

Insects



Phylum *Arthropoda*

Subphylum *Uniramia*

Class *Insecta*

Characteristics

- Largest arthropod group
- Found in freshwater & terrestrial habitats, especially tropical areas
- Legs, mouthparts, & antenna jointed
- Body segmented into three sections --- head, thorax, & abdomen
- Six legs & up to two pairs of wings located on thorax
- Have compound & simple eyes
- One pair of antennae on head
- Abdomen has 11 segments
- Exoskeleton, covering & protecting body, is made of chitin & must be molted to grow
- Elaborate mouthparts include:
 - * Mandibles - jaws
 - * Maxillae - paired sensory structures that move food to mouth
 - * Labium - lower lip
 - * Labrum - upper lip
 - * Palpi - used for tasting
- Known as mandibulates
- Spiracles on abdomen open into tracheal tubes for oxygen & carbon dioxide exchange
- Tympanic membranes on 1st abdominal segment aid in hearing
- Thorax divided into 3 sections --- prothorax, mesothorax, & metathorax
- One pair of legs on each thoracic segment
- Wings located on mesothorax & metathorax
- Ovipositor located on the end of the abdomen in female insects & used to dig hole & lay eggs

Common Insect Orders

- Orthoptera - grasshoppers, crickets, & cockroaches (2 pairs of straight wings & chewing mouthparts)
- Isoptera - termites (feed on wood)
- Dermaptera - earwigs (pincers on end of abdomen)
- Anoplura - sucking lice (wingless parasites)
- Hemiptera - true bugs (have triangular-shaped scutellum & last 1/3 of wings membranous)
- Homoptera - aphids & cicadas (membranous wings held roof-like over body)
- Ephemeroptera - mayflies (have 2 cerci on tail, membranous wings, & nonfunctional mouthparts in adults)
- Odonata - dragonflies & damselflies (2 pairs of equal size, membranous wings, strong fliers, feed on other insects)
- Neuroptera - Dobson flies & lacewings (2 pairs of membranous wings)
- Coleoptera - beetles (hard forewings or elytra, membranous hindwings)
- Lepidoptera - butterflies & moths (powdery scales covered wings)
- Diptera - flies & mosquitoes (one pair of wings, 2nd pair modified into balancing structure called halteres)
- Siphonaptera - fleas (parasites on birds & mammals, wingless as adults)
- Hymenoptera - bees, ants, & wasps (stinger on abdomen for protection, may live together in groups, pollinators)

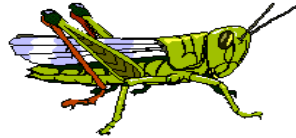
Success of Insects

- Found everywhere except in deep part of ocean
- Very short life span & rapidly adapt to new environments
- Small size helps minimize competition in habitats
- Flight helps escape predators & move into other environments

Environmental Impact

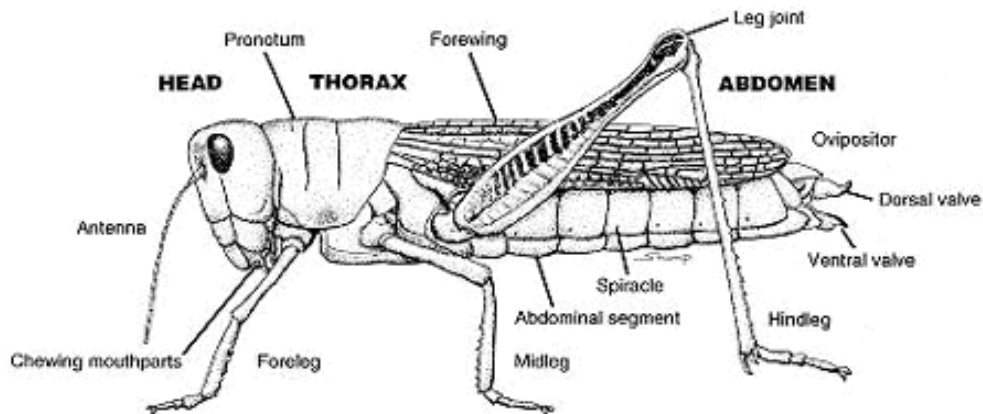
- Pollinate almost 2/3's of all plants
- Serve as food for fish, birds, & mammals
- Help recycle materials (termites recycle wood)
- Make useful byproducts such as silk & honey
- Some spread disease
- Agricultural pests

Grasshoppers



External Structure

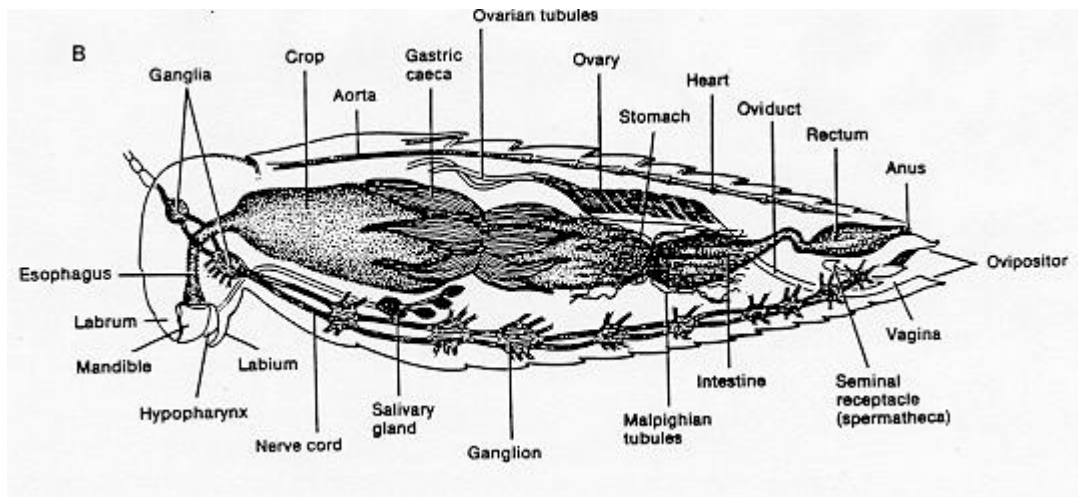
- Head with antenna, compound eyes, & chewing mouthparts
- Walking legs on prothorax & mesothorax; jumping legs on metathorax
- Tarsus are lower leg segments with spines, hooks, & pads
- Leathery, protective forewings on mesothorax & membranous hindwings for flight on metathorax
- Covering over thorax called pronotum



Internal Structure

Digestive & Excretory Systems

- Cutting & chewing mouthparts (labium, labrum, mandibles, & maxillae)
- Saliva added to food in mouth
- Esophagus carries food to crop for temporary storage
- Gizzard has chitinous plates to grind food
- Midgut (insect's stomach) has gastric caeca (pouches) to secrete digestive enzymes to break down food
- Food is absorbed into the body cavity or coelom in the hindgut (composed of the colon & rectum)
- Malpighian tubules filter chemical wastes from the blood & deposit them in the rectum where they leave through the anus



Circulatory System

- Open circulation of blood
- Aorta is the largest blood vessel carrying blood to the body cells
- Hearts are muscular regions of the aorta in the posterior end of the abdomen that pump blood toward head
- Blood flows back toward abdomen carrying digested food & re-enters the aorta through openings called ostia

Respiratory System

- Air enters through openings called spiracles along the sides of the abdomen & enters into tracheal tubes that branch into smaller tracheoles where gas exchange with body cells occurs
- Tracheal tubes carry oxygen to body cells & return carbon dioxide to leave the body through spiracles

Nervous System

- Simple brain, nerve cords, & ganglia
- Three simple eyes or ocelli (detect light) & a pair of compound eyes (can detect movement but not images)
- Tympanic membrane on 1st abdominal segment
- Pair of antenna contains sense organs for touch, taste, & smell detects sound
- Sensory hairs found on parts of the body
- Palpi for taste

Reproductive System

- Reproductive organs (ovaries & testes) located in abdomen
- Male deposits sperm into female's seminal receptacle
- Stored sperm fertilizes eggs as they are released by female
- Ovipositor on tip of female's abdomen is used to lay eggs
- Separate sexes
- Lay large number of eggs to ensure survival

Development

- Most insects go through changes in form & size called metamorphosis
- Some insects such as silverfish don't go through metamorphosis
- Incomplete metamorphosis goes from egg to nymph (immature form that looks like adult but without fully developed wings) to adult (3 stages)

- Instars are growth periods between molts of nymphs & larva
- Grasshoppers, termites, & true bugs go through incomplete metamorphosis



HEMIPTERAN (TRUE BUG) NYMPH

- Complete metamorphosis goes from egg to larva (segmented & wormlike) to pupa to adult (4 stages)



BUTTERFLY LARVA (CATERPILLAR)

- Butterflies, beetles, & flies go through complete metamorphosis
- In pupal stage, larval tissues break down & cells called imaginal disk develops into tissues of the adult
- Cocoon or chrysalis is a protective case formed around the pupa



BUTTERFLY COCOON

- Metamorphosis controlled by hormones
 - * Brain hormone stimulates the release of molting hormone (ecdysone)
 - * When juvenile hormone level high, larva molts
 - * When juvenile hormone level low, larva pupates
 - * When juvenile hormone absent, adult emerges from pupal case
- Different stages of metamorphosis eliminates competition between larva & adults for food & space
- Multi-stage life cycle helps insects withstand harsh weather
- Different stages have different functions (caterpillar/growth & adult/reproduction)

Defense Mechanisms

- Bombardier beetle sprays noxious chemical



BOMBARDIER BEETLE

- Wasps & bees can sting
- Some insects use camouflage to blend into their environments
- Some insects taste bad & have warning colorations



PAPER WASP

- Mullerian mimicry - poisonous or dangerous species have similar patterns of warning coloration so predators avoid all the species (black & yellow stripes on bees & wasps)
- Batesian mimicry - species that are nonpoisonous or not bad tasting have colorations that mimic other poisonous or bad tasting species (Viceroy butterfly mimics bad tasting Monarch)

Insect Communication

- Insects may communicate with each other using sound (cricket chirps), light (firefly), or "dances" (honeybee)
- Pheromones are chemicals released by some insects to attract mates or mark trails

Insect Behavior

- Insects may be solitary or social
- Social insects (bees, ants, & some wasps) live together in groups & share work (division of labor)
- Social insects have a caste system with different individuals doing different jobs
- Honeybee caste system:

* Workers

- sterile females
- care for queen & feed her honey and pollen
- make beeswax for hive
- fan wings to cool hive
- eat honey
- collect nectar, pollen, & royal jelly
- live about 6 weeks
- nurse bees care for larva
- secrete royal jelly to feed new queen

* Drones

- males
- mate with queen
- feed by workers
- driven out of hive to conserve food during winter

* Queen

- reproductive female
- mate only once but store sperm for up to 5 years in seminal receptacles
- feed by workers
- secretes chemical called queen factor that prevents other females from sexually maturing
- leaves hive with 1/2 the workers if there is overcrowding



HONEYBEE HIVE