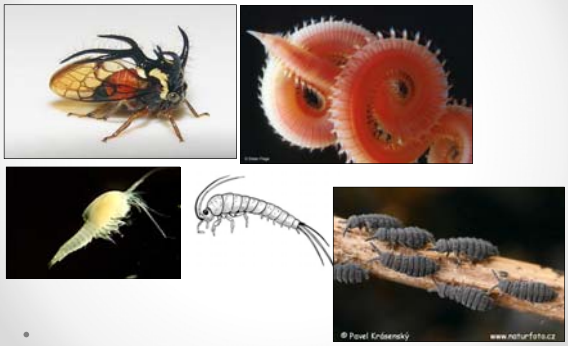
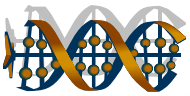
Class exercise: what is an insect?



Microevolution

- Changes in gene frequencies in a population, also known as change at or below the species level



Insect Macroevolution

Macroevolution

- Large-scale changes over a geological time period (i.e. extended microevolution)
- Changes at or above the species level

Diversity of Form and Function

Linnean rank			
kingdom	Animalia	Animalia	Animalia
phylum	Arthropoda	Chordata	Chordata
class	Insecta	Reptilia	Mammalia
order	Diptera	Ornithischia (Predentata)	Primates
family	Diopsidae	Ceratopsidae	Hominidae
genus	*Teleopsis*	*Triceratops*	*Homo*
species	*dalmanni*	*horridus*	*sapiens*

Taxon – a group at any taxonomic level.

2 big take-homes:

The major innovations in insect evolution

Great radiations of insects

Four major "innovations" in insect evolution

- **Tracheal system / impermeable exoskeleton** - allowed insects to colonize land
- **First wings** – allowed insects to disperse better, colonize new habitats, and escape from predators
- **Neoptery** – allowed insects to live in rougher habitats because their wings were protected.
- **Holometaboly** – allowed larvae to specialize on growth while adults specialized on reproduction.

Insects have been around for over 400 million years (before dinosaurs).

The first major "innovation" in arthropod evolution

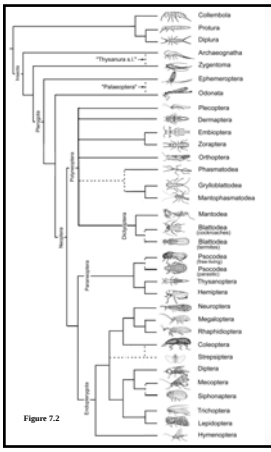
The ability to live out of the water

- The development of the tracheal system
- Impermeable exoskeleton

Insects are arthropods

phylum: Arthropoda

They share many features with the annelids (phylum Annelida) and onychophorans (phylum Onychophora)



Scientists are continually working to improve phylogenies

This is the latest, and is found in the textbook.

Insects are arthropods

phylum: Arthropoda

Extant arthropods include:

Chelicerates

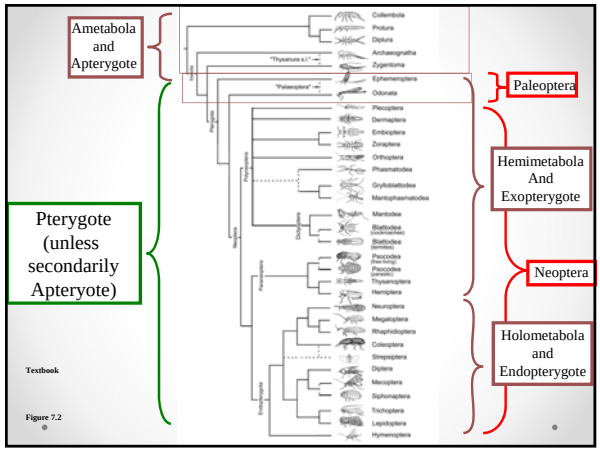
Arachnids, horseshoe crabs

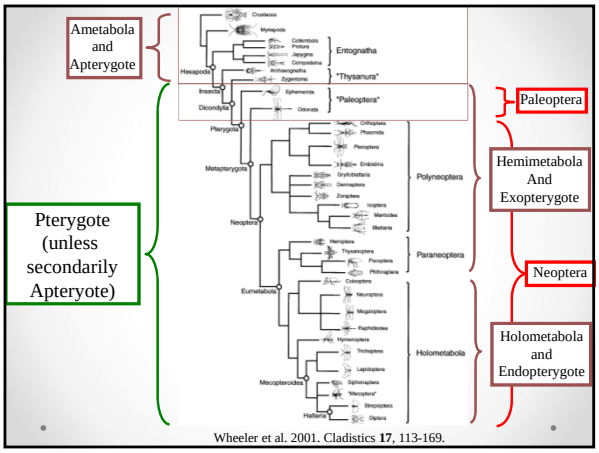
Crustaceans

Crabs, shrimp

Myriapods

Centipedes, millipedes



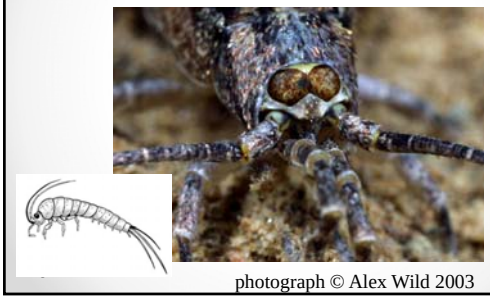


Wheeler et al. 2001. Cladistics **17**, 113-169.

Jumping Bristletail (Archaeognatha: Machilidae)

Stebbins Reserve, Solano County, California, USA

Very similar to the first insects!



photograph © Alex Wild 2003

Late Devonian ~350 MYA and into the Carboniferous Period (300 mya)

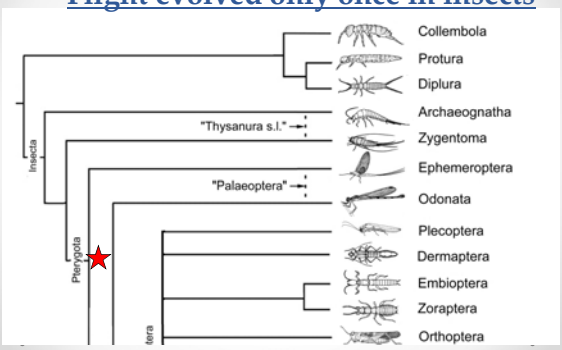
The second major evolutionary step: *FLIGHT*

Pterygote insects appeared!

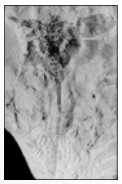
Including both extinct and extant groups

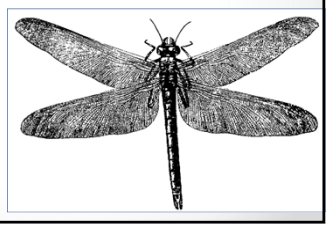
Paleopteran group ("old wing")
Extinct Order Paleodictyoptera (52 cm wingspan)
Extant Order Ephemeroptera
Neopteran groups
Extant Orders Orthoptera and Blattodea

Flight evolved only once in insects



With the colonization of the skies… The first great radiation of insects occurred





Fossil Paleodictyoptera

Note patterned wings and long cerci

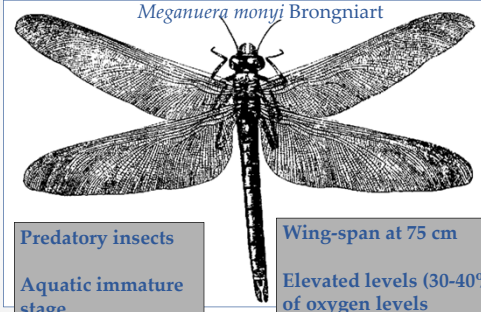
Wingspan of up to ½ a meter!

260 million years or so ago over what are today the prairies of central Kansas.

http://www2.southwind.net/~royb/fossil_insects.html

Order Meganisoptera

Meganuera monyi Brongniart



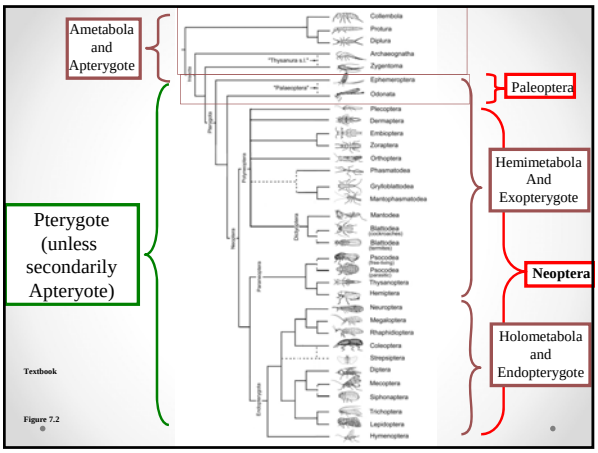
Predatory insects

Aquatic immature stage

Wing-span at 75 cm

Elevated levels (30-40%) of oxygen levels allowed for this gigantism

http://www.kheper.auz.com/gaia/biosphere/art



Wings

Wings are a principal distinguishing factor in the hierarchy of insects ('ptera' of order names).

Flight has provided insects with dispersal capabilities and is in part responsible for the radiation of insect species.

The third major "innovation"

Carboniferous Period (300 mya)

The evolution of a wing flexion mechanism

"Neopterous" or "new-winged"

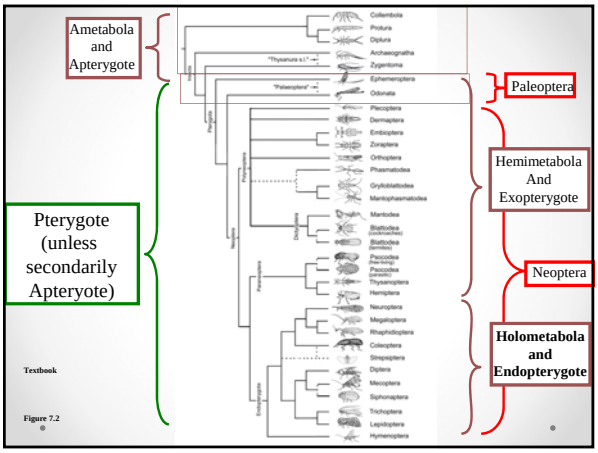
Primitively apterygote

vs.

Secondarily apterygote

Order Archeaognatha

Order Orthoptera



The fourth major evolutionary step:
Carboniferous Period (~300 mya)

The evolution of holometaboly (complete metamorphosis)

Permian Period (250 mya)

Gymnosperms (conifers) became dominate plant form.

To date, fossil remains belonging to thirty Insect Orders have been detected.

These include the extant Orders Odonata, Plecoptera, Embioptera, Diptera, Thysanoptera, Hemiptera, Coleoptera, and Mecoptera, and numerous additional extinct orders.

Sugarcane grub adult and larva
Photo: Lyle Buss

End of the Permian

The Permian-Triassic boundary was a time of major extinction

Holometabolous insects comprise nearly 85% of all insects!

Permian Period (250 mya)

At the end of the Permian was the biggest of the mass extinctions

95% of all marine life was killed
70% of all land families became extinct

This reduced the diversity in taxa within surviving insect orders

Mesozoic Era-Breakup of Pangaea

Gymnosperms, seed ferns dominated.
Known as "Age of the Reptiles."
Rise of the Hymenoptera and Lepidoptera

Mesozoic Era
Cretaceous Period (145 mya)

- Beginning of the Angiosperms (flowering plants).
- Increase in plant diversity resulted in the second great insect radiation
- Produced all of the extant orders and most of the families that we know today

Coevolution

- The process of reciprocal evolution between interacting species, driven by natural selection

Great radiations of insects

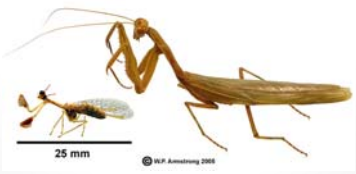
- Flight
- Angiosperm plants

Phylogenetics

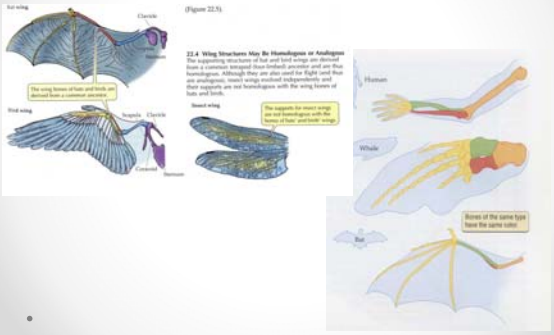
- The orders of insects are fairly clear
- However, relationship among orders and higher groups is more contentious
- Resemblance does not necessarily indicate relatedness

Phylogenetics

Resemblance does not necessarily indicate relatedness



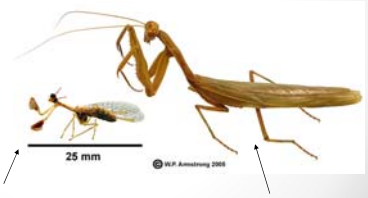
Why might different species resemble one another?



Phylogenetics

Why might different species resemble one another?

- Homoplasy
  Convergent Evolution



Order: Neuroptera

Order: Mantodea

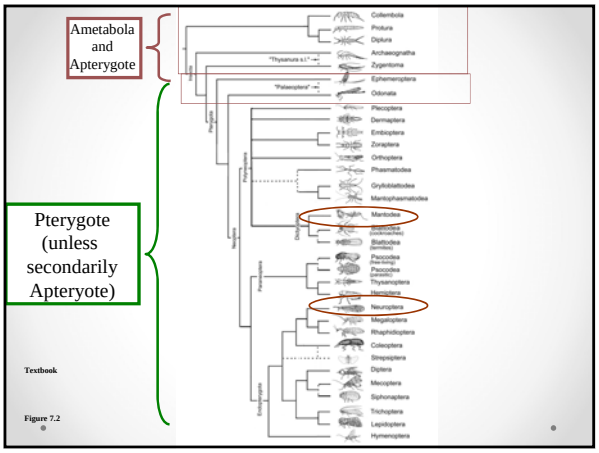
Phylogenetics

Why might different species resemble one another?

- Homoplasy

Belidae (Coleoptera)

Lycidae (Coleoptera)



Phylogenetics

Homoplasy

Similar or identical traits that have arisen independently in distinct species

Order: Neuroptera

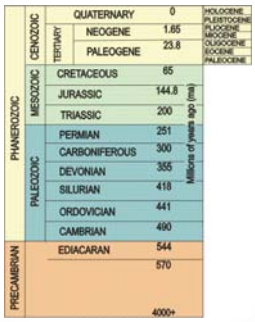
Order: Mantodea

Phylogenetics

Why might different species resemble one another?

- Homoplasy
- Homology

Coreidae
Leptoglossus


Hemiptera: Coreidae
Leptoglossus spp.



Order Hemiptera suborder Heteroptera