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Entomology Basics

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Fun Facts

- **Over 750,000 described species**
- **Estimates run as high as 30-50 million species**
- **Less than 3% of insects are classified as pests**
- **1/2-1/3 all species are insects**
- **The oceans and poles are the only habitats that insects have not been able to exploit**
- **In the typical backyard there are ~1000 insects at any given time**
- **An ant can pull 52 times its own weight - equal to a human pulling 4.5 tons!**
- **Honeybees communicate through dances**
- **Larvae eat 3-4 times their weight / day in food**
- **Aphids can process 100 times their weight in plant sap**
- **Some insects can survive being frozen solid**





Must have:

- **Exoskeleton**
- **Segmented body**
- **Jointed appendages**
- **Three body regions (head, thorax, abdomen)**
- **Six legs (3 pair)**
- **One pair of antennae**
- **None, one, or two pair of wings**

What is an insect?



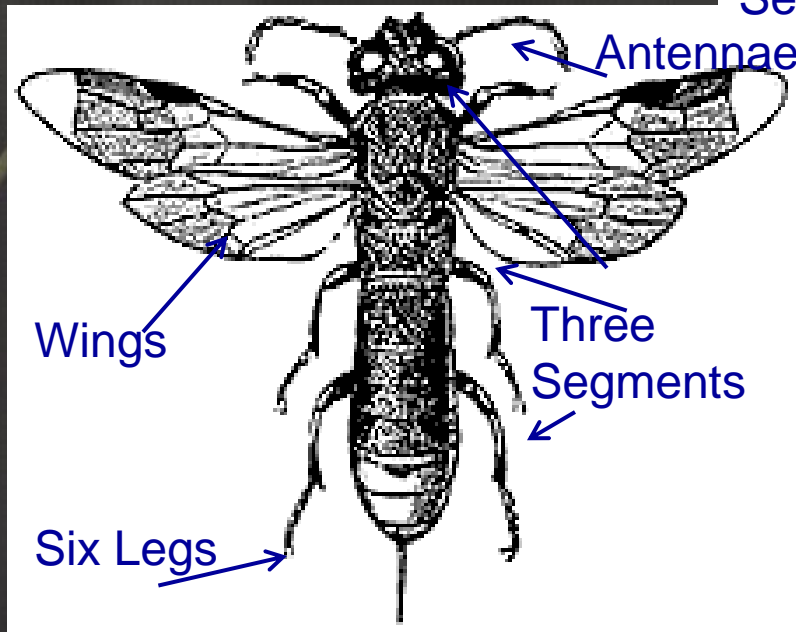
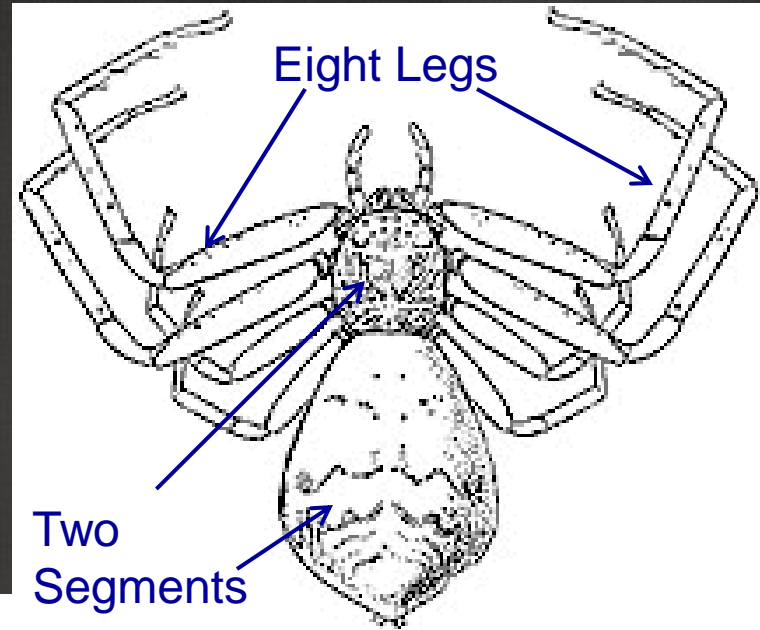
Are spiders insects?

No:

- **Class Arachnida**
- **2 body segments - head and abdomen**
- **8 legs**
- **Includes mites and ticks**
- **No wings**

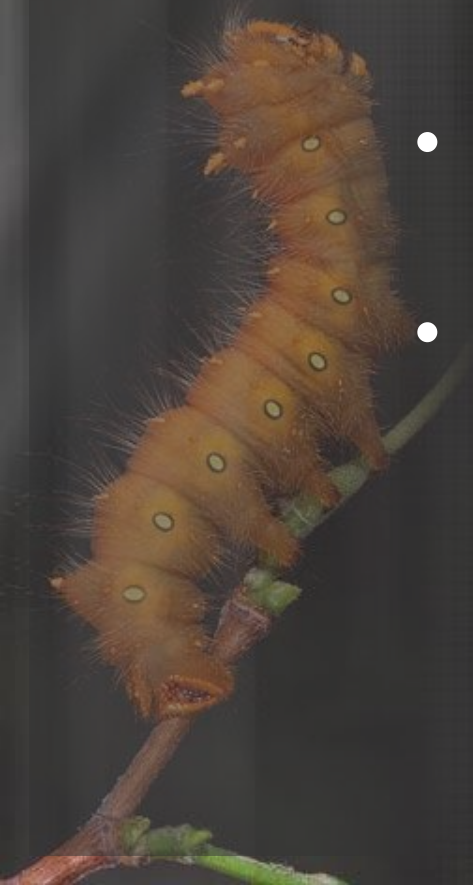


Insect vs. Spider



Growth and Development

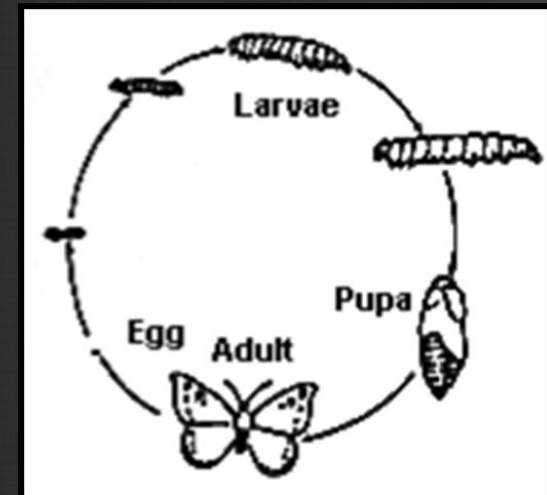
- **Molting – insects must shed their skin and produce a larger one in order to grow**
- **Period between molts is referred to as an instar**
- **Most insect life cycles have between 4 & 8 instars before the adult stage**
- **Insects can drastically change in shape and form during growth and development - called metamorphosis**



Complete Metamorphosis





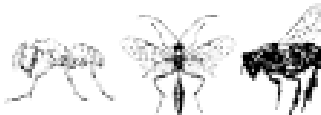
Metamorphosis – Change in shape and form

- **Complete**
 - **Four, distinct life stages**
 - **Egg, Larvae, Pupa, Adult**
 - **Examples: butterflies, moths, bees, wasps, flies, beetles**



Complete Metamorphosis

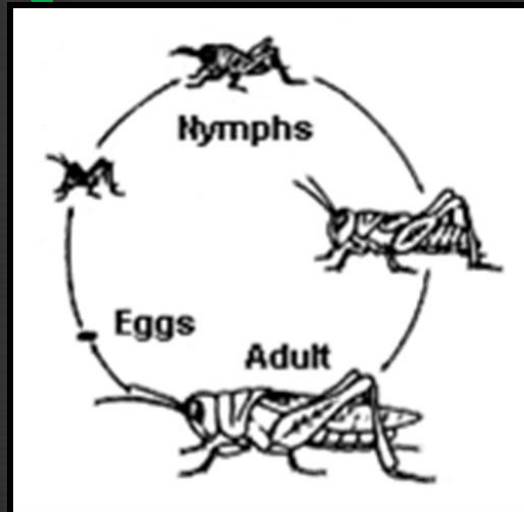
ORDERS WITH COMPLETE METAMORPHOSIS

Order/Common Name		Mouthparts	Wings
Coleoptera Beetles		adult: chewing larva (grub): chewing	2 pair 1 st hardened wingcover (=elytra)
Diptera Flies		adult: sucking, sponging, etc. larva (maggot): chewing	1 pair
Lepidoptera Butterflies Moths		adult: siphoning larva (caterpillar): chewing	2 pair scales on wings
Neuroptera Lacewings Antlions		adult: chewing larva: chewing	2 pair net-like veins
Hymenoptera Bees, ants wasps		adult: chewing larva (grub): chewing	2 pair both membranous








Incomplete Metamorphosis

- **Incomplete**
 - **No distinct stages**
 - **Egg, Nymph, Adult**
 - **Nymph often appears as small version of adult**
 - **Adult often characterized by wings**
 - **Examples: grasshoppers, stink bugs, spiders**



Incomplete Metamorphosis

ORDERS WITH GRADUAL METAMORPHOSIS

Order/Common Name	Mouthparts	Wings
Orthoptera Grasshoppers Crickets		chewing 2 pair 1 st leathery
Hemiptera True bugs		piercing-sucking 2 pair 1 st halfwing
Homoptera Aphids, scales mealybugs		piercing-sucking both membranous 2 pair (some without)
Thysanoptera Thrips		rasping-sucking 2 pair fringed/feathery
Dermaptera Earwigs		chewing 2 pair 1 st short wing cover



Molting

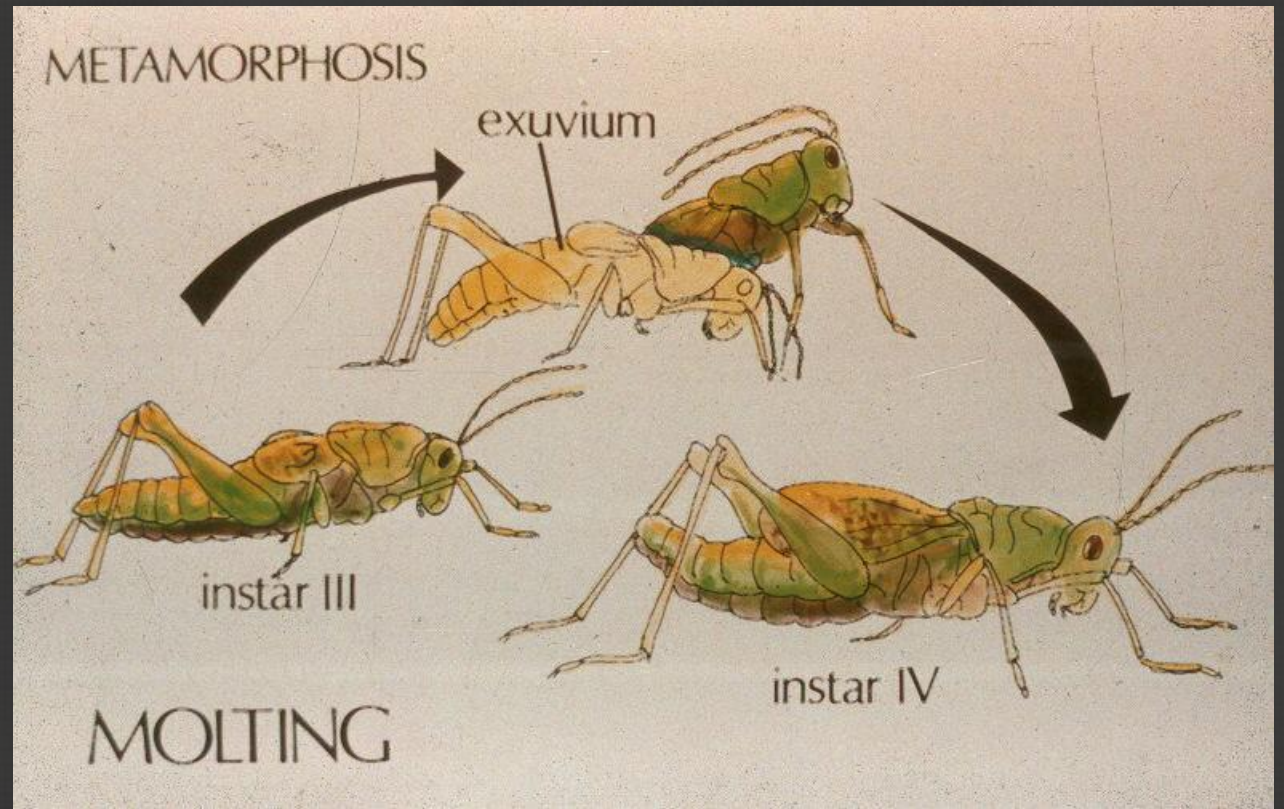
Insects are covered with a hard outer skeleton called the exoskeleton. The exoskeleton has many functions including:

- **Protective coating for the insect**
- **Serves as a place for muscle attachment**
- **Water barrier**
- **Sensory interface with the environment**

Periodically throughout an insects life, the exoskeleton becomes too small and actually splits. This process is called molting.



Molting



Molting



**Split
Exoskeleton
(exuvium)**

Life Cycle and Development

The life cycle of an insect can vary from species to species. Life cycles and development can be influenced by temperature, food availability, etc. Higher temperatures promote more active growth and development, whereas lower temperatures slow or hinder development. The majority of insects have either univoltine or multivoltine life cycles.



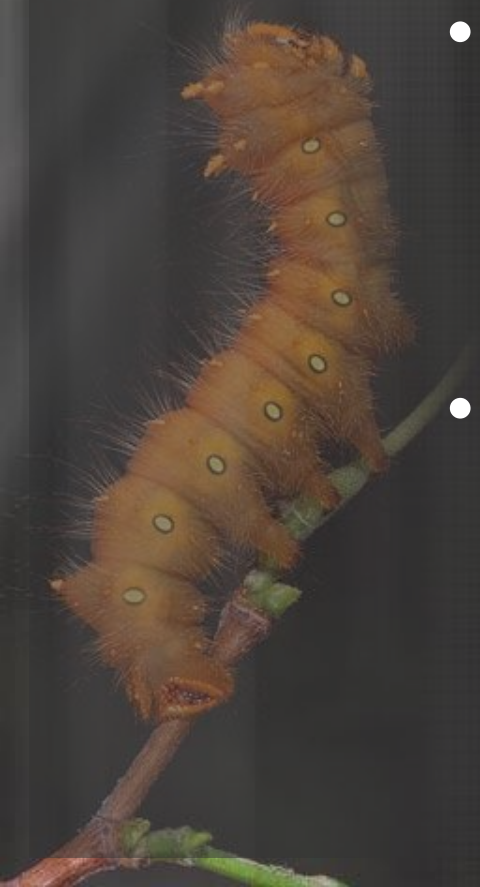
Voltinism

Indicate the number of broods or generations of an organism in a year



Univoltine

- **One generation per year**
- **Don't develop continuously throughout the year**
- **Enter into diapause (period of suspended development, overwinter) due to drought, temps high or low**
- **Example - Weevils**



Multivoltine

- **Multiple generations per year**
- **Generally develop quite rapidly**
- **Some species only live for a matter of days Example - fruit flies**



Insect Orders

- **Coleoptera**
- **Lepidoptera**
- **Hymenoptera**
- **Hemiptera**
- **Diptera**
- **Isoptera**
- **Orthoptera**
- **Dermaptera**
- **Dictyoptera**
- **Thysanoptera**
- **Homoptera**



Coleoptera - Beetles



Colorado Potato Beetle

- **Largest order of insects**
- **Complete metamorphosis - larvae are grubs**
- **Chewing mouthparts larvae and adults**
- **Two pairs of wings-first hardened into wing covers (elytra)**
- **Herbivores and carnivores**



Lepidoptera – Butterflies, Moths



- **Complete metamorphosis**
- **Larvae have chewing mouth parts**
- **Adults have sucking mouthparts (proboscis)**



**Two pairs of wings/
covered with scales**

Hymenoptera – Ants, Bees, Wasps, Sawflies

- **Complete metamorphosis- larvae are maggot like**
- **Chewing mouthparts in larvae**
- **Some adults have chewing (ants) some have sucking (bees)**
- **Two pairs of wings- both membranes hooked together to work as one**



Honey Bee

Hemiptera – True bugs, Stink bugs, Assassin bugs, Squash bugs

- **Simple development**
- **Sucking mouthparts**
- **Front wings generally hemelytrous, (thickened at the base and membranous at the tip)**
- **Hind wings membranous and shorter than the front wings**



Green Stink Bug



Diptera – True Flies

- **Complete metamorphosis
larvae are maggots**
- **Chewing mouthparts in
larvae and variable in
adults**
- **Adults only have 1 pair of
wings**



Isoptera - Termites

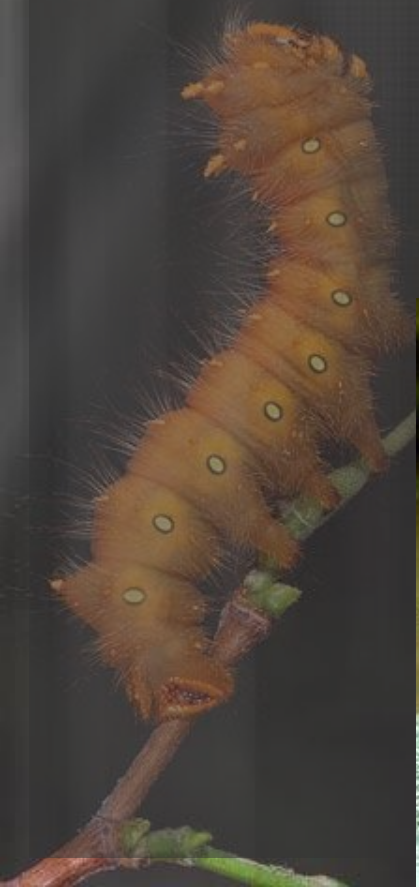


- **Specialized life cycle that includes; egg, larvae, nymph, worker, soldier, king, and queen**
- **Chewing mouthparts in larvae and variable in adults**
- **Wings are variable**
- **Have complex caste system (soldiers, sterile workers, reproducers)**
- **Reproducers excrete hormone to suppress sexual development of the rest of the colony**



Orthoptera – Grasshopper, Crickets

- **Incomplete metamorphosis**
- **Chewing mouthparts**
- **One/two pair of wings, no wings, nubs**
- **Modified hind legs**



Dermaptera – Earwigs

- **Incomplete metamorphosis**
- **Feed on animal and plant matter**
- **Chewing mouthparts**
- **Have pincers at the end of the abdomen**
- **Two pair of wings**



Dictyoptera – Mantids and Roaches

- **Incomplete metamorphosis**
- **Feed on animal and plant matter**
- **Chewing mouthparts**
- **Two pair of wings, no wings**



Praying Mantid

Thysanoptera – Thrips



- **Incomplete metamorphosis**
- **Generally feed on plant matter some are beneficial**
- **Chewing mouthparts**
- **Two pair of wings, some no wings**

Mouthparts

- **Chewing/biting**
- **Sucking**
- **Piercing sucking**



Mouthparts

Labrum - plate that serves as upper lip in insects with chewing mouthparts. Helps to pull food into the mouth.

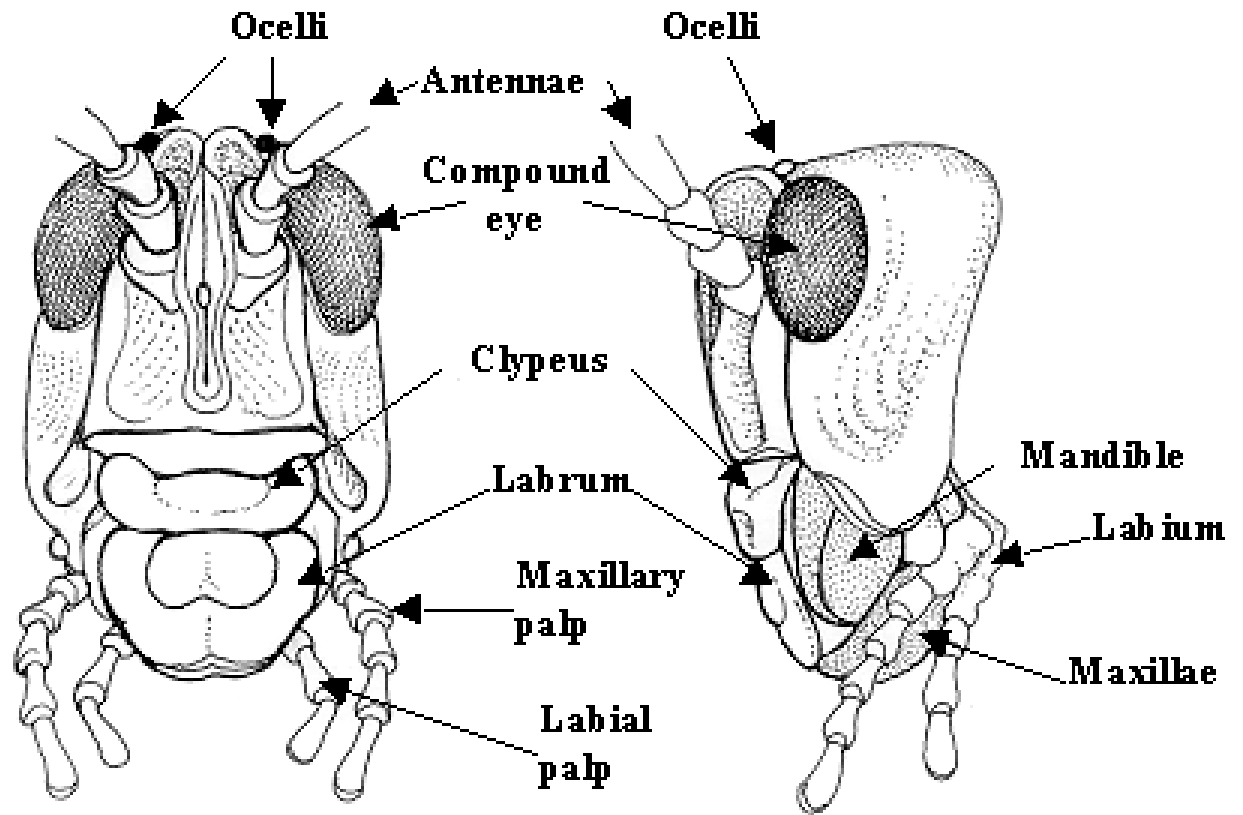
Mandible - appendage that becomes the 1st pair of mouthparts, analogous to jaw. Used to chew, cut, and tear food, to carry things, to fight, and to mold wax. Move from side to side rather than up and down.

Maxillae - 2nd pair of feeding appendages, used for food handling and sensing. More complicated than the mandibles but working in the same manner.

Labium - fused, 3rd pair of feeding appendages, analogous to lower lip. They function to close the mouth below or behind. Evolved from paired maxillae-like structures that are fused along the center line.



Chewing and Biting



Feeding Styles

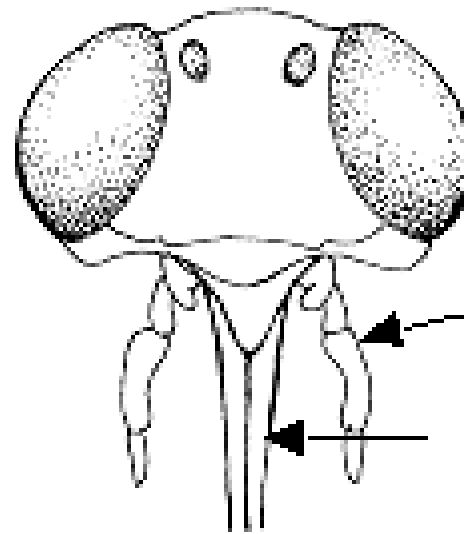


Chewing

- **Chews external plant parts**
- **Most primitive**
- **Holes in foliage, stem**
- **Ragged leaf edges**
- **Larval stages are almost always chewing**
- **Examples: grasshoppers, Japanese beetle, armyworms**



Sucking

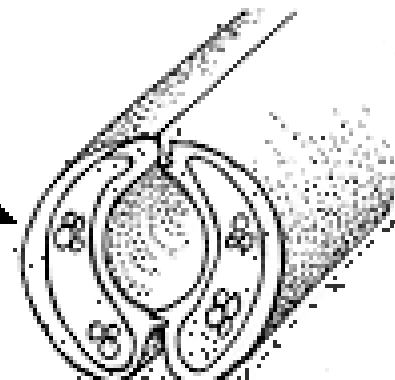


**Butterfly
mouth parts**

labial palp

proboscis (maxillae)

cross-section
of the proboscis



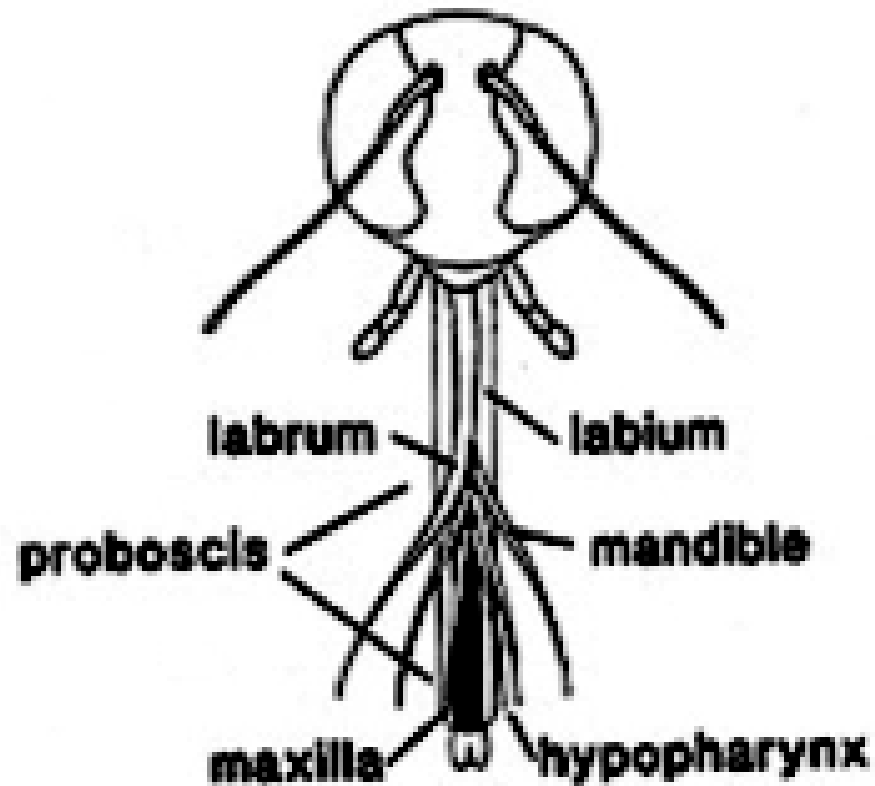
Feeding Styles

- **Sucking**
 - **Use proboscis to retrieve fluid from flowers and fruit.**
 - **Majority of moths do not have a proboscis. Most moths live off fat reserves stored during the larval stage.**



Piercing and Sucking

Mosquito



Feeding Styles

- **Piercing/Sucking**
 - **Pierce plant tissue and suck plant juices (like needle)**
 - **Slender and sharp pointed mouthpart (stylet)**
 - **Injury often appears as minute spotting, wilting, deformed tissue, browning of tissue**
 - **Many of these insects produce honeydew/sooty mold**
 - **Vectors of plant disease**
 - **Examples: aphids, scale insects, plant bugs, mosquitoes**



IPM

- **IPM – Integrated Pest Management or Intelligent Pest Management, using a combination of biological, mechanical, cultural, and chemical means to control pests.**
- **Helps to reduce pesticide resistance**
- **Reduces chemical costs**
- **Limits chemical exposure**
- **Reduces environmental exposure to pesticides**



IPM

- **Prevention is the first step.**
 - **Location**
 - **Soil Preparation**
 - **Plant inspection and selection**
- **Mechanical & Cultural Control**
 - **Crop Rotation**
 - **Companion Plantings**
 - **Spacing**
 - **Clean/Decon equipment**
 - **Maintain equipment**
 - **Resistant varieties**
 - **Trap plants**
 - **Barriers and traps**
 - **Sanitation remove plant debris**
 - **Destroy alternate hosts (weeds)**



Chemical

- **Chemical**
 - **Insecticides**
 - **It is always necessary to read pesticide labels and follow all directions including PPE requirements and application guidelines.**
 - **Insecticide – any substance intended for preventing, repelling or destroying insect pests.**
 - **Always start with soft chemicals first then move up from there.**



Pesticides

- **Naming**
 - **Common name (active ingredient) – Carbaryl**
 - **Trade name – Sevin**
- **Classification**
 - **Contact (Kills on contact) vs. Systemic (Chemical is taken up by the plant and kills pests as they feed).**
 - **Mode of entry**
 - **Chemical class (Organochlorines, Pyrethroids, Organophosphates, Carbamates, Botanicals)**
 - **Formulation (Active ingredient, plus additional mat.**



Insecticides

- **Formulation**
 - **Dusts**
 - **Oils**
 - **Soaps**
 - **Fumigants**
 - **Wettable powders**
 - **Emulsifiable (concentrated)**
 - **Granules**
 - **Sprays**



Insecticides

- **If there is any question on a chemical and its safety, contact the manufacturer and ask for the msds “Material safety data sheet”. These will tell you its chemical properties (flammability, reactivity, corrosiveness, etc.)**



Insecticides

Broad Spectrum

- **Wide range killers**
- **Used when several different kinds of insects are a problem**
- **Will not kill everything but very versatile**

Narrow Spectrum

- **Only kill specific insects, types, etc**
- **Pheromones**
- **Growth inhibitors**



Break Time!!!!!!





Cecropia Moth Larvae

Common Garden Pests



- **Feeds on beans, peas, sweet corn, okra, tomatoes, cabbage, eggplant, and pepper**

- **Early planting**

Corn Earworm



- **Feed on cole crops, cucurbits, beans, peas, potatoes, tomatoes, lettuce, turnips, spinach**
- **Wash off plants with strong stream of water**

Aphids



©MARLIN E. RICE

Insecticidal soaps
Biological control –
Wasps, Lady beetles



- **Feed on garlic, onion, blueberry, ornamentals**
- **Remove weed hosts**
- **Biological control – Lady beetles**

Thrips



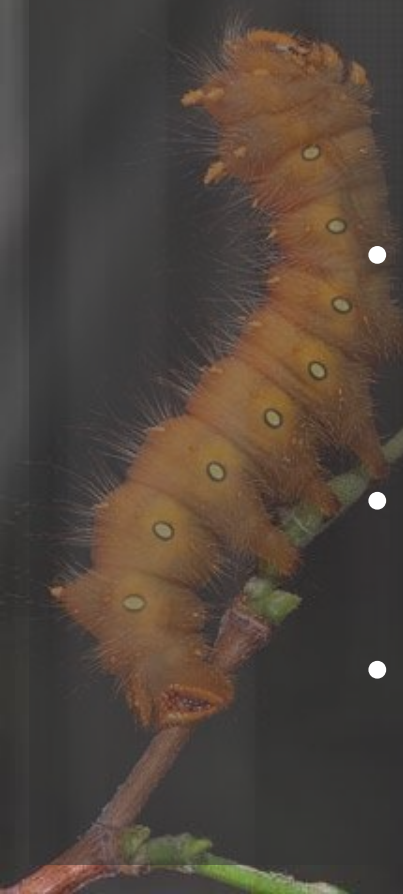
Mealybug

- **Soft scale insects that feed on foliage of various plants.**
- **Produce honeydew (sooty mold)**
- **Biological control – Lady beetles**



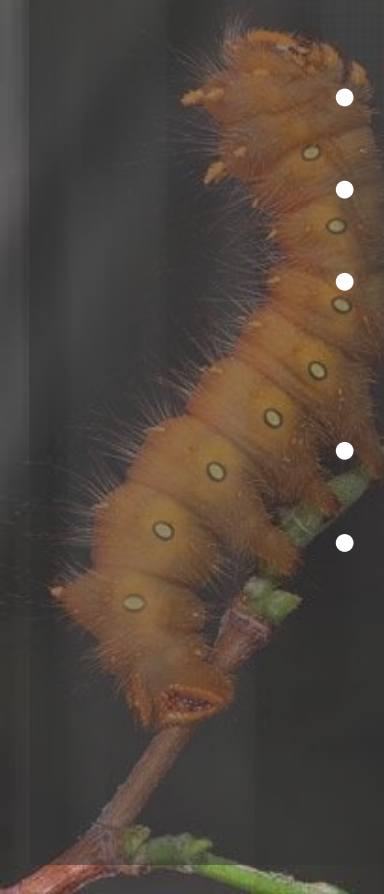
Leafminer

- Larvae of flies, moths, and beetles that feed in between upper and lower leaf surfaces
- Feed on beans, lettuce, celery, broccoli, etc.
- Biological control – lady beetles
- Remove visible infestations



Spider Mites

- **Not an insect**
- **Feed on beans, corn, tomato, and eggplant, etc.**
- **Remove weeds**
- **Adequate soil moisture**
- **High pressure water spraying**
- **Miticides**
- **Insecticidal soaps**



Japanese Beetles

- **Pest of turf, ornamentals, fruit, asparagus, soybean, corn, etc.**
- **Physical control**
- **Attractants, trapping (not recommended)**
- **Biological control - wasps**



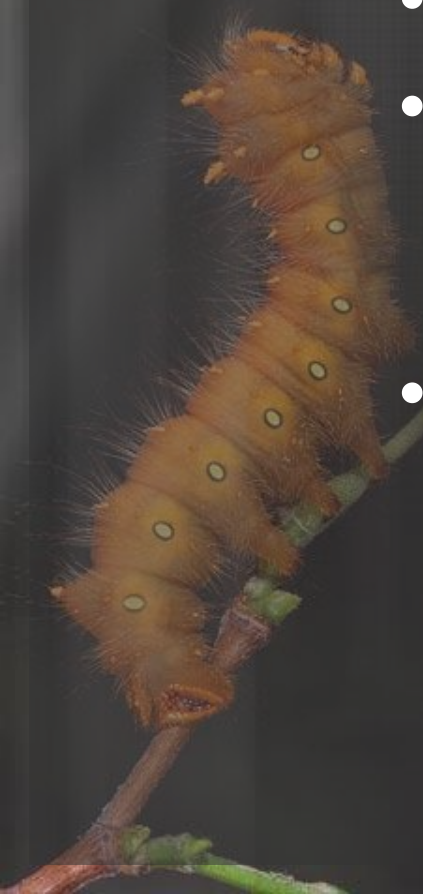
Slugs

- **Feed on corn, lettuce, beans, ornamentals, etc.**
- **Optimum irrigation timing**
- **Manual removal**
- **Baits**
- **Traps**
- **Stale beer**



- **Feed on Tomatoes, peppers, cole crops, citrus, etc.**
- **Prevention**
- **Biological control**
 - **Lacewings,**
 - Bigeyed bugs**
- **Remove heavily infested plants**

White Fly



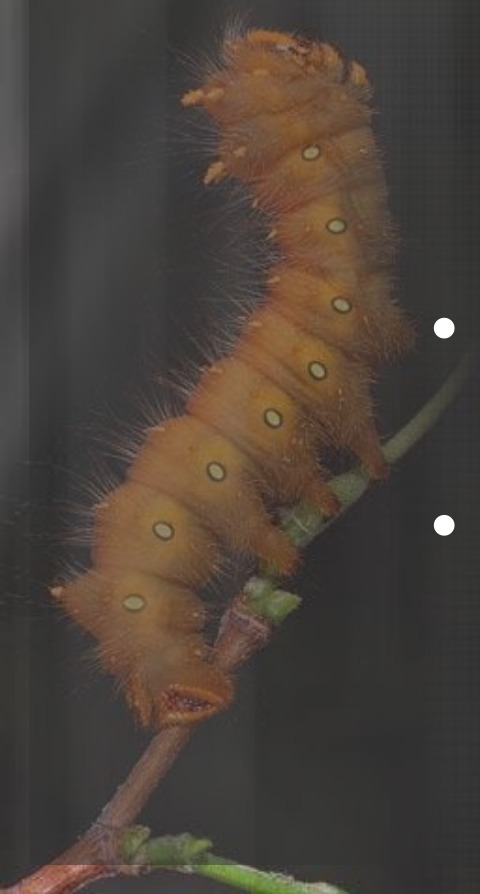
Tomato Horn Worm

- **Feed on Tomato, eggplant, pepper, potato, etc.**
- **Bt (Bacillus thuringiensis)**
- **Physical removal**
- **Biological control – Wasps**



Flea Beetles

- **Feed on potato, spinach, tomatoes, peppers, cucumbers, etc.**
- **Remove weed hosts**
- **Traps**



Corn Borers

- **Feed on corn, peppers, potato, etc.**
- **Variety selection**
- **Planting date**
- **Early harvest**
- **Bt**
- **Biological – Lady beetles**



Squash Bug

- **Feed on cucurbits**
- **Hard to control**
- **Early detection of nymphs offers best control**
- **Maintain healthy plants**



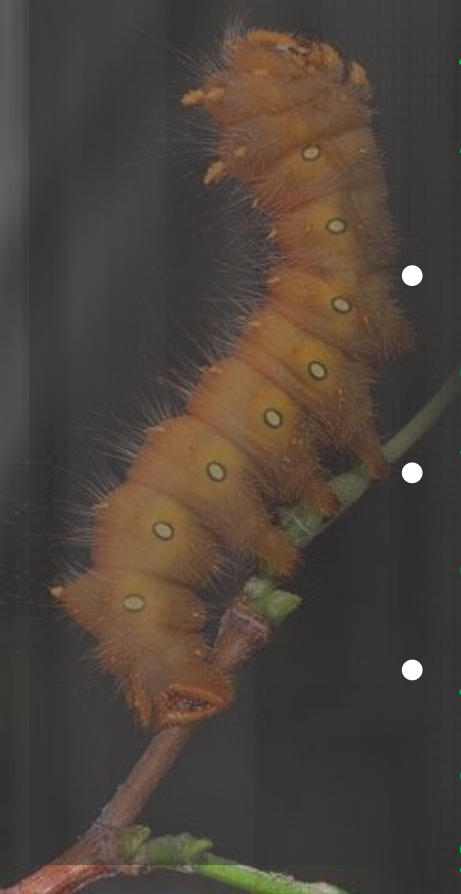
Cucumber Beetle

- **Feed on cucurbits**
- **Vector of disease**
- **Select resistant crops**
- **Can be spotted, stripped, or banded**



Black Cutworm

- **Feed on corn, asparagus, bean, beet, etc**
- **Sever plants at the base of stem and soil line**
- **Generally no other damage present**
- **Use Bt products for control**
- **Avoid planting in areas that were formerly fields**



Black Cutworm

- **Feed on corn plants – leaves and corn**
- **Actively scout plants before silk appears**



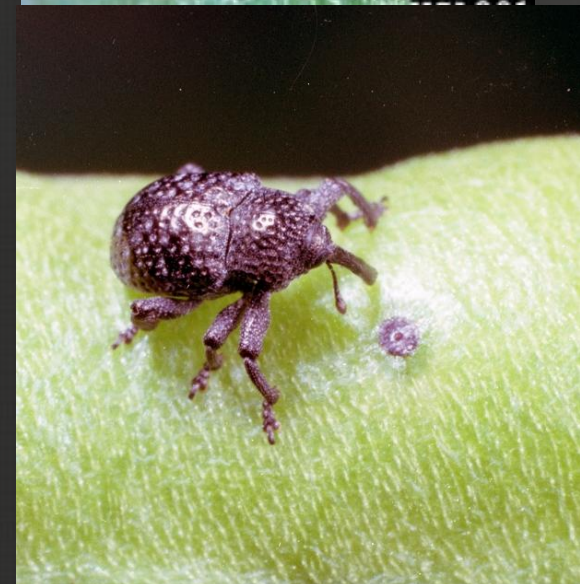
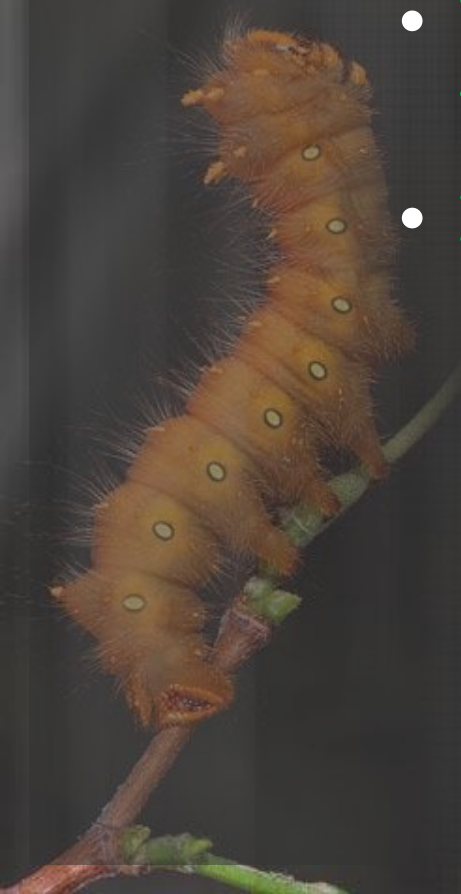
Leaf Hoppers

- **Feed on beans, lettuce, potato, etc**
- **Spread plant pathogens – bacterial, viral disease**



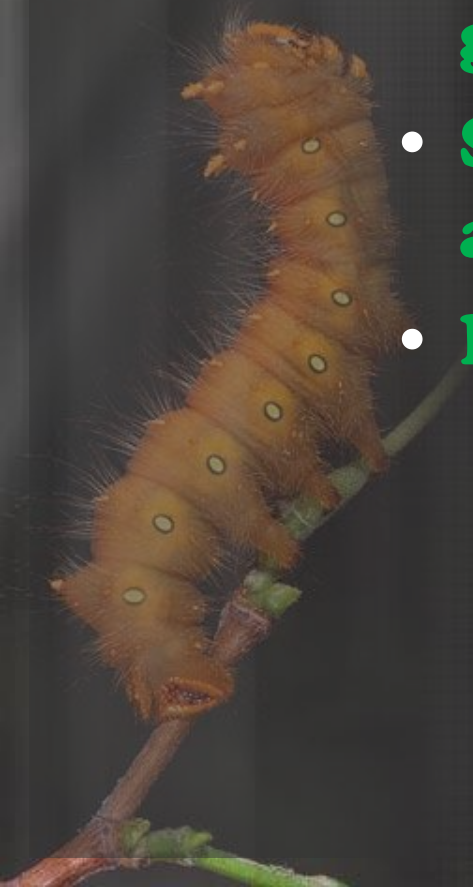
Curculios

- **Feed on peas, plum, cotton, lima bean and many other fruit**
- **Late season crops are less susceptible**
- **Rotate crops**



Squash Vine Borer

- **Squash, zucchini, pumpkins, and gourds are attacked**
- **Scout for borer activity**
- **Look for visible frass**



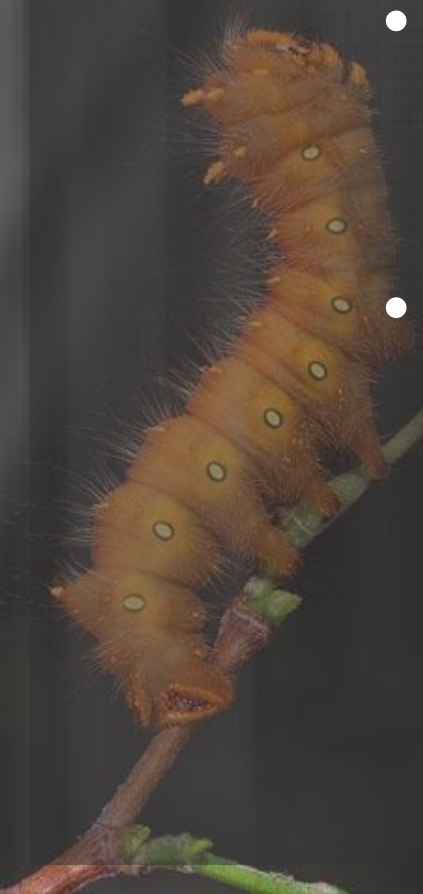
Tarnished Plant Bug

- **Attacks some 50 species of plants**
- **Destroy favorable overwintering sites**
- **Remove all host plants**



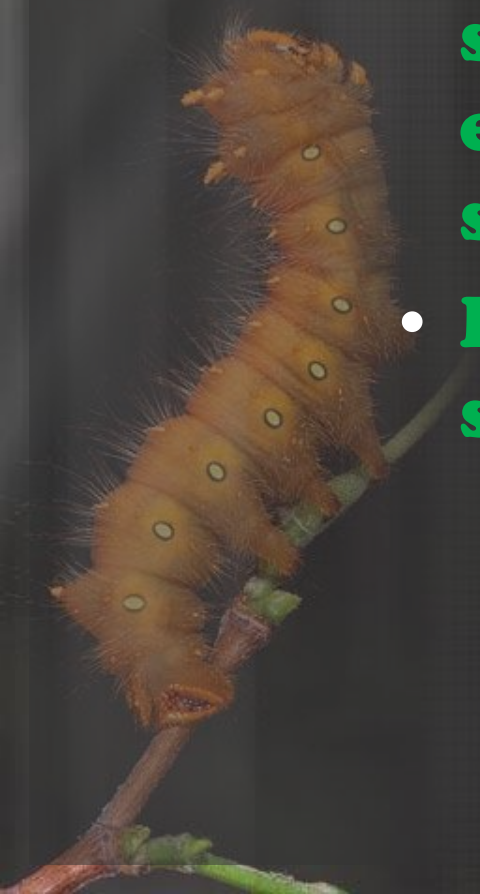
Leaf Roller

- **Attacks lime beans, peas, soybean cowpea etc**
- **Look for leaves rolled over attached with silk**
- **Shelters become larger when insects pupate**



Leaffooted Bug

- **Will attack cotton, peaches, and tomatoes, and seeds such as beans, black-eyed peas, and sorghum**
- **Damage similar to stinkbugs**





Tomato Hornworm parasitized by the Braconid Wasp

Beneficial Insects



Braconid Wasp

- **Adult wasp inserts eggs beneath the skin of caterpillar**
- **Larvae hatch and feed on caterpillar until they pupate and hatch out as seen in photo**
- **Will also parasitize other insects**



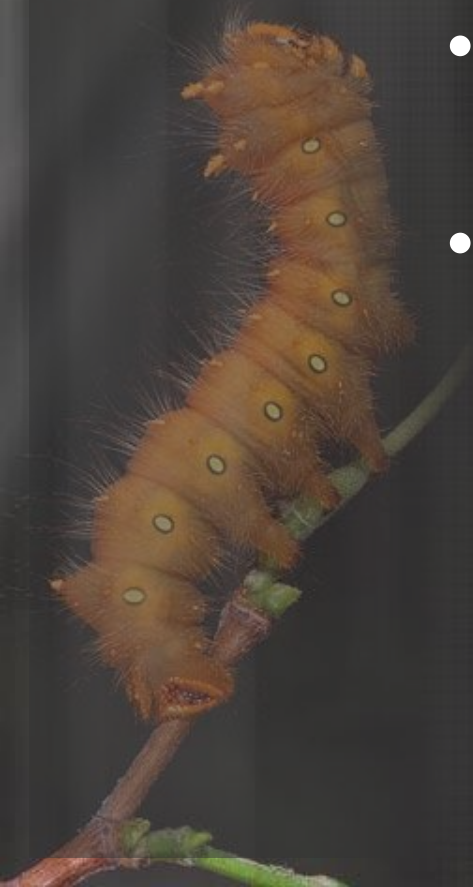
Tiger Beetle

- **Adults are opportunistic feeding on a wide variety of insects**
- **Larvae have burrows that they use as shelter and ambush prey as it passes by**
- **Tiger Beetles are also parasitized by Diptera sp.**



Syrphid Fly

- **Adult flies resemble bees or wasps**
- **Do not sting humans**
- **Prey on aphids**



Predatory Stinkbug

- **Most stinkbugs are pests**
- **Feed on beetles, caterpillars and other stinkbugs**



Ladybird Beetle

- **Larvae are voracious eaters of aphids, scale, mealy bugs**
- **Adults also feed on insects**
- **Multicolored Asian Beetles are also beneficial – THEY ARE NOT PESTS**



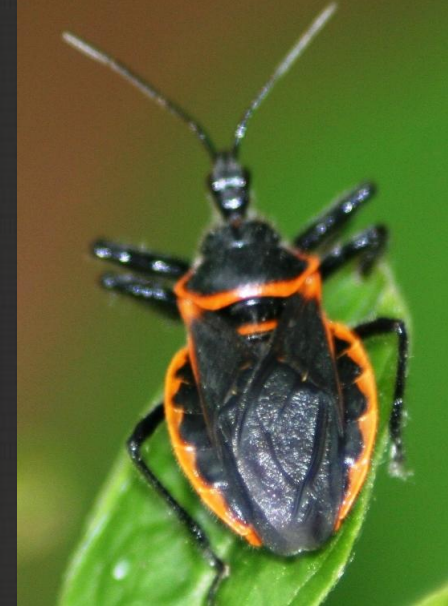
Lacewing

- **Adults and larvae feed primarily on aphids**
- **Larvae are often referred to as aphid lions**



Assassin Bug

- **Feed on aphids, leafhoppers, small caterpillars, and beetle eggs and larvae**
- **Can inflict a painful bite to humans**



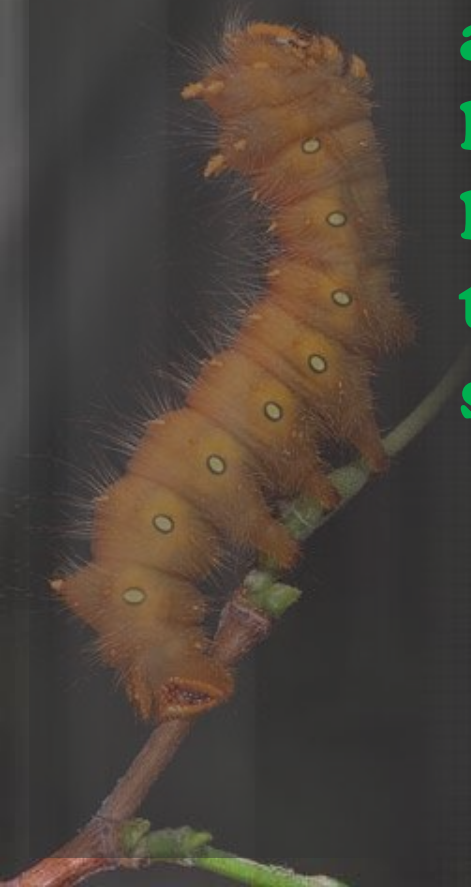
Soldier Beetle

- **Adults feed mostly on nectar with the occasional aphid**
- **Larvae are found under logs debris and feed on aphids, maggots, grasshopper eggs**



Damselfly Bug

- **Feed on caterpillar eggs, small larvae, aphids, fleahoppers, lygus bugs, leafhoppers, treehoppers and spider mites**



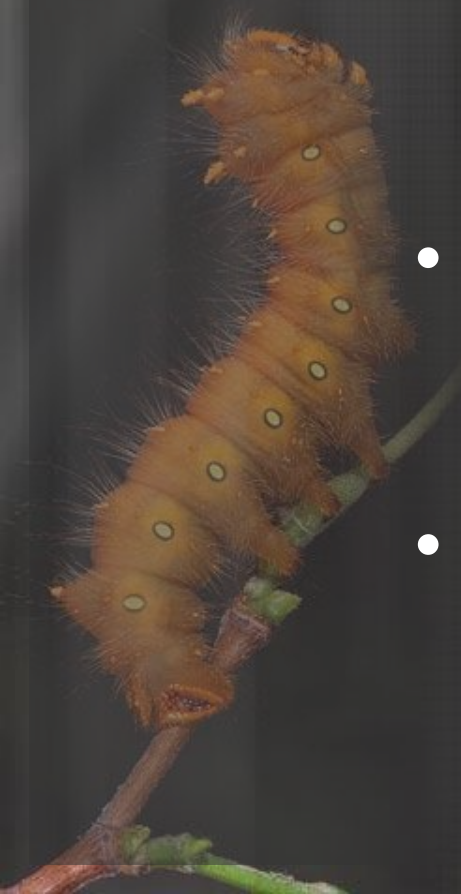
Tree Cricket

- **Feeds on aphids, scales**
- **May also feed on plant parts**
- **Not considered a pest**



Predatory Mite

- **Young mites are parasites on Orthoptera (grasshoppers, locusts and crickets)**
- **Utilized as a biocontrol agent against locusts**
- **Adults are voracious predators of various insects**



Spiders

- Feed on insects and other spiders
- Some spin webs and some are roamers
- Crab spider, wolf spider, and jumping spider pictured to the right



Robber Fly

- **Both adults and larvae feed on insects**
- **Larvae live in the soil and feed on insect larvae, eggs, and small insects**



Praying Mantis

- **Voracious insect predators**
- **Feed on anything they catch**
- **Will feed on pollinators**

