

SEED ORCHARD RECOMMENDATIONS

The following recommendations are examples of habitat manipulation techniques which can be used to enhance and promote natural biological pest control by attracting natural enemies and maintaining an environment that is favourable to their survival. They are inexpensive and easily integrated with other orchard practices.

1. USE PESTICIDES ONLY AS A LAST RESORT

..... and consider beneficials when selecting and applying them.

2. ENCOURAGE PLANT DIVERSITY

..... by allowing strips of flowering weeds to grow between rows, and maintaining hedges that naturally exist on orchard borders. This will increase the availability of resources such as alternate prey, adult food sources, and shelter areas, required to support natural enemies.

3. MAINTAIN PERMANENT GROUND COVER

..... to provide beneficials with moisture, overwintering sites, and protection against predators and climate extremes.

**A FIELD GUIDE TO BENEFICIAL INSECTS AND ARACHNIDS IN
BRITISH COLUMBIA SEED ORCHARDS**

by

Michelle J.A. Hall

B.Sc., Simon Fraser University, 1990

THESIS SUBMITTED IN PARTIAL FULFILLMENT OF
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APPROVAL

Name: **MICHELLE J. A. HALL**

Degree: **Master of Pest Management**

Title of Thesis:

**A FIELD GUIDE TO BENEFICIAL INSECTS AND ARACHNIDS IN BRITISH
COLUMBIA SEED ORCHARDS**

Examining Committee:

Chair: Dr. J. Rahe, Professor

Dr. John Borden, Professor, Senior Supervisor
Department of Biological Sciences, SFU

Dr. G. Gries, Assistant Professor,
Department of Biological Sciences, SFU

Mr. Gerry Fraser, Forester
Pacific Forest Products

Dr. Leland Humble, Research Scientist
Natural Resources Canada, Canadian Forest Service
Pacific Forestry Centre
Public Examiner

Date Approved 8 December 1995

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A Field Guide to Beneficial Insects and
Arachnids in British Columbia Seed Orchards.

Author:

(signature)

Michelle J.A. Hall

(name)

8 December 1995

(date)

ABSTRACT

This field guide is intended for use by all persons who work in conifer seed orchards in British Columbia. It features beneficial arthropods which are common and/or important in seed orchards, with emphasis on biology and conservation. The term beneficial is used to include not only predators and parasites, but also pollinators and nutrient recyclers.

Information in the guide is based on several years of monitoring and personal observations in seed orchards, and on reference to the literature. Each of 49 profiles is organized into 9 subjects: importance, distribution, biology, food source, seasonal occurrence, monitoring, conservation, recommended readings, and descriptions of life stages (with illustrations).

Habitat manipulation techniques are provided to assist seed orchard managers in attracting and retaining beneficial arthropods. Pesticide toxicities specific to each beneficial are listed when available.

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- BÉRUBÉ, Conrad - Figure 120.
- BLADES, David - Figures 7, 36, 46, 62, 71, 100, 102, 106, 114, 117-8.
- CHAN, C.K. (Agriculture Canada) - Figures 34, 39.
- CLAYTON, Marilyn (Canadian Forest Service, Pacific Forestry Centre) - Figures 112-3,
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- COOKE, M.B. and Robert A. CANNINGS (Royal B.C. Museum) - Figures 20, 31, 35,
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- CRAM, W.T. (Agriculture Canada) - Figure 74.
- DUNCAN, Robert (Canadian Forest Service, FIDS) - Figures 1, 18, 22-3, 25-7, 29-30,
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- GILLESPIE, Dave (Agriculture Canada) - Figure 32.
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- GRIES, Gerhard (Simon Fraser University) - Figures 2-6.
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- MACDIARMID, W. (Agriculture Canada) - Figures 28, 53.
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- SCHABER, B.D. (Agriculture Canada) - Figures 10, 12.
- SEVERSON, H. (Agriculture Canada) - Figure 37.
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- THOMAS, Diane. (Integrated Crop Management Inc.) - Figures 15, 56, 67, 69.
- WELLINGTON, W.G. (University of British Columbia) - 90-1, 99.

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INTRODUCTION

This field guide is specific to beneficial insects and arachnids in seed orchards. Some are common (e.g. ladybird beetles), and others are less commonly seen but have important beneficial effects (e.g. springtails). The guide also provides suggestions for seed orchard managers to enhance the environment to encourage beneficial arthropods to visit and/or remain in an orchard. Not covered in this guide are several other kinds of beneficial organisms including vertebrates, nematodes, bacteria, fungi and viruses.

Beneficial organisms are naturally present, helping to reduce pest insect and mite populations. Unfortunately, orchard practices sometimes interfere with their efforts. Slight changes (e.g. leaving some flowering weeds between tree rows when mowing) may allow the beneficials to exert a greater effect in suppressing pest populations. This can reduce the money, time and effort that seed orchard managers dedicate toward managing pests.

Seed Orchards

Seed orchards are a vital component of reforestation and the basis of tree improvement in British Columbia. A seed orchard is defined as “a plantation of genetically superior trees, intensively managed to produce frequent, abundant, and easily harvested high-quality seed crops which are adapted to specific seed planning zones”(6). Each year over 200 million trees are planted in British Columbia (6). The goal of the provincial government is to supply 50% of this seed from seed orchards by the year 2000. Close to 6000 kg of seed

orchard seed have been produced in the last 30 years, enough seed to produce 647 million seedlings (98). The total orchard area is increasing by an average of 12.5% per year (29).

Orchards currently (1995) produce seed for 13 species including Douglas-fir, western hemlock, western redcedar, yellow cedar, spruce (engelmann, interior, sitka and white), pine (lodgepole and white), true fir (amabilis and grand), and western larch (2), and have reached various stages of development. Seed orchards are concentrated on the Saanich Peninsula of Vancouver Island and in the Okanagan Valley due to favourable, Mediterranean climatic conditions (6).

Profile Topics

Information in this guide is based on several years of monitoring and personal observations in seed orchards, and on reference to the literature. Description of content in each of seven descriptive categories is as follows:

Importance. This category may include feeding nature of different lifestages of the insect, spider or mite, beneficial value, pest potential, origin, biological control history, commercial availability, how and where released, and status in other industries.

Distribution. Worldwide, North American and Canadian occurrence of taxon is given.

Biology. Biological subjects may include whether the organisms are active during the day or night, fecundity, oviposition habits, social organization, nesting habits, development times, life expectancy, courtship and mating behavior, reproduction, overwintering habits, generation time, type of development, territorial behavior, defence mechanisms and pheromone use.

Food Source. Preferred prey is given for each lifestage when possible, as well as alternate food sources, volume of prey consumed, preferred lifestage of prey, prey locating methods, and non-lethal effects on prey.

Seasonal Occurrence. The months when beneficial organisms are active (not necessarily feeding) are presented graphically. Data were obtained from trapping studies, B.C. Forest Service Seed Pest Management insect collection, pest survey report comments, and FIDS (Forest Insect and Disease Survey, Canadian Forest Service) insect collection. No distinction is made between different lifestages unless indicated.

Monitoring. Habitats where different lifestages of beneficials are likely to be collected are listed in order of most to least common occurrence. Other information may include preferred weather conditions, type of activity, host plant or tree species, and preferred time of day. Commonly used techniques (5,13,82,117) are suggested for detecting beneficials, with information on difficulty, degree of effectiveness or sensitivity, and handling procedures.

Conservation. This section provides suggestions for seed orchard managers who wish to attract and/or retain beneficials in the orchard. It may include attractants, alternative orchard practices, mowing techniques and pesticide toxicities (information obtained from the literature). Applying pesticides should be considered to be a last resort. When they are necessary, the Pesticide Toxicities List should be consulted to choose the least toxic alternative. Pesticides are listed by active ingredient, according to their degree of toxicity to the beneficials, in order of highest to least toxic, and may include trade names, application rates, application techniques and particularly susceptible lifestages. Pesticides registered in the United States were also included for the benefit of seed orchard managers in the Pacific Northwest states. The toxicity level assigned to a pesticide often differed between researchers. I chose the highest toxicity rating reported to represent the worst case scenario for the beneficials. These studies also reported their data in different ways. I followed the most common protocol and assigned toxicity levels as either high (>80% mortality), moderate (40-80%), low (10-40%), slight (<10%), or safe (0%). Information was obtained from the literature.

DRAGONFLIES

ORDER : ODONATA (*odous*=tooth, refers to chewing mouthparts)

Suborder: Anisoptera (*anisos*=unequal, *pteryx*=wing, refers to 2 pairs of wings which are unequal in length)

Families : Aeshnidae (hawkers/darners)
Libellulidae (skimmers/darters)

IMPORTANCE Both adults and nymphs are stages aggressive insect predators. Help reduce midge, moth and mosquito numbers. Some kill honeybees. Adults and nymphs commonly eaten by people in some Asian countries. Featured in British Columbia Haida and Tsimshian totem poles and spoon handles.

DISTRIBUTION Worldwide: 1750 spp. North America: 125 spp. Canada : 68 spp. (36,87)

BIOLOGY Eggs laid in summer. Ovipositor used to insert eggs in plant tissue or wet, rotten wood (Aeshnidae) near or below water surface. Libellulid eggs washed off abdomen in water during low flight, or brushed off on mud or vegetation that is later flooded. Some libellulid males continue to hold female during egg laying, others stay to fend off other males. Egg hatch: <1 month, egg to adult (10-15 instars): 1-2 years. Mature nymph emerges from water for final molt, sun-dried skin splits, teneral (newly emerged adult) emerges, wings must expand and harden before flight is possible, full colour obtained in several days. Adult: 6-8 weeks, sexually mature in 1-2 weeks. Tandem mating in flight or on land. Male transfers sperm to accessory sex organs before mating, catches female and initiates 'copulation wheel', grabbing her head with abdominal claspers, female arches body under male contacting accessory genitalia for sperm transfer (Fig. 3). Most overwinter as nymphs, some as eggs. Generation time: 1-4 years (*Aeshna* spp.). Hemimetabolous development (incomplete metamorphosis: naiads (aquatic nymphs) different from adults). Strong fliers, able to hover. Libellulids take short flights from perch to feed and defend territory.

FOOD SOURCE Midges, moths, mosquitoes and other small insects. Rely on sight to hunt and catch moving prey. Form basket with legs to catch flying insects while in flight. Nymphs stalk or ambush prey.

SEASONAL OCCURRENCE : (Adults)

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X	X	X	

MONITORING Methods - Adults: malaise trap, aerial net (may be difficult to catch).

Nymphs: dip net.

Habitats - Adults: in flight, perching on flat surfaces such as tree trunks, branches, rocks or fence posts, near aquatic areas inhabited by nymphs, resting in trees during cloudy weather. Nymphs: aquatic areas such as streams, lakeshores, ponds, marshes and swamps.

CONSERVATION Maintain unpolluted water bodies for nymph development.

Pesticide Toxicities - Safe : *Bacillus thuringiensis* var. *israeliensis*. (71,91)

RECOMMENDED READINGS : 13, 22, 88

DRAGONFLIES

DESCRIPTION

Adults 20-125 mm. Aeshnidae: long, slender abdomen, wingspan 65-90 mm, dark with striking blue, green or yellow marks, some very hairy (Fig. 1). Libellulidae: relatively shorter abdomen, wingspan 45-75 mm (much greater than body length), colourful (Fig. 2). Colours differ between sexes. 2 pairs of elongate clear or patterned wings (Libellulidae), held horizontally at rest, large compound eyes joined at top of large round head, chewing mouthparts (referred to by order name), short bristle-like antennae.

Eggs Cream, turn red-brown in 24 hours, either smooth and elongate (Aeshnidae) or spherical, sometimes equipped with anchors (Libellulidae).

Immatures Naiads (aquatic nymphs): short, stout, flattened, cylindrical body. May be hairy, spiny or camouflaged. Legs modified for walking or clinging. Longer antennae than adults, large mouthparts folded under head, shoot out to seize prey. Aquatic gill-breathers with rectal gill ridges. Water sucked in for respiration, expelled for propulsion. Climbers(Aeshnidae): streamlined, stalking predators, with highly developed eyes, live in submerged vegetation (Fig. 3). Sprawlers (most Libellulidae): slothful, among mud and bottom trash, concealed by mud and algae coating body, ambush approaching prey.

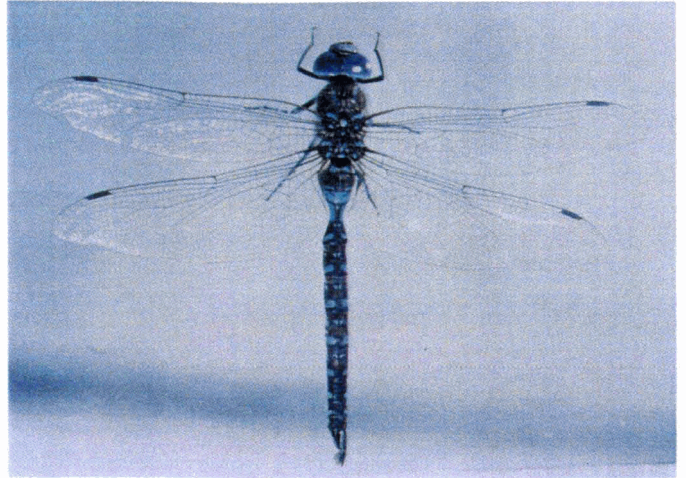


Figure 1 - Dragonfly (Aeshnidae).



Figure 2 - Dragonfly (Libellulidae).



Figure 3 - Mating dragonflies (Libellulidae).

D A M S E L F L I E S

- ORDER** : ODONATA (*odous*=tooth, refers to chewing mouthparts)
Suborder: Zygoptera (*zygon*=pair; joined, *pteryx*=wing, refers to joined wings)
Families : Coenagrionidae (narrow-winged damselflies)
 Lestidae (spread-winged damselflies)

IMPORTANCE Both adults and nymphs are predaceous. Help control midges and mosquitoes.

DISTRIBUTION Worldwide: 1200 spp. North America: 110 spp. Canada: 47 spp.
 (36,87)

BIOLOGY Lay eggs in aquatic vegetation in summer. Use ovipositors to make slits in which eggs inserted (Fig. 6). Egg hatch: 1-3 weeks (months in overwintering eggs), egg to adult (10-15 instars): few months-12 years, nymph development: days to months (most overwinter). Final instar emerges from water for last molt. Adults: 3-4 weeks. Male transfers sperm to accessory sex organs before mating, catches female and initiates 'copulation wheel', grabbing her thorax with abdominal claspers, female arches body under male contacting accessory genitalia for sperm transfer. Male may continue to hold female during egg laying. Overwinter as eggs (Lestidae) or nymphs. 1 generation/year. Hemimetabolous development (incomplete metamorphosis: naiads (aquatic nymphs) different from adults). Spend much time perching, taking short flights to feed and defend territory.

FOOD SOURCE Midges, moths, mosquitoes and other flying insects. Hunt by sight, catch prey in cupped legs while in flight. Hold prey in mouth with front legs, chew with mandibles. Nymphs ambush prey with hinged mouthparts which shoot out from under head to seize prey.

SEASONAL OCCURRENCE : (Adults)

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X	X		

MONITORING **Methods** - Adults: malaise trap, sweep net. Nymphs: dip net.

Habitats - Adults: flying in warm sunny areas, perching on flat surfaces such as tree trunks, branches, rocks, fence posts, resting or sunning themselves on emergent vegetation, or remaining near aquatic areas suitable for nymph development. Rest in grass during cloudy weather. Nymphs: aquatic weeds, crawling on submerged objects, on water bottom among debris.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort.

Maintain unpolluted ponds, lakes, and bodies of water. (71)

RECOMMENDED READINGS : 13, 22, 88

DAMSELFLIES

DESCRIPTION

Adults 20-60 mm long. Similar to dragonflies but smaller, broader head, eyes separate or stalked, 2 pairs of equal-sized long, narrow wings. Coenagrionidae: slender, weak fliers, with wings folded together above back at rest, males more brightly coloured than females, wingspan 20-45 mm (Fig. 4). Lestidae: usually larger than Coenagrionidae, hold body vertical at rest with wings partly-opened, bronze or green, wingspan 32-64 mm (Fig. 5). Whitish-blue colour in warm temperatures may change to purple-grey at cool temperatures.

Eggs Similar to dragonflies.

Immatures Naiads similar to dragonflies but with 3 leaf-like abdominal gills used for respiration and guiding movement through water. Either the middle gill filament is longest or all filaments are equal length (Lestidae). Body undulations provide propulsion.

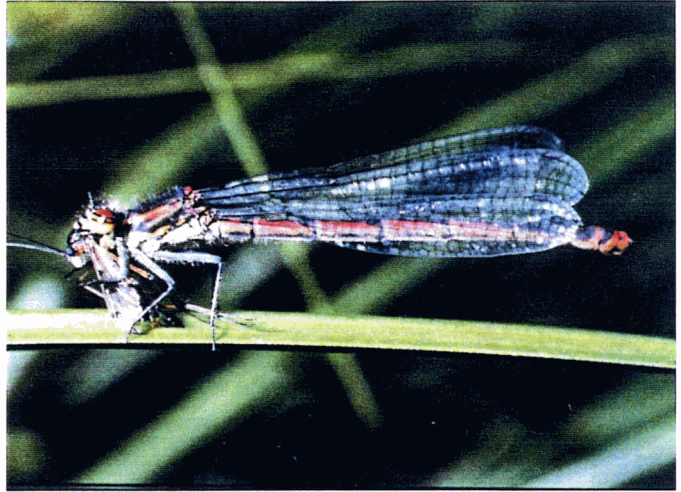


Figure 4 - Damselfly (Coenagrionidae) with prey.



Figure 5 - Damselfly (Lestidae).



Figure 6 - Damselfly (Coenagrionidae) female (green) ovipositing with male on guard.

E U R O P E A N E A R W I G S

ORDER : DERMAPTERA (*derma*=skin or hide, *pteryx*=wing, refers to leathery forewings)

Family : Forficulidae

Species : *Forficula auricularia*

IMPORTANCE Important predators of aphids, mites and nematodes in apple orchards. Also scavengers, decomposing organic matter, recycling nutrients back to soil. May chew small holes in vegetable and flower garden leaves. Often blamed for damage caused by slugs, snails, cutworms and other garden pests. Accidentally introduced to North America in 1907. Common name originates from unfounded belief that they enter the ear and crawl into the brain.

DISTRIBUTION Worldwide (temperate). (87)

BIOLOGY Nocturnal, hide in crevices and debris during day. Female digs cup-shaped burrow in upper soil or debris in spring, lays 2 batches of up to 30 eggs (1 each in spring and summer), cares for hatched nymphs until maturity. Egg hatch: 2-3 weeks (environment-dependent), nymph to adult (5 or 6 instars): 100 days. Lifespan: 1 year. Overwinter as eggs or adults, in soil, or under boards or stones. 1 or 2 generations/year. Paurometabolous development (gradual metamorphosis: terrestrial nymphs resemble wingless adults). Use forceps for defence, catching prey, cleaning nest and folding hindwings. When disturbed emit substance which smells like creosote.

FOOD SOURCE Forage at night for aphids, mites, nematodes, moth larvae and other insect larvae and pupae. Also dead plant matter. Some feed on living plants, algae and fungi.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	X

MONITORING

Methods - Branch beatings, light trap, tubes filled with crumbled pieces of paper.

Habitats - Under shelter (e.g. bark or debris) during day.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort.

Attractants - Nest boxes may be set out to attract greater numbers.

RECOMMENDED READINGS : 89, 97, 98

EUROPEAN EARWIGS

DESCRIPTION

Adults 10-15mm. Small to medium, elongate, flattened, reddish-brown to black, yellowish-brown underneath. Short, pale legs, small, leathery forewings (referred to by order name) do not cover abdomen, thread-like antennae, chewing mouthparts. Flexible abdomen with prominent, pincer-like appendages, curved on males, nearly straight on females. Rarely fly, many wingless (Figs. 7 and 8).

Eggs 2 mm diam. Round, greyish-white, with thin, translucent, cream-coloured chorion.

Immatures 13 mm. Nymphs resemble pale, small adults with shorter antennae, less-developed wings. Wingpads may be present.



Figure 7 - Female earwig.



Figure 8 - Female (above) and male (below) earwigs.

SPINED SOLDIER BUGS

ORDER : HEMIPTERA (*hemisus*=one-half, *pteryx*=wing, refers to forewings which are half leathery and half membranous)

Family : Pentatomidae

Genus : *Podisus* spp.

IMPORTANCE Important forest predators. Native obligate predators of moth and beetle larvae. *P. maculiventris* introduced to France in 1930's for biological control, considered "most useful of American predaceous Hemiptera." Commercially available for tent caterpillar control. Released in home and garden for pest control.

DISTRIBUTION North America: 9 spp.

BIOLOGY Each female lays up to 40 batches of 20-30 eggs in multiple rows, in or on plants or in crevices during 5-6 week season. Nymph to adult (5 instars): 6-8 weeks. First instar remains near eggs and molts. Adult: 5-8 weeks. Overwinter as adults, emerge in spring. 1-2 generations per year. Paurometabolous development (gradual metamorphosis: terrestrial nymphs resemble wingless adults). Emit strong odour when disturbed.

FOOD SOURCE Wide range of caterpillars (including eastern blackheaded budworm larvae and pupae in Eastern Canada), and sawfly larvae. First instar feeds on other eggs, water or plant juices. Predatory feeding begins in second instar, use stylets to pierce prey, secrete digestive enzymes, and suck up predigested food (Fig. 9). May feed on plants if insect prey unavailable.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X	X	X	X

MONITORING

Methods - Branch beatings, sweep net.

Habitats - On trees or other vegetation, in debris, or water.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort.

Attractants - Maintain permanent groundcover for shelter. (42)

RECOMMENDED READINGS : 42, 50

SPINED SOLDIER BUGS

DESCRIPTION

Adults 10-12 mm. Medium size, yellow to brown, resemble stink bugs with a spine-like projection on each anterior corner of shield-shaped body. Wings held flat on body with clear tips overlapping at rest. Long antennae, slender beak with piercing, sucking mouthparts folded beneath body. Order name refers to basal parts of outer wings which are thicker than the membranous distal portions.

Eggs Barrel-shaped.

Immatures Nymphs resemble small adults without wings.



Figure 9 - Spined soldier bug with prey.

DAMSEL BUGS

ORDER : HEMIPTERA (*hemisus*=one-half, *pteryx*=wing, refers to forewings which are half leathery and half membranous)

Family : Nabidae

IMPORTANCE Both adults and nymphs are fast, aggressive and predaceous. Important in natural pest control in orchards. Even if prey not consumed, death occurs due to paralysis inflicted by sharp mouthparts. Potential for use in biological control. May bite if handled.

DISTRIBUTION Worldwide: 400 spp. North America: 48 spp. Canada: 12 spp.
(36,87)

BIOLOGY Nocturnal. Eggs laid in rows in plant stems. Egg hatch: 1 week, nymphs immediately feed on prey larger than themselves. Nymph to adult: 3-4 weeks, adults overwinter, 2 or more generations per year, paurometabolous development (gradual metamorphosis: terrestrial nymphs resemble wingless adults).

FOOD SOURCE Aphids, caterpillars, moth eggs, spider mites, lygus bugs, psyllids, and leafhoppers. Seize prey with forelegs, insert beak into suture, emit digestive enzymes through stylets, suck up predigested food. Even if prey not eaten, paralysis leads to death within 24 hours.

SEASONAL OCCURRENCE

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	X

MONITORING

Methods - Branch beatings, sweep net.

Habitats - In trees, grasses, low-growing plants, on ground.

CONSERVATION Attractants - Plant alfalfa borders.

Mowing - Leave some flowering weeds between rows.

Pesticide Toxicities - More susceptible to insecticides in general than most beneficials.

High: aldrin, azinphosmethyl, diazinon, dimethoate, fenthion, malathion.

Potentially high: (environment-dependent): carbaryl (Sevin™), carbofuran.

Low to moderate: synthetic pyrethroids.

Variable (safer with ultra low volume spray than conventional spray): *Bacillus thuringiensis* (variety not stated), chinomethionate (Morestan™).

Safe: endosulfan (Thiodan™).

(35,42,43,77,97,107)

RECOMMENDED READINGS : 42, 88

DAMSEL BUGS

DESCRIPTION

Adults 7-11 mm. Small to medium, tan or grey, slender, fast-moving, with long legs (thick, spiny front pair) adapted for grasping prey, thin antennae, well-developed wings, thorax tapered to narrow head. Long beak folded beneath body when not in use (Figs. 10 and 11).

Immatures Nymphs resemble small, pale adults without wings (Fig. 12).



Figure 11 - Damsel bug.

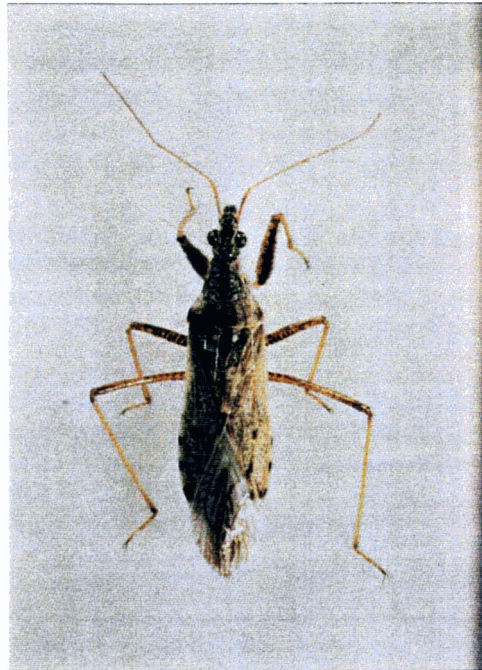


Figure 10 - Damsel bug.

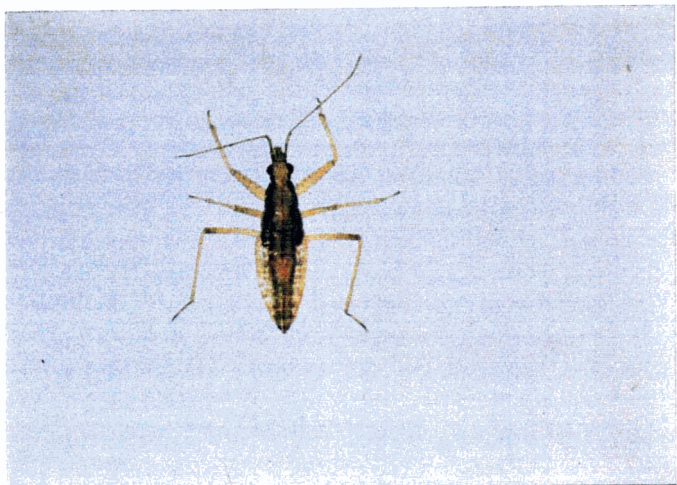


Figure 12 - Damsel bug nymph.

MINUTE PIRATE BUGS (or FLOWER BUGS)

ORDER : HEMIPTERA (*hemisus*=one-half, *pteryx*=wing, refers to forewings which are half leathery and half membranous)

Family : Anthocoridae

IMPORTANCE Most species (both adults and nymphs) are predaceous, a few are plant or pollen feeders. Commercially available for greenhouse biological control. Painful bite to humans.

DISTRIBUTION Worldwide: 500 spp. North America : 85 spp. Canada : 41 spp. (36,87)

BIOLOGY Eggs inserted into plant stem, midrib or other soft tissue. Live young may be produced. Egg to adult: 4-6 weeks, egg hatch: 3-5 days, nymphs: 2-3 weeks. Adults overwinter in bark crevices or plant material. Several generations per year. Paurometabolous development (incomplete metamorphosis: terrestrial nymphs resemble wingless adults).

FOOD SOURCE Aphids, spider mites (all life stages, nymphs: 33 mites/day), scales, thrips, springtails, small caterpillars, moth eggs, balsam woolly adelgid (*Acomporis lepidus*), Cooley spruce gall adelgid (*Tetrableps latipennis*, common in Pacific Northwest forests). Specially modified mouthparts used to pierce prey and suck out body fluids.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	X

MONITORING

Methods - Branch beatings, malaise trap, sweep net.

Habitats - Under bark, in flowers, vegetation, leaf litter, fungi, mammal burrows, bird nests, houses. Coniferous hosts include true fir, Douglas-fir, spruce, pine and larch.

CONSERVATION

Attractants - Encourage alfalfa and pollen plants.

Mowing - Leave some flowering weeds such as California buckwheat, daisies, goldenrod, stinging nettle, and yarrow between rows.

Pesticide Toxicities -

High : aldicarb, azinphosmethyl, chlordane, cypermethrin (Ripcord™), deltamethrin (Decis™), diazinon, dicrotophos, dimethoate, fenthion, fenvalarate (Sumicide™), malathion, methidathion, methylparathion, mevinphos (Phosdrin™), mexacarbate (Zectran™), parathion, permethrin (Ambush™), sulphur.

Potentially high (environment-dependent) : carbaryl, carbofuran, demeton, phorate, phosmet, phosphamidon, propoxur, ryania, trichlorfon.

Moderate: endosulfan (Thiodan™), fenvalarate, insecticidal soap, nicotine (Nicotine Sulfate™), permethrin, pirimicarb (Pirimor™), synthetic pyrethroids.

Low : benomyl (Benlate™), disulfoton, fenbutatin oxide (Vendex™), iprodione (Rovral™).

Safe : *Bacillus thuringiensis* (variety not specified), Chinomethionate™ (chinomethionat), dichloran (Botran™), ferbam, fixed nicotine, lead arsenate, lime sulfur, methoxychlor, naled, petroleum oils.

(29,35,42,43,77,96,97,107,127)

RECOMMENDED READINGS : 42, 88

MINUTE PIRATE BUGS (or FLOWER BUGS)

DESCRIPTION

Adults 2-5 mm. Small to minute, flattened, oval to elongate, black and/or brown with white marks, smooth, shiny or dull, with pointed head and beak. (Figs. 13 and 14). Fast-moving. Wings held flat on body at rest. Order name refers to the front half of the first pair of wings which are hardened.

Eggs Round white caps visible. (eggs inserted into plant tissue).

Nymphs 2-4 mm. Shiny, wingless, yellowish-pink to reddish-brown (Figs. 15 and 16).



Figure 13 - Minute pirate bug.



Figure 14 - Minute pirate bug.



Figure 15 - Minute pirate bug nymphs.



Figure 16 - Minute pirate bug nymph.

PREDACEOUS PLANT BUGS

ORDER : HEMIPTERA (*hemisus*=one-half, *pteryx*=wing, refers to forewings which are half leathery and half membranous)

Family : Miridae

Genus : *Deraeocoris* spp.

IMPORTANCE Most plant bugs are pests (e.g. lygus bugs), but predaceous species (e.g. *Deraeocoris* sp.) often occur in high numbers. Important predators in Oregon and Washington orchards. Successful biological control agents include *Blepharidopterus angulatus* (vs. forest tree mites), *Cyrtorhinus mundulus* (vs. sugarcane leafhoppers) and *C. fulvus* (vs. taro leafhoppers).

DISTRIBUTION Worldwide. North America : 60 spp.

BIOLOGY Eggs laid on stems or foliage, or inserted into plant tissue with blade-like ovipositor. 5 nymphal instars from late spring to early summer. Adults overwinter near orchards, 2 generations/year. Paurometabolous development (incomplete metamorphosis: terrestrial nymphs resemble wingless adults). Defensive abdominal gland secretions mimic ant alarm pheromones.

FOOD SOURCE Aphids, mites, scales, springtails, soft-bodied insects and their eggs.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X	X	X	

MONITORING

Methods - Branch beatings, malaise trap, sweep net.

Habitats - Vegetation infested with woolly adelgids.

CONSERVATION Pesticide Toxicities -

High: aldicarb, azinphos-methyl, diazinon, dicrotophos, dimethoate, fenthion, malathion, methidathion, methylparathion, mevinphos, mexacarbate (Zectran™), parathion.

Potentially high (environment-dependent): carbaryl, carbofuran, demeton, phorate, phosmet, phosphamidon, propoxur, ryania, trichlorfon..

Moderate : disulfoton, nicotine (Nicotine Sulphate™), sulphur.

Low : fenvalerate, permethrin.

Safe : *Bacillus thuringiensis* (variety not specified), chinomethionat (Chinomethionat™), cryolite, endosulfan, ferbam, glyodin, methoxychlor, mineral oil (Petroleum oil), naled.

(35,39,45,77,98,107)

RECOMMENDED READINGS : 88, 98

PREDACEOUS PLANT BUGS

DESCRIPTION

Adults 4-10 mm. Small to medium, oval to elongate, brownish-black with white markings, long thin antennae, thin legs, wide head with beak, hardened half of hind wing (referred to by order name) bent downward (Fig. 17).

Eggs Elongate, cylindrical, curved, laid in plant tissue.

Nymphs 4 mm. Pink to light grey with dark markings (Figs. 18 and 19), able to use rectum for extra footing.



Figure 17 - Predaceous plant bug.



Figure 18 - Predaceous plant bug nymph.



Figure 19 - Predaceous plant bug nymph.

S N A K E F L I E S (CAMELNECK-FLIES)

ORDER : NEUROPTERA (*neuron*=nerve, *pteryx*=wing, refers to complex venation of wings, resembling nerve webs)

Suborder : Raphidioidea (*raphid*=needle-like)

IMPORTANCE Both adults and larvae are predaceous. Economically important at high densities. European species released for biological control in New Zealand.

DISTRIBUTION Worldwide (mainly northern hemisphere): 855 spp.

North America: 21 spp. Canada: 7 spp. (36,87)

BIOLOGY Diurnal. Female uses long ovipositor to lay cluster of up to 100 eggs, stuck together, under loose bark or in bark cracks of conifers and deciduous trees. Up to 800 eggs per female lifetime. 10-15 larval instars. Overwinter as larvae or pupae. Generation time: 2-3 years. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: mature budworm (*Choristoneura* sp.) larvae and pupae, aphids, small insects. Larvae: aphids, caterpillars, small arthropods.

SEASONAL OCCURRENCE (Adults):

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X			

MONITORING

Methods - Branch beatings, malaise trap, sweep net.

Habitats - Woodlands. Adults: on foliage, branches, trunks of pines, firs, other trees. Larvae: near insect prey on, under bark, rotten wood, in debris.

CONSERVATION

Pesticide Toxicities -

High: azinphos-methyl, carbaryl, carbofuran, dicrotophos, fenitrothion, malathion, methylparathion, mevinphos, monocrotophos, mexacarbate (Zectran™), parathion, phosmet.

Variable (environment-dependent) : carbophenothion, dimethoate, endosulfan, phosphamidon, rotenone.

Safe : aldicarb, demeton, methidathion, methoxychlor, naled, ryania, tetradifon, trichlorfon. (77)

RECOMMENDED READINGS : 13, 50, 92

SNAKEFLIES (CAMELNECK-FLIES)

DESCRIPTION

Adults 12-25 mm. Resemble tiny winged serpents, shiny, dark-grey or dark reddish-brown, elongate, long neck able to raise head above body like snake ready to strike. Large compound eyes, long antennae, flat, elongate head with flexible biting mouthparts, elongate, mobile thorax, 2 pairs of clear wings with complex venation held roof-like at rest (Figs. 20 and 21), female with long flexible ovipositor (Fig. 22). Poor fliers.

Eggs 1.5 mm x 0.4 mm. Elongate to oval, yellowish-white with knob.

Larvae Similar to beetle larvae. Black, elongate, flattened, land-dwelling larva with biting mouthparts (Fig. 23). Agile, move quickly forward or backward when disturbed.

Pupae Active, very mobile, with flexible mouthparts.



Figure 20 - Snakefly female.



Figure 21 - Snakefly female.

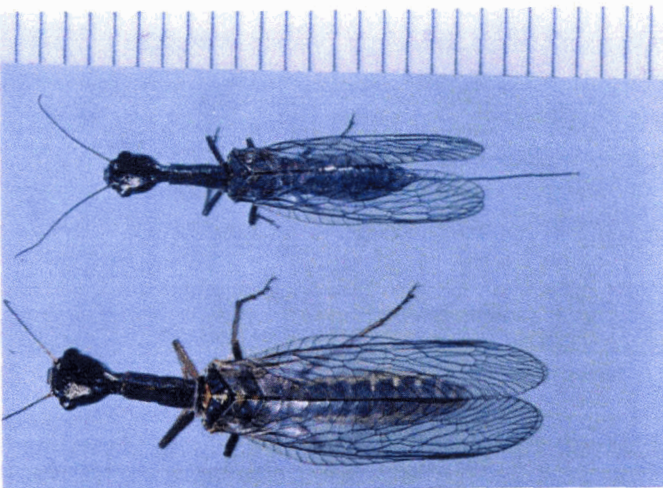


Figure 22 - Snakefly male (bottom) and female (top).

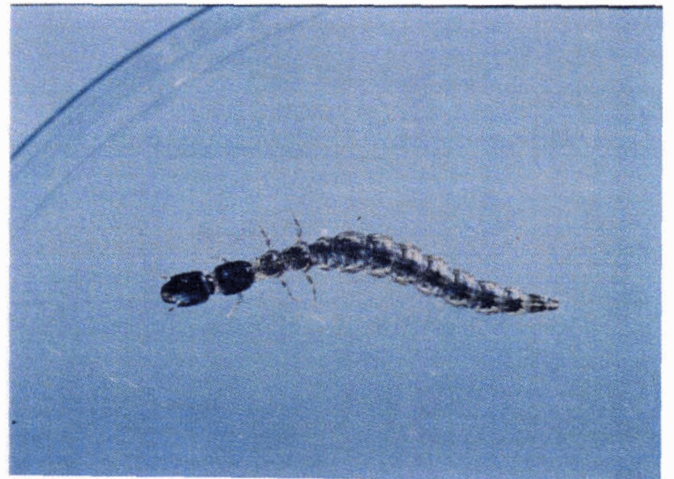


Figure 23 - Snakefly larva.

D U S T Y - W I N G S

ORDER : NEUROPTERA (*neuron*=nerve, *pteryx*=wing, refers to complex venation of wings resembling nerve webs)

Family : Coniopterygidae

IMPORTANCE Both adults and larvae are predaceous. Important in fruit orchard pest control. Some occasional pollen or honeydew feeders.

DISTRIBUTION Canada: 7 spp. (36)

BIOLOGY Eggs laid singly on foliage or bark, hatch in 1-3 weeks. Larva development (3 or 4 instars): few weeks - few months, pupate in foliage or bark crevices. Overwinter as prepupae, generation time: few weeks - few years. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Moth larvae, aphids, spider mites, scales, insect eggs and other small arthropods. Mandibles used to catch prey, inject enzymes into prey to dissolve body contents and suck fluids through narrow tube formed with maxillae.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	X	X	X	X	X	X	X	X	X	X	X

MONITORING

Methods - Branch beatings, light trap.

Habitats - Trees infested with insect pests.

CONSERVATION

Pesticide Toxicities -

High : azinphos-methyl, carbaryl, carbofuran, dicrotophos, fenitrothion, malathion, methylparathion, mevinphos, monocrotophos, mexacarbate (Zectran™), parathion, phosmet.

Variable (environment-dependent) : carbophenothion, dimethoate, endosulfan, phosphamidon, rotenone.

Safe : aldicarb, demeton, methidathion, methoxychlor, naled, ryania, tetradifon, trichlorfon. (77)

RECOMMENDED READINGS : 13, 92

DUSTY - WINGS

DESCRIPTION

Adults 2.5-5 mm. Minute, soft-bodied, covered with white waxy powder, two pairs of membranous wings (longer than the body) held roof-like at rest, chewing mouthparts, long thread-like antennae (Fig. 24). Weak fliers.

Eggs Oval to elongate, with micropyle.

Immatures Free-living larvae, with long sucking, sickle-like jaws, short head (Fig. 25), 5 pairs of simple eyes.

Pupae Inside flat cocoon within 2 distinct envelopes spun of silk from anal glands (Fig. 26).



Figure 24 - Dusty-wing.

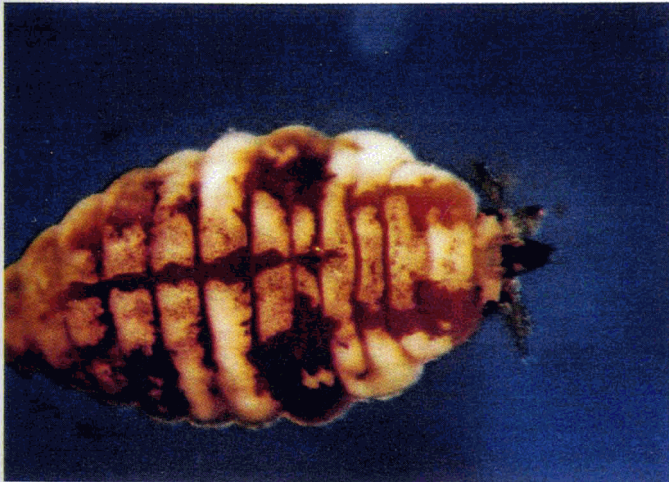


Figure 25 - Dusty-wing larva.



Figure 26 - Dusty-wing cocoons.

BROWN LACEWINGS

ORDER : NEUROPTERA (*neuron*=nerve, *pteryx*=wing, refers to complex venation of wings, resembling nerve webs)

Family : Hemerobiidae

IMPORTANCE Predaceous adults and larvae common in seed orchards. Active even in early spring. Considered for biological control around world. Generalist feeders, may disrupt other biological control programs.

DISTRIBUTION Worldwide: 900 spp. North America: 58 spp. Canada: 23 spp. (36,87)

BIOLOGY Nocturnal, hide in vegetation during day. Eggs (not stalked like green lacewings) laid singly or in groups, attached by their sides to plants. Up to 2500 eggs laid per lifetime. Life span: several months. Egg hatch: few days (unless overwintering), egg to adult: 24-30 days, larval development (3 instars): several weeks. Overwinter as eggs, prepupae or pupae in cocoons, or as adults. Generation time: few weeks to few years, up to 4 generations per year. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). May feign death when disturbed.

FOOD SOURCE Aphids (many thousands of aphids per lifetime) including balsam woolly adelgid (*Hemerobius neadelphus*), spider mites (all life stages), scales, moth eggs, moth larvae (larger than themselves), thrips and other soft-bodied arthropods. Emit enzymes for digestion outside body. Suck up body fluids with tube formed by maxilla and mandible. Cannibalistic tendencies.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	X

MONITORING Methods - Branch beatings, light trap, sweep net.

Habitats - Adult : hiding in vegetation during day in forests, fields, orchards, gardens, lighted buildings on summer nights. Larva : wherever prey occur, or in soil. Pupae : under protection, beneath loose bark, in soil, on vegetation.

CONSERVATION **Attractants** - Spray artificial diet (simulated aphid honeydew made from 1:1:10 Wheat™ or Formula 57™, sugar, and water) onto trees or posts (also increases egg production). Encourage pollen and nectar flowers such as dill and buckwheat. Other attractant plants include angelica, California coffeeberry, camphor weed, carrot, oleander, soapbark tree, tree-of-heaven, wild lettuce. Provide water sources during drought conditions.

Mowing - Leave some flowering weeds such as dandelion and goldenrod between rows.

Pesticide Toxicities - **High** : azinphos-methyl, carbaryl, carbofuran, dicrotophos, fenitrothion, malathion, methylparathion, mevinphos, monocrotophos, mexacarbate (Zectran™), parathion, phosmet.

Variable (environment-dependent) : carbophenothion, dimethoate, endosulfan, phosphamidon, rotenone.

Safe : aldicarb, demeton, insecticidal soap (Safer's™ soap, adults: when able to fly away), methidathion, methoxychlor, naled, ryania, tetradifon, trichlorfon. (42,77,97)

RECOMMENDED READINGS : 88, 92, 97

BROWN LACEWINGS

DESCRIPTION

Adults 4 - 12 mm. Small to moderate, similar to green lacewings but smaller, brown. Soft-bodied, prominent brown compound eyes, long thread-like antennae, chewing mouthparts, two pairs large, clear wings with complex venation, held roof-like over body at rest (Figs. 27 and 28). Weak, erratic fliers.

Eggs White, turning orange, pink, and dark brown before hatching, elongate, lightly sculptured, not stalked like green lacewing.

Immatures "Aphid wolf" larvae resemble minute alligators with prominent sickle-like jaws, short antennae. Similar to green lacewings, but swing head side to side when moving, also shorter, stouter mouthparts (Fig. 29).

Pupae Prepupae and pupae in loosely woven elliptical silk cocoons, spun from anus (Fig. 30). Equipped with mandibles to chew exit hole.



Figure 27 - Brown lacewing.



Figure 28 - Brown lacewing.



Figure 29 - Brown lacewing larva with prey.



Figure 30 - Brown lacewing pupa inside cocoon.

GREEN LACEWINGS

ORDER : NEUROPTERA (*neuron*=nerve, *pteryx*=wing, refers to complex venation of wings, resembling nerve webs)

Family : Chrysopidae

IMPORTANCE Both adults and larvae are predaceous, larvae most effective. Commercially available across North America for biological control of agricultural pests. Able to suppress aphid numbers early in cool spring.

DISTRIBUTION Worldwide except New Zealand: 2000 spp. North America: 88 spp.
Canada: 25 spp. (36,87)

BIOLOGY Nocturnal. Lay 10-30 eggs per day in spring on hair-like stalks, under foliage, singly, in rows, or in close groups. Egg stalks protect against cannibalistic siblings and predators. Egg to adult: 30-40 days, egg hatch: 5 days, larvae: 12 days, pupae: 10 days, adults: 20-40 days. Overwinter as adults or pupae. 3- 4 generations/year. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). May emit offensive odour when disturbed.

FOOD SOURCE Larvae: balsam woolly adelgid (*Chrysopa quadripunctata*) and other aphids, spider mites, mite eggs, small moth larvae, moth eggs, thrips, leafhoppers, and mealybugs. Use pincer-like jaws to pierce and suck body fluids from prey. Cannibalistic when prey is scarce. Adults prefer plant nectar and aphid honeydew.

SEASONAL OCCURRENCE (Adults)

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X				

MONITORING Methods - Branch beatings, light trap, sweep net.

Habitats - Adults: orchards, gardens, meadows, forest edges: in grass, weeds, trees, shrubs.

Larvae: aphid-infested foliage.

CONSERVATION Attractants - (see brown lacewings).

Mowing - (see brown lacewings).

Pesticide Toxicities - High : azinphos-methyl, carbaryl, carbofuran, dicrotophos, diflubenzuron, triflumuron (BAY SIR 8514, insect growth regulator) fenitrothion, malathion, methylparathion, mevinphos, monocrotophos, mexacarbate (Zectran™), oxydemeton-methyl (Metasystox-R™), parathion, phosmet, tetrachlorvinphos, thiometon.

Variable (environment-dependent) : carbophenothion, dimethoate, endosulfan, phosphamidon, rotenone.

Low : *Bacillus thuringiensis* (BT) (Dipel 4L™, for larvae), bioresmethrin (Isathrine™), cypermethrin (Ripcord™), deltamethrin (Decis™), fenvalarate (Sumicidin™), permethrin (Ambush™).

Safe : aldicarb, BT (Dipel 4L™, for adults), demeton, insecticidal soap (Safer's™)(for adults, when able to fly away), methidathion, methoxychlor, naled, pirimicarb (Pirimor™), ryania, tetradifon, trichlorfon.

(19,57,58,62,64,77,96,97)

RECOMMENDED READINGS : 42, 63, 88

GREEN LACEWINGS

DESCRIPTION

Adults 14-20 mm. Pale yellow to green body, 2 pairs of clear, delicate, lace-like wings with complex green venation, small head with large, shiny, golden, brass or red eyes, long antennae, prominent, strong, sickle-shaped chewing mouthparts used as sucking tubes (Figs. 31 and 32).

Eggs White, elongate, on long slender stalk (Fig. 33).

Immatures 6-10 mm, "aphid lion" larvae active, flattened, alligator-shaped body, large sickle-like jaws, short antennae, pale yellow, white or greenish with brown or black marks (Fig. 34). More stout than brown lacewings, mandibles are more slender and curved, do not swing head side to side when moving, some carry debris such as sucked out prey bodies on hooked dorsal spines for concealment.

Pupae Inside hard, round, white, cocoon which may have debris woven within it. Attached under foliage.

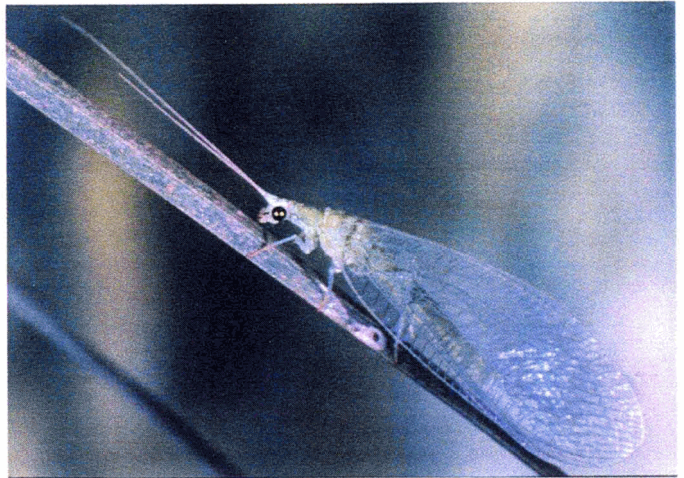


Figure 31 - Green lacewing.

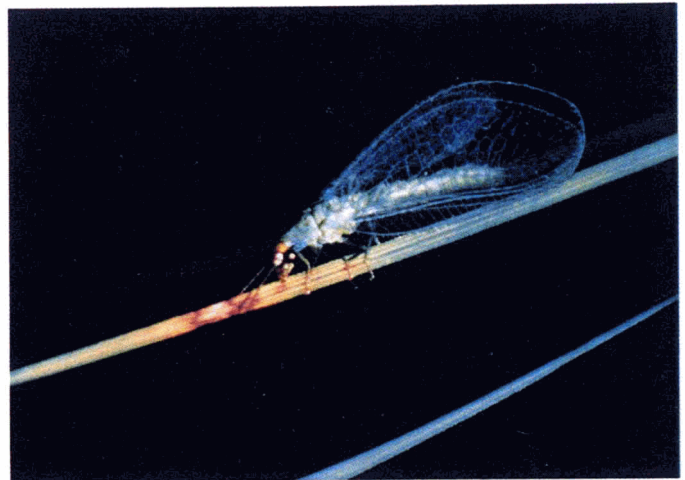


Figure 32 - Green lacewing.



Figure 33 - Green lacewing egg.

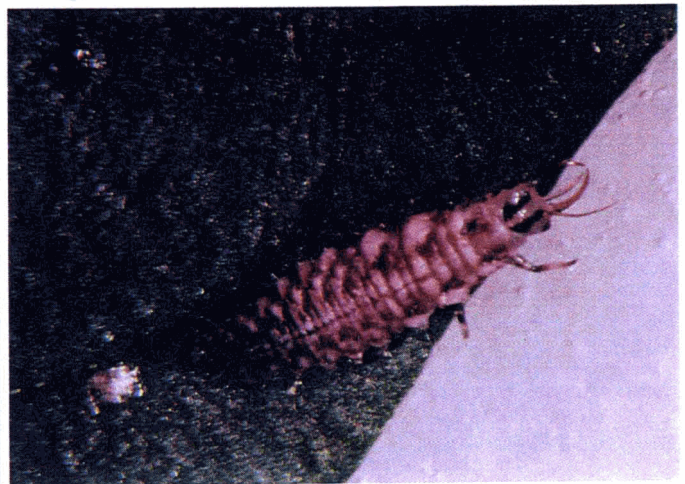


Figure 34 - Green lacewing larva.

TIGER BEETLES

ORDER : COLEOPTERA (*koleos*=sheath, *pteryx*=wing, refers to hardened forewings which cover the membranous hind pair)

Family : Cicindellidae (considered by many authors to be subfamily of Carabidae)

IMPORTANCE Both adults and larvae are fierce, voracious predators. Often found in high numbers.

DISTRIBUTION Worldwide (primarily tropical): 2,000 spp. North America: 108 spp.
(87)

BIOLOGY Most diurnal, some nocturnal. Very active, especially on hot, sunny days. Fastest running insect (almost 2 mph), fast flier. Single eggs laid in soil burrows. Larval development: many months (environment-dependent), pupation may occur in pupal chamber adjacent to larval tunnel. 2-3 years per generation. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). May bite when handled.

FOOD SOURCE Moth larvae, aphids, flies, small beetles, bugs, grasshoppers, ants, spiders and other small insects. Adults are aggressive hunters. Larvae wait in burrow entrance with jaws set to trap passing insects, dragging them to the bottom to be eaten.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X	X		

MONITORING

Methods - Light trap, pitfall trap, and aerial net (most effective).

Habitats - In or near vertical dry soil burrows in open, sunny areas such as fields, dry roadside paths, forest clearings, tree trunks.

CONSERVATION

Attractants - Maintain permanent groundcover for shelter.

Pesticide Toxicities -

Toxic : chorphenvinphos, diazinon, parathion.

Safe : azinphos-methyl. (42)

RECOMMENDED READINGS : 88, 135

TIGER BEETLES

DESCRIPTION

Adults 6-24 mm. Shiny, metallic bronze, blue, green, purple or orange, some with patterns or spots, slightly flattened, widest behind mid-body. Long, strong hairy legs, broad head with large, bulging eyes, thread-like antennae, distinct strong, sharp toothed mandibles, front wings hardened, and hindwings folded and membranous (Figs. 35 and 36).

Immatures Segmented, S-shaped larvae. Flattened head acts as lid or plug for vertical soil burrow. 2 or 3 pairs of curved hooks anchor larva in tunnel.



Figure 35 - Tiger beetle.



Figure 36 - Tiger beetle.

GROUND BEETLES

ORDER : COLEOPTERA (*koleos*=sheath, *pteryx*=wing, refers to hardened front wings which cover the membranous hind pair)

Family : Carabidae

IMPORTANCE Both adults and larvae are important predators of caterpillars and other insects, often found in large numbers. Attempts to establish colonies of *Calasoma sycophanta* for biological control (against various moths and loopers) in British Columbia, Washington, California, New Mexico and Colorado have been unsuccessful. Few feed on fungi, pollen, and seeds. One species (*Pterostichus algidus*) causes significant loss of Douglas-fir seed.

DISTRIBUTION Worldwide: 40,000 spp. North America: 2,270 spp. Canada: 861 spp.
(includes Cicindellidae) (36,87)

BIOLOGY Most nocturnal, some diurnal. Breed in spring or fall. Egg to adult: 1 year, adult: 2-4 years. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). Run quickly when disturbed, never fly. May emit strong odour.

FOOD SOURCE Forest tent caterpillar larvae, tussock moths, cutworm larvae and other moth larvae, weevils, aphids, nematodes, mites, thrips, maggots, slugs, snails, earthworms, rove beetles, fruit flies, soldier flies, spiders, soldier beetles, springtails. Some feed on plant material including seeds.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	X

MONITORING Methods - Bait trap, Berlese funnel trap, branch beatings, light trap, pitfall trap, sieves, aerial net.

Habitats - Hiding under stones, soil, plant debris during day, climb trees and shrubs to catch caterpillars at night.

CONSERVATION Attractants - Encourage white clover. Avoid disturbing groundcover.

Mowing - Leave some weeds (especially pigweed) between rows.

Pesticide Toxicities -

High : fenitrothion, phosphamidon, thionazin.

Variable (environment-dependent) : diazinon.

Low : permethrin.

Low to none: *Bacillus thuringiensis* (Dipel™)

Safe: carbofuran, chorphenvinphos, azinphosmethyl. (17,35,45,77,97)

RECOMMENDED READINGS : 13, 88, 135

GROUND BEETLES

DESCRIPTION

Adults 2-85 mm. Vary in size, shape and colour. Small to large, fast-moving, strong-jawed, flattened ground-dwelling, thread-like antennae. Metallic blue, brown, or black, and shiny, may have long legs. Punctures or grooves run length of the elytra (Fig. 37).

Eggs Some eggs laid in cells made of mud, twigs, leaves.

Immatures Free-living larvae, flattened, hairless, tough-skinned, tapered at both ends, elongate, paler colour than adult. Some have large heads with pincer-like jaws. Well-equipped hunters with well-developed legs, powerful jaws (Fig. 38).

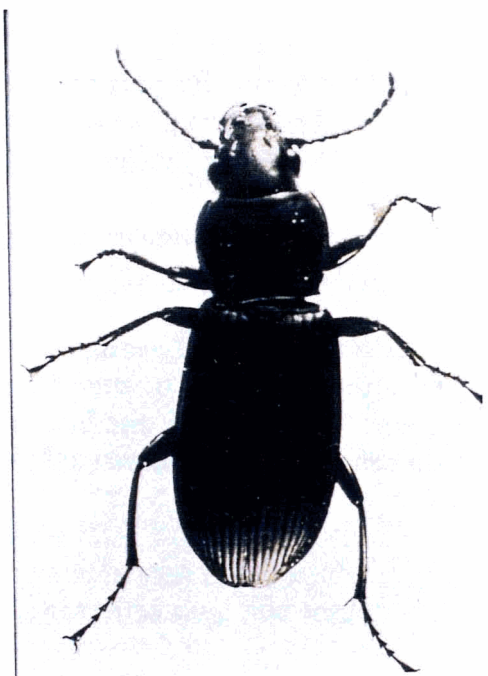


Figure 37 - Ground beetle.

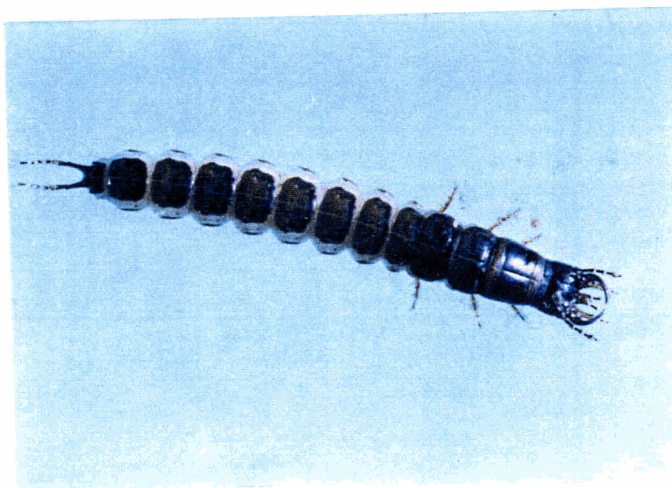


Figure 38 - Ground beetle larva.

ROVE BEETLES

ORDER : COLEOPTERA (*koleos*=sheath, *pteryx*=wing, refers to hardened front wings which cover membranous hind pair)

Family : Staphylinidae

IMPORTANCE Both adults and larvae are important predators of aphids, mites, flies and soil dwelling pests. Some parasitize other insects (13), or decompose manure and dead plant matter. None are pests. May bite when handled.

DISTRIBUTION Worldwide: 32,000 spp. North America: 3200 spp.
Canada: 1129 spp. (87)

BIOLOGY Large species nocturnal, small ones diurnal. Eggs laid in soil or decaying plant matter. 3 larval instars. Pupate in soil. Overwinter as adults, become active in spring. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). Often run fast with abdominal tip raised. Strong fliers.

FOOD SOURCE Soil insects (especially eggs and larvae) including fly maggots, nematodes, pest springtails, aphids and spider mites. Also slugs and snails.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		X	X	X	X	X	X	X	X	X	X

MONITORING

Methods - Light trap, pitfall trap, sieve trays, aerial net.

Habitats - Near dung, carrion and other decaying matter. Under stones or objects on ground, in fungi, leaf litter, flowers. In ant, termite, mammal or bird nests.

CONSERVATION

Attractants - Maintain permanent groundcover to protect overwintering adults. Provide rocks or boards for shelter. (42)

RECOMMENDED READINGS : 13, 42, 135

ROVE BEETLES

DESCRIPTION

Adults 1-25 mm. Small, elongate, black or brown, resemble earwigs without pincers. Short stubby outer wings cover folded, well-developed hindwings. Long, slender, sharp mandibles. Bead-like or clubbed antennae (Figs. 39 and 40).

Immatures Larvae resemble small adults, without wings.

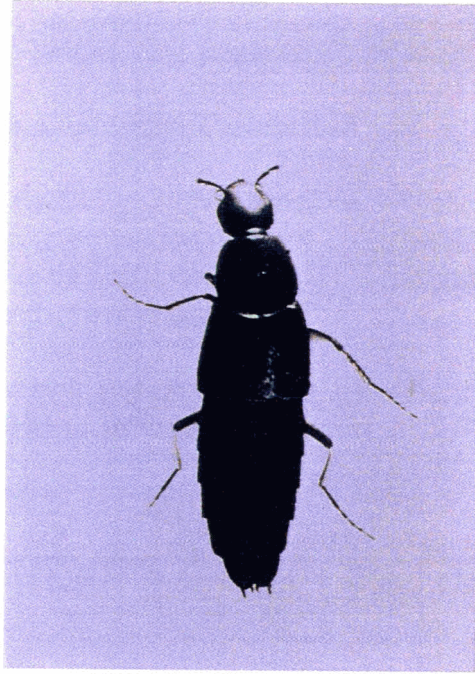


Figure 39 - Rove beetle.

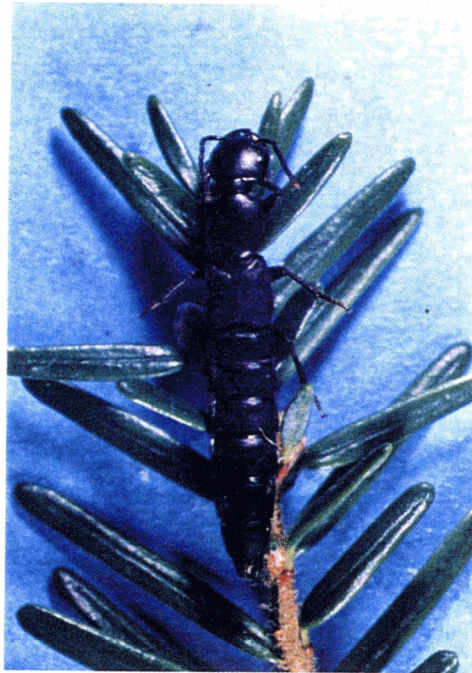


Figure 40 - Rove beetle.

HISTER BEETLES

ORDER : COLEOPTERA (*koleos*=sheath, *pteryx*=wing, refers to hardened front wings which cover membranous hind pair)

Family : Histeridae

IMPORTANCE Adults and larvae prey on beetles, flies and ants. Some scavengers.

DISTRIBUTION Worldwide. North America: 359 spp. Canada: 118 spp. (135)

BIOLOGY Eggs laid on decaying matter. Rate of growth depends on availability of resources. Pupate in soil beneath food supply. 1 generation per year. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). Feign death when disturbed.

FOOD SOURCE Mainly maggots. Also weevils and other beetles, mites, termites, ants, fly eggs, and springtails. Use sharp, curved jaws to seize and cut up prey.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		X	X	X	X	X	X	X			

MONITORING

Methods - Malaise trap, pitfall trap, visual examination of tree wounds, rotting vegetation, and dung.

Habitats - In or near decaying organic matter including dung, fungi, carrion, tree wounds. Some flat species occur under loose bark, others in ant or termite nests. Some live in wood boring insect galleries.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort.

RECOMMENDED READINGS : 13, 89

HISTER BEETLES

DESCRIPTION

Adults 0.5-10 mm. Small, shiny, black, hard-shelled oval to round body with short hindwings. Some flattened, others elongate and cylindrical (Figs. 41 and 42). Short, elbowed, clubbed antennae.

Immatures Elongate, cylindrical larvae. Well-developed legs, antennae, and mouthparts.

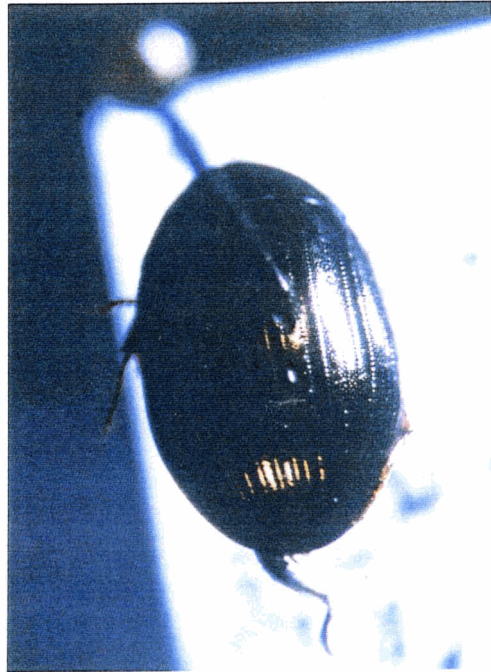


Figure 41 - Hister beetle.



Figure 42 - Hister beetle.

CLICK BEETLES

ORDER : COLEOPTERA (*koleos*=sheath, *pteryx*=wing, refers to hardened front wings which cover membranous hind pair)

Family : Elateridae

IMPORTANCE Mainly agricultural pests. Some predaceous forest species. Few potential minor pests in forest nurseries and outplantings but no threat to mature trees.

DISTRIBUTION Worldwide: 8500 spp. North America: 890 spp. Canada: 369 spp.
(87)

BIOLOGY Eggs laid in soil. Egg hatch: 2-4 weeks, larvae: 2-5 years. During last year of development larvae form cell in soil in late summer to pupate (some pupate in dead wood or under bark). Move deep into soil each fall, returning to upper soil in spring to feed on roots and lay eggs. Overwinter as larvae or adults in soil. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). Named for behavior of clicking and throwing their bodies into the air when placed on backs. Body is arched, snapped and recoiled in air.

FOOD SOURCE Adults: some feed on plant material, many do not feed. Larvae: predators feed on wood borers and soil dwelling moth pupae. Others feed on roots, underground stems, tubes, bulbs, corms. Larvae digest food externally.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X			

MONITORING

Methods - Branch beatings, light trap, malaise trap, pan trap, pitfall trap, sweep net, outer and inner examination of rotting logs or stumps.

Habitats - Adults: on ground, under bark and litter, on foliage and flowers, in decaying wood. Larvae: under bark, in soil, fungi and ant nests, rotting wood, living or decaying vegetation, near dung and rotting fungi, in damp shaded woodlands.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort.

RECOMMENDED READINGS : 13, 50, 87

CLICK BEETLES

DESCRIPTION

Adults 10-30 mm. Distinctive shape: elongate, flattened, parallel-sided, posterior corners of pronotum drawn out to sharp point, brown or black, some with yellow, red or white eyespots (Fig. 43), slightly shiny, smooth, may be covered in short red-brown or black hairs.

Immatures “Wireworm” larvae: cylindrical, elongate, shiny, hard-shelled, with horny hooks at posterior end (Fig. 44). Some soft-bodied.



Figure 43 - Click beetle.



Figure 44 - Click beetle larvae.

SOLDIER BEETLES

ORDER : COLEOPTERA (*koleos*=sheath, *pteryx*=wing, refers to hardened front wings which cover membranous hind pair)

Family : Cantharidae

IMPORTANCE Adults feed on pollen and nectar. Most larvae feed on soft-bodied insects. Some are omnivorous.

DISTRIBUTION Worldwide: 4000 spp. North America: 468 spp. Canada: 126 spp.
(87)

BIOLOGY Diurnal. Eggs laid in soil. Newly hatched larvae remain inactive for short period. Pupate in spring. Larvae overwinter in soil. Up to 2 generations per year. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). Produce defensive chemicals.

FOOD SOURCE Adults: aphids, moth larvae, beetle larvae, grasshopper eggs. Some feed on pollen and nectar of flowers including milkweed, goldenrod and wild parsley. Larvae: soft-bodied insects such as small moth larvae, maggots, grasshopper eggs. May feed on plants.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		X	X	X	X	X	X				

MONITORING

Methods - Branch beatings, sweep net, visual examination of goldenrod, milkweed, and catnip.

Habitats - Adults: flying in warm sunshine, on flowers and foliage in moist and shady areas, on ground, in soil and low-growing plants, under bark, near hedgerows, grassy areas and woodland edges, under bark. Larvae: in soil, leaf litter, on damp ground, under loose bark and debris.

CONSERVATION

Attractants - Encourage pollen plants. Maintain permanent groundcover for protection of pupating beetles.

Mowing - Leave some flowering weeds such as milkweed, goldenrod and wild parsley between rows.
(42,97)

RECOMMENDED READINGS : 42, 87, 135

SOLDIER BEETLES

DESCRIPTION

Adults 5-15 mm. Elongate, parallel-sided, soft-bodied beetles, black or dark blue with bright yellow, red or orange markings, some mainly yellow, some entirely black. Large head with bulging eyes, curved, sharply-pointed jaws, long, slender legs, long thread-like antennae pointing downward. Short, leathery elytra expose wings and abdomen. Family name comes from colouring resembling old military uniforms (Figs. 45 and 46).

Immatures Similar to ground beetle larvae, dark-coloured, flattened, covered with short, dense, velvet-like bristles.



Figure 45 - Soldier beetle.

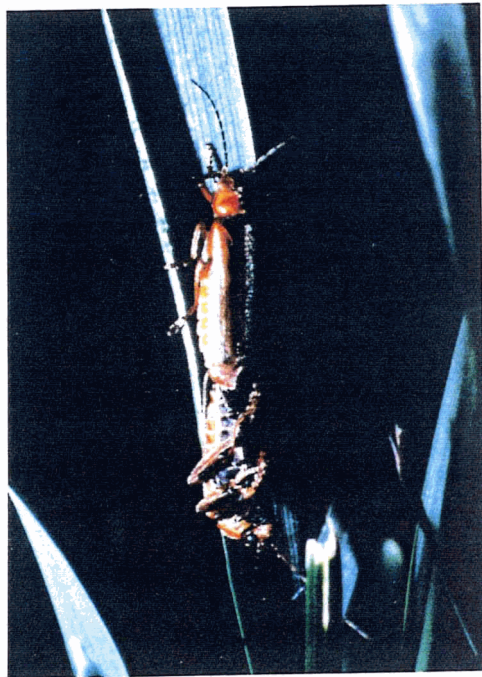


Figure 46 - Mating soldier beetles.

CHECKERED BEETLES

ORDER : COLEOPTERA (*koleos*=sheath, *pteryx*=wing, refers to hardened front wings which cover membranous hind pair)

Family : Cleridae

IMPORTANCE Both adults and larvae are predaceous. Important in suppressing bark beetle populations. Some scavengers. Few species also feed on flower pollen and nectar. One pest species on stored meat.

DISTRIBUTION Worldwide (mainly tropical): 3500 spp. North America (mainly southwest U.S.): 270 spp. Canada (mainly south): 50 spp. (includes subspecies). (87,135)

BIOLOGY Diurnal. Very active. Larvae may develop inside grasshopper egg pods. Pupate at base of tree. Overwinter as larvae, pupae or adults. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). Some use pheromones of bark beetles to find them.

FOOD SOURCE Adults: wood- and bark-boring insects, sometimes pollen and nectar. Larvae: wood- and bark-boring beetle larvae and pupae, sometimes bee and wasp larvae and grasshopper egg pods. *Enoclerus schaefferi* feeds on cone insect pests (including Douglas-fir cone moth and *Cydia* sp. seed moths) on true fir, Douglas-fir, pine and spruce. Adults and larvae use bark beetles sex pheromones to locate prey.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	X	X	X	X	X	X	X	X	X		

MONITORING

Methods - Branch beatings, light trap, sweep net, visual inspection of habitats.

Habitats - Adults : wooded areas, on foliage of woody plants, on or under bark of dying trees or recently killed trees, near bark beetle infested trees. Sometimes associated with carrion. Larvae : under bark.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort.

RECOMMENDED READINGS : 50, 87, 135

CHECKERED BEETLES

DESCRIPTION

Adults 5-12 mm. Small to medium, elongate, slightly-flattened, cylindrical, soft-bodied, brightly coloured with blue, green, red, brown or pink (may be checkered). Few species black or brown, may have grey marks. Some with red abdomen. Forest species dark-coloured with whitish-grey checkers, large, wide head with bulging eyes, short, clubbed antennae, covered with long bristles, strong-legged, fast-moving (Fig. 47).

Immatures 9-14 mm. Slender, cylindrical, slightly flattened larvae, white when young, turning pink, then purple or blue when mature. Hairy, lightly sclerotized with a pair of abdominal hooks (Fig. 48).



Figure 47 - Mating checkered beetles.

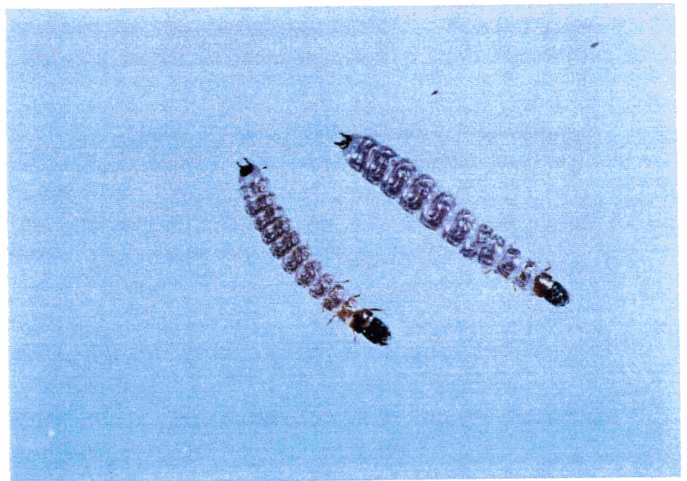


Figure 48 - Checkered beetle larva.

LADYBIRD BEETLES

ORDER : COLEOPTERA (*koleos*=sheath, *pteryx*=wing, refers to hardened front wings which cover membranous hind pair)

Family : Coccinellidae

IMPORTANCE Predaceous adults and larvae help control orchard insect pests. *Scymnus (Pullus) impexus* Mulsant and *Aphidecta oblitterata* (L.) were introduced from Europe to British Columbia, Washington and Oregon to control balsam woolly adelgid and successfully established, but adequate control not achieved. Several species commonly purchased for greenhouse pest control. Not recommended for outdoors unless release is community wide. 'Ladybird' name derived from middle ages dedication to 'Our Lady' in appreciation for natural pest control obtained on grapevines.

DISTRIBUTION Worldwide (mainly temperate): 5000 spp. North America: 400 spp.
Canada: 162 spp. (includes subspecies). (87)

BIOLOGY Diurnal. Clusters of 3-300 eggs laid near aphid colonies in early spring, several hundred eggs laid per lifetime. Lifespan: 1 year. Egg hatch: 5-8 days. Larvae (4 instars): several weeks, last one attaches to foliage to pupate for 7-10 days. Adults: 1-2 months, feed throughout fall, lay eggs and die, or diapause under shelter, emerging in spring to feed, lay eggs and die. Mate in spring and summer. 2-3 generations per year. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). Adults reflex bleed (toxic fluid oozes from leg joints to deter predators or trap enemies).

FOOD SOURCE Aphids (larvae: 3-600, adults: 2-3000), adelgids, scales (e.g. pine needle scale, oystershell scale), mites, mealybugs. When prey is scarce will feed on insect eggs, small moth larvae, immature plant bugs, aphid honeydew, or siblings.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	

MONITORING Methods - Branch beatings, malaise trap, sweep net.

Habitats - Adults: vegetation infested with aphids, adelgids, scales, mites or mealybugs. Under loose bark or leaf litter (in winter). Larvae: in aphid colonies.

CONSERVATION Attractants - Encourage pollen or nectar flowers such as alfalfa, angelica, California coffeeberry, camphorweed, evergreen euonymus, goldenrod, Mexican tea, morning-glory, oleander, ragweed, soapbark tree. Extrafloral nectaries may be provided.

Mowing - Leave weeds such as dandelions, wild carrot and yarrow between rows.

Pesticide Toxicities - More tolerant than other predators. Ultra-low volume applications are safer than conventional sprays.

High : azinphos-methyl (Guthion™), *Bacillus thuringiensis* (BT) (Bitoxibacillin™, Ecotoxin™), BHC, carbaryl, carbofuran, carbophenothion, cryolite, demeton, diazinon, dicrotophos, dimethoate, endosulfan, endrin, dioxathion (Delnav™), ethion, fenthion, fenvalarate (Sumicidin™), formetanate, lindane, malathion, malathion + oil, methoxychlor, methylparathion, mevinphos, mexacarbate (Zectran™), naled, oxydemeton-methyl (Metasystox-R™), parathion, parathion + oil, permethrin (Ambush™), phosphamidon, rotenone, sulphur.

Low to Moderate : aldrin, BT (Entobakterin™), nicotine (Nicotine Sulfate™), trichlorfon.

Safe: aldicarb, BT (Dipel 4L™, Thuricide™), endosulfan (eggs), monocrotophos, NPV, phosalone, phosmet, pirimicarb (Pirimor™), tetradifon. (8,35,42,45,58,62,77,96,97,107)

RECOMMENDED READINGS : 63, 87, 97

LADYBIRD BEETLES

DESCRIPTION

Adults 4-10 mm. Oval to round, flat-bottomed, shiny, usually red or orange with black dorsal spots or marks, some solid black or black with red spots (bright colours warn predators of unpleasant taste). Short, clubbed antennae, hard outer wings cover membranous flying wings, highly mobile (Fig. 49). Feign death by pulling short legs under body.

Eggs Elongate, upright, yellowish-orange, spindle-shaped (Fig. 50).

Immatures 1-15 mm. Very active, elongate, slightly-flattened, soft-bodied, alligator-like larvae, with warts or spines. Dark with bright-coloured spots or bands, well-developed legs (Fig. 51), some with fragile hairs which release repellent liquid when broken.

Pupae Resemble bird droppings, one end attached to foliage (Fig. 52).



Figure 49 - Ladybird beetle.

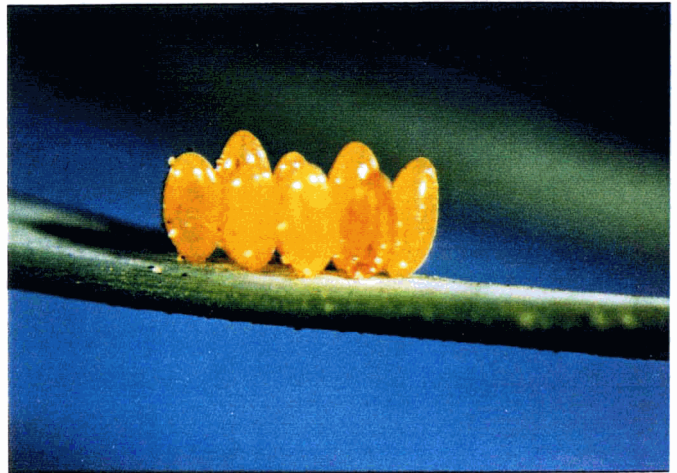


Figure 50 - Ladybird beetle eggs.

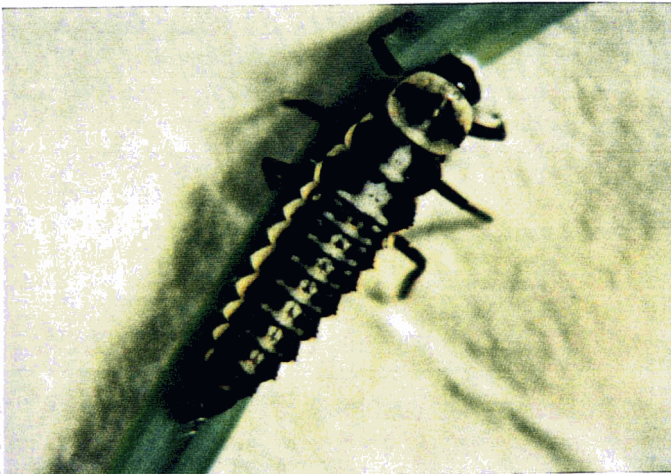


Figure 51 - Ladybird beetle larva.



Figure 52 - Ladybird beetle pupa.

APHID MIDGES

ORDER : DIPTERA (*diploous*=two, *pteryx*=wing, refers to presence of 2 wings instead of the typical 4)

Family : Cecidomyiidae

Genus : *Aphidoletes* spp.

IMPORTANCE Predaceous genus. Other genera are parasitic or predaceous. Commercially available for aphid control in fruit orchards and greenhouses. 1 European species successfully established in British Columbia, Washington and Oregon for balsam woolly aphid control.

DISTRIBUTION Worldwide. North America: 3 spp.

BIOLOGY Up to 250 eggs laid in aphid colonies, may be glued to live aphids. Egg hatch: 3-5 days, larvae (4 instars): 1-2 weeks. Larvae drop to soil, burrow, pupate in delicate cocoons. Emerge after 2-3 weeks, or in late spring or summer if shorter daylength triggers diapause. Adult: 10 days. Mating occurs first night after emergence, eggs laid on second. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adult: sap, nectar. Honeydew required to lay full egg complement. Larvae: aphids (> 60 spp.). Also mites and scales, and their eggs. More aphids killed than consumed. Paralyze aphids with toxic saliva, suck out body fluids (Fig. 55).

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
				X	X	X	X				

MONITORING Methods - Larvae and eggs: inspect aphid colonies. Adults: branch beatings, sweep net. Infested foliage may be placed in plastic bag (keep out of direct sunlight) to watch for larvae or adult emergence.

Habitats - Eggs and larvae: near aphid colonies in late spring, summer. Pupae: in soil in winter.

CONSERVATION Attractants - Encourage pollen and nectar flowers. Provide water source during drought conditions.

Mowing - Leave some weeds such as dandelions, wild carrot and yarrow between rows.

Biological Control Releases - Release in enclosed area. If release intended during short days and cooler temperatures, purchase predators from supplier rearing under long-light conditions.

Pesticide Toxicities -

High : acephate (Orthene™), deltamethrin (Decis™), diazinon, dichlorvos, chlorpyrifos (Dursban™), endosulfan (Thiodan™), methomyl (Lannate™), malathion, neoplectanid or steinernematid nematodes (when pupae in soil), nicotine, parathion, permethrin (Ambush™), pirimicarb (Pirimor™), sulfotep.

Moderate : dicofol (Kelthane™), soap.

Low : BT (Dipel™), fenbutatin oxide (Vendex™), oils.

(29,42,97)

RECOMMENDED READINGS : 13, 50, 97

APHID MIDGES

DESCRIPTION

Adults 2-3 mm. Small, delicate brown flies, resemble tiny mosquitoes with long legs, long beaded antennae, 1 pair of wings and hindwings reduced to halteres (Fig. 53).

Eggs Minute, orange, oval paprika-like specks.

Immatures 3 mm. Tiny, bright orange maggots, small poorly developed head, minute mouthparts, mature larvae: dark T-shaped body plate underneath (Figs. 54 and 56).

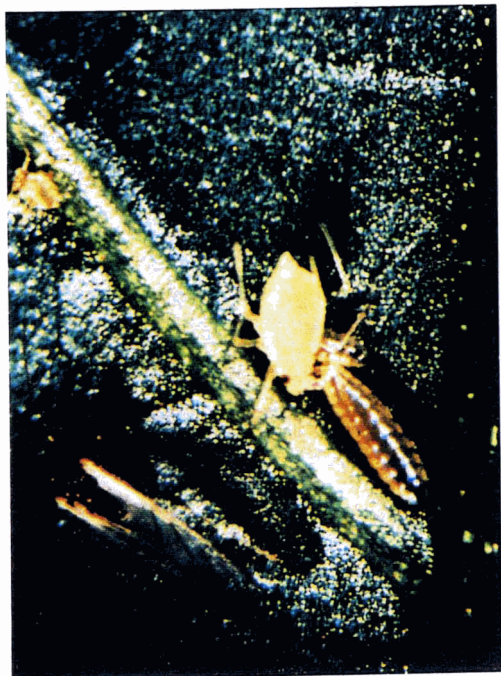


Figure 55 - Aphid midge attacking aphid.

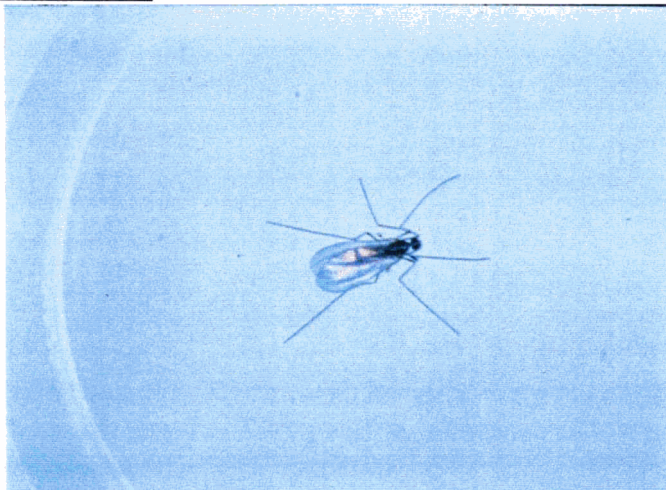


Figure 53 - Aphid midge.

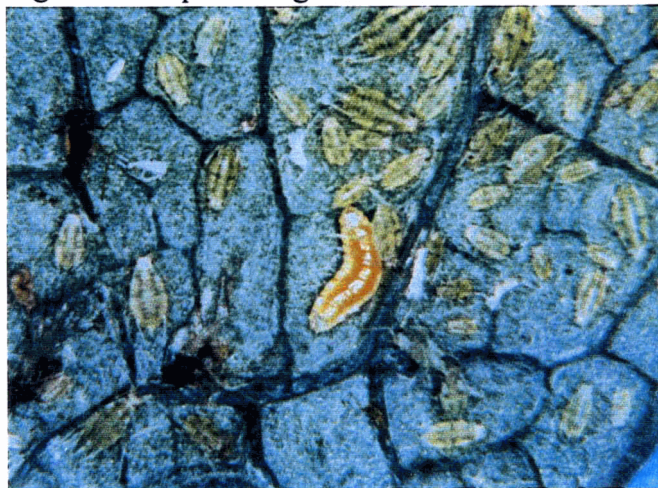


Figure 54 - Aphid midge larva with aphids.

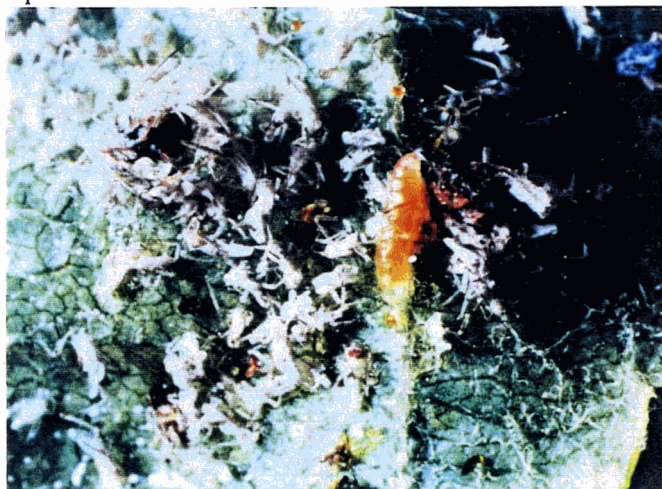


Figure 56 - Aphid midge larva with dead aphids and cast skins.

SN IPE FL IES

ORDER : DIPTERA (*diploous*=two, *pteryx*=wing, refers to presence of only 2 wings instead of the typical 4)

Family : Rhagionidae

IMPORTANCE Predaceous adults and larvae. Some feed on nectar and honeydew. Some commonly bite humans and vertebrates in western mountains and coastal areas.

DISTRIBUTION Worldwide. North America: 108 spp. Canada: 35 spp. (36)

BIOLOGY Adults of species with aquatic larvae lay egg clusters on twigs hanging over streams. Larvae hatch, fall in, female remains, dies on egg masses. Additional females may lay eggs and die on same mass, forming a large ball. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: small insects. Sometimes nectar or honeydew. Larvae: small insects. Some terrestrial larvae (wormlions) well known for building pits.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
				X	X	X	X				

MONITORING

Methods - Branch beatings, malaise trap, pan trap, sweep net.

Habitats - Adults: on foliage or grass in wooded areas. Also associated with flowers.

Larvae : mainly in decaying vegetation, rotting wood or moist soil in shady woods. Some aquatic species.

CONSERVATION

Attractants - Encourage pollen or nectar flowers.

Mowing - Leave weeds such as dandelions, wild carrot, yarrow between rows.

(42,97)

RECOMMENDED READINGS : 13, 14

SNIPE FLIES

DESCRIPTION

Adults 8-15 mm. Small to medium, brown or grey, sometimes black with white, yellow or green spots or bands, short abdomen, tapered to posterior, large, round head, long legs, wings may be spotted, weak fliers, short, sparse hairs on body and legs (Fig. 57).

Larvae Elongate, tapered maggot with narrow head capsule. May have bristles or hairs.



Figure 57 - Snipe fly.

SOLDIER FLIES

ORDER : DIPTERA (*diplos*=two, *pteryx*=wing, refers to presence of only 2 wings instead of typical 4)

Family : Stratiomyidae

IMPORTANCE Mainly scavengers. Some predaceous larvae (Pachygastrinae) found under bark help reduce bark beetle numbers. Larvae of very few pest species damage grass roots.

DISTRIBUTION Worldwide: 1800 spp. North America: 260 spp. Canada: 84 spp.
(36,87)

BIOLOGY Sluggish, inactive, lay masses of eggs on plants near water, on water surface, in dung, moss, leaf litter, soil, decaying wood. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Small insects including bark beetles, fly larvae. Also honeydew, algae and decaying plant matter.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
				X	X	X	X	X	X	X	

MONITORING

Methods - Branch beatings, malaise trap, sweep net.

Habitats - Adults: on flowers or foliage or damp areas in woods or meadows. Larvae: decaying vegetation, wood, under bark. Some aquatic.

CONSERVATION

Attractants - Encourage pollen or nectar flowers.

Mowing - Leave weeds such as dandelions, wild carrot, yarrow between rows.

(42,97)

RECOMMENDED READINGS : 87, 89

SOLDIER FLIES

DESCRIPTION

Adults 9-15 mm. Small to medium, stocky, flattened flies, mainly large wasp mimics, dark-coloured with contrasting bright yellow, green or white bands or stripes, others smaller, brown or metallic bluish-black, abdomen either broad and flat, or elongate and narrowed at base, thorax may be hairy, rounded head, as wide as thorax, large eyes, short distinctive antennae, wings folded flat over body at rest (Fig. 58), weak fliers, some able to hover like syrphid flies.

Immatures Mainly terrestrial, some aquatic larvae, elongate, flattened with tough leathery body, some aquatic species breathe through spiracles near the anus.



Figure 58 - Soldier fly.

ROBBER FLIES

ORDER : DIPTERA (*diploous*=two, *pteryx*=wing, refers to presence of only 2 wings instead of typical 4)

Family : Asilidae

IMPORTANCE Aggressive, predaceous adults and larvae. Generalist feeders also consume beneficial arthropods. Very painful bite to humans.

DISTRIBUTION Worldwide: 5000 spp. North America: 983 spp. Canada: 125 spp. (36,87)

BIOLOGY Fast fliers, especially active in sunshine. Adult activity severely reduced below 20°C. Eggs laid in soil or attached to foliage or bark, sometimes in grass seedheads. Larvae develop in soil or rotting wood. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: mainly wasps and flies. Attack larger insects (e.g. dragonflies, grasshoppers, moths) while in flight. Pounce on prey from above. Feeding behaviour similar to spiders. Stab prey at weak point (e.g. neck), paralyze with neurotoxic, protein-dissolving saliva, then suck up body fluids (Fig. 61). Larvae: beetles (including emerging mountain pine beetles and longhorned beetle larvae), and all life stages of several other insects. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	X	X	X	X	X	X	X	X			

MONITORING

Methods - Branch beatings, malaise trap, pan trap, sweep net.

Habitats - Adults: clearings in or near forest, perched on stone or twig watching for passing insects. Larvae: soil, leaf litter, decaying wood.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort.

RECOMMENDED READINGS : 13, 87

ROBBER FLIES

DESCRIPTION

Adults 8-14 mm. Moderate size, 'beard' of bristles on face, depression in forehead between widely separated, bulging eyes, brownish or black with yellow or reddish-orange marks, elongate abdomen tapered to posterior, hairless, resemble damselflies, some stout, very hairy, excellent bumblebee, sphecid or vespid mimics, fast fliers, short, erect antennae, large, spiny legs modified for grasping prey in flight, sharp, stout proboscis (for stabbing and sucking) points forward, clear wings may have dark patches (Fig. 59 and 60).

Immatures Elongate free-living larvae, cylindrical, neutral-coloured, tapered at both ends, small distinct head.



Figure 59 - Robber fly.



Figure 60 - Robber fly.

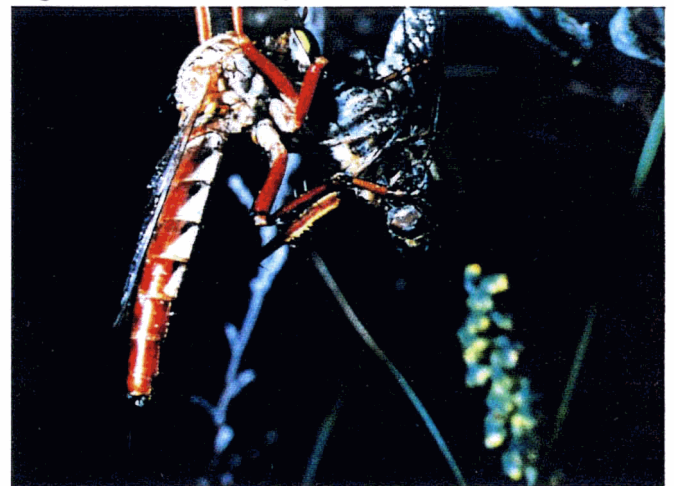


Figure 61 - Robber fly with prey.

B E E F L I E S

ORDER : DIPTERA (*diploous*=two, *pteryx*=wing, refers to presence of only 2 wings instead of typical 4)

Family : Bombyliidae

IMPORTANCE Economically important. Parasitic larvae attack several arthropod pests. Some kill other beneficials.

DISTRIBUTION Worldwide: 5,000 spp. North America: 800 spp. Canada: 70 spp.
(36,87)

BIOLOGY Some females hover over holes, quickly dipping their abdomens to throw in an egg. Sand grains may be gathered in abdominal chamber to coat eggs. Some eggs laid near bee nests. First instar larvae enter, parasitize bee larvae, and larvae become maggots after host pupates. Fly pupates inside bee cell, sharp sclerotized horns used to break out of host cell enabling adult fly to emerge. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: nectar and pollen. Larvae: flies, moth larvae and pupae, beetle larvae, bee and wasp larvae, neuropterans (e.g. lacewings), grasshopper eggs, locusts.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		X	X	X	X	X	X	X			

MONITORING

Methods - Adults: branch beatings, malaise trap, sweep net.

Habitats - Adults: open, sunny, dry areas, near water holes in arid areas, feeding or flying near flowers, resting on sandy ground.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort.

RECOMMENDED READINGS : 87, 88

BEE FLIES

DESCRIPTION

Adults 2-28 mm. Medium to large, mimic wasps, bees or syrphids, stout and hairy, brown, red or yellow with bright markings. Round head with short and fleshy, or long proboscis, adapted for sucking nectar from long-tubed flowers. Flat or humpbacked thorax. Broad and rounded, or slightly elongate abdomen, long, slender legs, clear wings, held outstretched at rest, may have dark bands or marks, especially on leading edge (Fig. 62). Very fast fliers able to hover.

Immatures 9-22 mm. First instar larvae flattened. Active, mobile with small prolegs or bristles. Mature larva whitish, crescent-shaped, anteriorly tapered, with ring-like segments, slender, sickle-shaped mandibles.



Figure 62 - Bee fly.

DANCE FLIES

ORDER : DIPTERA (*diplous*=two, *pteryx*=wing, refers to presence of only 2 wings, not 4 which is typical of insects)

Family : Empididae

IMPORTANCE Predaceous adults and larvae help control mites, scales, mosquitoes, and other pests.

DISTRIBUTION Worldwide (mainly northern hemisphere): 3500 spp.
North America: 730 spp. Canada: 300 spp. (36,87)

BIOLOGY Swarms commonly 'dance' up and down in air, mainly for mating, sometimes for predation. Some males offer freshly killed prey, sometimes wrapped in silk to attract females, other males lure females with empty silk packages, holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: ambush small flies and other insects. Some females do not hunt prey, relying on male's mating gifts for food. Some steal prey from spider webs. Larvae: general predators of mites, scales, mosquitoes, black fly larvae and other small, soft-bodied insects.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X	X		

MONITORING **Habitats** - Adults: over forest streams, on flowers and tree trunks in damp vegetated areas. Larvae: soil, water, decaying vegetation or wood.

Methods - Branch beatings, light trap, malaise trap, sweep net.

CONSERVATION Avoid pesticide use.

RECOMMENDED READINGS : 11, 87

DANCE FLIES

DESCRIPTION

Adults 1.5- 11 mm. Minute to small, dark brown and black to yellow, bristly, large, stout, humpbacked thorax, long tapered abdomen. Males have obvious male genital lobe under abdomen, but not folded forward like long-legged flies. Large eyes, proboscis modified for piercing, chewing, long, slender legs used for mating and grasping prey, round head, distinct neck (Fig. 63).

Immatures 3-10 mm. White, elongate, spindle-shaped free-living larvae, with retractable head, some aquatic species with 7-8 pairs of prolegs, legless terrestrial species.



Figure 63 - Dance fly.

LONG-LEGGED FLIES

ORDER : DIPTERA (*diploous*=two, *pteryx*=wing, refers to presence of only 2 wings not the typical 4)

Family : Dolichopodidae

IMPORTANCE Mainly predaceous adults and larvae. *Medetera* spp. are important predators of mountain pine beetle, Douglas-fir beetle and spruce beetle. Some are herbivorous.

DISTRIBUTION Worldwide: 6000 spp. North America: 1230 spp. Canada: 500 spp.
(36,87,120)

BIOLOGY Complex courtship includes various mating dances. Some males wave fans or disks of black or white leg scales, others use wing patterns to attract females. Males try to mate with any similar sized objects. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: immature bark beetles and wood borers and other small insects. Squeeze and chew prey with fleshy mouthparts, then suck juices. Also feed on flowers and nectar. Larvae: various insects. May be highly selective for prey (e.g. bark beetles only).

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	X	X	X	X	X	X	X	X	X		

Adults are very sensitive to cold and rarely appear after first frost.

MONITORING

Methods - Branch beatings, malaise trap, sweep net.

Habitats - Adults: moist, shady areas such as meadows, woodlands, stream and lake margins, and cool North American mountains. Many are habitat specific. Larvae: aquatic. Also in moist soil, rotting wood, dense vegetation, under bark and leaf litter, in water. Some on bark beetle larvae beneath tree bark.

CONSERVATION

Attractants- Encourage goldenrod. (97)

RECOMMENDED READINGS : 87, 89

LONG-LEGGED FLIES

DESCRIPTION

Adults < 4 mm. Minute to small, metallic green, blue or copper, bristly with long legs, round or flattened head with short, fleshy proboscis. Abdomen either flattened and elongate, or short and cylindrical. Males with large genitalia, folded forward under abdomen (unlike dance flies), female abdomen ends in sharp point. Males have hairy tufts and ornaments on legs, antennae and body, used to signal females during mating (Figs. 64 and 65).

Immatures 0.5 mm. White, cylindrical, bluntly rounded, anteriorly tapered maggots with retractable head and dark mouthparts. Evenly segmented. Pseudopodia with spines facilitate movement.



Figure 64 - Long-legged fly.



Figure 65 - Long-legged fly.

SYRPHID (or HOVER) FLIES

ORDER : DIPTERA (*diploous*=two, *pteryx*=wing, refers to presence of only 2 wings instead of the typical 4)

Family : Syrphidae

Subfamily : Syrphinae

IMPORTANCE Effective aphid-feeding larvae, common in seed orchards. Important pollinators. None bite man.

DISTRIBUTION Canada: approx. 150 spp. (36)

BIOLOGY Up to 1000 eggs (per female lifespan) glued horizontally, singly or in batches, in aphid colonies. Egg hatch: 2-3 days, larva development (several molts): 7-10 days, pupae: 1 week, attached to foliage or burrow in soil. Emergent adults ready to mate. Females must feed on pollen or nectar to produce eggs. Overwinter as larvae, pupae or adults. 2-4 generations per year. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Larvae: balsam woolly adelgid (native *Syrphus vitripennis*) and aphids (up to 200-800 per larva). Also caterpillars, beetles, thrips, sawfly larvae, scales, diseased bee and wasp larvae and pupae. Swing raised head side-to-side while searching for aphids. Immobilize aphids with sticky glue. Raise prey overhead, sucking out contents. Some are scavengers. Few feed on plants. Adults: nectar, pollen, aphid honeydew

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X	X		

MONITORING Methods - Adults: branch beatings, malaise trap, pan trap, sweep net.

Larvae: aphid colony inspection, branch beatings.

Habitats - Adults: in flight near flowers or aphid colonies. Larvae: in or near aphid colonies, in ant, termite or bee nests. Scavenger species in rotting wood, dung, mud or dirty water.

CONSERVATION Attractants - Encourage pollen and nectar flowers such as fennel, ivy, meadow foam, morning-glory, oleander, silver lace vine, snowberry, soapbark tree, tree-of-heaven, wild carrot, wild lettuce, and yarrow.

Mowing - Leave some flowering weeds between rows.

Pesticide Toxicities - Very sensitive (especially larvae) to most insecticides.

High : *Bacillus thuringiensis* (BT) (Bitoxibacillin 202™), oxydemeton-methyl (Metasystox- R™), parathion, pirimicarb (Pirimor™).

Moderate : bioresmethrin (Isathrine™), cypermethrin (Ripcord™), deltamethrin (Decis™), permethrin (Ambush™).

Low to Moderate : nicotine (Nicotine Sulfate™).

Low : fenvalarate (Sumicidin™).

Safe : water (use force to remove aphids).

(42,45,58,77,83,97,107)

RECOMMENDED READINGS : 14, 63, 98

S Y R P H I D (or HOVER) F L I E S

DESCRIPTION

Adults 8-15 mm. Medium to large, brightly-coloured with yellow, brown, black, or entirely black or brown. Resemble wasps or hairy bumblebees, but no stinger, able to hover and only 1 wing pair. Strong, quick fliers, able to go backwards or hover still in strong winds. Males have large eyes which meet on head, smaller, well separated eyes on female (Fig. 66).

Eggs White, elongate, finely textured, attached horizontally to foliage, alone or in clusters (Fig. 67)

Immatures 10-15 mm. Minute, flattened, wrinkled maggots, tapered body, no distinct head, yellow-green to brown. Many aphid feeders green with white stripes and fleshy pseudopodia for movement around colonies (Fig. 68), colour pattern develops with growth.

Pupae Tear-shaped, resemble grape seeds (Fig. 69).



Figure 66 - Syrphid fly female.



Figure 67 - Syrphid fly egg.



Figure 68 - Syrphid fly larva.



Figure 69 - Syrphid fly pupa.

DUNG FLIES

ORDER : DIPTERA (*diploous*=two, *pteryx*=wing, refers to presence of only 2 wings instead of the usual 4)

Family : Scathophagidae

IMPORTANCE Predaceous adults. Larvae may be plant-feeders, predators or scavengers. Some are mechanical vectors of diseases. One species accidentally introduced to North America through livestock brought over by European colonists.

DISTRIBUTION Worldwide (mainly northern hemisphere): 250 spp.
North America: 148 spp. Canada: 130 spp. (36,87)

BIOLOGY Eggs laid near manure or on flowers. Larvae tunnel into manure, pupate in soil. Copulation occurs near manure or flowers. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: flies and other small insects. Pierce neck of prey to suck out body fluids. Also feed on grasses, sedges and docks. Larvae: plants, insects, dung.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
					X	X	X				

MONITORING

Methods - Branch beatings, malaise traps, sweep net.

Habitats - Near fresh dung in sheep and cow pastures.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort.

RECOMMENDED READINGS : 88, 89

DUNG FLIES

DESCRIPTION

Adults 8-10 mm. Medium size, elongate, resemble house flies, male yellowish-brown to gold, covered with short hairs, female duller, wings yellow-brown in front, clear behind, long, slender legs may have strong dark bristles, slender abdomen with enlarged rear end, round head with broadly separated red eyes (Fig. 70).

Immatures 6-8 mm White or creamy white maggots, slender and hairy, nearly cylindrical, some conical with circular bands, retractable head with antennae.



Figure 70 - Dung fly.

F L E S H F L I E S

ORDER : DIPTERA (*diploous*=two, *pteryx*=wing, refers to presence of only 2 wings instead of the typical 4)

Family : Sarcophagidae

IMPORTANCE Important pupal parasites and predators of spruce budworm, Douglas-fir tussock moth and other Lepidoptera. Able to decimate tent caterpillar populations by transmitting tent caterpillar virus. One species has been reported to cause intestinal problems in people who ate contaminated food. Some scavenger species.

DISTRIBUTION Worldwide (mainly northern hemisphere): 2100 spp.
North America: 330 spp. Canada: 45 spp. (36,87)

BIOLOGY Some viviparous species deposit several first instar larvae simultaneously, sometimes from the air. Ovoviviparous species lay eggs near bee or wasp nests, or on paralyzed prey (which will be food for fly larvae). May also lay eggs on open wounds of mammals (referred to by common name). Larval development: few days. Pupate in soil, adults emerge in summer. Breed in carrion, dung and decaying material. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: nectar, sap, honeydew, stored pollen. Larvae: larvae and/or pupae of spruce budworm, Douglas-fir tussock moth, western blackheaded budworm, large aspen tortrix, tent caterpillars, pine butterfly, loopers and satin moth. Also beetles, grasshoppers, spider egg sacks, snails, earthworms, scorpions, millipedes, frogs and other wild or domestic vertebrates. Scavengers feed on dead insects and animal waste.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X			

MONITORING

Methods - Branch beatings, malaise trap, pan trap, pitfall trap, sweep net.

Habitats - Near exposed excrement, on flowers or trees, near aphid colonies, on ground near bee or wasp nests.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort.

RECOMMENDED READINGS : 87, 89, 113

FLESH FLIES

DESCRIPTION

Adults 6-10 mm. Resemble house flies, robust with grey and black checkered or striped thorax, red compound eyes, clear wings with brown veins, yellowish body hair (Fig. 71). Sexually dimorphic.

Immatures 5-25 mm. White or yellow, cylindrical, anteriorly tapered, bluntly rounded, segmented maggot. Short spines, retractable head with antennae, sickle-like toothed mouthparts.



Figure 71 - Flesh fly.

TACHINID FLIES

ORDER : DIPTERA (*diploous*=two, *pteryx*=wing, refers to presence of only 2 wings instead of typical 4)

Family : Tachinidae

IMPORTANCE Important parasites controlling forest and shade tree pests. Many species used or considered for biological control. One species successfully introduced to British Columbia from Europe to control European earwigs. Cutworm tachina fly established in parts of Canada. Another species introduced for satin moth control in western North America and for gypsy moth and brown moth control in the east.

DISTRIBUTION Worldwide: 7800 spp. North America: 1280 spp. Canada: 500 spp. (36,87)

BIOLOGY Many variations in biology and oviposition habits. In some species single female may lay thousands of eggs on or through skin of host, on plant material to be eaten by host, or into mouth of host while feeding. Eggs mature in body long enough to ensure immediate egg hatch following oviposition. In other species, live young are produced and deposited in similar habitats. Newly hatched larvae burrow into host, feed for days on internal organs, obtain air through host's tracheal system, drop to ground to pupate nearby. Males often wait in groups on hill tops for receptive females. Up to 2 generations per year. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: plant secretions, honeydew from aphids, scales, leafhoppers. Larvae: immature moths (Douglas-fir and western tussock moths, western hemlock looper, tent caterpillar, western blackheaded budworm, *Archips* spp., *Dioryctria* spp., silver-spotted tiger moth), sawflies, beetles. Also adult moths, beetles, all plant bug lifestages, grasshoppers, wasps, flies. Some selective species (e.g. only concealed caterpillars such as leaf rollers).

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	

MONITORING Methods - May be difficult to catch. Adults: branch beatings, malaise trap, pan trap, sweep net. Larvae: look for white eggs on hosts.

Habitats - Adults: near flowers, tree sap or honeydew. Larvae: on or in hosts.

CONSERVATION Attractants - Encourage pollen and nectar flowers such as California buckwheat, California coffeeberry, camphorweed, coriander, coyote bush, dill, evergreen euonymus, fennel, ivy, Mediterranean umble, parsley, silver lace vine, snowberry, white sweet clover.

Mowing - Leave some weeds such as goldenrod, pigweed, scorpion weeds and wild carrot between rows.

Pesticide Toxicities -

Low : *Bacillus thuringiensis* (BT) (Dipel 4L™).

Safe : BT (Dipel™, Thuricide HPC™), BT var. *kurstaki*, nuclear polyhedrosis virus. (42,45,97)

RECOMMENDED READINGS : 16, 88

TACHINID FLIES

DESCRIPTION

Adults 5-15 mm. Small to large. Resemble bristly houseflies, bees or wasps. Pale or dark brown to black, red or metallic green, thorax plain, or with stripes, spots or bands of contrasting colour, abdomen with stout, erect hairs concentrated on rear end (Figs. 72-74).

Eggs White, round to oval and membranous.

Larvae First instar larvae has hook-like mouthparts. Second and third instars have well-developed mandibles.

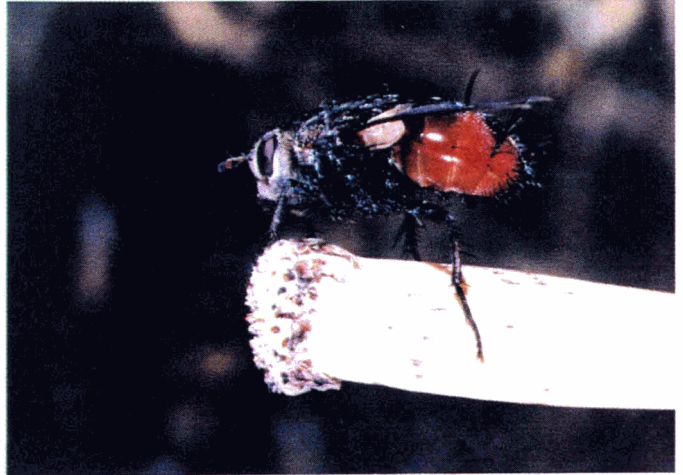


Figure 72 - Tachinid fly.



Figure 73 - Tachinid fly.

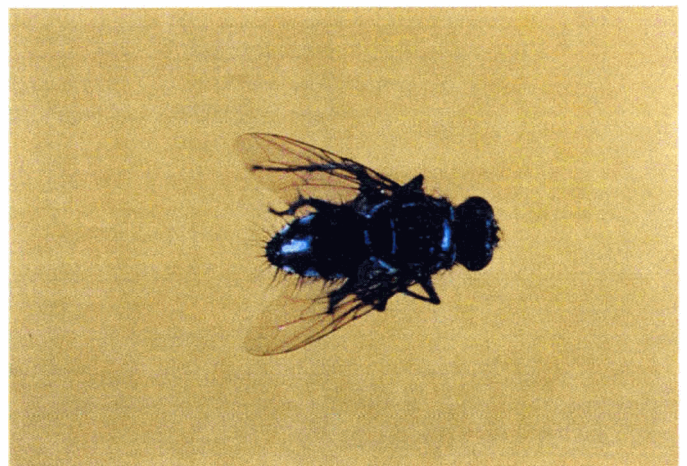


Figure 74 - Tachinid fly.

B R A C O N I D W A S P S

ORDER : HYMENOPTERA (*hymen*=membrane, *pteryx*=wing, refers to membranous wings)

Family : Braconidae

IMPORTANCE Important parasites. Help control bark beetles, other beetle and moth forest pests, and aphids. Some species commercially available for biological control. A European larch casebearer parasite released throughout North America established and still provides effective control. Another species released in British Columbia and Washington to control satin moth is successfully established. Very few hyperparasites.

DISTRIBUTION Worldwide: 40,000. North America: 2000 spp. Canada: 830 spp. (36,87)

BIOLOGY Solitary or gregarious. Ectoparasitic and endoparasitic species. Few polyembryonic species with 16-24 larvae originating from each egg. Egg injected into or laid on host (Fig. 75), larvae feed slowly on single host which is dead by the time the parasite(s) emerge. Pupate inside or near host mummy (Fig. 76), sometimes in a silken cocoon. Adult wasps emerge. **Typical aphid parasite** quickly injects egg into aphid while feeding on host plant. Disturbed aphid remains on plant. Mature larva glues mummy to plant, used as protection for pupa. Adult emerges after 1 week, empty mummy shell remains (Figs. 77 and 78). **Typical caterpillar parasite** lays 1 egg in host which divides and produces several larvae. Host dies, larva pupate, emerge as adults. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: plant fluids, water, nectar, honeydew. Larvae: wide variety of insect hosts including larch casebearers, spruce budworm, *Dioryctria* spp., giant conifer aphids, bark and wood boring beetles, wasps, tussock moths, false hemlock looper, sawflies, flies, ants, true bugs.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X			X

MONITORING Methods - Adults: malaise trap, pan trap, sweep net. Larvae: rear parasitized hosts.

Habitats - Adults: near host, flowers, water. Larvae: on or in hosts.

CONSERVATION Attractants- Encourage small-flowered nectar plants such as dill, parsley and yarrow. Also alfalfa, angelica, anise, California coffeeberry, camphorweed, caraway, carrot, catnip, coyote brush, evergreen euonymus, fennel, goldenrod, ivy, mustard, oleander, Queen-Anne's-Lace, scorpion weeds, soapbark tree, stinging nettle, sunflower, sweet clover, tree-of-heaven, white clover.

Mowing - Leave some flowering weeds between rows.

Pesticide Toxicities-High : carbaryl, carbofuran, diazinon, dichlorvos, disulfoton, fenitrothion, malathion, methylparathion, mevinphos, monocrotophos, parathion, permethrin, phorate, phosphamidon, propoxur, thiometon, zectran.

Moderate : aldicarb, azinphosmethyl, carbophenothion, chlorinated insecticides, cypermethrin, demeton, dimethoate, disulfoton, endosulfan, methoxychlor, rotenone, trichlorfon.

Low : *Bacillus thuringiensis* (Bactospeine™, Bakthane™), buthrenin, fenvalarate.

Safe: *Bacillus thuringiensis* (Biotrol XK™, Bitoxibacillin 202™, Dipel 4H™, Dipel HG™,

Entobakterin™, Thuricide™, Thuricide HPC™), dioxathion, naled, nicotine (Nicotine Sulfate™), nuclear polyhedrosis virus, pirimicarb, ryania, sabadilla, tetradifon. (16,35,42,45,97)

RECOMMENDED READINGS : 11, 50

BRACONID WASPS

DESCRIPTION

Adults 2-15 mm. Resemble brown or black ichneumons but smaller, stout, thread-like waist, long antennae, abdomen as long as head and thorax combined (not long and slender or laterally compressed). Ovipositor often visible even when not in use (Fig. 75).

Immatures Tiny, cream-coloured larvae, with toothed mandibles.

Pupae Characteristic small, silk, white cocoons on or near host mummy (Figs. 76-78).



Figure 75 - Braconid ovipositing in aphid.

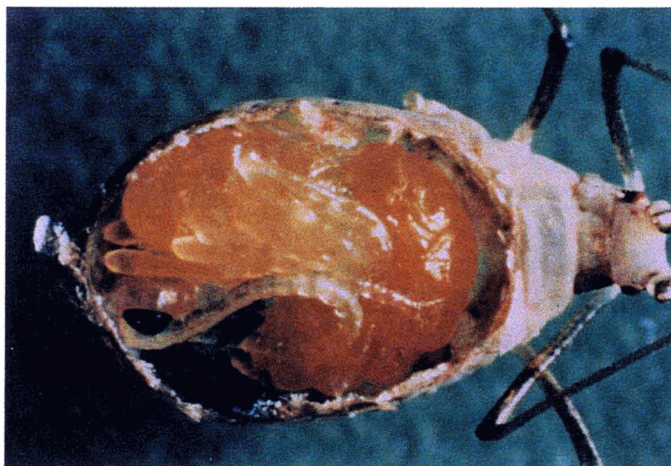


Figure 76 - Braconid pupa inside aphid mummy.



Figure 77 - Braconid aphid mummy with living aphids.



Figure 78 - Braconid aphid mummy.

ICHNEUMONID WASPS

ORDER : HYMENOPTERA (*hymen*=membrane, *pteryx*=wing, refers to membranous wings)

Family : Ichneumonidae

IMPORTANCE Effective natural control agents of moths, beetle larvae, wasps and other forest pests. An English larch sawfly parasite released in Canada still provides effective control in British Columbia. A North American horntail parasite was released in New Zealand. Some hyperparasites of braconids and other ichneumonids.

DISTRIBUTION Worldwide: 60,000 spp. North America: 10,000 spp. Canada: 2000 spp. (36,87)

BIOLOGY Some use ovipositors to probe bark scales and lichens (Figs. 80 and 81), and insert eggs into host eggs or small overwintering host larvae. Some carry eggs (attached to short stalks) on ovipositor. Eggs discarded if no hosts found. Eggs hatch quickly, larvae feed internally, killing host. Pupate in cocoons formed in, on or near host. Larvae, pupae or adults overwinter inside hosts, continue development in spring. Univoltine or multivoltine (up to 10 generations per year). Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: nectar, water. Use antennae to search for hosts. Larvae: wide variety of insect hosts including larvae and/or pupae of spruce budworm, *Dioryctria* spp., Douglas-fir tussock moth, and hemlock loopers. Also wood- and bark-boring beetles, flies, sawflies, some spiders, syrphid flies.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X		

MONITORING **Methods** - Adults: branch beatings, light trap, malaise trap, pan trap, sweep net. Larvae: rear parasitized hosts.

Habitats - Adults: common everywhere, especially near damp habitats, flowers or lights. Larvae: inside, on or near hosts.

CONSERVATION **Attractants**- Encourage pollen and nectar plants such as alfalfa, California coffeeberry, camphorweed, carrot, coyote brush, evergreen euonymus, goldenrod, oleander, rue, soapbark tree, tree-of-heaven, white clover, yarrow.

Mowing - Leave some flowering weeds between rows.

Pesticide Toxicities-High : carbaryl, carbofuran, diazinon, dichlorvos, disulfoton, fenitrothion, malathion, methylparathion, mevinphos, monocrotophos, nuclear polyhedrosis virus, parathion, phorate, phosphamidon, propoxur, *Serratia marcescens*, thiometon, zectran.

Moderate : aldicarb, azinphosmethyl, BT var. *entomocidus*, carbophenothion, chlorinated insecticides, demeton, dimethoate, endosulfan, methoxychlor, rotenone, trichlorfon.

Low : *Bacillus thuringiensis* (BT) (Dipel™)

Safe to Low : dioxathion, naled, nicotine (Nicotine Sulfate™), pirimicarb, ryania, sabadilla, tetradifon.

Safe: BT (Dipel 4H™, Thuricide™, Thuricide HPC™), granulosis virus (Hawaiian Granulosis Virus™), nuclear polyhedrosis virus (Niron/H™) (42,45,77,97)

RECOMMENDED READINGS : 50, 88

ICHNEUMONID WASPS

DESCRIPTION

Adults 5-36 mm. Small to large, resemble large, slender braconid wasps. Brown, red or black with variable marks and white head marks on male, abdomen longer than head and thorax combined, joined to thorax by slender stalk, may be flattened, non-retractable ovipositor longer than the body, able to penetrate up to 13 mm of wood. Long antennae constantly moving, antennae and ovipositor longer than stinging wasps. Some have compressed abdomens with sharp ovipositors, others have short ovipositors withdrawn into body. Differ from braconids with abdomen longer than combined head and thorax, sexually dimorphic (Figs. 79-82).

Immatures White, legless, tapered larvae.



Figure 79 - Ichneumonid wasp.

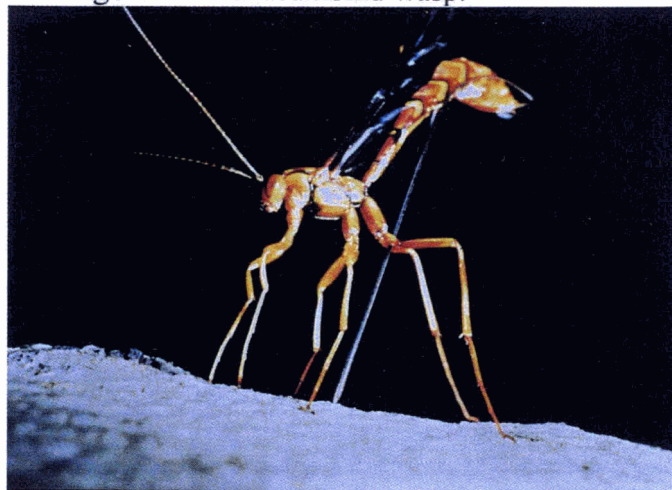


Figure 80 - Ichneumonid ovipositing in wood.



Figure 81 - Ichneumonid ovipositing.



Figure 82 - Ichneumonid.

CHALCIDOID WASPS

ORDER : HYMENOPTERA (*hymen*=membrane, *pteryx*=wing, refers to membranous wings)

Superfamily : Chalcidoidea

IMPORTANCE Majority are parasitoids with remarkable reproductive potential. Efficient searchers. Commercially available for biological control of moths, scales, fly larvae and beetle larvae (egg parasitoid, *Trichogramma* spp.). Also introduced against insect defoliators. Very few pollinators and plant- and seed-feeders (*Megastigmus* spp.).

DISTRIBUTION Worldwide: 100,000 spp. North America: 2200 spp. Canada: 500 spp. (13,36,97)

BIOLOGY May oviposit in immature caterpillars. Single egg may produce 12 or more (up to thousands) adults by asexual reproduction. Larvae feed inside host which may still live up to one week once chalcid pupates. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). Jump or feign death when disturbed.

FOOD SOURCE Adults: nectar, honeydew, water, host blood (obtained at oviposition). Host-specific, effective searchers, unable to switch to alternate prey. Larvae: leafrollers, loopers, tent caterpillar, larch casebearer and European pine shoot moth. *Trichogramma* spp. attack budworm eggs, and eggs of over 200 other lepidoptera species. Also aphids, scales, psyllids, gall midges, bark and wood boring beetles, weevils, ladybird beetles, sawflies, ants, wasps, thrips, ticks, mites, spiders (and eggs).

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	X	X	X	X	X	X	X	X	X	X	

MONITORING Methods - Flight intercept trap, malaise trap, pan trap, sweep net.

Habitats - Mixed and deciduous forests.

CONSERVATION Attractants - Encourage or plant alfalfa, angelica, anise, caraway, carrot, catnip, corn, coyote brush, dill, evergreen euonymus, fennel, goldenrod, lovage, mustards, oleander, parsley, Queen-Anne's-lace, scorpion weeds, soapbark tree, stinging nettle, sunflower, white clover, yarrow.

Mowing - Leave some flowering weeds between rows.

Pesticide Toxicities - High: acephate (Orthene™), aldrin, carbaryl, carbofuran, carbophenothion, chlorpyrifos (Dursban™), cypermethrin, deltamethrin (Decis™), demeton, diazinon, dichlorvos, dicofol (Kelthane™, to immatures), dimethoate, dioxathion (Delnav™), disulfoton, endosulfan (Thiodan™, to adults), endrin, ethion, fenitrothion, fenvalerate, insecticidal soap (to adults), lime-sulfur, lindane, malathion (to adults), malathion+oil, methomyl (Lannate™), methoxychlor, methylparathion, mevinphos, mexacarbate (Zectran™), monocrotophos, naled (Dibrom™, to adults), oils (to adults), parathion (to adults), parathion+oil, permethrin, phorate, phosphamidon, propoxur, rotenone, sulfotep (to adults), sulphur, thiometon, trichlorfon (Dylox™).

Moderate: aldicarb, azinphos-methyl, dicofol (Kelthane™, to adults), insecticidal soap (to immatures), malathion (to immatures), methoxychlor, naled (Dibrom™, to immatures), nicotine (to adults), parathion (to immatures), pirimicarb (Pirimor™, to adults), ryania, sulfotep (to immatures).

Low: *Bacillus thuringiensis* (BT) (Dipel 4L™, maximum rate), Bordeaux mixture, captan (Captan™), chlorobenzilate, cryolite, daminozide (B-Nine™), dicofol (Kelthane™, to immatures), endosulfan (Thiodan™, to immatures), fenbutatin-oxide (Vendex™), ferbam, kinoprene (Enstar™, to adults), nicotine (to immatures), oil (to immatures), pirimicarb (Pirimor™, immatures), zineb.

Safe to Low: BT, bioresmethrin (Isathrine™), sabadilla, tetradifon.

Safe: BT (Dipel 4L™, label rate), granulosis virus, nuclear polyhedrosis virus.

Biological Control Releases - Release at 5-7 day intervals for codling moth in apple orchards during flight time as determined by pheromone monitoring. 5-7000 per tree. Problems include determining precise release time, poor quality control and purchasing wrong species. (8,16,42,77,88,96,97)

RECOMMENDED READINGS : 14, 97

CHALCIDOID WASPS

DESCRIPTION

Adults <5 mm. Minute to small, smaller than braconids and ichneumonids, black, blue-black or green, may be metallic with bright yellow legs or body marks. Short, elbowed antennae, short ovipositor, wings may be smokey with simple venation, held flat at rest. Few without wings. Teeth under hind legs, sclerotized, well-developed triangular jaws (Figs. 83 and 84).

Eggs May be stalked.

Immatures Flattened 1st instar larvae with triangular jaws. Mature larvae white with simple head, sclerotized jaws (Fig. 84). Separate mid- and hindgut. Some with tubercles for locomotion.



Figure 83 - Chalcidoid ovipositing in aphid.

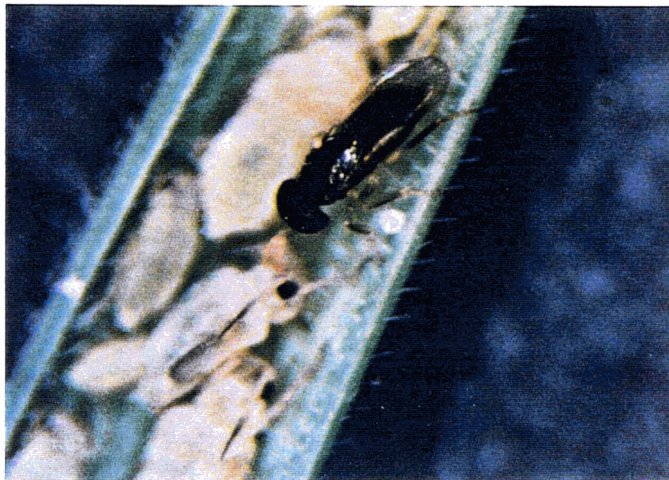


Figure 84 - Chalcidoid.



Figure 85 - Chalcidoid larvae in sawfly pupal case.

THREAD-WAISTED WASPS

ORDER : HYMENOPTERA (*hymen*=membrane, *pteryx*=wing, refers to membranous wings)

Family : Sphecidae (authors' opinions vary on the concept of this family)

IMPORTANCE Excellent predators. Many species prey on insect pests.

DISTRIBUTION Worldwide: 8000 spp. North America: 1140 spp. Canada: 225 spp.
(36,87)

BIOLOGY Active in sunshine. Solitary or gregarious. Some make own nests in ground or cavities, or use abandoned burrows (e.g. wood borer beetle holes or insects galls). May use mud. Nests stocked with food before eggs laid. Habits reflected in common names of groups (e.g. digger wasps, sand wasps, mud-daubers). Two or more females may cooperate to construct a nest, some females continue to supply young with food as they grow. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: grasshoppers, cockroaches, true bugs, sucking bugs, beetles, flies, moths, butterflies, wasps and spiders. Also nectar and honeydew. May lay eggs in other wasp nests. Each species restricted to one prey type. Sting and paralyze prey, drink body fluids, drag or carry to nest to feed larvae. Do not prechew their food for young like yellowjackets and hornets. Males do not hunt. Larvae: arthropod prey caught by mother.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
				X	X	X	X				

MONITORING

Methods - Branch beatings, malaise trap, sweep net.

Habitats -Near sandy, open areas, especially near flowers or sugary liquids.

CONSERVATION

Attractants - Encourage daisy or yarrow.

Mowing - Leave some flowering weeds between rows. (42,97)

RECOMMENDED READINGS : 13, 87, 88

THREAD-WAISTED WASPS

DESCRIPTION

Adults 2-40 mm. Small to large, diverse in appearance, from stout-bodied to slender, black, brown, metallic-blue or green, or black with white, red, yellow or light green marks. Wings held together over abdomen at rest. Name refers to narrow part of body joining thorax to abdomen (may be elongate and thread-like), broad head, females often with toothed, comb-like digging structures on front legs (Figs. 86-88).

Immatures 5-40 mm. Unusually diverse in appearance. Mature larvae white, tapered, smooth body with few short hairs, dark mandibles, head capsule may be coloured (Fig. 89).

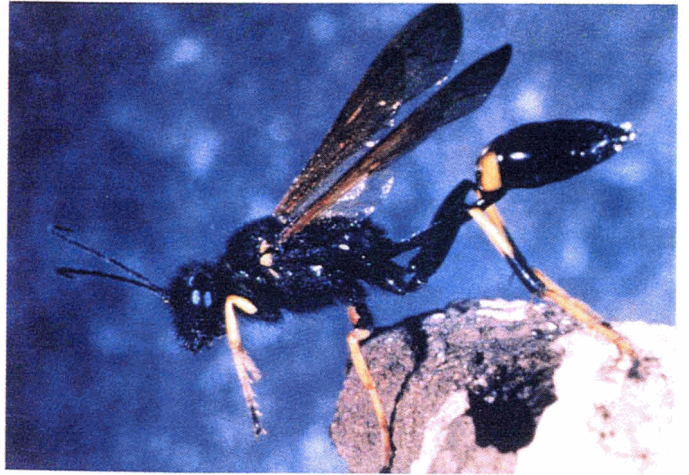


Figure 86 - Mud-dauber.



Figure 87 - Sand wasp.



Figure 88 - Mud-dauber.



Figure 89 - Thread-waisted wasp larva.

YELLOWJACKETS AND HORNETS

ORDER : HYMENOPTERA (*hymen*=membrane, *pteryx*=wing, refers to membranous wings)

Family : Vespidae

Subfamily : Vespinae

IMPORTANCE Important predators and scavengers. Help suppress several pest insects. Can be a nuisance to humans.

DISTRIBUTION Worldwide. North America: 18 spp. (13)

BIOLOGY Caste system includes queens, workers (sterile females), and males (to fertilize queens). Only young fertilized queens survive past late fall and leave nest to hibernate. In spring queens chew wood and leaves into pulp to build paper nests in ground, hollow trees or under building overhangs (Fig. 92), and lay eggs. First generations are reared. Adult workers build tiers of nests surrounded by outer coverings, care for young and seal their cells with silk before they pupate. Colonies last 1 year. Only queens overwinter under bark or other protection. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: flies, caterpillars, insect larvae, insect carcasses, nectar, ripe fruit. Larvae: chewed insects, meat scraps and nectar chewed and fed by workers.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X	X		

MONITORING

Methods - Branch beatings, commercial plastic trap, malaise trap, sweep net.

Habitats - Terrestrial.

CONSERVATION

Avoid destroying nests unless situated in area frequented by people or pets, or if anyone is allergic.

Attractants - Encourage white sweet clover and ivy. Nest boxes may attract greater numbers.

Mowing - Leave some flowering weeds between rows.

Pesticide Toxicities -

High : avermectin, carbaryl, diazinon, methoprene, pyrethrin, resmethrin. (17,42,77,97)

RECOMMENDED READINGS : 11, 113

YELLOWJACKETS AND HORNETS

DESCRIPTION

Adults 10-30 mm. Medium to large, black with yellow or white marks, wings folded lengthwise at rest, parallel to body.

Yellowjackets: black and yellow banded abdomens (Fig. 90). Hornets: black with yellow or white marks on face, thorax and abdomen (Fig. 91). Strong mandibles, notched eyes, smoky wings.

Immatures White, grub-like larvae, develop within cells in paper nests.



Figure 90 - Yellowjacket with prey.



Figure 91 - Bald-faced hornet.

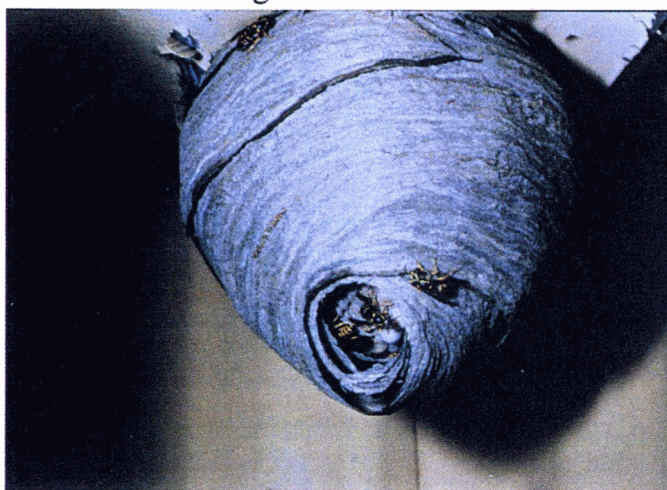


Figure 92 - Yellowjacket aerial nest with adults at entrance.

ANTS

ORDER : HYMENOPTERA (*hymen*=membrane, *pteryx*=wing, refers to membranous wings)

Family : Formicidae

IMPORTANCE Extremely common predators or scavengers. Vital to terrestrial ecosystems. Potential for use in biological control of forest caterpillars and other insect pests. Some species feed on plants or seeds. Few species damage forest trees or wood products.

DISTRIBUTION Worldwide. North America: 660 spp. Canada: 139 spp. (11,36)

BIOLOGY Female-dominant society. 3 caste system includes queens, males (fertile) and workers (sterile and fertile females). Most ants are non-winged sterile female workers, gathering food and stocking and maintaining the nest, eggs, larvae and pupae. Few spp. have no workers. The queen starts the colony and lays most of the eggs, living up to several years. Winged reproductive males and females perform mating flights, males die soon after. Females lose their wings, become queens and establish new colonies which may have up to several thousands of members, including more than one egg-laying queen. Nests may be made underground (several feet deep) and in natural cavities (e.g. dead wood galleries). Overwinter as workers, reproductives and immature larvae. Most bite when disturbed, many sting. Species-specific secretions emitted by mouth or anus used for colony regulation, trail-marking, alarm-raising, defence and attack. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: liquid food including caterpillar haemolymph, springtails, and other insects (*Formica* spp.), honeydew and other hemipteran secretions, some plants and some fungi. Food exchanged amongst individuals. Larvae: solid food including regurgitated, chewed food or fungi from workers.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	X	X	X	X	X	X	X	X	X	X	

MONITORING Methods - Aspirator, berlese funnel, branch beatings, pan or pitfall trap, sweep net.
Habitats - Terrestrial.

CONSERVATION Avoid destroying ant hills if possible.

Pesticide Toxicities -

High : carbaryl, carbofuran, diazinon, dichlorvos, disulfoton, fenitrothion, formethion, guthoxon, malathion, methylparathion, mevinphos, mexacarbate (Zectran™), monocrotophos, parathion, phorate, phosphamidon, propoxur, thiometon.

Moderate : aldicarb, azinphos-methyl, carbophenothion, chlorinated insecticides, demeton, dimethoate, endosulfan, methoxychlor, rotenone, trichlorfon.

Safe to Low : *Bacillus thuringiensis*, dioxathion, naled, nicotine (Nicotine Sulfate™), pirimicarb, ryania, sabadilla, tetradifon. (45,77)

RECOMMENDED READINGS : 14, 88, 89

ANTS

DESCRIPTION

Adults 1-25 mm. Pale yellow, reddish-brown to black, distinctive waist between abdomen and thorax, obvious elbowed antennae, large compound eyes, long body hairs. Queens and males have wings, workers do not (Figs. 93 and 94). Queens larger than other castes. Head modifications vary according to species and caste (Fig. 95).

Eggs Microscopic.

Immatures 5-15 mm. White, curved, segmented, grub-like larvae with small, weakly sclerotized head, simple mouthparts, no eyes, 3 larval instars.

Pupae White, similar to egg, sometimes naked.

Cocoons Yellow to light brown and papery. May contain meconium (fecal matter accumulated in larval stage and excreted from newly emerged adult).

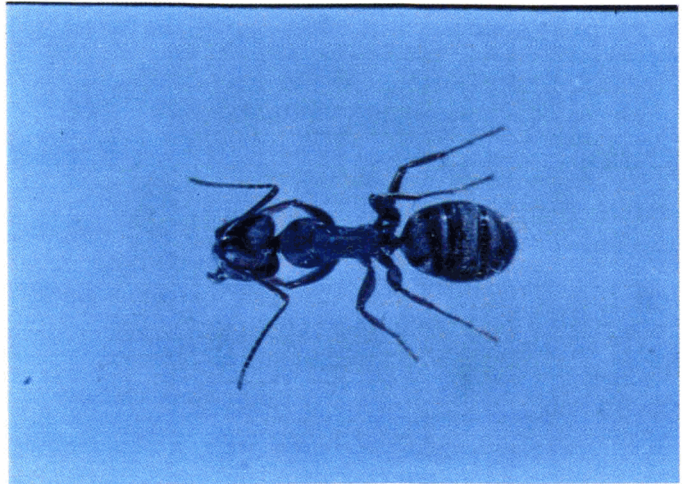


Figure 93 - Carpenter ant (worker).

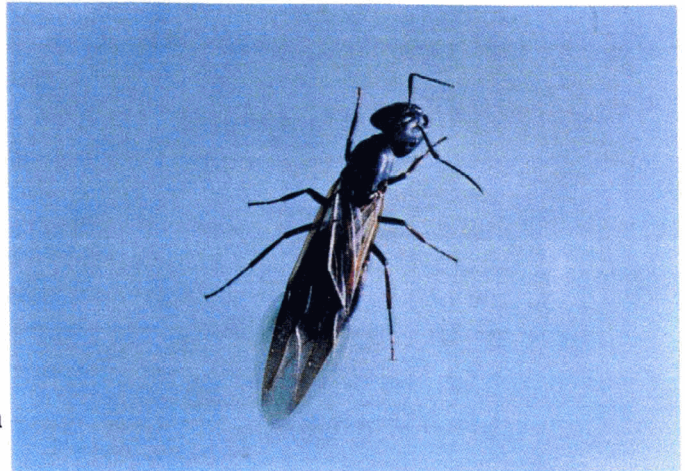


Figure 94 - Carpenter ant.



Figure 95 - Carpenter ant (worker).



Figure 96 - Ant hill.

ORB - WEAVING SPIDERS

CLASS : ARACHNIDA (*arachne*=spider)

ORDER : ARANEAE (*arachne*=spider)

Family : Araneidae (*arachne*=spider)

IMPORTANCE All species predaceous web-builders. Important in suppressing pest outbreaks. Able to survive during long periods when prey is scarce. Some people rear egg masses and release them in conifers for home and garden biological control.

DISTRIBUTION Worldwide: 2500 spp. North America: several hundred spp.
Canada: 69 spp. (36,81,89)

BIOLOGY Poor vision. Spiral orbs spun on support lines radiating out from centre hub, some with zigzag designs (*Argiope* spp.), may be on vertical, horizontal or slanting plane. Males often spin a web on outer edge of female's web. Sacs full of hundreds of eggs produced by females in fall, attached to plant material nearby. Some species hatch quickly and overwinter as spiderlings. Others overwinter as eggs and hatch the following spring. Immatures make perfect orb webs, older spiders specialize their webs, characteristic of their species. Many eat their web and spin a new one each day at dawn or dusk. Often rest with head down in centre of web, waiting for prey. Some retreat in rolled up leaves near web. May drop to the ground when disturbed.

FOOD SOURCE Small, soft-bodied, jumping or flying insects including aphids, leafhoppers, flies, and springtails. Also grasshoppers and beetles (larger orb-weavers). Orb webs used to catch prey. Web vibrations transmitted to centre hub or to retreat from signal lines. Entangled prey is bitten and injected with digestive enzymes. Prey is spun in silk, carried to centre hub or retreat in corner and sucked dry (Fig. 98). Uneaten remains drop to the ground.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	

MONITORING Methods - Berlese funnel, branch beatings, pan trap, pitfall trap, sweep net.
Habitats - Grasses, weedy areas, woods, caves, dark places.

CONSERVATION Avoid destroying webs if possible.

Attractants - Maintain plantings of goldenrod, ragweed. Permanent ground cover will provide spiders with hiding places, protect them from extreme climate and provides plenty of moisture.

Pesticide Toxicities -

If pesticide treatments are required, apply when spiders least active, i.e. past noon.

Toxic : azinphos-methyl, carbaryl, parathion, permethrin, silica aerogel (Drione™).

Safe to Moderate : fenthion (ultra-low volume, ULV) (EC), trichlorfon ULV.

Safe to Low : dimethoate, propoxur, trichlorfon ULV (EC).

Safe : disulfoton, fenthion ULV, sulphur, trichlorfon ULV (50%). (35,39,42,64,77,97)

RECOMMENDED READINGS : 81, 89

ORB-WEAVING SPIDERS

DESCRIPTION

Adults 2-28 mm. Vary in shape, size, colour. Black, brown, grey or red with lighter coloured marks, legs often banded (Figs. 97 and 99), 8 eyes arranged in 2 horizontal rows, smaller males. Some males equipped with clasping spurs.



Figure 97 - Orb-weaving spider.



Figure 98 - Orb-weaving spider with prey.

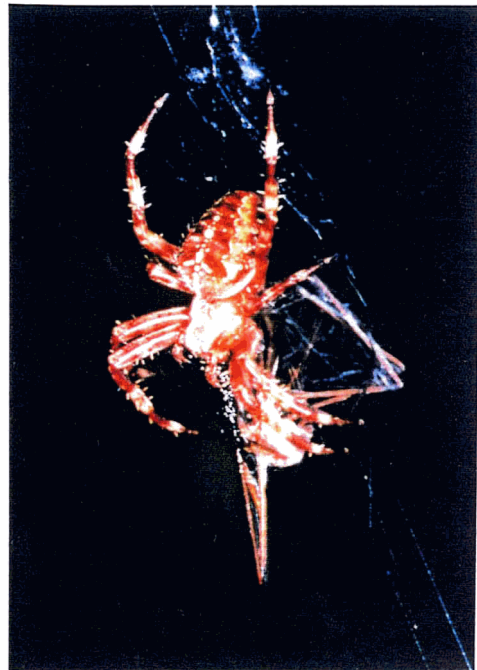


Figure 99 - Orb-weaving spider.

TETRAGNATHID SPIDERS

CLASS : ARACHNIDA (*arachne*=spider)

ORDER : ARANEAE (*arachne*=spider)

Family : Tetragnathidae (*tetra*=four, *gnathos*=jaw, refers to prominent jaws)

IMPORTANCE All species are web-building predators. Consume greater proportion of pests (80%) than beneficials. Important in natural regulation of many pest insects. Able to survive long periods of scarce prey.

DISTRIBUTION Worldwide: 250 spp. North America: 25 spp. Canada: 21 spp.
(36,81,89)

BIOLOGY Orb webs made on an angle with 12-20 radii and widely spaced spirals. Sits in centre hub or clings to an upright structure such as a blade of grass. Some sit waiting at side of the web. Drop to ground if disturbed. Long-jawed orb weavers hold on with their short 3rd pair of legs while extending the other long pairs. Young thick-jawed spiders make small orb webs with a small inner spiral and a central hole, between branches of shrubs. Egg sac attached to close plant. Spiderlings spin their own webs.

FOOD SOURCE Leafhoppers, midges, plant bugs, ants, moth larvae, tachinid flies, braconid wasps, springtails and other insects. Digestive enzymes injected into prey to liquefy tissue. Body shell is sucked dry.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X				

MONITORING Methods - Berlese funnel, branch beatings, pan trap, pitfall trap.

Habitats - Marshy areas. Common in shrubby meadows and woodland edges near water. Thick-jawed spiders are often under debris, in dense vegetation, near water.

CONSERVATION Avoid damaging webs if possible.

Attractants - Maintain plantings of goldenrod, ragweed.

Pesticide Toxicities - If pesticides are required apply when spiders are inactive, i.e. past noon. Organophosphates (excluding azinphos-methyl) are the least harmful insecticides. Chlorinated insecticides are the most toxic.

Toxic : azinphos-methyl, fenvalarate, permethrin silica aerogel (Drione™).

Moderate : carbaryl, parathion.

Safe to Moderate : fenthion (ultra-low volume, ULV) (EC), trichlorfon ULV.

Safe to Low : dimethoate, propoxur, trichlorfon ULV (EC).

Safe : disulfoton, fenthion ULV, sulphur, trichlorfon ULV (50%). (35,39,77)

RECOMMENDED READINGS : 81, 89

TETRAGNATHID SPIDERS

DESCRIPTION

Adults 3-9 mm. Long, slender, brown, legs (front pair especially) (Fig. 100). Males have large, protruding, powerful jaws. Differ from orb-weavers by lacking female external genitalia. Long-jawed orb-weavers have pale yellow cephalothorax and silver abdomen with dark grey dorsal stripes. Male jaws are $\frac{2}{3}$ the length of the cephalothorax, female holds her jaws vertically. Other species have the same general size and colour, but differ in the proportions of jaws and legs.

Eggs Encased in silk cocoon.



Figure 100 - Tetragnathid spider.

CRAB SPIDERS

CLASS : ARACHNIDA (*arachne*=spider)

ORDER : ARANEAE (*arachne*=spider)

Family : Thomisidae and Philodromidae

IMPORTANCE All species predaceous hunters. Do not spin webs to catch prey. Able to feed on insects many times their size

DISTRIBUTION Worldwide: 1800 spp. (mainly Northern Hemisphere).
North America: >200 spp. Canada: 110 spp. (36,81)

BIOLOGY No retreats or overwintering nests. Males may tie down potential mate with silk during courtship. Female guards egg sac until she dies, spiderlings emerge after her death. *Philodromus* spp. attach egg sacs to leaves or bark.

FOOD SOURCE Moths (*Thanatus* spp.), any insects resting on flowers (goldenrod spider), small flies, thrips, springtails, stinging bees, beetles. Catch prey by chance encounters, hunting or waiting in ambush. Some hold their legs stretched out, ready to catch prey. Vision is very good for detecting movement. Prey is bitten, raised overhead and contents sucked dry. Some wait on flowers for bees and flies. Venom is toxic enough to kill much larger insects.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	

MONITORING

Methods - Berlese funnel, branch beatings, malaise trap, pan trap, pitfall trap, sweep net.

Habitats - Resting on flowers (goldenrod spiders) or other vegetation (*Misumeriops celes*, *M. asperatus*, and *Thanatus* spp.), in and under bark (*Coriarachne* spp.), under rocks (*Philodromus* spp.), and on the ground (*Xystirus*, inconspicuous crab spider), in orchards, forests, grasslands, gardens or on daisies, goldenrod and other white or yellow flowers.

CONSERVATION

If pesticides are required apply when spiders are inactive, i.e. past noon.

Pesticide Toxicities -

High : permethrin. (35)

RECOMMENDED READINGS : 81, 89

CRAB SPIDERS

DESCRIPTION

Adults 1-11 mm. Hold legs crab-like (as common name suggests), able to move forward, backward and sideways. Flattened body, either short and broad (Thomisidae) or elongate (Philodromidae). 8 small eyes on raised bumps in 2 backward curved rows of 4 eyes each. Legs may be long and slender with hairy tufts, 2nd pair heavier and longer (Figs. 101-103). Females much larger than males which have longer legs and smaller jaws. Well-camouflaged. Goldenrod spider (flower spider, red-spotted crab spider) yellowish-white with crimson marks between eyes. Females have pale legs, male cephalothorax is dark reddish-brown with white spot in center and in front of eyes. White abdomen with 2 red bands, male has 2 pairs of reddish-brown forelegs, 2 pairs of yellow hind legs. Colour can change to yellow for camouflage on daisies and goldenrod. *Xysticus* spp. dull brown, resemble their background, may be sexually dimorphic. *Coriarachne* spp. extremely flat for hiding under bark. *Tibellus* spp. resemble long-jawed orb weavers especially when they stretch out in wait for prey. Inconspicuous crab spiders small, with larger female and male with pale abdominal tip.

Eggs May be inside silken sac for protection (goldenrod spider), egg sac may be flattened and attached to leaf, twig or rock (*Philodromus* spp.).



Figure 101 - Crab spider.



Figure 102 - Thomisid spider.



Figure 103 - Crab spider.

WOLF SPIDERS

CLASS : ARACHNIDA (*arachne*=spider)

ORDER : ARANEAE (*arachne*=spider)

Family : Lycosidae (*lykos*=wolf)

IMPORTANCE All species active hunters. Do not spin webs to catch prey. Especially valuable to farmers and gardeners.

DISTRIBUTION World: 1500-2000 spp. North America: >200 spp. Canada: 90 spp.
Amongst most common spiders on ground. Also at high altitudes and in the Arctic. (36,81,89)

BIOLOGY Daytime hunters, some also at night in warm climates. Only 1 genus spins web. Dig burrows in ground or under rocks, some have no retreat. Males court females by waving their pedipalps. Females produce large egg sacs which are stuck to the spinnerets. If removed, they will pick up something else to replace it. Egg sac is dragged behind until the spiderlings hatch. Spiderlings carried around until maturity. Good vision. The thin-legged wolf spider female spins a lens-shaped oval cocoon and drags it around. It is green at first, turning dirty gray with time. She carries spiderlings around on her back. Do not build a shelter. Hunt over a limited territory. Bask in the sun.

FOOD SOURCE Aphids, leafhoppers, springtails, flies, grasshoppers, beetles and other insects. Inject prey with digestive fluids and suck the insect dry.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	

MONITORING

Methods - Berlese funnel, pan trap, pitfall trap. Can also be lured from burrow by inserting straw or piece of grass.

Habitats - Common running on ground, over rocks, up plants or at rest under stones in sandy areas, open fields and grassy fields.

CONSERVATION If pesticides are required apply when inactive, i.e. past noon.

Pesticide Toxicities -

Safe or Low : *Bacillus thuringiensis* (BTB-202™). (45,77)

RECOMMENDED READINGS : 81, 89

WOLF SPIDERS

DESCRIPTION

Adults 3-35 mm. Dark, mottled, well-camouflaged amongst dead leaves and rocks. Characteristic eye pattern: 4 small eyes in 1st row, 2 large in 2nd and 2 small in 3rd, long legs (Figs. 104-106). The thin-legged wolf spider is slender and hairy, may be striped lengthwise, with long spiny legs, prominent upper row of large eyes. The private wolf spider has a V-shaped mark on its back. Less common *Arctosa* spp. may change colour to match their background.



Figure 104 - Wolf spider.



Figure 105 - Wolf spider.



Figure 106 - Wolf spider.

JUMPING SPIDERS

CLASS : ARACHNIDA (*arachne*=spider)

ORDER : ARANEAE (*arachne*=spider)

Family : Salticidae (*saltare*=to leap, refers to jumping ability)

IMPORTANCE Excellent hunters known. Stalk and pounce on prey.

DISTRIBUTION Worldwide: >2800 spp. (mainly tropical). North America: 300 spp.
Canada: 100 spp. (36,81)

BIOLOGY Diurnal, especially active in warm sun. Stay in small silk shelters under rocks or in crevices during cool temperatures and at night. Good jumpers (able to cover distance many times their body length), secure silk thread before taking off. Male reaches sexual maturity earlier. When he finds female wrapped in silk awaiting final molt, waits for her to emerge to mate with her. Courting behaviour includes waving brightly coloured legs, jaws and abdomen, wiggling the abdomen, and hopping. Excited males may perform mating displays for their own reflections. If accepted, he spins a rectangular web for sperm transfer. After mating she spins a silk cell in which eggs are laid and fertilized, guarding them until they hatch. More curious than timid, retreat when disturbed.

FOOD SOURCE Beetles, treehoppers, cockroaches and other insects. Zebra spiders: flies, moths, ants, beetles. Excellent vision (can see colour) used to stalk prey until few inches away. Jump, and grab prey with front legs, using fangs to stab prey and inject venom, and teeth to chew.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
	X	X	X	X	X	X	X	X	X	X	

MONITORING

Methods - Berlese funnel, pan trap, pitfall trap, sweep net.

Habitats - In buildings, on vegetation or under stones in meadows and woods. Some species at high altitudes (up to 23,000 ft in Himalayas).

CONSERVATION

If pesticides are required apply when spiders inactive, i.e. past noon.

Pesticide Toxicities -

High : permethrin.

(35)

RECOMMENDED READINGS : 81, 89

JUMPING SPIDERS

DESCRIPTION

Adults 3-15 mm. Small to medium, hairy, attractive, brightly coloured with iridescent scales, green, red or gray with red, white and black marks. Short legs, jumping power provided by slightly modified 4th pair. 8 eyes (including 2 which are large) arranged in 3 rows provide excellent binocular vision, able to change eye colour. *Phidippus* spp.: large, heavy bodies. Metaphid jumping spiders : 3-6 mm, brownish-yellow to gray, males have a white band on sides of abdomen, both sexes have spots, bands or chevrons (Fig. 107). Zebra jumping spider: black with white abdominal bands, strong front legs, larger females (Fig. 108).



Figure 107 - Metaphid jumping spider.

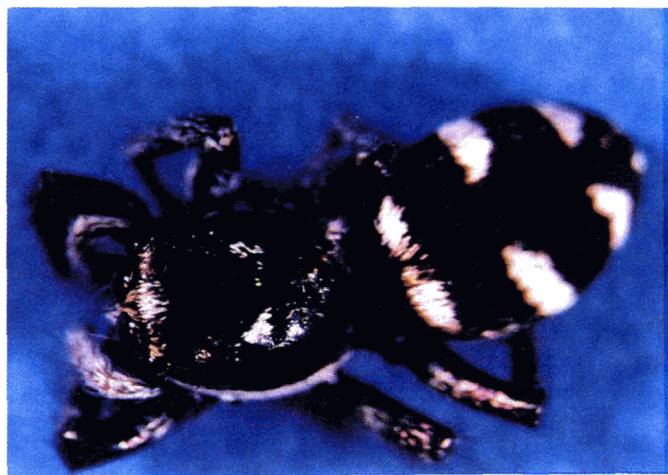


Figure 108 - Zebra jumping spider.

H A R V E S T M E N

CLASS : ARACHNIDA (*arachne*=spider)

ORDER : OPILIONES (*opilio*=shepherd, refers to first species recorded which were first seen at harvest time in autumn)

IMPORTANCE Predaceous. Some scavengers and plant feeders.

DISTRIBUTION World (temperate Eurasia, North America): 3500 spp.
North America: 200 spp. Canada: 47 spp. (36)

BIOLOGY Mainly nocturnal, some diurnal. May be found in large groups joined by their legs. Eggs laid by female in ground in fall, hatch in spring. Lifespan: 1-2 years. Do not spin silk, no courtship. Unlike spiders males have a penis which is inserted into jaws of female to transfer sperm. May wave second pair of legs or release odorous fluid when disturbed.

FOOD SOURCE Spiders, flies, aphids, leafhoppers, snails, earthworms, dead animals, fruit, soft decaying organic matter, plant juices.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X			X	X	X	X	X	X	X	X	X

MONITORING

Methods - Berlese funnel, branch beatings, pantrap, pitfall trap.

Habitats - In woods, dense vegetation and other moist areas.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort. If treatment is required apply during inactive periods. (42)

RECOMMENDED READINGS : 42, 81, 89

HARVESTMEN

DESCRIPTION

Adults 4-12 mm. 4 pairs of long slender legs, 2nd pair longer, used as antennae. Legs broken off not regenerated. Round or oval body. Head, thorax and abdomen broadly joined. Similar to some spiders but segmented and not constricted between cephalothorax and abdomen. Females larger with shorter legs and long stout ovipositor. 2 eyes in middle of head, scent glands on carapace above 1st and 2nd legs.

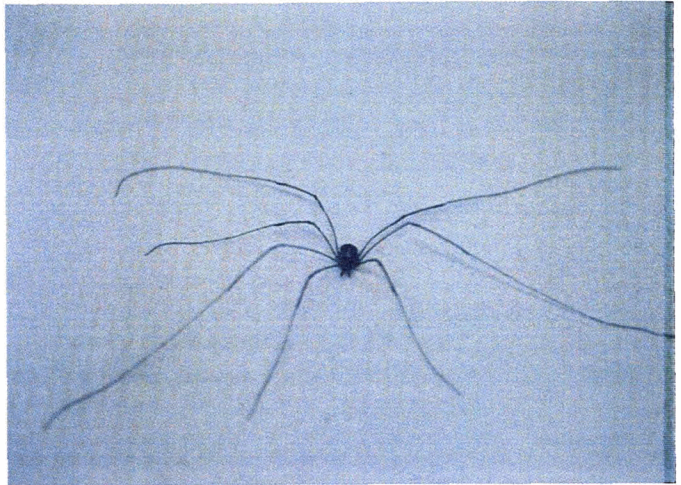


Figure 109 - Harvestman.

ANYSTID (or WHIRLIGIG) MITES

CLASS : ARACHNIDA (*arachne*=spider)

ORDER : ACARI (*acarus*=mite)

Suborder : Prostigmata

Family : Anystidae

IMPORTANCE General predators, important in pest control. Highly mobile and voracious, able to suppress aphid populations. Not likely feasible for biological control against spider mites due to long generation time, prey size discrimination, impairment by spider mite webbing, cannibalism and rearing difficulties.

DISTRIBUTION Canada: 2 spp. (36)

BIOLOGY Female lays up to 3 egg clusters of 23 eggs each (sometimes in chains), attached to moss or bark on trees, or on soil. Egg to adult (11 life stages): 49 days. Half of lifetime spent in inactive stages (egg, prelarva, molting phase). Larvae return to trees. Males perform behavioral dance prior to transferring stalked spermatophores. Generally equal sex ratios, but females predominate in agriculture, 2 or more generations/year.

FOOD SOURCE Spider mites (39/day), aphids, lepidopteran eggs, scales, thrips, leafhoppers, and nearly any other insect or mite they can catch and puncture. Prey selection includes chance encounters and tactile contact. Toxins may be used to subdue prey. Prey type may change body colour. Cannibalistic tendencies.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
		X	X	X	X	X	X	X	X		

MONITORING Methods - Berlese funnel, branch beatings, pantrap, pitfall trap.

Habitats - Common on plants infested with phytophagous mites. Also on ground, tree trunk, foliage, moss, under bark. Higher numbers on non-crop plants in agricultural fields and border rows than on crops themselves, possibly due to pesticide applications and/or residues, or lack of prey.

CONSERVATION

Mowing - Leave some weeds to provide a longer succession of prey.

Pesticide Toxicities -

High : acephate (Orthene™), benomyl (Benlate™), carbaryl, chlorpyrifos (Dursban™), cryolite, deltamethrin (Decis™), demeton, dichlorvos, dicofol (Kelthane™), dieldrin, methomyl (Lannate™), parathion, permethrin (Ambush™), sulfotep, sulphur.

Moderate : diazinon, endosulfan (Thiodan™), malathion, maneb (Manzate™), naled (Dibrom™), oils, soap (Insecticidal Soap™).

Low : *Bacillus thuringiensis* (BT)(Dipel™), captan, chlormequat (Cycocel™), copper, daminozide (B-Nine™), diazinon (drench), dichloran (Botran™), dinocap (Karathane™), fenbutatin oxide (Vendex™), iprodione (Rovral™), kinoprene (Enstar™), nicotine, pirimicarb (Pirimor™).

Safe : lime sulphur.

(29,64,97,107)

RECOMMENDED READINGS : 76, 118

ANYSTID (or WHIRLIGIG) MITES

DESCRIPTION

Adults 0.8-1.2 mm. Medium to large (for mites), soft, oval to elongate with 1-4 pairs of legs. Change in prey type may change colour from usual bright orange to red or reddish-black (Figs. 110 and 111).

Eggs 195x155 μ . Oblong, starts out translucent, turning bright orange.



Figure 110 - Anystid mite.



Figure 111 - Anystid mite.

SPRINGTAILS

ORDER : COLLEMBOLA (refers to collophore, tube-like appendage used for water uptake)

Suborders : Arthropleona and Symphypleona

IMPORTANCE Mainly scavengers. Enhance soil fertility by breaking down organic matter, cycling nutrients. Some predators. No forest tree pests. Very common soil arthropods, often found in high numbers (100,000/m³ soil surface). Not often observed due to small size and concealed habitats.

DISTRIBUTION Worldwide: 620 spp. Canada: 520 spp. (36,87)

BIOLOGY Eggs laid singly or in groups, several times/lifetime. Egg to adult (5 or 6 instars): 2-3 months (temperature- and species-dependent). 3-4 generations/year. Ametabolous development (no metamorphosis: nymphs same as adults but smaller).

FOOD SOURCE Scavengers: algae, lichen, fungi, decomposing plant and animal material. Also bacteria, arthropod feces, pollen. Predators: nematodes, rotifers, protozoa, water bears, other small arthropods.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	X

MONITORING

Methods - Branch beatings, pitfall trap, visual inspection of habitat with hand lens.

Habitats - Soil, plant debris, and decomposition sites such as dung. Also in grass, flowers, other vegetation, under living or dead tree bark, freshwater pool surface.

CONSERVATION

Pesticide Toxicities -

Toxic (levels unavailable) : simazine, Safer's Soap™ (used as drench), fungal spores of *Cephalosporium* (=Verticillium) *lecanii*. (50,97)

RECOMMENDED READINGS : 13, 50, 92

SPRINGTAILS

DESCRIPTION

Adults 1-6 mm long. Minute, wingless, soft-bodied. Slender and segmented (suborder: Arthropleona, Fig. 112), or squat and unsegmented (suborder: Symphypleona, Fig. 113). Grey, yellow, purple, black and mottled varieties common in Vancouver Island seed orchards. Short antennae, simple eyes, elongate chewing mouthparts. When disturbed use spring-like jumping organ, furcula, (referred to by common name) kept folded beneath body at rest. Order name refers to the collophore (tube-like appendage) under abdomen for water uptake, not for holding springtail on its perch, as previously believed.

Eggs Pale, smooth spheres.

Immatures Nymphs resemble small adults.

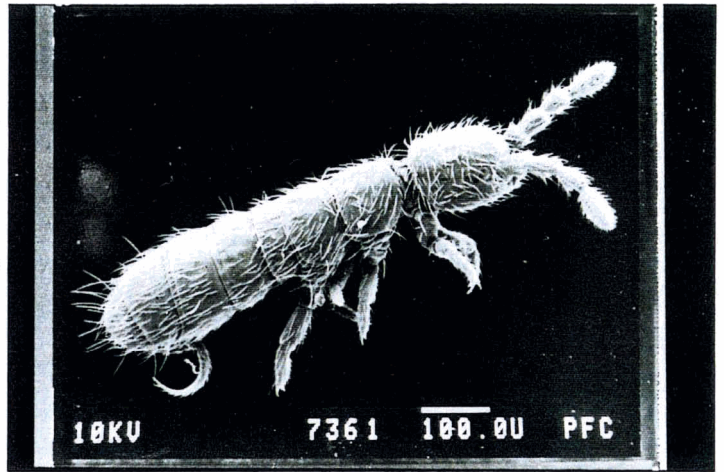


Figure 112 - Arthropleona springtail.

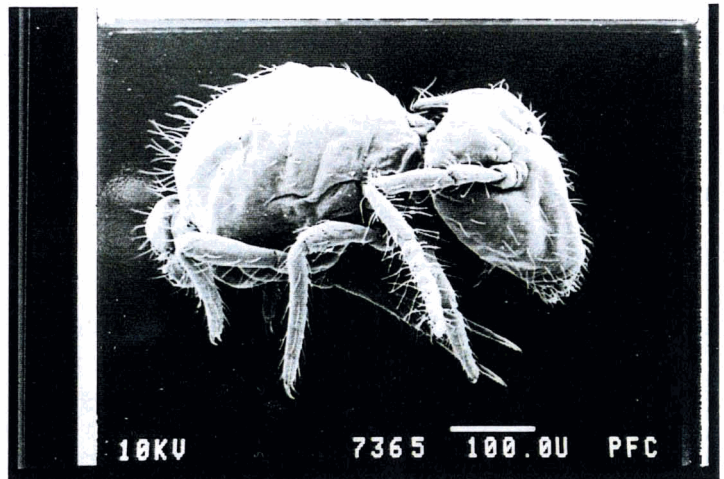


Figure 113 - Symphypleona springtail.

BARK LICE

ORDER : PSOCOPTERA (*psochos*=rubbed small, *pteryx*=wing, refers to mouthparts used to hold head still as jaws scrape food from substrate)

IMPORTANCE Important scavengers. Recycle nutrients from microflora to other food chain members. Some predators. No pests. Abundant on conifers in British Columbia, but rarely observed due to minute size, camouflage colour, and hiding habits.

DISTRIBUTION Worldwide: 3200 spp. North America: 287 spp. Canada: 72 spp.
(36)

BIOLOGY Females lay up to 57 eggs (some give birth to nymphs), singly or in groups, glued in bark cracks or crevices, or on foliage. Life cycle (6 instars) : 8-10 weeks. Gregarious nymphs, may aggregate under light webbing. Paurometabolous development (gradual metamorphosis: terrestrial nymphs resemble wingless adults).

FOOD SOURCE Mainly scavengers or herbivores feeding on dry organic matter such as dry plant material (e.g. bark), lichen, algae, fungi, moss, dead insect parts, and sooty mold growing on aphid honeydew. Some occasionally feed on invertebrate eggs.

SEASONAL OCCURRENCE :

Jan.	Feb.	Mar.	April	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	X

MONITORING

Methods - Berlese funnel (filled with dry branches), branch beatings, habitat inspection with hand lens, sweep net. Handle with aspirator or fine paintbrush.

Habitats - On or under bark of living and dead conifer trees and shrubs, in bird nests, on lichen and algae, on and under rocks, on fences. Some in silken webs on tree branches.

CONSERVATION

Pesticide Use - Use pesticides only as a last resort.

RECOMMENDED READINGS : 11, 88

BARKLICE

DESCRIPTION

Adults 1-10 mm. Small to minute, soft-bodied, resemble aphids or psyllids in shape and size. Long brown antennae, chewing mouthparts, large round mobile head with protruding compound eyes. Some with 2 clear pairs of wings, held roof-like at rest, others without wings (Fig. 114). Order name refers to rod-shaped mouthparts used to hold head against substrate as jaws scrape at lichen, mold or algae. Fast runners, some jump, do not fly readily. Common seed orchard species are beige, brown, black, and yellow, some with dark markings.

Eggs May be covered with silk or debris (Fig. 115).

Immatures Nymphs resemble small adults without wings (Fig. 116).

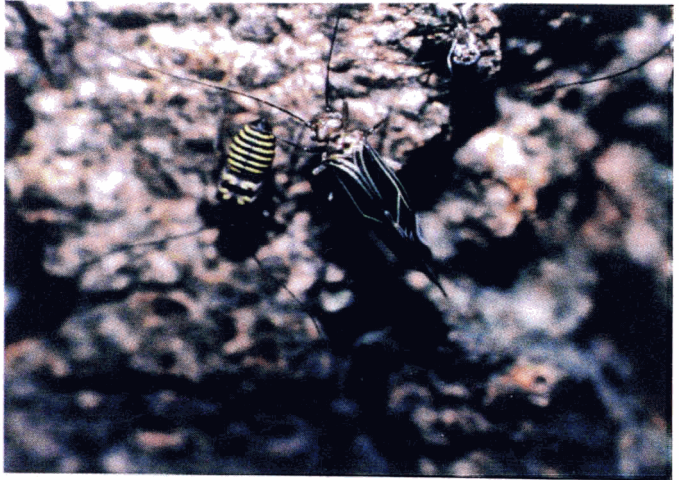


Figure 114 - Barklice.



Figure 115 - Barklouse eggs.

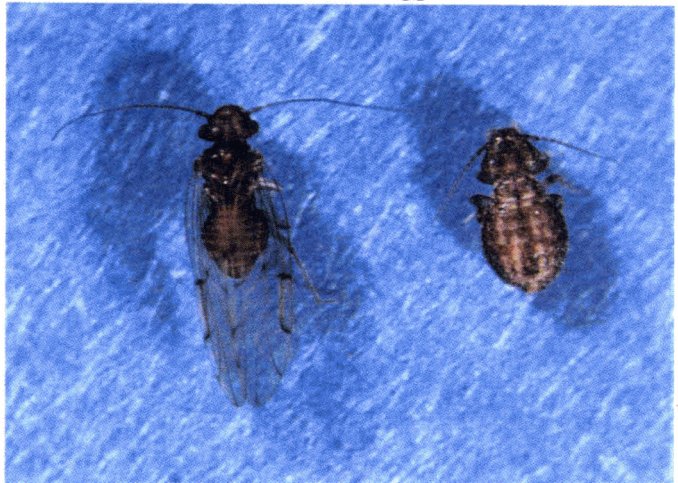


Figure 116 - Barklouse adult and nymph.

CARRION BEETLES

ORDER : COLEOPTERA (*koleos*=sheath, *pteryx*=wing, refers to hardened front wings which cover membranous hind pair)

Family : Silphidae

IMPORTANCE Scavengers. Important in decomposing organic matter and recycling nutrients within food chain. Some prey on caterpillars and maggots. Two species in Canada are phytophagous and may be pests of root crops.

DISTRIBUTION Worldwide (mainly northern hemisphere): 250 spp.
North America: 46 spp. Canada: 27 spp. (36,87,135)

BIOLOGY Eggs laid beneath buried carcasses or in underground galleries to provide larvae with regurgitated food supply. Follow smell of dead animals. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult).

FOOD SOURCE Adults: mainly carrion, also fly larvae in carcasses. Larvae: dead vertebrates, snails, caterpillars, plants.

SEASONAL OCCURRENCE (Adults):

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X				X	X	X	X	X	X	X

MONITORING

Methods - Bait trap, light trap, pitfall trap, visual examination of dead animals.

Habitats - Adults: on carrion and vegetation (living or dead), in fungi and ant nests, near dung and rotting fungi, in damp shaded woodlands.

CONSERVATION

Pesticide Use - Apply pesticides only as a last resort.

RECOMMENDED READINGS : 87, 135

CARRION BEETLES

DESCRIPTION

Adults 10-35 mm. Large, slightly flattened, dull or shiny, black or brown with red, yellow or orange bands or spots, head with bulging eyes, strong curved mandibles, and short, clubbed antennae. Wing covers broad toward the rear, sometimes exposing several abdominal segments, strong, spiny legs (Fig. 117).

Immatures Broad, flattened, heavily-sclerotized larvae.



Figure 117 - Carrion beetles.

BUMBLE BEES

ORDER : HYMENOPTERA (*hymen*=membrane, *pteryx*=wing, refers to membranous wings)

Family : Apidae

Subfamily : Bombinae

IMPORTANCE Important pollinators. Commercially available for pollinating greenhouse crops.

DISTRIBUTION Worldwide except Australia. (92)

BIOLOGY Complex social organization. Caste system includes queen, males and sterile female workers. Annual colonies. Only mated queens overwinter, queen emerges in spring to begin nest, under or on ground (often old mouse or bird nests). Initial brood cells made of wax, workers reared first to build up colony, perform all jobs except laying eggs. New workers collect pollen and nectar, rear next 2 or 3 broods. Males appear late summer, in fall, young females mature, fly away to mate, and colony disperses. Some species have no workers and lay eggs in nests of other bumble bees, leaving young to be reared by host nest workers. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). Sting when defending nest.

FOOD SOURCE Adults: pollen, nectar, stored honey (over winter). Larvae: pollen, honey.

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X	X		

MONITORING Methods - Branch beatings, malaise trap, sweep net.

Habitats - Near flowers in gardens and meadows, also at higher altitudes and latitudes.

CONSERVATION Plant pollen and nectar plants, provide water during dry spells, minimize pesticide use, apply pesticides late in the evening after the bees have returned to their hives.

Attractants - Plant asters, borage, catnip, goldenrod. Allow some flowering weeds such as dandelion, sweet clover and scorpion weeds to remain between rows.

Pesticide Toxicities -

High : acephate, azinphos-methyl, bendiocarb, carbaryl, carbofuran, chlorpyrifos, cypermethrin, deltamethrin, diazinon, dichlorvos, dimethoate, endosulfan, fensulfothion, fenthion, fenvalarate, lindane, malathion, methamidophos, methidathion, methomyl, methyl bromide (Dowfume™), mevinphos, naled, oxydemeton-methyl, permethrin, phosmet, propoxur.

Moderate : carbophenothion, disulfoton.

Low : chlorfenvinphos, dicofol, methoxychlor, oil sprays, pyrethrum, rotenone, tetradifon, trichlorfon.

Safe : *Bacillus thuringiensis*, citrus oils.

(16,42,45,97,119)

RECOMMENDED READINGS : 13, 42, 87

BUMBLE BEES

DESCRIPTION

Adults Queen: 14-23 mm, workers: 9-18 mm, drones: 9-15 mm, large, stout, hairy, yellow and black, may have orange marks, yellow, orange or black body hairs, chewing mouthparts, thick waist, noisy fliers (Figs. 118 and 119).

Immatures Fat, white grub-like larvae.



Figure 118 - Bumble bee.



Figure 119 - Male bumble bee.

HONEY BEES

ORDER : HYMENOPTERA (*hymen*=membrane, *pteryx*=wing, refers to membranous wings)

Family : Apidae

Subfamily : Apinae

Species : *Apis mellifera*

IMPORTANCE Important worldwide. Agricultural crop pollination value 100 times greater than value of honey and wax production.

DISTRIBUTION Worldwide. (87)

BIOLOGY Caste system includes queen, males and sterile female workers. Most highly evolved social insects. Nest in man-made hives (Fig. 122). Some escape and nest in hollow trees. Each colony has 1 egg-laying queen, up to 20,000 workers and up to 2000 drones (males). Young workers are nurses and comb-builders, older ones are guards and foragers, maintaining the colony and producing wax to build combs. Unlike bumble bees, queen honey bees are unable to begin new colonies alone. Only fertilized eggs become females (males otherwise), females become queens if fed royal jelly (a white liquid secreted from the worker's head), otherwise a sterile worker, the old queen either kills her or leaves the nest with some of the workers. New queen mates in mating flights. She only leaves the nest to swarm, males needed to fertilize the queen, eventually killed by the workers afterwards. Colony overwinters clustered in hives. Nest contains multiple layers of double-sided wax combs composed of thousands of hexagonal cells used to rear young and store pollen and honey. Holometabolous development (complete metamorphosis: larvae do not resemble adults, 4 life stages include egg, larva, pupa and adult). Workers use a special dance language to communicate distance, quality and direction of food source. Flower type communicated by odor carried by nectar on the body hairs, colony defence coordinated by pheromones. Sting in defence.

FOOD SOURCE Adults: pollen, nectar, stored honey (over winter). Larvae: pollen, honey, royal jelly (queens only).

SEASONAL OCCURRENCE (Adults) :

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
			X	X	X	X	X	X			

MONITORING Methods - Malaise trap, sweep net.

Habitats - Near flowers in gardens and meadows.

CONSERVATION Plant pollen and nectar plants, provide water during dry spells, minimize pesticide use, apply pesticides in the evening after the bees have returned to their hives.

Attractants -Plant asters, borage, catnip, goldenrod. Allow some flowering weeds such as dandelion, sweet clover and scorpion weeds to remain between rows.

Pesticide Toxicities -High : acephate, azinphos-methyl, *Bacillus thuringiensis* var. *kurstaki*, bendiocarb, carbaryl, carbofuran, chlorpyrifos, cypermethrin, deltamethrin, diazinon, dichlorvos, dimethoate, endosulfan, fensulfothion, fenthion, fenvalarate, lindane, malathion, methamidophos, methidathion, methomyl, methyl bromide (Dowfume™), mevinphos, naled, oxydemeton-methyl, permethrin, phosmet, propoxur, sabadilla.

Moderate : carbophenothion, disulfoton.

Low : chlorfenvinphos, dicofol, methoxychlor, oil sprays, pyrethrum, rotenone, tetradifon, trichlorfon.

Safe or Low : *Bacillus moritai*, *B. sphaericus*, BT var. *dendrolimus*, BT var. *israeliensis*, granulosis virus, nuclear polyhedrosis virus. (16,42,45,97,119)

RECOMMENDED READINGS : 13, 42, 87, 136

HONEY BEES

DESCRIPTION

Adults Queen: 18-20 mm, workers: 10-15 mm, drones: 15-17 mm, smaller than bumble bees, noisy fliers, slender, reddish-brown with paler orange-yellow rings on abdomen, translucent wings on workers and reproductives, females with corbicula (specialized pollen baskets) on hind legs, chewing mouthparts, thick waist, hairy eyes, pale body hairs (Figs. 120 and 121).

Immatures White grub-like larvae inside wax combs in hives.

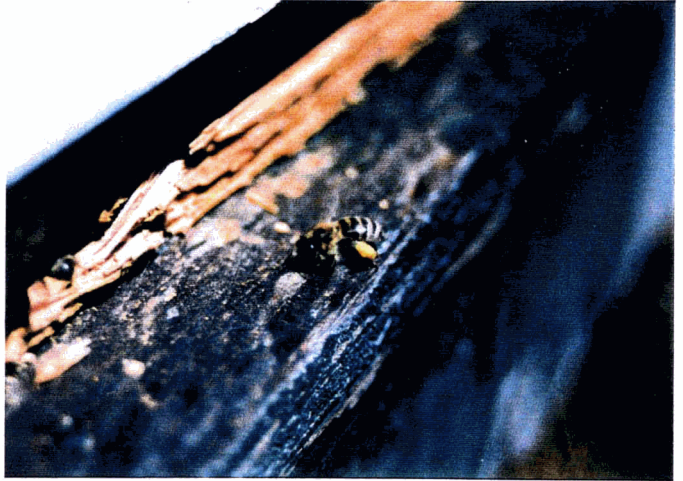


Figure 120 - Honey bee.



Figure 121 - Honey bee.

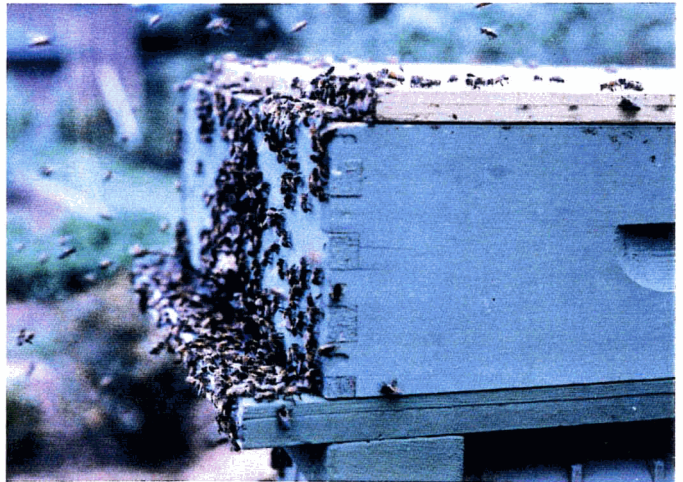


Figure 122 - Honey bee hive.

ORIBATID (or BEETLE) MITES

CLASS : ARACHNIDA (*arachne*=spider)

ORDER : ACARI (*acarus*=mite)

Suborder : Oribatida

IMPORTANCE Important scavengers in forestry and agriculture. Improve soil fertility by decomposing organic matter, creating humus and recycling nutrients. Major component of soil fauna (up to 1 million/m³). Some plant-feeders. Few predators. Some are intermediate hosts of tapeworms in sheep and cattle.

DISTRIBUTION Worldwide. Canada: 71 spp. (36)

BIOLOGY 4 instars have similar habits as adults. Cast skins often remain on back.

FOOD SOURCE Decaying organic matter, fungi (including woody fungi), yeast, algae, bacteria, living mosses or lichens, tapeworm eggs.

SEASONAL OCCURRENCE

Jan.	Feb.	Mar.	Apr.	May	June	July	Aug.	Sept.	Oct.	Nov.	Dec.
X	X	X	X	X	X	X	X	X	X	X	X

MONITORING

Methods - Berlese funnel, branch beatings, pitfall trap.

Habitats - Under bark, decaying leaf litter, stones, soil litter and in decaying wood. Also in saltwater, freshwater, caves, rodent burrows, nests and on trees.

CONSERVATION

Apply pesticides only as a last resort.

Pesticide Toxicities -

Toxic : carbofuran, dormant oil (to eggs only), lime sulfur, soap spray, sulfur, superior (summer) oil. (16,40,42)

RECOMMENDED READINGS : 13, 36

ORIBATID (or BEETLE) MITES

DESCRIPTION

Adults 0.2-1.3 mm. Hard, shiny shell, oval body, vary in form. Some resemble tiny dark brown or black beetles (beetle mites), others tuck their legs under hinged 'wings' to form a ball. Unsegmented, abdomen broadly joined to cephalothorax. Spiracles may be present near mouth (Figs. 123 and 124).

Immatures Larvae and nymphs less sclerotized than adult, slightly resemble acarid mites (Fig. 125).

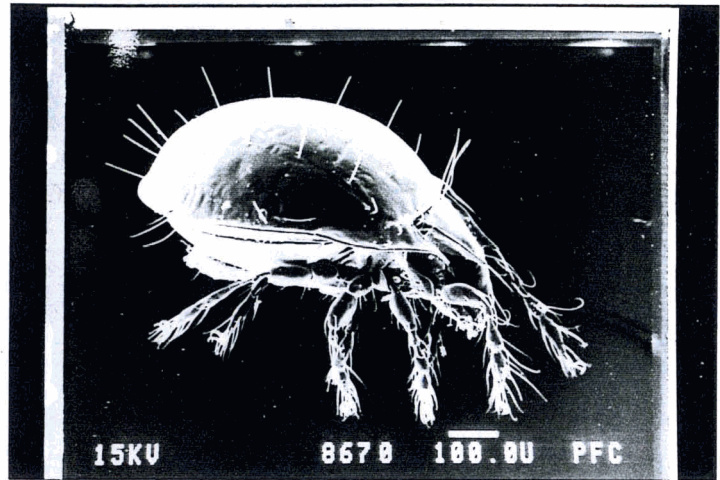


Figure 123 - Oribatid mite.

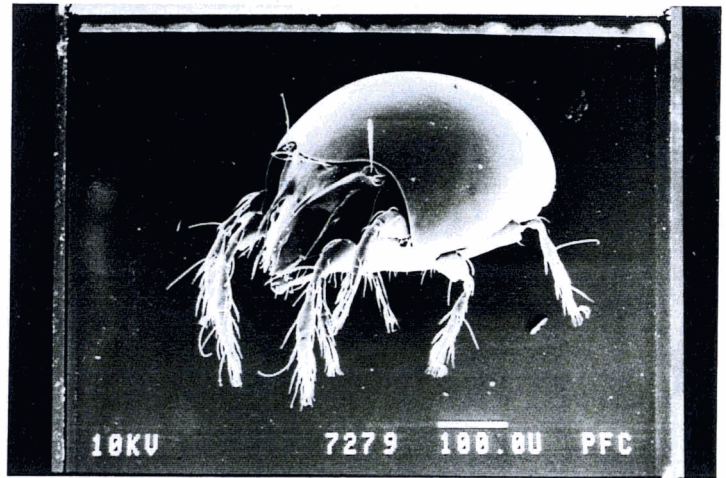


Figure 124 - Oribatid mite.

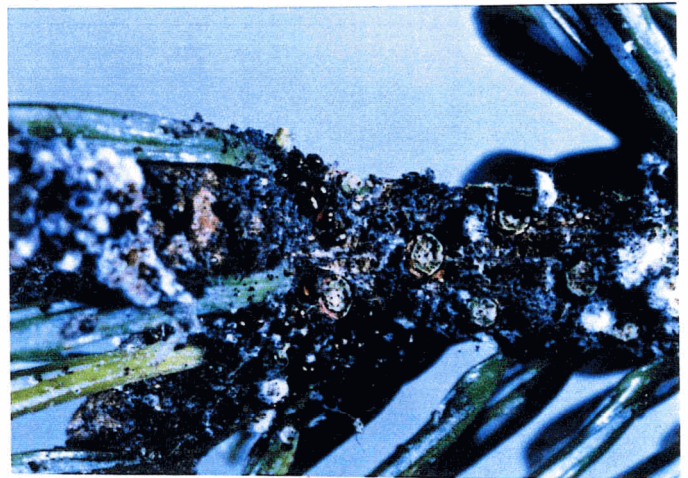


Figure 125 - Immature oribatid mites.

APPENDIX - SAMPLING METHODS

There are several sampling methods available to detect insects and arachnids. To collect the greatest variety of beneficials, as many types of sampling methods as possible should be used (117). The following methods were used to collect seasonal occurrence data included in this guide.

Beating Tray

Beating trays take advantage of the behaviour of many insects which feign death and drop down to the ground when vegetation is jarred. The tray or sheet (Fig. 126) is held under a tree branch which is knocked with a stick. The insects are dislodged, fall off the branch, and are easily seen against the light back-ground. This method is especially effective in cold weather, or in the cool air in early morning or late evening, when insects are inactive and hide in the vegetation. I prefer this method because the equipment is easily portable, it detects most of the beneficials listed in this guide, and it is possible to release the live insects once they have been recorded. (13,117)



Figure 126 - Beating sheet.

Collecting Net

Collecting nets are the most common and widely known of insect collecting equipment. There are 3 types - sweep nets, aerial nets and aquatic nets. Aerial nets are used to chase flying insects or catch those resting on vegetation. (Fig. 127) The nets are effective in collecting beetles, neuropterans, dragonflies, damselflies, barklice, true bugs, flies and wasps. (5,13,82)



Figure 127 - Aerial nets.

Malaise Trap

When many insects fly into a barrier such as the mesh wall of a malaise trap (Fig. 128), they tend to crawl or fly upwards while trying to escape, and end up getting caught in the highest part, in the collecting jar. The malaise trap collects strong-flying insects that are attracted to light, such as large wasps, flies, some beetles and some moths. (82)



Figure 128 - Malaise trap.

Pitfall Trap

The pitfall trap (Fig. 129) relies on the insects encountering the trap, falling down into the container and being unable to escape. It is inexpensive, easy to make, easily portable, commonly used and provides excellent results. Bait may be used. One advantage is that one can live trap for mark and recapture studies. The traps catch insects that do not readily fly, such as scarab beetles, rove beetles, ground beetles, springtails, ants, earwigs, some wasps and flies, and spider mites. (5,13,82,117)



Figure 129 - Pitfall trap.

Pan Trap

A pan trap (Fig. 130) is similar to a pitfall trap, but much shallower. Plastic microwave or organizer trays may be used and either dug into the soil or litter surface, or set on top of the ground, although traps sunken into the soil are most effective. Yellow-painted traps attract more wasps and homopterans, while white traps attract more flies. Pan traps can also be set beneath malaise traps to catch insects that crawl down or fall off the mesh netting. They're effective at catching large numbers of small arthropods which live near the ground and may not be collected by sweeping vegetation, such as some spiders, springtails, ground beetles, small flies, winged aphids, leafhoppers, seedbugs and wasps. (13,82)



Figure 130 - Pan trap.

Light Trap

Many insects are attracted to the light source of a light trap (Fig. 131), and are guided by baffles into the centre where they drop down into the collecting container. Most light traps use UV lights which are inexpensive and easily portable. Along with UV light, black lights and mercury vapour lights attract more insects than incandescent lights. It works best on warm, humid, dark nights. Light traps collect mobile insects which are active at night, such as moths, beetles, some flies, neuropterans, wasps and true bugs. (5,13,82,117)



Figure 131 - Light trap.

Seed Orchard Recommendation

It would not be practical or necessary for seed orchard staff to use several types of sampling methods. A beating tray alone would be sufficient to monitor trends in beneficial populations throughout the year. A number of randomly selected trees may be sampled periodically throughout the year. Keeping records is advisable for detecting trends of prevalent beneficials in your orchards. If you are particularly interested in further monitoring, a lot of the collecting equipment and many of these traps are simple enough to be home made; otherwise, they can be ordered through scientific supply companies.

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CONTACT ADDRESSES FOR UNPUBLISHED REFERENCES

Agnew, Janet. B.C. Ministry of Forests, Silviculture Practices Branch, 31 Bastion Square, Victoria, B.C. V8W 3E7.

Barber, Brian. B.C. Ministry of Forests, Silviculture Practices Branch, 31 Bastion Square, Victoria, B.C. V8W 3E7.

Coast Agri Ltd. Pro-TECT Department, 464 Riverside Road South, R.R. #2, Abbotsford, B.C. V2S 4N2.

Gilkeson, Linda. B.C. Ministry of Environment, Lands and Parks, Pollution, Prevention and Pesticide Management Branch, 777 Broughton Street, Victoria, B.C. V8V 1X4.

Reid, David. B.C. Ministry of Forests, Coastal Seed Orchards, 7380 Puckle Road, Saanichton, B.C. V8M 1W4.

Rudolph, Dan. B.C. Ministry of Forests, Saanich Seed Orchard, 7380 Puckle Road, Saanichton, B.C. V8M 1W4.

Safer Ltd. 465 Milner Avenue, Scarborough, Ontario M1B 2K4.