Common Greenhouse Insects and Mites
Identification and Management
The list of common greenhouse insects and mites in Colorado is a fairly short one:

- Aphids (several species)
- Whiteflies (one species)
- Thrips (two common species)
- Twspotted spider mite
- Fungus gnats
- Tomato/potato psyllid
Aphids

Hemiptera: Aphididae
Primary aphid species found in greenhouses

Green peach aphid

Cotton-melon aphid

Potato aphid
Body plan of a typical, wingless aphid
All aphids go through three feeding stages, each punctuated with a molting event.
“Cast skins”, the discarded remnants of the exoskeleton after molting.
Diagnostic: “Cast Skins” remain after aphids molt
Live birth and asexual reproduction are the norm with aphids.
Aphid populations can increase rapidly.
Adults may be winged or wingless.
Wing pads of late stage aphid nymph
Adults may be winged or wingless.
Piercing-sucking mouthparts of Hemiptera (aphids, whiteflies, mealybugs, leafhoppers, etc.)
Aphids use their mouthparts to access the fluids of the phloem.

Little, if any, cell injury is produced by most aphids.
Important Note: Presence of aphids does not always equate to occurrence of plant injury!
Honeydew production
Uptake of phloem fluids here
Leaf with sparkles of honeydew – *and* cast skins
The leaf above the honeydew – an aphid colony
Leaf with sparkles of honeydew – and cast skins
Some non-aphid honeydew producing insects

Mealybugs

Whiteflies

Leafhoppers (some)

Soft Scales
Sooty Molds

Fungi that grow on honeydew-contaminated surfaces
Sooty mold growing on linden aphid honeydew
Sooty mold growing on aspen bark...and on the sidewalk under the aspen

Cause: Honeydew excreted by aphids living on aspen leaves
Ants are commonly associated with honeydew producing insects.
Ants and Aphids
A Mutualistic Relationship

- Aphids provide food – *honeydew*
- Ants provide protection
Primary aphid species found in greenhouses

- Green peach aphid
- Cotton-melon aphid
- Potato aphid
Cabbage Aphid
A species that produces a fine powder of wax
Rice root aphid
*Rhopalosiphum rufiabdominalis*

Massed aphids in roots of rice

Colonizing roots of hydroponically cultured cannabis

Winged forms caught on leaves

Wingless forms at base of plant
Cannabis Aphid

*Phorodon cannabis*
Plant Injuries Aphids May Produce

- Contamination of produce by insects, honeydew
- Reduced vigor from heavy, sustained feeding
  - Leaf yellowing, premature senescence
- Leafcurl distortions of new growth
- Vectors of some viral diseases
Plant Injuries Aphids May Produce

- Contamination of produce by insects, honeydew
- Reduced vigor from heavy, sustained feeding
- Leafcurl distortions of new growth
- Vectors of some viral diseases
Aphids as Contaminants of Produce

Red lettuce aphid on lettuce

Cabbage aphids on Brussels sprouts
Some aphids can cause the new leaves of some kinds of plants to become curled.
Sustained feeding by high populations of aphids can produce wilting, leaf yellowing, retarded growth
However, outdoors there are normally numerous natural enemies usually curtail aphids before serious damage occurs.

Flower fly larva

Green lacewing larva

Lady beetle larva
BIOLOGICAL CONTROL ORGANISMS FOR INSECTS AND MITES

Whitney Cranshaw, Austin Broberg, and Wendlin Burns
Colorado State University
May 31, 2017 Version

A wide variety of beneficial organisms are offered for sale by several suppliers to assist in management of insects and mites. The following is a listing of most of the US suppliers and it is organized into three sections. First is a brief description of organisms with potential applications followed by reference to sources where they may be purchased. This is followed by a brief summary listing of pest groups and the associated potential biological controls. At the end is a listing of addresses of many suppliers/ producers.

Predators of Insects/Mites

Convergent Lady Beetle/Lady Beetles. When sold as “lady beetles” or “ladybugs” the species involved is the convergent lady beetle, *Hippodamia convergens*, a native lady beetle found throughout North America. Purchased lady beetles are all field collected insects, captured in high elevation areas of California where they periodically migrate to and mass aggregate, allowing easy collection. Ability of the collected lady beetles to reproduce is suspended (they are in "reproductive diapause") so eggs are not produced for several weeks after release. (Pre-feeding lady beetles prior to release can allow some egg maturation to start and a few companies provide such "pre-conditioned" lady beetles). Lady beetles tend to readily disperse from the area of release. Since they store well, lady beetles are available most of the year, although supplies often are limited by midsummer.

Sources: 1, 2, 4, 5, 8, 10, 11, 12, 13, 14, 15, 16, 18, 19, 20, 21, 23, 24, 25, 26, 27, 28, 30, 32, 33, 34
Natural Enemies Sold for Aphid Control

- **Predators**
  - Green lacewing larvae
  - Aphid predator midge
  - Convergent lady beetle?

- **Parasitoids**
  - Various *Aphidius* spp. wasps

- **Pathogens**
  - *Beauveria bassiana*
  - *Isaria fumosorosea*

* These are registered pesticides applied as sprays
Aphid Parasitoid Wasps

Aphid mummies
Insect Pathogenic Fungi

Beauveria bassiana, Isaria fumosoroseus

Trade names include Botanigard, Naturalis, Preferal, PFR-97
Green Lacewings

Neuroptera: Chrysopidae
Aphid predator midge
*Aphidoletes aphidimyza*
Purchasing lady beetles?
Whiteflies

Hemiptera: Aleyrodidae

Photograph courtesy of Jim Kalisch, University of Nebraska
Why are they called whiteflies?

The adults are white. And they fly.
Adult whiteflies, some old “cast skins” in the background, and some droplets of honeydew covered with wax.
Extremely heavy infestation of greenhouse whitefly on squash leaf
Common Whiteflies found in Greenhouses in North America

- **Greenhouse whitefly** (*Trialeurodes vaporariorum*)
- **Sweetpotato whitefly** (*Bemisia tabaci*)
  - B & Q Biotypes exist with differences in pesticide sensitivity

Photograph courtesy of David Shetlar, Ohio State University
Whiteflies have simple metamorphosis – but have considerable differences in appearance and habit in adult and nymphal stages.
Generalized Life History of a Whitefly
Whitefly adult and many dozen eggs laid on underside of a leaf

Whitefly eggs on leaf

Greenhouse whitefly eggs laid in a semicircular pattern
Mixed stages of whitefly nymphs
Instar III

Instar IV

“Pupa”
Instar IV nymphs of whiteflies – “whitefly pupae”
The Instar IV pupa is the stage that can be best used to determine which species of whitefly is present.

Greenhouse whitefly

Sweetpotato whitefly
Adults, last stage nymphs and old skins of nymphs of whiteflies
Whiteflies (like aphids) suck fluids from the phloem.
Whiteflies do excrete some honeydew as a waste product
Sooty mold associated with high numbers of whiteflies
Whitefly Life Cycles

At 70°F, the greenhouse whitefly life cycle takes: 6-10 days for egg hatch, 3-4 days as a nymph I, 4-5 days as nymph II, 4-5 days as nymph III, 6-10 days for the pupa. Adults can live for 30 to 40 days.
Development Times for Greenhouse Whitefly

<table>
<thead>
<tr>
<th>Temp (°F)</th>
<th>Egg Hatch</th>
<th>Nymphs I-II-III</th>
<th>“Pupa” (nymph IV)</th>
<th>Female Preoviposition</th>
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<td>85°</td>
<td>3</td>
<td>7</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>75°</td>
<td>6</td>
<td>8</td>
<td>7</td>
<td>1</td>
</tr>
<tr>
<td>70°</td>
<td>8</td>
<td>11</td>
<td>8</td>
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<tr>
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<td>11</td>
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<td>12</td>
<td>2</td>
</tr>
<tr>
<td>60°</td>
<td>18</td>
<td>25</td>
<td>24</td>
<td>2</td>
</tr>
</tbody>
</table>

Period from egg laying to first eggs being laid: 85F - 18 days; 75F - 22 days; 70F - 28 days; 65F - 42 days; 60F - 69 days

Slide courtesy of David Shetlar, the Ohio State University
Host-free periods can be used to eliminate greenhouse whitefly

- Greenhouse whitefly is a tropical/subtropical species
  - Outdoor survival does not occur where there are cold winters
  - Developing stages require living plants
  - Adults survive about 3 days without plants
CAREFULLY

INSPECT TRANSPLANTS
JUST SAY NO!
Sticky Traps for Whiteflies
Can sticky traps control whiteflies?
Sticky traps for whiteflies can:

- Capture some adult whiteflies
- Be used to monitor changes in populations of whiteflies
Sticky traps for whiteflies can \textit{not}: 

- Capture immature stages of whiteflies
- Capture all adult whiteflies

• Capture immature stages of whiteflies
• Capture all adult whiteflies
Sticky traps can be one component of a whitefly control program.
Whiteflies

Biological Controls

- Parasitic Wasps
  - *Encarsia formosa*
  - *Eretmocerus eremicus*
- *Beauveria bassiana*
Whitefly parasites – Parasitic wasps that selectively attack whiteflies
Encarsia formosa-parasitized whitefly ‘pupae’

Left: Card containing parasitized whiteflies for release
Whitefly parasite – Effective only in warm temperature greenhouses – Above about 72F average
Whiteflies

Biological Controls

- Parasitic Wasps
  - *Encarsia formosa*
  - *Eretmocerus californicus*

- *Beauveria bassiana*
Beauveria bassiana Products (Naturalis, Botanigard)
Thrips

Thysanoptera: Thripidae
Two species of thrips predominate in greenhouses. Both are very common insects on outdoor plants in Colorado.

**Western flower thrips**  
*Frankliniella occidentalis*

**Onion thrips**  
*Thrips tabaci*
Thrips mouthparts – a unique type of piercing-sucking mouthpart
Thrips Mouthparts

• Single *mandible*
  – 2\textsuperscript{nd} mandible vestigial
  – penetrates leaf surface

• Paired *maxillae*
  – punctures cells below surface

• Labium forms a supporting cone

• Functions to “puncture – poke – suck”
Thrips injuries – Silvery scars with small dark fecal spots
Leaf injuries by thrips

Photograph courtesy of USDA Forest Service
Fruit scars caused by thrips feeding
Several species of thrips feed on flower buds and flowers.

Most are in the genus *Frankliniella*
Thrips Life Cycle

Simple type, with a twist (non-feeding stages)
Life stages of a thrips

Instar I and II Nymphs – Feeding Stages

Instar III and IV Nymphs – Nonfeeding Stages in Soil

Egg – inserted into plant tissue

Adult

Figure drawing courtesy of Oregon State University
Eggs are inserted into leaves, petals.
Ovipositor (used to insert eggs into leaf tissues)
Thrips oviposition wounds

Pansy spot on Idared

Thrips "pansy spot" on mature Idared apples (Utah State University).
The first two stages feed on plants
The last two stages do not feed. They typically occur in the soil or at the base of leaves and similar protected sites.
Thrips Transmission of Viruses* to Plants

• Tomato spotted wilt
• Impatiens necrotic spot
• Iris yellow spot

* Viruses transmitted by thrips are in the virus family Tospoviruses
Ring spot symptoms on foliage – tomato spotted wilt virus (TSWV)

Photograph courtesy of Paul Bachi, University of Kentucky Research and Education Center

Photograph courtesy of John Fisher, Ohio Department of Agriculture
Ring spot symptoms on foliage –
Impatiens necrotic spot virus (INSV)
Ring spot symptoms on fruit
Leaves may show necrotic lesions without ringspots.
Necrotic lesions on stems resulting from tomato spotted wilt infection
Wilting and stunting associated with tomato spotted wilt virus

Photograph courtesy of Gerald Holmes CA Polytechnic University, San Luis Obispo
Characteristics of Thrips Transmitted Viruses

• Thrips are the only insect vector
  – Humans do not spread the virus
Characteristics of Thrips Transmitted Viruses

• Thrips are the only insect vector
  – Humans do not spread the virus

• Thrips can only acquire the virus if they feed on an infected plant in their first nymphal stage (Instar I)
  – Adult stages cannot acquire the virus
Thrips can only spread viruses if the first stage nymphs were developing on a plant that was infected with the plant virus.
Characteristics of Tnrips Transmitted Viruses

- Thrips are the only insect vector
  - Humans do not spread the virus
- Thrips can only acquire the virus if they feed on an infected plant in their first nymphal stage (Instar I)
  - Adult stages cannot acquire the virus
- Thrips that have acquired the virus can transmit it for the rest of their life
Management of Thrips-transmitted Viruses in a Greenhouse

- Make intensive effort to identify all sources of the virus and destroy them
- Make intensive effort to identify all sources of the virus and destroy them
- Make intensive effort to identify all sources of the virus and destroy them
Management of Thrips in a Greenhouse

• Exclude thrips
• Trap adults thrips for some suppression and monitoring
• Consider use of biological controls to produce some suppression
• Use insecticides effective against thrips to produce some suppression
Thrips

Biological Controls

• Life stages on foliage
  – Some predatory mites

• Life stages in soil
  – Insect parasitic nematodes (*Steinernema feltiae*)
  – Soil predator mites (*Hypoaspis* spp.)
Some predators used to control leaf feeding stages of thrips

Neoseiulus cucumeris

Amblysieus swirskii

Minute pirate bugs (Orius spp.)
Insect parasitic nematode
*Steinernema feltiae*

Some predators used to control soil dwelling stages of thrips (Instar III-IV)

*Dalotia coriaria* (rove beetle)

Soil predator mite *Stratiolaelaps scimitus* (= *Hypoaspis miles*)
Key diagnostic: Silvery scars with small dark fecal spots
Thrips have:

- Unique wing type
- Unique form and function of mouthparts
- Unique metamorphosis pattern
- Odd name
Thrips is both singular and plural

One thrips, two thrips, ..... million thrips
Twospotted spider mite
*Tetranychus urticae*
Spider mites pierce cells with their whip-like chelicerae. Typically they will destroy 1 to 2 dozen cells at each feeding site – then move on.
Each feeding site produces a small area of dead cells – a type of stippling injury
With high mite populations, the stippling injuries may cover much of the leaf area.
Webbing may be produced by spider mites and becomes visible when they are in high populations.

Photographs courtesy of David Shetlar, Ohio State University
Spider mites travelling along webbing
Life Stages of the Twospotted Spider Mite
Male spider mites are smaller than females and have an abdomen that tapers.
Male spider mite

Female spider mite with eggs

Photographs courtesy of David Shetlar
A high population of honeylocust spider mite (on a honeylocust leaf)
Length of time to complete a Life Cycle – Egg being laid to Adult form present

65 F - about 17 days
75 F - about 10 days
85 F - about 7 days

Adults will typically lay eggs over a 2-4 week period.

2-5 days
2-3 days
5-6 days
2-3 day preoviposition period

Egg  Larva  Protonymph  Deutonymph  Adult
Mites can disperse some distance by being wind blown – *(ballooning)*
Color change in mites going into dormancy (Diapause)

Dormancy is broken following a chill period and increasing day length (photoperiod)
Changes in color can occur during the year.

Green summer form on leaves

Orange-red overwintering form around buds
Twospotted Spider Mite (*Tetranychus urticae*)
Spider Mite Management

- Monitor high risk plants
- Minimize drought stress
- Increase humidity
- Consider introduction of mite predators
- Use effective miticides/avoid pesticides that aggravate mite problems
Monitor to detect incipient outbreaks
Detect symptoms at this point

Before it progresses to this..

...and then this.
Old cast skins and egg shells are good diagnostics.
Drought and low humidity can contribute to spider mite problems
Predators of spider mites include minute pirate bugs (left), predatory mites (below left) and predatory thrips (below)
Some Predatory Mites of Spider Mites that are Commonly Used in Greenhouse Production

- *Mesoseiulus longipes*
- *Neoseiulus californicus*
- *Galendromus occidentalis*

Note: The above species are the predatory mites that are most tolerant of low humidity. However, performance of all is reduced under low humidity.
Potato/Tomato Psyllid

*Bactericera cockerelli*

Hemiptera: Triozidae

…..and psyllid yellows disease
Potatoes and tomatoes are susceptible. Other plants that this insect feeds on (e.g., peppers, tomatillo) do not seem to be seriously injured.
The potato/tomato psyllid annually migrates northward from overwintering areas in the southwestern US and Mexico.

Incidence of potato/tomato psyllid in northern areas varies greatly from year-to-year.
Adult potato psyllids

Note: They jump when disturbed
Eggs are laid leaves. They have a tiny stalk.
Young nymphs tend to be light brown; older nymphs green.
Late stage nymph
Old nymphal skin
Adult
“Psyllid sugar” is a unique and diagnostic excrement it produces.
Psyllid sugar collected on leaves of in hoop house-grown tomatoes
Psyllid Yellows

A plant disease produced from the effects of toxic saliva introduced by the potato/tomato psyllid. (Plant toxemia)
Color change (yellowing, purpling) is a common symptom.
Internode thickening and ‘aerial tubers’ are a common symptom
Yields can be greatly reduced from effects of psyllid yellows
Premature Sprouting
Symptoms to new growth of tomato
Effects on tomato yield

Dull color of fruit. Often associated with reduced flavor.

Reduced fruit size
Key diagnostic: Psyllid sugar
Fungus Gnats

*Diptera: Sciaridae*

These are extremely common insects that occur outdoors in areas of decaying plant matter.

Photograph courtesy of David Cappaert, Michigan State University
Potential Concerns Associated with Fungus Gnats

• Nuisance problems with adults in vicinity of infested plants
• Some root feeding by larvae
  – Wounding may allow colonization of roots by rot rotting fungi
Adult fungus gnats
Fungus gnats on sticky card
Figure 1. Fungus gnat life cycle

Figure credit: Raymond Cloyd, Kansas State University
Adult fungus gnats usually live for only 4-5 days. Females lay eggs in soil cracks along surface.

Photograph courtesy of Raymond Cloyd, Kansas State University
Fungus gnat larvae require 3-4 weeks or more before being full grown. They primarily eat fungi and decaying plant matter.
Fungus gnat larvae on a potato slice
Springtails
Fungus Gnat – Cultural Controls

• Reduce soil moisture (if possible) to limit growth of decay fungi in soil

• Eliminate sources of decaying vegetation
  – Waste plant material piled in greenhouse
  – Incompletely decayed compost
Fungus Gnats

Biological Controls (Larvae)

- Soil predator mite (*Stratiolaelaps scimitus*)
- Rove beetle (*Dalotia coriaria*)
- Entomopathogenic nematodes (*Steinernema feltiae*)
- *Bacillus thuringiensis* var. *israelensis*
Insect parasitic nematode
Steinernema feltiae

Some predators used to control soil dwelling stages of fungus gnats

Dalotia coriaria (rove beetle)

Soil predator mite Stratiolaelaps scimitus (= Hypoaspis miles)
Bacillus thuringiensis

- Derived from a widely distributed soil bacterium
- Active ingredient a toxic protein crystal that destroys cells of the midgut
- Used as a stomach poison
Several strains are present, each with specific activity

- *kurstaki*, *aizawi* strains (leaf feeding Lepidoptera larvae)
- *tenebrionis* strain (leaf beetles)
- *israelensis* strain (mosquito, gnat, black fly larvae)
Bacillus thuringiensis israelensis strain can be used as a soil drench to suppress populations of fungus gnat larvae.
Small Flies Incidentally Associated with Growing Plants

- Fungus gnats (Mycetophilidae, Sciaridae)
- Shore flies (Ephydridae)
- Moth flies (Psychodidae)
- Humpbacked flies (Phoridae)
Shore Fly (left) versus Fungus Gnat (right)
Shore Flies
‘Fly specks’ associated with shore flies
Algae is the food of larval stages of shore flies
Some Differences Between Fungus Gnats and Shore Flies

<table>
<thead>
<tr>
<th></th>
<th>Fungus Gnats</th>
<th>Shore Flies</th>
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<tr>
<td>Food</td>
<td>Fungi</td>
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<tr>
<td>&quot;Fly Specks&quot;</td>
<td>No</td>
<td>Yes</td>
</tr>
<tr>
<td>Bt - Susceptible</td>
<td>Yes</td>
<td>No</td>
</tr>
</tbody>
</table>
Psychodidae – Moth Flies aka Drain flies

Associated with bacterial slime coating surfaces with high amounts of fertilization
Phoridae –
Humpbacked Flies
aka “Drain Flies”

Associated with all manner of moist decaying organic matter
Small Flies Incidentally Associated with Growing Plants

- Fungus gnats (Mycetophilidae, Sciaridae)
- Shore flies (Ephydrididae)
- Moth flies (Psychodidae)
- Humpbacked flies (Phoridae)
This presentation will be posted at the Insect Information web site

- Housed at Department of Bioagricultural Sciences and Pest Management
  - Search “BSPM CSU”

- Within “Outreach”

- “Insect Information”
  - Extension presentations for 2018 posted at bottom of page – this one will be the last
Insect Information

All materials needed in another accessible format can be made available upon request.

Arthropods of Colorado Fact Sheets
This is a listing of about 200 downloadable fact sheets related to insects and other “bugs” found in Colorado. It contains fact sheets that are written for the Colorado Arthropods of interest series and the Extension fact sheets that are related to insects.

Fact Sheets

Some Entomology Hot Links:
- Colorado Hemp Insect Website
- Western Colorado Entomology Website
- IPM Images/Bugwood (Cranshaw)
- IPM Images/Bugwood (Peairs)
- Entomology Resources List
- Honey Bee Swarm Hotlines
Master Gardener Information
This includes the handouts and PowerPoint presentations (as PDF) used in Master Gardener Entomology training. These will get updated annually at the end of the winter/spring training programs.

Handouts

PowerPoint Presentations Used in 2018

Recent Extension Presentations
This is a listing that provides the PowerPoint presentations (as PDF) of most Extension entomology programs conducted during the past 12 months.

PowerPoint Presentations/Webinars