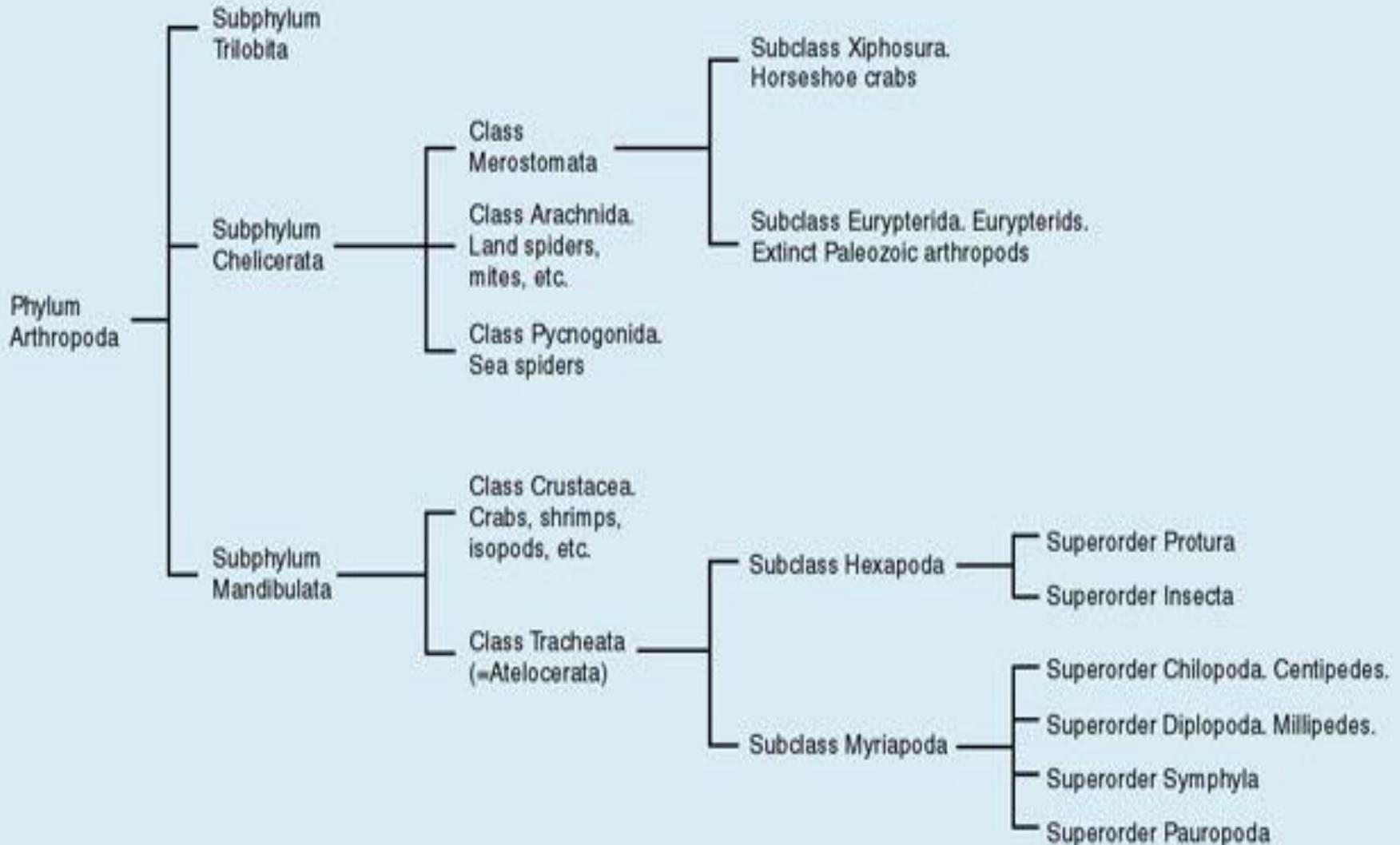


Insects



Arthropoda



Hexapoda



Protura



- Proturans are usually regarded as the most primitive of all hexapods. They have six legs and three body regions (head, thorax, and abdomen), but they lack most of the other physical features that are common to arthropods. They are always found in moist habitats -- usually in the humus and leaf mold of temperate deciduous forests. Both adults and immatures feed on organic matter released by decay.
- Proturans do not have eyes or antennae. The front pair of legs are usually held in front of the body and apparently serve as sense organs. Newly hatched proturans have nine abdominal segments. Each time they molt, another segment is added near the end of the abdomen until they are fully grown (and sexually mature) with 12 abdominal segments. Additional molts may occur during adulthood, but the body does not grow any longer.

Diplura



- They have a pair of long, beaded antennae on the head and a pair of segmented sensory structures (**cerci**) at the rear. In one common family (Japygidae), these cerci are developed into strong pincers. They have no eyes.
- Diplura are tiny, cryptozoic animals that live in moist soil, leaf litter, or humus. They have small, eversible vesicles on the ventral side of most abdominal segments that seem to help regulate the body's water balance, perhaps by absorbing moisture from the environment.
- Most Diplura are predators; their diet probably includes a wide variety of other soil-dwellers, including collembola, mites, symphyla, insect larvae, and even other diplurans. They may also survive on vegetable debris and fungal mycelia, but most species seem to prefer animal prey.

Collembola



- The springtails are among the most abundant of all soil-dwelling arthropods. They live in a variety of habitats where they feed as scavengers on decaying vegetation and soil fungi. Can be found on snow or on puddles. Some have eyes.
- Springtails are named for a forked jumping organ (the **furcula**) found on the fourth abdominal segment. Releasing the tenaculum causes the furcula to snap down against the substrate and flip the organism some distance through the air. This device, present in all but a few genera, seems to be an effective adaptation for avoiding predation.
- Immature collembola are similar in appearance to adults. They usually molt 4-5 times before reaching sexual maturity, and continue to molt periodically throughout the rest of their life.

Insecta

Adult members of this class can be identified by the following characteristics:

- three pairs of legs;
- a segmented body including a head, thorax, and abdomen;
- and one pair of antennae;
- external mouthparts

Insect Services



Pollination

- Some plants depend on a single species or type of insect for pollination. Smyrna fig – fig wasp species, Yucca – yucca moth genus
- Apple, pear, cherry, blackberry, & strawberry depend chiefly on honey bees for pollination. Other crops mostly pollinated by honey bees are: peaches, plums, squash, cucumbers, melons, almonds, and many seed crops.
- Other insect pollinators: beetles, other bees, wasps, flies, butterflies, some ants

Insect Products

- Honey
- Beeswax – used for candles, sealing wax, polishes, inks, dental impressions, cosmetics
- Silk – from cocoons of the silk moth.
- Shellac – secretions of the lac insect, at type of scale insect.
- Dyes- the cochineal insect is used to make red dye, anytime you see an ingredients list that includes carmine, or cochineal extract you can be sure that there's a little powdered bug in your food.
- Food – people around the world eat insects

Insects in Surgery and Medicine

Allantoin used today to treat deep wounds in which there is decaying flesh was developed by observing blow fly larva in wounds. Sometimes the larva themselves are used to eat dead flesh from wounds.



Compounds derived from blister beetles have been shown in the lab to be effective in treating certain cancers in cell cultures, and have been used to treat warts.

Aesthetic Value of Insects

Leafhopper pattern used in Mexican & Central American art.

Morpho butterfly often used as decoration.



Ecological Roles (other than pollination)

- Soil aeration & fertilization
- Prevent build up of manure from large animals
- Food for other animals
- Entomophagous – control other insect populations



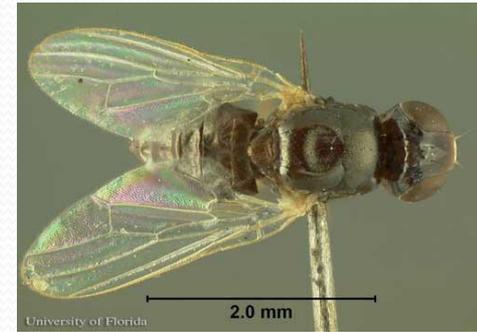
Harm to Growing Crops

Phytophagous insects harm crop plants. They spread damage plants or diseases through

- Ovipositing or feeding Ex. Squash bug, aphid
- from carrying bacteria on the exteriors of their bodies, ex. Fire blight carried by flies and bees



Damaging Stored Products



- Wood Pests – termites, powderpost beetles, carpenter ants
- Fabrics – dermestid beetles & clothes moths
- Stored Food – bean and pea weevils, cheese skipper
- The flies are detritivores, and even have been found on the exhumed remains of Egyptian mummies. *Piophilidae*, have been implicated as useful in the forensic investigation of determination of "time since death." Often found as pests in meat and cheese, these small flies often are cited as a cause of enteric (intestinal) myiasis, where the fly larvae invade the living tissue of animals including humans.

Harming Humans and Animals

- Annoying or provoking entomophobia
- Insect venom may cause swelling, pain, paralysis or anaphylactic shock. More people in the US are killed by wasps and bees than by snakes.
- Transmit disease they picked up with their food – flies regurgitating when they eat – cholera, typhoid fever, dysentery
- Transmit disease by passing along organism that lives in their bodies – malaria,

Irritation – fleas, lice, bed bug, blister beetle, caterpillars



Insect Anatomy

- Exoskeleton made of hardened plates, but also endoskeleton made of supports, braces and sites for muscle attachment.
- Exterior wax layer – limits water loss

Abdomen

- usually 11 segments,
- immature forms may have gills (mayflies) or prolegs (caterpillars) on the abdomen,
- genitals,
- cerci. Cerci sensory, defense (earwigs), or accessory copulatory organs (dragonflies).
- Spiracles- openings for gas exchange

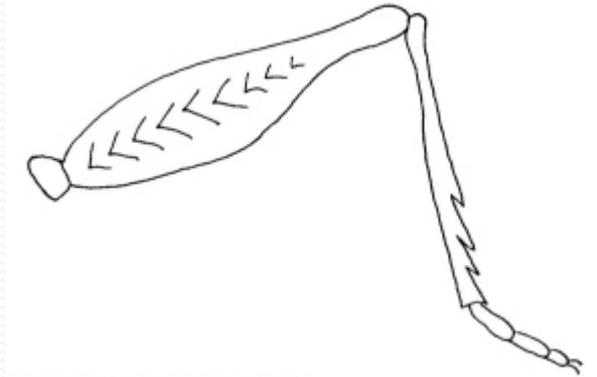
Leg Types

Walking/running

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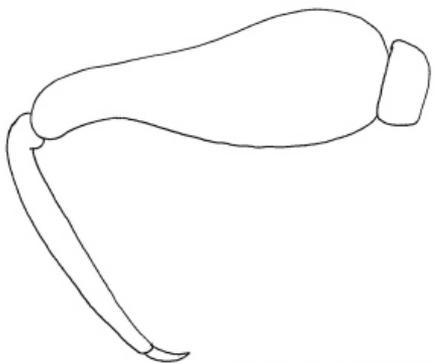


Jumping



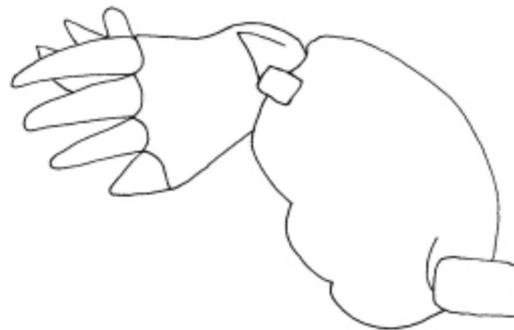
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Raptorial



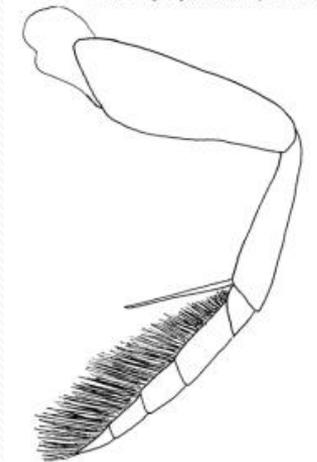
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Digging



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swimming



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Insect Anatomy

Thorax

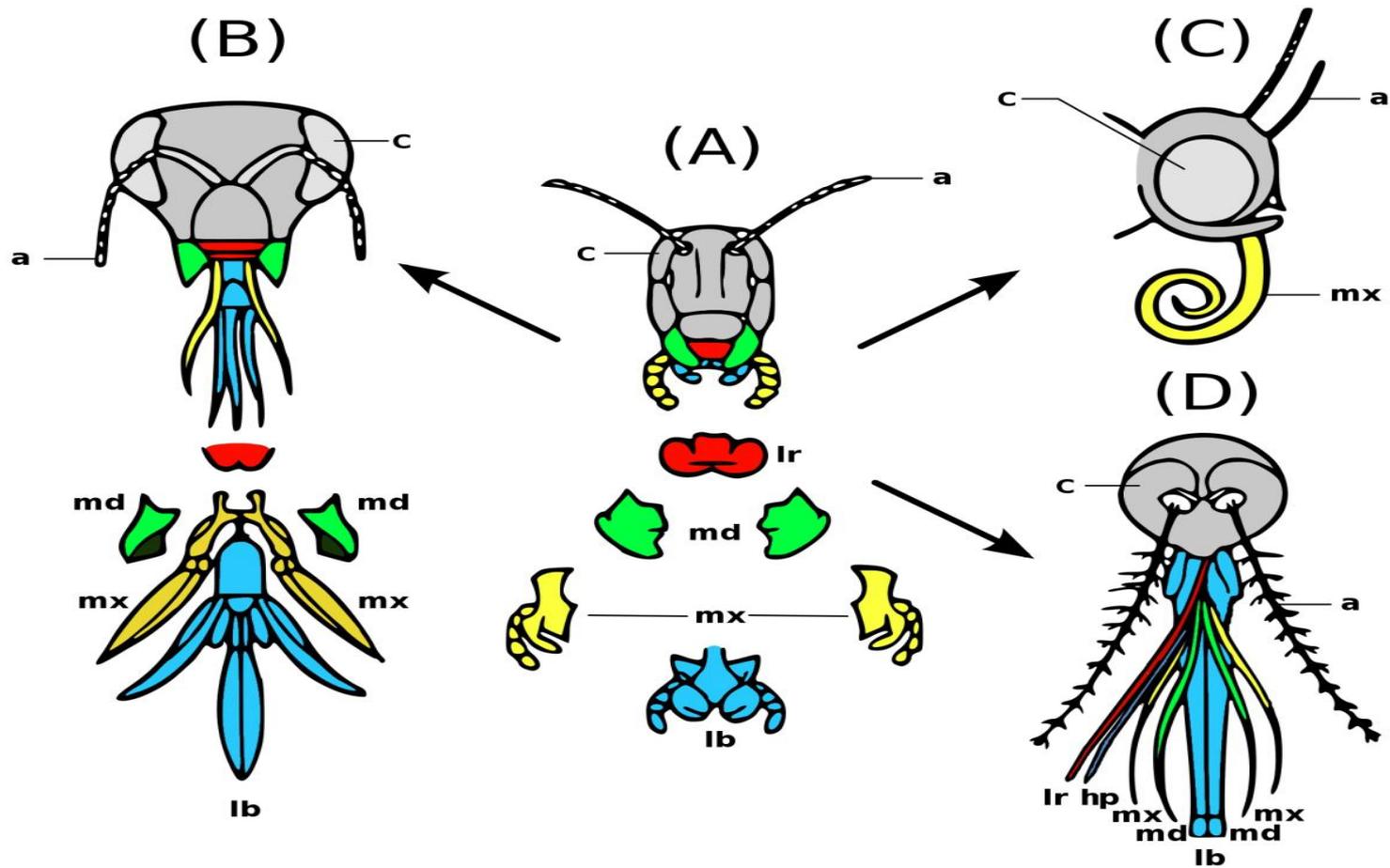
- 3 segments
- Up to 2 pairs of spiracles
- Legs
- Zero to four wings – in some insects front & hind wing hook together to move together (wasps), in other the wings move independently (dragonflies).

Insect Anatomy

Head

- Eyes
- Antenna – tactile, smell, hearing
- Mouthparts – chewing (grasshoppers), piercing\sucking (assassin bug), sponging (house flies), siphoning (butterflies).

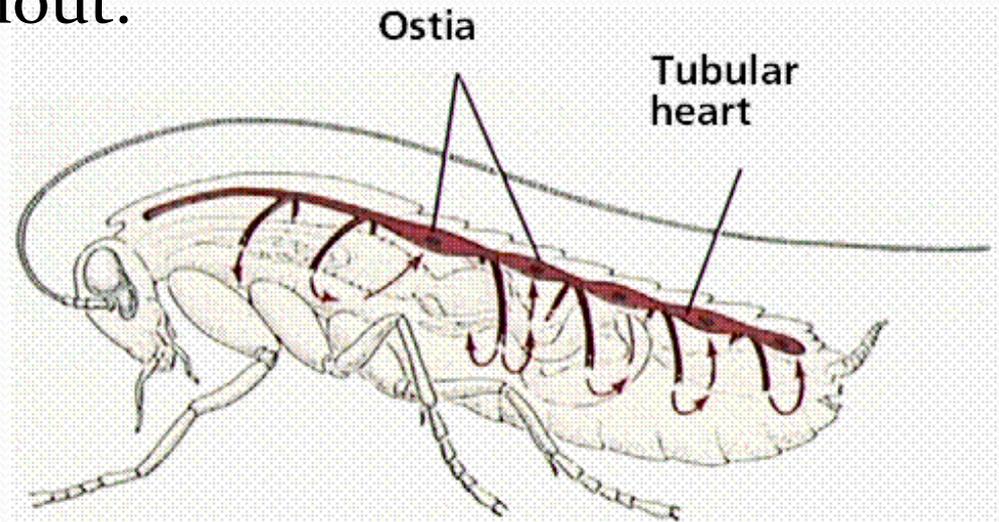
Mouth types



Circulatory System

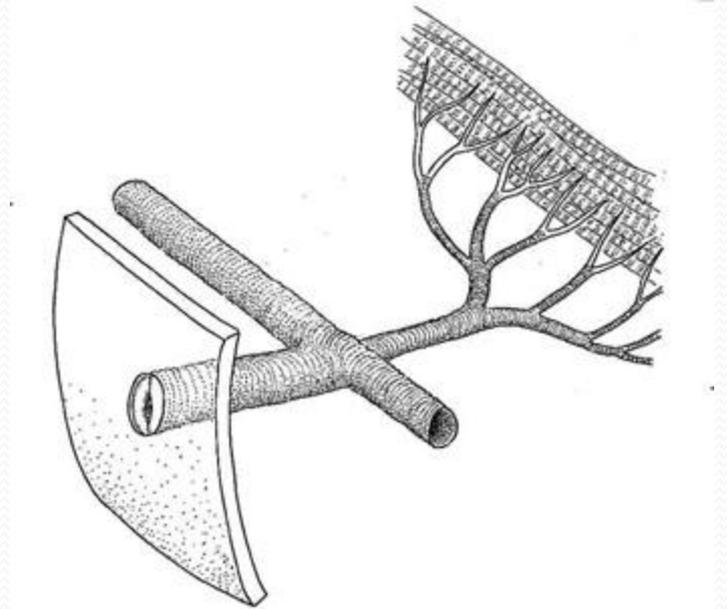
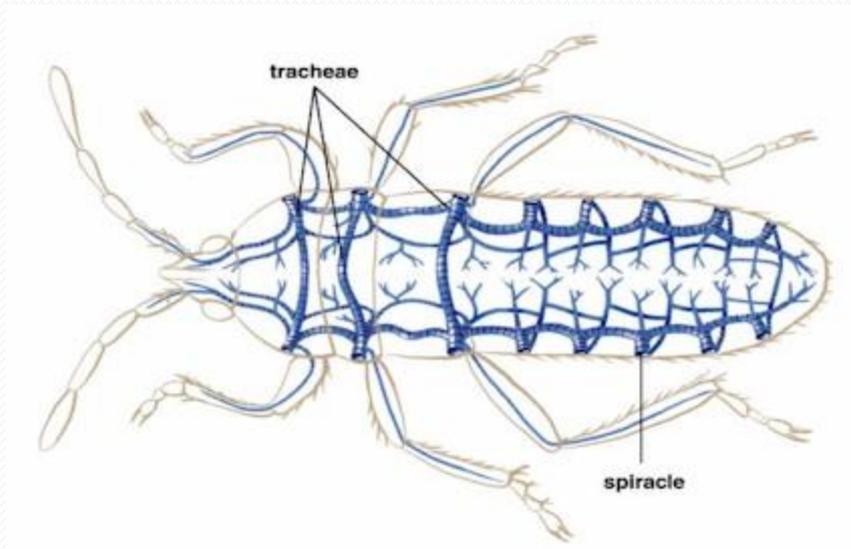
The circulatory system does not carry gases. It carries nutrients, hormones and wastes. It also fights infections and seals wounds.

It is an open system, blood bathes the tissues and is not carried by tubes throughout.



Respiratory System

A tracheal system transports gases. Valves to outside can close, which helps insects retain water. Gas enters, or leaves, cells through diffusion. Some aquatic or parasitic insects have closed spiracles and gas exchange is by diffusion through gills or body wall.



Body Temperature

- Poikilothermic (cold-blooded)
- Thoracic flight muscles can raise temperature above ambient temperature. In flight grasshopper and butterflies may be 5-10 degrees C above environmental temperatures, moths & bumble bees may be 20-30 degrees C warmer.
- Flight muscles must be a certain temperature to function. Many insects vibrate wing muscles to warm them.

Sense Organs

Chemical senses – taste and smell. Receptors extend through the exoskeleton, usually in peglike structures.

Taste receptors may be on the mouthparts, antennae (bees, wasps, ants) or feet (butterflies, moths, flies).

Mechanical senses – touch, pressure or vibration. Use hair sensilla used for touch and to detect movement of air and water.

Hearing – use hair sensilla or tympanal organs to detect airborne sounds. Tympanal organs may be located on the abdomen (some grasshoppers, moths) and legs (some crickets). Mosquitoes use hair sensilla on antennae for hearing.

Insect antennae



Grasshopper tympanal organ

Vision

Two types of eyes – ocelli & compound

- Ocelli have a single, domelike lens and are light sensitive. They do not form images.
- Compound eyes are made up of ommatidia. Ommatidia have hexagonal lenses.
- Insects cannot see the color red, they can see ultraviolet.





Metamorphosis

Simple (incomplete)

- young are called nymphs and usually look similar to the adults.
- There is no pupal stage.
- Nymphs have compound eyes if adults do.
- Wings appear as budlike outgrowths.
- Three types of simple metamorphosis. Bristletails and Silverfish don't change much. Mayflies, dragonflies and stoneflies go from aquatic to terrestrial and don't look like adults. Others have more gradual changes going from wingless to winged, and live in same habitat, for example squash bugs.

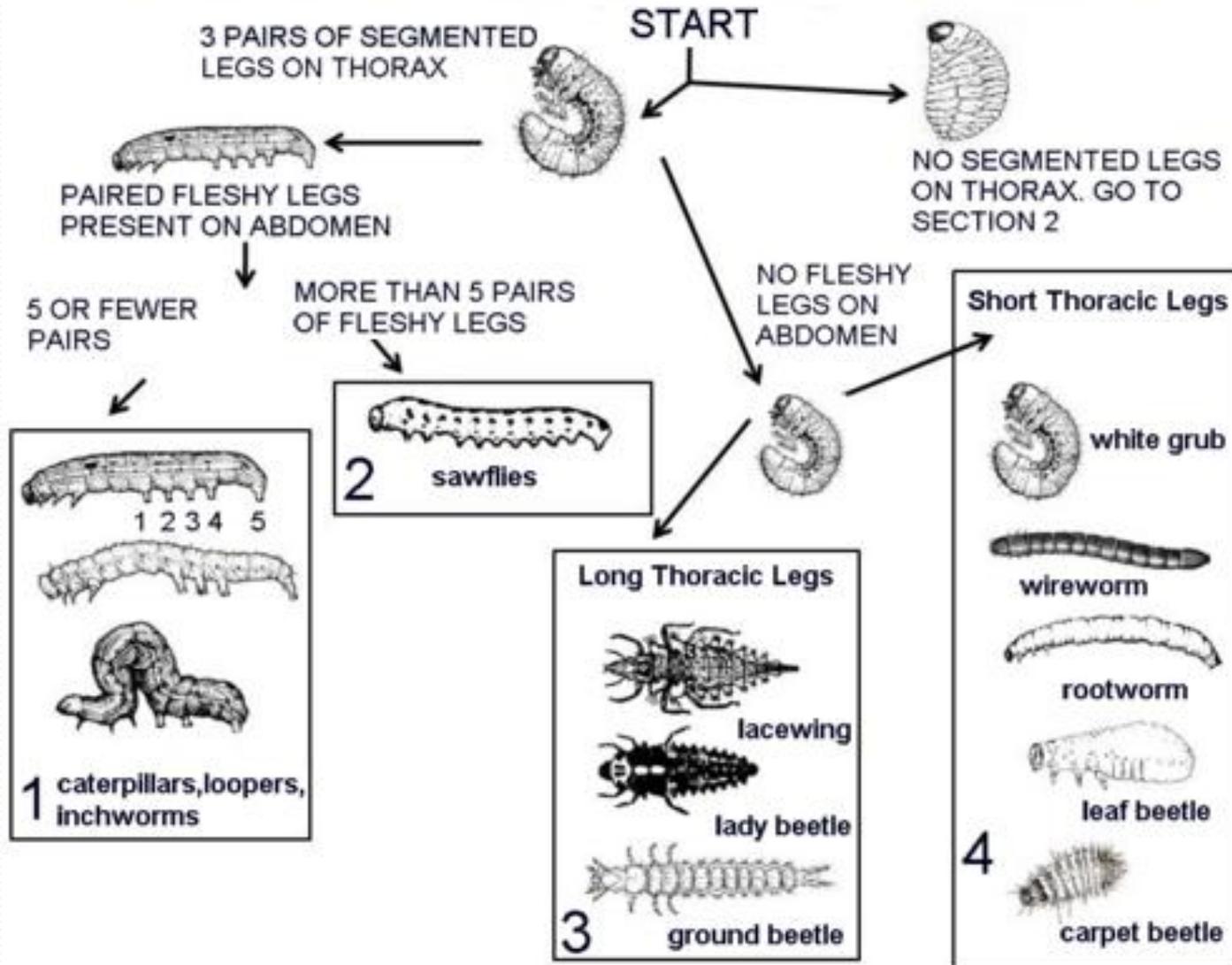
Metamorphosis

Complete

- Four stages: egg, larva, pupa and adult
- Young are called larvae, do not resemble adult
- Larval stage is more or less wormlike, developing wings are not visible, generally have chewing mouth parts even when adults do not.
- Pupa stage does not move and is generally inactive. May be covered by a cocoon or other protective material.
- A few insects have intermediate types of metamorphosis.

Types of Larvae

PICTURE KEY TO INSECT LARVAL TYPES: SECTION 1





Jumping Bristletails – Order Microcoryphia (small head)



- Have simple eyes
- No wings
- Most are nocturnal
- Live in grassy or wooded areas under leaves, bark or stones; in dead wood or in similar situations.
- Feed primarily on algae, mosses, and decaying fruits.
- Very small, no larger than 15 mm
- Very active, jump when disturbed
- When they molt they glue themselves to substrate with what appears to be fecal material.
- Simple metamorphosis

Silverfish – *O. Thysanura* (fringed tail)

- No wings
- Moderate to small insects
- May have compound and simple eyes
- Silverfish feed on starchy substances and cause damage to books, starchy foods and wallpaper. Lives in cool places.
- Firebrat lives in warm places around furnaces, boilers and steam pipes.
- Simple metamorphosis



Mayflies – O. Ephemeroptera (lasting a day wing)

- Small to medium.
- Front wings are usually large and triangular, hind wings are very small or absent. Wings held above body.
- Simple metamorphosis
- Aquatic nymphs, gills along abdomen, feed on algae and detritus
- Usually nymph changes to a winged form, flies, molts again to become adult
- Adults do not feed and die within a day or two
- Often emerge in huge numbers. Important fish food.



Dragonflies and Damselflies –

O. Odonata (tooth)

- Dragonflies rest with wings held straight out. Damselflies rest with the wings held over the abdomen.
- Aquatic, predaceous nymphs. Catch prey with extendable “lip” with 2 teeth
- Damselfly nymph gills are external
- Dragonfly nymph gills are inside the rectum. It breathes by drawing water into its rectum and then expels it. It can create “jet propulsion” when it wishes to move quickly.
- Exist as nymphs 1-3 years.
- Live 3-8 weeks as adults depending on species.
- Most adults catch insect prey by making a basket of their legs. Land and chew prey. Occasionally eat hummingbirds.

<http://imnh.isu.edu/digitalatlas>



Grasshoppers, Crickets and Katydid- O. Orthoptera (straight wing)

- Most are plant feeders, may be winged or wingless
- Front wings are usually long and thickened. The hind wings are membranous and rest folded fanwise under the front wing.
- Chewing mouthparts, simple metamorphosis.
- The ‘singing’ orthoptera usually have tympana on the abdomen. Crickets and long-horned grasshoppers produce sound by rubbing front wings together. Band-winged grasshoppers make noise by snapping their hind wings in flight. Slant-faced grasshoppers sing by rubbing the hind legs across the front wings.
- Grasshopper often regurgitate when caught.

Mormon Cricket (a katydid)



Big-headed Grasshopper



Tree Cricket



Katydid



Jerusalem Cricket



Mantids – *O. mantodea* (mantis)

- Only insect that can “look over its shoulder.”
- Vast majority of mantids seen in Idaho are the European mantis. Color depends upon air moisture.
- Ground mantids, *Litaneutria minor*, may be present in Idaho’s dry regions.



Earwigs – O. Dermaptera (skin wing)

- Idaho has the European earwig
- Can cause substantial crop damage to crops
- Front wings are short and leathery. Hind wings are membranous and rest folded under the hind wings with the tip showing. Rarely seen to fly.
- Males have strongly curved cerci, female's cerci are fairly straight.
- Eggs are attended by the female, who frequently moves the eggs around the cell, and apparently keeps mold from developing on the eggs . Females guard their eggs from other earwigs, and fight with any intruders.



Stoneflies- Plecoptera (folded wing)

- The hind wing is folded when the wings are at rest.
- Chewing mouthparts, many adults do not feed.
- Nymphs look similar to mayfly nymphs, but have 2 tails and not 3 like mayflies do. Gills look different, not leaf-like along the abdomen like in mayfly nymphs.
- Nymphs are primarily plant feeders. Found under stones.
- Important to fish and fly fishermen.
- Indicator of good water quality.
- Simple metamorphosis.



Psocids –

O. Pscoptera (gnawed or rubbed wing)

- First part of Greek name refers to how they feed
- Booklice, barklice



Hackberry Gall Psyllid



True bugs, Cicada, Hoppers, Aphids and more.
Former orders Hemiptera & Homoptera lumped together

Heteroptera, formerly hemiptera (half-wing)

- Half of front wing is thickened, the other half is membranous. Hind wing is totally membranous.
- The wings at rest are held flat over the abdomen one over the other giving their backs a distinctive appearance.
- Mouthparts are piercing-sucking types that arises from front part of the head.
- Simple metamorphosis.



Ambush Bug



Squash Bug



Common Water Skipper

Stink Bug



Backswimmer

Water Boatmen



Auchenorrhyncha- cicadas, treehoppers, planthoppers, spittlebugs (neck nose)

- Piercing-sucking mouthparts arise from the back of the head near the neck region.
- Most feed on plant fluids
- Front wings are the same throughout, either thickened or membranous. Hind wings are membranous.
- Wings are held tent-like over the body.
- One or both sexes may be wingless.
- Simple metamorphosis.



Cicada



Spittlebug



Buffalo
Treehopper



Sternorrhyncha – whiteflies, aphids, scale insects, mealybugs (chest nose)

- Piercing-sucking mouthparts, consume plant juices
- Many are soft bodies
- Most are wingless
- Simple metamorphosis

Aphids





Scale Insect

Mealybug



Whitefly



Thrips – O. Thysanoptera (fringe wing)

- Tiny
- With or without wings
- Rasping -sucking mouthparts
- Flower thrips, in numbers can feed heavily in rosebuds, for instance, so buds fail to open into flowers, or if they do, the petals show discoloring in streaks or spots. Thrips also may carry diseases from one plant to another.



Lacewings, Antlions and more – O. Neuroptera (nerve wing)

- Four wings with many veins
- Complete metamorphosis
- Mandibles, long antennae

Green lacewing



Antlion



Beetles – O. Coleoptera (sheath wing)

- The largest order in the class Insecta.
- The front wings, known as elytra, fold down over the abdomen and serve as protective covers for the large, membranous hind wings.
- At rest, both elytra meet along the middle of the back, forming a straight line.
- Both larvae and adults have chewing mouthparts.
- Many species are herbivores. Many beetles are predators.
- Some are scavengers, feeding primarily on carrion, fecal material, decaying wood, or other dead organic matter.
- There are even a few parasitic.



Blister Beetle



Locust Borer



Milkweed Beetle



Click Beetle, Wireworm



Stink Beetle

Black Vine Weevil



Sweet Clover Weevil

Blue Milkweed Beetle



Rove beetle



Ten-lined June Bug



Great Predaceous Diving Beetle



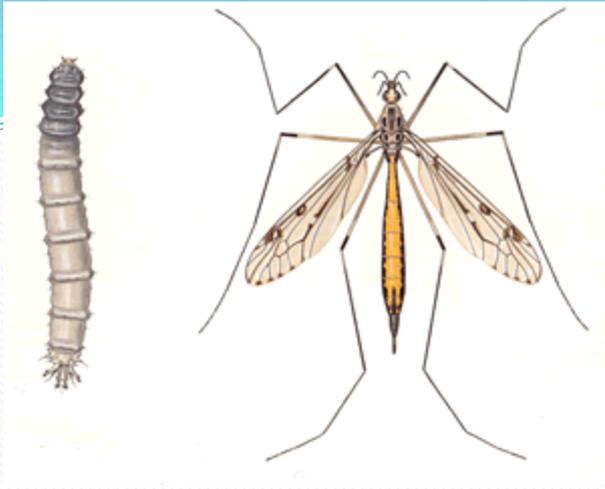
Giant Black water
Scavenging Beetle

Japanese Beetle



Flies – O. Diptera (two wing)

- Complete metamorphosis
- Hind wings are reduced to small, club-shaped structures called halteres. Act like gyroscopes.
- Larvae are legless
- Their mouthparts are so diverse that some entomologists suspect the feeding adaptations may have arisen from more than a single evolutionary origin. In many families, mouth is adapted for sponging and/or lapping. In other families, the mouth is adapted for cutting or piercing the tissues of a host.



Crane Fly



Midge



Cherry Fruit Fly



Mosquito



Hover Fly



Robber Fly



Tachinid Fly

Caddisflies- O. Trichoptera (hair wing)

- The body and wings are clothed with long silky hairs.
- At rest the wings are held tent-like over the abdomen.
- Many caddisflies have reduced or vestigial mouthparts.
- All caddisfly larvae live in aquatic environments; they may be herbivores, scavengers, or predators.
- The predatory species are free-living or spin silken structures in the water (webs or tunnels) to entrap prey.
- The scavengers and herbivores live within protective "cases" which they build from their own silk and stones, twigs, leaf fragments, or other natural materials. The case is usually portable, dragged around like a snail shell as the insect moves, and held in place by a pair of hooked prolegs at the tip of the abdomen.
- Most species have thread-like abdominal gills and get oxygen from water that circulates inside the case. All larval growth and development (including pupation) occurs within the case.





Butterflies, Moths & Skippers –

O. Lepidoptera (scale wing)

- Second largest order.
- Nearly all larvae are called caterpillars. They have a well-developed head with chewing mouthparts. In addition to three pairs of legs on the thorax, they have two to eight pairs of fleshy abdominal prolegs that are structurally different from the thoracic legs.
- Most lepidopteran larvae are herbivores; some species eat foliage, some burrow into stems or roots, and some are leaf-miners.
- Adults are distinctive for their large wings, which are covered with minute overlapping scales. Most entomologists believe that these scales are structurally related to the hair (setae) covering adult caddisflies.
- Although moths probably diverged from caddisflies about 230 million years ago, adults in a few primitive families (e.g., Micropterygidae) still retain evidence of chewing mouthparts.

- In all other lepidopteran families, the mouthparts are vestigial or form a tubular proboscis that lies coiled like a watch spring beneath the head. It uncoils by hydrostatic pressure and acts as a siphon tube for sipping liquid nutrients, such as nectar, from flowers and other substrates.
- From a taxonomic standpoint, the distinction between moths and butterflies is largely artificial -- some moths are more similar to butterflies than to other moths. As a rule, butterflies are diurnal, brightly colored, and have knobs or hooks at the tip of the antennae. At rest, the wings are held vertically over the body.

- Skippers have the antennae clubs hooked backward like a crochet hook.
- Skippers also have generally stockier bodies and larger compound eyes than the other two groups, with stronger wing muscles in the plump thorax in this resembling many moths.
- When at rest, skippers keep their wings usually angled upwards or spread out, and only rarely fold them up completely.
- Most (but not all) moths are nocturnal. They are typically drab in appearance, and have thread-like, spindle-like, or comb-like antennae. At rest, their wings are held horizontally against the substrate, folded flat over the back, or curled around the body.
- Some moths have tympana and can hear bat sonar.



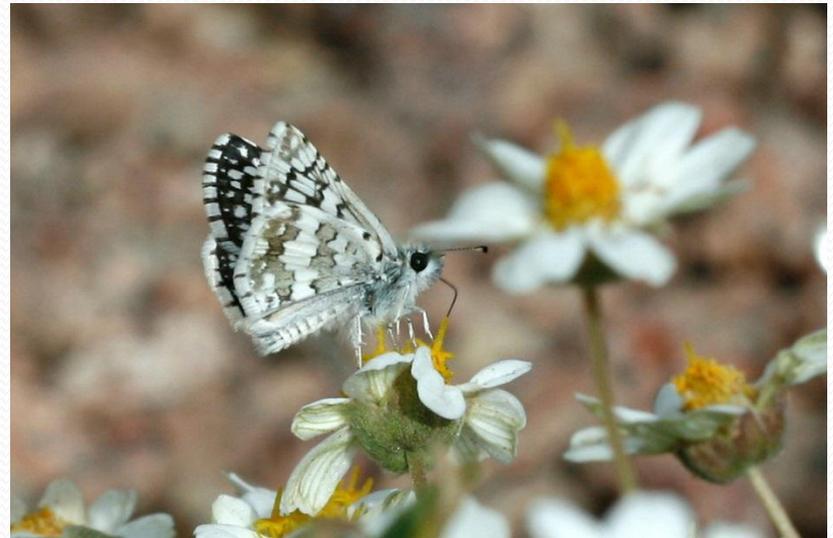
Lorquin's Admiral

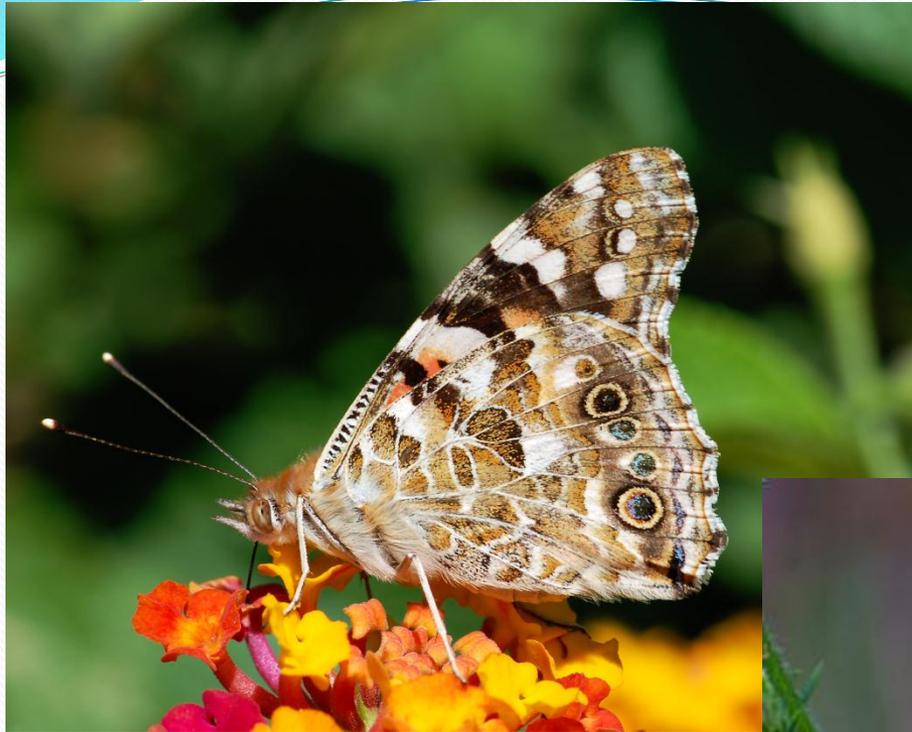


Western Swallowtail



Common
Checkered
Skipper





Painted Lady





Corn Earworm

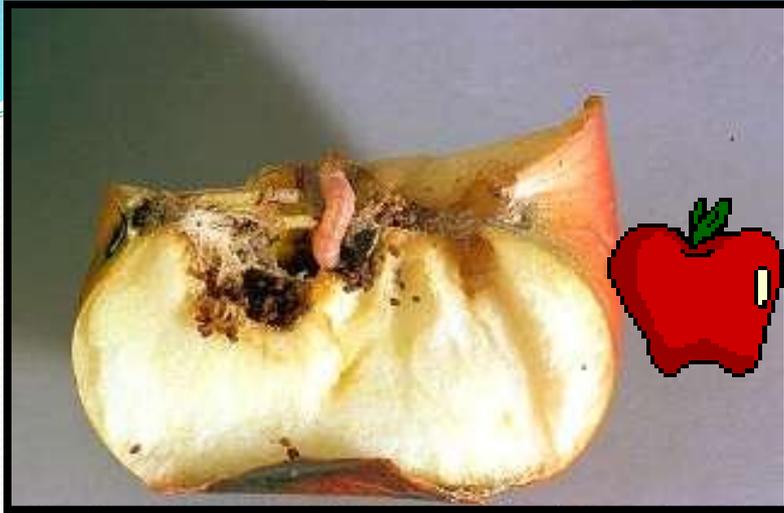


Cutworm



Looper





Coddling Moth



Clothes Moth



Peach Tree Borer



Banded Woolly Bear

Sawflies, Wasps, Ants & Bees – O. Hymenoptera (membrane wing)

- Winged or Wingless
- Two pair of membranous wings
- Few feed on plant foliage
- Mouthparts: chewing and sucking
- Beneficial as pollinators, parasites & predators
- Stings are a nuisance

Red Harvester Ants

- Will sting or bite
- Colonies occur in open areas
- Do not invade homes



Red harvester ants

Carpenter Bees



Male



Female

Leaf Cutter Bees



Bumble Bees



Yellow Jackets & Hornets



Bald-faced Hornet



Western Yellow Jacket



Paper Wasps

Mud Daubers

Sand Wasps



Mud Daubers



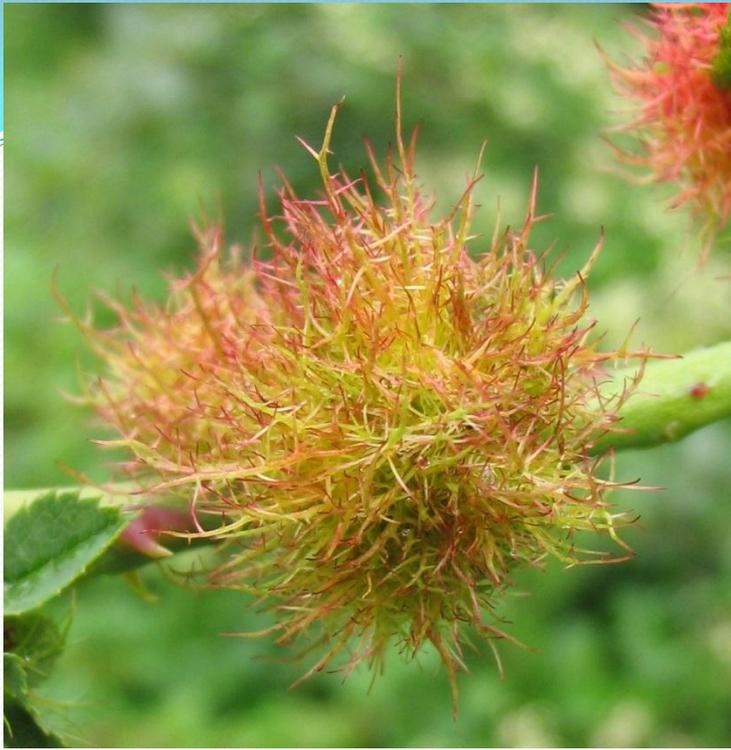
Sand Wasp

Velvet Ant



- Cowkiller, Velvet Ant





Mossy Rose Gall Wasp



Males are very rare. A female infected with the bacteria *Wolbachia* produces only diploid eggs, which leads to entirely female progeny. When the females were treated with antibiotics, they were then able to produce normal male and female eggs.



Ichneumon wasp

