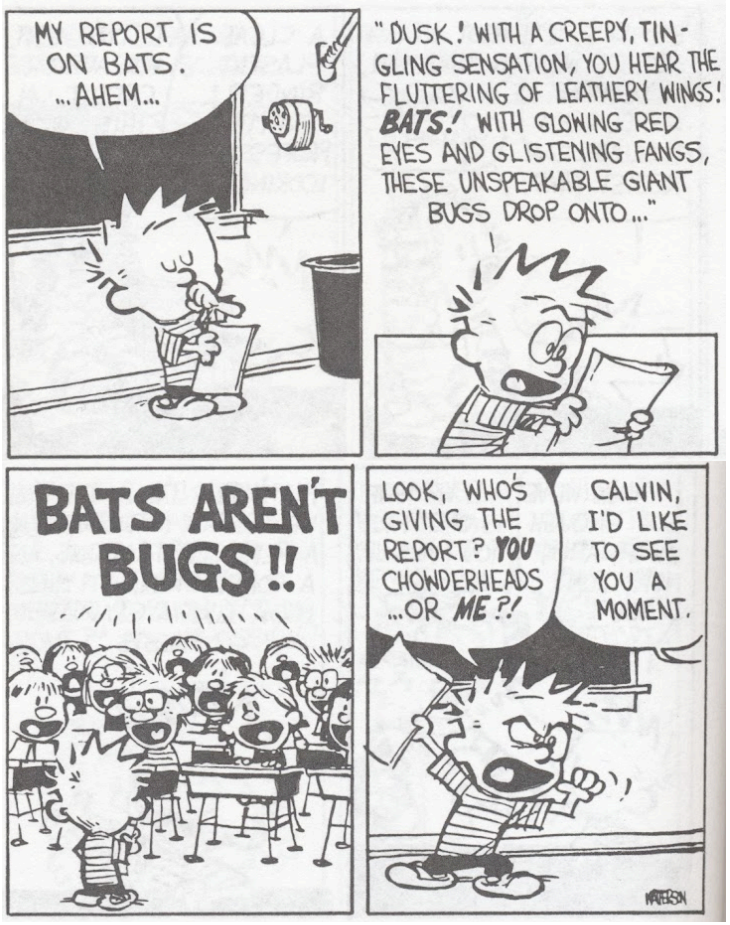
- **Ecdysozoa**
  - **Nematoda** *Caenorhabditis*
  - **Arthropoda**
    - **Chelicerata**
      - **Opiliones** *Phalangium*
      - **Scorpionida** *Pandinus*
      - **Acari** *Sarcoptes, Ixodes*
      - **Araneae** *Haplopelma, Nephila*
    - **Myriapoda**
      - **Chilopoda** *Scolopendra*
      - **Diplopoda** *Glomeris*
    - **Crustacea**
      - **Branchiopoda** *Daphnia, Triops*
      - **Malacostraca** *Homarus, Stenopus, Birgus, Oniscus*
    - **Hexapoda**
      - **Collembola** *Podura*
      - **Insecta**
        - **Thysanura** *Lepisma*
        - **Pterygota**
          - **Odonata** *Libellula*
          - **Neoptera**
            - **Dictyoptera**
              - **Blattaria** *Blatta*
              - **Isoptera** *Macrotermes*
            - **Orthoptera** *Tettigonia, Schistocerca*
            - **Phthiraptera** *Pediculus*
            - **Hemiptera** *Aphis, Cicadella*
            - **Endopterygota**
              - **Coleoptera** *Carabus, Agrilus, Curculio, Psylliodes*
              - **Hymenoptera** *Urocerus, Agaon, Rhyssa, Apis, Vespa*
              - **Lepidoptera** *Papilio, Macroglossum, Acronicta, Geometra*
              - **Diptera** *Culex, Tabanus, Eristalis, Drosophila*
              - **Siphonaptera** *Pulex*



Ecdysozoa:

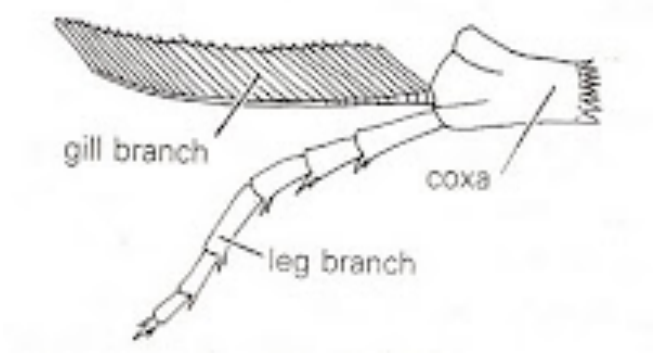
- Basic characteristics:
  - Symmetry? Development?

- What is it named for?
  - Hormone involved?

- Also includes Nematoda and Tardigrada
  - Which one of these is not like the other?

Arthropoda:

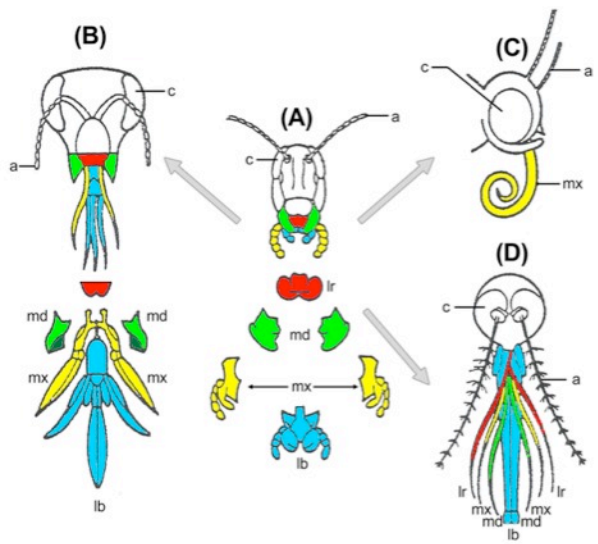
- Also includes:
  - Trilobitomorpha
  - Chelicerata
    - Phalangium, Pandinus, Sarcoptes, Ixodes, Haplopelma, Nephila
  - Myriapoda
    - Scolopendra, Glomeris
  - Crustacea
    - Daphnia, Triops, Homarus, Stenopus, Birgus, Oniscus
- Biramous appendages

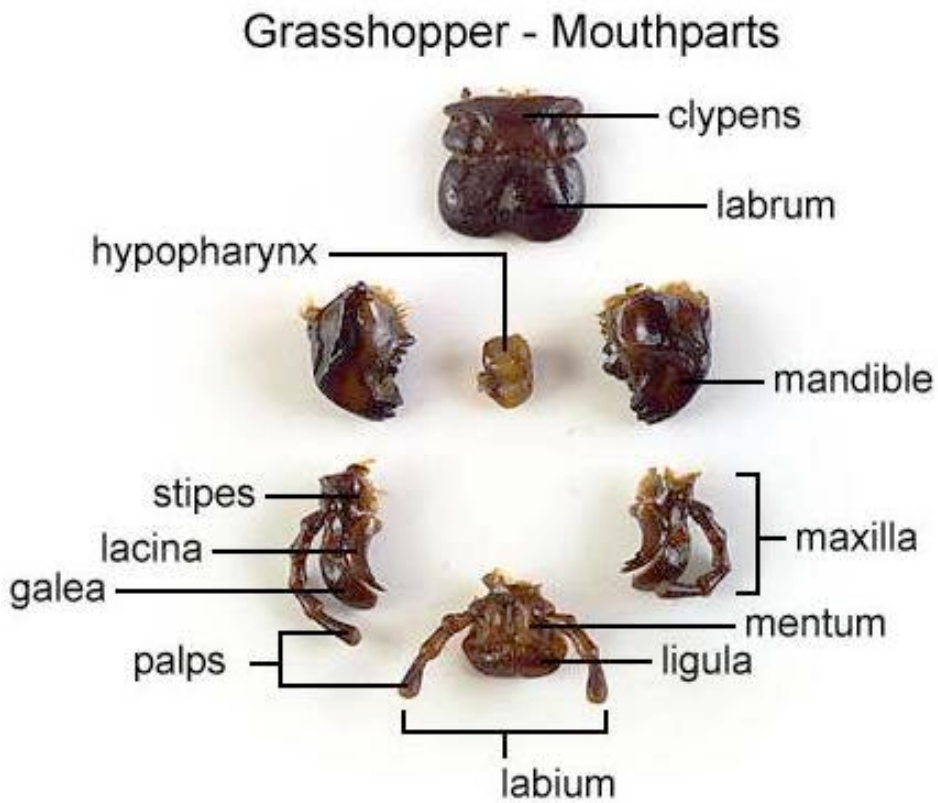


- Coelomate
  - Where is it located?
- Hemocoel
  - What function does it take in insects?

Hexapoda:

- Three thoracic segments
  - Three pairs of legs
  - 'Tripod' walking
- Wings?





Podura aquatica

Also includes entognaths

- Collembola – springtails
  - Short legs, plump oval body, few abdominal segments
  - Furcula 'tail' held under tension under the body allows jumping

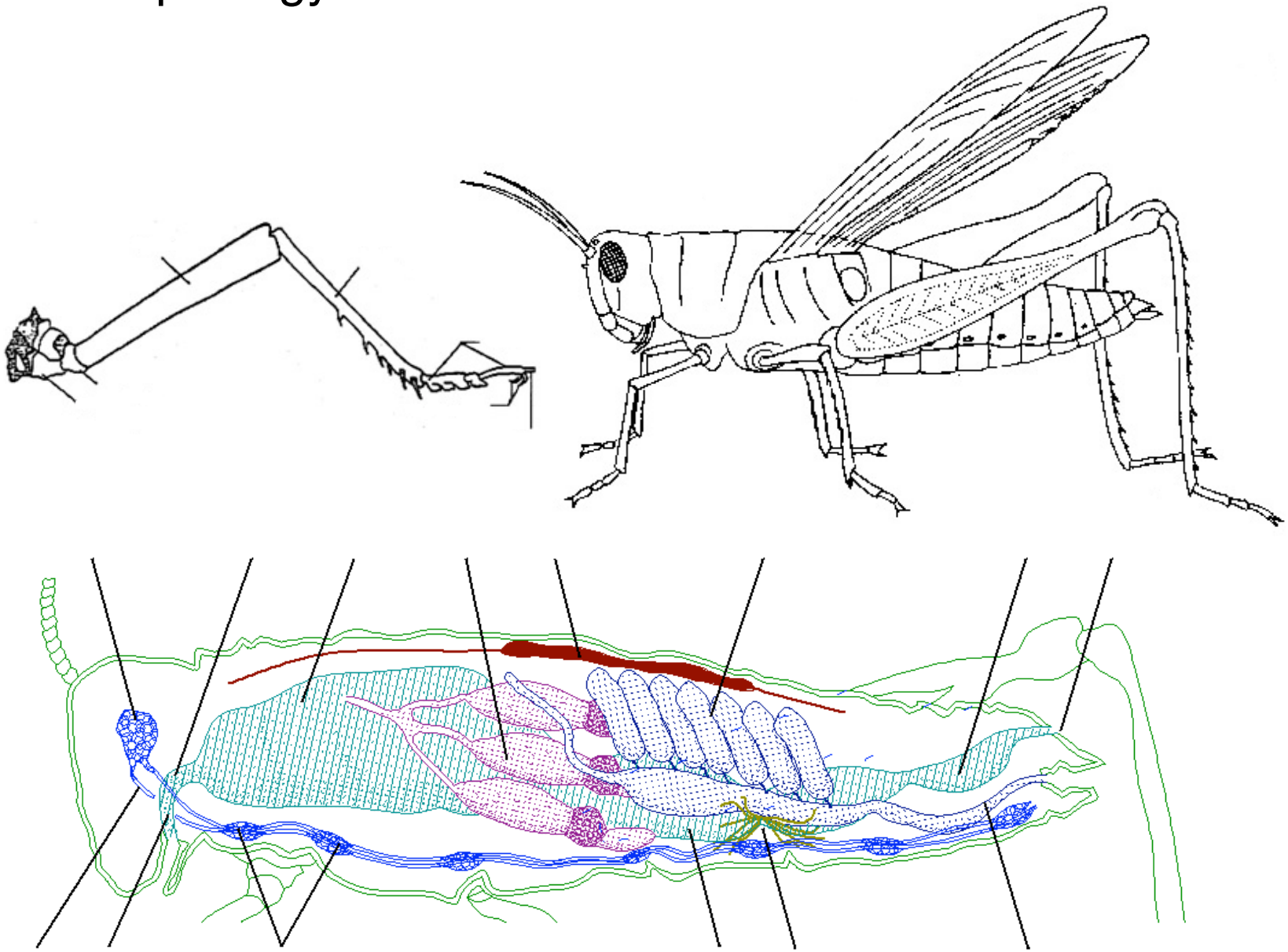
Insecta:

- Latin *insectum* – divided body
- Primarily land and air – who rules the sea?

- Metamorphosis
  - Anamorphosis
  - Simple metamorphosis – hemimetabolous
    - Nymph, instar
  - True metamorphosis – holometabolous

- First appear in the Devonian period ~400 million years ago

Insect morphology



Thysanura: Silverfish

- Greek *thysanos oura* – tassel tail
    - Two lateral abdominal cerci and a caudal filament

- Wingless
- Long flat body, simple mouthparts, reduced or no eyes, long antennae
- Unique life cycle – effectively no metamorphosis
- Continue to molt after sexual maturity
- Unspecialized chewing mouthparts
- Often mistaken for earwigs - Dermaptera

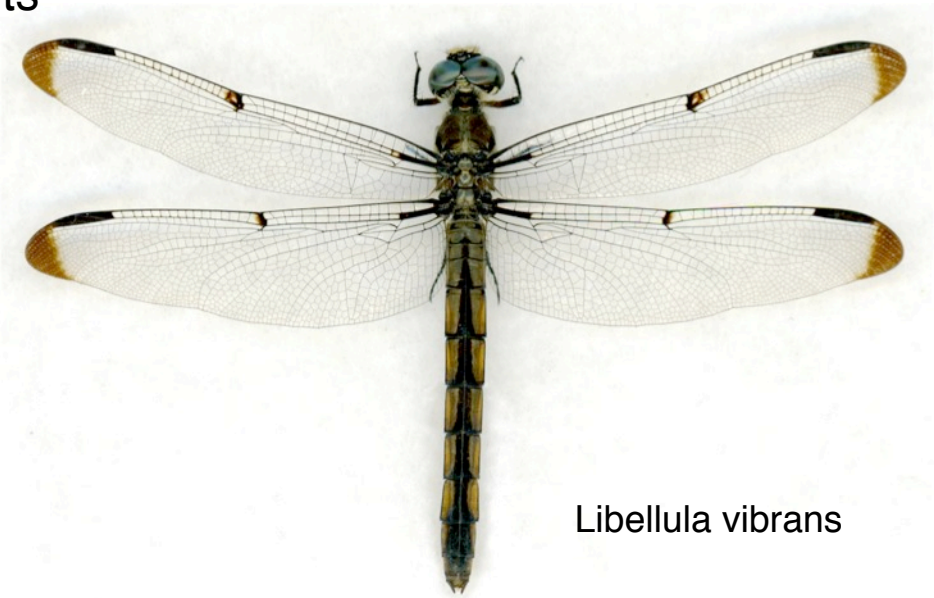
Lepisma saccharina

Pterygota:

- Winged insects
  - Many secondarily wingless

Odonata: Dragonflies

- Greek *odontos* – tooth
  - Toothed mandibles (bad name, lots of other insects also have this)
- Carnivorous chewing mouthparts
- Large compound eyes
- Short filiform antennae
- Hemimetabolous development



Libellula vibrans

Neoptera:

- Able to fold wings back over the abdomen

Dictyoptera:

- Greek *diktuon pteron* – net wing
- Also includes Mantodea, the mantids

Blattaria: Cockroaches

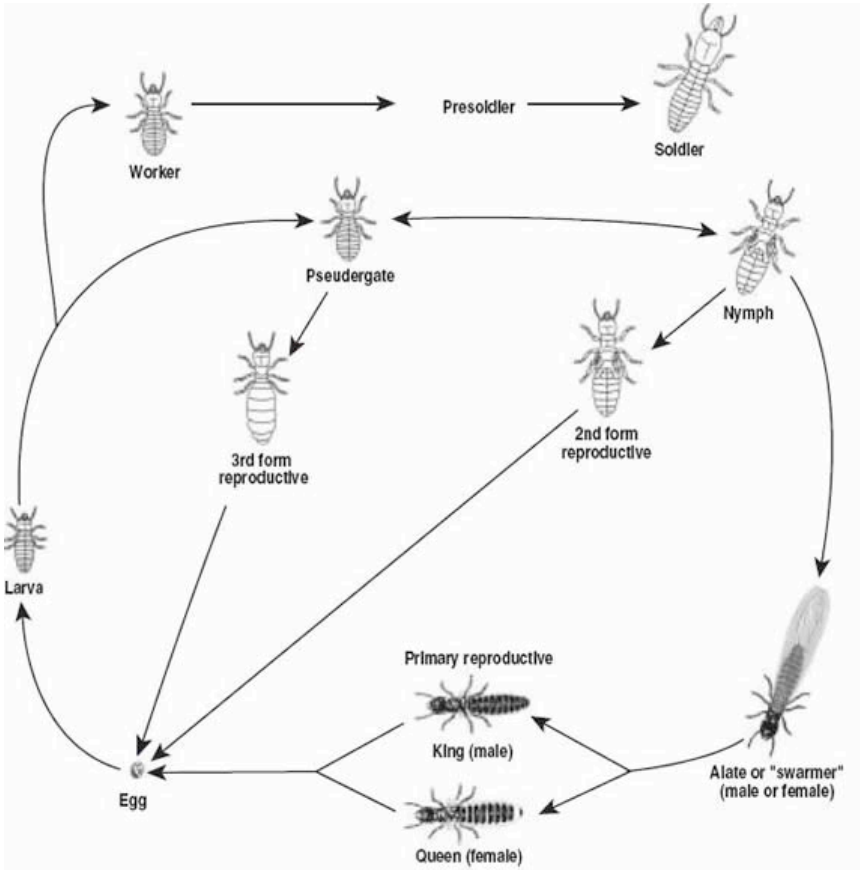
- Latin *blatta* – cockroach
- Thickened forewings – tegmina
- Prominent cerci, flat body, small head under extended pronotum, long filiform antennae
- Chewing mouthparts
- Hemimetabolous – young are often very pale

- Blattabacterium cuenoti – mutualistic endosymbiont found in all Blattaria

Blatta orientalis

Isoptera: Termites

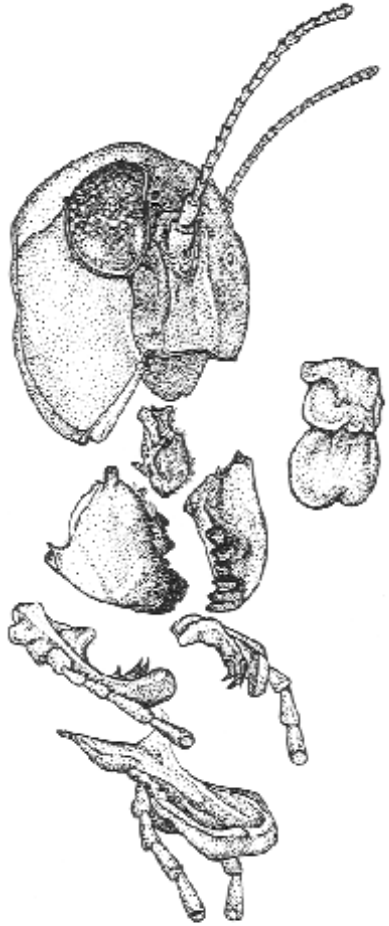
- *Iso pter* – same wings
- Winged individuals have two sets of nearly identical wings
- Typically wingless
  - Winged alates are reproductive
- Eusocial caste system
  - Differential caste morphology
- Thorax-abdomen connection is often not distinct



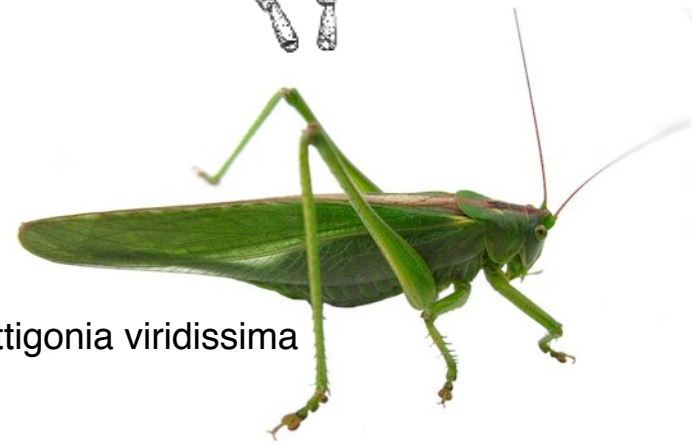
Macretermes glivus

Orthoptera: Grasshoppers, crickets

- Greek *ortho ptera* – straight wing
- Prominent tympanum ‘eardrum’
- Chewing mouthparts
- Simple metamorphosis



Schistocerca pallens



Tettigonia viridissima

Phthiraptera: Lice

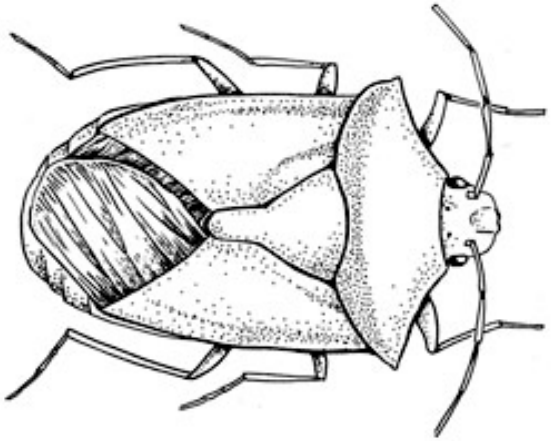
- Greek *phtheir a ptera* – louse no wings
- Obligate parasites of mammal and avian species
    - Which mammals don't get lice?

- Biting/sucking mouthparts - parasitic
- Dorsoventrally flattened body
- Generally colorles
- Often eyeless, or very reduced eyes
- Reduced filiform antennae
- Adapted tarsal hooks

Pediculus humanus

Hemiptera: Generic ‘bugs’ – cicadas, aphids, stink bugs

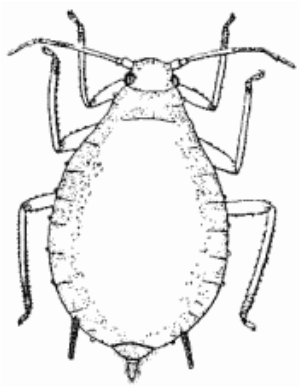
- Hemimetabolous – how’d you guess?
  - Wingless young slowly develop wings through successive instars
- Some have “half-and-half” forewings
  - Half leathery and half membranous
    - “X marks the bug”
  - Don’t mistake them for beetles!
    - Visibly crossed wings



- Piercing mouthparts – Rostrum
  - Feed on fluids
- Varied antennae

Cicadella viridis

Aphis pomi

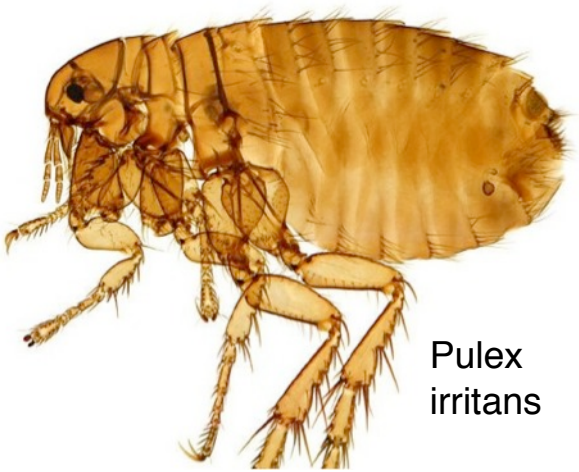


Endopterygota:

- *Endo ptery* – internal wings
  - Wings develop within – true metamorphosis
- AKA holometabola
  - All orders of endopterygota are holometabolous

Siphonaptera: Fleas

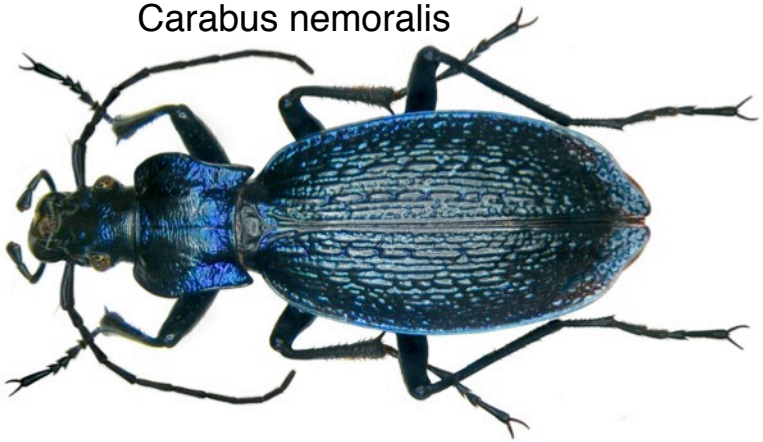
- *Siphon a ptera* – tube no wing
- Piercing/sucking mouthparts
- Powerful jumping legs
  - Elastic protein resilin stores energy in tarsi
- Sexual maturity in fleas is influenced by hormones in host blood
- Laterally flattened body
  - Allows movement between hairs
- Short recessed antennae



Pulex irritans

Coleoptera: The Beatles

- Also includes weevils
- Greek *koleos pteron* – sheath wing
    - Thickened forewings – elytra
    - Hind wings are membranous flight wings
- Pronounced pronotum
- Downward pointing head
- Often enlarged specialized mandibles



Carabus nemoralis

Psylliodes affinis

Curculio villosis

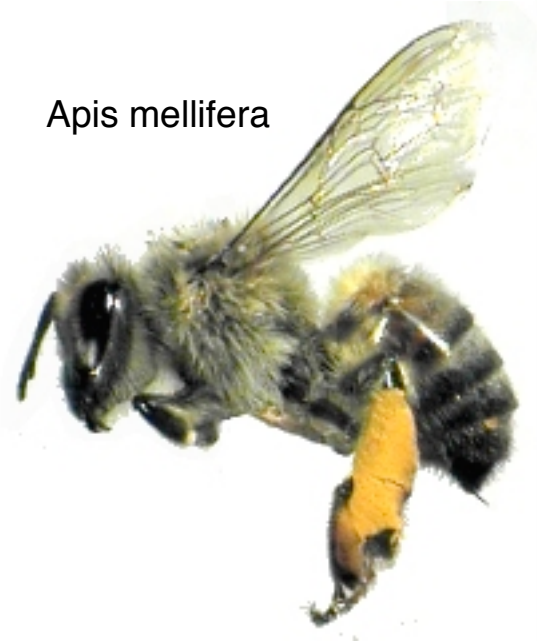
Agrilus albogularis

Hymenoptera: Bees, wasps, ants

- Greek *hymen ptera* – membranous wing
- Complete metamorphosis
- Two pairs of wings act as one
    - Hamuli hooks on hind wings attach to forewings
- Some mouthparts modified to sucking proboscis
- Distinctive pinched abdomen
- Major modification of ovipositor to sting

Vespa crabro

Apis mellifera



Urocerus gigas

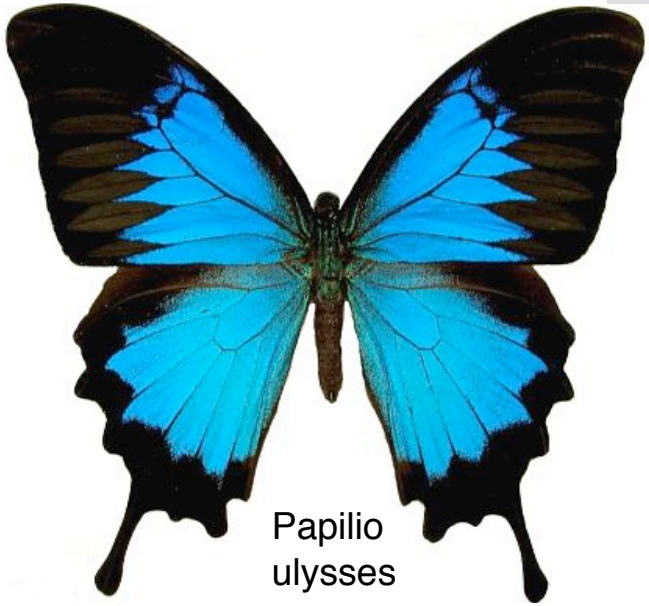
Rhyssa amoena

Lepidoptera: Butterflies, moths

- Greek *lepis ptera* – scale wing
- Larval chewing mouthparts, adult sucking mouthparts
- Large compound eyes
- Proboscis

Geometra papilionaria

Acronicta americana



Papilio ulysses

Macroglossum pyrrhosticta

Diptera: Flies, mosquitoes

- Greek *di ptera* – two wings
- A winged insect with only one pair of wings? That's unpossible!
    - Halteres – greatly reduced wings
    - Originate from which segment?
- Highly modified mouthparts
- Short simple antennae
- Well developed eyes

Eristalis tenax

Tabanus bovinus

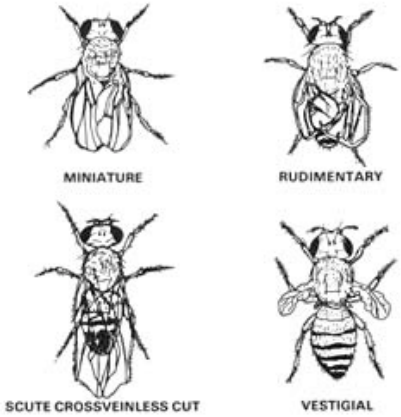
Drosophila melanogaster

Culex quinquefasciatus

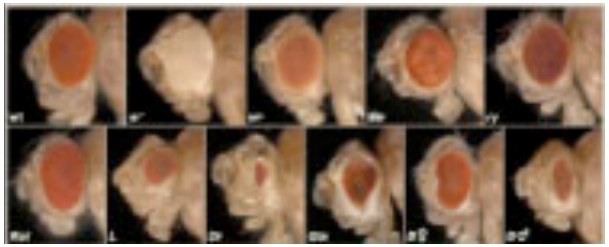
Drosophila!

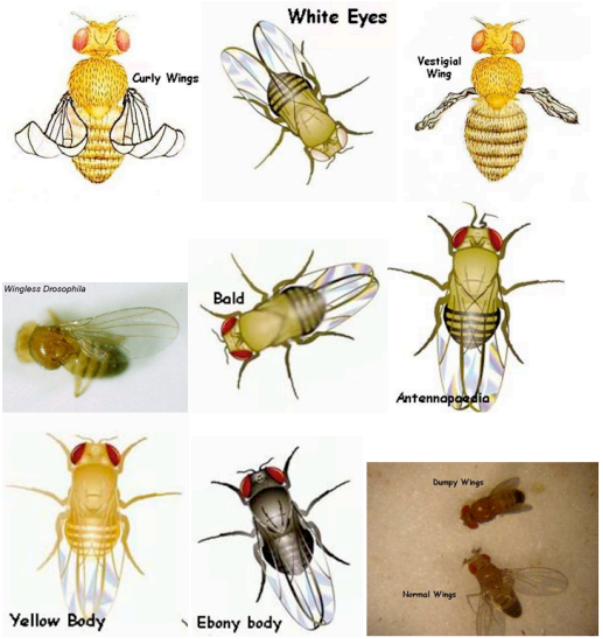
- Sexing
- Identifying virgins
- Common mutant phenotypes

🡐 Well, at least two out of three sound exciting

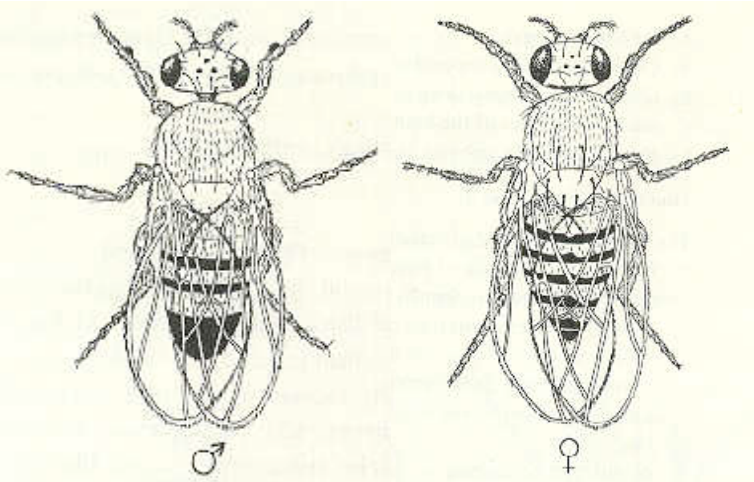


Commonly observed mutations: eye and body color, wing shape, hair morphology



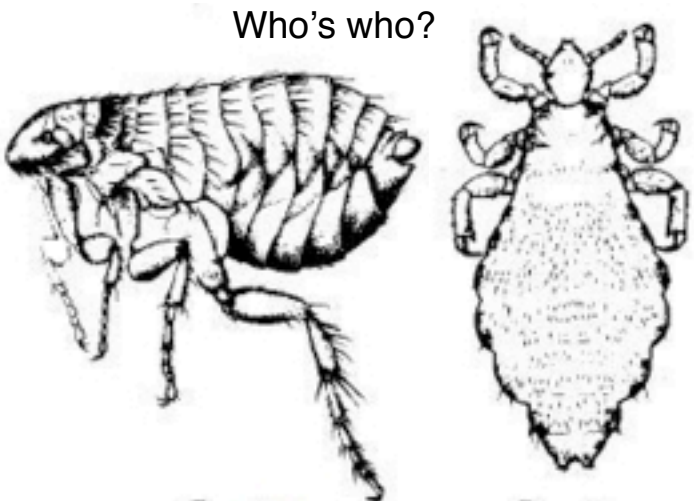


Virgins are much lighter in color with a dark splotch in the abdomen – the meconium



Male: Sex combs on forelegs, rounder darker abdomen, dark spots on wings in some species
Female: Pointed abdomen, often larger

Tricky bugs



Which one of these is not like the others?

Insect behavior

- Lots of mimicry
- Complex social interactions
    - Colonial populations – relatedness influences behavior
    - Sex determination by chromosome count
- Learning and memory
- Symbolic communication