

Insect Orders



1

Objectives



After you have completed this unit you should know for each order:

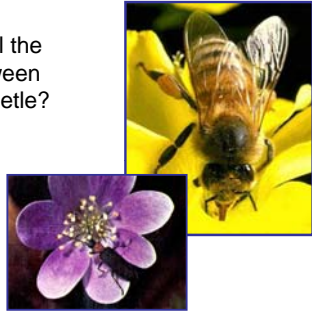
- its common name, order name, and meaning of the order name
- its development or metamorphosis
- 3-4 facts regarding its life history and/or economic importance
- its wing type, leg types and mouth adaptations



2

Question

How do you tell the difference between a bee and a beetle?



3

Introduction

Bees and Beetles

- Six legs
- Exoskeleton
- Two antennae
- Four wings



scarab beetle



honey bees



4

Classification Review

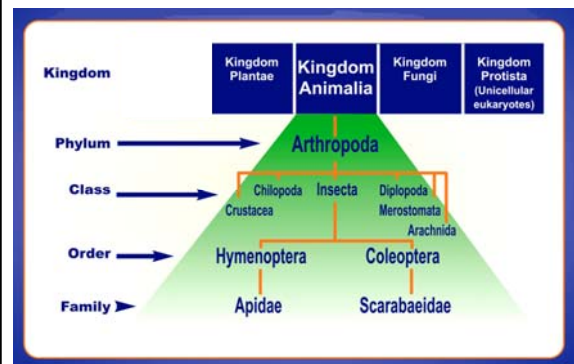
- Kingdom
- Class
- Order
- Family
- Genus
- Species



Dung Beetle: Insecta, the order Coleoptera and the family Scarabaeidae.
 Honey Bee: Insecta, the order Hymenoptera, and the family Apidae.

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Classification Review Diagram



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Review Terms

This unit will familiarize you with some of the major insect orders. Before you get started, see how many of these terms you know by writing their definitions on a piece of paper. These terms will help you throughout the unit and on your lab projects.

1. Anamorphic:
2. Ametabolous:
3. Hemimetabolous:
4. Holometabolous:
5. Apterygote:
6. Paleopterous:
7. Pterygote:
8. Neoptera:
9. Exopterygote:
10. Endopterygote:



Cuckoo wasp

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Review Terms: Answers

Anamorphic: Development in some parainsects where abdominal segments are added during the molting process.

Ametabolous: An insect that undergoes slight or no metamorphosis. The young look just like the adult. They also keep molting even after becoming an adult, something the other kinds of insects don't do.

Hemimetabolous: An insect that undergoes incomplete metamorphosis. The young look very similar to the adult.

Holometabolous: An insect that undergoes complete metamorphosis. This type of metamorphosis includes the egg stage, larval stage, pupal stage and adult stage.

Ametabolous



Hemimetabolous



Holometabolous



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Review Terms Answers Continued

Apterygote: An insect that doesn't have wings.

Paleopterous: Insects having wings, but the wings cannot fold back over the insect's abdomen.

Pterygote: This term refers to all winged insects.

Neoptera: Having wings, but the wings have a **flexon**, or hinge, that allows the wing to be folded back over the abdomen.

Exopterygote: Insects with wings that develop from structures called wing pads located on the **outside** of the growing insect.

Endopterygote: Insects with wings that develop from **internal** wing pads present in the larvae.



vespid wasp

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Hexapoda

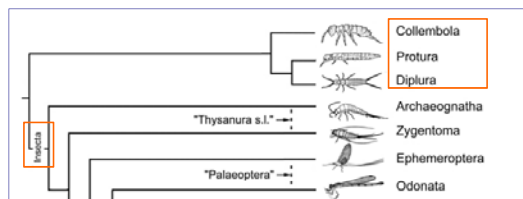


All six-legged arthropods, hexapods, were once classified in the Class Insecta. After some debate, some scientists group hexapods into three classes, Parainsecta, Entognatha, and Insecta and some scientists split them into four classes, Protura, Collembola, Diplura and Insecta. Each of the classification schemes are based on certain similarities between the groups. We will take a look at two cladograms that show the differing opinions of how these organisms should be classified.

Note: Because the parainsects are so closely related to the insects, we still consider them insects in the non-technical sense of the term and encourage you to include them in your insect collection.

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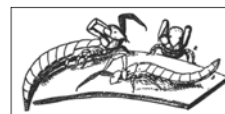
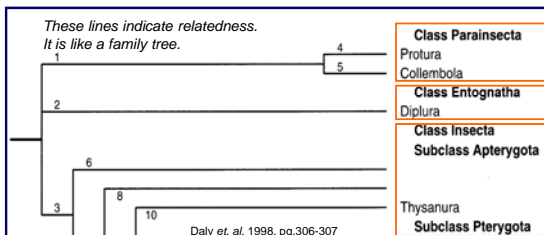
Four Class Scheme



In this cladogram, the proturans, collembolans, diplurans and insects are all considered to be separate classes. We will study each of these groups individually, but here, you can follow the lines to see how the classes are all related.

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Three Class Scheme



Early woodcut of the first published illustrations of Protura (Berlese 1907).

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Objectives Recap

With those terms and ideas firmly established in your mind you are now ready to learn about the insect orders. There are 28 insect orders in the current classification scheme. We won't be able to cover some of the lesser known orders in this lecture, but you can read about them if you wish. You will learn about each of the more common orders in the lecture and readings and will complete the chart on your study guide.

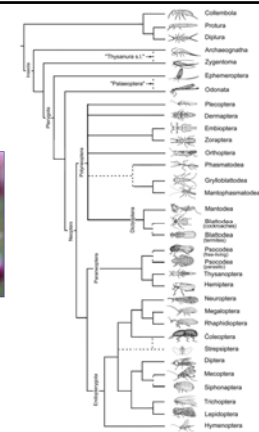
1. its common name
2. its development, or metamorphosis
3. 2-3 facts regarding its life history and/or economic importance
4. any special adaptations of mouthparts, legs, or wings
5. the meaning of the order name



thrips

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Insect Taxonomy



Gullen and Cranston, 2010, Figure 7.2

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Class Parainsecta: Order Protura

first tail

- Eyeless
- Lack antennae
- Small (<2mm)
- anamorphic development
- Enlarged forelegs (sensory organs)
- Lack tentoria and cerci
- 5 segmented legs
- nymphs begin with nine segments, but an adult have twelve
- Feed on fungi and vegetable matter
- called coneheads



Proturan life stages.
P=prelarva, L1=larva I,
LII=larva II, A=adult

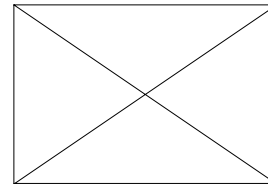


proturan

Notice the meaning of the order name in the top right corner.

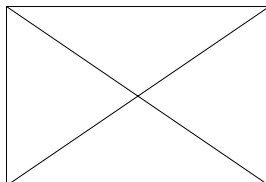
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Proturan Walking Video



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Proturan Defensive Posture Video



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Class Parainsecta: Order Collembola

glue wedge

Springtails can tuck their tail (furcula) underneath them-- similar to cocking a gun--and can snap it back out "springing" them off of the ground.

- anamorphic development
- 1 pair of antennae
- no compound eyes
- soil dwelling arthropod
- scavenger
- collophore (for water management – once thought to have glue – thus the name)
- Furcula – jumping organ



collembolan

Fill out the table on your study guide under the heading "Insect Orders."

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Class Entognatha: Order Diplura

two tail

Entognathans are a group that have enclosed mandibles.

- soil arthropods
- Predators feeding on mites, insects, collembolans, etc.
- 700+ described species
- eyeless
- 1 pair of antennae
- Sclerotized forceps on the abdominal tip (cerci)
- 0.5-50mm
- 10 body segments
- Continued molting



dipluran

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

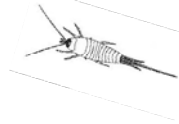
Notice that the ending
-ura means tail.

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Class Insecta: Subclass Apterygota Order Archaeognatha

ancient jaw

- Bristletails
- Mostly nocturnal
- 350 known species
- Common in leaf litter
- Scavengers/herbivores : feed on algae, lichens and vegetation
- Wingless
- Primitive jaw arrangement
- Continual molting (ametabolous)
- Female picks up sperm packet for each egg clutch
- Cerci shorter than medial caudal filament



Watch Dr. Yanoviak from the University of Arkansas Little Rock as he describes the unique gliding behavior of this primitive insect.

<http://www.youtube.com/watch?v=tsNZ1V1WU0k&feature=related>

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Class Insecta: Subclass Apterygota: Order Zygentoma (Thysanura)

bristle tail

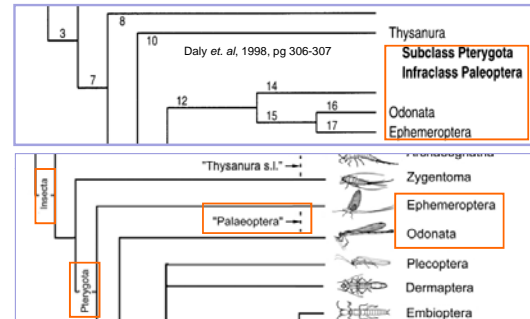
- include silverfish and firebrats
- ametabolous development
 - some species live more than 6 years and can molt more than 60 times.
- wingless
- covered in silver scales
- compound eyes
- three caudal filaments
- Indirect fertilization
 - males leave sperm packets
- occasional invaders of homes
- prefer moist environments.



silverfish

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Primitive Pterygotes



Gullen and Cranston, 2010, Figure 7.2

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Paleoptera – “ancient wings” (cannot fold wings)

Class Insecta: Subclass Pterygota: Order Ephemeroptera (Mayflies)

ephemera - short-lived



mayfly

- Aquatic
- Herbivores
- Indicators of water quality
- Naiads have gills and caudal filaments
- Subimago stage
 - only insects to molt once they have wings
- Triangular wings
- Adults (imago) emerge, mate, lay eggs, and expire
- Vestigial mouthparts as adults (do not feed)

We are now entering the division
of the winged insects. Notice that
the name often ends in -ptera
which means wing.

Note: a naiad is an aquatic nymph of a hemimetabolous insect.

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Class Insecta: Subclass Pterygota: Order Odonata (Damselflies, Dragonflies)

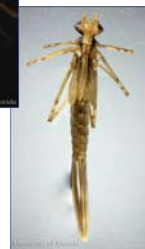
toothed ones



The gills on the damselfly larvae are articulated and easily break off when the animal is disturbed.




Naiad jaw




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Can you tell which is which? Remember, the damselfly naiad has external gills.


Order Odonata (Damselflies, Dragonflies) continued toothed ones



compound eyes



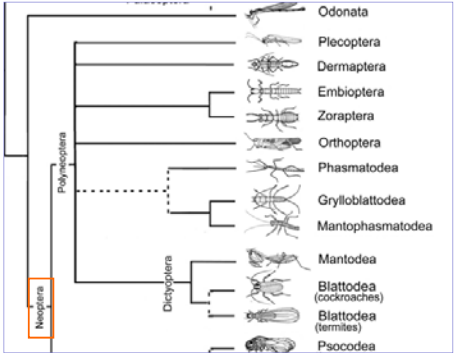
damselfly



dragonfly

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Neopteran Phylogeny



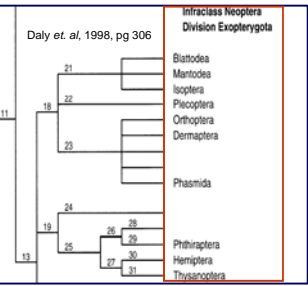
26

Gullen and Cranston, 2010, Figure 7.2

Infraclass Neoptera: Division Exopterygota



Wing pads




predatory hemipterans

Note: These wing pads are an indication that the insect has not developed into the adult stage. This is a tip you can use while you are out collecting your insects.


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Order Plecoptera: (stoneflies) folded wing



Adult stonefly

- Hemimetabolous
- Filiform antennae
- Flat appearance
- Require clean, moving water




The adults emerge at the same time and live for only a few weeks.

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Order Dermaptera (earwigs) skin wing

- Hemimetabolous
- beaded antennae
- short elytra with fan-shaped flight wings
- nocturnal
- scavengers
- pincer-like cerci
- females protect eggs and young (sub-social)




earwig

Myth: Earwigs were once thought to enter the ear and burrow into the skin of sleeping individuals.

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Embioptera (webspinners) Lively wings

- front legs with silk producing glands
- hemimetabolous
- filiform antennae
- adult males are winged
- found under tree bark
- herbivores
- build tunnels of silk
- enlarged hind legs to move backwards
- live in groups



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Zoraptera (angel insects)

Pure without wings

- Rare and not well understood
- Some are winged
- Small >4mm
- Moniliform antennae
- Found in rotting wood or in sawdust



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Order Orthoptera (grasshoppers, crickets, katydids)

straight wing

You can tell that you have now entered the section of neopterous insects. As you can see, the wings are folded on top of each other over the abdomen and are not held out to the side or straight back.



Cricket



A mole cricket with fossorial front legs.



A large lubber grasshopper with coloring that tells predators it's nasty to eat.

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Order Phasmatodea (Walking sticks)

From the Greek "phasm" or phantom

- hemimetabolous
- chewing mouthparts
- eggs are dropped to the ground from the trees
- long slender antennae
- reduced (brachypterous) wings
- Defensive secretion from thorax
- Can regenerate legs
- longest insects representative



Florida walking stick

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Grylloblattodea (Rockcrawlers)

Cricket cockroach

- found on mountaintops and in caves at low temperatures
- hemimetabolous
- filiform antennae
- only 25 species worldwide
- slow development (7 years per generation)



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Order Mantophasmatodea (Heel Walkers or Gladiators)

Greek for Mantis and Phantom

This is an order that is only found in Africa. Why then should we mention it? This order, thought to be extinct, was recently found living in South and Eastern Africa. Species in this hemimetabolous order are still being named and described. The media blitzed this discovery of such a strange critter. Read more about this find on pages 189 and 349.



Gullan and Cranston 2005, pg 501

For more information, click on read the Gladiators article from Scientific American.

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Order Mantodea (Praying Mantids)

Mantis is the Greek word for Mantids



praying mantis



Mantis egg case

- Hemimetabolous
- Chewing mouthparts
- Triangular head
- Compound eyes
- Raptorial front legs
- Predaceous
- Long pronotum that allows the head to turn

36

Order Blattodea (Cockroaches and Termites)

Blatta is the Greek word for cockroach

- Hemimetabolous
- Dorso-ventrally flattened
- Filiform antennae
- Cursorial legs
- Chewing mouthparts

Cuban cockroach

Florida woods cockroach and egg case

Australian cockroach

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Order Blattodea - continued (Termites)

Termites are also known as white ants. They are the only hemimetabolous insect with true social behavior. These insects have a caste system that includes workers, soldiers, and reproductives. The worker is the bread winner of the family. They are nearly blind and they forage for food by building tunnels to protect themselves. The workers are charged with protecting the colony. They have a larger head than the common workers and large strong mandibles. Termite colonies consist of both males and females and the king remains with the queen in the colony.

soldier termites

termite reproductive

Note: Believe it or not, termites are closely related to cockroaches.

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Order Psocodea (Lice)

wingless louse

Two groups:

- Bark and book lice (formally Psocoptera) – scavengers that feed on fungi, lichens, insect eggs, and organic debris
- Parasitic lice (chewing and sucking lice) (formally Phthiraptera) – ectoparasites that feed on blood, skin, hair, and feathers.
 - Lice are wingless parasites of birds and mammals. These lice are pretty host specific and may be limited to feeding on a specific species. Lice are ectoparasites and need to remain close to the host. Therefore, they attach their eggs, or nits, to the hair or feathers of the host.

A chewing louse, a common pest of birds.

A sucking louse on a human's skin.

head lice nits

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Order Thysanoptera (Thrips)

fringe wing

Some thrips are common pests of plants. They inject their mouthparts and suck the plant juices of the buds, flowers or fruits of the plant causing damage to these structures. Some species are predaceous and feed on mites. Adults can be winged or wingless. The wings are thin and are covered with a fringe of hairs. Thrips are hemimetabolous, but they may have a pseudo pupal stage with a silken cocoon. This puzzles scientists and may be an instance of convergent evolution.

thrips

NOTE: The term "thrips" is used both as the singular and plural form!

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Order Hemiptera (True Bugs)

half wings

- Hemimetabolous development
- Piercing-sucking mouthparts
- Half-wings
- Scutellum
- Defensive secretions
- Predators, herbivores, and parasites

Chinch Bug

Wheel Bug

A common stink bug.

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Hemiptera - continued (Cicadas, Leafhoppers, aphids, whiteflies, scales, etc.)

Homopterans differ from hemipterans by uniformity of their wings and the origin of their piercing-sucking mouthparts. Homopteran forewings have a uniform texture unlike the half-wings of their hemipteran brothers and the winged homopterans hold their wings in a tent shape over their bodies. The proboscis is opisthognathous meaning that it is on the ventral posterior margin of the head capsule. The proboscis, or beak, is smaller in homopterans and they use this beak to suck out juices from vascular plants.

cicada

spittlebug

spittlebug immature

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Hemiptera Continued

(Cicadas, Leafhoppers, aphids, whiteflies, scales, etc.)



scale insect



whiteflies



aphids



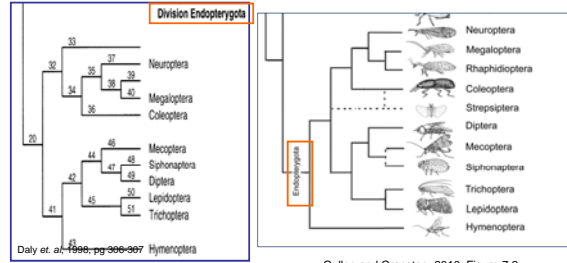
treehopper

The digestive system of most homopterans has a filtering system. This allows the insect to ingest large amounts of sap and then excrete the excess water and sugars. Ants appreciate this meal of honeydew and provide protection to the insects in exchange for this sweet meal. Many homopterans, like aphids and leaf hoppers, are important carriers of plant diseases. Others are beneficial, like the lac scale that produces shellac and the cochineal scale that produces red dye.



Scarf dyed with cochineal dye 43

Infraclass Neoptera: Division Endopterygota



If you remember from our discussion on insect evolution, the fourth stage of insect evolution was neopterous wings with holometabolous development. Endopterygota is composed of insects with that description. They have a wingless larval stage that looks different from the adult. 44

Order Neuroptera (Lacewings, Antlions, etc.)

nerve wing

- Holometabolous
- Beneficial predators
- Weak fliers



brown lacewing



green lacewing



Doodlebug and pupal case



lacewing eggs



antlion adult

Note: Orders similar to the neuropterans include Megaloptera, and Raphidioptera.

For a bit of neuropteran fun, visit http://www.antlionfarms.com/videos_pics.

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Order Megaloptera (dobsonflies)

large wings



dobsonfly



male dobsonfly



Dobsonfly eggs - bird dropping mimic



Dobsonfly larva - helgrammite

46

Mecoptera, Strepsiptera, and Raphidioptera

Mecoptera – scorpionflies and hangingflies
predators, scorpion-like tail is harmless

Strepsiptera – twisted-wing parasites
parasites of insects, only have hind wings

Raphidioptera – snakeflies
predaceous, found in Europe, Asia and the Western US.



scorpionfly

47

Order Coleoptera (Beetles)

sheath wing



A carrion beetle. CSI anyone?



Wow! What a pile of dung. Can you believe the Egyptians worshiped this beetle?



A firefly or lightning bug. Of course this is neither a fly or a bug, but a beetle.



tiger beetle – a quick predator

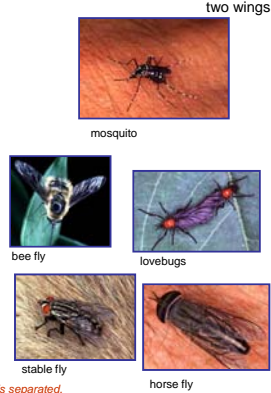


A scarab beetle with flared antennae to catch the scent of a mate or food.

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Order Diptera (True Flies)

- Dipterans are the true flies.
- Holometabolous development
- 2 functional wings
- Hindwings as halteres
- Various mouthparts
- Larvae called maggots



If you notice the names, you will see that if the word fly is separated, then it is a Dipteran. If it is attached, it is not. Example: House fly or Butterfly

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Order Siphonaptera (fleas)

- Hematophagous with piercing-sucking mouthparts
- Laterally flattened (secondarily wingless)
- Holometabolous
- Can transmit disease
- Saltatorial hind legs
- 2400 species with ¼ affiliated with rodents



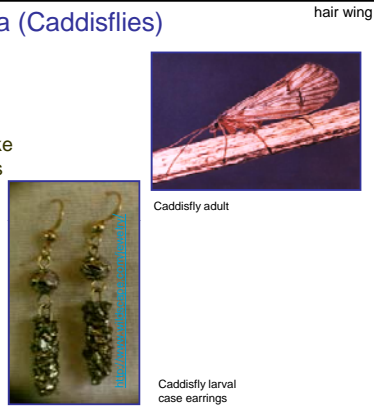
Oriental Rat Flea: Plague vector

The bubonic plague was the most common form of the Black Death. The mortality was close to 100% (even today there is no treatment). Symptoms are a high fever and skin turning deep shades of purple due to disseminated intravascular coagulation. Yes, all from a flea bite.

50

Order Trichoptera (Caddisflies)

- Holometabolous
- Filiform antennae
- Hairy wings
- Wings held roof-like
- Aquatic immatures
- Case makers



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Order Lepidoptera (Butterflies and Moths)

- Lepidoptera is the second largest order of insects behind Coleoptera.
- Lepidopterans are holometabolous and the larvae are known as caterpillars.

While it appears that caterpillars have many legs, there are only three true pair and 2-8 pair of fleshy prolegs.

- Most caterpillars are herbivorous and many can cause substantial damage to crops trees, or ornamental plants.
- Some caterpillars can sting because they are covered with urdicating hairs.
- Adult legs are well known for their scaled wings.
- The adult butterflies and moths feed by a siphoning tube that is coiled for storage.



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Moth and Butterfly differences

Moths

- the antennae taper to a point
- they are thick bodied
- the wings lay against the abdomen at rest



Butterflies

- the antennae end in a club
- the body is more delicate
- the wings are held upright or out to the side at rest



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Order Hymenoptera (bees, ants, and wasps)

Hymenopterans are social insects that are specialized for their particular niche. They are holometabolous and have mandibulate mouthparts (some, like bees have modifications where their mouth is shaped like a tongue to lap nectar from flowers). They have four wings that are joined together (fore and hind) by tiny hooks called hamuli. Some wasps are herbivores and form galls, others are tiny and are parasites of other insects. Many bees and wasps are important pollinators of plants. As the bee lands on a flower to suck its sweet nectar for food, it catches pollen on its body. When it lands on another flower, this pollen will fall off thereby fertilizing the flower. Ants are common pests around homes. Those of you in the Southeastern US, are familiar with fire ants. These were accidentally introduced into the US in the 1930's and have been quite successful. An interesting fact about hymenopterans is that females develop from fertilized eggs and males develop from unfertilized eggs. Cool huh?



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Review

In review, the insect orders are grouped according to whether or not they are ametabolous, hemimetabolous or holometabolous. You will also see that the insect orders are grouped according to the absence or presence of wings and whether or not the wing has a flexon, i.e. **apterygote**, **paleopterous** or **neopterous**. The orders are also grouped according to how the wings develop. If the wings develop from structures on the outside of the body the insect is called an **exopterygote**. If the wings develop from internal wing pads, the insect is called an **endopterygote**. Be sure you know which orders go with each classification.



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Learning Game Placeholder

Learning Game: Word Quiz

Title: Terms Quiz

Learning Game Placeholder

Learning Game: Choices

Title: Review Quiz

Conclusion

Your mind is probably spinning with all the terms and the characteristics of each order. Do you know the difference between a bee and a beetle yet? How many wings does a fly have? During an upcoming lab or in your own collection, you should be able to look at specimens and the differences will become clearer to you. Now that you know the order characteristics, you will be an expert in no time.



wingless wasp – cow killer ant

Note: To review the order characteristics and check your chart from the study guide, you may refer to http://entnemdept.ufl.edu/choate/insect_orders.htm.

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