

## Systematics and Taxonomy, Entognatha through Blattaria

### Systematics:

### Taxonomy:

#### Hierarchy of categories used in classification ...

Phylum (and subphylum)

Class (and subclass)

Order (and suborder)

Superfamily

Family (and subfamily)

(Tribe)

Genus (and subgenus)

Species (and subspecies)

Names of the people who described a species:

*Papilio glaucus* Linnaeus (Lepidoptera: Papilionidae)

The scientific name of the tiger swallowtail described by Linnaeus in the genus *Papilio*

*Leptinotarsa decemlineata* (Say) (Coleoptera: Chrysomelidae)

The scientific name of the Colorado potato beetle, originally described by Say, but using a genus name other than *Leptinotarsa*. (The parentheses around the name of the descriptor tells you it was first described in a different genus.)

### Phylum Arthropoda

Phyla that are most closely related are the Annelida (the segmented worms, including earthworms, sea worms, and leaches) and the Onychophora (wormlike and slug-like creatures that live in moist habitats in the southern hemisphere). Unlike arthropods, annelids do not have segmented appendages, a chitinous exoskeleton, or a tracheal system. Their circulatory system is closed, skeletal muscles are not striated, and excretion is by nephridia. Onychophorans have segmented antennae but not segmented legs or striated muscles; excretion is by nephridia. They do have a chitinous exoskeleton, a tracheal system, and an open circulatory system.

### Subphyla:

**Trilobita** - the trilobites (fossils only). One pair of antennae, paired leg-like appendages, anterior portion covered with a carapace. Marine animals with gill-like structures at the base of the appendages.



Trilobite fossil (New Mexico State University Museum)

**Chelicerata** – the chelicerates. No antennae; the first pair of appendages are chelicerae (involved in food handling); 2 distinct body regions -- cephalothorax and abdomen.

Classes include:

Merostomata -- horseshoe crabs



Horseshoe crab

**Arachnida** –



Left: black and yellow argiope (Oklahoma Biological Survey). Right: brown recluse spider (University of Arkansas Arthropod Museum)

Pycnogonida -- sea spiders ... see

<http://www.ucmp.berkeley.edu/arthropoda/pycnogonida.html>

**Crustacea** 2 pairs of antennae; most appendages end in a 2-branched segment ("biramous")

Classes include:

Branchiopoda -- fairy shrimp



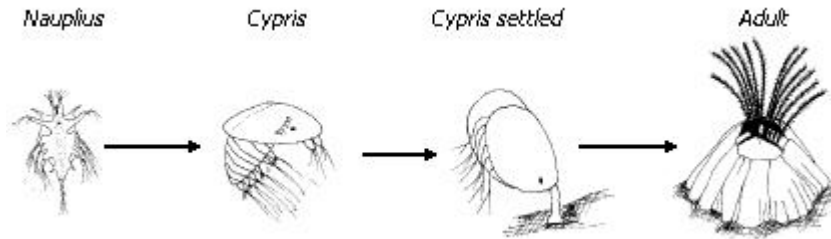
Fairy shrimp (U.S. Fish and wildlife Service)

Copepoda -- copepods (*Cyclops*)



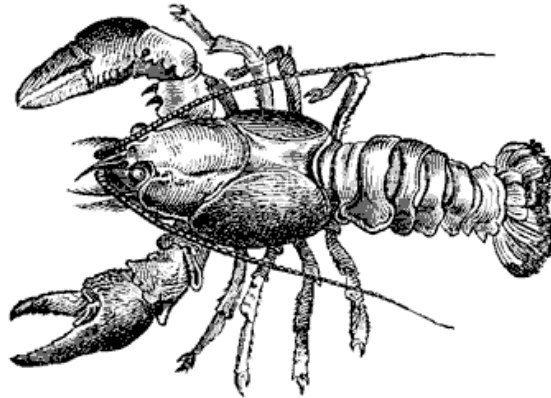
A copepod (University of Florida)

Cirripedia -- barnacles



Barnacle life cycle (Canadian Department of Fisheries and Oceans)

**Malacostraca --**



A lobster (Florida Educational Technology Clearing House).

**Atelocerata**

A single pair of antennae, unbranched appendages, unique structure of mandibles (in comparison with the Chelicerata)

Classes include:

**Diplopoda –**



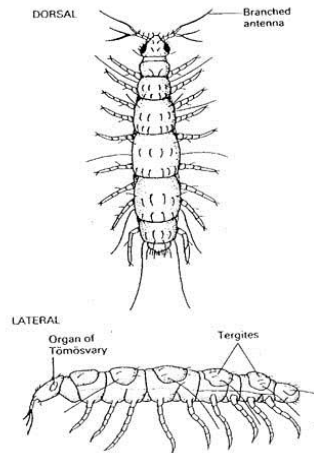
A millipede (University of Illinois)

**Chilopoda –**



A house centipede (University of Kentucky)

### **Pauropoda – pauropods**



Pauropoda (University of Missouri)

### **Symphyla – symphylans**



Garden symphylan (Oregon State University)

### **Hexapoda –**

In this course, we cover all the orders of insects in 6 lectures ... so this portion of the course is indeed an **introduction** to insect taxonomy from an applied standpoint. For each order, you should review your text and consult the web sites that are listed to gain additional background information and see some excellent illustrations. Two sites that are useful for almost all orders are:

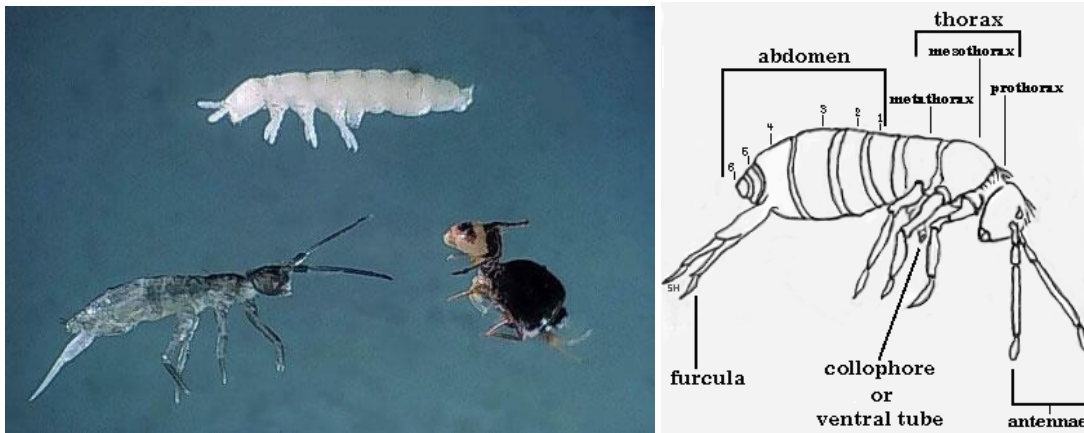
- [An Introduction to Insect Taxonomy at the Wonderful World of Insects](#)
- [The tree of life](#)

This lecture spans the following orders:

Protura -- proturans* Diplura -- diplurans* Collembola -- springtails	Entognatha	Apterygota
Thysanura -- silverfish and firebrats Microcoryphia -- jumping bristletails*	All are ectognathous	Pterygota
Ephemeroptera -- mayflies Odonata -- dragonflies and damselflies Grylloblattaria -- rock crawlers* Phasmida -- walking sticks and leaf insects Orthoptera -- grasshoppers, crickets, and katydids Mantodea -- mantids Mantophasmatodea -- heelwalkers Blattaria -- cockroaches		

\*To cover this range of orders, lecture 6 devotes only a little time to each. In addition, the Protura, Diplura, Microcoryphia, and Grylloblattaria are not discussed at all in this course.

**Collembola:** The springtails



Left: Examples of Collembola (North Carolina State University). Right: Springtail anatomy (University of Missouri).

Coll = glue; embola = bolt or wedge; in reference to the collophore. The common name "springtail" is derived from the fork-like furcula that propels these insects.

Web sites to check:

- [The Order Collembola](#) (at The Wonderful World of Insects)
- <http://en.wikipedia.org/wiki/Springtail>
- <http://www.ext.colostate.edu/pubs/insect/05602.html>

Description and identification:

Mouthparts: Chewing (withdrawn into the head = entognathous)



Size: 0.25 - 6 mm (up to ¼-inch) long

Wings: None

Distinguishing characteristics: The first abdominal segment bears the collophore (an eversible structure once thought to help in clinging [hence the name], now known to function in water uptake). The 3rd abdominal segment bears a tenaculum (catch) and the 4th segment bears a springlike furculum. Most have several eye facets (ommatidia).

Metamorphosis: None (ametamorphosis); immatures (called juveniles) look like adults.

Habitat: Organic debris and soil (some are aquatic) – most feed on decaying plant material, fungi, and bacteria; some feed on arthropod feces, pollen, or algae; some feed directly on plants.

Pest or Beneficial Status: Usually none (direct). Very rarely pests in gardens, greenhouses, mushrooms, alfalfa (Australia: *Sminthurus viridis* L., the lucerne flea).

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**Thysanura:** The bristletails (silverfish and firebrats)



Left: a silverfish. Right: a firebrat. (Clemson University)

Thysan = fringe; ura = tails

Web sites to check:

- [The Order Thysanura](#) (at The Wonderful World of Insects)
- <http://en.wikipedia.org/wiki/Silverfish>
- [Silverfish and firebrat management guidelines](#)

Description and identification:

Mouthparts: chewing

Size: Common species are about 12 mm (1/2-inch) long.

Wings: None

Distinguishing characteristics: Elongate and somewhat flattened; compound eyes present; body covered with scales; long antennae; 3 caudal filaments, 2 lateral, 1 central; abdominal styli.

Metamorphosis: None (ametamorphosis); immatures (called juveniles) look like adults.

Habitat: Debris, under bark, in buildings (some cool and damp, others warmer sites).

Pest or Beneficial Status: Primarily nuisance, some property damage by silverfish and firebrats (may feed on starch of book bindings, similar materials)





**Ephemeroptera:** The mayflies



Left: Mayfly adult (University of Minnesota). Right: Mayfly naiad (George Mason University).

Ephemera = for a day, short-lived; ptera = wings. Adults are very short-lived.

Web sites to check:

- [The Ephemeroptera](#) (at The Wonderful World of Insects)
- [The Order Ephemeroptera](#) (in the Tree of Life)
- ["Mayfly Central"](#) at Purdue University

Description and identification:

Adults:

Mouthparts: None (vestigial)

Size: 2 – 32 mm (1/10 – 1/1/2 inch) long, plus long caudal filaments

Wings: Usually 4, some species only 2. Membranous, with numerous net-like cross-veins. Fore wings are larger, triangular.

Other distinguishing characteristics: Short hair-like (setaceous) antennae; 2 or 3 long caudal filaments; adults very short-lived.

Immatures (called naiads):

Leaf-like abdominal gills; 3 long caudal filaments; winged subimago (sexually immature preadult) emerges from the water, molts to the adult stage the next day.

Metamorphosis: Incomplete (naiads do not look like adults and live in water; wing “pads” develop gradually and externally through successive stages.

Habitat: Immatures are aquatic; adults are found near water. Most nymphs feed on algae or decaying organic material; some are predaceous.

Pest or Beneficial Status: Important fish food; indicators of water quality; mass emergence may be problematic.

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**Odonata:** The dragonflies and damselflies

Odonata = tooth, referring to toothed mandibles

Web sites to check:

[The Order Odonata](#) (in An Introduction to the Classification of Insects)

<http://en.wikipedia.org/wiki/Odonata>

[Odonata photo archive](#)



Left: A dragonfly (Texas A & M University). Right: A damselfly (University of Florida).

Description and identification:

Adults:

Mouthparts: Chewing

Size: 20 to 135 mm (3/4 to 5½ inches in length)

Wings: 4, membranous, with numerous net-like cross-veins. Fore and hind wings are roughly the same length. Wings are marked by a **stigma** -- a thickened, darkened cell at the costal margin of the fore and hind wings.

Other distinguishing characteristics: Very large compound eyes; short hair-like (setaceous) antenna

Suborder **Anisoptera**: dragonflies -- hind wings wider than front wings; wings held horizontally at rest.

Suborder **Zygoptera**: damselflies -- fore and hind wings similar in shape and narrowed at base; wings held together above the body when at rest.

Immatures (called naiads):

Aquatic; labium modified to catch prey; dragonflies with internal (rectal) gills; damsel fly naiads with 3 leaflike gills at the end of the abdomen.

Metamorphosis: Incomplete (naiads do not look like adults and live in water; wing “pads” develop gradually and externally through successive stages.)



Left: dragonfly naiad. Right: damselfly naiad. (Texas A & M University)

Habitat: Immatures are aquatic; adults are found near water. Nymphs and adults are predaceous.

Pest or Beneficial Status: Generalist predators; indicators of water quality.

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**Phasmida:** The walkingsticks and leaf insects (also known as Phasmatodea)



A walkingstick (University of Minnesota).

Web sites to check:

[The order Phasmida](#) (at the Wonderful World of Insects)

<http://en.wikipedia.org/wiki/Phasmatodea>

Description and identification:

Adults:

Mouthparts: Chewing

Size: North American species range from 15 to 180 mm.

Wings: Reduced or absent in stick insects, forewings leaf-like in leaf insects (tropical)

Other distinguishing characteristics: Stick- or leaf-like appearance, slow moving; eggs overwinter, sometimes not hatching until after 2 winters. They are plant-feeders, well-disguised for life on twigs and leaves. They also emit a foul-smelling deterrent. Walking sticks are able to regenerate lost legs, at least in part.

Immatures (nymphs):

... are similar to adults. In those with wings, external wing pads develop as nymphs mature.

**Metamorphosis:** Gradual; nymphs resemble adults and share the same habitat. In those with wings, external wing pads develop as nymphs mature.

**Habitat:** Often on trees and shrubs.

**Pest or Beneficial Status:** Rarely numerous enough to damage host plants.

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**Orthoptera:** The grasshoppers, crickets, and katydids

Ortho = straight; ptera =wing

Web sites to check:

[Orthopterists Society Home Page](#)

[The Order Orthoptera](#) (in The Wonderful World of Insects)

<http://en.wikipedia.org/wiki/Orthoptera>

Description and identification:

Adults:

Mouthparts: Chewing

Size: Moderate to large

Wings: 4, front wings (tegmina) are leathery or parchment-like; hind wings are membranous.

Some are wingless. Wings (and legs) may bear sound-producing structures for stridulation.

Other distinguishing characteristics: Elongate bodies; well-developed cerci; antennae are mostly long and filiform; the ovipositor may be long; hind legs of most are modified for jumping.

Immatures (nymphs):

... are adult-like, and external wing pads develop as nymphs mature.

**Metamorphosis:** Gradual.

**Habitat:** Many types of vegetation

**Pest or Beneficial Status:** Some grasshoppers are crop pests; some crickets are household nuisance pests. In some parts of the world, migratory locusts occur in great numbers and destroy vast areas of crops and other vegetation.

**Family Acrididae:** The shorthorned grasshoppers and locusts:



*Melanoplus* sp. grasshopper (Oregon State University)

Acridids are common late summer grasshoppers. Their antennae are shorter than the body, and the tympanae are located on first abdominal segment. The ovipositor is short in most species. Most are brown to gray, with brightly colored hind wings, and most species overwinter as eggs in the ground. Males sing during the day. Subfamilies include the lubber grasshoppers, the spur-throated grasshoppers (which include *Schistocerca* and *Melanoplus* - this genus in the U.S. contains the migratory grasshopper, the differential grasshopper, and the red-legged grasshopper), the slant-faced grasshoppers, and the band-winged grasshoppers.

**Family Tettigoniidae:** The longhorned grasshoppers / katydids:



An adult katydid (University of Kentucky)

Tettigoniids have long, hair-like antennae, tympanae at the base of the front tibiae, and a flattened, blade-like ovipositor. Most species overwinter as eggs; eggs may be inserted into plant tissue. Subfamilies include the coneheaded grasshoppers (most *Neoconocephalus* species sing a prolonged buzz; *N. ensiger* sings a series of lisped sounds; this group sings at night), the bush katydids (we often see the green bush katydid here), the true katydids (this subfamily contains the northern true katydid, the owner of the “katy did, katy didn’t” song) (evening singers), meadow grasshoppers, and the shield-backed grasshoppers (including the Mormon cricket).

[Katydid and cricket songs.](#)

**Family Gryllidae:** The crickets

Crickets have long antennae, the auditory organs on the front tibiae, and needle-like (cylindrical) ovipositors; most species overwinter as eggs. The family Gryllidae contains many common singers. Subfamilies include the tree crickets (Oecanthinae) (the snowy tree cricket chirps at a rate that varies with temperature; tree crickets may damage woody plants by laying their eggs under bark) and the house and field crickets (Gryllinae). The house cricket, *Acheta domestica* (L.) was introduced from Europe.

**Family Gryllotalpidae:** The mole crickets

Front legs are modified for digging. In the southern portion of the Gulf Coast states, mole crickets are serious pests of turf grass.





Left: a mole cricket (Texas A & M University). Right: a tree cricket (North Carolina State University).

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**Mantodea:** The mantids



Adult Chinese mantid (photo by J. Filippini.)

Web sites to check:

<http://en.wikipedia.org/wiki/Mantis>

<http://www.earthlife.net/insects/mantodea.html>

Description and identification:

Adults:

Mouthparts: Chewing

Size: Moderate to large

Wings: 4, front wings (tegmina) are leathery or parchment-like; hind wings are membranous.

Other distinguishing characteristics: Prothorax greatly elongate; forelegs modified for grasping prey; the head can turn (but not around-and-around); eggs overwinter in foamy masses.

Immatures:

... are adult-like, external wing pads develop as nymphs mature.

Metamorphosis: Gradual.

Habitat: Many types of vegetation.

Pest or Beneficial Status: Predaceous on other insects (and each other), but not particularly valuable in biological control because they eat pest and beneficial species alike.

The large mantid that is common in the Midwest is the Chinese mantid, *Tenodera aridifolia sinensis* ... introduced to the U.S. in the early 1900s. The European mantid, *Mantis religiosa*, (much smaller) was introduced in the northeast around the same time; it remains more common in eastern states. The small mantid that is common here in Illinois is the Carolina mantid, *Stagmomantis carolina*. (And not all females eat males after mating.)

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**Mantophasmatodea:** The heelwalkers.

<http://www.cals.ncsu.edu/course/ent425/library/compendium/mantophasmatodea.html>  
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**Blattaria:** The cockroaches.

Web sites to check:

<http://en.wikipedia.org/wiki/Cockroach>

<http://tolweb.org/Blattaria>

Description and identification:

Adults:

Mouthparts: Chewing

Size: 3-50 mm (1/8 inch to inches).

Wings: 4, front wings (tegmina) are leathery or parchment-like; hind wings are membranous.

Wings are reduced in some species.

Other distinguishing characteristics: Fast runners; long, filiform antennae; body is oval and flattened; cerci may be long. Eggs are enclosed in capsules (oothecae) that the female may carry internally until the eggs are ready to hatch.

Immatures (nymphs):

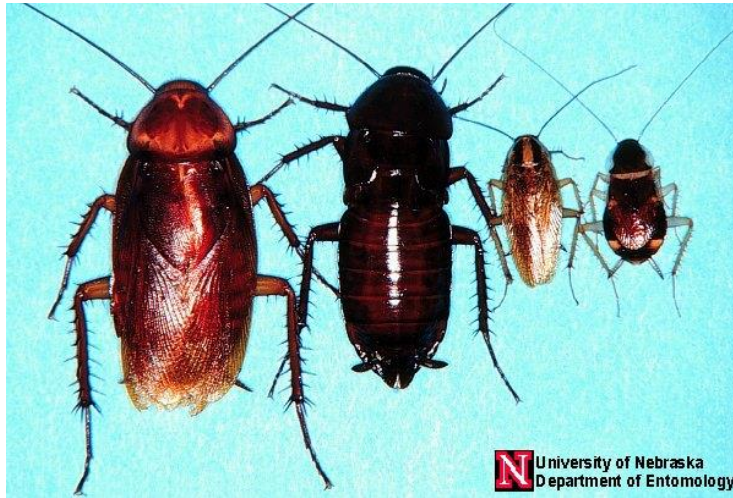
... are adult-like, external wing pads develop as nymphs mature.

Metamorphosis: Gradual.

Habitat: Many habitats in the tropics, but most common species are indoor pests in the Midwest

Pest or Beneficial Status: Indoor pests due to odor, allergic reactions, general disdain.





From left: American, Oriental, German, and brownbanded cockroaches (University of Nebraska). Common pest species in the midwestern US are the American, Oriental, German, and brownbanded cockroaches. All are considered pests because of their nuisance and public health roles as inhabitants of many types of dwellings (especially student apartments).

For an overview of arthropod systematics, see Arthropoda, at The Tree of Life (<http://tolweb.org/tree?group=Arthropoda&contgroup=Animals>) ... not all the nomenclature will match up with names used in this and subsequent lectures, but the Tree of Life site illustrates the relationships among groups insects and other arthropods.