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 beetle and a bee?

3

Introduction

Bees and Beetles

- Six legs
- Exoskeleton
- Two antennae
- Four wings

scarab beetle

honey bees

4

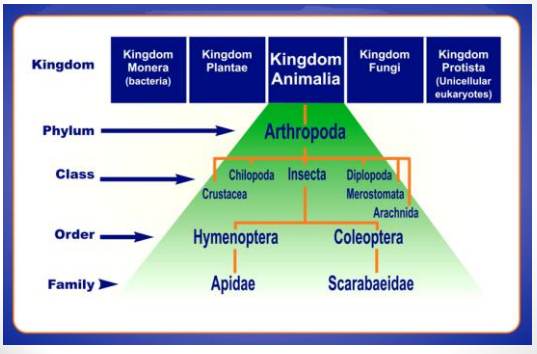
Classification Review

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.

5

Classification Review Diagram



6

Review Terms

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

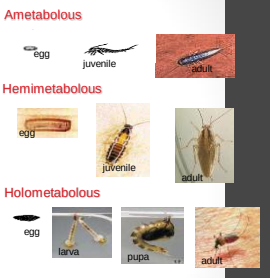
Review Terms: Answers

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.



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.

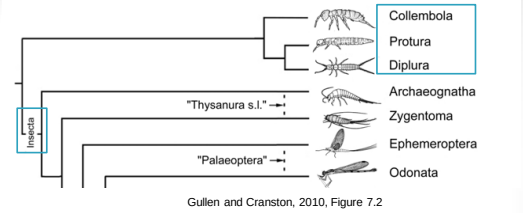
vespid wasp

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.

Four Class Scheme

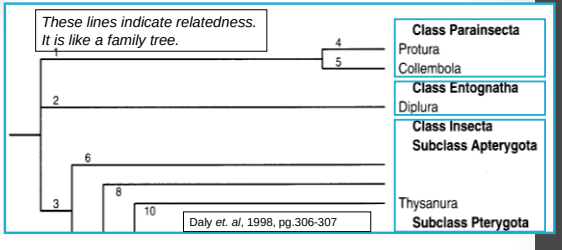


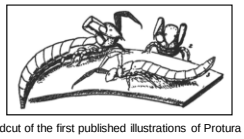
Gullen and Cranston, 2010, Figure 7.2

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.

Three Class Scheme





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

Objectives Recap

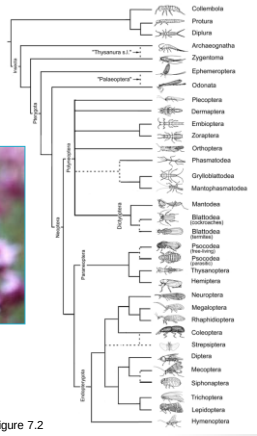
- 28 insect orders.

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

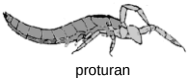
Insect Taxonomy



Gullen and Cranston, 2010, Figure 7.2

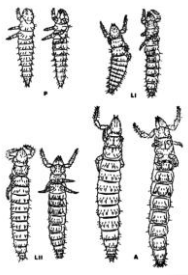
Class Parainsecta: Order Protura

- 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

first tail



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

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

Proturan Walking Video

Proturan Defensive Posture Video

Class Parainsecta: Order Collembola

Springtails can tuck their tail (furcula) underneath and 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

glue wedge

collembolan

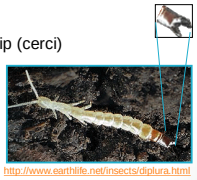
Fill out the table on your study guide under the heading "Insect Orders."

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 forcepts on the abdominal tip (cerci)
- 0.5-50mm
- 10 body segments
- Continued molting



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

dipluran

Notice that the ending -ura means tail.

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
- Primative 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=tsNZtVfWUOk&feature=related

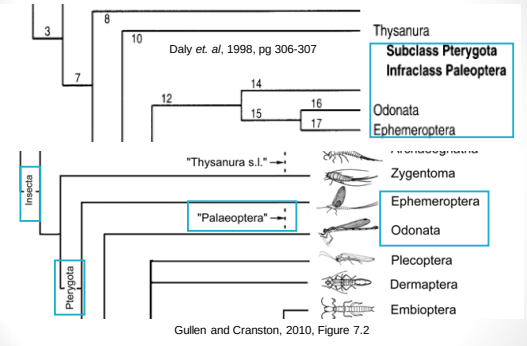
Class Insecta: Subclass Apterygota: Order Zygentoma (Thysanura)

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

Primitive Pterygotes



Gullen and Cranston, 2010, Figure 7.2

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.

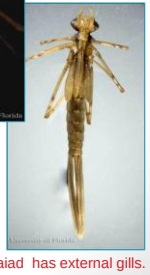
Note: a naiad is an aquatic nymph of a hemimetabolous insect.

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



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

Order Odonata (Damselflies, Dragonflies) (continued)

toothed ones

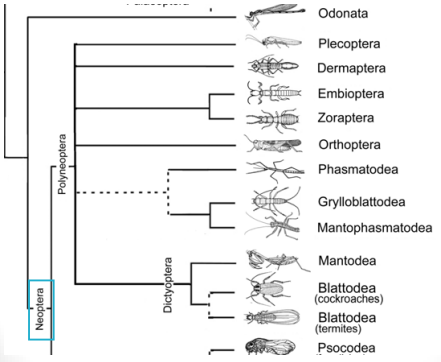
dragonfly

damselfly

compound eyes

25

Neopteran Phylogeny



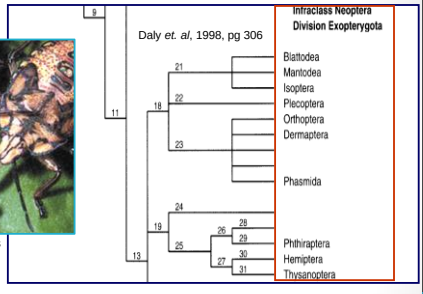
Gullen and Cranston, 2010, Figure 7.2

26

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.

27

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.

28

Order Dermaptera (earwigs)

skin wing

- Hemimetaolous
- 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.

29

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

30

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

31

Order Orthoptera (grasshoppers, crickets, katydids)

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.

straight wing

Cricket

A mole cricket with fossorial front legs.

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

32

Order Phasmatodea (Walking sticks)

- 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

From the Greek "phasm" or phantom

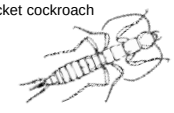
Florida two-lined walking stick

33

Grylloblattodea (Rockcrawlers)

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

Cricket cockroach



34

Order Mantophasmatodea (Heel Walkers or Gladiators)

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.

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

Greek for Mantid and Phantom

Gullan and Cranston 2005, pg 501

35

Order Mantodea (Praying Mantids)

Mantis is the Greek word for Mantids

praying mantis

Mantis egg case

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

36

Order Blattodea (Cockroaches and Termites)

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

Blatta is the Greek word for cockroach

Florida woods cockroach and egg case

Australian cockroach

Cuban cockroach

37

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.

38

Order Psocodea (Lice)

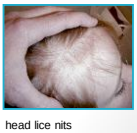
wingless louse

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

39

Order Thysanoptera (Thrips)

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. Thirps 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.

fringe wing

thrips

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

40

Order Hemiptera *(True Bugs)*

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

Chinch Bug

Wheel Bug

half wings

A common stink bug.

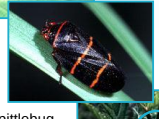
41

Hemiptera – (continued)

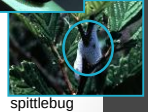
(Cicadas, Leafhoppers, aphids, whiteflies, scales, etc.)

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 opistognathous 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

42

Hemiptera – (continued)

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


scale insect


whiteflies

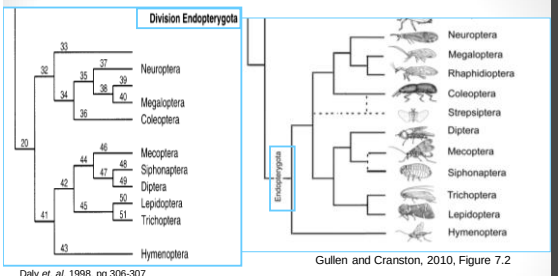

aphids


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

Infraclass Neoptera: Division Endopterygota



Daly *et. al*, 1998, pg 306-307

Gullen and Cranston, 2010, Figure 7.2

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.

Order Neuroptera (Lacewings, Antlions, etc.)

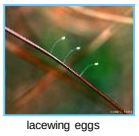
nerve wing

- 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.

Order Megaloptera (dobsonflies)

large wings


dobsonfly

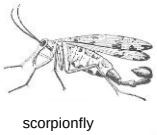

male dobsonfly


Dobsonfly eggs – bird dropping mimic


Dobsonfly larva - helgrammite

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

Order Coleoptera (Beetles)

sheath wing


A carrion beetle.
CSI anyone?

- Coleoptera is the largest order of insects (about 40% of all known animals).
- These guys are holometabolous and the larvae are referred to as grubs.


tiger beetle – a quick predator


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.


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

Order Diptera (True Flies)

two wings

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


mosquito


bee fly


stable fly


horse fly


lovebugs

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

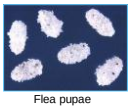
49

Order Siphonaptera (fleas)

wingless tube

- Hematophagous with piercing-sucking mouthparts
- Laterally flattened (secondarily wingless)
- Holometabolous
- Can transmit disease
- Saltorial hind legs
- 2400 species with ¾ affiliated with rodents


Flea larva


Flea pupae


flea

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)

hair wing

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

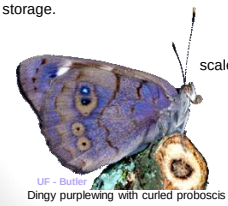

http://www.wildscape.com/jewelry/
Caddisfly larval case earrings


Caddisfly adult

51

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 leps are well known for their scaled wings.
- The adult butterflies and moths feed by a siphoning tube that is coiled for storage.



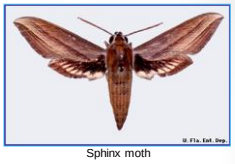
Dingy purplewing with curled proboscis


brushfooted butterfly

52

Moth and Butterfly differences

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


Sphinx moth


Monarch caterpillar and adult

- 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)

- Holometabolous
- Mandibulate mouthparts
  - (some, like bees have modifications where their mouth is shaped like a tongue to lap nectar from flowers).
- 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.
- Ants are common pests around homes.
- Hymenopteran females develop from fertilized eggs and males develop from unfertilized eggs.


parasitic wasp


bee pollinating a flower


ant

membrane wing

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Review

- 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.
- Additional groupings concern 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.

wingless wasp – cow killer ant

Now that you know the order characteristics, you will be an expert in no time.

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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