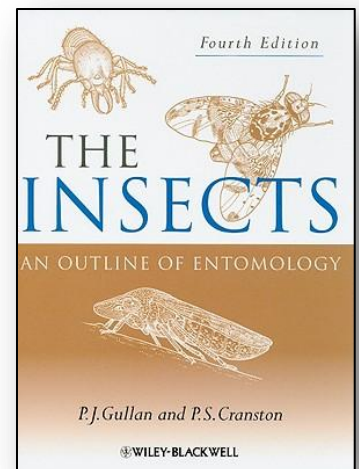


Hexapod Orders

Updated August 2011

Based on the phylogeny in Gullan & Cranston 2010

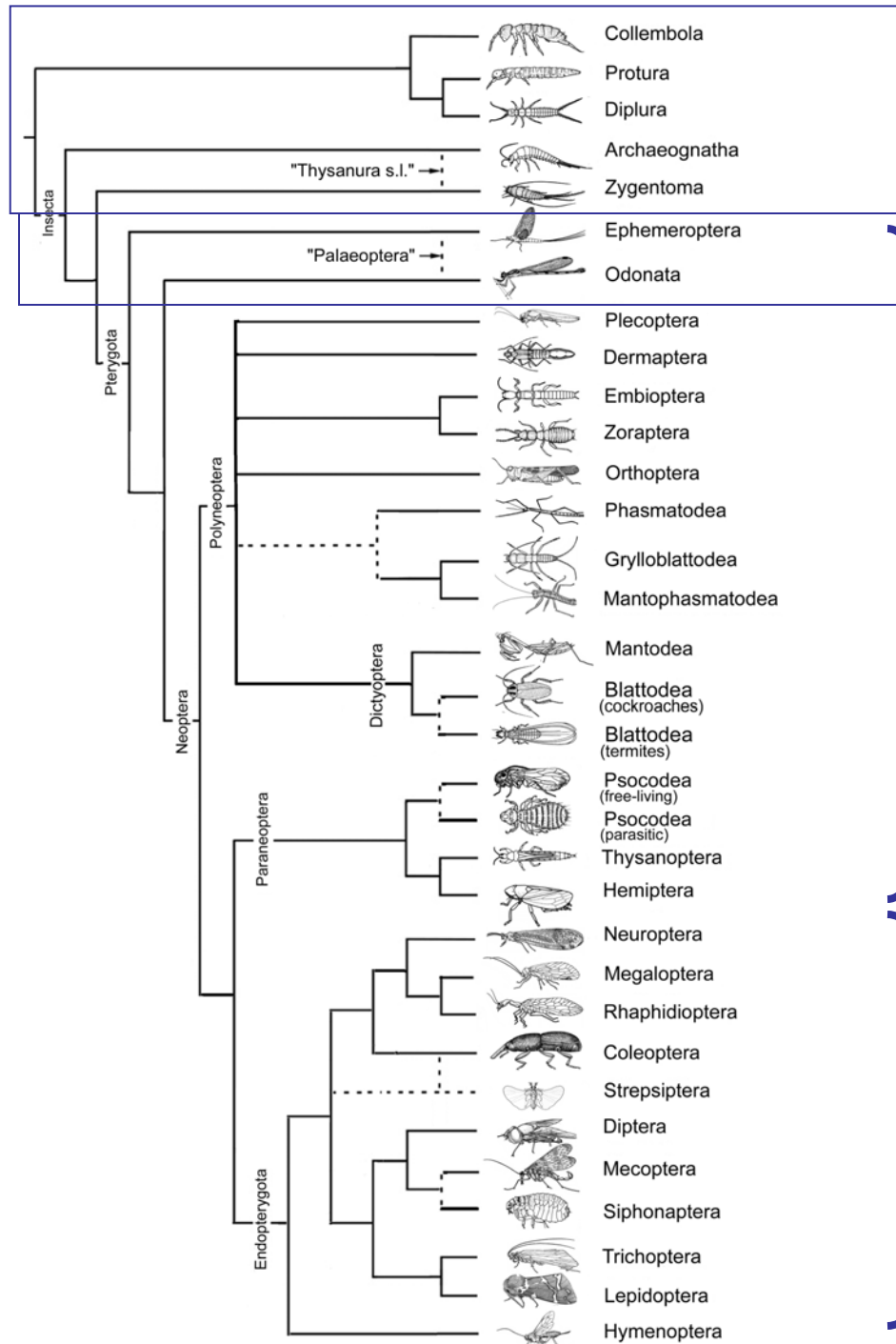


Some terms

- **Ametabola** – “without metamorphosis” ; eggs hatch into young which are smaller than adults, but similar in appearance.
- **Hemimetabola** – have development in which the body form gradually changes at each molt; incomplete metamorphosis
- **Holometabola** – development in which the body form abruptly changes at the pupal molt; complete metamorphosis.
- **Apterygota** – without wings
- **Pterygota** – with wings
- **Paleoptera** – the primitive groups of winged insects (most extinct) that lack the ability to fold the wings over the abdomen
- **Neoptera** – the orders of winged insects that can flex their wings over their abdomens

Ametabola
and
Apterygote

Pterygote
(unless
secondarily
Apterygote)



Paleoptera

Hemimetabola
And
Exopterygote

Neoptera

Holometabola
and
Endopterygote

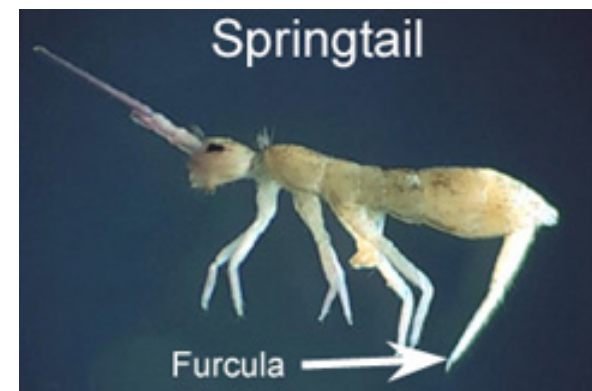
Textbook
Figure 7.2

Collembola

the springtails



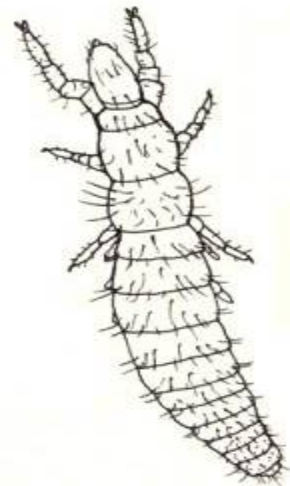
- Springtails may be extremely abundant in certain habitats. Population densities exceeding 750 million individuals per hectare (300 million per acre) have been found in some grassland communities.
- Springtails "hop" by snapping their furcula against the substrate. In this manner, they may propel themselves up to 20 cm in the air - a distance 50-100 times their own body length!



Protura

the coneheads

- Uncommon -- found in damp habitats usually associated with soil and leaf mold. They are part of the community of decomposers that help break down and recycle organic nutrients.
- Proturans do not have eyes or antennae
- With only about 500 species worldwide, Protura is one of the smallest orders (sometimes considered a class) in the phylum Arthropoda.



Diplura

the diplurans

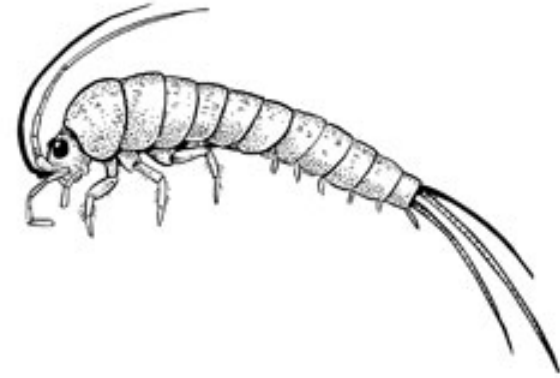


- Diplura can be found under rocks and logs or in the soil, and are small, eyeless insects with two antennae and two tails (cerci)
- Most Diplura are predators; their diet probably includes a wide variety of other soil-dwellers, including collembola, mites, insect larvae, and even other diplurans.

Archaeognatha

the bristletails

- This order of wingless insects consists of about 350 known species. They hide under bark, in litter, and in rock crevices, and feed on algae, lichens, and vegetable debris.
- The sexes are separate, but copulation does not occur. Males produce a packet of sperm (spermatophore) and leave it on the ground to be picked up by a female.



Zygentoma

silverfish

- “Thysanura” has now been split into Zygentoma and Archaeognatha
- A few species are resistant to desiccation and well-adapted to survive in domestic environments such as basements and attics.
- Some species have been known to live more than 6 years -- through 60 instars. One hypothesis for the frequent molting is that it helps reduce the risk of infection by parasitic fungi.



Ephemeroptera

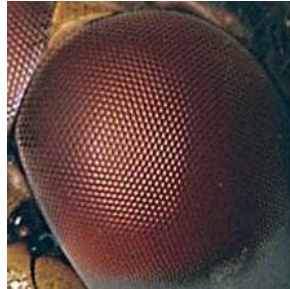
the mayflies

- The subimagos of mayflies are the only insects that molt when they have wings.
- Most adults are delicate insects with a very short lifespan. They do not feed (mouthparts are vestigial), and some species emerge, reproduce, and die in a single day.
- Many northern lakes and rivers (in both the United States and Europe) support unbelievably large populations of mayflies. The naiads are "ecological indicators" of good water quality and are an important source of food for fish and other aquatic wildlife.



Odonata

the dragonflies and damselflies

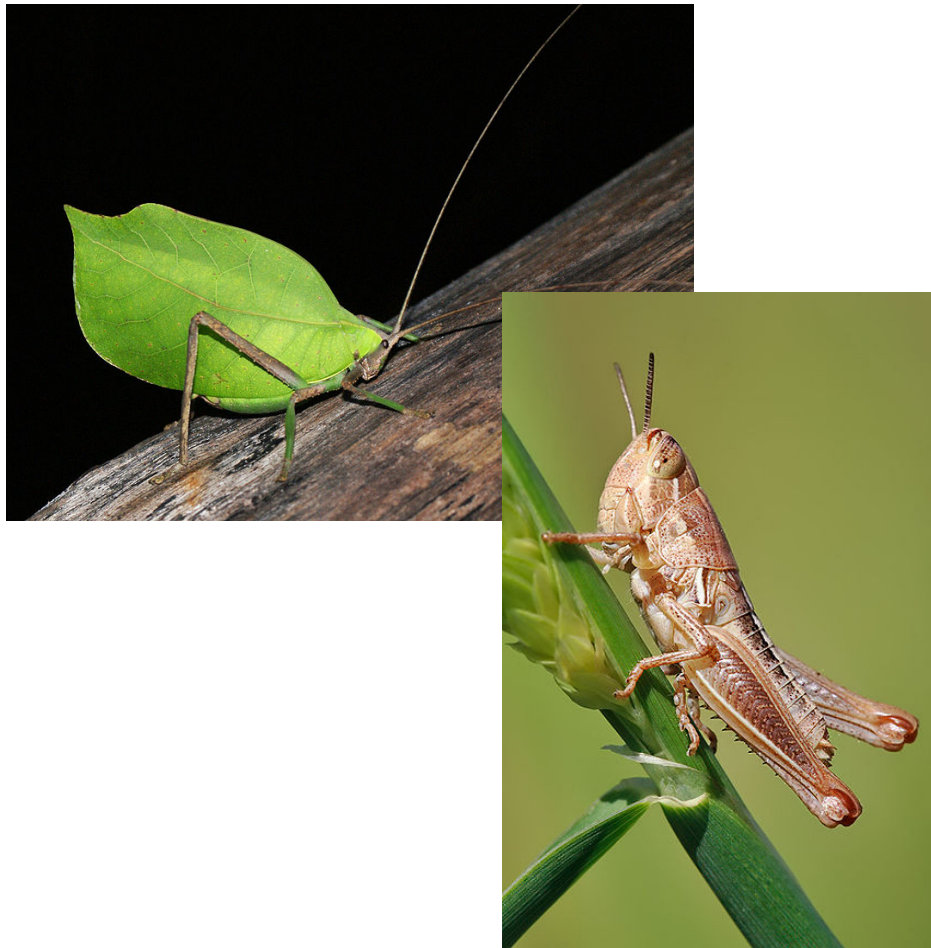


- The compound eyes of some dragonflies may have up to 28,000 facets.
- Dragonflies and damselflies are predaceous both as immatures and adults.
- Eggs hatch into aquatic immatures (naiads) that feed opportunistically on other forms of aquatic life. Some of the large dragonfly naiads will even attack small fish and tadpoles.



Orthoptera

the grasshoppers, locusts, crickets,
and katydids

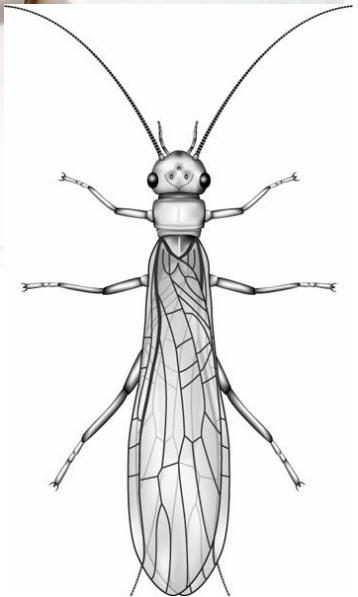


In many species of Orthoptera, the males use sound signals (chirping or whirring) in order to attract a mate. The sound is produced by stridulation -- rubbing the upper surface of one wing against the lower surface of another wing, or the inner surface of the hind leg against the outer surface of the front wing.

Plecoptera

the stoneflies

- Stonefly eggs are coated with a sticky slime that adheres to rocks and keeps the eggs from washing away in fast moving water.
- The nymphs physically resemble wingless adults, but often have external gills, which may be present on almost any part of the body.



Mantophasmatodea

the gladiators or heelwalkers

- The order Mantophasmatodea was erected in 2002. It is the first new insect order since Grylloblattodea was described in 1915.
- The order comprises a handful of species restricted to Africa.
- They are voracious carnivores.



Dermaptera

the earwigs

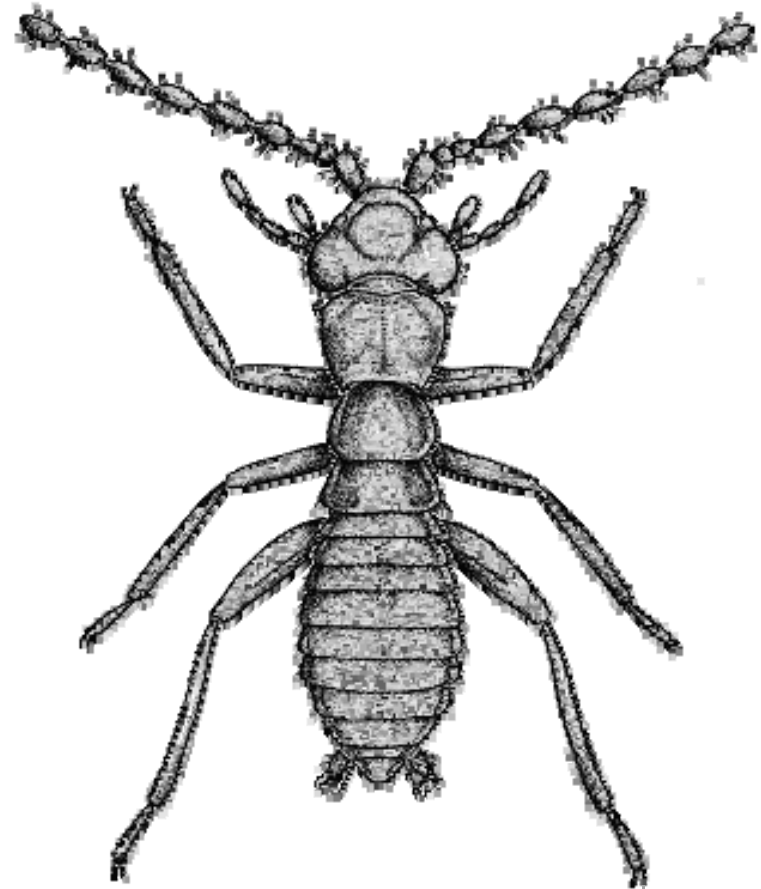


- The common name "earwig" is derived from an old superstition that these insects crawl into people's ears at night and burrow into the brain. There is no truth to this myth.
- Earwigs are mostly scavengers or herbivores that hide in dark recesses during the day and become active at night.
- Female earwigs usually remain in the nest burrow and care for their eggs and young nymphs. If the nymphs do not leave the burrow after one or two molts, they are likely to be eaten by their mother.

Zoraptera

the angel insects

- The order **Zoraptera** is one of the least diverse and most poorly understood of insect lineages.
- Members of this order are small (less than 4 mm) and usually found in rotting wood, under bark, or in piles of old sawdust.



Grylloblattodea

the rockcrawlers

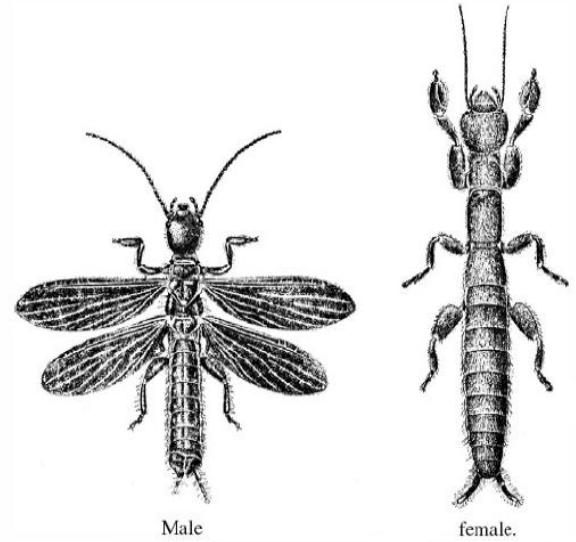
- With only 25 species described worldwide, this is the second smallest order of insects.
- Rock crawlers cannot tolerate warm temperatures. Most species are active below freezing and usually die above 10 degrees Celsius, They are usually found at the top of mountains.



Embioptera

the webspinners

Only adult males are winged. They apparently disperse from one colony to another before mating and die soon after mating. Sometimes they are eaten by their mate.



Embia major (Embioptera).

From A. D. Imms, 1913, On *Embia major* n. sp. From the Himalayas,
Trans. Linn. Soc. Zool. 11:167-195.

Phasmatodea

the walkingsticks

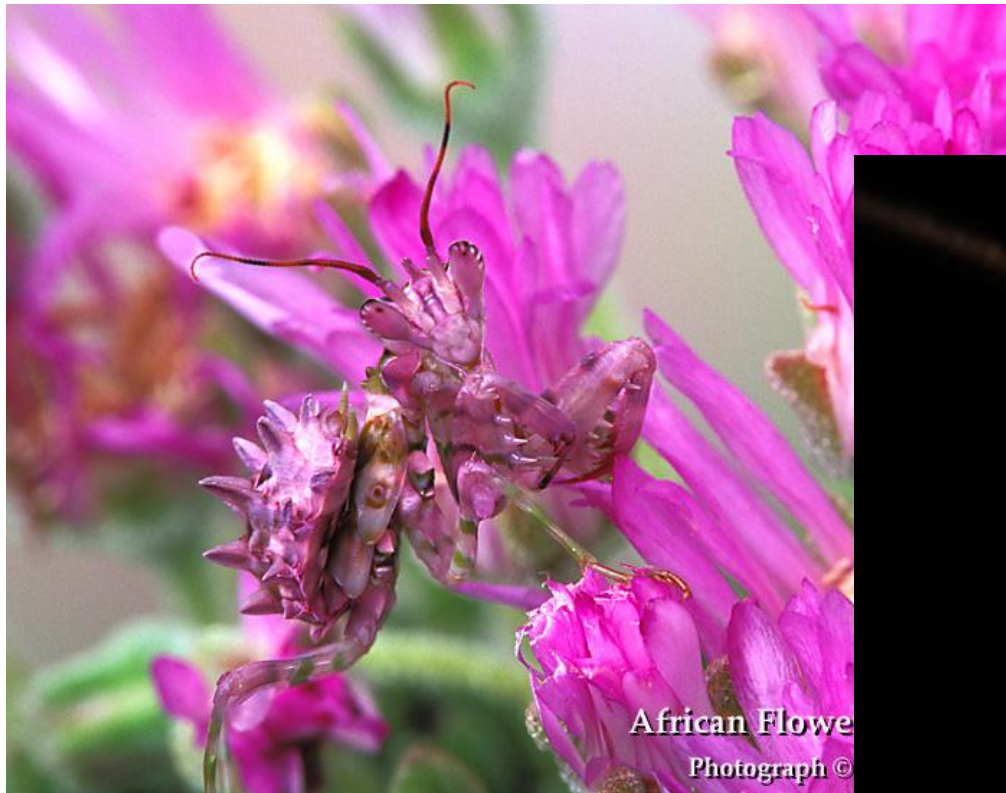
- In some parts of the tropics, stick insects are so abundant that eggs falling out of the trees sounds like rain on a tin roof.
- Some walkingsticks are sold as pets. They are easy to rear if kept in a warm environment with fresh foliage from their host plant
- Some species can even regenerate lost legs at the next molt. These are the only insects able to regenerate body parts.



Mantodea

the mantids

Although mantids usually feed on insect prey, they have been known to catch and eat small frogs, lizards, and even birds



Blattodea

the roaches and termites

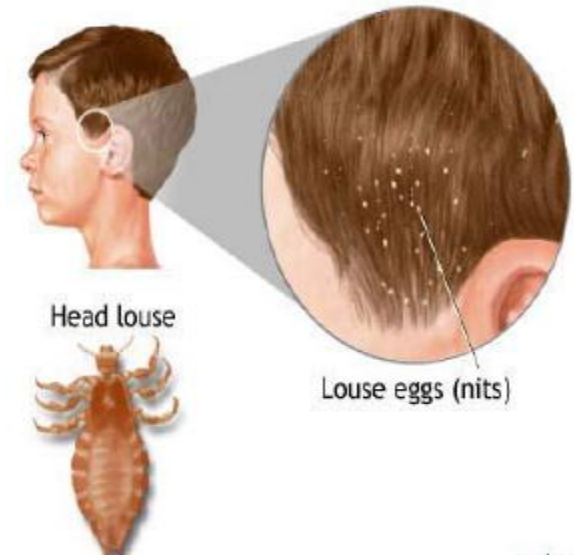
- Scientists recently discovered that termites (former order Isoptera) evolved from roaches. Thus, the termites and roaches are now considered one order.
- Termites cannot digest wood. Their digestive systems contain symbiotic protozoa and bacteria that digest cellulose in wood for them.
- Despite the bad reputation of roaches, only about a dozen species (out of over 4,000 worldwide) are regarded as pests.



Psocodea

"Phthiraptera" chewing lice and sucking lice
"Psocoptera" bark and book lice

- Scientists have recently grouped all lice into one order.
- All Phthiraptera are wingless external parasites of birds and mammals.
- Trench fever, spread by lice, was especially widespread among soldiers during World War I, and was probably a major factor in the final collapse of the Russian army.
- Booklice are common in human dwellings and warehouses. They are wingless and small (less than 2mm). Most species feed on stored grains, book bindings, wallpaper paste, fabric sizing, and other starchy products.



Hemiptera

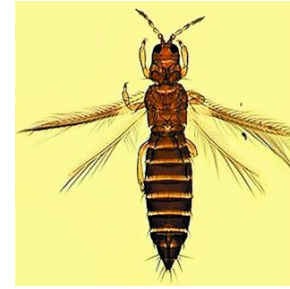
the true bugs

- Divided into the Heteroptera and Homoptera sub-orders
- Heteroptera have very distinctive front wings, called **hemelytra**, in which the basal half is leathery and the apical half is membranous.
- Water striders in the genus *Halobates* (family Gerridae) are the only insects that are truly marine. They live on the surface of the Pacific Ocean.



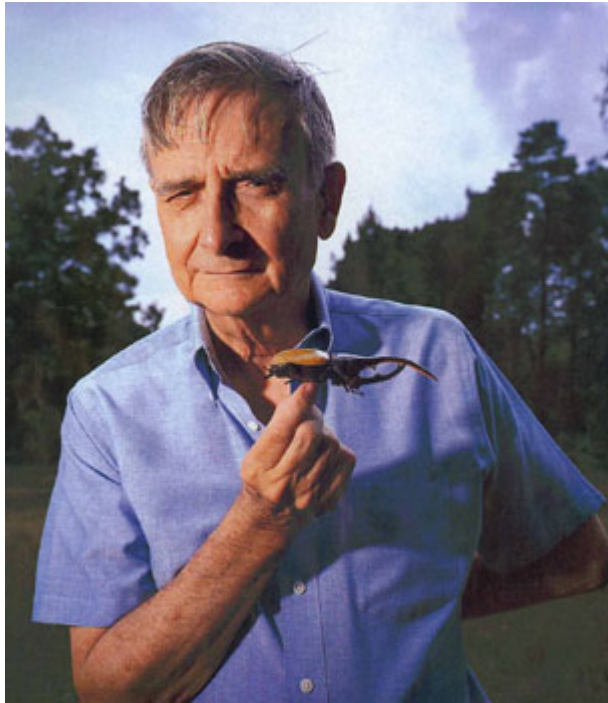
Thysanoptera

the thrips



- The word "thrips" is both singular and plural. There is no such thing as a "thrip"
- Many thrips are destructive pests of plants, especially grain crops, fruits and vegetables, and ornamentals. Feeding activities result in plant deformities, scarring, loss of yield, and in some cases, transmission of plant pathogens.





Coleoptera

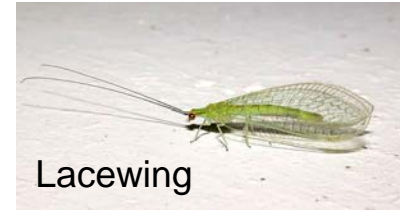
the beetles



- Coleoptera is the largest order in the animal kingdom. It includes 40% of all insects and nearly 30% of all animal species.
- Two families of Coleoptera are bioluminescent (able to produce light). Fireflies (family Lampyridae) and glowworms (family Phengodidae) have light-producing organs in the abdomen
- Bombardier beetles, *Brachinus* spp. (family Carabidae), have the ability to discharge a defensive spray of hot quinones. Two chemical reactants are stored in adjacent compartments of an abdominal gland and combine explosively when the insect is disturbed

Neuroptera

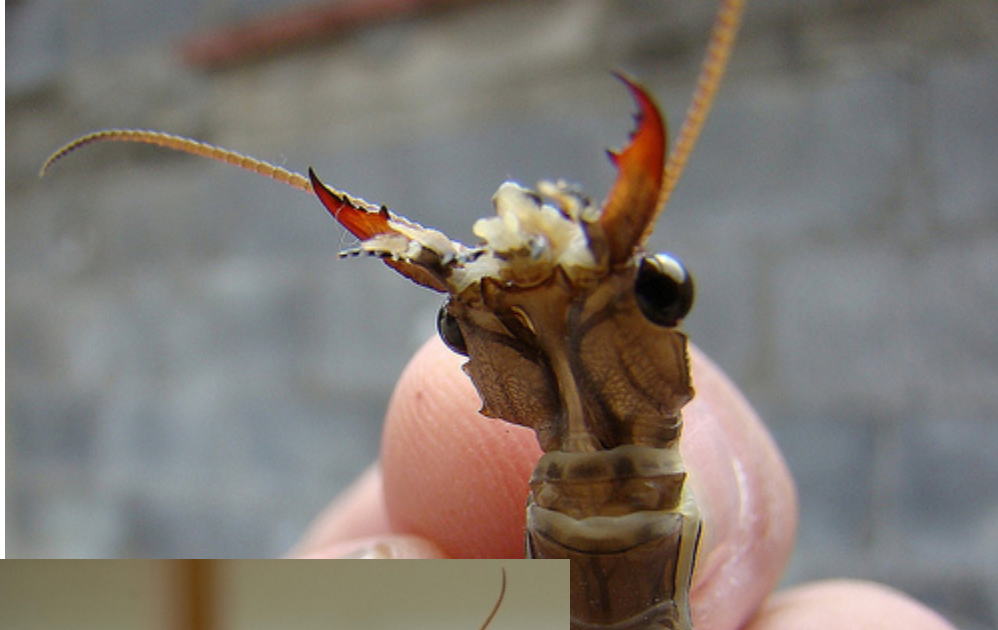
antlions and lacewings



- A lacewing's egg sits atop a slender stalk secreted by the female's reproductive system. For many years, biologists thought these eggs were the fruiting bodies of a fungus.
- Neuroptera, Megaloptera, and Raphidioidea are closely related, and some scientists consider them all just one order.

Megaloptera

alderflies and dobsonflies



Though both male and female dobsonflies have sharp mandibles, those of an adult male dobsonfly are actually so big, with such poor leverage, that they are unable to harm humans. Their mandibles are used exclusively during mating, where males show them off and grasp the females during copulation

Raphidioptera

snakeflies



- Both adults and larvae are predators
- They are very common in areas of temperate Europe and Asia. In North America they are only found in the Western USA, especially the Rocky Mountains.

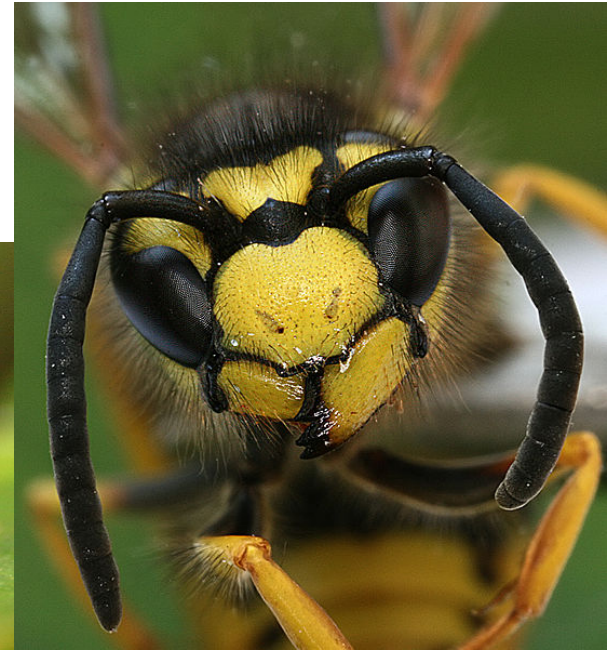


Hymenoptera

The sawflies, ants, wasps, and bees



Sawfly larvae



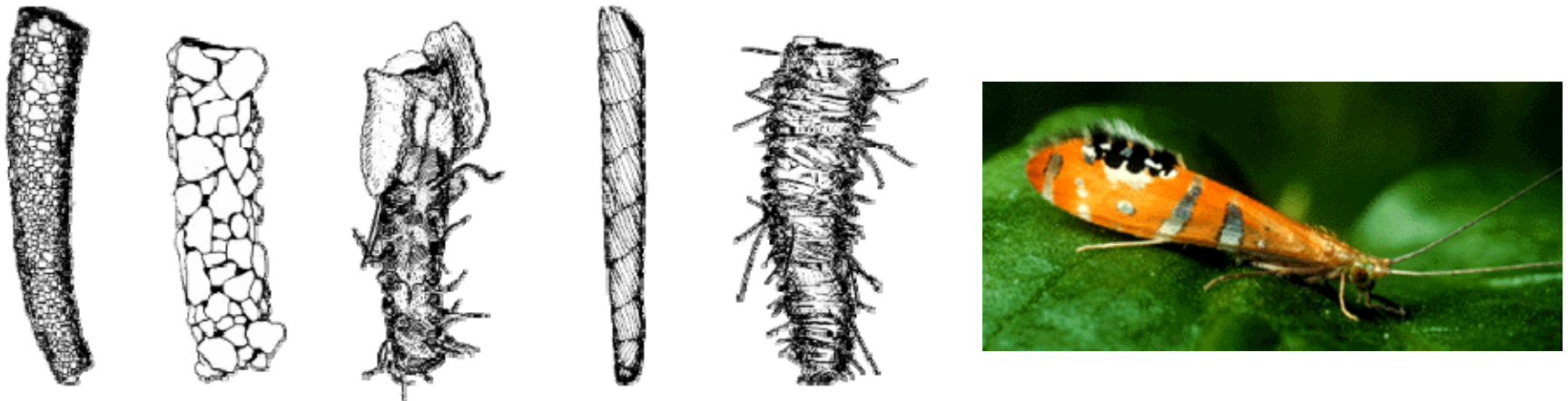
In the Hymenoptera, females develop from fertilized eggs and males develop from unfertilized eggs. Since females control whether or not an egg is fertilized, they can regulate the sex ratio of their offspring

Trichoptera

the caddisflies

All caddisfly larvae live in aquatic environments; they may be herbivores, scavengers, or predators. In most cases, 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. Case design and construction is distinctive for each family or genus of caddisfly.

Examples of Caddisfly Cases



Mayfly



Stonefly



Caddisfly



Lepidoptera

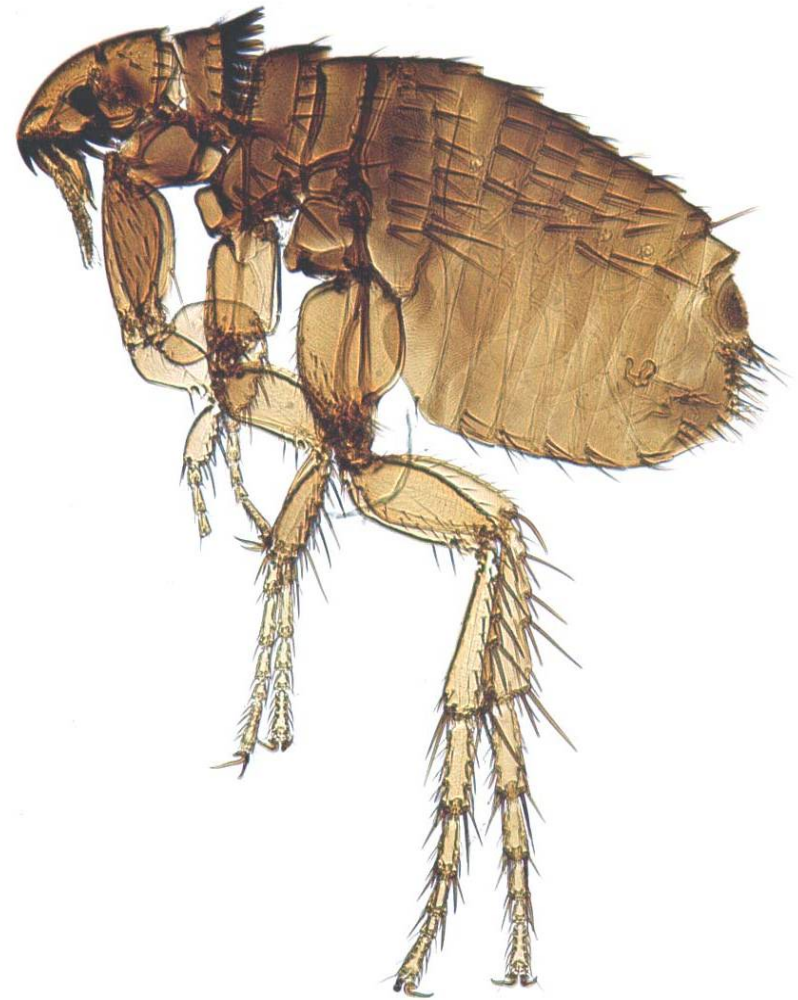
the butterflies and moths

- Moths probably diverged from caddisflies in the early Triassic period, about 230 million years ago
- Adults of most Noctuidae and Arctiidae have "ears" in the thorax that help them detect and evade echo-locating bats. Some species of Arctiidae even produce high-pitched ticks that confuse the bats



Siphonaptera

- As adults, all fleas are blood-sucking external parasites. Most species feed on mammals, although a few (less than 10%) live on birds
- Flea larvae are usually found in nests or bedding material of the adult host. There larvae feed as scavengers on organic debris (including adult feces).



Mecoptera

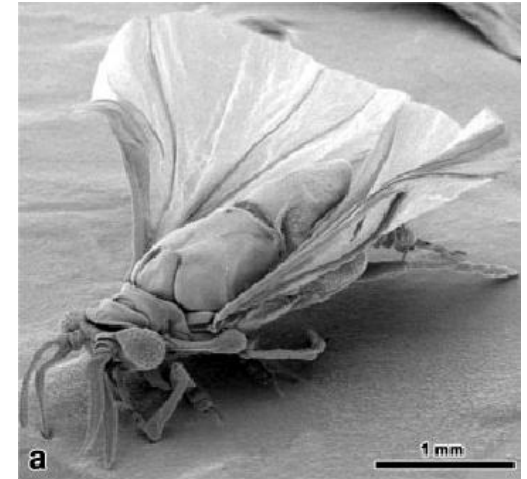
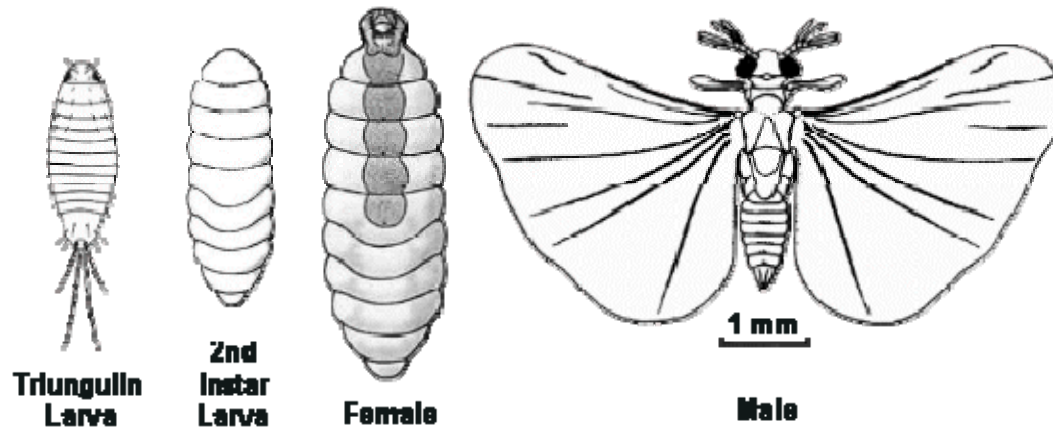
the scorpionflies and hangingflies



- Some female scorpionflies will accept a male suitor only if he brings her a gift of prey. Males occasionally mimic females in order to get a free meal!
- The common name of this order (scorpionfly) refers to the distinctive appearance of male genitalia in members of the family Panorpididae. Despite its appearance, the scorpionfly's tail is quite harmless.
- Hangingflies are the only predatory insects that catch prey with their hind legs.

Strepsiptera

the twisted-wing parasites



- Most Strepsiptera (also known as twisted-wing parasites) live as internal parasites of bees, wasps, grasshoppers, and members of the order Hemiptera
- They manipulate the biology of their hosts. Insects infected with these parasites tend to be less active than usual, and they can live about five times as long.



Diptera

the flies



- Although they have only two wings, flies are among the best aerialists in the insect world - they can hover, fly backwards, turn in place, and even fly upside down to land on a ceiling.



- The little scuttle fly, *Megaselia scalaris* (Diptera: Phoridae), is truly an omnivore. It has been reared from decaying vegetation, shoe polish, paint emulsions, human cadavers pickled in formalin, and even lung tissue from living people.



References and resources

- Tree of Life: www.tol.org
- Featured Creatures:
<http://entomology.ifas.ufl.edu/creatures/>
- On the Order Mantophasmatodea:
http://news.nationalgeographic.com/news/2002/03/0328_0328_TVstickinsect.html
- NC State's Entomology website:
<http://www.cals.ncsu.edu/course/ent425/library/compendium/index.html>

For the Order Quiz

- Scientific order names
- Common order names
- Are they hemimetabolous, ametabolous, or holometabolous?
- Pterygote or apterygote?
- Paleoptera or neoptera?
- All facts on study guide
- Definitions of the terms above