. The head is higher than long, with the number of bristles reduced; there are one or two orbital bristles, an inner and outer vertical bristle and a single genal bristle. The third antennal segment is usually elongate, sometimes with a sharp point at the tip, and bearing a slender arista, either bare or setose.

The proboscis and palps are well developed. Thorax with at most one pair of dorsocentral bristles; two or three pairs of scutellar bristles present. The wing is normally long and slender; C with break near base, but no subcostal break near end of Sc. Vein Sc is complete; vein R1 is setose above. Cell cup is always rounded at the tip, never with a pointed extension at the lower end.

Little is known of the life histories of platystomatid flies, but the lives of adults and larvae are probably much like those of the Otitidae. In other parts of the world, adults frequently visit mammal dung; larvae live in logs and vegetation damaged by other insects or attacked by fungi.

Closely related to the Otitidae (and in the past classified as a subfamily within it), most of the 119 genera and 1200 described species of Platystomatidae are found in tropical and subtropical Africa, Asia and Australia. North America records 41 species in four genera, by far the largest being the world-wide genus *Rivellia*. Two platystomatid species are known in BC. *R. maculosa* Namba ranges from the southern Alberta Rocky Mountains east to North Carolina and Florida and is likely to be found in BC. *Senopterina foxleei* Shewell lives from BC to the US Southeast. Other species, yet to be recorded, probably occur in the province.

Family TEPHRITIDAE (Fruit Flies) [Fig. 64]

Small to medium-sized and often brightly coloured, tephritid flies usually have wings banded or spotted in various patterns. The head is variable; in some exotic species the compound eyes are stalked. Usually one pair of inner and outer vertical bristles occur, along with one pair of postocellars and ocellars and one to several pairs of orbital and

frontal bristles. The latter two types of setae are sometimes thickened or flattened. Vibrissae are absent. The second antennal segment sometimes bears a seam on top and the third segment is often pointed on the upper end; the arista is usually bare or finely setulose. The proboscis is sometimes long and elbowed. The scutellum is swollen and shining in some genera, with 1-4 pairs of bristles, normally on the margin. The bristles on the scutum are variable, but there is always at least one pair each of dorsocentral and acrostichal bristles. The wing has a distinctive Sc bent sharply forward toward the costa and weakened after the bend, often not reaching the costa. Vein R_1 always bears short setae above. The cell cu_1 usually has an acute projection on the hind margin. Colour patterns usually present, ranging from almost entirely dark brown or black to combinations of bands, stripes, spots or reticulations in black, browns and yellows.

Adult female fruit flies lay eggs in living, healthy plant tissue and the developing maggots feed in a wide variety of plant parts, depending on the species. Some form galls on stems and roots; a few tunnel in leaves; others develop in the fruits, seeds and ovaries, especially in plants of the huge aster family. Those that attack fruits and vegetables can be severe agricultural pests. One of the worst, *Ceratitis capitata* (Wiedemann) (Mediterranean Fruit Fly) does not occur in BC. The Tephritidae is among the most economically important fly families, not only because of its destruction of useful plants, but also because many species are extensively used in the biological control of weeds. Adults are frequently seen on their host plants, walking around and raising and lowering their patterned wings.

The Family Tephritidae is a speciose cosmopolitan family of about 4350 known species, in 481 genera; 62 genera and about 361 species are known in the Nearctic. In BC there are at least 70 species in 24 genera based on the published literature and collections of BC Diptera. The genus *Rhagoletis* is important economically; many of the species attack agricultural crops. Adults are usually dark bodied, with the wing marked with three more or less transverse bands, the outer one extending along the front of the wing apex. *Rhagoletis indifferens* Curran (Western Cherry Fruit Fly) first appeared in Okanagan cherry orchards in 1968. Its principal host is the native *Prunus emarginata* Douglas; *R. fausta* (Osten Sacken) (Black cherry Fruit Fly) is much less common. *R. basiola* (Osten Sacken) is widespread on wild roses, *R. berberis* Curran attacks Oregon Grape and *R. ribicola* Doane feeds on currants. *R. tabellaria* (Fitch) develops in currants and juniper berries, *R. zephyria* Snow in snowberries (*Symphoricarpos*). *Euphranta canadensis* (Loew) attacks gooseberries and currants all over North America; it is yellow with green eyes and narrow bands on the wings.

Many of BC's fruit flies breed in flower heads, especially in plants of the Family Asteraceae; *Trupanea californica* Malloch and *Campiglossa variabilis* (Doane), from the valleys of the southern Interior, are examples. Others include *C. genalis* (Thomson), developing in *Senecio* and other genera, *C. murina* (Doane) in *Chrysothamnus nauseosus* (Rabbitbrush), *Euaesta aequalis* (Loew) in *Xanthium strumarium* (Common Cocklebur), *Tephritis angustipennis* (Loew) (Fig. 64) in *Achillea millefolium* (Yarrow), *T. araneosa* (Coquillett) in *Artemisia* (sages) and *Arnica* and *Terellia occidentalis* (Snow) and *T. ruficauda* (Fabricius) in *Cirsium* (thistles). *Urophora affinis* Frauenfeld and *U. quadrifasciata* (Meigen) were introduced from Eurasia into the grasslands of the southern

Interior to combat the noxious *Centaurea diffusa* (Diffuse Knapweed) and other knapweeds. Together they have reduced seed production of diffuse knapweed by 86 %. *Eurosta* species have broad wings speckled with yellow; they make root and stem galls. *E. solidaginis* (Fitch) makes globular galls on the stems of goldenrod plants. *Eutreta diana* (Osten Sacken), with a bright rufous abdomen and brown wings with clear spots, produces galls on *Artemisia tridentata* (Big Sagebrush).

Family PYRGOTIDAE (Pyrgotid Flies) [Fig. 65]

Pyrgotids are medium to large flies (wings 6-18 mm long), relatively slender, usually with strongly patterned wings. Head is usually prominent and rounded although sometimes tapering ventrally; face often broad with a medial pronounced ridge. Mouthparts, palpi, and compound eyes normal; vibrissae and ocelli absent. Head bristling often greatly reduced with the exception of the inner vertical bristle which is always distinct, ocellar and postocellar setae sometimes well-developed (BC species). Antenna generally large, with an elongate pedicel; flagellomere somewhat oval in shape, with a medial to near basal, bare arista. Dorsal thoracic bristles generally reduced giving thorax a setulose appearance.

Wing long, with a humeral break and sometimes a subcostal break in the costa; subcosta usually reaching costa. Wing with either a distinct banding pattern, like some Tephritidae, or with a more diffuse mottled colouring. Cell dm long, cell cup with lower apical corner straight (1 North American species) to having a long pointed corner (most species including the BC species). Alula and calypteres well developed (BC species) to virtually absent. Legs long, but robust; strong bristles lacking; hind tibia of BC species with basal third much smaller in diameter than apical two-thirds. The abdomen of the female is greatly elongate and highly modified to lay eggs onto adult scarab beetles while in flight. Larval pyrgotids are internal parasites of adult scarabs and some pyrgotid species are known to help control population levels of some species of pest scarabs. As the scarabs fly at night, generally it is most effective to collect pyrgotids at night using light traps when the flies are actively pursuing hosts.

There are about 330 described species in 50 genera worldwide, with 8 species in 5 genera occurring in North America, north of Mexico. These species were reviewed by Steyskal (1978) who noted that there is only one species known from BC. *Boreothrinax shewelli* Steyskal has been collected from Oliver, Keremeos and Victoria during the month of April and from Boulder Colorado in May; its host is unknown.

Reference

Steyskal, G.C. 1978. Synopsis of the North American Pyrgotidae (Diptera). Proceedings of the Entomological Society of Washington 80: 149-155.

Superfamily NERIOIDEA

Family MICROPEZIDAE (Stilt-legged Flies) [Fig. 66]

Stilt-legged flies are small to medium-sized (3.5 to 20 mm long), slender, and almost without bristles or setulae. The common name, stilt-legged flies, is a reference to the strikingly long, slender legs. Colours vary from yellow through red to black and the body often is banded or has pale pruinescence. The wings are clear or coloured, often with spots or bands of brown. The head is usually globular or sometimes conical and pointed in front (eg, *Micropeza*). The eyes are large. The third segment of the antenna is oval and, on top near its base it bears a setose or bare arista. There are no vibrissae or ocellar bristles. The thorax is elongate, with the front legs placed well forward of the middle pair; the scutellum is small with one pair of bristles. The wing is long and slender. Vein C reaches the wing tip at vein M_{1+2} and has no breaks; Sc is complete. All longitudinal veins are rather straight and extend to the wing margin; R_{4+5} and M_{1+2} usually converge or fuse near wing tip. Cell dm is long and narrow. The abdomen is elongate, slender and sometimes constricted at the base; the genitalia of both sexes are flexed down and forward. Males often have processes under segments 5 and 6 and laterally on segment 7 (especially on left side).

Stilt-legged fly larvae develop in decaying wood, fruit and other vegetable matter. Some larvae feed in dung and one oriental species attacks growing ginger roots. Adults are usually found in marshes or wet woods, perched on leaves and tree trunks, often at wounds in the bark. Some are evidently predators of aphids and other small insects that they stalk in vegetation. Still others are wingless and mimic ants.

The Micropezidae is a cosmopolitan, but mainly tropical family containing about 520 described species, 33 of which are known from North America. Three genera and nine species are recorded in BC. The genus *Micropeza* has 16 of these species, but only *M. lineata* Van Duzee (Fig. 66), a widespread western species and *M. chillcotti* Merritt and Peterson, known only from Vancouver, are known in BC. *Cnodacophora nasoni* (Cresson) ranges across the boreal and mountain forests, south in the west to Colorado and in the east to New York. There are at least six species of *Compsobata* in the province. *C. univitta* (Walker) is a red fly with a pruinose thorax; it is distributed transcontinentally. *C. mima* (Hennig) and *C. pallipes* (Say) are black with the thorax partly shining above; the former is western, the latter is transcontinental. *C. columbiana* Merritt and Peterson, is one of BC's most common and widespread micropezids. In BC, *C. jamesi* Merritt is restricted to the south coast and *C. kennicotti* has been recorded only near the Yukon border.

Reference

Merritt, R.W. and B.V. Peterson. 1976. A synopsis of the Micropezidae (Diptera) of Canada and Alaska, with descriptions of four new species. Canadian Journal of Zoology 54: 1488-1506.

Superfamily DIOPSOIDEA

Family TANYPEZIDAE (Tanypezid Flies) [Fig. 67]

North American tanypezids are 5 to 7 mm long, slender, long-legged and with patches of silvery tomentum on the body. The legs are yellow. The head, in profile, is higher than long; the compound eyes are very large. The frons is narrower than the eye and is much narrower in males than in females. The third antennal segment is oval, rather large and somewhat elongate, with a basal, setulose arista. Vibrissae are absent; the upper orbital bristle arises on the vertex. The scutellum has two pairs of bristles, but is otherwise bare. The wing is clear; the costa has a weak subcostal break and Sc is complete. Veins R_{4+5} and M almost meet at the wing tip; cell cup is closed by the L-shaped CuA_2 . Vein A_1 almost reaches the wing margin.

Hardly anything is known of the biology of the family. The adults live in damp forests.

The Tanypezidae is primarily a New World family containing three genera and about 22 species. Only *Tanypeza*, with two species, occurs in North America. *T. longimana* Fallén (Fig. 67) is Holarctic and in the Nearctic ranges from the Rocky Mountains to the Atlantic Ocean. *T. picticornis* Knab and Shannon has an eastern North American distribution. Although *T. longimana* Fallén is not recorded in BC, it likely occurs throughout the province.

Family STRONGYLOPHTHALMYIIDAE (Strongylophthalmyiid Flies) [Fig. 68]

Strongylophthalmyiids are slender, long-legged flies about 3.5 to 4 mm long. Bristles are few. The only North American species is mostly black with coarse yellow setulae; the antennae, front of head and legs are yellow. The wings are faintly patterned with pale brown patches. The head is almost globose, slightly longer than high, with prominent compound eyes and fine, short setulae on the antenna and its arista, which arises on the basal half of the ovate third segment. At the level of the anterior ocellus, the frons is wider than the compound eye; frons width is equal in males and females. There are three orbital bristles followed by a row of fine short setae reaching the level of the antenna. No vibrissae occur; one inner and one outer vertical bristles are present. The thorax is elongate, almost twice as long as wide. The wing has a strong subcostal break near the end of vein R_1 ; Sc fades just before this break. The fork of Rs is strongly divergent. Vein A_1 does not reach the wing margin. The legs are slender with front coxa distant from middle coxa; bristles lacking except for a short apical one on the middle tibia.

Little is known of the biology of these flies. The larvae have been collected from under the bark of trees.

World wide, the family Strongylophthalmyiidae contains 33 known species in two genera: *Nartshukia* with one species in Vietnam and *Strongylophthalmyia* with 23 species in the Oriental and Australasian regions, eight in the Palaearctic region and one in the Nearctic. These flies have long been placed in the Psilidae, but the family is probably most closely related to the Tanypezidae. The sole described North American species, *Strongylophthalmyia angustipennis* Melander (Fig. 68) was discovered and described from Puget Sound in Washington; it ranges from BC east to Nova Scotia and south to Massachusetts, Michigan and Wyoming. It is the basis for the description above.

Family PSILIDAE (Rust Flies) [Fig. 69]

Members of the Psilidae are small to medium-sized flies (Nearctic species are 3 to 8 mm long), rather slender and with only sparse bristles. The body colour ranges from yellow and red to brown or black; the wings are usually clear, yellowish or smoky, sometimes with the crossveins or wingtip darkened. The head is circular or triangular in profile with the frons projecting anteriorly and the face below the antennae strongly sloped backwards. The compound eyes are variable in size, but the back of the head below them is somewhat swollen. The antenna ranges from short to rather long, the third segment (and sometimes also the first two) often elongate (*Loxocera*) and bearing a setulose arista on the basal half. Head bristles are few and variable, but there is always at least an inner and outer vertical bristle on each side; vibrissae are absent. The wing has a strong subcostal break well before the end of R_1 ; a clear strip in the wing membrane obliterates the end of Sc and reaches or crosses R_1 . The outer end of cell cup is squarely truncate and vein A_1 fails to reach the wing margin. The legs lack bristles, but there are longer setae on the tips of the tibia. The underside of the femur of *Loxocera* species bears a pad of short dense setulae near the tip.

Larvae feed in the roots and stems of many kinds of plants (recorded hosts include sedges, rushes and lupines); a few species are pests of crops. The most injurious species is *Psila rosae* (Fabricius), the Carrot Rust Fly, which tunnels in the roots of carrots, parsnips and celery. Larvae also live under the damaged bark of trees. Adults rest on foliage, especially in the shade; some species are attracted to tree sap.

The Family Psilidae is mainly Holarctic with a few species scattered in the southern hemisphere. It contains seven genera and about 200 species; three of these genera and 31 species occur in North America. From the literature and collection records of BC psilids there are at least 13 species in three genera in the province. *Psila* contains at least six species in BC: *P. dimidiata* Loew, a yellow and black species, is boreal; the all-black *P. washingtona* Melander ranges from Alaska to Washington; the garden pest *P. rosae*, a European immigrant, is dark green with yellow head and legs. *Loxocera microps* Melander and *L. collaris* Loew are western. *Chyliza erudita* Melander and *C. notata* Loew range transcontinentally; *C. scrobiculata* Melander and *C. leguminicola* Melander occur from BC to Oregon. The latter has been reared from *Lupinus polyphyllus* Lindl. (Large-leaved Lupine).

Superfamily LAUXANIODEA

Family LAUXANIIDAE (Beach Flies or Lauxaniid Flies) [Fig. 70]

Small robust flies, 2.5 to 5.5 mm long. Yellow, brown, black or a combination of these colours, dull or shiny, sometimes with dark spots or vittae. The shape of the head is quite variable, but the eyes are bare or sparsely micropubescent, and the antennal arista is bare to long plumose. The vertex is not strongly excavate, but rounded or carinate. Vibrissae are absent, and the postocellar bristles are distinctly convergent. There are four pairs of strong backward leaning bristles between the eyes. The thorax has the metepisternum bare, and the posterior thoracic spiracle lacks both bristles and outstanding setae on the lower margin. The legs usually have a preapical dorsal bristle on all tibiae, but sometimes this is absent on the hind tibia. The middle tibia have one to three apical spurs, the hind tarsus is sometimes ornamented, and the fore femur may have a ctenidium. The wings are often tinged with yellow, and sometimes spotted or clouded. The costal vein C is without a subcostal break and ends at M_1 , while Sc is complete and separate from R_1 .

Adults are normally found in woodlands and in dense vegetation by water in the shade. They may come to light and to traps baited for fruit flies or flesh flies. Larvae are saprophagous, and typically live in leaf litter, vegetable trash, in rotting tree stumps, dung and bird's nests.

The family, often previously called the Sapromyzidae, occurs on all continents, except Antarctica. Worldwide there are about 1,600 species, in some 128 genera. There are 28 genera and some 158 species in North America, with 104 species reported from Canada. At least nine genera occur in British Columbia. Species of *Calliopium*, which are shiny black, sometimes with yellowish legs include *C. livingstoni* (Coquillett), and *C. quadrisetosum* (Thomson). *Camptoprosopella* with a flat face and sometimes a median black spot, includes a species near *C. borealis* Shewell. *Homoneura*, with ctenidium on the fore femur, and two apical spurs on the middle tibia, includes *H. inaequalis* (Malloch), *H. lamellata* (Becker), *H. occidentalis* (Malloch) and *H. shewelli* Miller. There are at least four species of *Minettia*, including the introduced European *M. rivosus* (Meigen), and at least four species of the genus *Sapromyza* Fallén.

Lauxania Latreille with the arista thickly white pubescent is represented by the Holarctic *L. cylindricornis* (L.) and the Arctic *L. nigrimana* Coquillett. So far, only one species of *Lyciella* Collin has been detected, the yellow to brownish European *L. rovida* (Fallén). The genus *Poecilolycia* Shewell is present in that there are two species, namely *P. annulata* (Melander) and *P. spatulata* Shewell in our collections, together with an undetermined species of *Poecilominettia* Hendel.

Family CHAMAEMYIIDAE (Aphid Flies) [Fig. 71]

Small and rather robust flies, 1.0 to 4.0 mm long. Most species are silvery gray to brown, and usually densely pruinose, but they can also be shiny black, often with brown stripes on the thorax, and black spots or bands on the abdomen. The head is as broad as or

broader than the thorax, the compound eyes being bare or with short pubescence. The ocellar triangle is occasionally enlarged and prominent. Vibrissae are absent, and there are from zero to three pairs of fronto-orbital bristles. The antennae are short and porrect. The thoracic scutum bears neatly arranged setulae and bristles, and the scutellum has just four long setae. The legs are rather weakly bristled, except for the fore femur which have strong bristles. All tibiae lack a preapical dorsal bristle. The wings are usually uniformly milky hyaline, but occasionally have brown markings. The costal vein C is unbroken, and Sc is complete and free. The radial vein R is bent forward close to Sc, and ends close to the apex of Sc. The A_1 vein is abruptly terminated in the basal third to half of the wing.

Very little is known about the biology of most adults. The larvae of most species are free-living predators of adelgids, aphids, coccids and scale insects.

About twenty genera are known worldwide. There are from 100 to 150 species in North America, but over half are still undescribed, since only 55 are described to date in nine genera. It is estimated that some 105 species occur in Canada. The family is poorly studied in British Columbia, but there are at least four genera, *Chamaemyia* Meigen, with three European species *C. geniculata* (Zetterstedt), *C. herbarum* (Robineau-Devoidy) and *C. juncorum* (Fallén), *Leucopis* Meigen (*L. ocellaris* Malloch, *L. pulvinariae* Malloch), *Plunomia* Curran (*P. elegans* Curran, *P. transversa* Malloch) and *Pseudodinia* Coquillett (*P. nitens* (Melander & Spule), *P. varipes* Coquillett).

Superfamily SCIOMYZOIDEA

Family COELOPIDAE (Seaweed Flies) [Fig. 72]

Robust, flattened, strongly bristled flies, 3.7 to 8.9 mm long. Black or grayish-black in colour, shiny or subshiny. The head has the face strongly concave in profile, and the compound eyes are oblique. The antennae are short, and appressed to the face. The thorax is distinctly flattened, with the metepisternum setose below the posterior thoracic spiracle. This latter spiracle lacks bristles on the lower margin. The fore femora are strongly swollen, and tibiae on all legs have a long dorsal preapical bristle. The wings lie flat on the abdomen, with the wing blade posterior to cell dm frequently folded under and closely appressed to the ventral surface, of the anterior portion of the wing. The veins are generally bare, but the upper and lower surfaces of the stem of R, and the upper surface of the apical third of R_1 are sometimes setose. The costa is without a subcostal break and without obvious spines. The subcosta is complete, and A_1+CuA_2 extends to the wing margin.

Seaweed flies, as the common name suggests, are found on sea coasts, associated with seaweeds. The larvae live in rotting seaweed, and breed in vast numbers, the adults often occurring in dense swarms around kelp.

Worldwide there are about 30 described species in nine genera. Two genera and five species occur in North America, with four of these species recorded from Canada. The abundance and strength of bristles of the body and legs, especially in males, varies greatly within some species. As a result, this variation has produced a great deal of

confusion in taxonomy at the species level. Western North American species in the old literature were called *Coelopa frigida* (Fabricius), but his Holarctic species evidently is confined to the Atlantic and Arctic coasts. Species in British Columbia have been identified as *C. nebularum* Aldrich and *C. stejnegeri* Aldrich (Fig. 72). Both of these species have a range extending to Alaska and St. Paul Island in the Bearing Sea. *C. vanduzeei* Cresson which ranges from California to southern Alaska has also been identified from BC.

Family SEPSIDAE (Black Scavenger Flies) [Fig. 73]

Slender flies, 2 to 6 mm long, mostly shiny black, but also can be dull black, brownish or yellowish. The head is more or less globular, with large compound eyes and bare antennal arista. The thorax has a silvery pruinescence on at least part of the pleuron, and the posterior thoracic spiracle has one or more fine bristles on the lower margin. The legs are slender, and males have the fore femora, and often also the fore tibiae with characteristic bristles, tubercles or emarginations, for grasping the base of the wing of the female during copulation. The middle tarsus of the male sometimes has enlarged or varicolored segments, and the hind tibia often has a slit or elongate area (osmeterium). The wings are narrow and hyaline, and usually with a dark spot near the tip of vein R_{2+3} . The wings are also sometimes blackish at the base. The costa is without a subcostal break. The abdomen is usually elongate, and often constricted near the base, giving these flies an ant-like appearance.

Adults are scavengers, and most often can be caught by sweeping grass in meadows or woods, or around or on dung. When walking about these flies repeatedly and characteristically flip their wings outward. Larvae are often found in carrion or excrement. The Sepsidae with about 250 described species in 21 genera occur worldwide with numerous species often present on more than one continent. There are 34 described species reported from North America in 11 genera, but there are numerous others that are either undescribed or undetermined described species. The family is not well studied in British Columbia, so the number of species is uncertain although at least 7 described species in 5 genera are known from the literature and collections of BC Diptera. These species include: *Decachaetohora aeneipes* (Meijere), an immigrant in the northwest from Asia; *Meroplus sterocoraria* (Robineau-Desvoidy); *Sepsis biflexuosa* Strobl; *Sepsis puncta* (Fabricius); and *Themira putris* (Linnaeus). The latter four species are Holarctic in their distributions.

Family DRYOMYZIDAE (Dryomyzid Flies) [Fig. 74]

Moderately bristly to quite setose flies, 4 to 12 mm long, yellowish, brown or dark grey in colour. Head with face convex in middle, and with clypeus large and prominent in profile, bulging below lower margin of face. The vertex is not strongly excavated, and the postocellar bristles vary from slight convergent to greatly divergent. Vibrissae are absent, and the antenna have a short pedicel. The thorax is somewhat longer than wide, and the metepisternum is bare. The scutellum has two or three pairs of bristles, and the posterior thoracic spiracle is lacking both bristles and outstanding setae. The tibiae with dorsal preapical bristles, and males may have an apicoventral projection on

the first segment of the fore and hind tarsi. The wings are hyaline to smoky or tawny, and sometimes dark brown spots are present on crossvein r-m and on the posterior crossvein. The costa lacks a subcostal break, and the subcosta is complete to the costa at some distance proximal to the tip of vein R_1 . The costa may have costal spines, and crossvein bm-cu is always present.

Species of *Dryomyza* have been reared from decaying organic matter, including decaying fungi, carrion, and dung. Members of the subfamily Helcomyzinae (often now considered a separate family) have been reared from seaweed.

The subfamily Dryomyzinae is restricted to the Holarctic region, with currently 20 described species in the two genera. The Helcomyzinae are restricted to marine coasts and occur worldwide, with 13 species in six genera described to date. There are nine species of Dryomyzinae in North America, with two described genera. There are also two genera of Helcomyzinae in North America, each with a single species. Nine species of Dryomyzidae are reported to occur in Canada, at least six of which are known to occur in British Columbia. The Holarctic *Dryomyza anilis* Fallén (Fig. 74) occurs along the Pacific Coast north to Alaska and is a robust, yellowish species with yellowish hyaline wings and clouded crossveins. Three other species of *Dryomyza*, namely *D. flaveola* (Fabricius), *D. melanderi* Steyskal and *D. setosa* (Bigot) have also been reported from this province. One species of *Oedoparena*, *O. glauca* (Coquillett) occurs from Alaska to California, and can be separated from species of *Dryomyza* by having three pairs of scutellar bristles, whereas only two pairs occur in *Dryomyza*. *O. glauca* is a lead-coloured fly with grayish hyaline wings, yellowish costal cell, and yellow halteres. The only species of Helcomyzinae known from British Columbia is the large, gray, 11 mm long *Helcomyza mirabilis* Melander. As noted above, these flies are to be found on sea beaches associated with wrack beds, the species also being known from Oregon and Washington.

Family SCIOMYZIDAE (Marsh Flies) [Fig. 75]

Slender to robust flies, 1.8 to 11.5 mm long. Colour varying from shiny black to dull gray, brown, reddish or yellowish. Head with face usually concave in profile, the frons being wide in both sexes, and the vertex not strongly excavate. The postocellar bristles are strong and parallel or slightly divergent. The compound eyes are prominent and bare, and vibrissae are absent. The antennae are characteristically porrect, with the pedicel usually elongate. However, the antennae can be short or long, but typically the arista is short, pubescent to plumose. The thorax lacks a precoxal bridge and the metepisternum is bare. The posterior thoracic spiracle also is without either bristles or setae. The legs typically have the femora well developed and usually strongly bristled. One or more of the tibiae also have a preapical dorsal bristle. The wings are usually longer than the body, and are immaculate or heavily patterned or spotted. The costa lacks spines and is without a subcostal break. The subcosta is complete, being free from vein R_1 distally, and ending in the costa.

Adults can often be swept from vegetation along streams or ponds. Larvae are associated with freshwater or terrestrial molluscs, and are parasitic or predaceous. A few may be saprophagous.

Worldwide there are some 600 described genera in 60 genera. The North American fauna has some 194 species in 21 genera. So far, 110 species are reported to occur in Canada. There are many specimens from British Columbia still to be determined, but there are at least 39 species in nine genera known from the literature and from collections of BC Diptera. *Dictya* Meigen and *Pherbellia* Robineau-Desvoidy with 4 species each, *Sepedon* Latreille with 8 species, *Tetanocera* Duméril with 16 species are the most speciose genera in BC.

Species of *Dictya* which have a white face with a central black spot include *D. expansa* Steyskal, *D. montana* Steyskal and *D. stricta* Steyskal. *Pherbellia* species which have the fore tibia with a single preapical dorsal bristle and a non-shiny frons include *P. albocostata* (Fallén), *P. quadrata* Steyskal, *P. tenuipes* (Loew) and *P. vitalis* (Cresson). *Sepedon* species which lack ocellar bristles, have one orbital bristle on each side, and have the postocellar bristles well developed include *S. armipes* Loew, *S. borealis* Steyskal, *S. fuscipennis* Loew (Fig. 75), *S. lignator* Steyskal, *S. praemiosa* Giglio-Tos, *S. pseudoarmipes* Fisher & Orth, and *S. pusilla* Loew. *Tetanocera* species with their black arista include *T. annae* Steyskal and at least 15 other species. *Trypetoptera canadensis* (Macquart) which occurs in BC, also has a black arista, but has the subalar sclerite with vallar bristles, unlike *Tetanocera* species.

Superfamily SPHAEROCEROIDEA

Family HELEOMYZIDAE (Heleomyzid Flies) [Fig. 76]

Robust and bristly flies, 3.0 to 7.0 mm long, yellow, reddish yellow or reddish brown to black in colour, and often distinctly pruinose. Head with one to three pairs of orbital bristles, and with ocellar bristles, arising on ocellar triangle above anterior ocellus. One or two pairs of oral vibrissae are present, and the postocellar bristles are strong and convergent. The antennae are short, and the arista minutely pubescent to plumose. The thoracic scutellum has two or three pairs of strong bristles. The legs are moderately bristled; middle and hind tibiae usually have a preapical dorsal bristle although this may be fine in some genera such as *Borboropsis* Czerny. The wings are usually hyaline, but sometimes faintly yellowish or brownish. The wing surface may be mottled with contrasting whitish and dark gray areas, the crossveins are often clouded and the longitudinal veins fuscous. The costa extends to the end of vein M_{1+2} and has a distinct subcostal break, but no humeral break. The costa also usually has strong and conspicuous spines. The subcosta is usually completely separate from vein R_1 , ending in the costa sometimes close to vein R_1 , and a pterostigma is often present. Vein CuA_2 is short, and fuses with vein A_1 , the combined vein often nearly reaching the wing margin.

Adults are commonly collected in moist, shaded area. Many larvae breed in fungi, but those of the subfamily Heliomyzinae breed in decaying plant and animal matter, and

are known to occur in bird's nests, mammal burrows, bat caves, carcasses of large mammals, and excrement.

Often workers now consider the Heleomyzidae to include the family Trixoscelididae as the subfamily Trixoscelidinae. We have maintained them as separate families to allow for easy generic identifications using the Manual of Nearctic Diptera. Worldwide there are about 65 described genera and over 500 described species in the Heleomyzidae, in the broad sense. There are 27 described genera with 120 species of heleomyzids (in the strict sense) in the Nearctic. There are 19 described genera with 53 species known to occur in BC based on the published literature and collections of BC Diptera. At least four species *Amoebaleria scutellata* Garrett, *Anypotacta aldrichi* (Garrett), *Heleomyza genalis* (Coquillett) and *Neoleria diversa* (Garrett) seem to be endemic.

At least another nine species also occur in Europe as well, but some may be truly Holarctic and not alien introductions. This latter group includes *Aecothea fenestralis* (Fallén), *Amoebaleria flavotestacea* (Zetterstedt), *Borboropris fulviceps* (Strobl), *Heleomyza brachypterna* (Loew), *H. pleuralis* (Becker), *H. serrata* (Linnaeus) (Fig. 76), *Neoleria inscripta* (Meigen), *Suillia nemorum* (Meigen) and *Tephrochlamys rufiventris* (Meigen).

Family TRIXOSCELIDIDAE (Trixoscelidid Flies) [Fig. 77]

Small flies, 1.5 to 3.0 mm long. Legs, face, antennae and a portion of the frons yellow, but in species of *Zagonia* Coquillett, the whole body is yellow. The body is mostly pruinose, but the abdomen is sometimes glabrous. The face is slightly concave, and the ocellar bristles arise just outside the ocellar triangle, being beside or slightly below the anterior ocellus. Vibrissae are present, and the postocellar bristles are strong and not divergent. The vertex is not strongly excavated, and the antenna may be partly hidden in an antennal socket. The thoracic scutellum has four bristles. The fore femora are slightly swollen, and all tibiae have a preapical dorsal bristle. The middle tibiae also have one or more apicoventral bristles. The wings are hyaline, and sometimes fuscous along the veins and crossveins, but the wing can be blackened with conspicuous hyaline spots. The costa has a subcostal break, but lacks a humeral break, and extends to the end of vein M_{1+2} . The subcosta is complete and free from vein R_1 , ending in the costa near vein R_1 , near the basal third of the wing.

Adults are frequently collected on flowers or vegetation. However, nothing is known about the larval biology and habitats.

This family is often now included within the Heleomyzidae. If kept separate, the Heleomyzidae are recognized by the ocellar bristles arising on the ocellar triangle, above the anterior ocellus, whereas in the Trixoscelididae, these bristles lie just outside the ocellar triangle.

Three genera and 27 species are reported in North America, with six species occurring in Canada. There are 4 described species in two genera known to occur in BC,

based on the published literature and collections of BC Diptera. The two most common species in BC appear to be the European *Trixoscelis frontalis* (Fallén) with the body predominantly gray, and the Nearctic *Zagonia flavicorvis* Melander, with the body entirely or predominantly yellow.

Family SPAEROCERIDAE (Lesser or Small Dung Flies) [Fig. 78]

Lesser dung flies are small, to minute, robust, 0.9 to 5.0 mm long, easily recognized by the short, thick basal segment to the hind tarsus. These are generally dull coloured flies, often black or dark brown, but sometimes brown or with head or legs yellowish; some tropical groups of lesser dung flies are highly coloured. The frons is broad, and slightly narrowed anteriorly, typically with two proclinate or laterocline bristles. Vibrissae are present, and the antennae are short with the arista preapical or subapical. The thoracic scutum is usually setose, but is warty in some species of the subfamily Sphaerocerinae. The anepimeron is bare. Legs with the femora, especially the hind femora somewhat swollen, and with the hind tarsus distinctive with its swollen basal segment. Wings may be fully developed (macropterous), or reduced (brachypterous), or may be totally absent (apterous). If macropterous, the wings are rarely spotted, with costa ending at vein R_{1+2} , or at vein R_{4+5} , or between them, and with costagial, humeral, and subcostal breaks. The subcosta is incomplete, and vein A_1 never reaches the wing margin.

North American lesser dung flies have larvae that are scavengers, commonly associated with decaying organic matter, including animal dung, carrion, cave debris, compost, conifer litter, dead vegetation, fungi, leaf litter, mammal nests and supralittoral seaweed debris.

There are over 1340 described species of lesser dung flies in 111 genera worldwide with 38 genera and 273 species reported from the Nearctic. At least 25 genera and 91 species are known from British Columbia. Two endemic species are *Phthitia squamosa* Marshall and *Minilimosina sitka* Marshall which are known from the Sitka spruce forests of the Carmanah Valley on Vancouver Island. *Coproica ferruginata* (Stenhammer), *Copromyza equina* Fallén and *Norrbomia sordida* (Zetterstedt) are largely cosmopolitan species which are commonly found in BC.

Family CHYROMYIDAE (Chromyid Flies) [Fig. 79]

Very small, *Drosophila*-like flies, 1.0 to 4.5 mm long, usually yellow in colour. Head with frons narrowed anteriorly, and with ocellar bristles usually relatively strong. The postocellar bristles are usually present, and convergent. Vibrissae are present, but rather weak, and the antennae are short, with the arista microscopically pubescent. The thorax has yellow bristles and spines, and the proepimeral bristle is absent. Also, the proepisternal bristle is usually absent, while the anepimeron is bare. The legs are weakly bristled, with the fore and hind femora in the male frequently enlarged. All tibiae lack a dorsal preapical dorsal bristle. The costa has a subcostal break only, and extends to vein M_1 . Subcosta is complete, but weak on the apical one-fifth, and joining the costa very close to the insertion of vein R_1 . Cell cup is present at the base of the wing posteriorly.

Adults have been swept from foliage of shrubs and herbs, especially at margins of creeks and ponds. Adults of the genera *Chyromya* Robineau-Desvoidy and *Gymnochiromyia* Hendel have been reared from bird's nests, mammal burrows, and wood debris of hollow trees. However, adults of species of *Aphaniosoma* Becker appear to frequent grasses and sedges on seashores, and around alkaline or saline ponds or lakes.

Worldwide, three genera and about 40 species are reported, with all three genera and nine species occurring in North America. Seven described species in three genera have been collected in Canada, but so far only one species, the Nearctic *Gymnochiromyia concolor* (Malloch) is known to occur British Columbia based on the published literature. There are at least 3 species occurring in BC, including one that is undescribed, based on collections of BC Diptera.

Superfamily EPHYDROIDEA

Family DROSOPHILIDAE (Pomace Flies, Vinegar Flies, Lesser Fruit Flies) [Fig. 80]

Nearctic Pomace Flies are small to medium-sized, 1 to 6 mm long; body colour varies from yellow to brown or black, and can be shiny or grey pruinose. There are frequently stripes or spots on the thorax and abdomen. The compound eyes usually are covered in a distinct micro-pubescence and are often bright red in life. The head has three orbital bristles; usually the back two curved rearward, the front one forward. The ocellar bristles vary from large to small, as do the postorbitals; the latter are convergent and are almost always present. There is one to several strong vibrissae. The antennal arista is normally plumose, although it can be bare or have reduced branching. The scutum usually has two postsutural dorsocentral bristles. The tibiae have apical and preapical dorsal bristles. The wing has both humeral and subcostal breaks of the costa; the end of the subcosta is usually vestigial. Crossveins r-m and dm-cu are always present; cells bm and dm either separated or joined.

The larvae of pomace flies mostly eat yeasts and other microorganisms in fermenting organic matter. Adults live around garbage, compost, rotting fruits and vegetables, decomposing cacti, sap from tree wounds, fungi and dung. A few species can be annoying pests in markets, breweries, bakeries and canneries. Some are used as laboratory animals for genetic and physiological research because they are small, fecund and so easy to rear and maintain. Many species of *Scaptomyza* Hardy are leaf miners; larvae of *Cladochaeta* Coquillett are ectoparasites of cercopid nymphs; species of *Pseudiastata* Coquillett prey on mealybugs.

The family Drosophilidae is speciose, with about 60 genera and 3000 species worldwide many of them in the tropics. North America has about 182 described species in 16 genera. Eight genera and about 35 described species are known to occur in BC based on published records and collections of BC Diptera. The family is dominated by the genus *Drosophila* Fallén, which has about 1600 described species worldwide, about 114 in the Nearctic and over 20 in BC. *Drosophila melanogaster* Meigen (Fig. 80) is probably the most familiar species in the genus; it is certainly the best known scientifically because of its wide use in research laboratories. It is common in BC as are *D. buskii* Coquillett

and *D. funebris* (Fabricius), European species now widely cosmopolitan; both are particularly attracted to sour milk and rotting potatoes. *D. hydei* Sturtevant is also cosmopolitan and widespread across southern BC, as is *D. pseudoobscura* Frolova (a native New World species) which is common in the southern Interior. *D. athabasca* Sturtevant and Dobzhansky, is more common in eastern BC, especially in and around the Rocky Mountains.

Cacoxenus guttatus Hardy and Wheeler is a native of northwestern North America; the larvae feed on stem rusts on Lodgepole Pine (*Pinus contorta* Douglas). *Chymomyza aldrichii* Sturtevant lives in the boreal forests from Alaska to Maine, where it develops in logs of White Spruce (*Picea glauca* (Moench) Voss) and Trembling Aspen (*Populus tremuloides* Michaux). *C. caudatula* Oldenberg is a Holarctic relative, also common in the western mountains. *Cladochaeta inversa* (Walker) ranges transcontinentally; it is ectoparasitic on spittlebug nymphs of the genus *Clastoptera* Germar – an unusual habit for a drosophilid. Species of *Scaptomyza* are mostly leaf miners; there are at least seven reported from BC, including *S. adusta* (Loew) a species widespread in North America and in the Neotropics, and *S. graminum* (Fallén) a Holarctic species. *S. montana* Wheeler is boreal; the larvae mine in the leaves of Common Water Cress (*Nasturtium officinale* R. Br.). The introduced *S. pallida* (Zetterstedt) is now cosmopolitan; it lives in decaying vegetable matter. *Leucophenga montana* Wheeler ranges from BC to Utah and California; it breeds in fungi. *Stegana coleoptrata* (Scopoli), a boreal, Holarctic fly that develops under the bark of trees such as pine, larch and birch, and is the only species of the genus reported from the province.

Family DIASTATIDAE (Diastatid Flies) [Fig. 81]

Diastatids are small flies, about 2.5 to 4.0 mm long, grey-brown, with patterned wings. The head is higher than long and the frons narrows from the vertex to the antennae. The vertical bristles are strong; the inner pair is often longer than the outer pair. The postocellar bristles converge and the ocellar bristles arise prominently behind the front ocellus. Two orbital bristles of unequal size curve backward and a third one points forward. The face is flat; the vibrissa is strong, lying in front of a row of 5 to 7 subvibrissal setae. The compound eye is bare. The antenna has the second segment swollen above; the third segment points downward and bears an arista that ranges from almost bare to feathery. The scutum has short, depressed setae; two postsutural dorsocentral bristles are present. The scutellum is flat, lacks setulae but bears two pairs of bristles. The wing is usually twice as long as wide; the anal lobe and alula are weak to absent. The costa is weakly but distinctly spiny and has both humeral and subcostal breaks. It extends to the end of vein M_{1+2} at the wing tip but is weak past the end of vein R_{4+5} . The subcosta is incomplete. Crossvein r-m is basal to the middle of cell dm and the cossvein dm-cu is about as long as the part of vein CuA_1 apical to dm-cu. Vein A_1 is weak and short. The wing is usually spotted with brown or has white spots on a brown background. The legs are slender; the front femur always has a comb of short stout setae on the lower front margin of the apical half. All tibiae have a dorsal bristle just before the tip.

Adults are encountered around rich herbaceous vegetation in moist woodland and on the edges of peatlands and other wetlands. The males of some species wave their spotted and reflective wings during courtship displays. The biology of the immature stages is unknown.

The Diastatidae is a nonspeciose family, mostly Holarctic in distribution, containing about 40 described species in four genera worldwide; one genus is extinct and known only from Baltic amber. North America has six described species in *Diastata* Meigen and *Campichoeta* Macquart; three in the former genus and one in the latter are recorded in BC. *Diastata eluta* Loew ranges from Alaska to Idaho and Oregon; *D. modesta* Melander is recorded from BC and Washington. The third species in the province, *D. vagans* Loew (Fig. 81), is boreal. *Campichoeta griseola* (Zetterstedt) lives in Eurasia as well as in the boreal and western montane forests of North America.

Family EPHYDRIDAE (Shore Flies) [Fig. 82]

Ephydrids are small to medium-sized flies (1 to 11 mm long), usually dark and dull in colour, but highly variable in structure and difficult to characterize. The head has the frons usually wider than long; the face is variable in form, setulose and arched, often bulging, tubercles and ridges are often present. The subcranial cavity is often large and gaping and the mouthparts, if large, can be pendulous. Fronto-orbital bristles often prominent, curving forward or backward, often in many species, strongly projecting laterally. The antennae are short, the second segment often has a single bristle above; the third segment bears a dorsal arista, which is bare, finely setulose or comb-like, with any arisal rays almost always on the upper surface only. The thorax is extremely variable in surface features – shiny, dull, or densely pruinose, sculptured or smooth. The wing is clear or spotted and has with both humeral and subcostal breaks of the costa; the subcosta is incomplete and vein R_1 joins the costa before the middle of the wing. Cells bm and dm are not separated by a crossvein; cell cup is absent. The fore and middle femora often have spines or bristles below; the forelegs of *Octhera* Latreille are raptorial. A preapical dorsal bristle occurs only on the middle tibia. The empodia and pulvilli are frequently reduced or absent in Subfamily Ephydrinae.

Shore flies typically live in aquatic and semiaquatic habitats. Many species develop along the muddy shores of marshes, ponds and streams but many also live in marine marshes, tidal pools, and the alkaline lakes of arid and semiarid environments. It is in these harsh saline habitats that the most distinctive forms have evolved and where the family has reached its greatest biological importance. In these habitats the both immature stages and adults can be so abundant that they are significant food for wildlife, especially waterfowl and shorebirds. The family is pre-eminent in its ability to withstand the osmotic pressure of salt water. Most larvae feed by filtering microorganisms such as bacteria, algae and yeasts from the water and mud, but others feed on excrement in places such as cess pits and in the sludge found in sewage filters; from sewage it is a short step to feeding on decomposing carrion and carcasses. In salty aquatic habitats, especially, there is a strong trend to carnivory; *Octhera* larvae eat chironomid midge larvae. Others exploit the many invertebrates that fall into the water and cannot escape. The carnivorous

larvae of *Helaeomyia petrolei* (Coquillett) live in pools of crude petroleum that flow from the ground in California; they feed on organisms trapped in the oil.

Some larvae of genera such as *Hydrellia* Robineau-Desvoidy and *Psilopa* Fallén are leaf or stem miners; some species of the former genus develop in plants far from water. Other species of *Hydrellia*, when abundant, can damage crops of watercress, rice and other irrigated cereals. Species of *Hydrellia* mining the leaves of the aquatic genus *Potamogeton* Linnaeus can access oxygen by inserting their posterior spiracles (which open near the ends of sharp, hollow spines) into the leaf tissue.

Most adult shore flies feed on unicellular algae and other microorganisms. Both the adults and larvae of several shore fly species feed on the bacteria and cyanobacteria growing in algal mats in hot springs. Adults of *Ochthera* feed on small insects and still others eat nectar and leaf tissue.

The family Ephydriidae is speciose, with about 1800 described species in 114 genera worldwide. The 460 known North American species are sorted into about 70 genera, the largest of which are *Hydrellia* (70 species) and *Notiphila* Fallén (55 species). BC has about 37 recorded genera and 95 species. *Hydrellia*, with about 13 species known in BC, is the province's most speciose ephydrid genus. Small, usually about 1 or 2 mm long and with densely micro-pubescent compound eyes, *Hydrellia* species are found mostly in grassy, sedgy areas. The larvae mostly mine in the leaves of grasses and aquatic plants such as *Eleocharis* Brown (eg, *H. tibialis* Cresson) and *Potamogeton* (eg, *H. pulla* Cresson). *H. griseola* (Fallén) is Holarctic and widely distributed across North America. In BC it ranges from Atlin to the Kootenays; elsewhere, it can be a pest of rice and wild rice (*Zizania* Linnaeus). *Atissa pygmaea* (Haliday) is also a tiny Holarctic species; it ranges all the way to South America. Only 1 mm long, it is almost completely white pruinose.

The ten BC species of *Parydra* Stenhammar live mainly around the fresh waters of lakes, ponds and streams. *Parydra aurata* Jones is a Cordilleran species ranging south to New Mexico; *P. borealis* (Cresson) and *P. varia* Loew are boreal. Species of *Scatophila* Becker are also common around small streams; three species are recorded from BC -- *S. despecta* (Haliday) is perhaps the most widespread of the genus in North America. At least three species of *Ephydra* Fallén live in BC around marshes and alkaline lakes; perhaps the most common is *E. riparia* Fallén (Fig. 82), widespread in Europe and all across North America.

Many BC species inhabit saline environments. Particularly remarkable in the dry Interior of the province is *Hydropyrus hians* (Say), which ranges over the west wherever alkaline ponds and lakes occur. In the Cariboo the larvae and pupae are found massing in huge numbers in almost completely saturated sodium carbonate solutions, the adults swarming on the salt crusts and on the water surface itself. *Clanoneurum americanum* Cresson is also common in salty habitats in both western North America and along the Atlantic coast and *Coenia curvicauda* (Meigen) is frequent in coastal and inland salt marshes transcontinentally. *Glenanthe litorea* Cresson lives in coastal salt marshes from

Alaska to Central America and from the Canadian Maritimes to Texas. *Lamproscatella quadrisetosa* (Becker) is a seabeach species on both sides of the continent.

Octhera mantis (De Geer) is widespread in the temperate northern hemisphere and perhaps is the most distinctive BC ephydrid. It uses its massive raptorial forelegs to crush small flies and grab mosquito larvae from the water or chironomid larvae from the mud. Many ephydrids are subtly colourful at close range including some species that have brown wing spots. *Ilythea spilota* (Curtis), a common Holarctic species, is one of these. Others have white spots on dark wings; *Scatella* Robineau-Desvoidy and its relatives are among these species. *Scatella stagnalis* (Fallén) is one of five or six BC species in the genus.

Superfamily OPOMYZOIDEA

Family ODINIIDAE (Odiniid Flies) [Fig. 83]

Odiniid flies are small, rather stout insects, about 3 to 4 mm long. They are gray, marked with brown; the wings are spotted or mottled with brown. The head is higher than long; the frons is as broad as long, equally wide in both sexes. The postocellar bristles are divergent; the inner vertical bristle is usually stronger than the outer one; the lower of the three orbital bristles points inwards. The oral vibrissa is strong, with adjacent bristles decreasing in size rearwards. The antenna is mostly yellow; the second segment has a dorsal bristle and the globular third segment bears a shortly setulose arista. The scutellum is large and convex with two pairs of bristles; the scutum is usually strongly bristled, including four or five dorsocentral bristles. The wing is short and broad, always darkened around the subcostal break in North American species. The costa is broken at the subcosta only, and extends around the wing to R_{4+5} or M_1 . The subcosta is incomplete; R_1 lacks setae and joins wing margin near the subcostal break. Cells bm and dm are complete; the apex of cell cup is convex. Vein A_1 does not reach the wing margin. The stout legs are often yellow and usually the tibiae are banded with brown; the hind femur is enlarged in males. The legs are moderately bristled; preapical dorsal bristles are present and are strongest on middle tibia. The abdomen is short and broad; it is normally grey spotted with brown.

Adult odiniids gather at wounds in trees, on polypore fungi and rotting tree trunks and stumps. The larvae are apparently frequently associated with wood boring beetles and moths. They may feed on fluids of decay or on fungi in insect galleries or decaying wood; some may parasitize other insect larvae.

Closely related to the Agromyzidae, the family Odiniidae occurs worldwide. It is divided into ten living genera containing about 60 described species. In North America, three genera contain 12 species; eight, including the two recorded in BC, are in the cosmopolitan genus *Odinia*. *Odinia betulae* Sabrosky (Fig. 83) is widespread throughout North America, including BC. *O. xanthocera* Collin is Holarctic, but in North America has been recorded only in BC. *O. boletina* (Zetterstedt) is Holarctic and has been recorded from southwestern Alberta; it may occur in BC.

Family AGROMYZIDAE (Leafminer Flies) [Fig. 84]

The Agromyzidae is a large family of minute to small, stocky flies (1 to 6 mm long) ranging from yellow to brown, grey and black in colour; often they are black with yellow markings. The wings are normally clear, but are patterned in some tropical forms. The compound eye is vertical or slanting, bare or sometimes setulose. There are one to three orbital bristles and one to five frontal bristles, the lower ones usually angled inwards; the postocellar bristles diverge. A well-developed vibrissa is present; sometimes several vibrissae are fused (eg, in males of some *Ophiomyza*). The third segment of the antenna varies from small and globular to elongate; the arista is bare or short-setose. The thorax bears two to five dorsocentral bristles; there are one or two pairs of scutellar bristles. The wing has the costa ending near vein R_{4+5} or vein M_1 and broken only at the end of the subcosta. Subcosta is either distinct and joins R_1 or is reduced to a fold that may or may not end in the costa. Cell cup is present; vein A_1 fails to reach the wing margin. The legs lack preapical dorsal bristles on all tibiae. The abdomen is usually more or less depressed and tapering; six segments are visible in front of the genitalia.

Agromyzid larvae eat living plant tissue. Most species feed between the upper and lower surfaces of leaves, making conspicuous mines, but others attack stems, roots and seeds. Most, being small and inconspicuous, are more easily recognized by the mines that they make than they are by the adult insects themselves. Mines can be blotch-like, linear or serpentine and their location in the leaf can be diagnostic. Even the distribution pattern of frass can be characteristic. Most agromyzids limit their development to particular plant species or groups of related species. Some are more polyphagous, including species such as *Liriomyza trifolii* (Burgess), which attacks many legumes and other plants such as tomatoes, cucumbers, asters and chrysanthemums. Many species are pests of agricultural crops and ornamental plants.

The Family Agromyzidae ranges throughout the world, inhabiting all environments from arctic tundra to tropical forests. There are over 2700 species named in 29 genera, but certainly many hundreds of species remain undescribed. In North America, over 700 species are described in 22 genera, including almost 200 in *Phytomyza* and over 100 in *Liriomyza*. About 75 species in 17 genera are known in BC and over 30 more species are recorded close to the province's borders, especially in the Alberta Rockies. About 20% of the species belong to *Phytomyza*. *P. ilicis* Curtis (Holly Leaf Miner) was introduced into western North America from Europe with its host; by the 1930s was causing considerable damage in south coast holly farms. *Agromyza albitarsis* Meigen, one of at least 13 species in the genus in BC, is Holarctic; its mines in cottonwood and aspen leaves are familiar. *Agromyza pseudoreptans* Nowakowski, a Holarctic species, is widespread in BC; it mines nettle (*Urtica dioica* Linnaeus) leaves. About ten known species of *Cerodontha* develop in grasses, rushes and other monocots in the province; *C. dorsalis* (Loew) is one of the more common species.

Chromatomyia nigra (Meigen) and *C. syngenesiae* Hardy occur in both the Old and New worlds; the latter feeds on the weed *Senecio jacobaea* (Linnaeus) (Tansy Ragwort) and may have been introduced to North America with its host. *C. involucratae* Spencer develops in honeysuckles (*Lonicera* spp.). Eight, and probably more, species of

Liriomyza, including *L. bellissima* (Spencer) and *L. baptisiae* (Frost) are BC natives. The former is common from Atlin to Osoyoos. The latter lives in southern BC and feeds on lupines. *Ophiomyia*, including species such as *O. coniceps* (Malloch), *O. nasuta* (Melander) and *O. pulicaria* (Meigen) mine the leaves of weedy composites such as dandelion (*Taraxacum*) and sow-thistle (*Sonchus*). *Phytobia amelanchieris* (Greene) bores in the cambium of Saskatoon (*Amelanchier*) bushes

Reference

Spencer, K.A. 1969. The Agromyzidae of Canada and Alaska. *Memoirs of the Entomological Society of Canada* 64: 1-311.

Family CLUSIIDAE (Clusiid Flies) [Fig. 85]

Flies of the family Clusiidae are slender, small to medium-sized (1.8 to 7.5 mm long), yellow to black species. The bodies are often marked, but are seldom pruinose. The wings are frequently smoky or marked with brown, especially at the tips. The head is normally higher than long and wider than high, flat or concave at the back. The antennae are short -- the first segment is tiny, the second has a dorsal bristle and often with a characteristic triangular projection on the outer margin. The third segment is more or less globular, bearing an arista near the tip; the arista is usually setulose. The ocellar bristles are short; the postocellars, when present, are divergent. The vertical bristles are prominent; the inner ones are longer than the outer ones. There are two to five fronto-orbital bristles. Oral vibrissae are strong and pointed forward and upward. The wing is usually twice as long as wide with a broadly rounded tip. Costa normally has a subcostal break and usually rounds the apex and reaches M_1 . Subcosta is complete, running parallel to R_1 . Cell bm is complete, but vein A_1 does not reach the wing margin. On the legs, most species have well-developed preapical dorsal bristles on at least the middle tibia. The abdomen is slender and tapered.

Clusiid larvae develop in rotten wood, mostly under the bark of dead and dying deciduous trees. They can jump like the larvae of Piophilidae. The adults feed on nectar, sap and decayed vegetable matter. In some species, lekking occurs, where males aggregate to interact and attract females. In these situations, male dominance hierarchies can develop. Males of many species use their patterned wings in mating displays and head-pushing in male-male interactions sometimes occurs.

The cosmopolitan family Clusiidae is based on about 220 species in 25 genera; four genera and about 40 species are recorded in North America. However, recent work suggests there are over 600 species worldwide and almost 400 in the New World. Eight species in three genera are known to occur in BC from the literature and collections of BC Diptera. The more common species include, *Clusia occidentalis* Malloch, one of three species in the genus in North America, ranges from BC south to California. It has a yellow face and black spots on the sides of the abdomen and has been reared from alder trees. *Clusiodes albimanus* (Meigen) and *C. melanostoma* (Loew) are transcontinental species; the former also occurs in the Old World. The former develops in birch, the latter in poplars.

Family ACARTOPHTHALMIDAE (Acartophthalmidae Flies) [Fig. 86]

Acartophthalmids are dull grey or black flies only 2.5 to 3.0 mm long; the wings are somewhat infusate. The head is higher than long and bears prominent bristles; the compound eyes are round and finely setulose. The frons is strongly narrowed from the top of the head to the antennae. There are three fronto-orbital bristles; the upper is the longest, the lower the shortest.

The ocellar, inner and outer verticals and postocellar bristles are strong and all about the same length; the postocellars are widely separated and diverging. The vibrissae are weak and are accompanied by four or five additional bristles about the same size. The antennae are short, the third segment is globular with a shortly setulose arista near the base. The scutum has three or four dorsocentral bristles; two pairs of bristles on the scutellum. The subcosta is complete, meeting the costa well before the end of vein R_1 ; the costa is broken near the humeral crossvein. Cell bm is complete; vein A_1 does not reach the edge of the wing. The legs lack strong bristles; preapical dorsal tibial bristles are absent.

The habits are poorly known in this family, and the immature stages are undescribed. Adults sometimes are seen on logs, stumps and rotting fungi in wet forests. The males often flick their wings in the manner of otitid flies.

Formerly treated as a subfamily of the Clusiidae, the Acartophthalmidae consists of only three known species, two Holarctic and one Palearctic in distribution.

Acartophthalmus nigrina (Zetterstedt) ranges from Alaska to the Atlantic Ocean; it has been collected in southern BC from the Brooks Peninsula on western Vancouver Island to the southern interior valleys. *A. bicolor* Oldenberg has not been recorded in BC although it is known from Canada.

Family OPOMYZIDAE (Opomyzid Flies) [Fig. 87]

Opomyzids are small, slender flies, 2.0 to 4.5 mm long; the body is yellow, red, brown or black and can be shiny or pruinose. The wings always have at least a dark spot at the tip; usually there are additional markings, especially on the crossveins. Some *Geomyza* species have reduced wings and are nearly flightless. The head has the frons somewhat narrowed towards the antennae. There is one strong orbital bristle, the inner and outer vertical bristles are strong and the postocellar bristles are usually lacking; if present, they are diverging. No vibrissae occur on the weak vibrissal angle, but a significant row of setae may be present under the compound eye. The compound eye is sparsely clothed with short setulae. The third antennal segment is oval, produced downward; the arista often has the upper setulae longer than the lower ones. The scutum is strongly bristled; there are three or four dorsocentral bristles. The scutellum has four bristles, the basal pair are often weak. The wing is moderately broad to unusually narrow; the alula and anal lobe are frequently absent. Costa extends to M_1 and is broken only at the end of the subcosta. Subcosta is incomplete; cells dm and bm usually are incompletely separated; cell cup is present. Vein A_1 is incomplete or absent. There are no dorsal preapical bristles on the tibiae.

Adult opomyzids usually frequent moist grassy habitats. The larvae feed within the stems of grasses.

The Family Opomyzidae is small, with about 40 species in four genera; most live in the north temperate regions, but a few occur in eastern and southern Africa. In North America there are 13 species recorded in three genera; the largest is *Geomyza*, with 10 species. All three genera likely occur in BC. *Anomalochaeta guttipennis* (Zetterstedt) is Holarctic and ranges across the continent in the northern forests; it has striking dark wings with clear spots. Although not formally recorded from BC it is known from the adjacent provinces, territories and states and likely occurs here. *Geomyza balachowskyi* Mesnil has been introduced to both coasts from Europe. *G. lurida* (Loew) (Fig. 87) ranges from Alaska to California along the coast; *G. monostigma* Melander and *G. parvistigma* Vockeroth have both been collected in southern BC. *Opomyza petri* Mesnil is a well-established introduction to south coastal BC from Europe, where the larvae feed in grasses such as *Holcus lanatus* Linnaeus.

North American species have been monographed by Vockeroth (1961).

Reference

Vockeroth, J.R. 1961. The North American species of the family Opomyzidae (Diptera: Acalypterae). Canadian Entomologist 93:503-522.

Family ANTHOMYZIDAE (Anthomyzid Flies) [Fig. 88]

Small, slender flies, 2.0 to 3.0 mm long. Shining black to moderately pruinose, yellow to black in colour. The frons of the head is slightly narrowed anteriorly, and there are one to three pairs of orbital bristles, with the anterior pair small or even absent. Ocelli are present, and the ocellar bristles are strong. Post-ocellar bristles are short, weak and convergent, while there is a row of very weak genal setae present below the compound eye, ending anteriorly in one or two distinct vibrissa-like bristles. The compound eyes are bare. The antennae are short, turned downward, and the arista has short to long setae. The thoracic postnotum has one bristle, and the scutellum is bare with two short subbasal and two long, apical bristles. The prosternum and anepisternum are bare. All tibiae lack a dorsal preapical bristle, and the fore femora usually have a strongly developed ctenidial spine. Wings are usually slender and unmarked, but rarely can be reduced or even absent. Wings when fully developed have the costa extending to the apex of vein M, with a subcostal break, while the subcostal vein is incomplete, and not reaching the costa. Cell cup is present at the base of the wing, while the halteres may be well developed or rudimentary. The abdomen is more or less depressed.

Adults are commonly swept from grass or low vegetation, especially in marshy areas. Larvae are associated with *Juncus*, *Typha*, *Elymus*, etc., living between the closely fitting leaf blades of terminal shoots.

Worldwide there are about 53 species in 14 genera. Four genera and 22 described species occur in North America, with many additional species awaiting description.

Stiphrosoma humerale Rohacek & Barber is a recently described species that occurs in British Columbia, at Robson. *Anthomyza tenuis* (Loew) is the other described species known from BC at Robson and at Likely.

Family PERISCELIDIDAE (Periscelidid Flies) [Fig. 89]

Periscelidids are small *Drosophila*-like flies, 3.0 to 4.0 mm long. Colour dull grayish-black or brownish-black. Head broader than high, narrowed below the antennae. The frons has one pair of orbital bristles, and the postocellar bristles are strong and divergent. Ocelli distinct and single pair of ocellar bristles distinct. Antennae arista plumose. Compound eyes with short sparse pubescence. Thorax with propleura and scutellum bare, the latter with four bristles. Legs short and stout, with tibiae frequently banded. Fore and middle femora each with row of fairly strong posteroventral setae. Preapical dorsal bristles on tibiae undeveloped. Wings short and broad with milky, sometimes brownish markings. Costal vein without subcostal or humeral breaks. Subcosta is incomplete and not reaching costa, but vein R_1 joining costa near middle of wings, and veins R_{4+5} and M not convergent. Veins CuA_2 and A_1 atrophied. Abdomen rather broad and dorsoventrally flattened.

Adults frequent wounds and sap fluxes on trunks of deciduous trees. Adults of *Periscelis wheeleri* (Sturtevant) has been reared from larvae found in galleries of the cerambycid *Sternochetus lapathi* (L.) on willow (*Salix* sp.) in British Columbia.

The Periscelididae has primarily a Neotropical distribution, with about 9 genera and fewer than 60 species described worldwide. *Periscelis* Loew is the only genus known from North America, with three extant species: *Periscelis wheeleri* is the only species known from British Columbia. There is a second BC species of *Periscelis* that may be undescribed, occurring in collections of BC Diptera.

Family ASTEIIDAE (Asteiid Flies) [Fig. 90]

Asteiids are very small, delicate and rarely collected flies, 1.0 to 2.5 mm long. Head normally higher than long, with face concave. Frons broad and compound eyes large and bare. Frons with one or two pairs of bristles. Ocelli present, and ocellar bristles short or seta-like, divergent or proclinate. Post ocellar bristles weak or absent. Oval vibrissae are well developed, but pale and inconspicuous. Antennae short and decumbent, the arista with alternating short and long setae, giving the arista a characteristic zigzag appearance. Thoracic scutellum with two pairs of marginal bristles, the basal pair of bristles often seta-like, but the posterior bristles are well developed and obvious. Legs are short and slender, with tibiae lacking preapical dorsal bristles. The wings are long, hyaline and unspotted. The costa is without a subcostal and without a humeral break, and the subcostal vein is incomplete, not reaching the costa. R_1 joins the costa in the basal third of the wing, R_{4+5} and M are distinctly convergent distally, and CuA_2 and A_1 are atrophied. The abdomen is narrow, rather membranous and at most weakly sclerotized.

Little is known about the biology and life cycle of these flies. Adults have been collected on windows and at bleeding wounds on trees or fungi. Elsewhere in the world, adults have been reared from fungi, and plant parts or remains.

Worldwide there are about 100 species in 11 genera. Five genera with 18 species are known from the Nearctic. There are 2 genera and 4 described species known to occur in BC based on the published literature and from collections of BC Diptera. Two of the most common BC species are *Asteia beata* Aldrich (Fig. 90) and *A. multipunctata* Sabrosky.

Superfamily CARNOIDEA

Family CARNIDAE (Carnid Flies) [Fig. 91]

Small flies, 1.0 to 3.0 mm long, and more or less shining black. Face of head rather concave, and frons with at least two orbital bristles. Ocellar bristles strong, and postocellar bristles subparallel. The gena has a row of strong bristles in the middle. Vibrissae are present and strong, and there is a row of strong subvibrissal bristles. The antennae often lie in a deep antennal groove. The proboscis has a bulbous base and short inconspicuous labella. The thoracic scutellum is armed with four short bristles, and the propleura are bare. The legs are slender, and tibia lack a preapical dorsal bristle. Wings when fully developed are hyaline, and the costa has both a humeral and subcostal break, while the subcosta is complete although weak and faint distally. Vein R_{2+3} is typically bisinuate. In the genus *Carnus* Nitzsch the wings are usually broken off, leaving merely a short stub. The abdomen normally well developed, but in *Carnus*, it is rather inflated, lacks sterna, and the membranes have numerous setiferous sclerotized spots in females.

Most species are saprophagous, and associated with carrion or excrement, with many having been reared from bird's nests. The Holarctic *Carnus hemipterus* Nitzsch occurs in bird's nests and adults are often found on nestlings and may feed on blood. The genus *Carnus* was reviewed by Grimaldi, 1997.

This is mostly a Holarctic family, with over 40 described species. Three genera occur in North America, with 16 described species. Fifteen species occur in Canada. *Carnus hemipterus*, as well as at least five species of *Meoneura* including *M. flavifacies* Collin and *M. triangularis* Collin are reported from British Columbia.

Reference

Grimaldi, D. 1997. The bird flies, genus *Carnus*: species revision, generic relationships, and a fossil *Meoneura* in Amber (Diptera: Carnidae). American Museum Novitates 3190. 30pp.

Family TETHINIDAE (Tethinid Flies) [Fig. 92]

Tethinids are small stocky flies, 1.5 to 3.0 mm long, coloured yellow, grey or black and usually strongly pruinose. The head is usually higher than long; the frons and

face are strongly to weakly narrowed in front; the face has a weak depression below each antenna and has a slight median ridge. Ocellar bristles, inner and outer vertical bristles and 1 to 5 orbital bristles are strong (the latter curve backward or laterally); postocellar bristles are absent; inner occipital bristles are variable in size and convergent. The lower edge of the head below the compound eye bears a row of weak to strong setae; the foremost are vibrissa-like. The short antennae usually droop; the third segment is almost circular; the arista bears extremely short setulae. The scutum has one presutural and three postsutural dorsocentral bristles. The scutellum is rounded, about twice as broad as long, without setae but with two pairs of marginal bristles. The wings are clear or sometimes slightly white or brown; rarely with brown clouds on the crossveins. The anal angle and alula are well-developed. The costa has no spines and is broken only at the end of the subcosta. The subcosta is complete or sometimes fused with vein R_1 near its tip. Veins R_{2+3} , R_{4+5} and M_1 typically rather straight and more or less parallel to the long axis of the wing. Cell *cup* is present but small. The legs are slender, the femora sometimes slightly swollen. The coxae and femora bear a few weak bristles; the mid- and hind tibiae usually have an apical bristle below.

Most tethinid flies live along ocean beaches or near alkaline ponds and lakes in more interior regions. The larval biology is poorly known, although the larvae probably live in the soil or in masses of algae or seaweed. Some species in the southern hemisphere may be associated with seabird colonies.

The Tethinidae is a cosmopolitan family occurring on all the main continents and many oceanic islands. It is a nonspeciose group, with about 120 described species in 14 genera, although many other undescribed species likely exist. In North America, 26 species are described in five genera and at least five species in four genera occur in BC based on published reports and collections of BC Diptera. *Neopelomyia rostrata* (Hendel) lives on the beaches of the Pacific Ocean from southern BC to California. *Pelomyiella melanderi* (Sturtevant) is also western but occurs around alkaline lakes in central BC south to California, Arizona and Mexico in both inland and coastal habitats. In the west, including BC, *P. mallochi* (Sturtevant) is a widespread inland species, but it lives on sea beaches in the eastern Arctic and along the Atlantic coast. The genus *Tethina* may also occur on the province's south coast beaches, but it has yet to be recorded in the literature from the province. *T. horripilans* (Melanders), recorded as far north as Washington, is the most likely species to show up in BC.

Family MILICHIIDAE (Milichiid Flies) (Fig. 93)

Milichiids are physically small, 1-7 mm long, acalyptrate flies, often largely brown or black, occasionally orange or yellow. Males of some genera with silvery pollinosity on abdomen. Milichiids usually have two or three pairs of mediocline frontal bristles, and two or three pairs of laterocline to procline orbital bristles; rarely with many reclinate frontal and orbital setae in an indistinguishable series. Frons usually with two rows of interfrontal setae, sometimes on distinctly shining stripes; lunule often with one or two pairs of setulae; proboscis often elongate, geniculate. Wing with humeral and subcostal break; the region of latter is often modified into a costal lappet; cell *cup*

closed, small. Milichiids are generally recognizable based on the head bristling, humeral and subcostal breaks and the closure of cell cup.

Although the biology of the majority of species is unknown, many milichiids have general saprophagous or coprophagous larvae, developing in decaying matter ranging from rotting fish and animal dung to rotting plant material. In addition to these more mundane lifestyles, larvae of many milichiids have a close association with Hymenoptera. In the Nearctic, larvae of the genus *Eusiphona* have been found feeding on the pollen in megachilid bee nests, this habit may hold true for *Eusiphona mira* Coquillett in BC. Some *Phyllomyza* species have been found in association with formicine and ponerine ants in the Palearctic and Oriental Regions; these groups of ants may also be hosts of *Phyllomyza* species in BC. Two Nearctic species of *Pholeomyia* have been recorded from the refuse heaps in leaf-cutting ant nests. Neither of these species of *Pholeomyia* nor the hosts occur in British Columbia.

Species in the genera *Pholeomyia*, *Milichiella*, *Leptometopa*, and *Phyllomyza* are known from caves and in association with bat guano, and may occur in similar habits in BC. Many adult milichiid flies including the genera: *Phyllomyza*, *Desmometopa*, *Neophyllomyza*, *Paramyia*, *Milichiella*, and *Leptometopa*, all of which occur in British Columbia, have species with adults that are kleptoparasitic on a wide range of predaceous arthropods, such as spiders, assassin bugs and robber flies. Often the kleptoparasitic milichiids will ride around on their hosts and feed on their hosts' partially digested prey. The vast majority of milichiid specimens collected as kleptoparasites of spiders are female and it is suspected that the extra protein from kleptoparasitic meals may be necessary for egg maturation. Although *Leptometopa latipes* (Meigen) is documented as a spider kleptoparasite, the larvae are also commonly associated with bird nests, including records from bird nests in BC. Adults of species in several genera (*Desmometopa*, *Leptometopa*, *Neophyllomyza*, *Paramyia*, *Milichiella*, and *Pholeomyia*) have been collected at flowers. Like the cases of kleptoparasitism most specimens found at flowers are female, there appears to be no oviposition on the plants and it is thought that the flies may be receiving nutrition essential for egg maturation. Adult male milichiids have equally well documented unique behaviors. Males of some species of *Milichiella*, and *Pholeomyia* have silvery abdomens and form mating swarms that can be seen from long distances.

Worldwide there are about 20 described genera and 275 described species, of which 12 genera and 39 species occur in the Nearctic region. The genera *Paramyia*, *Phyllomyza*, *Madiza*, *Desmometopa*, and *Pholeomyia* each have one described species recorded in British Columbia while the genus *Leptometopa* has two described species recorded from BC, for a total of seven described species. There are several other described widespread species of the genera *Desmometopa*, *Eusiphona*, and *Milichiella* that occur in BC collections in Canadian entomological museums, but are unpublished records. As well, there are numerous undescribed species of *Neophyllomyza*, and *Phyllomyza* in British Columbia awaiting formal description.

Family CHLOROPIDAE (Frit Flies, Grass Flies) [Fig. 94]

Frit flies are minute to small, 1.5 to 5.0 mm long; with the number and size of the body bristles clearly reduced. The body is black, grey, black and yellow, or black and red. The frons is broad, usually with the ocellar triangle well-developed, plate-like, clearly demarcated, shining to pruinose and normally with a single row of hair-bearing punctures along the lateral margins. The frons usually projects only slightly and the face is normally somewhat concave with the vibrissal angle rounded. The third antennal segment is usually round, sometimes kidney-shaped or elongate and bearing an arista that is normally pubescent or sometimes setulose, but rarely is bare. The head bristles are usually short and weak; the inner and outer verticals, ocellars and postocellars are commonly present. The latter bristles are parallel, convergent or crossed. The fronto-orbitals are usually represented by short setae curving rearward. Vibrissae, when present, are usually fine and setulose. The scutum is normally longer than broad, with fine setulae set in distinct rows and frequently with coarse, setulae-bearing punctures; one posterior dorsocentral bristle almost always occurs. The scutellum sometimes has marginal tubercles bearing bristles. The propleuron is sharply ridged in front. The wings are rarely absent or reduced and normally lack any colour pattern. The costa has a subcostal break; the subcosta is incomplete, usually faint. Veins R_{4+5} and M_{1+2} are long, the former ending before the wing tip, the latter ending behind the tip. Cells b-m and d-m are completely joined, forming a single long cell; CuA_1 often has a characteristic jog near the middle of cell bm+dm. Vein A_1 and cell cup are always missing; the anal area of the wing is usually broadly rounded. Normally the legs are short, slender, and without bristles, except an apical or subapical spur sometimes occurs on the middle or hind tibia. Many species have an elongate oval tibial organ on the upper surface of the hind tibia. The abdomen is broad, tapers to the tip, and each segment in front of the terminalia is about equal in length.

The larvae of many species of frit flies develop in grass stems, shoots, and decaying plant matter. A few species damage crops; one of the best known is the Frit Fly, *Oscinella frit* (Linnaeus), so-called because the wheat it damaged was termed “frits” by Swedish farmers. It also attacks rye, barley, lawn grasses and corn. The Wheat Stem Maggot, *Meromyza americana* Fitch, is also destructive. Some species produce galls; the European *Lipara lucens* Meigen forms galls on the giant marsh grass, *Phragmites*. Predaceous chloropids include: *Thaumatomyia glabra* (Meigen) which preys on root aphids, and the larvae of *Pseudogaurax* Malloch which feed on egg masses of spiders, tussock moths and mantids. Adult chloropids are most common in grass and sedge habitats. Some are found on flowers and a few, especially in the genus *Hippelates* Loew, are bothersome and even transmit disease by hovering around sweating faces and sipping liquid secretions from eyes, sores and wounds. *Pseudogaurax* and *Hippelates* are not known from BC.

The family Chloropidae ranges around the world, with over 2000 described species in more than 160 genera; over 50 genera containing about 290 species occur in North America. In BC there are at least 14 genera and over 30 described species. There are two prominent subfamilies in BC -- members of the Oscinellinae are usually black bodied while those of the Chloropinae are yellow or red, marked with red to black stripes. The latter subfamily contains *Thaumatomyia* Zenker, one of the most speciose genera in the province with at least five species recorded. *T. glabra* is Holarctic and common over

all of North America; its larvae prey on various root aphids including the economically damaging sugarbeet root aphid (*Pemphigus populivenerae* Fitch). There are only two species of *Chlorops* Meigen recorded in BC, although probably more occur in the province; the species are usually yellow with black stripes. *C. certimus* Adams (Fig. 94) ranges over much of the continent; *C. stigmatus* Becker is confined to the mountains of the Northwest. *Meromyza* Meigen contains the Wheat Stem Maggot, *M. americana* Fitch, which apparently is not known in BC. But the Holarctic *M. pratorum* Meigen and *M. saltatrix* (Linnaeus) are recorded; the former is boreal, the latter cordilleran. In the Oscinellinae, *Elachiptera* Macquart has at least two species occurring in BC including *E. decipiens* (Loew) which is widespread. The Frit Fly, *Oscinella frit* (Linnaeus) and *O. nitidissima* (Meigen) are Holarctic and also are known from BC. Other BC genera include *Olcella* Enderlein, *Tricimba* Lioy, *Lasiosina* Becker and *Malloewa* Sabrosky.

Table 1. Order DIPTERA. List of Figures

Figure No.	Family Name	Illustration origins from MND* unless otherwise indicated	Species
1	TANYDERIDAE	Figure 6.1	<i>Protoplasa fitchii</i> Osten Sacken, male
2	TIPULIDAE	7.1	<i>Tipula trivittata</i> Say, male
3	BLEPHARICERIDAE	8.1	<i>Agathon comstocki</i> (Kellogg), male
4	DEUTEROPHLEBIIDAE	9.1	<i>Deuterophlebia inyoensis</i> Kennedy, male
5	AXYMYIIDAE	11.1	<i>Axymyia furcata</i> McAtee, male
6	PACHYNEURIDAE	12.1	<i>Cramptonomyia spenceri</i> Alexander, male
7	BIBIONIDAE	13.1	<i>Bibio longipes</i> Loew, male
8	MYCETOPHILIDAE	14.2	<i>Macrocera variola</i> Garrett, male
9	SCIARIDAE	15.1	<i>Sciara</i> sp., female
10	CECIDOMYIIDAE	16.1	<i>Cecidomyia resinicola</i> (Osten Sacken), female
11	PSYCHODIDAE	17.1	<i>Psychoda</i> sp., female
12	TRICHOCERIDAE	18.1	<i>Trichocera garretti</i> Alexander, male
13	ANISOPODIDAE	19.1	<i>Sylvicola alternatus</i> (Say), female
14	SCATOPSIDAE	20.1	<i>Scatopse notata</i> (Linnaeus), male
15	CANTHYLOSCELIDAE	21.1	<i>Synneuron decipiens</i> Hutson, female
16	PTYCHOPTERIDAE	22.1	<i>Bittacomorpha clavipes</i> (Fabricius), male
17	DIXIDAE	23.1	<i>Dixa</i> sp., male
18	CHAOBORIDAE	24.1	<i>Chaoborus americanus</i> (Johannsen), male
19	CULICIDAE	25.1	<i>Aedes sticticus</i> (Meigen), female
20	THAUMALEIDAE	26.1	<i>Thaumalea americana</i> Bezzi, female
21	SIMULIIDAE	27.1	<i>Prosimulium mixtum</i> Syme & Davies, female
22	CERATOPOGONIDAE	28.1	<i>Culicoides variipennis</i> (Coquillett), female
23	CHIRONOMIDAE	29.1	<i>Chironomus plumosus</i> (Linnaeus), male
24	XYLOPHAGIDAE	34.1	<i>Xylophagus abdominalis</i> Loew, female

Figure No.	Family Name	Illustration origins from MND* unless otherwise indicated	Species
25	XYLOMYIDAE	35.1	<i>Xylomya americana</i> (Wiedemann), female
26	STRATIOMYIDAE	36.1	<i>Stratiomys barbata</i> Loew, female
27	RHAGIONIDAE	33.1	<i>Symphoromyia hirta</i> Johnson, female
28	PELECORHYNCHIDAE	30.1	<i>Bequaertomyia jonesi</i> (Cresson), female
29	OREOLEPTIDAE	Fig. 1 **	<i>Oreoleptis torrenticola</i> sp.n. , female
30	ATHERICIDAE	32.1	<i>Atherix variegata</i> Walker, female
31	TABANIDAE	31.1	<i>Hybomitra lasiophthalma</i> (Macquart), female
32	NEMESTRINIDAE	44.1	<i>Neorhynchocephalus sackenii</i> (Williston), female
33	ACROCERIDAE	43.1	<i>Ogcodes eugonatus</i> Cole & Wilcox, male
34	THEREVIDAE	37.1	<i>Thereva fucata</i> Loew, female
35	SCENOPINIDAE	38.1	<i>Scenopinus finestrals</i> (L.), female
36	MYDIDAE	40.1	<i>Mydas clavatus</i> (Drury), female
37	APIOCERIDAE	41.1	<i>Apiocera haruspex</i> Osten Sacken, male
38	ASILIDAE	Frontispiece ***	<i>Lasiopogon hinei</i> Cole & Wilcox, male
39	BOMBYLIIDAE	45.1	<i>Bombylius pygmaeus</i> Fabricius, male
40	HILARIMORPHIDAE	46.1	<i>Hilarimorpha ditissa</i> Webb, male
41	EMPIDIDAE	47.1	<i>Empis browni</i> Curran, male
42	DOLICHOPODIDAE	48.1	<i>Dolichopus cuprinus</i> Wiedemann, male
43	PLATYPEZIDAE	50.1 [4.123]	<i>Plesioclythia agarici</i> (Willard), female
44	LONCHOPTERIDAE	49.1	<i>Lonchoptera furcata</i> Fallén, female
45	PHORIDAE	51.1 [4.125]	<i>Phora occidentata</i> Malloch, male
46	SYRPHIDAE	52.1 [4.126]	<i>Syrphus torvus</i> Osten Sacken, male
47	PIPUNCULIDAE	53.1 [4.127]	<i>Pipunculus ater</i> Meigen, male
48	SCATHOPHAGIDAE	103.1	<i>Scathophaga stercoraria</i> (Linnaeus), male
49	ANTHOMYIIDAE	104.1	<i>Anthomyia pluvialis</i> (Linnaeus), male
50	MUSCIDAE	105.1	<i>Musca domestica</i> Linnaeus, male
51	CALLIPHORIDAE	106.1	<i>Calliphora terraenovae</i> Macquart, female

Figure No.	Family Name	Illustration origins from MND* unless otherwise indicated	Species
52	OESTRIDAE	107.1 [4.158]	<i>Oestrus ovis</i> Linnaeus, female
53	SARCOPHAGIDAE	108.1 [4.159]	<i>Arachnidomyia aldrichi</i> (Parker), male
54	TACHINIDAE	110.1	<i>Tachina florum</i> Walker, male
55	HIPPOBOSCIDAE	111.1 [4.161]	<i>Ornithomya anchineuria</i> Speiser, female
56	NYCTERIBIIDAE	112.1	<i>Basilia forcipata</i> Ferris, female
57	STREBLIDAE	113.1 [4.160]	<i>Trichobius corynorhini</i> Cockerell, female
58	CONOPIDAE	54.1 [4.128]	<i>Physoconops brachyrhynchus</i> (Macquart), female
59	LONCHAEIDAE	62.1 [4.133]	<i>Lonchaea polita</i> Say, female
60	PALLOPTERIDAE	68.1	<i>Toxoneura superba</i> (Loew), female
61	PIOPHILIDAE	69.1	<i>Piophila casei</i> (Linnaeus), male
62	OTITIDAE	63.1	<i>Ceroxys latiusculus</i> (Loew), male
63	PLATYSTOMATIDAE	64.1 [4.134]	<i>Rivellia flavimana</i> Loew, female
64	TEPHRITIDAE	66.1	<i>Tephritis angustipennis</i> (Loew), female
65	PYRGOTIDAE	65.1	<i>Pyrgota undata</i> Wiedemann, female
66	MICROPEZIDAE	56.1 [4.130]	<i>Micropeza lineata</i> Van Duzee, male
67	TANYPEZIDAE	58.1 [4.129]	<i>Tanypeza longimana</i> Fallén, female
68	STRONGYLOPHTHALMYIIDAE	59.1	<i>Strongylophthalmyia angustipennis</i> Melander, female
69	PSILIDAE	60.1	<i>Psila collaris</i> Loew, female
70	LAUXANIIDAE	87.1	<i>Minettia lupulina</i> (Fabricius), male
71	CHAMAEMYIIDAE	88.1	<i>Chamaemyia polystigma</i> (Meigin), female
72	COELOPIDAE	82.1	<i>Coelopa stejneri</i> Aldrich, male
73	SEPSIDAE	86.1 [4.145]	<i>Sepsis punctum</i> (Linnaeus), male
74	DRYOMYZIDAE	83.1	<i>Dryomyza anilis</i> Fallén, male
75	SCIOMYZIDAE	84.1	<i>Sepedon fuscipennis</i> Loew, male
76	HELEOMYZIDAE	89.1	<i>Heleomyza serrata</i> (Linnaeus), male
77	TRIXOSCELIDIDAE	90.1 [4.148]	<i>Trixoscelis fumipennis</i> Melander, male
78	SPHAEROCERIDAE	93.1 [4.149]	<i>Sphaerocera curvipes</i> Laterille, male

Figure No.	Family Name	Illustration origins from MND* unless otherwise indicated	Species
79	CHYROMYIDAE	91.1 [4.147]	<i>Chyromya flava</i> (Linnaeus), male
80	DROSOPHILIDAE	95.1 [4.151]	<i>Drosophila melanogaster</i> Meigen, female
81	DIASTATIDAE	96.1 [4.152]	<i>Diastata vagans</i> Loew, males
82	EPHYDRIDAE	98.1 [4.155]	<i>Ephydra riparia</i> Fallén, male
83	ODINIIDAE	72.1 [4.139]	<i>Odinia betulae</i> Sabrosky, male
84	AGROMYZIDAE	73.1	<i>Agromyza albipennis</i> Meigen, female
85	CLUSIIDAE	70.1	<i>Clusia lateralis</i> (Walker), female
86	ACARTOPHTHALMIDAE	71.1 [4.137]	<i>Acartophthalmus nigrinus</i> (Zetterstedt), female
87	OPOMYZIDAE	74.1 [4.142]	<i>Geomyza lurida</i> (Loew), male
88	ANTHOMYZIDAE	75.1	<i>Anthomyza gracilis</i> Fallén, male
89	PERISCOLIDIDAE	77.1	<i>Periscelis annulata</i> (Fallén), male
90	ASTEIIDAE	78.1	<i>Asteia beata</i> Aldrich, female
91	CARNIDAE	80.1	<i>Carnus hemapterus</i> Nitzsch, female
92	TETHINIDAE	101.1 [4.156]	<i>Tethina parvula</i> Loew, male
93	MILICHIIDAE	79.1 [4.143]	<i>Desmometopa m-nigrum</i> (Zetterstedt), female
94	CHLOROPIDAE	99.1 [4.154]	<i>Chlorops certimus</i> Adams, female

*MND = *Manual of Nearctic Diptera, Volume 1*, Research Branch, Agriculture Canada, Monograph No. 27, 1981.
Manual of Nearctic Diptera, Volume 2, Research Branch, Agriculture Canada, Monograph No. 28, 1987.

Source: Manual of Nearctic Diptera - Volumes 1 and 2, Figure numbers* as indicated in third column in above table, Agriculture & Agri-Food Canada, 1981 and 1987. Reproduced with the permission of the Minister of Public Works and Government Services Canada, 2006.

Note: Numbers in brackets ([]) refer to figures shown on pages 111-113 and 116-117, Volume I.
 Illustrations from MND were scanned directly from the publications for presentation on the website (<http://www.zoology.ubc.ca/bcdiptera>).

** Family OREOLEPTIDAE (Figure 29)

Zloty, J., Sinclair, B., and Pritchard, G. 2005. Discovered in our backyard: a new genus and species of a new family from the Rocky Mountains of North America (Diptera: Tabanomorpha). *Systematic Entomology* 30(2), 248-266. Figure 1, *Oreoleptis torrenticola* **sp.n.**

*** Family ASILIDAE (Figure 38)

Insects of the Yukon. 1997. (Eds. H.V. Danks and J.A. Downes). Biological Survey of Canada (Terrestrial Arthropods), Ottawa, ON. Robber Flies (Diptera: Asilidae) of the Yukon by R.A. Cannings. Frontispiece, page 637. *Lasiopogon hinei* Cole & Wilcox, male.

APPENDIX I. Checklist Order DIPTERA

Order DIPTERA

Suborder NEMATOCERA

Infraorder TIPULOMORPHA

Family TANYDERIDAE

Family TIPULIDAE

Infraorder BLEPHARICEROMORPHA

Family BLEPHARICERIDAE

Family DEUTEROPHLEBIIDAE

Infraorder AXYMIOMORPHA

Family AXYMYIIDAE

Family PACHYNEURIDAE

Infraorder BIBIONOMORPHA

Family BIBIONIDAE

Family MYCETOPHILIDAE

Family SCIARIDAE

Family CECIDOMYIIDAE

Infraorder PSYCHODOMORPHA

Family PSYCHODIDAE

Family TRICHOCERIDAE

Family ANISOPODIDAE

Family SCATOPSIDAE

Family CANTHYLOSCELIDAE

Infraorder PTYCHOPTEROMORPHA

Family PTYCHOPTERIDAE

Infraorder CULICOMORPHA

Family DIXIDAE

Family CHAOBORIDAE

Family CULICIDAE

Family THAUMALEIDAE

Family SIMULIIDAE

Family CERATOPOGONIDAE

Family CHIRONOMIDAE

Suborder BRACHYCERA

Infraorder XYLOPHAGOMORPHA

Family XYLOPHAGIDAE

Infraorder STRATIOMYOMORPHA

Family XYLOMYIDAE

Family STRATIOMYIDAE

Infraorder TABANOMORPHA

Family RHAGIONIDAE

Family PELECORHYNCHIDAE

Family OREOLEPTIDAE

Family ATHERICIDAE

Family TABANIDAE

Infraorder MUSCOMORPHA

Family NEMESTRINIDAE

Family ACROCERIDAE

Superfamily ASILOIDEA

Family THEREVIDAE

Family SCENOPINIDAE

Family MYDIDAE

Family APIOCERIDAE

Family ASILIDAE

Family BOMBYLIIDAE

Family HILARIMORPHIDAE

Superfamily EMPIDOIDEA

Family EMPIDIDAE

Family DOLICHOPODIDAE

Superfamily PLATYPEZOIDEA

Family PLATYPEZIDAE

Superfamily PHOROIDEA

Family LONCHOPTERIDAE

Family PHORIDAE

Superfamily SYRPHOIDEA

Family SYRPHIDAE

Family PIPUNCULIDAE

CALYPTRATAE

Superfamily MUSCOIDEA

Family SCATHOPHAGIDAE

Family ANTHOMYIIDAE

Family MUSCIDAE

Superfamily OESTROIDEA

Family CALLIPHORIDAE
Family OESTRIDAE
Family SARCOPHAGIDAE
Family TACHINIDAE

Superfamily HIPPOBOSCOIDEA
Family HIPPOBOSCIDAE
Family NYCTERIBIIDAE
Family STREBLIDAE

ACALPTRATAE
Superfamily CONOPOIDEA
Family CONOPIDAE

Superfamily TEPHRITOIDEA
Family LONCHAEIDAE
Family PALLOPTERIDAE
Family PIOPHILIDAE
Family OTITIDAE
Family PLATYSTOMATIDAE
Family TEPHRITIDAE
Family PYRGOTIDAE

Superfamily NERIOIDEA
Family MICROPEZIDAE

Superfamily DIOPSOIDEA
Family TANYPEZIDAE
Family STRONGYLOPHTHALMYIIDAE
Family PSILIDAE

Superfamily LAUXANIOIDEA
Family LAUXANIIDAE
Family CHAMAEMYIIDAE

Superfamily SCIOMYZOIDEA
Family COELOPIDAE
Family SEPSIDAE
Family DRYOMYZIDAE
Family SCIOMYZIDAE

Superfamily SPHAEROCEROIDEA
Family HELEOMYZIDAE
Family TRIOSCELIDIDAE
Family SPHAEROCERIDAE
Family CHYROMYZIDAE

Superfamily EPHYDROIDEA

Family DROSOPHILIDAE

Family DIASTATIDAE

Family EPHYDRIDAE

Superfamily OPOMYZOIDEA

Family ODINIIDAE

Family AGROMYZIDAE

Family CLUSIIDAE

Family ACARTOPHTHALMIDAE

Family OPOMYZIDAE

Family ANTHOMYZIDAE

Family PERISCELIDIDAE

Family ASTEIIDAE

Superfamily CARNOIDEA

Family CARNIDAE

Family TETHINIDAE

Family MILICHIIDAE

Family CHLOROPIDAE

APPENDIX II. Order DIPTERA: Alphabetical List of Families

Family ACARTOPHTHALMIDAE
Family ACROCERIDAE
Family AGROMYZIDAE
Family ANISOPODIDAE
Family ANTHERICIDAE
Family ANTHOMYIIDAE
Family ANTHOMYZIDAE
Family APIOCERIDAE
Family ASILIDAE
Family ASTEIIDAE
Family AXYMYIIDAE
Family BIBIONIDAE
Family BLEPHARICERIDAE
Family BOMBYLIIDAE
Family CALLIPHORIDAE
Family CANTHYLOSCELIDAE
Family CARNIDAE
Family CECIDOMYIIDAE
Family CERATOPOGONIDAE
Family CHAMAEMIIDAE
Family CHAOBORIDAE
Family CHIRONOMIDAE
Family CHLOROPIDAE
Family CHYROMYIDAE
Family CLUSIIDAE
Family COELOPIDAE
Family CONOPIDAE
Family CULICIDAE
Family DEUTEROPHLEBIIDAE
Family DIASTATIDAE
Family DIXIDAE
Family DOLICHOPODIDAE
Family DROSOPHILIDAE
Family DRYOMYZIDAE
Family EMPIDIDAE
Family EPHYDRIDAE
Family HELEOMYZIDAE
Family HILARIMORPHIDAE
Family HIPPOBOSCIDAE
Family LAUXANIIDAE
Family LONCHAEIDAE
Family LONCHOPTERIDAE
Family MICROPELIDAE

Family MILICHIIDAE
Family MUSCIDAE
Family MYCETOPHILIDAE
Family MYDIDAE
Family NEMESTRINIDAE
Family NYCTERIBIIDAE
Family ODINIIDAE
Family OESTRIDAE
Family OPOMYZIDAE
Family OREOLEPTIDAE
Family OTITIDAE
Family PACHYNEURIDAE
Family PALLOPTERIDAE
Family PELECORHYNCHIDAE
Family PERISCELIDIDAE
Family PHORIDAE
Family PIOPHILIDAE
Family PIPUNCULIDAE
Family PLATYPEZIDAE
Family PLATYSTOMATIDAE
Family PSILIDAE
Family PSYCHODIDAE
Family PTYCHOPTERIDAE
Family PYRGOTIDAE
Family RHAGIONIDAE
Family SARCOPHAGIDAE
Family SCATHOPHAGIDAE
Family SCATOPSIDAE
Family SCENOPINIDAE
Family SCIARIDAE
Family SCIOMYZIDAE
Family SEPSIDAE
Family SIMULIIDAE
Family SPAEROCERIDAE
Family STRATIOMYIDAE
Family STREBLIDAE
Family STRONGYLOPHTHALMYIIDAE
Family SYRPHIDAE
Family TABANIDAE
Family TACHINIDAE
Family TANYDERIDAE
Family TEPHRITIDAE
Family TETHINIDAE
Family THAUMALEIDAE
Family THEREVIDAE
Family TIPULIDAE


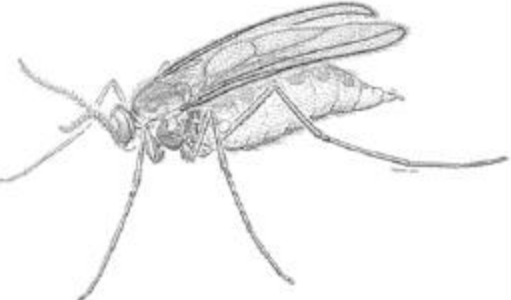


Family TRICHOCERIDAE

Family TRIXOSCELIDIDAE

Family XYLOMYIDAE

Family XYLOPHAGIDAE

APPENDIX III. DIPTERA Families Illustrations (ordered as in manuscript).

	<p>Figure 1 Family TANYDERIDAE</p>
	<p>Figure 10 Family CECIDOMYIIDAE</p>
	<p>Figure 11 Family PSYCHODIDAE</p>
	<p>Figure 12 Family TRICHOCERIDAE</p>

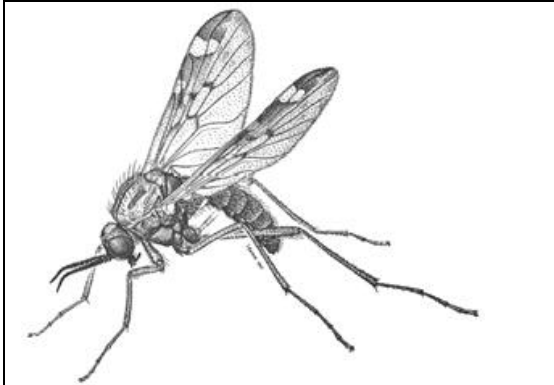


Figure 13
Family ANISOPODIDAE

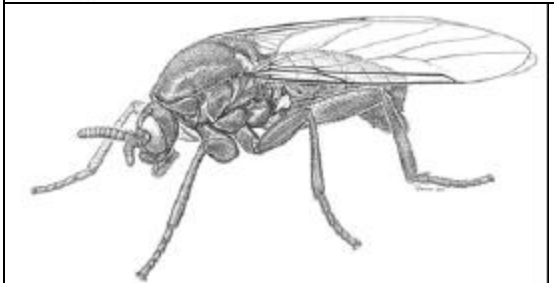


Figure 14
Family SCATOPSIDAE

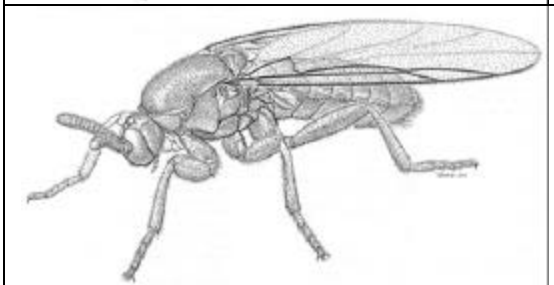


Figure 15
Family CANTHYLOSCELIDAE

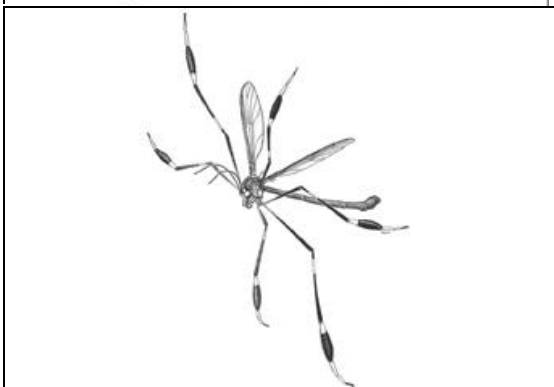


Figure 16
Family PTYCHOPTERIDAE

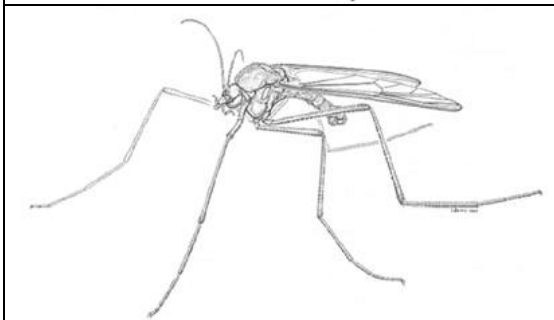



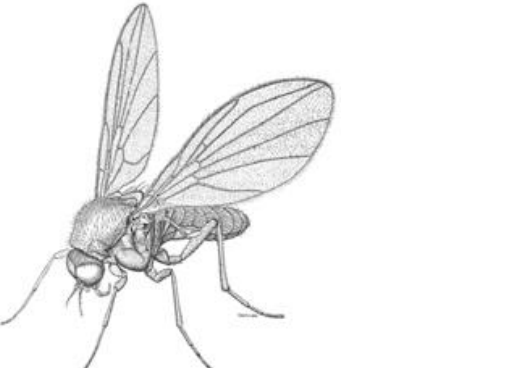
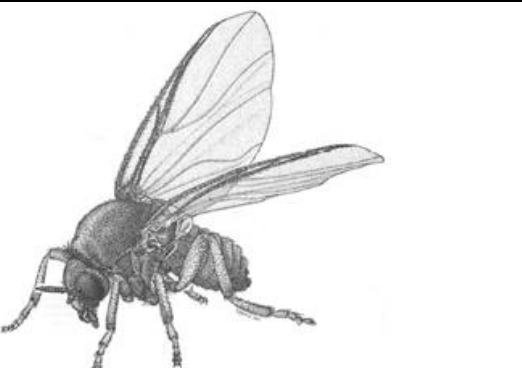


Figure 17
Family DIXIDAE

	<p>Figure 18 Family CHAOBORIDAE</p>
	<p>Figure 19 Family CULICIDAE</p>
	<p>Figure 2 Family TIPULIDAE</p>
	<p>Figure 20 Family THAUMALEIDAE</p>
	<p>Figure 21 Family SIMULIIDAE</p>

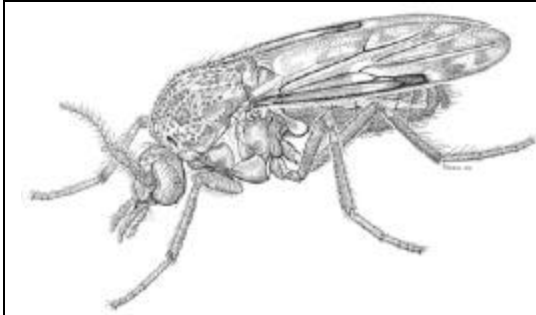


Figure 22
Family CERATOPOGONIDAE



Figure 23
Family CHIRONOMIDAE



Figure 24
Family XYLOPHAGIDAE

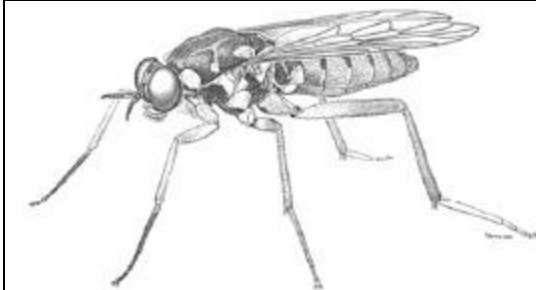


Figure 25
Family XYLOMYIDAE

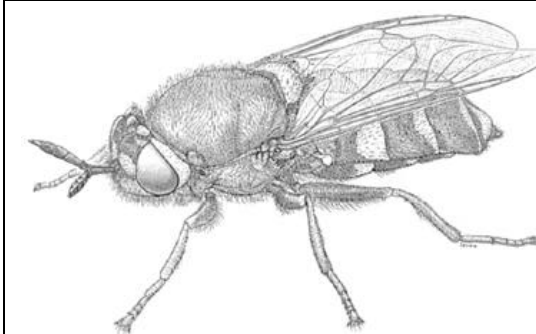


Figure 26
Family STRATIOMYIDAE

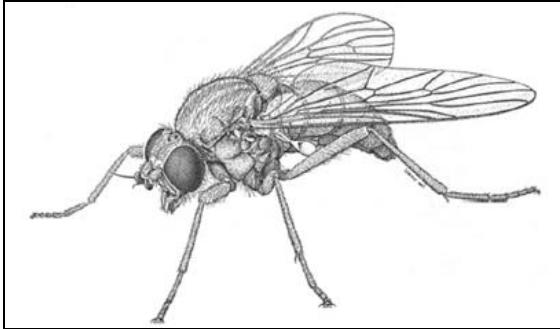


Figure 27
Family RHAGIONIDAE

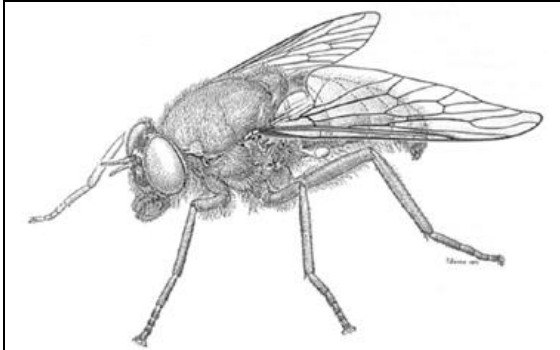


Figure 28
Family PELECORHYNCHIDAE

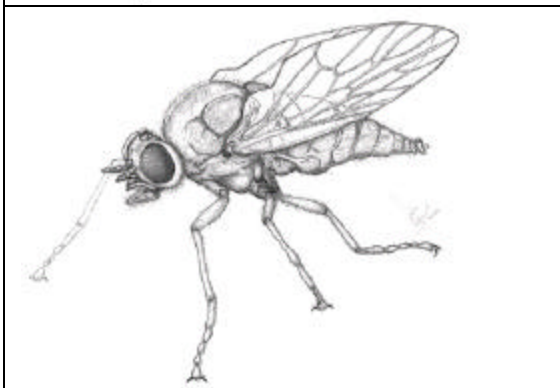


Figure 29
Family OREOLEPTIDAE

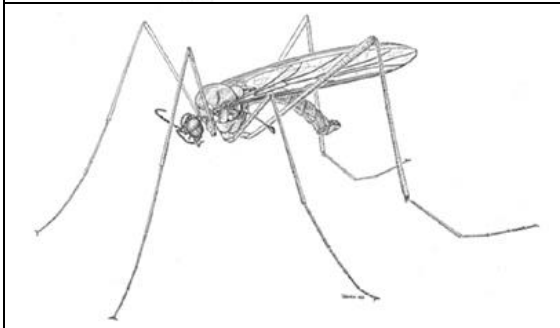


Figure 3
Family BLEPHARICERIDAE

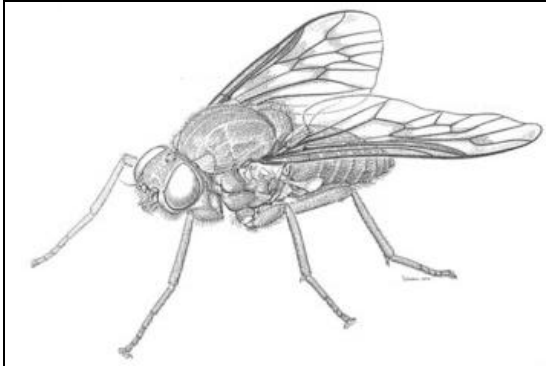


Figure 30
Family ATHERICIDAE

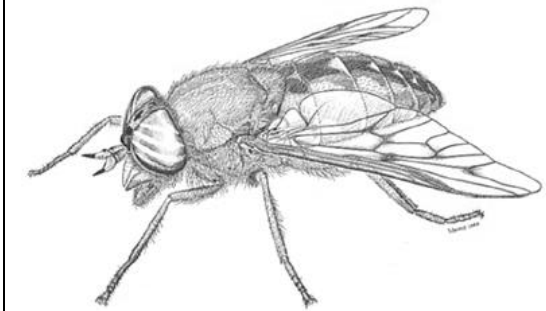


Figure 31
Family TABANIDAE

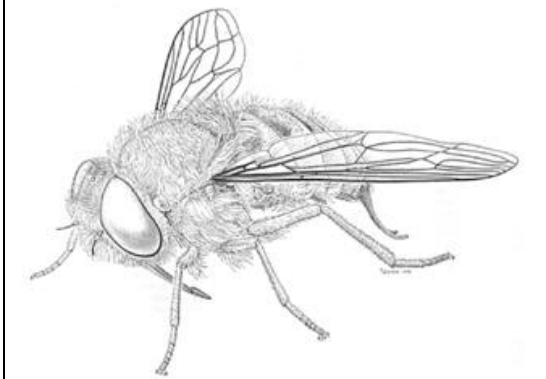


Figure 32
Family NEMESTRINIDAE



Figure 33
Family ACROCERIDAE

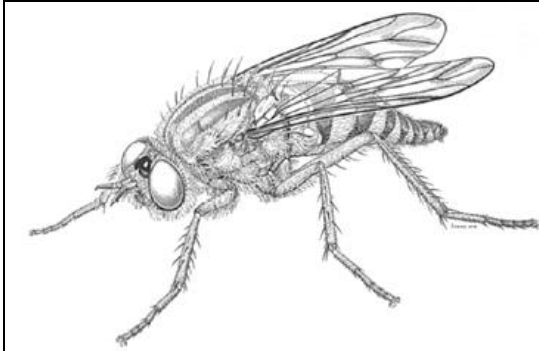


Figure 34
Family THEREVIDAE

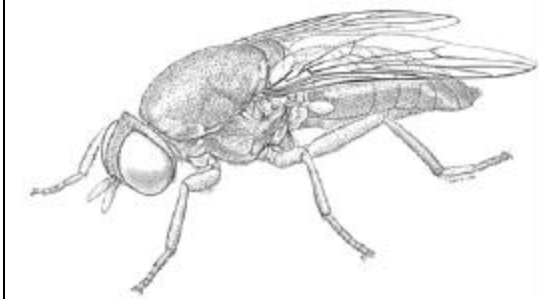


Figure 35
Family SCENOPINIDAE

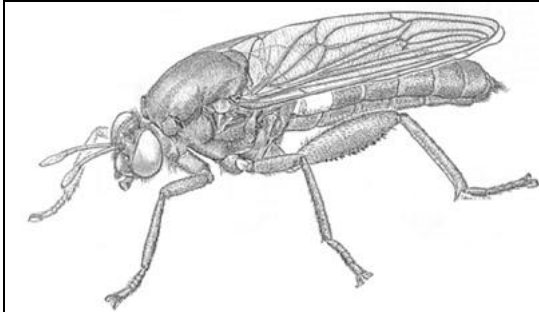


Figure 36
Family MYDIDAE

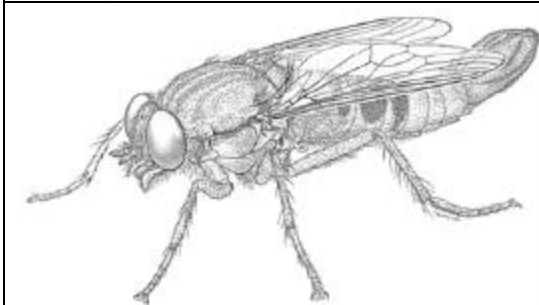


Figure 37
Family APIOCERIDAE

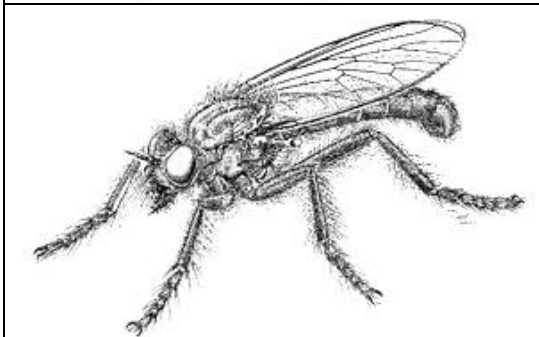


Figure 38
Family ASILIDAE

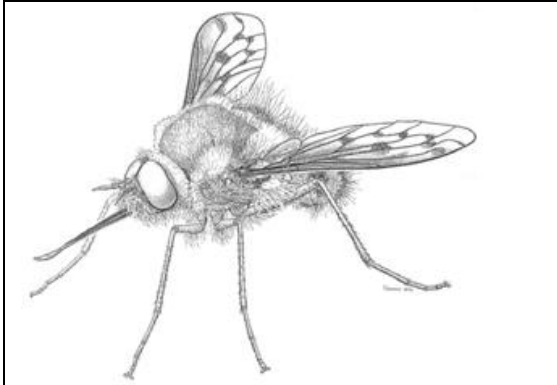


Figure 39
Family BOMBYLIIDAE

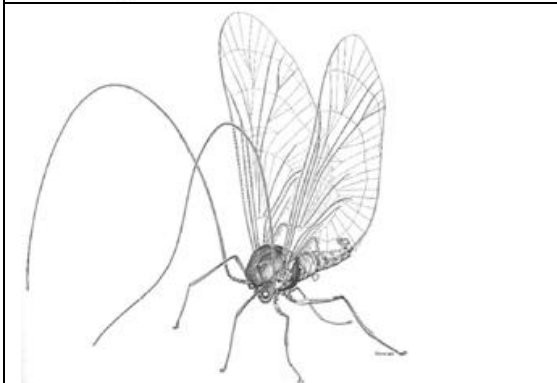


Figure 4
Family DEUTEROPHLEBIIDAE

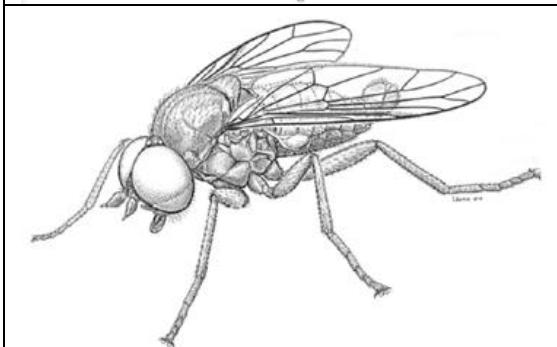


Figure 40
Family HILARIMORPHIDAE

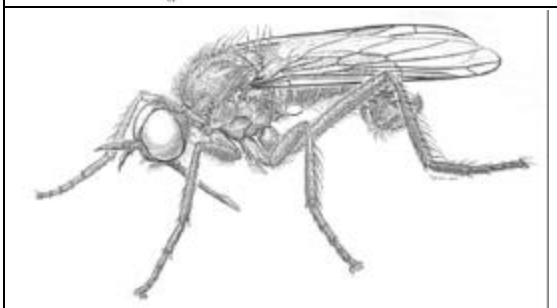


Figure 41
Family EMPIDIDAE

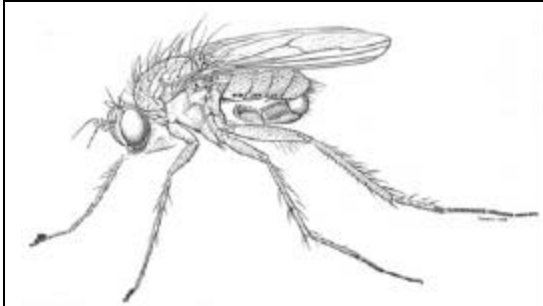


Figure 42
Family DOLICHOPODIDAE

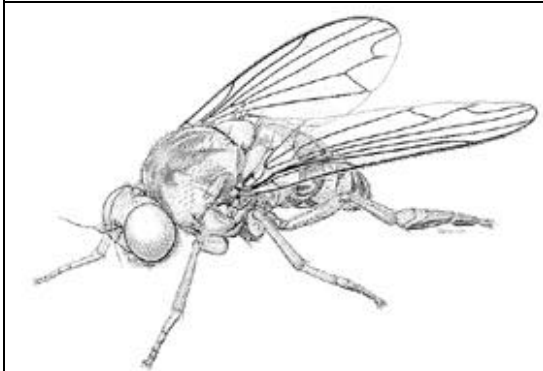


Figure 43
Family PLATYPEZIDAE

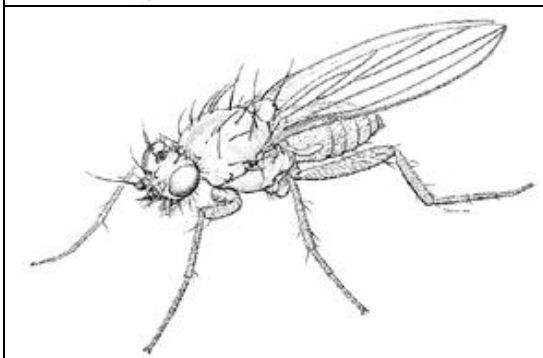


Figure 44
Family LONCHOPTERIDAE

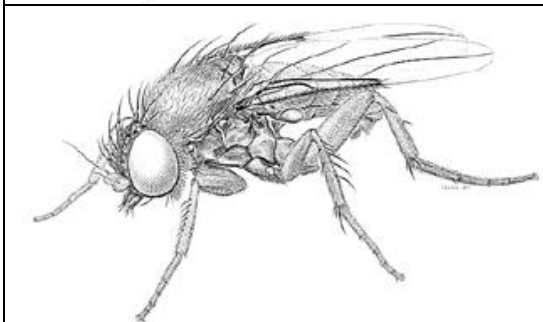


Figure 45
Family PHORIDAE

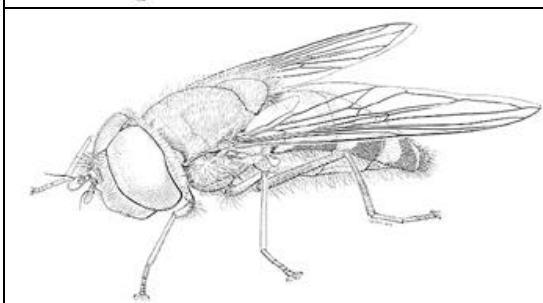


Figure 46
Family SYRPHIDAE

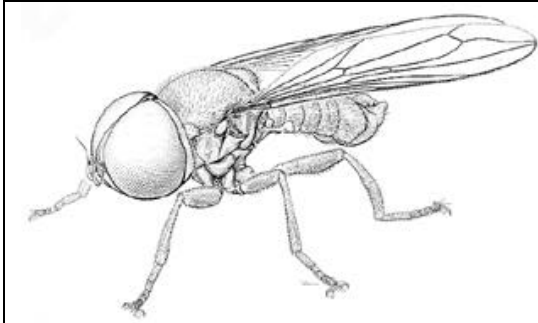


Figure 47
Family PIPUNCULIDAE

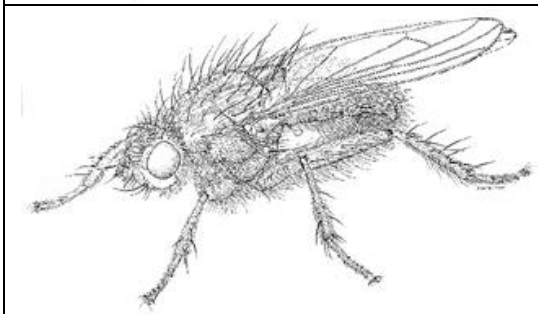


Figure 48
Family SCATHOPHAGIDAE



Figure 49
Family ANTHOMYIIDAE

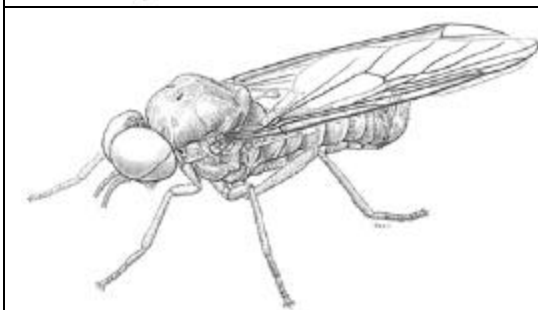


Figure 5
Family AXYMYIIDAE



Figure 50
Family MUSCIDAE



Figure 51
Family CALLIPHORIDAE

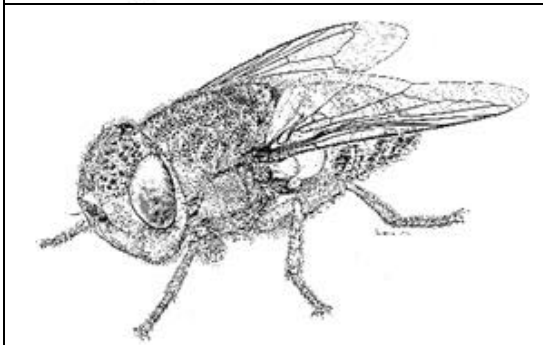


Figure 52
Family OESTRIDAE

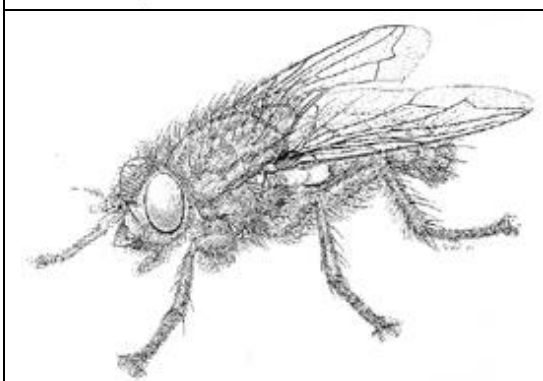


Figure 53
Family SARCOPHAGIDAE

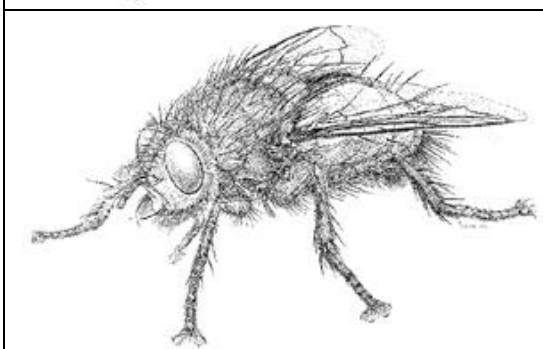

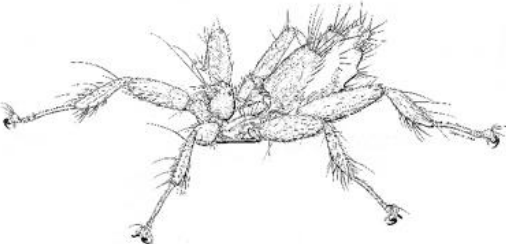
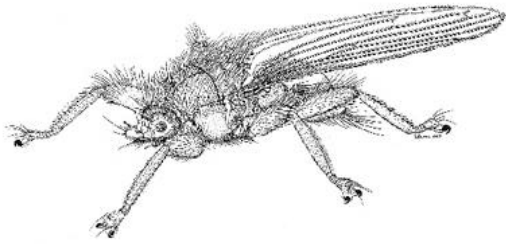

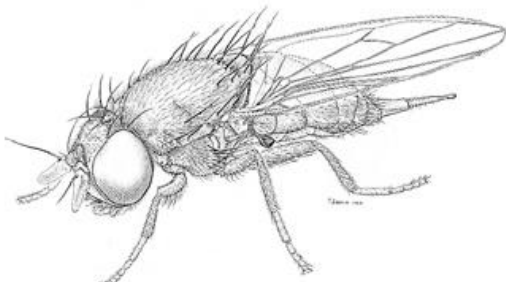


Figure 54
Family TACHINIDAE

	<p>Figure 55 Family HIPPOBOSCIDAE</p>
	<p>Figure 56 Family NYCTERIBIIDAE</p>
	<p>Figure 57 Family STREBLIDAE</p>
	<p>Figure 58 Family CONOPIDAE</p>
	<p>Figure 59 Family LONCHAEIDAE</p>

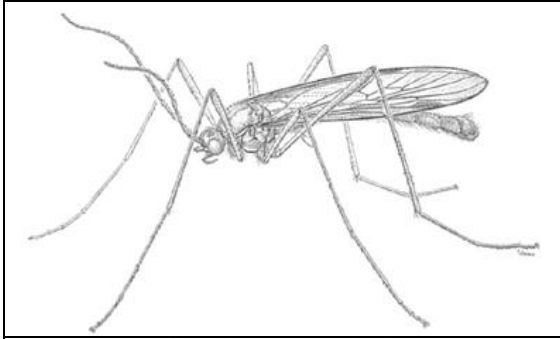


Figure 6
Family PACHYNEURIDAE

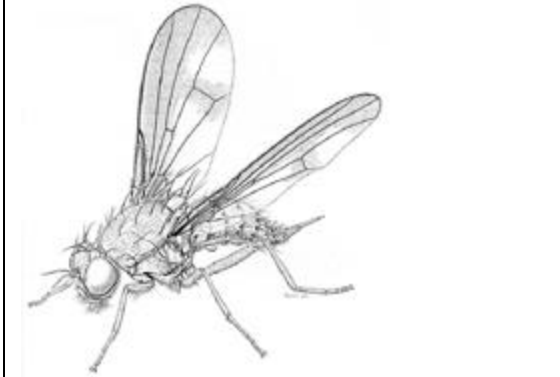


Figure 60
Family PALLOPTERIDAE

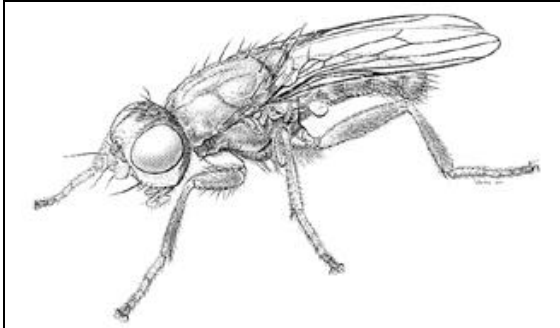


Figure 61
Family PIOPHILIDAE

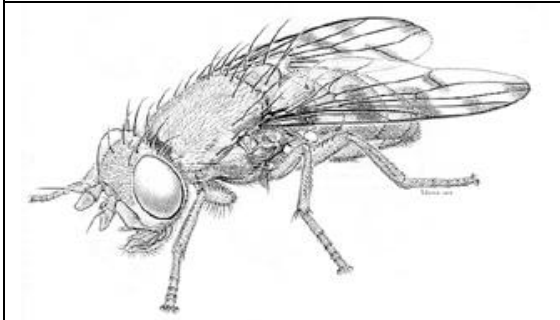


Figure 62
Family OTITIDAE

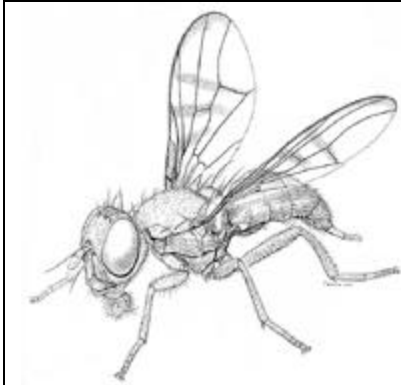


Figure 63
Family PLATYSTOMATIDAE



Figure 64
Family TEPHRITIDAE

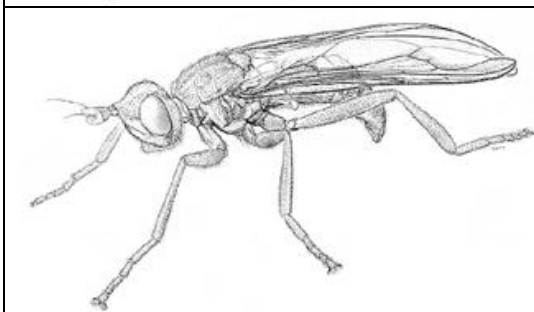


Figure 65
Family PYRGOTIDAE

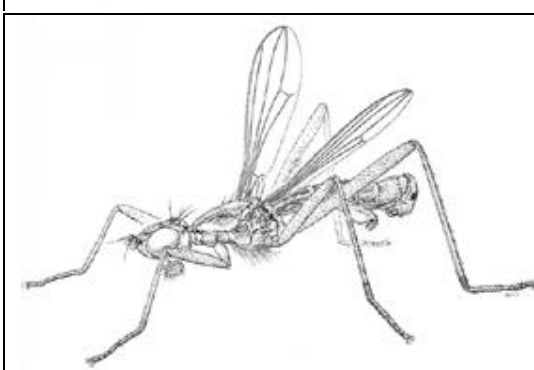


Figure 66
Family MICROPEZIDAE

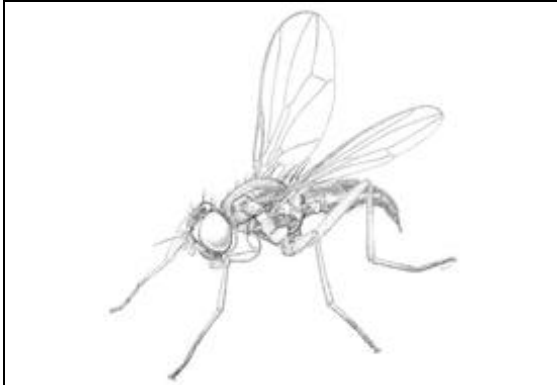


Figure 67
Family TANYPEZIDAE

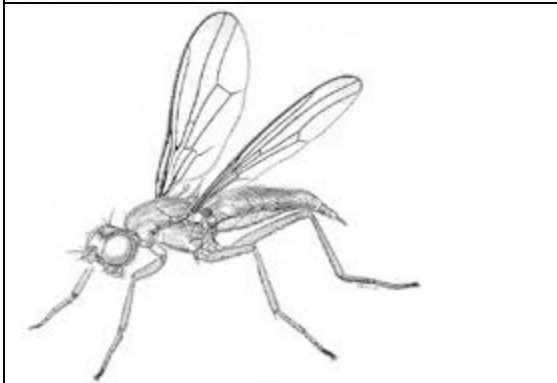


Figure 68
Family STRONGYLOPHTHALMYIIDAE

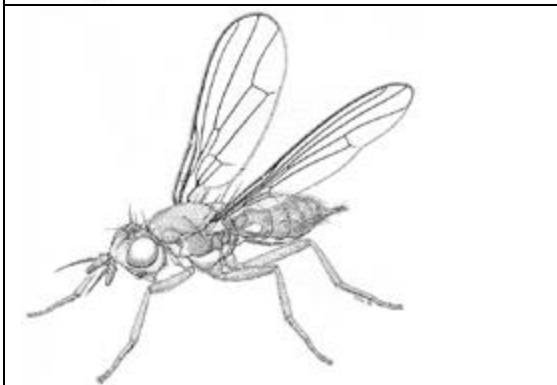


Figure 69
Family PSILIDAE

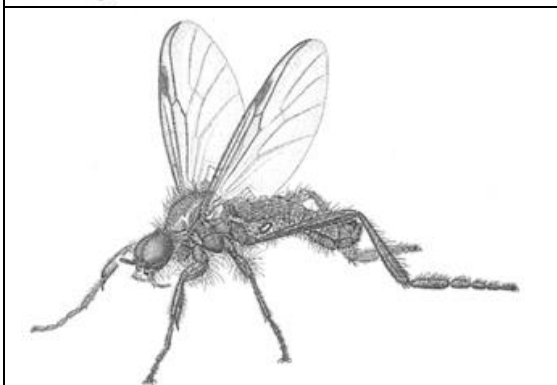


Figure 7
Family BIBIONIDAE

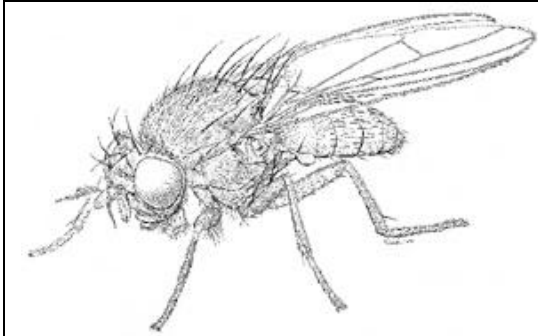


Figure 70
Family LAUXANIIDAE

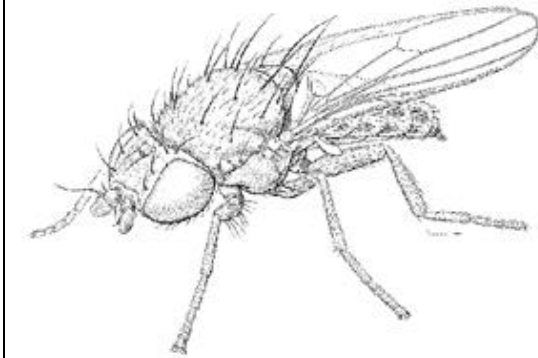


Figure 71
Family CHAMAEMYIIDAE

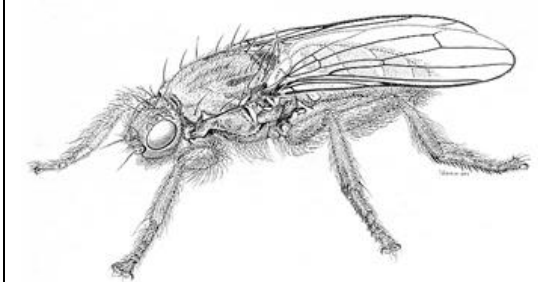


Figure 72
Family COELOPIDAE

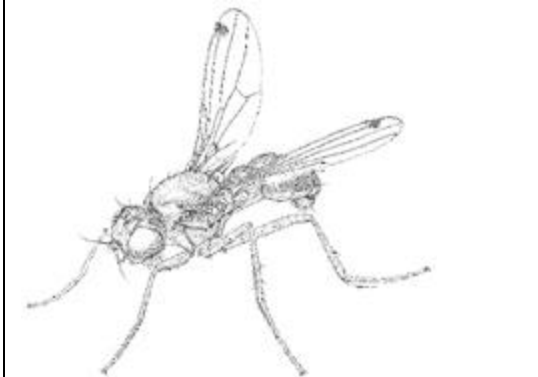


Figure 73
Family SEPSIDAE

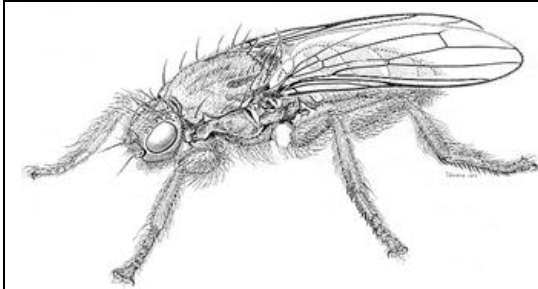


Figure 74
Family DRYOMYZIDAE

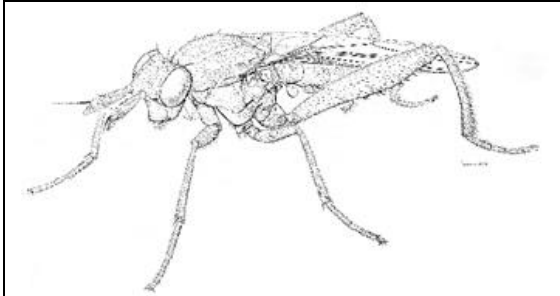


Figure 75
Family SCIOMYZIDAE

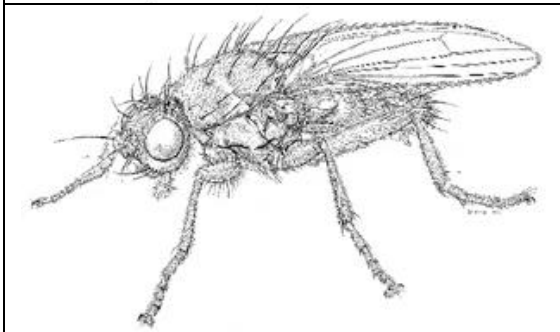


Figure 76
Family HELEOMYZIDAE

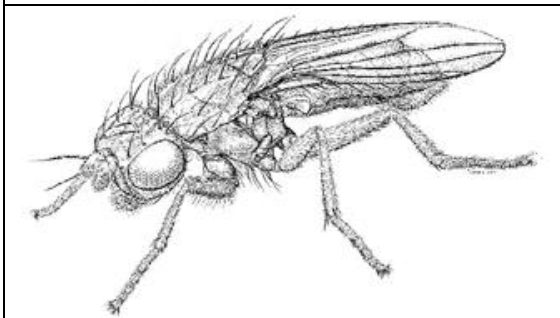


Figure 77
Family TRIXOSCELIDIDAE

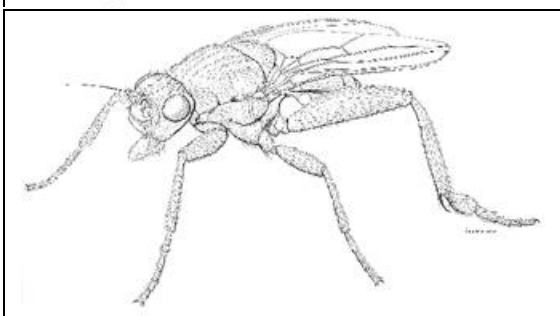


Figure 78
Family SPHAEROCERIDAE

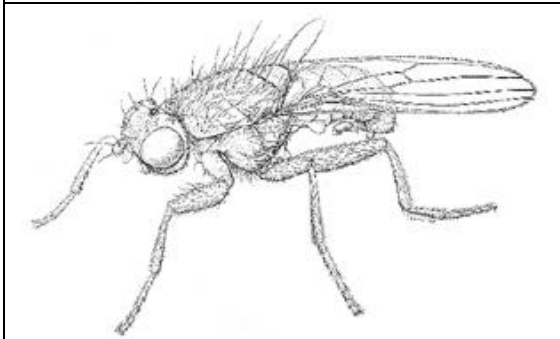


Figure 79
Family CHYROMYIDAE



Figure 8
Family MYCETOPHILIDAE

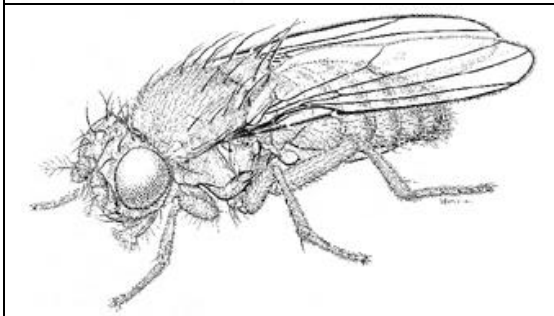


Figure 80
Family DROSOPHILIDAE

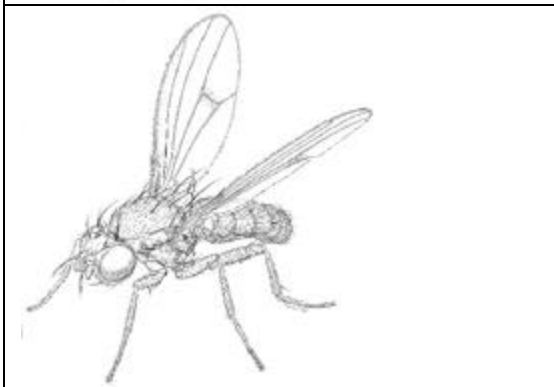


Figure 81
Family DIASTATIDAE

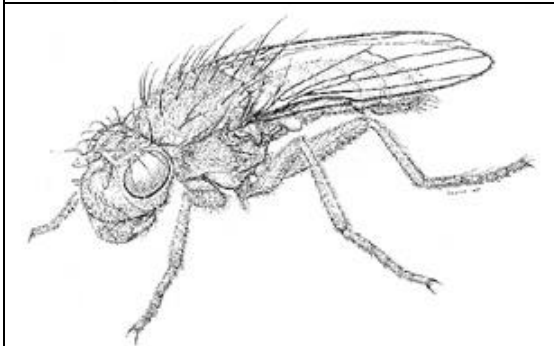


Figure 82
Family EPHYDRIDAE

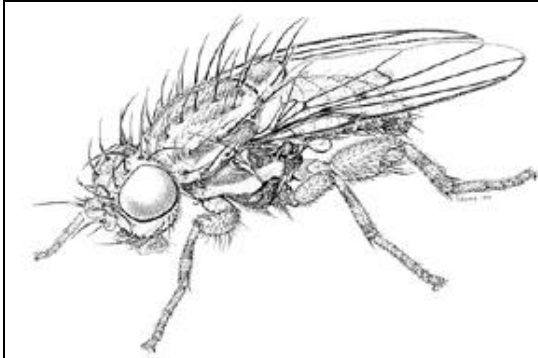


Figure 83
Family ODINIIDAE



Figure 84
Family AGROMYZIDAE



Figure 85
Family CLUSIIDAE

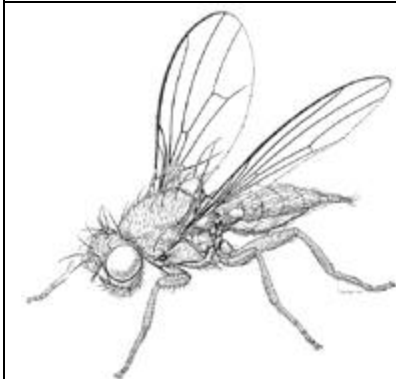


Figure 86
Family ACARTOPHTHALMIDAE

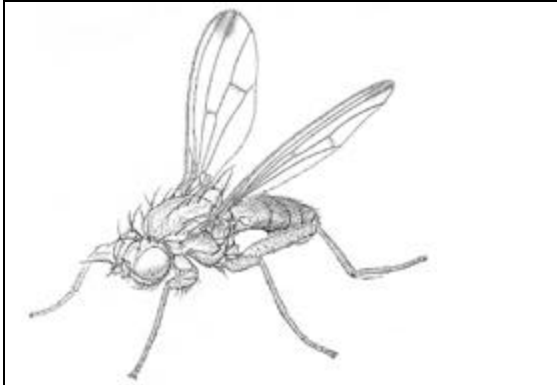


Figure 87
Family OPOMYZIDAE

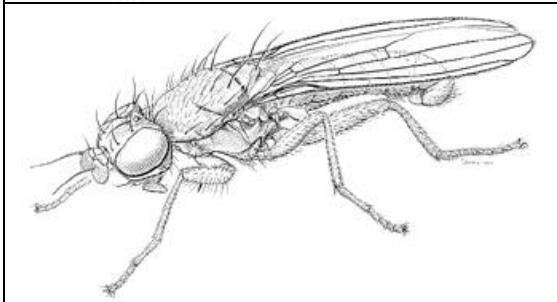


Figure 88
Family ANTHOMYZIDAE

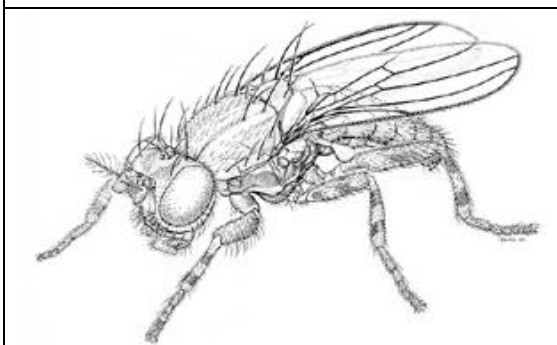


Figure 89
Family PERISCELIDIDAE

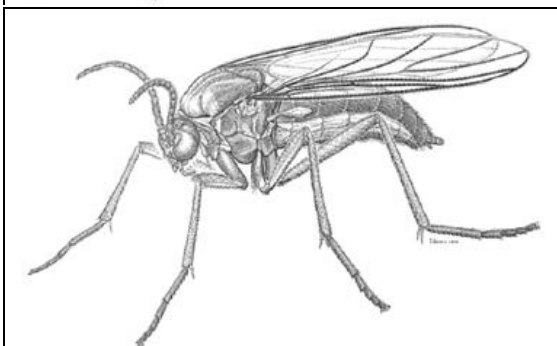


Figure 9
Family SCIARIDAE

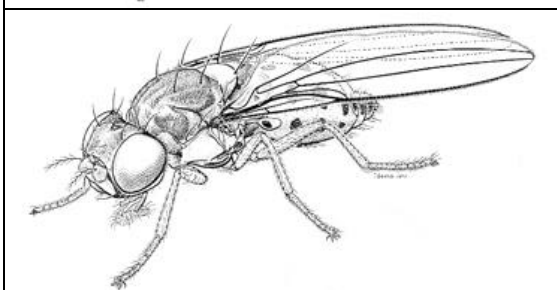


Figure 90
Family ASTEIIDAE

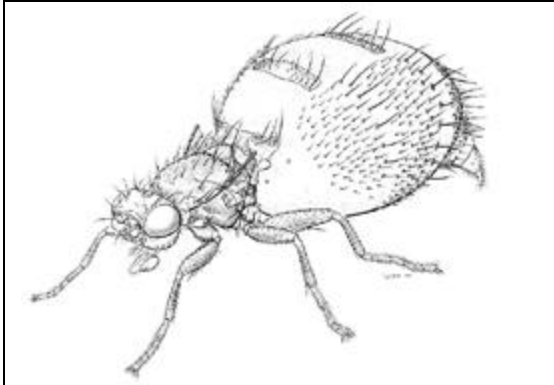


Figure 91
Family CARNIDAE

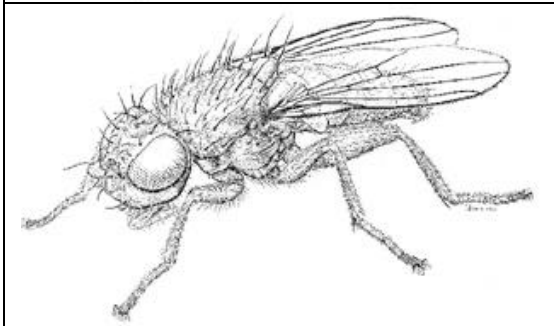


Figure 92
Family TETHINIDAE

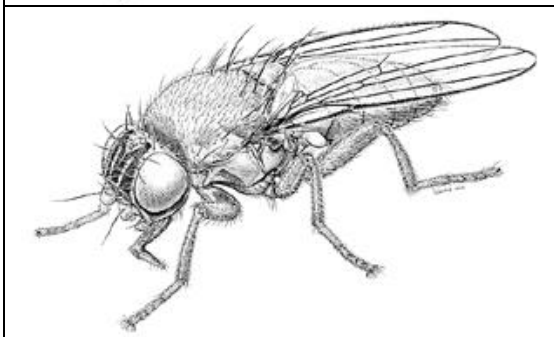


Figure 93
Family MILICHIIDAE

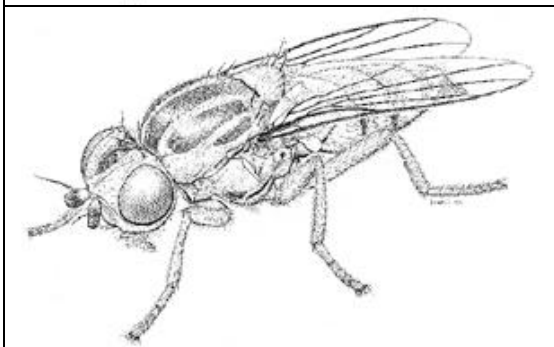


Figure 94
Family CHLOROPIDAE

Glossary

A

Abdomen. The hindmost of the three main body divisions of an insect.

Acanthophorite. Lamelliform dorsal appendage at base of proctiger.

Acropod. Pretarsus.

Acrostichal spines. Two rows of spines along midline of suture.

Acute. Ending in a sharp point.

Aedeagus. Intromittant organ in most insects, formed from a subdivision of the primary phallic lobes.

Aedeagal tines. Lateral branches of 3-branched aedeagus in Tabanomorpha.

Alula. Restricted membranous basal portion of posterior wing margin, distal to upper calyptera and basal to anal lobe.

Anal angle. Hind angle of wing.

Anal lobe. Posterior lobe of wing.

Anal vein (A). Longitudinal unbranched vein posterior to cubitus.

Anepimeron. Upper division of mesepimeron.

Anepisternum. Upper division of mesepisternum.

Annulated. Ring-like.

Antenna (pl., Antennae). Pair of segmented appendages located on the head and usually sensory in function.

Anterior. Concerning or facing the front, towards the head.

Apex. The point where the costal vein and the outer margin of the forewing meet.

Aphidophagous. Pertaining to or descriptive of insects which feed upon aphids, typically as predators.

Apical. At or concerning the tip or furthest part of any organ: apical cells, for example are at the wing-tip.

Apodeme. Ridge-like in-growth of the exoskeleton of an arthropod that supports internal organs and provides attachment points for muscles.

Appendage. Any limb or other organ.

Appressed. Closely applied to.

Aquatic. Organisms living in fresh or salt water (salt-water forms are usually described as marine).

Archaic. Ancient.

Arista. A specialized bristle, or process on the antenna, usually dorsal, rarely apical.

Aristomere. Article of Arista.

Arolium. A median, more or less sac-like protrusion from the end of the pretarsus.

Atrophied. Reduced in size

Axillary membrane. Membrane at base of wing.

B

Basal. Concerning the base of a structure - that part nearest the body.

Biological control. The control of pests by employing predators, parasites, or disease; the natural enemies are encouraged and disseminated by man.

Bisinnate. With two distinct inward and outward bends.

Book lungs. Book-like gill for air-breathing, open to exterior by a small slit.
Bulbous. Bulb-like.

C

Calcar. Movable spur or spine-like process.

Calyptera. Basal lobes formed from the posterobasal portion of the axillary membrane.

Cell. Any closed area in an insect wing bounded by veins. (For nomenclature in Diptera see Glossary Fig. A).

Cephalothorax. United head and thorax.

Cercus (pl., Cerci). Paired appendage of abdominal segment X1.

Chitin. A white amorphous horny substance forming the harder part of the outer integument of insects, crustacea, and various other invertebrates.

Cibarial. Pertaining to the cibariu.

Cibarium. Preoral cavity between base of hypopharynx and under surface of clypeus.

Clavate. Club-like or becoming thicker towards the apex.

Claw. A hollow, sharp, multicellular organ; generally paired and at the apex of the insect leg.

Clypeus. Part of head below frons, to which labrum is attached.

Cocoon. The protective case of larval from before they pupate.

Comb. A group of spines on the leg of an insect specifically used for cleaning other parts of the insects body.

Compound eye. An eye consisting of many individual elements or ommatidia each of which is represented externally by a facet.

Concave. Hollowed or rounded inward.

Contiguous. Touching.

Convex. Bulging or rounded outwards.

Cosmopolitan. Common everywhere; widely spread; found in all parts of the world.

Costagial break. Costal break slightly proximal to humeral crossvein.

Costa (C.). First longitudinal vein of wing, running along anterior margin.

Costal lappet. A somewhat triangular, free region of the wing formed by a deep notch at the subcostal break.

Costal margin. The front edge of the wing.

Costal. Relating to the costa.

Coxa (pl., Coxae). The basal segment of the insect leg. The coxa articulates with the pleural wall of the thorax and is attached to the trochanter. Coxae are paired, ventrolateral in position and found on each of the thoracic body segments.

Coxopleural streak. A suture-like depression separating the katepimeorn.

Crossvein. Typically short veins between the length-wise veins and their branches (For nomenclature in Diptera see Glossary Fig. B).

Ctenidial spine. Relatively large brittle armory those comprising the ctenidium on the fore femur.

Ctenidium. Comb-like structure at distal end of antero-ventral surface of fore femur.

Cubital. Pertaining to the cubitus.

Cubitus (Cu). The sixth longitudinal vein of the wing, and posterior to the median.

Cupuliform. Cup-shaped.

Cuticle. A secretion of the epidermis covering the whole insect as well as invaginations of the epidermis.

D

Dichoptic. In adult Diptera, having the eyes markedly separated medially.

Dimorphism. A genetically controlled, non-pathological condition in which individuals of a species are characterized by distinctive or discrete patterns of colouration, size or shape. Dimorphism can be a seasonal, sexual or geographic manifestation.

Distal. Near or toward the free end of any appendage, or the part of a structure farthest from the body.

Dorsal. On or concerning the back or top of an animal.

E

Ectoparasite. A parasite that lives on the outside of its host.

Emarginate. With a distinct notch or indentation in the margin.

Empodium (pl., Empodia). An unpaired process arising from the ventral part of the arolium.

Endemic. Restricted to a certain region.

Endoparasite. Organism that develops as a parasite within the body of another organism, at the expense and to the detriment of the “host”.

Epimeron. Posterior division of a thoracic pleuron.

Episternum. Anterior division of a thoracic pleuron.

Excavate. Made hollow.

Extant. Still existing.

Eye bridge. Narrow row of facets above the antennae connecting the two compound eyes.

F

Face. In the Diptera, the area between the base of antennae, oral margin, eyes and cheeks.

Facet. Lens-like divisions of the compound eye.

Family. In zoological classification, refers to a level in the taxonomic hierarchy below the Order and above the Genus. All zoological Family names end in IDAE; all zoological Subfamily names end in INAE. The Family-level taxon must include a type-genus which holds a type-species.

Femur. The 3rd (counting out from the body) and often the largest segment of the insect leg.

Flagellum. The distal (furthest away from the body) part of the antennae, the third primary segment of the antenna.

Frass. Excrement of larva, or refuse left by boring insects.

Frons. Upper part of the insect face, dorsal to the insertion of the antennae, above the clypeus.

Frontal vitta. Relatively elastic median area of the frons.

Furcated. Forked.

G

Gena. Part of the head on each side below the compound eye.

Geniculate. Bent like a knee-joint.

Genus. An assemblage of species, agreeing in one character or a series of characters. It is usually considered arbitrary and opinionative grouping, though some consider it a natural assemblage.

Glabrous. Smooth, without setae.

Globose. Spherical, or nearly so.

Greater ampulla. A bulbous swelling in the basal portion of the pleural wing process.

H

Halter. Modified hindwing in Diptera, which are sense organs concerned with the maintenance of stability in flight.

Head. The anterior body region of insects which bears the mouthparts, eyes, and antennae.

Hemispherical. Like half a sphere.

Herbivorous. Feeding on plants.

Holometabolous. Of an insect undergoing complete metamorphosis.

Holoptic. With the eyes touching or almost touching on the top of the head. In adult Diptera, having the eyes touch each other medially.

Humeral break. Break in costa located slightly distal to the humeral crossvein.

Humeral pit. Pits coincident with the prescutal suture.

Hyaline. Clear, transparent or partly so; glass-like, water-like in color.

Hypermetamorphosis. Metamorphosis involving two or more distinct types of larval instars.

Hypopharynx. A median lobe in mouthparts, immediately behind the mouth.

I

Infusate. Darken with a brownish tinge, as of insect wings.

Integument. Outer layer of an insect.

Interfrontal setae. Setae on the frontal vitta.

K

Katepimeron. Lower portion of a divided epimeron.

Katepisternum. Lower portion of a divided episternum.

Kleptoparasite. Food stealing.

L

Labellum (pl., Labella). Paired oval lobes or pads at distal end of proboscis.

Labium. The mouth part or appendage of the sixth head segment, forming the lower lip.

Lanceolae. Spear-shaped.

Larva (pl., Larvae). Immature stage of insect that has a complete metamorphosis.

Lateral. Concerning the sides.

Laterocline. Directed laterally.

Linear. Elongated or nearly parallel-sided.

Lunule. A small oval or crescent space above the bases of the antennae.

M

Macrotrichia. Setal conspicuously larger than adjacent setae.

Mandible. The jaw of an insect.

Maxilla (pl., Maxillae) One of the two components of the insect mouth-parts lying just behind the jaws.

Medial. Referring to, or at the middle of a structure.

Median (M). The fifth longitudinal vein of the wing.

Membranous. Thin, transparent, and not heavily sclerotized.

Meron. Posterior part of the proximal rim of coxa.

Mesepimeron. The epimeron of the mesothorax.

Mesonotum. Dorsal sclerite on the mesothoracic segment.

Mesoscutum. Scutum of the mesothorax.

Mesothorax. Second or middle thoracic segment.

Metanotum. Dorsal sclerite or notum of the mesothorax.

Metathorax. Third or posterior thoracic segment.

Metepisternum. Episternum of the metathorax.

Micropubescent. With dense microsetae.

Microtrichia. Small covering setae, found on the wings of some insects, distinguished by the absence of basal articulation.

Monocotyledonous. Having only one cotyledon, seed lobe, or seminal leaf.

Monophyletic. A monophyletic taxon is one which includes all the evolutionary descendants of the taxon's common evolutionary ancestor and only those descendants.

Multifaceted. With numerous facets.

Mycelia. Thread-like vegetation part of fungi.

Mycetophagous. Feeding on fungi.

Mystax. A patch of stiff setae on the lower part of the face.

N

Notopleural. Pertaining to the notopleuron.

Notopleuron. Clearly delimited sunken area in the anterior region of the scutum, between the post-pronotal lobe and the base of the wing.

Notum. Dorsal. Sclerite of a thoracic segment.

Nuptial. Mating gift.

O

Obligate. Not optional.

Oblique. Slanting.

Obtuse. Of blunt form, not sharp pointed.

Occiput. In the Diptera, the entire posterior surface of the head.

Ocellus (pl., Ocelli) One of the simple eyes of insects, usually occurring on the top of the head.

Ommatidium (pl., Ommatidia). One of the single eyes forming the compound eyes of crustaceans, insects, and other invertebrates; one of the eyes of an ommateum.

Order. Any comprehensive group of animals or plants including several subordinate related groups.

Osmeterium. Specialized scent producing area on the hind tibia.

Ovipositor. Egg-laying.

Ovipositor. Egg laying apparatus.

Ovoid. Egg-shaped.

P

Palp. A segmented leg-like structure arising on the maxilla or labium. Palps have a sensory function and play a major role in tasting food.

Parafacial. Area between ptilinal fissure and eye.

Paraphyletic: A paraphyletic taxon is one which includes descendants from only one ancestor, but not all of them; and a polyphyletic taxon is one descended from more than one ancestor.

- Parasite. An organism which lives in, on, or at the expense of another organism during at least part of its lifetime.
- Parasitoid. An organism that, during its development, lives in or on the body of a single host individual.
- Parthenogenesis. Referring to reproduction without fertilization. Development of individuals from egg-cells without fertilization by the male gamete.
- Pedicel. The 2nd antennal segment.
- Pedicellate. Supported by a pedicel or stalk.
- Petiolate. Stemmed or stalked projection.
- Pharynx. Part of foregut between mouth cavity and oesophagus.
- Phytophagous. Feeding upon plants.
- Pilose. Covered with setae.
- Pleural wing process. The produced dorsal margin of the pleuron, which serves as a fulcrum for the movement of the wing.
- Pleural. Pertaining to the plura or lateral sclerites of the thoracic segments.
- Pleuron (pl., Pleura). The lateral sclerotized area of a thoracic segment.
- Plumose. Feather-like.
- Pollinose. Covered with a loose, mealy, often yellow dust.
- Pollinosity. A pollinose covering.
- Porrect. Extruding horizontally forward.
- Postabdomen. Modified, slender, posterior part of the abdomen including the genital segments.
- Posterior. Term of position pertaining to a structure situated behind the axis. Referring toward the rear, caudal or anal end of the insect.
- Postnotum. The dorsal sclerite below and behind the scutellum of the mesothorax.
- Postocellar seta. Seta arising just behind the ocelli or the vertex.
- Postpronotal. Pertaining to the postnotum, or posterior region of the pronotum.
- Preabdomen. The broader, unmodified basal part of the abdomen.
- Predator. An animal that attacks and feeds on other animals, usually smaller and weaker than itself.
- Pregenital. Anterior to the genital segments.
- Prehalter. A membranous scale in front of the true halter.
- Prehensile. Adapted for grasping.
- Prementum. Region of the labium distal to the mentum.
- Prescutal suture. Suture separating prescutum from scutum.
- Prescutum. Anterior area of the mesonotum or metanotum in front of the scutum.
- Presutural. Pertaining to the prescutum.
- Pretarsus. Last segment of insect leg.
- Primary phallic lobe. Pair of ectodermal out grows that give rise to all or part of the intromittent organ in insects.
- Proboscis. In Diptera, it refers to the extensile mouthparts.
- Proclinate. Inclined forward or downward.
- Proctiger. Reduced abdominal segment X, bearing the anus.
- Proepimeral. Pertaining to the epimeron of the prothoracic.
- Proepisternum. Anterior division of the lateral sclerite of the prothoracic segment.
- Prognathous. Having a more or less horizontal head, with the mouth-parts at the front.
- Proleg. An unjointed fleshy lobe on larvae that functions as a leg.

Prong. A slender sclerotized projection.

Pronotum. Dorsal sclerite of the prothorax.

Proscutellum. A small ridge proceeding the scutellum.

Prosternum. Sternum of the prothorax.

Prothorax. First or anterior thoracic segment.

Protrusible. Capable of being extended or protruded.

Pruinose. Covered with fine dust, as if frosted; with the brightness of a surface somewhat obscured by the appearance of a plum-like bloom, but which cannot be rubbed off.

Pseudopod. Same proleg.

Pterostigma. An enlarged, pigmented area on the costal margin of the wing near its middle or at the apex of the radius.

Ptilinal fissure. A transverse groove on the frons that crosses above the antennae.

Ptilinal suture. The same as the ptilinal fissure.

Ptilinum. An eversible sac capable of being thrust out of a fissure in the head, thereby splitting of the cap of the puparium and permitting emergence of the adult.

Pubescent. Clothed with soft, short, fine, loosely set setae.

Pulvilliform. Shaped like a pulvillus.

Pulvillus (pl., Pulvilli). Membranous, pad-like structures located between the tarsal claws.

Cushions of short, stiff setae on underside of tarsal joints.

Punctate. Covered with tiny pits or depressions.

Pupa. Any insect in that stage of its metamorphosis which usually immediately precedes the adult, or imago, stage.

Puparium. The sclerotized, caste skin of the third larval instar, within which the pupa is formed.

R

Radial. Pertaining to the radius.

Radius (R). The third longitudinal vein of the wing.

Raptorial. Adapted for seizing prey.

Reclinate. Inclined backward and upward.

Recumbent. Lying down, reclining.

Relict. Surviving relatively unchanged over time.

Riparian. Associated with streams or river banks.

Rostrum. A snout-like projection of the head.

Rugose. With many wrinkles or ridges.

S

Saprophagous. Pertaining to insects, which feed on dead or decaying animal or vegetable matter.

Scale. A flat unicellular outgrowth of the integument.

Scape. The 1st antennal segment, especially if it is longer than the other segment.

Scavenger. Feeding on dead organisms.

Sclerite. An area of sclerotization in the integument.

Sclerotized. Hardened especially by the formation of sclerotin: an insoluble tanned protein permeating and stiffening the chitin of the cuticle of arthropods.

Scutellum. Small and shield-like sclerite. In Diptera, a subhemispherical part cut off by an impressed line from the mesonotum.

- Scutum. The second dorsal sclerite of the meso- or metathorax, being the middle division of the notum.
- Seam. Line of junction between two edges.
- Seep. Site of seepage or oozing out.
- Segment. One of the rings or divisions of the body, or one of the sections of a jointed limb.
- Semiaquatic. Partly living in or near water.
- Sensoria. Sensory organs.
- Serrate. Toothed like a saw.
- Seta (pl., Setae). A sclerotized hair-like structure of the insect cuticle, arising from a single cell, and surrounded at base by the cuticular ring.
- Setaceous. With setae.
- Setiferous. Bearing setae.
- Setiform. Seta-like.
- Setose. With many setae.
- Setulae (pl., Setulae). Small stiff seta.
- Setulose. With setulae.
- Silk glands. Glands that secrete liquids that harden into silk on exposure to the air.
- Sinuate. With distinct inward and outward bends.
- Sinuuous. With many curves.
- Speciose. With many species.
- Spiracle. One of the breathing pores - openings of the tracheal system - through which diffusion of gases takes place. They usually occur on the third thoracic segment and all the abdominal segments.
- Spur. A large and usually movable spine, normally found on the legs.
- Spurious vein. In adult Syrphidae, a vein-like thickening of the wing membrane between the radius (R) and the media (M).
- Sternum. Ventral sclerite of a segment.
- Styliform. In the shape of a stylus.
- Stylus (pl., Styli). A small pointed non-articulated process.
- Subcosta (Sc). The second, usually unbranched, longitudinal wing vein, posterior of the costa.
- Subcosta break. Break in costal vein just proximal to where the subcosta joins the costa or to the point where it would join the costa if the subcosta was complete.
- Subcranial cavity. Ventral cavity of cranium from which mouthparts protrude.
- Subfamily. One of the subdivisions, of more importance than genus, into which certain families are divided.
- Subscutellum. A transverse ridge or lobe on median portion of the longitudinal divided postnotum.
- Subvibrissae. Seta along the anteroventral margin of the gena.
- Suture. Line of junction between two sclerites.
- Synanthropic. Associated with man.
- Synonym. Identical to.

T

- Tarsomere. Subdivision of the primary tarsal segment.
- Tarsus (pl., Tarsi). The insect's foot: primitively a single segment but consisting of several segments in most living insects.

Taxon. Animal or plant group having natural relations.

Tergite. Subdivision of the tergum.

Tergum. Dorsal sclerite of a segment.

Terminal. Pertaining to the apex or extreme tip of a structure or appendages.

Terminalia. The terminal abdominal segments modified.

Terrestrial. Living on or in the land.

Thorax. The middle of the three major divisions of the insect body. The legs and wings (if present) are always attached to the thorax.

Tibia (pl., Tibiae) The fourth leg segment between the femur and the tarsus.

Tomentum. A form of pubescence composed to form the genital segments of short, matted, wooly setae.

Trachea. (pl., Tracheae). One of the minute tubes which permeate the insect body and carry gases to and from the various organs etc. They open to the air at the spiracles.

Trochanter. The second segment of the leg, between coxa and femur: often very small and easily overlooked.

Tubercle. A small knob-like or rounded protuberance.

U

Ubiquitous. Being everywhere.

Urogenital. Of or relating to the urinary and reproductive systems.

V

Vector. A carrier, especially any agent transferring a parasite to a host.

Vectoring. The act of being a vector.

Vein. Any chitinous, rod-like or hollow tube-like structure supporting and stiffening the wings in insects, especially those extending longitudinally from the base of the wing to the outer margin.

Venation. Complete system of veins in an insect wing.

Ventral. Pertaining to the under surface of abdomen.

Vertex. The top of the head, between and behind the eyes.

Vestigial. Small, or degenerate. The remains of a previously functional part, or organ, like remnants or vestiges. Structure in the process of disappearing.

Vestiture. The general surface covering comprised of cuticular projections, such as setae or scales, etc.

Vibrissa. Stout setae arising on the angular prominence at the ventral edge of the facial ridge.

Vittae. A band, or stripe, of color.

Glossary Figures A and B

Figure A. Dorsal view of right wing to show structure and venation. Redrawn from *Manual of Nearctic Diptera, Volume 1*, Research Branch, Agriculture & Agri-food Canada, Monograph No. 27, 1981 (Fig. 67).

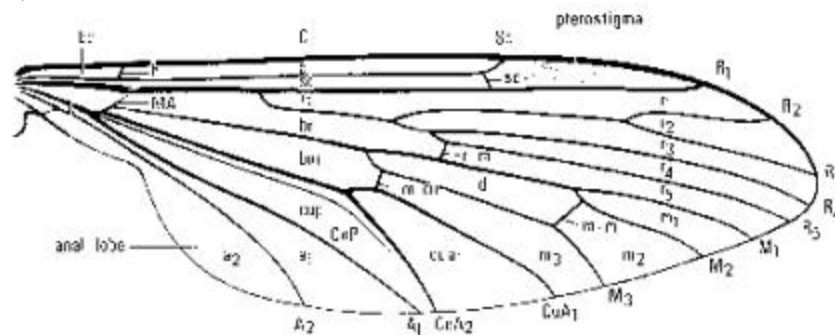
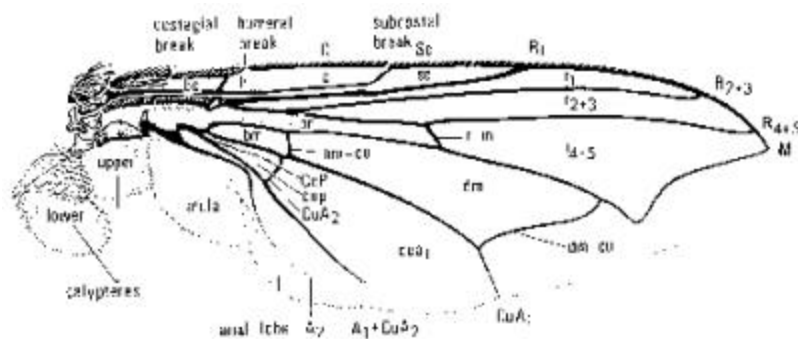


Figure B. Dorsal view of complete right wing of *Paralucilia wheeleri* (Hough). Redrawn from *Manual of Nearctic Diptera, Volume 1*, Research Branch, Agriculture & Agri-food Canada, Monograph No. 27, 1981 (Fig. 69).



veins	cells	crossveins
A ₁ , A ₂ ; branches of anal veins	a ₁ , a ₂ ; anal	bm-cu, basal medial-cubital*
C, costa	bc, basal costal	dm-cu, discal medial-cubital
CU, cubitus	bm, basal medial	h, humeral
CuA, anterior branch of cubitus	br, basal radial	m-cu, medial-cubital*
CuA ₁ , CuA ₂ ; anterior branches of cubitus	c, costal	m-m, medial
CuP, posterior branch of cubitus	cua ₁ , anterior cubital (cubital fork)	r-m, radial-medial
M, media	cup, posterior cubital	sc-r, subcostal-radial
M ₁ , M ₂ , M ₃ ; posterior (sectoral) branches of media	d, discal (1m ₂)	
MA, anterior branch of media	dm, discal medial	
R, radius	m ₁ , m ₂ , m ₃ , medial	
R ₁ , anterior branch of radius	r ₁ , r ₂ , r ₃ , r ₄ , r ₅ ; radial	
R ₂ , R ₃ , R ₄ , R ₅ ; posterior (sectoral) branches of radius	Sc, subcostal	
Rs, radial sector		
Sc, subcosta		

*Crossvein bm-cu is the same as crossvein m-cu, but the designation 'b'm-cu is used to distinguish crossveins bm-cu from m-cu when both occur.