

Master Gardeners:
Managing Insects, Mites and Other Arthropods

Purdue University

For More Information

Many of the Purdue Extension publications mentioned during this class are available in your green Master Gardener notebook or online

<http://www.ces.purdue.edu/extmedia/ent.htm>

What you will learn

- What is a pest
- What it means to be an arthropod
- Basic biology of insects and mites
- How insects and mites damage plants with representative pests
- Approaches to insect control

What is a pest

- Any unwanted plant, animal, or microorganism

Is This a Pest?



E-214

Classification of Japanese Beetle

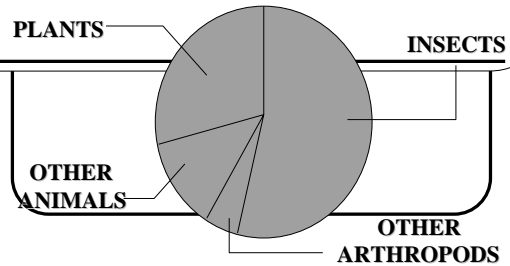
- Kingdom Animalia
- Phylum Arthropoda
- Class Insecta
- Order Coleoptera
- Family Scarabaeidae
- Genus Popillia
- Species japonica



Arthropoda (jointed foot)

- Arachnida
 - Spiders, Ticks, Mites, Scorpions
- Insecta- Insects
- Crustacea
 - Sowbugs, Pillbugs, Crabs, Shrimp
- Diplopoda - Millipedes
- Chilopoda - Centipedes

Species Percentage



Over
1,000,000 species known

Possibly
10,000,000 species
UNIDENTIFIED

Insects & Relatives

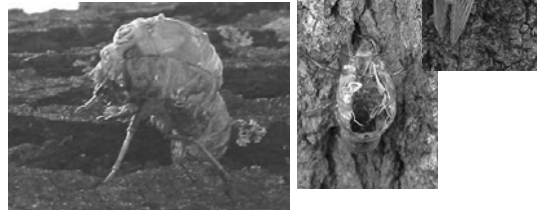
- 100,000 species in N America
- 1,000 in a typical backyard
- Mostly beneficial or harmless
 - Pollination
 - Food for birds and fish
 - Produce honey, wax, shellac, silk
- Less than 3% are pests
 - Destroy food crops, ornamentals
 - Attack humans and pets
 - Transmit disease

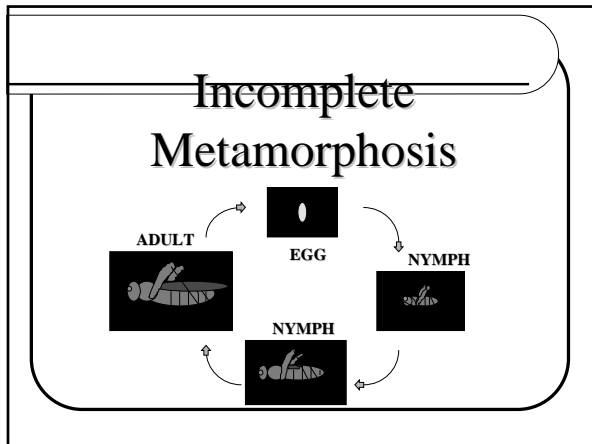
Arthropod Characteristics

1. Have exoskeleton
2. Segmented body
3. Jointed appendages
4. Grow by molting into larger stages called instars
5. Ventral nerve chord
6. Breathe through gills or spiracles

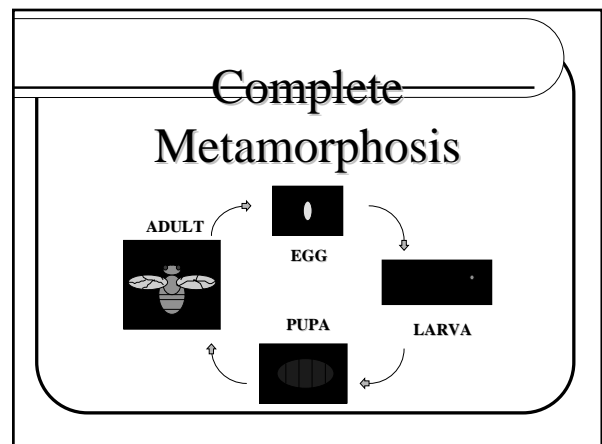
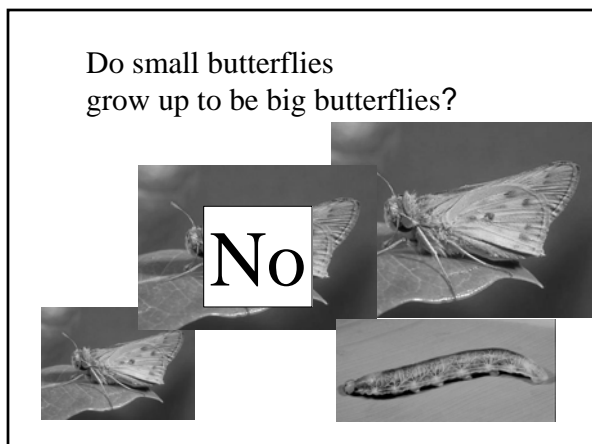
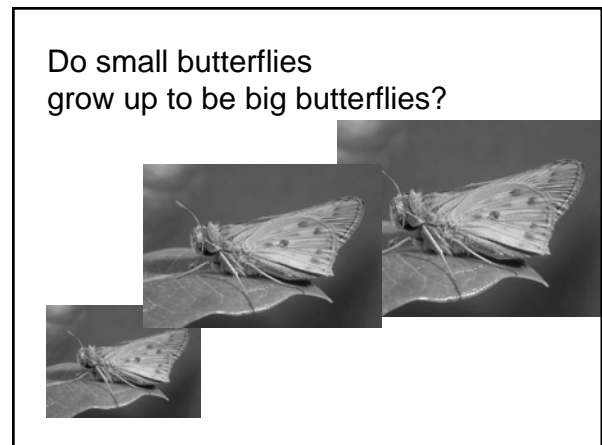
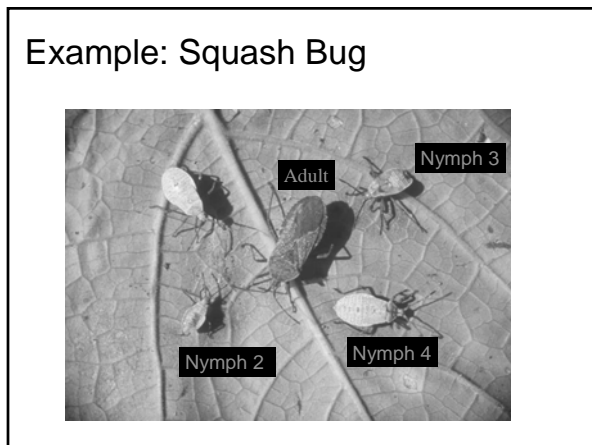
Metamorphosis

Adult breaks through a split in the insect exoskeleton





- ## Incomplete Metamorphosis
- 3 Insect Stages
 - Eggs
 - Larvae
 - Body form resembles adult
 - No wings
 - Adults
 - No increase in size
 - Reproduction
 - Wings fully grown if present



Complete Metamorphosis

- 4 Insect Stages

- Eggs
- Larvae
- Pupae
 - Transformation from larva to adult
 - True legs, wings, antennae are formed
- Adults
 - No increase in size
 - Reproduction
 - Short Life span

Do insects with complete metamorphosis feed on the same food?



egg 1st 2nd 3rd pupa adult
instar larva

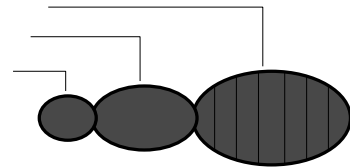
Insect Characteristics

- Three body regions
- 3 pairs of legs
- Adults usually have 2 pairs of wings

Insects

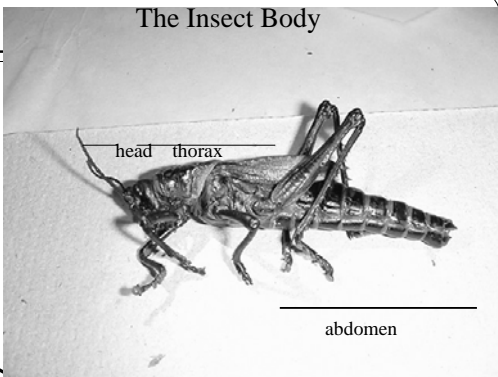
- 3 Distinct body regions

- Abdomen
- Thorax
- Head



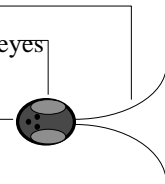
****EXOSKELETON****

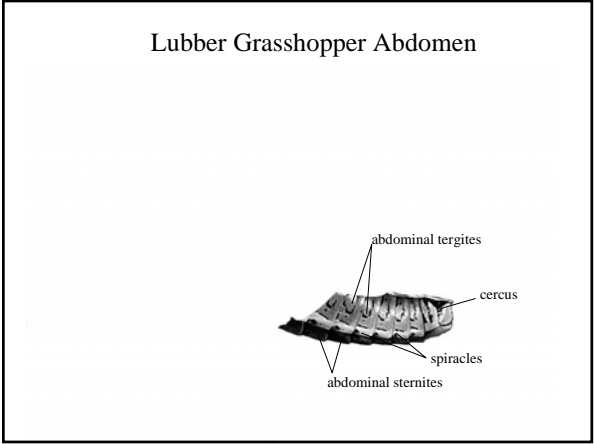
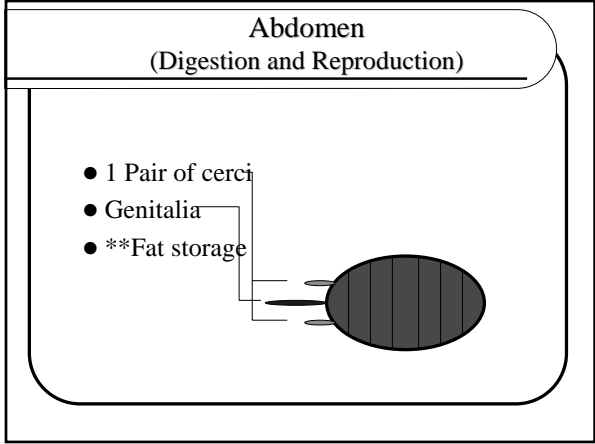
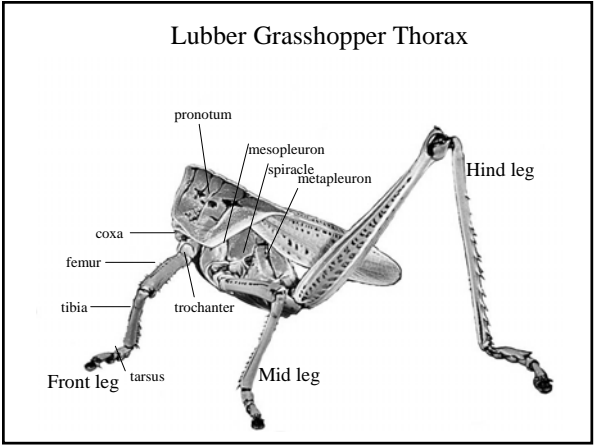
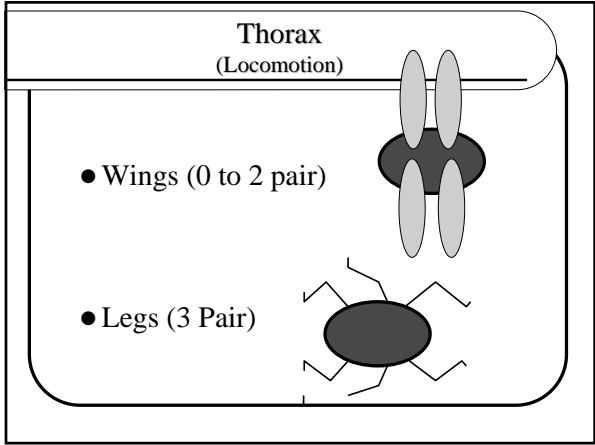
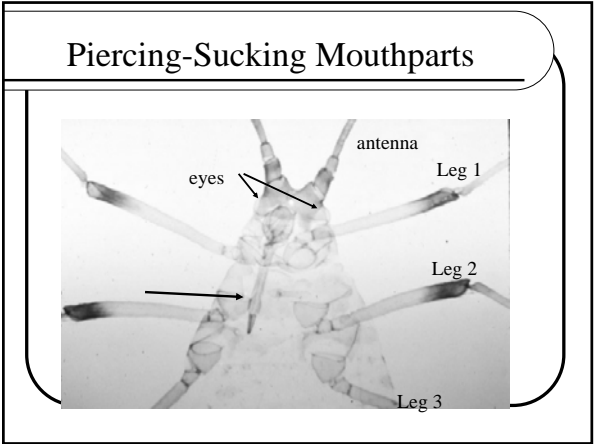
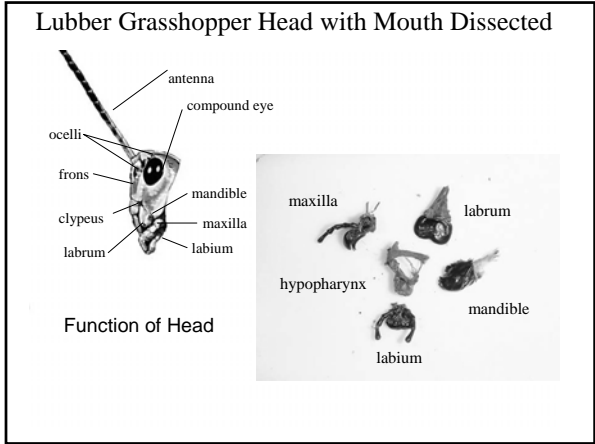
The Insect Body



Head (Perception and Ingestion)

- 1 Pair of antennae
- 1 Pair of compound eyes
- Ocelli
- ****Mouthparts**

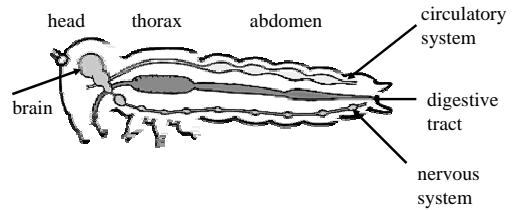




Lubber Grasshopper

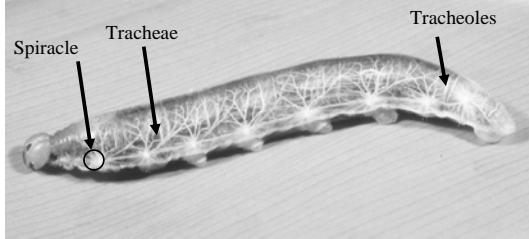


Internal Insect Systems



(after John Meyer NC-State)

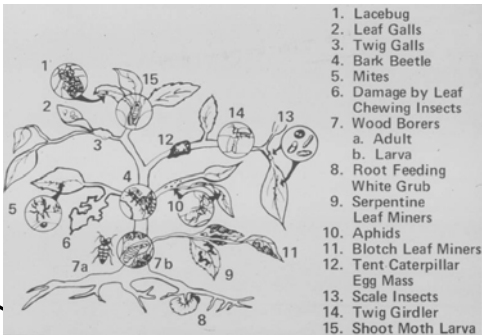
Insect Respiration



Important clues to diagnosing problems

- Symptom- change in plant appearance caused by pest
- Sign- part of the pest itself
- Plant species
- Time of year

Where Insects and Mites Attack Plants



Leaf Chewing Injury

- Chew off external plant parts
- Chew holes in the leaves
 - beetles, wasps and sawflies, moths and butterflies, and grasshoppers and their relatives

Leaf Symptoms- Defoliation= Parts missing

Skeletonization
(all veins remain)

Complete defoliation
(all leaf tissue consumed)



Leaf Symptoms- Notch Shape Matters!

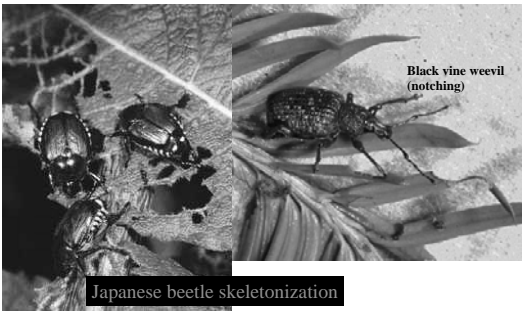
Irregular pattern



Circular pattern



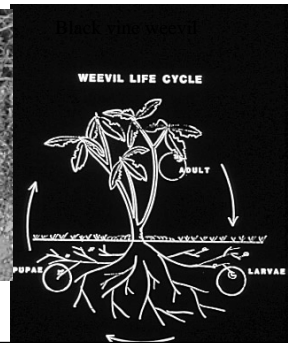
Coleoptera (Beetles)
Chewing Leaves



Coleoptera (Beetles)
Chewing Roots



White grubs



Coleoptera (Beetles)

- Coleoptera (Beetle order) (Leathery wings)
 - Adults have hard outer skeleton
 - Adults have 2 pairs wings
 - Chewing mouthparts
 - Antennae
 - Larvae with head capsule
 - 3 leg pairs on thorax
 - Complete metamorphosis

Hymenoptera
(bees, wasps, sawflies)



Redheaded pine sawfly
adult, larvae, & pupae

Hymenoptera (Bees, Ants, Wasps)

- Adults have 2 pairs of membranous wings
- Larvae have no legs or 3 pairs of legs on thorax and more than 4 leg pairs on abdomen
- Usually chewing mouthparts
- Soft-bodied or slightly hard-bodied adults
- Complete metamorphosis

Lepidoptera: Butterflies and Moths

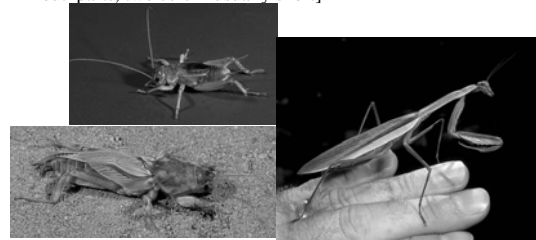


Lepidoptera (Butterflies, Moths, Caterpillars, Cutworms)

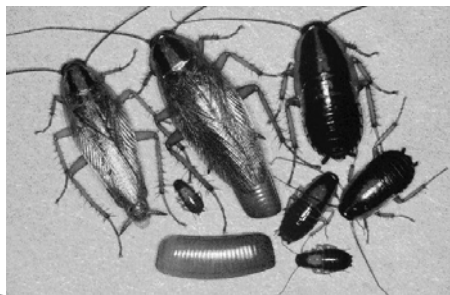
- Soft bodied adults, with 4 wings
- Larvae have chewing mouthparts
- Adults have coiled, sucking tube; feed on nectar
- Larvae are caterpillars; worm-like
- Larvae have legs on abdomen and thorax
- Complete metamorphosis

Orthoptera (Grasshopper, Cricket, Praying Mantid, Cockroach, Termite)

[front wings leathery, hind wings folded like a fan, chewing mouthparts, two cerci - usually short]



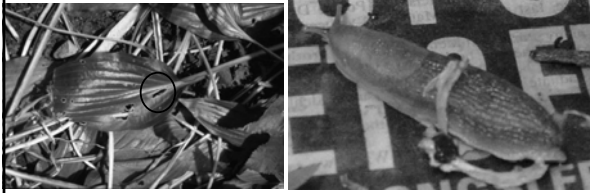
(Cockroaches) (E-23)



Orthopteroid Orders (Grasshopper, Cricket, Praying Mantid, Cockroach, Termite)

- Adults are moderate to large, often hard-bodied
- Simple metamorphosis
- Adults have 2 pairs of wings
- Chewing mouthparts
- Both adults and nymphs are damaging
- Hind legs usually enlarged for jumping
- Immature stages are called nymphs and resemble adults, but are wingless

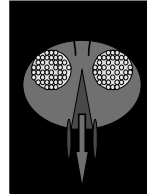
Slugs



- Slugs thrive in moist conditions on perennials like hosta.
- Slugs feed on leaves low to the ground.
- Control by reducing moisture.
 - Water in the morning, pull back mulch.
- Use baits as chemical control.

E-45

Sucking Mouthparts



PIERCING-SUCKING



APHID

Piercing Sucking Injury

- Pierce skin and suck sap
- Spotting of white, brown, red on leaves, fruits, twigs
- Curling or puckering leaves
- Deformed fruit and seeds
- Wilting, browning, dying plant
- Sticky excrement - Honeydew
- Aphids, scale insects, squash bugs, leafhoppers, plant bugs

Homoptera

(buglike insects: aphids, mealybugs, leaf, plant & tree hoppers, scales, cicadas)

[front wings same texture throughout, leathery or membranous (wings often absent); long or bristlelike antennae; sucking mouthparts arise from base of head, between front legs]



Aphid Control

- Natural enemies, such as lady beetles, lacewings, hover flies and parasitic wasps, often provide control
- Sprays of insecticidal soap, summer spray oil and other insecticides are effective
- A forceful spray of water may control small populations
- Ants feed on the honeydew of aphids and may kill aphid predators

Homoptera

(Scale Insects, Mealybugs, Aphids)

- Small, soft bodied (except cicada)
- Winged and unwinged forms
- Sucking mouthparts
- Incomplete metamorphosis
- Many carry plant pathogens

Homoptera (cont'd)

(buglike insects: aphids, mealybugs, leaf, plant & tree hoppers, scales, cicadas)

aphids

mealybugs

white stippling

armored scales

Liquid Excrement of Sucking Insects and Sooty Mold

Piercing-Sucking Injury

(white stippling on leaf surface)

Stippling on upper surface + black fecal spots + black eggs on lower surface = (Lacebugs).

Fecal spots

eggs

Stippling on upper surface + webs and eggs on lower surface = (spider mite).

spider mite

egg

webs

Spruce Spider Mite

Spider Mites (Class Acari)



Two-Spotted Spider Mite: *Tetranychus urticae*



Spruce Spider Mite: *Oligonychus ununguis*



Identification

- Tiny, 8-legged animals barely visible to the naked eye. Sharply striking branches over white paper will knock onto the paper where they can be easily seen

E-42, E-21, E-70

Spider Mite Control

- Avoid broad spectrum insecticides whenever possible to avoid killing natural mite enemies
- Monitor using the tap method with an 8.5x11 sheet of paper (2 dozen mites requires control with pesticides)
- Apply a forceful spray of water for low populations (<2 dozen) of mites
- Insecticidal soap, summer oil and other miticides are effective (2 sprays often needed)

Hemiptera (true bugs)

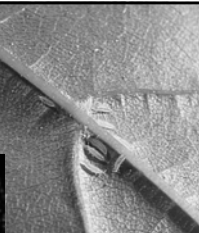
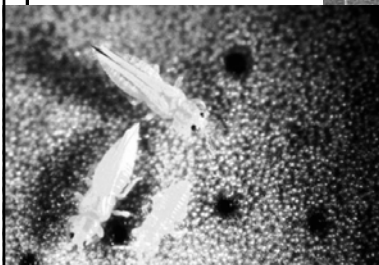
[front wings half leathery & half membranous; hind wings membranous; usually long antennae; sucking mouthparts arise from front of head]



Hemiptera (True Bug Order)

- All bugs are insects, not all insects are bugs
- Incomplete metamorphosis
- Have 2 pairs of wings
 - First pair are half-wings
 - Second pair are membranous
 - Nymphs resemble adults
 - Piercing-sucking mouthparts
 - Adults and nymphs are both damaging

Thysanoptera (thrips)



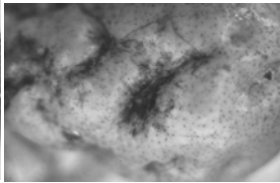
Thysanoptera (Thrips)

- Adults are small, soft-bodied insects
- Mouthparts are rasping-sucking
- Varied metamorphosis (complete; gradual)
- Found on flowers or leaves of plants
- Wings in 2 pairs, slender, feathery

Piercing-sucking injury can distort plant tissue



wooly elm aphid



tarnished plant bug
on apple

Oviposition Injury

- Laying Egg Injury
 - Laying eggs in critical plant tissues
 - Cicada deposits eggs, splitting & killing twigs
 - After hatching, no further damage



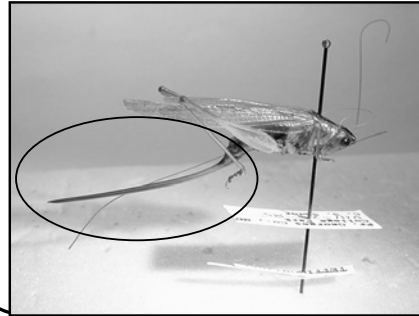
Egg scar



Adult cicada
Lays eggs

E-47W

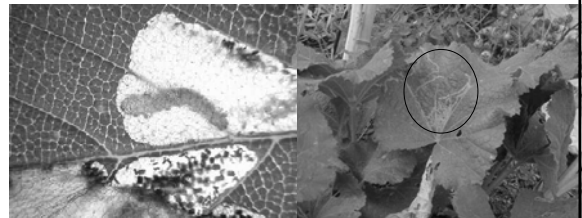
Ovipositor for Egg Insertion



Internal Feeding Leaf miners, Gall Makers, Borers

- Eggs deposited into plant tissue
- Eggs hatch inside plant
- Larger hole is where insect exits plant
- Leaf miners; Gall insects
- Borers in wood or pith; Weevils in Fruits, nuts or seeds
- Control emerging adults or immature stages prior to entering plant

Leaf Symptoms- Leaf mining (moths, flies, beetles, wasps)



Horned Oak Gall



E-56

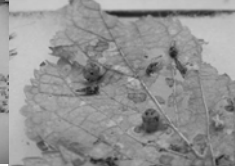


Stem and Leaf Galls

Galls



Gall makers



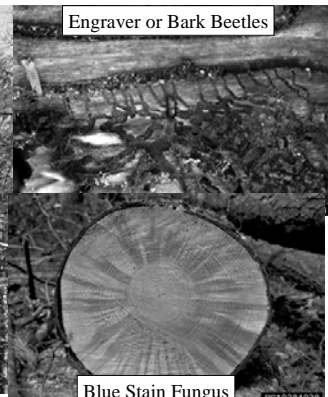
Wood Borers



Sanitation +
Adequate water=
Cultural Control



Death by borers



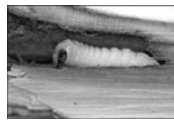
Engraver or Bark Beetles

Blue Stain Fungus

Longhorned Beetle Life cycle



1. Egg Niche



2. Larva



5. Adult



4. Emergence Hole

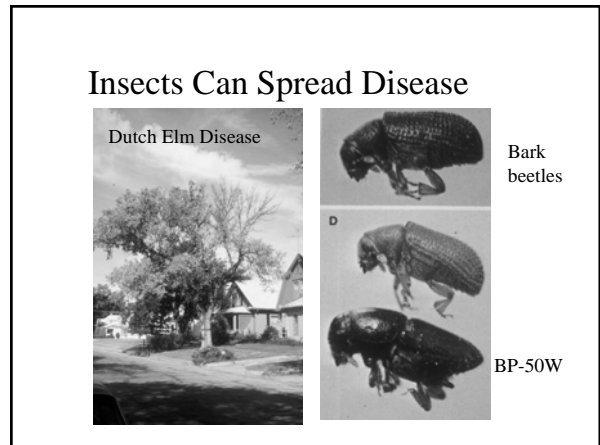
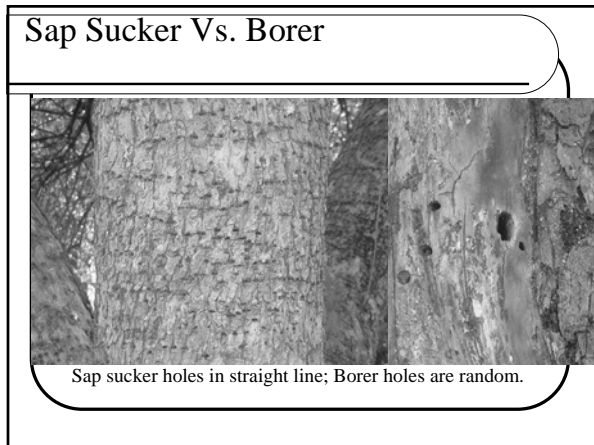
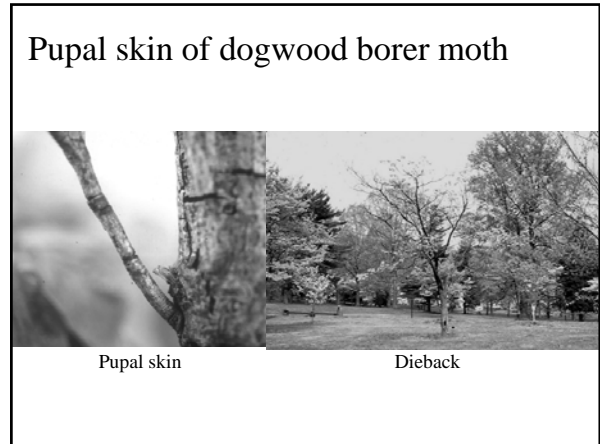
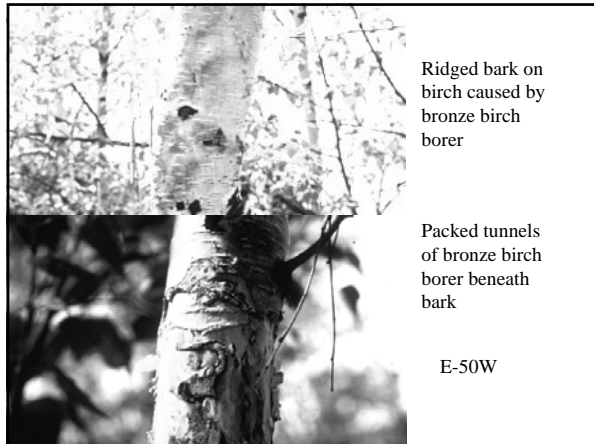


3. Pupa



Metallic wood boring beetle





How Insects Spread Disease

- Insects disseminate over 200 plant diseases
 - Bore into plants creating disease entrance point
 - Carry disease causative agents from plant to plant
 - Carry pathogens on insect body and inject plant as insects feed
 - Insect may serve as essential host for pathogen during a part of life cycle

Break

- Pest and Natural Enemy Cards
 - Pest or Beneficial?
 - Complete or Incomplete Metamorphosis
- Insecticide Table (E-221W)
- Reference Library

Pest Management Process

- Correctly identify the pest
- Determine whether the number of pests will cause enough damage to warrant control
- Consider more than one control tactic
- Apply control methods at the correct time
- Evaluate level of control obtained

Insect Control Tactics

- Cultural – select and grow plants that are genetically resistant to pests; Place plants in correct place.
- Biological – conserve and/or release natural predators, parasites or diseases
- Mechanical – physically remove or exclude pests
- Chemical – select the least toxic pesticide to provide the control desired only after considering other methods

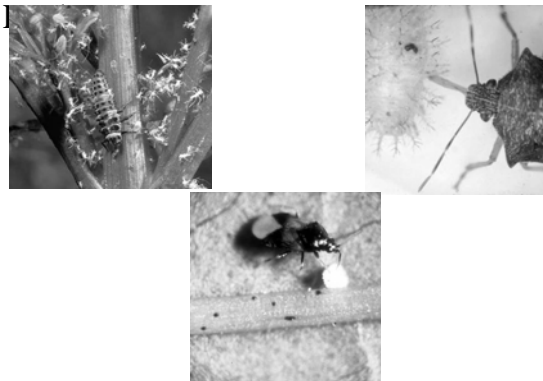
Is there a pest in this photo?



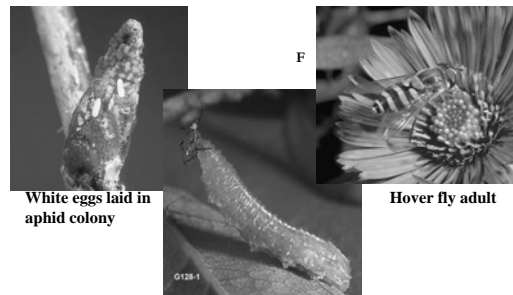
It's not easy being an insect

- Predators
- Parasites
- Diseases

E-92



Hover fly (predator)



White eggs laid in aphid colony

Hover fly adult

Larva eating aphids

Hover (left) Fly - Wasp (right)



E-92

- Number of wings
- Waist
- Shape of antenna
- Eyes



E-44

Neuroptera (dobsonfly, lacewings, antlions)

[two pair wings with numerous veins, elongate larvae with elongate mandibles, larvae & adults usually predatory]

Green lacewing adult



Eggs



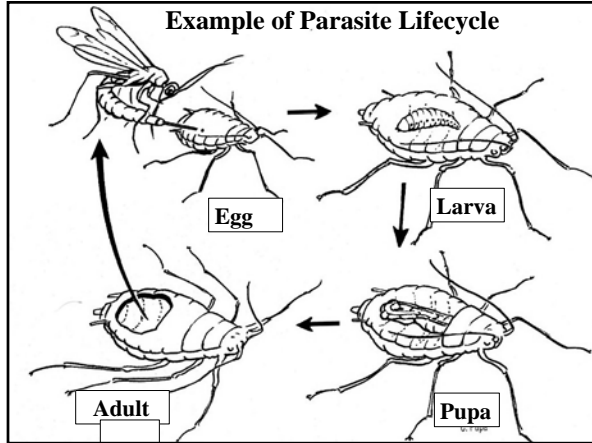
Larva



Cocoon



Example of Parasite Lifecycle



Parasites

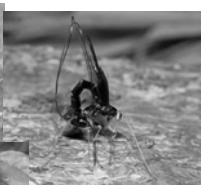


Hymemoptera (bees, wasps, ants)

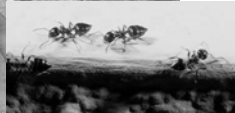
Aphid wasp parasitizing aphid



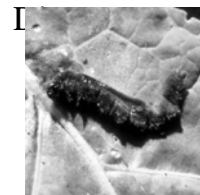
Ichneumonid wasp attacking wood-boring larva



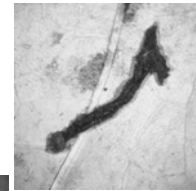
Acrobat ants



Yellowjacket wasp



Bacteria



Virus



Fungi

IPM Definition

- I = Integrated: use multiple control methods (as many as possible)
- P = Pest: determine that the insect or other pest found is the cause of the specific problem
- M = Management: manage the pest population at an acceptable level (not total eradication)

Microbial insecticides

Commercially prepared products that contain active insect-pathogenic microorganisms.

- Usually specific



Botanical insecticides

- Naturally occurring toxic materials derived from plants.



Neem-Repellent and insect growth regulator

Other insecticides

- Oils and soaps smother the insects
- Active only when wet



Other insecticides

Spinosad kills caterpillars, leafminers and thrips.

- Moves through leaf surfaces
- Spares most natural enemies of spider mites and aphids
- Kills bees and wasps



Chemical Control Trends

- Cannot usually control in the egg or pupa stage
- May or may not need to control adults
- After egg hatch is often the best time to control pests

How to use a pesticide effectively

- Identify the pest
- Find out the specific life cycle
- Apply the recommended control at the proper time

Japanese Beetle

- Two damaging forms
 - Grubs – August to mid May
 - Adults – Latter June to late August
- Treat them as two separate problems
- Review life cycle

Japanese Beetles



Popillia japonica

Identification

- Adult is a stout, $\frac{3}{8}$ - $\frac{1}{2}$ " long, metallic green beetle with coppery wing covers
- Larva is a C-shaped, white grub up to 1" long

ID-217W, E-75

How Insecticides & Miticides Work

Japanese Beetle Life Cycle in Indiana

JAN FEB MAR APR MAY JUN JUL AUG SEP OCT NOV DEC



E-61

Preventive Strategy
Curative Strategy
RESCUE

Japanese Beetle Grubs

- Killing grubs will not prevent adults from crossing the property line and eating your foliage!
- Not all grubs are Japanese Beetle grubs!
- Timing is critical to success!
- Two different strategies to controlling grubs

Preventative Grub Treatment

- New class of products (Grubex, Merit, etc.) applied near July 1. Products are systemically absorb by grass. Baby grubs then die when ingesting roots.
- Not generally recommended unless the area is consistently infested by grubs.

Curative/Rescue Treatment

- Best applied in mid-August to early Sept. (curative)
- After mid-Sept., effectiveness to treatment drops off sharply. (rescue)
- Spring time treatments rarely effective, but that is when homeowners notice the large grubs. May be needed if soil is being “stirred”
- Most effective springtime treatment is probably Dylox

Tips for a Successful Curative Treatment

- Water lawn 24 hours before application with 1 to 1.5 inches of water: brings the grub closer to the surface
- Apply a granular insecticide, not a liquid
- Water lightly immediately to activate the insecticide and wash it to the soil surface

White Grub – Cultural Control

- Adults lay few eggs in un-watered turf or under trees. Minimize irrigation in July
- Keep turf vigorous (water & fertilizer) once grubs have hatched in August
- Scout irrigated turf in early August by cutting through the turf and pulling it back

White Grub Control

- 10 or more grubs per square foot cause turf damage and require insecticide treatment. Do not treat small grub populations
- Avoid planting root crops in new gardens where grass was growing in the past 3 years
- Maintain gardens free of grassy weeds

Japanese Beetle Adult Control

- Plant less susceptible ornamentals
- Hand-pick adult beetles and early damage
- Protect small plants with netting or cheesecloth
- Use insecticides against the beetles

E-75,
ID-217W – Crabapples resistant to apple scab and Japanese beetle.

Japanese Beetle Adult Control

- Don't use traps, they attract more than catch
- Treat for aesthetics; the beetles are unlikely to harm the health of established plants
- Adults can fly 0.5-2.0 miles per day so grub control is unlikely to reduce adult beetle damage

JB and Other White Grubs

Masked Chafer - *Cyclocephala* sp.

Japanese Beetle - *Popillia japonica*

True White Grub - *Phyllophaga* sp.

Identification

- Larva is a C-shaped white grub up to 1" long
- Masked chafer adults are 1/2" long, stout, tan beetles
- Japanese beetle adult is a stout, 3/8-1/2" long, metallic green beetle with coppery wing covers
- True white grub adults are usually 1" long, stout, brownish beetles
- E-61, E-75, E-70, E-21



Bagworms

Bagworm

Thyridopteryx ephemeraeformis

Identification

- Each caterpillar lives in a silk tent up to 1 1/2" long that is covered with pieces of brown foliage. (a)
- Adult males are black, 1/2" long heavy-bodied moths with clear wings
- Adult females are caterpillar-like and stay in the bag

E-27

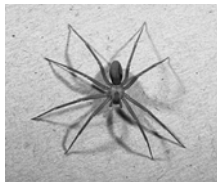


Bagworm Control

- Eliminate eggs in old female bags by removing and destroying bags between September and June
- Handpick and destroy the caterpillar-containing bags if practical
- Apply biological insecticides (Btk, Spinosad) in mid to late June; check again for live bagworms in 2 weeks

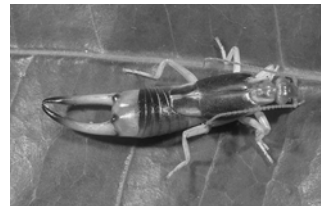
Occasional Invaders

- Spiders (E-72)
- Earwigs
- Millipedes, centipedes, sowbugs (E-55)
- Bugs (boxelder) (E-24)
- Asian lady beetle (E-214W)
- Clover mite (E-59)



Brown recluse spider
(=fiddleback)

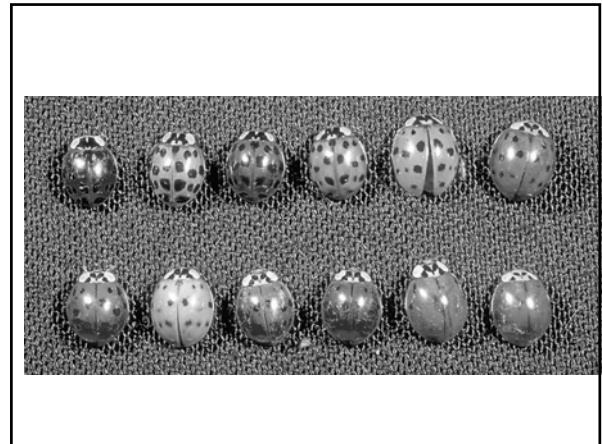
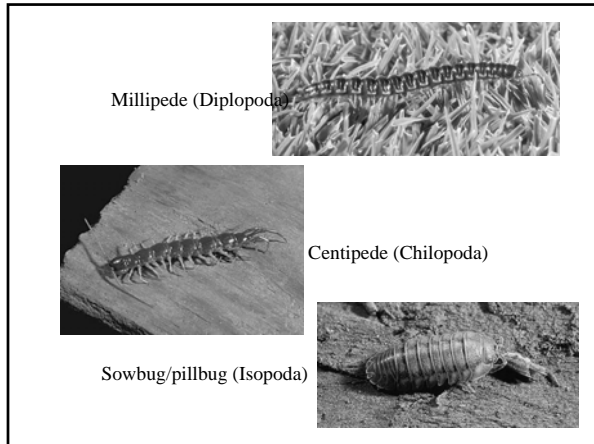
Black Widow spider



Shore earwig

European earwig
with eggs





Occasional Invader Management

- Monitor (identify species involved, find outside sources)
- Modify Landscape (reduce foundation plantings, organic mulches, aphid & scale prone plants)
- Exclusion (caulk & seal doors & windows; fix screens & door sweeps)
- Mechanical Destruction (vacuum)
- Pesticides (As needed. "Scheduled" perimeter & baseboard sprays not recommended!)

Stinging Insects

- Social Wasps & Hornets (E-44)
(yellowjackets, baldfaced hornet, *Polistes*, etc.)
- Solitary Wasps & Bees (E-63)
(carpenter bee, cicada killer, mud daubers, etc.)
- Honey Bees & Bumble Bees (E-44)
- Ants (E-22)

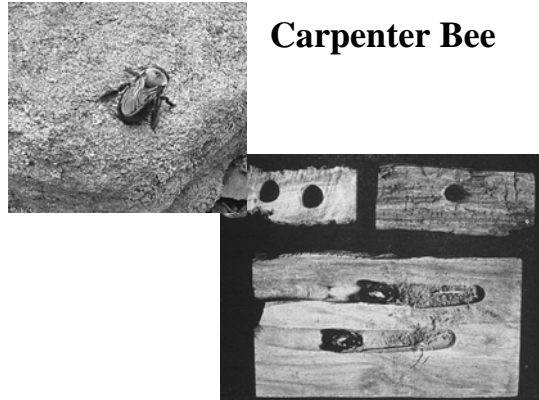
Yellowjacket

Baldfaced Hornet

***Polistes* Wasp = Umbrella Wasp**



Carpenter Bee



Cicada Killer



Wasp (feeds on horse flies!)



**Ground Wasps
(feed on caterpillars!)**



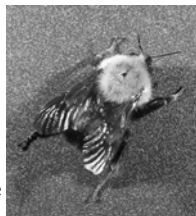
**Mud dauber nest
(feed on spiders!)**



Honey bee swarming



Bumble bee



Stinging Insect Management

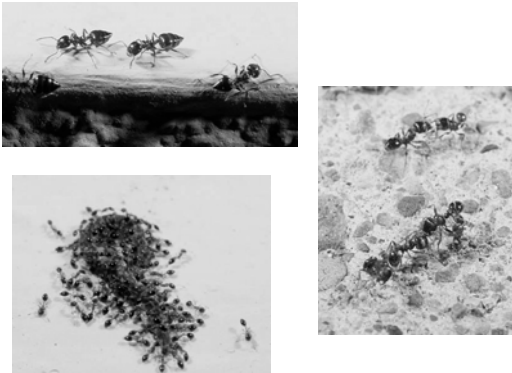
- **Monitor** (identify species involved; find nesting site)
- **Modify Landscape** (reduce ground covers, thick mulch layers, maintain turf)
- **Exclusion** (caulk & seal access to all voids; fix screens; tightly seal garbage & dumpsters)
- **Mechanical Removal** (professionals only!)
- **Pesticides** ("Wasp & Hornet" sprays – prefer professional use!)
- **Education** (notify residents of offensive materials – musk oils & strong perfumes/deodorants, body odor, patterned clothing)

Nuisance Ants

- **Food Preferences** (sugars, oils, or omnivores)
- **Nesting Habits** (soil, tree voids, or building voids)
- **Reproductive Strategy** (single or multiple queens)

Common Indiana Ants House & Building Invaders

- Larger Yellow (Citronella) Ant
- Odorous House Ant
- Acrobat Ants
- Argentine Ant
- Little Black Ant
- Pavement Ant
- Pharaoh Ant
- Thief Ant



Ant Management

- Identify species if possible
- Locate nesting site (outside and/or inside)
- Prune back trees and shrubs touching infested building
- Seal external entry sites
- Exclude with perimeter sprays
- Select appropriate bait
- Treat colonies (injection, dusts, baits)

Common Indiana Ants Carpenter Ant

- Characterized by having polymorphic workers
- Nest by excavating decaying wood or voids (they don't eat the wood, they cast out wood shavings!)
- Major nests in trees (satellite nests in buildings where water is available)
- Most active at night (best time to find colony(ies) is at night!)

Carpenter Ant Management

- Locate nesting site(s) (outside and/or inside - look at night, repair water damaged structures)
- Prune back trees and shrubs touching infested building
- Seal external entry sites
- Exclude with perimeter sprays
- Treat colonies (injection, dusts) (baiting is rarely successful)

Carpenter Ants

- Enter structures from by foraging above ground.
- Live in wood, do not feed on wood.
- Have thin waists
- Black ants up to 1/2" long with one bump on petiole
- Active at night. Follow them to find nests



E-22

Termites

- Enter structures in mud tubes constructed from soil
- Require moisture
- Feed on wood
- Immatures are white and wingless
- Adults have equal sized wings

E-2, 4



Household Related Parasites

- Fleas (E-8)
- Ticks (E-71)
- Lice (head, body, pubic)
- Mosquitoes (E-52-W)

Fleas

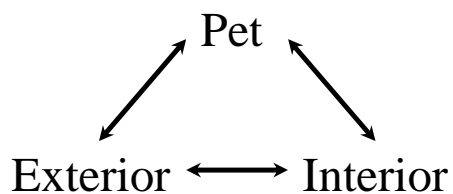


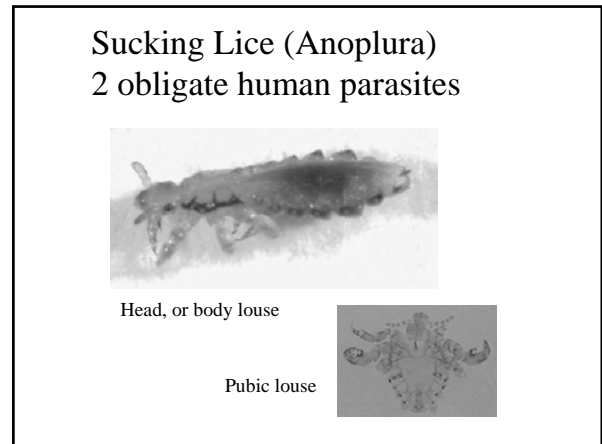
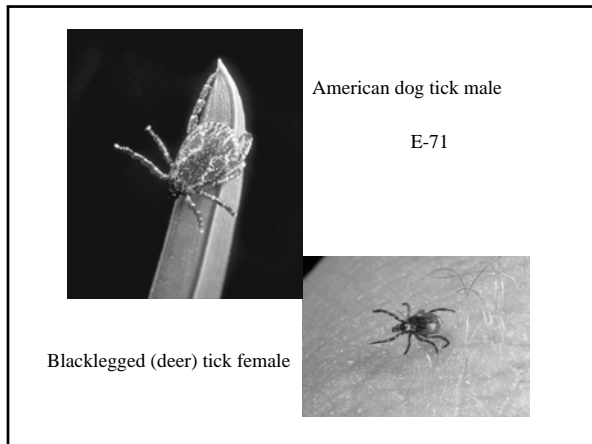
- Cat, dog & rat fleas are most commonly found (cat flea is, by far, the most common on dogs and cats!)
- Adults suck blood for food
- Eggs drop from host
- Flea larvae feed on organic debris & blood excrement from adult fleas
- Pupae may remain dormant

Flea Life Cycle

Eggs - 2-14 days
Larvae - 7-60 days
Pupae - 5-15 days
Adults - 2-12 months
females - 15-20 eggs/day –
600 total

Flea Control Coordination





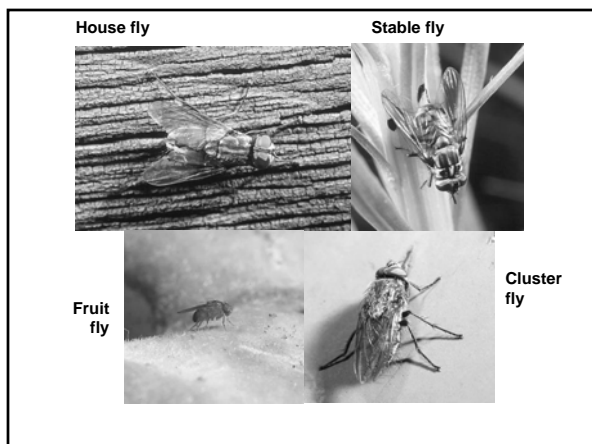
Mosquitoes

- Many species involved – varied life cycles
- Larvae grow in temporary pools of water (from acres of wet fields to tiny tree holes and roadside cans, old tires, plant containers or trash)
- May require area treatments

E-52W

Nuisance & Filth Flies (E-7)

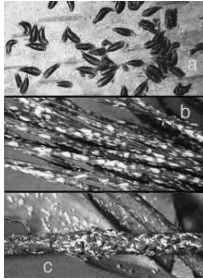
- House Fly
- Blow Flies
- Flesh Flies
- Fruit Flies
- Moth Flies (drain fly)
- Cluster Fly
- Phorid Flies



Nuisance & Filth Fly Pest Management

- **Monitor** (identify species involved)
- **Sanitation** (destroy attractants – food & breeding materials; remove pet feces)
- **Exclusion** (store foods in tightly sealed containers; seal trash & garbage)
- **Exclusion** (seal buildings – window screens, door sweeps)
- **Traps** (sticky traps, light traps)
- **Pesticides** (surface residuals, aerosols – last resort! Use on exterior in severe cases.)

Scale Insects



Oystershell Scale: *Lepidosaphes ulmi*
Pine Needle Scale: *Chionaspis pinifoliae*
Euonymous Scale: *Unaspis euonymi*

Identification

- Oystershell scale is $\frac{1}{8}$ " long, brown or gray, curved. (a)
- Pine needle scale is $\frac{1}{8}$ " long, white, and wider at one end. (b)
- Euonymous scale males are $\frac{1}{8}$ " long, slender, white; females like oystershell. (c)

E-29, E-70

Scale Insect Control

- Dormant oil sprays are effective; apply in late winter or early spring when above 40 degrees
- Crawlers, newly hatched nymphs, can be controlled with insecticidal soap, summer oil and various other insecticides, but timing is critical
- Identify the scale species correctly to determine the proper time to control the crawlers

Jumping Spider



- Abdomen
- Cephalothorax
- Chelicera (fang)
- Pedipalp