

Entomology for Master Gardeners

Objectives

Learn the basic anatomy of insects and spiders.

Learn how insects and spiders develop.

Learn the characteristics of 8 insect orders, with examples of some common species.

Learn how to use a dichotomous key for identification

Classification & Names

Phylum: Arthropoda

Class Insecta = Insects (Class Arachnida = Spiders)

Order: The technical name of the orders we learn today describes the wings.

e.g.: Coleoptera: “coleo” = sheath; “ptera” = wing; that is, a sheath-wing insect.

Family; Genus and species

Scientific name = the Latin name; the genus and species.

Genus begins with a capital letter; species begins with a small letter.

Genus and species names underlined when handwritten, in *italics* when in print.

(Genus is singular; genera is plural; species is both singular and plural.)

Common name

Glossary (See MG Handbook)

Metamorphosis (Insect development)

4 possible life stages: egg; larva or nymph; pupa; adult.

Hatch = the youngster *hatches* from the egg.

Emerge = the adult *emerges* from the pupa.

Molt = Shed exoskeleton

Illustrations
in MG Handbook
& this handout are
not to scale.

A. Complete metamorphosis

4 distinct life stages: egg → larva → pupa → adult

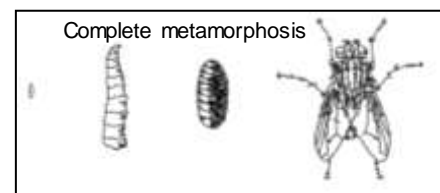
Larva very different form/shape than the adult.

Larva often feeds on different food than the adult;

in some species, adults don't feed.

Examples: Beetles; butterflies and moths; ants, bees, sawflies and wasps; flies.

Note: After an insect becomes an adult, it is full-sized; a small adult fly will always be small.



B. Simple metamorphosis = (a.) Gradual, metamorphosis; (b.) Incomplete metamorphosis

a) Gradual metamorphosis

3 life stages: egg → nymph (3 to 5 stages) → adult

e.g.: Box elder bugs; earwigs; grasshoppers; stink bugs

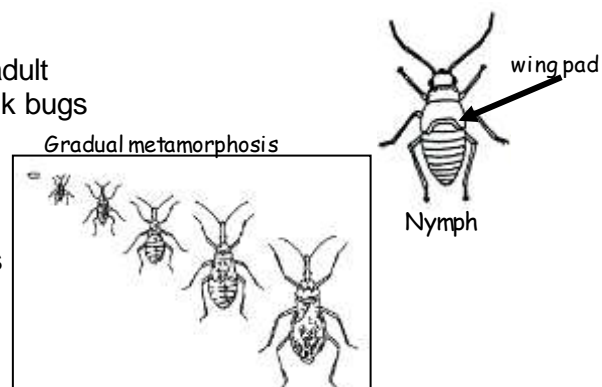
Larva (nymph) resembles adult without wings.

Nymph often feeds on same food as the adult.

b) Incomplete metamorphosis

e.g.: Some aquatic orders – dragonflies; mayflies

Larva (nymph or naiad) in water; adult is aerial



Pheromone (Chemicals used for communication)

- e.g.: Alarm pheromones
- Aggregation pheromones
- Mating pheromones
- Trail pheromones

Anatomy of insects, spiders and more

Directional terms:

1. dorsal (top)
2. ventral (underside)
3. lateral (side)
4. proximal (near, or toward, the midline)
5. distal (away from midline)
6. anterior to (in front of)
7. posterior to (behind)

Exoskeleton

Sclerotized ("hardened")

Insect anatomy

1. Head

Mouthparts: Sucking or chewing

Antenna (antennae): Sensory organ. Spiders lack antennae.

Palps

Eyes: a. Compound
b. Simple (ocellus, ocelli)

2. Thorax

Legs

True legs (jointed legs)

Prolegs (fleshy protrusions from abdomen; in caterpillars and sawfly larvae)

Wings (Veins and/or other markings may be critical for ID)

Forewings: May be hardened (all or in part) or may be membranous

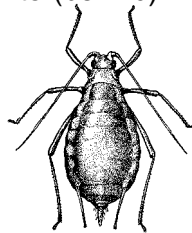
May be fused and non-functional in some Coleoptera (beetles and weevils)

Hindwings: Membranous; may be reduced in size, such as halteres in flies

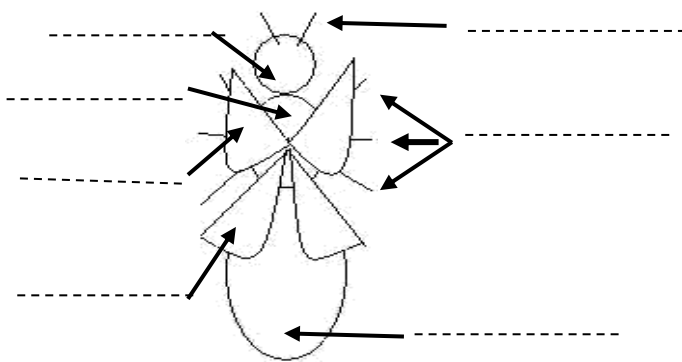
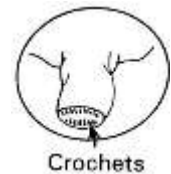
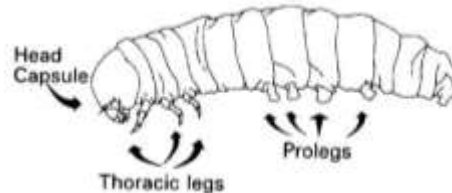
3. Abdomen

Cephalothorax: The head and thorax are combined into one body part, as in spiders

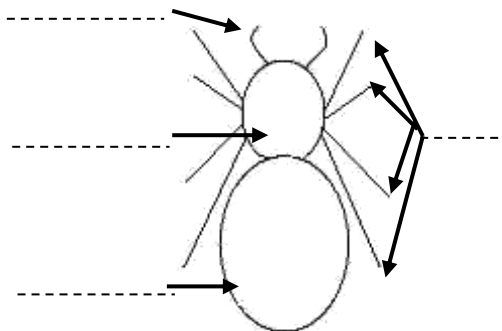
Carapace: A hardened cover on the dorsum (top surface) of a spider's cephalothorax



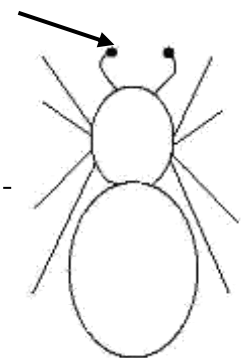
When aphids molt, their shed exoskeletons may remain on the plant. Clients may say "I see lots of small white bugs."



Insect (may have 0, 1, or 2 pair of wings)



Spider (female)



Spider (male)

Mouthparts: Match the plant damage with the mouthparts

An insect's mouthparts determine what sort of damage to expect. Similarly, the damage suggests which insect is responsible.

1. Chewing arthropod pests eat plant tissue:

Plants and/or plant parts disappear; holes appear.

e.g.: Beetles; caterpillars; grasshoppers; weevils.

2. Sucking arthropods “drink” fluids:

a. **Siphoning mouthparts:** Drink floral nectar.

e.g.: Butterflies; moths.

b. **Piercing-sucking mouthparts:**

e.g.: Adelgids; aphids; mealybugs; scale; true bugs; whiteflies; mites.

Pierce tissue, then withdraw liquids or liquefied tissues.

Plant tissue may discolor and/or distort.

If distortion is present, rule out disease.

Honeydew: Sticky, sugary liquid excreted by certain sucking insects.

e.g.: Adelgids; aphids; mealybugs; soft scale; whiteflies

Sooty mold: A ubiquitous air-borne fungus which grows on honeydew

The result: A thin black film which resembles soot

3. Rasping-sucking pests: e.g.: Thrips.

The damaged leaf surface is silvery and marked with small glossy dark spots of fecal material.

e.g.: Damage from gladiolus thrips = Buds and/or florets are streaked, distorted, or appear as if scorched.

4. Chewing-lapping arthropods: e.g.: Bumble bees, honey bees, wasps.

e.g.: Leaf cutter bees cut circles or half circles from leaves, petals; honey bees lap nectar

5. Sponging: e.g.: Flies.



chewing damage
(parts are missing)

Eight common orders of insects

Coleoptera (beetles; weevils): The largest order of insects: plant damagers, scavengers, predators. “Coleo” = sheath. Metamorphosis: complete.

Larva: Various forms: grubs, wireworms & more.

3 pair of legs, usually.

Mouth: chewing.

Adult: 2 pair wings.

Forewings (elytra):

Hardened, and meet in a straight line.

Hindwings: membranous.

Mouth: chewing.

Invasive 2016: Japanese beetle, *Popillia japonica*



Lady beetle



Carpet beetle



Rice weevil



Ground beetle

Dermaptera (earwigs)

“Derm” = skin; leathery. Metamorphosis: simple.

Cerci (“pincers”) at end of abdomen.

Larva (nymph):

Resembles adult; wings absent or small.

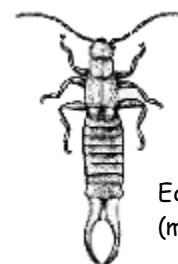
Adult:

2 pair wings:

Forewings: short and somewhat hardened.

Hindwings: membranous.

Mouth: chewing; are predators and scavengers; plant damage = small raggedy holes.



Earwig
(male)

Diptera (flies; gnats; mosquitoes; certain leafminers) Diverse roles: beneficial; health hazard; plant damager; pollinator; scavenger.

“Di” = two.

Metamorphosis: complete.

Larva (maggot): Mouth chewing or with hooks.

“Wormlike” (elongated) and without true legs.

Adult:

1 pair of membranous wings.

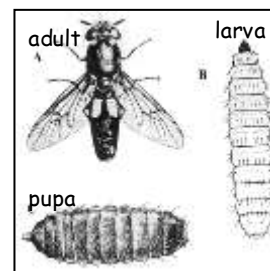
(2nd pair reduced; called halteres.)

Mouth: sponging; piercing.

Invasive insect 2009: Spotted wing drosophila (SWD; *Drosophila suzukii*); 2-3 mm long



Flower fly



Soldier fly

Hemiptera (true bugs) Predators and plant damagers.

(Due to a recent taxonomic re-classification, this order is now Heteroptera.)

“Hemi” = half (Half of wing is hard, half membranous.)

Metamorphosis: simple.

Larva (nymph):

Resembles adult but may be very different color(s).

“Wing pads” and gradually enlarge to full size wings

Adult:

2 pair wings:

Forewings: forward half hard, tip half membranous.

Forewings cross diagonally forming a triangle at the base.

Hindwings: membranous.

Mouth: piercing-sucking

Invasive insect 2008: Azalea lace bug (ALB; *Stephanitis pyrioides*)

Invasive insect 2008: Brown marmorated stink bug (BMSB; *Halyomorpha halys*)

Invasive insect 2014: Elm seed bug, *Arocatus melanocephalus*



Big-eyed bug



Leaf-footed bug

Homoptera (plant feeders, among them adelgids; aphids; mealybugs; leafhoppers; scales; whiteflies; cicadas) “Homo” = same; mirror image

Some excrete honeydew (e.g.: adelgids, aphids, mealybugs, whiteflies, soft scales).

Metamorphosis: “simple”

Larva (nymph): May resemble adult; may have wing pads.

Adult: Diverse body forms; scale (females) are stationary.

2 pair wings, or none.; both pair membranous.

Often held tent-like over the back.

Mouth: piercing-sucking.

Note: Diagnostic character for aphids = cornicles.



Scale (cutaway w/crawlers)



Aphid

cornicles

Recent classification change: The order Hemiptera now includes (1) Heteroptera (true bugs) and (2) Homoptera, which is subdivided into sub-order Sternorrhyncha (aphids, scale, whiteflies) and sub-order Auchenorrhyncha (cicadas, spittle bugs, leafhoppers, planthoppers, treehoppers)

Hymenoptera (ants; bees; horntails; sawflies; wasps)

Diverse roles: Biocontrol agents (parasitoids); pests; pollinators; scavengers; structural pests.

“Hymen” = membrane.

Metamorphosis: complete.

Larva: Some damage plants.

Ants, bees, and wasps without legs.

Sawflies: 3 pair true legs, plus 6-8 pair prolegs.

Prolegs lack crochets (small hooks).

Chewing mouthparts: damage leaves, stems; may feed in groups.

One pair large ocelli. (Ocellus = simple eye; ocelli = plural.)



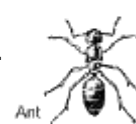
Sawfly larva



Sawfly



Wasp



Ant



Bee

Adult:

2 pair wings, both pair membranous.

Ants: Adult workers lack wings but alates (adult mating forms) have wings.

Carpenter ants: Galleries in damaged wood are smooth & clean

“Waist” (connection between thorax and abdomen) often slender.

Mouth: chewing, or chewing-lapping.

Adult ants, bees, and wasps are beneficial insects, often pollinators

Isoptera (termites) Live in soil (subterranean termites) or wood (dampwood termites).

(Not discussed in MG Handbook; are structural pests)

“Iso” = equal (All 4 wings are the same length.)

Metamorphosis: simple

Larva: Resembles adult; no wings

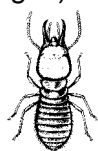
Adult: Soldiers & alates (reproductives)

2 pair wings; membranous;
much longer than the body.

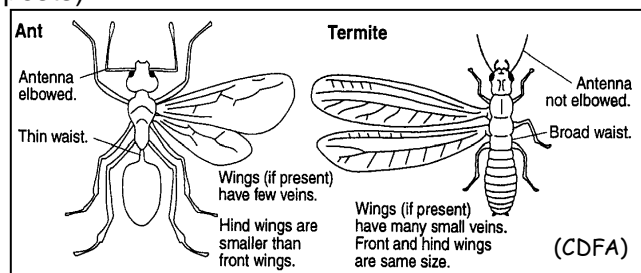
Broad “waist”

Mouth: chewing (Damage dead wood)

Galleries in damaged wood are filled with frass (i.e.: are messy)



Termite soldier



Lepidoptera (butterflies; moths) “Lepido” = scale.

Metamorphosis: complete.

Larva (caterpillar): Damage plant tissue, stored foods, some fabrics.

3 pair true legs, plus 2-5 pair of prolegs.

Prolegs with crochets (small hooks)

(Note: Crochets on caterpillars, but not on sawfly larvae.)

Mouth: chewing.

Each “eye” is a group of 6 ocelli.

Adult (butterfly; moth): Many are pollinators.

2 pair wings: both pair covered with scales.

Mouth: siphoning; some adults don’t feed.



Caterpillar

Pupa



Looper



Adult

A brief look at biological control

Overview:

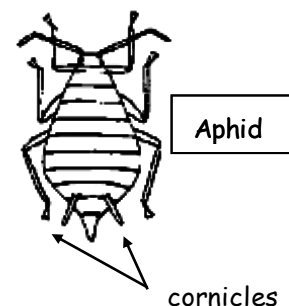
- Conserve and enhance existing populations of existing predators and parasitoids
- Tolerate a few pests because they are food for the beneficial insects and mites
- Eliminate, or reduce, pesticides, including kinds labeled “organic” or “natural”

If required, use products considered to be least-toxic, such as insecticidal soaps; horticultural oils; and Bt (*Bacillus thuringiensis*)

Principles:

1. Prevent problems: The right plant, the right place, the right care.
2. Monitor (observe) your plants regularly.
Identify the insect/mite; is it a friend or foe?
Look for the pests’ naturally-occurring enemies.
3. If needed, use Integrated Pest Management (IPM):
Tolerate a few pests; they’re food for the helpful insects.
4. Assist our beneficial insects: clean plants; small flowers.
5. Limit ants that patrol plants.
6. Set action threshold of damage;

Note: Some pests must remain to serve as food for beneficials.



Aphid

cornicles

Naturally-occurring enemies of arthropods; the 3 Ps: Predators, Parasitoids, and Pathogens: Among purchased predators, lacewings are useful; ladybugs leave; praying mantids are an interesting novelty.

Example: Naturally-occurring enemies of aphids (at right) which are small (about 1/8"), pear-shaped, soft-bodied, w/ cornicles; various colors, some with spots; sucking mouthparts; produces honeydew; some have wings

Cast exoskeletons (white, papery, non-moving fragments) may also be present.

Aphid enemies: (The gardener, too!)

- Ladybugs (both the adults and youngsters).
- Lacewings (fragile, pale green; of the species in NW, only the youngsters).
- *Aphidius* species: Parasitoid wasps that lay an egg in an aphid; the aphid transforms into a tan, bloated, papery "shell" stuck to the leaf.
- Larvae of flower flies, also called hover flies or syrphid flies.
- Fungus diseases.

Resources for Entomology: Books & Websites (2019)

Insects (a Peterson Field Guide): Pictorial identification keys inside front and back covers.

Descriptions contain info re similar insects which helps refine your ID skills.

How to use a Dichotomous Key & Spot ID Characters for the Major Orders of Insects (NCSU)

<https://genent.cals.ncsu.edu/students/lab-schedule/lab-2-identification-part-1-insect-orders/>

Garden Insects of North America (Whitney Cranshaw; 2nd edition)

Organized by plant damage. Brief descriptions with numerous photos.

Spiders and Their Kin (a Golden Guide)

An excellent, inexpensive resource.

Beneficial Insects, Spiders, and Other Creatures (WSU)

<http://cru.cahe.wsu.edu/CEPublications/EM067E/EM067E.pdf>

PNW Insect Management Handbook (<http://pnwhandbooks.org/insect>)

Note: Offer insect management recommendations only after the ID is confirmed.

Caution: Suggest Home Use recommendations, only.

OSU Publications Catalog: OSU Publications w/ research-based information

<https://catalog.extension.oregonstate.edu/>

OSU Monthly Garden Calendars

<https://extension.oregonstate.edu/gardening/techniques/monthly-garden-calendars>

UC IPM Online: <http://www.ipm.ucdavis.edu/PMG/menu.homegarden.html>

University of California Extension publications <http://anrcatalog.ucanr.edu/>

e.g.: *Pests of the Garden and Small Farm* (Publication 3332; a book)

Natural Enemies Handbook (Publication 3386; a book)

Odorous house ants <http://cru.cahe.wsu.edu/CEPublications/eb1550e/eb1550e.pdf>

ID and Habits of Key Ant Pests <http://cru.cahe.wsu.edu/CEPublications/PNW624/PNW624.pdf>

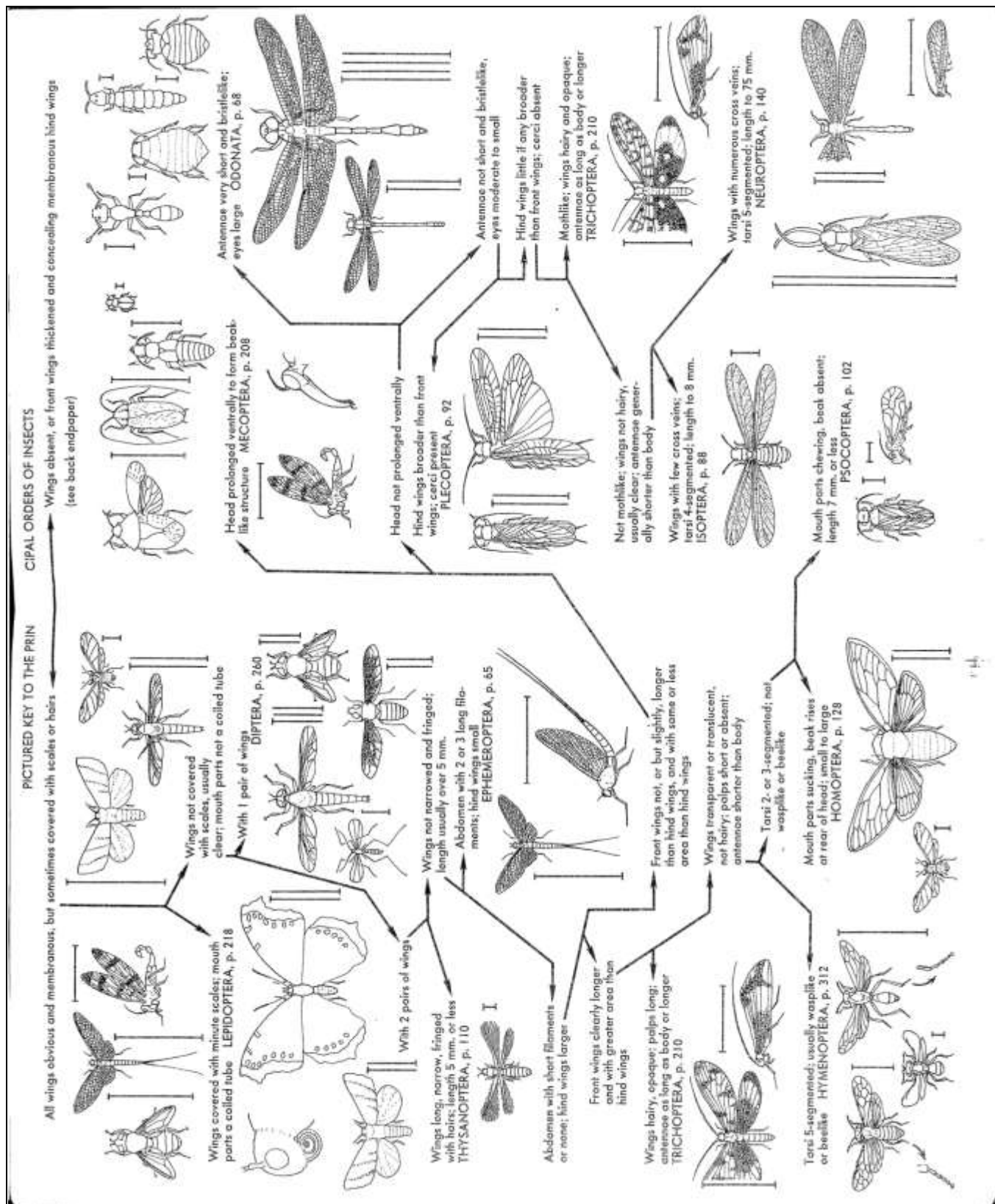
How to Identify the Hobo Spider (PLS 116; WSU) Definitive info for ID of hobo spiders

<https://s3.wp.wsu.edu/uploads/sites/408/2015/02/PLS-116-How-to-Identify-or-Misidentify-the-Hobo-Spider.pdf>

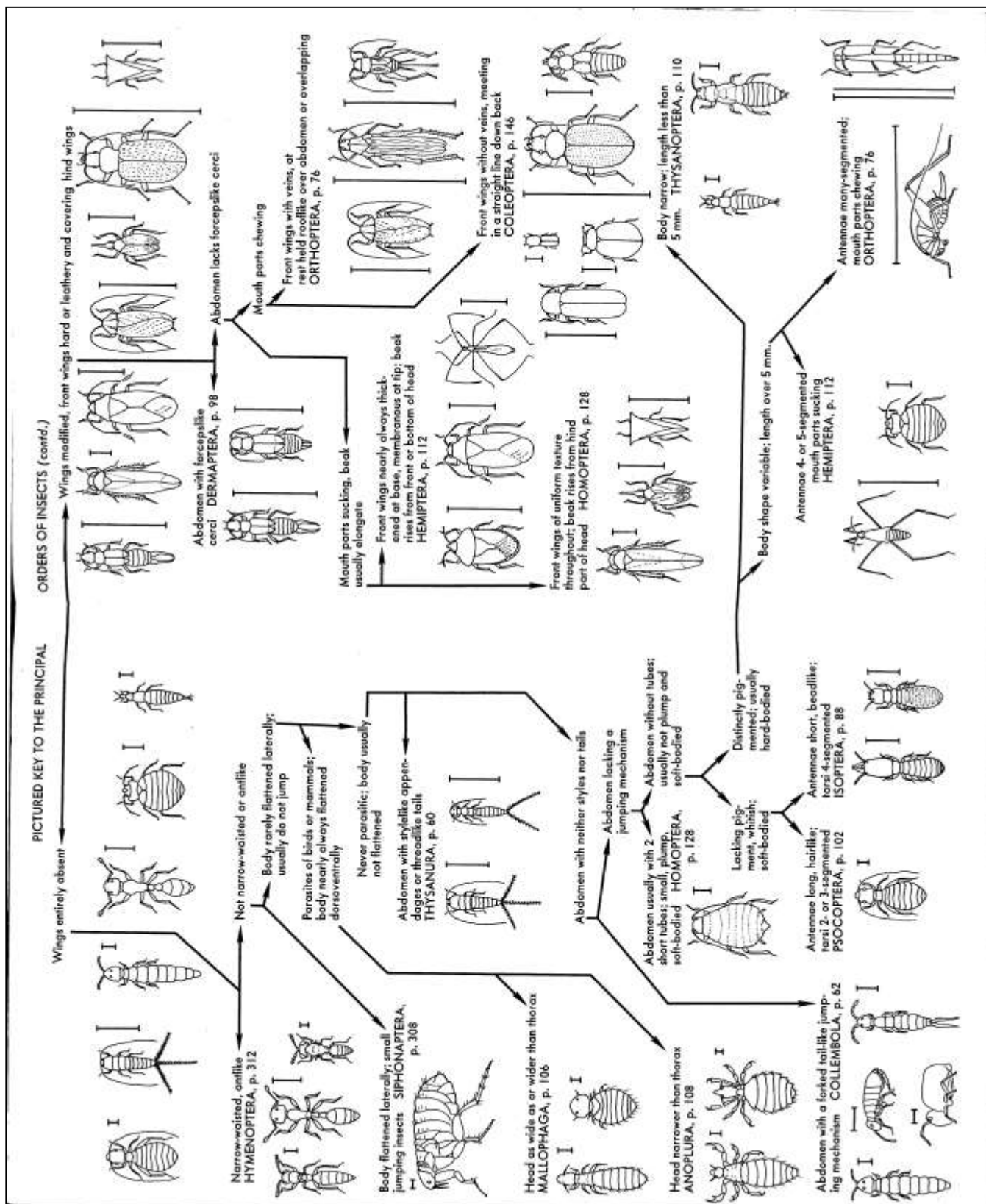
Bed Bugs: *Bed Bugs* <http://ipm.ucanr.edu/PMG/PESTNOTES/pn7454.html>

Recent invasive insects:

1. Spotted Wing *Drosophila* (*Drosophila suzukii*, SWD) <https://spottedwing.org/>
2. Brown Marmorated Stink Bug (*Halyomorpha halys*; BMSB) www.stopbmsb.org
3. Azalea Lace Bug http://oregonstate.edu/dept/nurspest/Azalea_lacebug.pdf
4. Elm Seed Bug, *Arocatus melanocephalus* – includes how to pest-proof your home https://www.landcan.org/pdfs/Spring_2013_ESB_Fact_Sheet_update.pdf
5. Japanese beetles, *Popillia japonica* <https://www.japanesebeetlelpx.info/prevention.html>



Source: *Insects* (a Peterson Field Guide) by Donald J. Borror & Richard White; inside front cover.



Source: *Insects* (a Peterson Field Guide) by Donald J. Borror & Richard White; inside back cover.