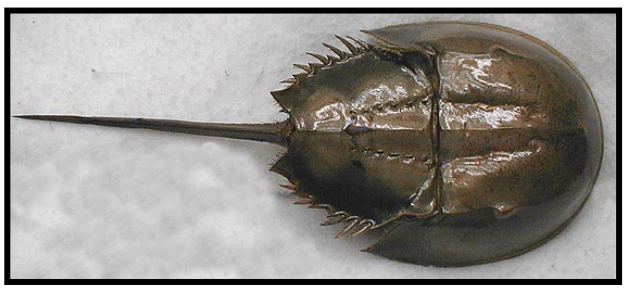
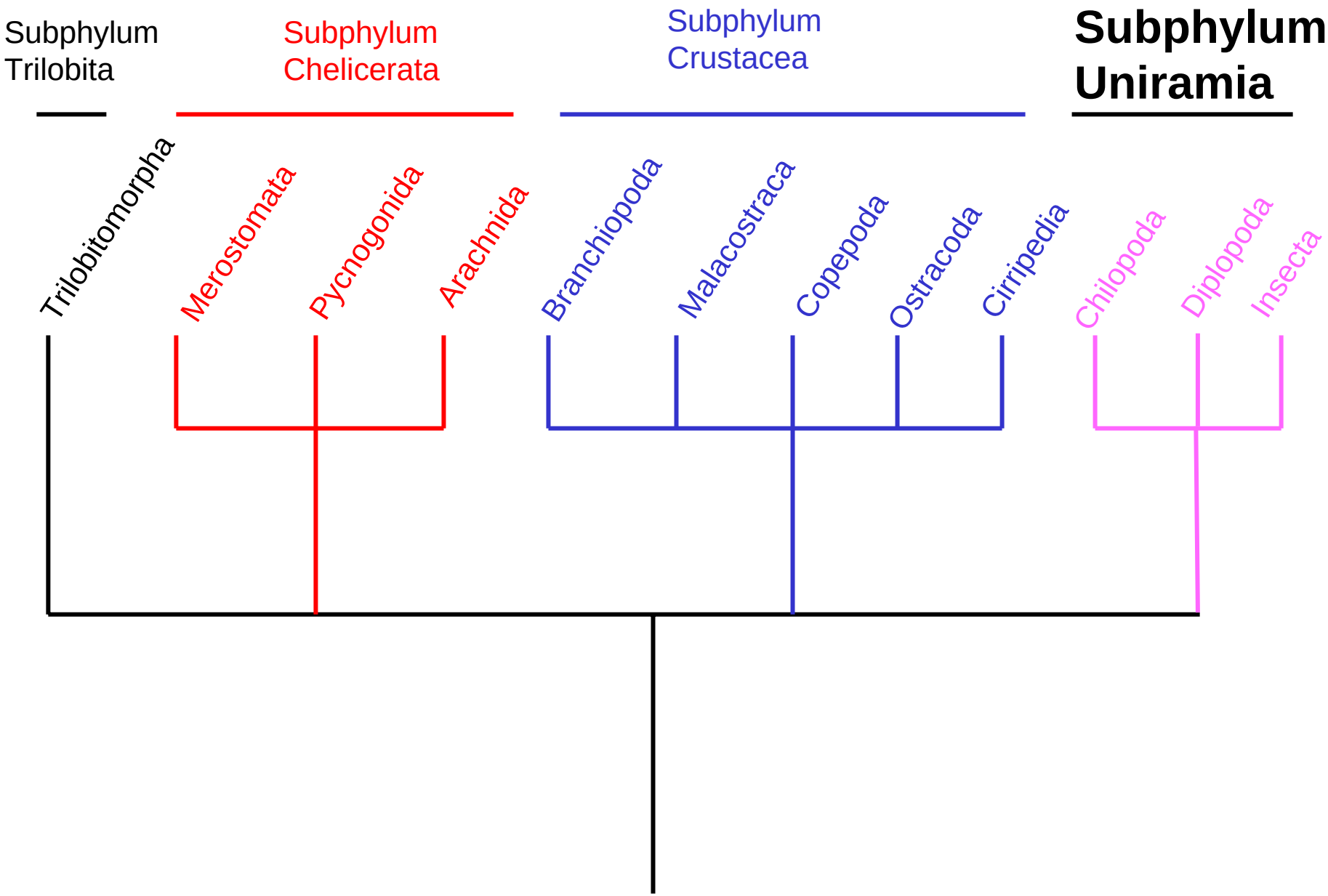



Phylum Arthropoda

“joint-footed” animals

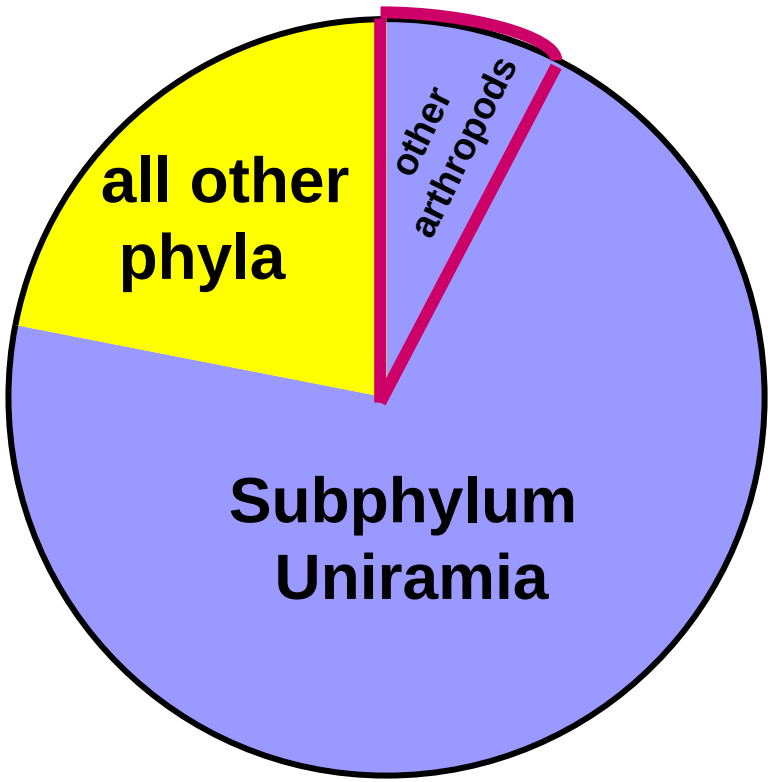




Subphylum
Trilobita
Subphylum
Chelicerata
Subphylum
Crustacea
Subphylum
Uniramia
Trilobitomorpha
Merostomata
Pycnogonida
Arachnida
Branchiopoda
Malacostraca
Copepoda
Ostracoda
Cirripedia
Chilopoda
Diplopoda
Insecta

Phylum Arthropoda
Subphylum Uniramia

- the largest subphylum
- comprises ~75% of all known animals



Uniramia Characteristics

Have the general arthropod characteristics plus:

1. unbranched (uniramous) appendages
2. 1 pair of antennae
3. mandibles
4. 2 pairs of maxillae (usually)
5. body is covered with a cuticular exoskeleton

Feeding

- Free living: Herbivores, carnivores, detritivores
- Parasites and parasitoids

Parasitic insects are usually only parasites for part of their lives (e.g. mosquitoes). However, some insects are parasites for their entire lives (lice).

***Anopheles* mosquitos transmit malaria**

Lice are ectoparasites of most birds and mammals

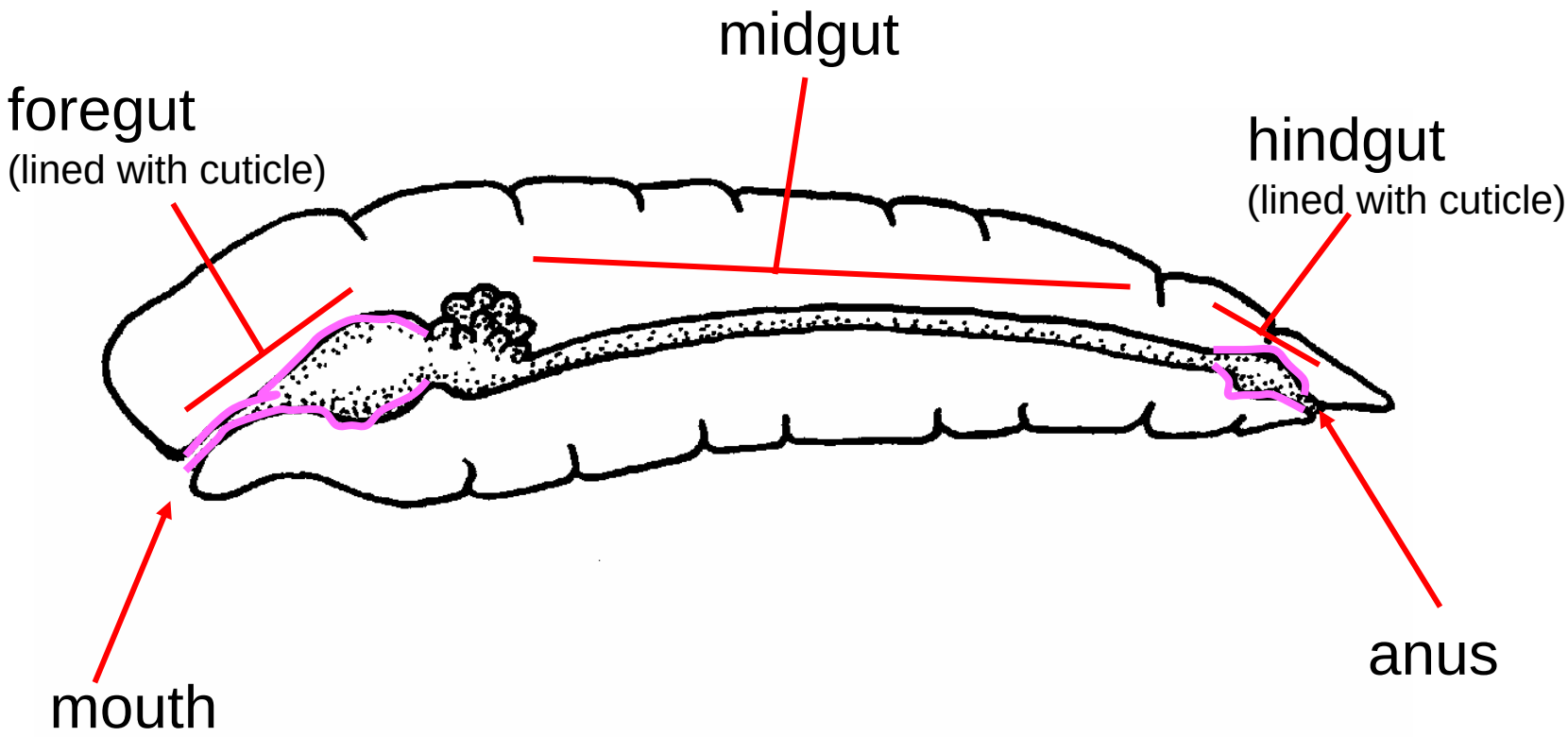
Parasitoids

Parasitoid larvae are parasites that eventually kill their hosts, while the adults are free-living.

Digestive System

- complete with regional specialization

Generalized Arthropod Digestive System



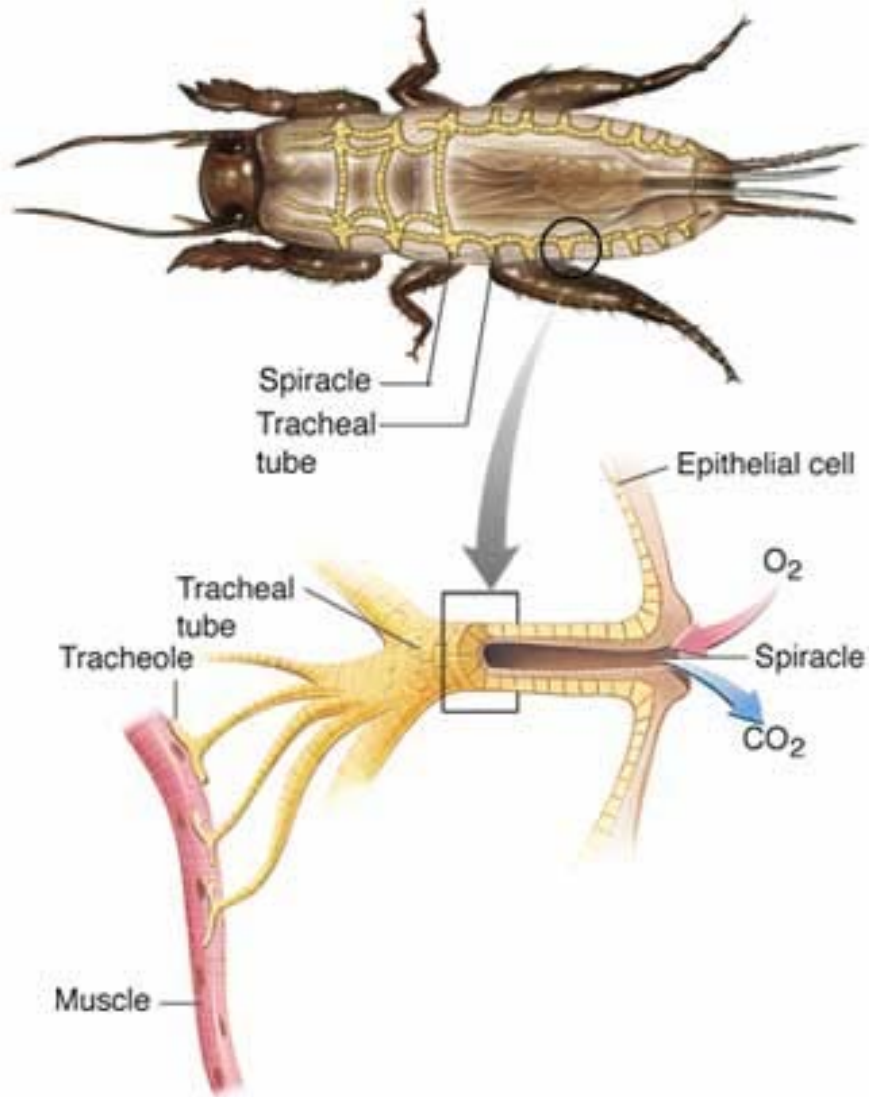
9y/99

Subphylum Uniramia

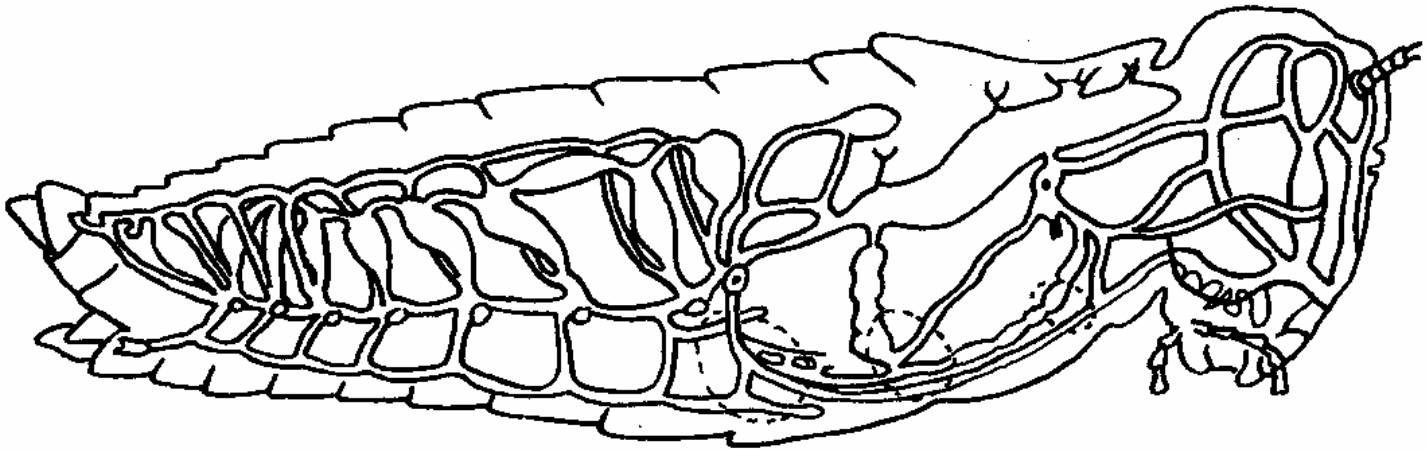
Gas Exchange

- by tracheal system (consists of thin-walled tubes)
- tracheal tubes open to the outside by spiracles
- if juveniles are aquatic, they may have gills

Insect tracheal system



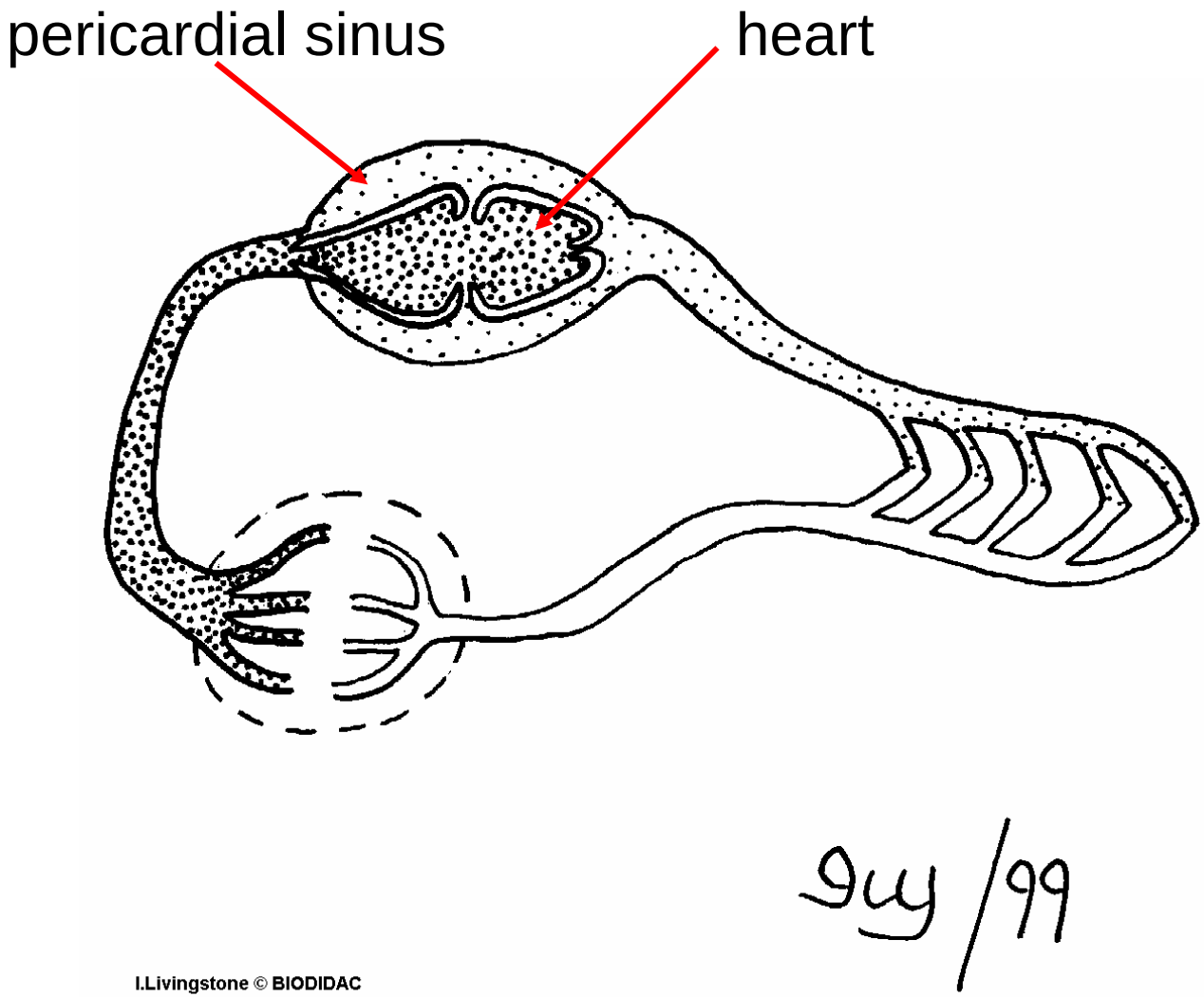
Insect tracheal system

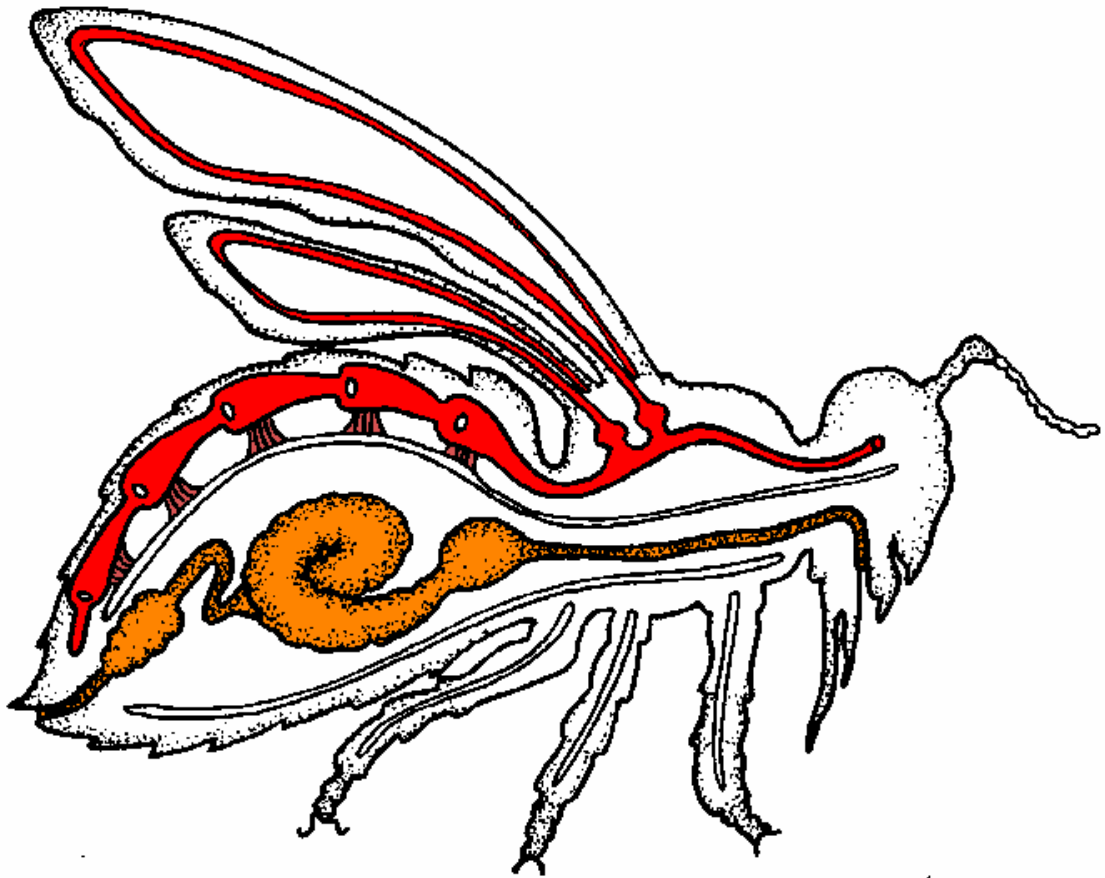


Ivy/97

Circulatory System

- open circulatory system consisting of a hemocoel (main body-cavity) filled with hemolymph (blood)

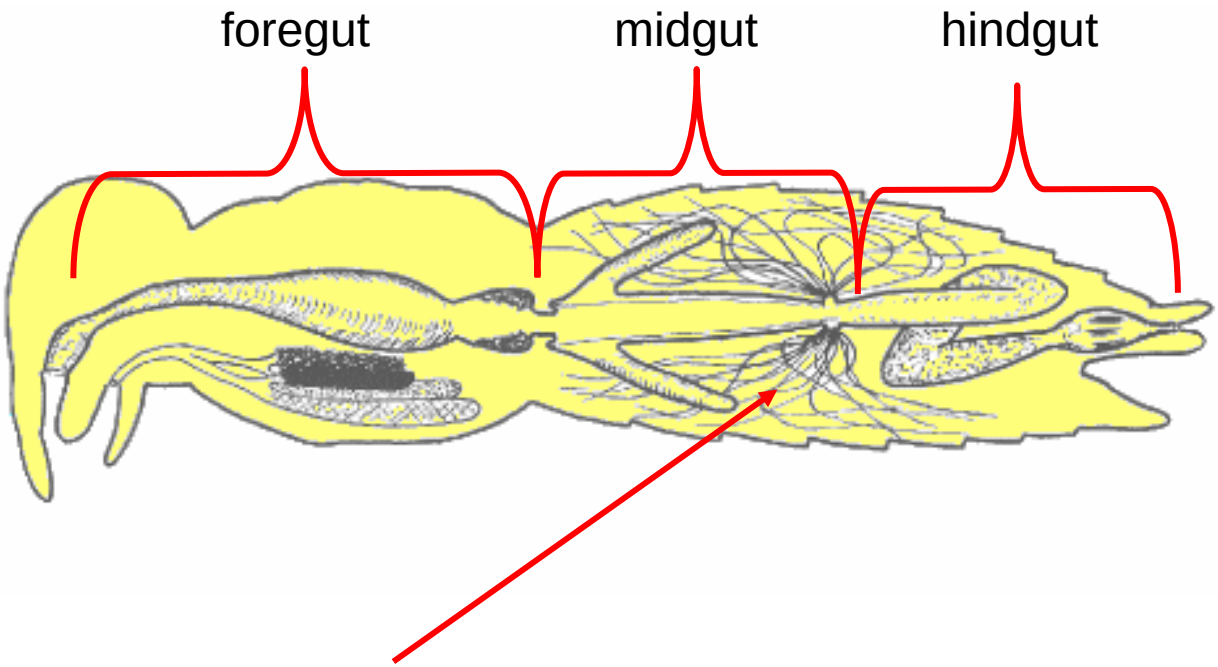




Arthropoda Characteristics

Excretion

- Malpighian tubules



Malpighian tubules: collect waste from the hemocoel, and pass it into the hind gut where water and ions are resorbed

Arthropoda Characteristics

Reproduction

- usually sexual and dioecious
- usually internal fertilization

Subphylum Uniramia

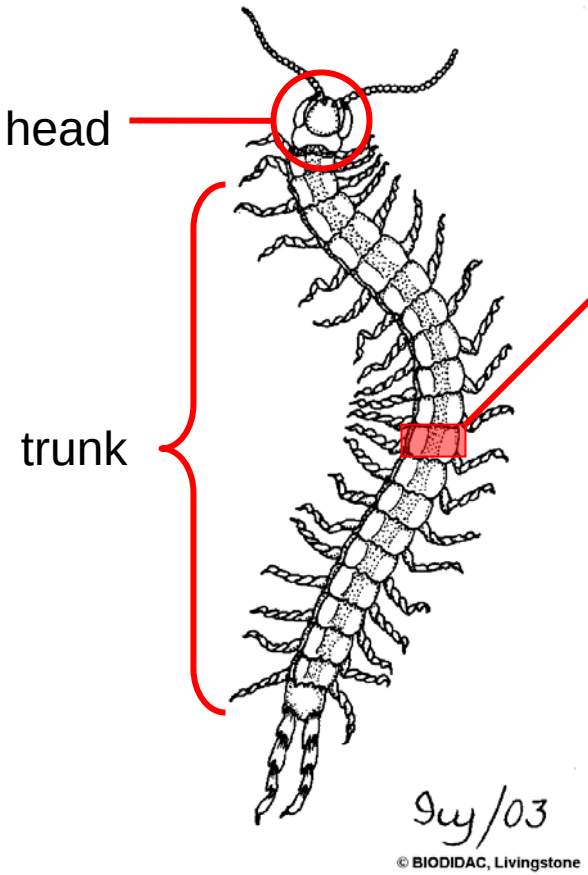
Class Chilopoda

- centipedes
- active predators
- body is slightly flattened dorsoventrally

Subphylum Uniramia

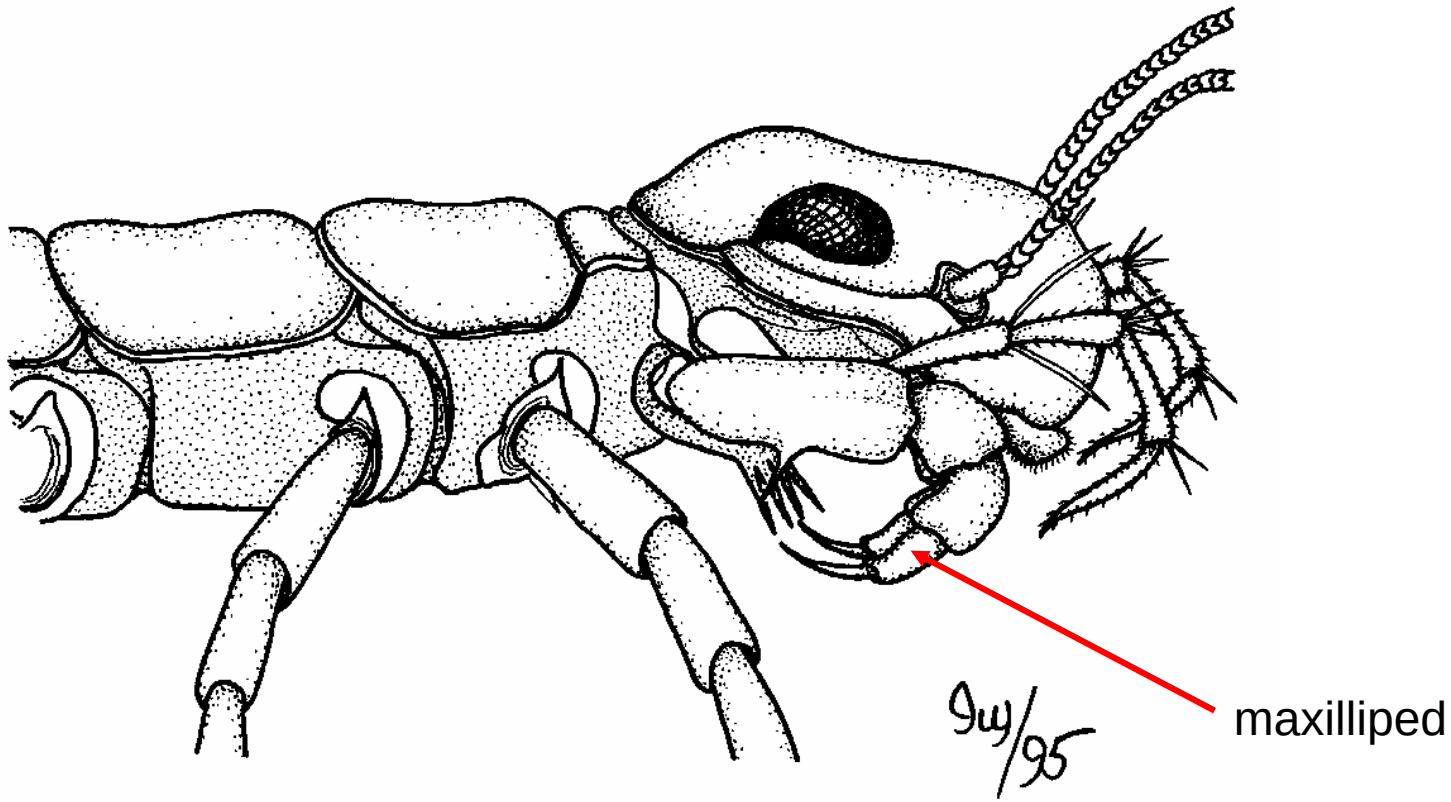
Class Chilopoda

- **2 tagmata:**

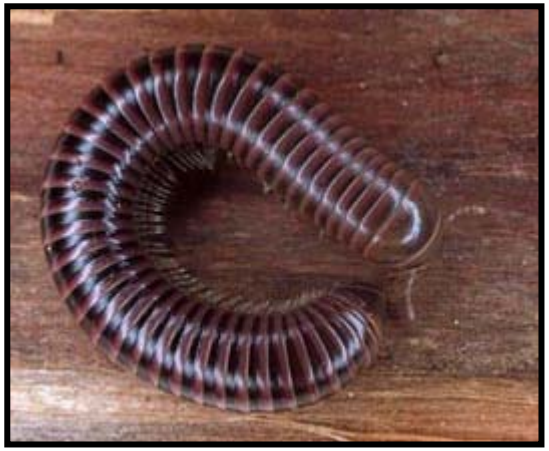


1 pair of appendages on most somites

1st somite has poison claws



Livingstone, © BIODIDAC



Subphylum Uniramia

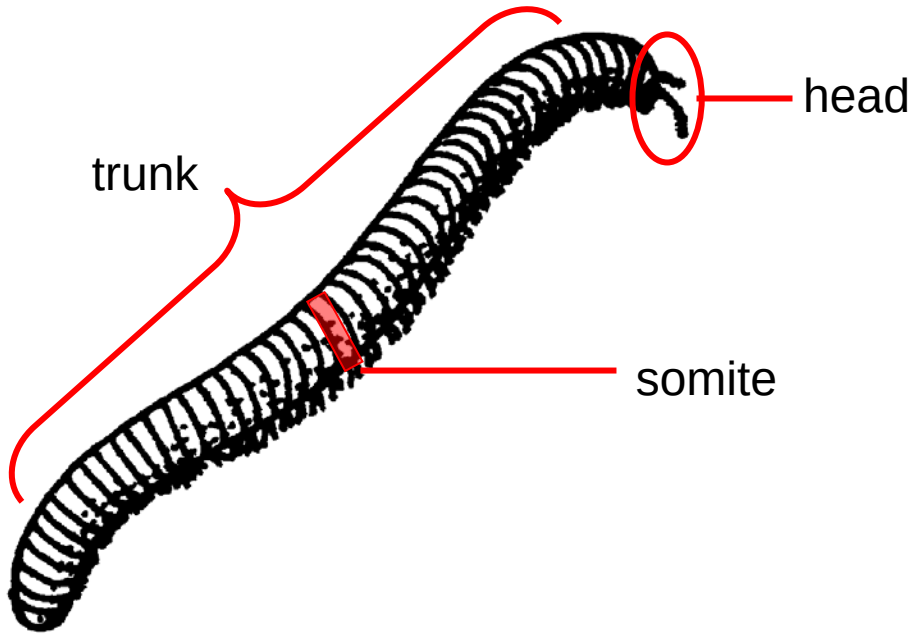
Class Diplopoda

- millipedes
- generally herbivores + detritovores
- body is cylindrical

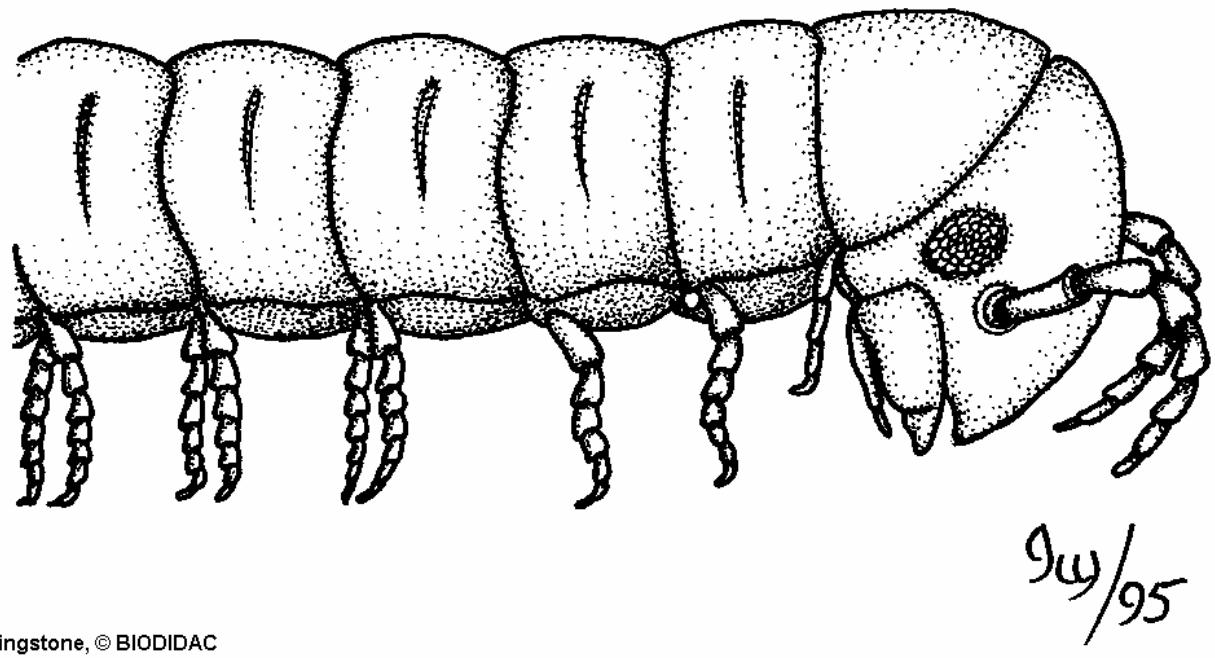
Subphylum Uniramia

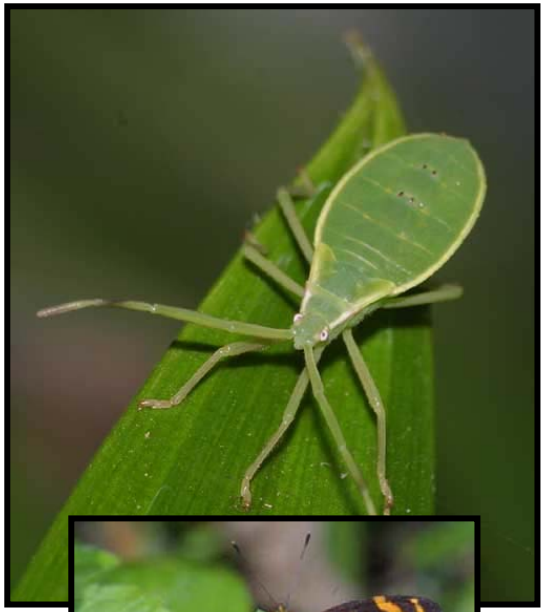
Class Diplopoda

- **2 tagmata:**



2 pairs of appendages on <u>most</u> somites





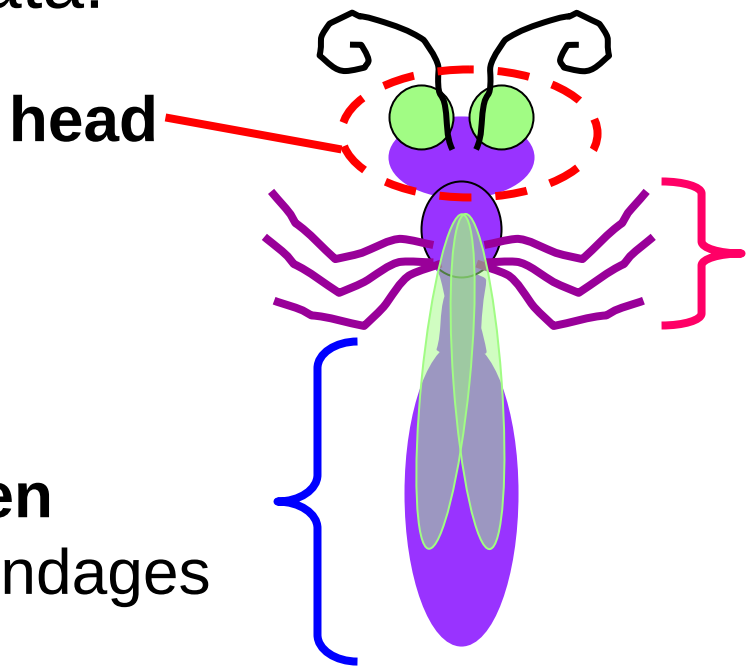
Subphylum Uniramia

Class Insecta

Most numerous and diverse group of the arthropods
~ 1 million species with many still undiscovered and undescribed

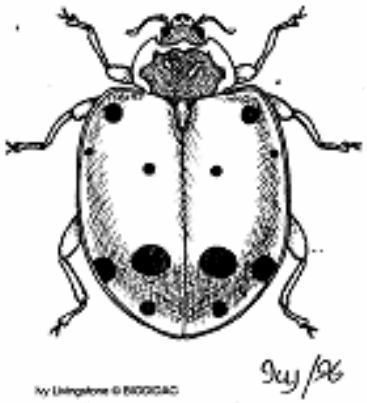
Class Insecta Characteristics

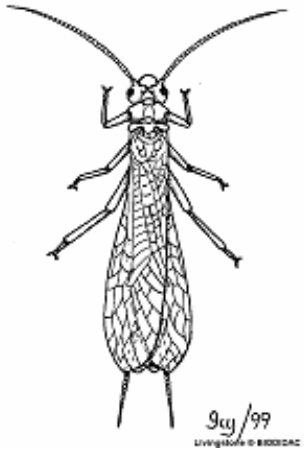
- 3 tagmata:



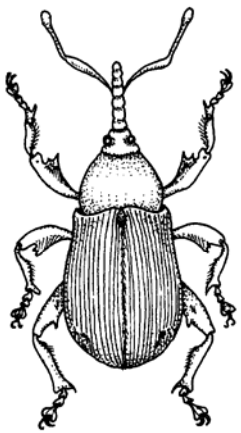
thorax
- has 3 pairs of legs
- may have 2 pairs of wings (usually)

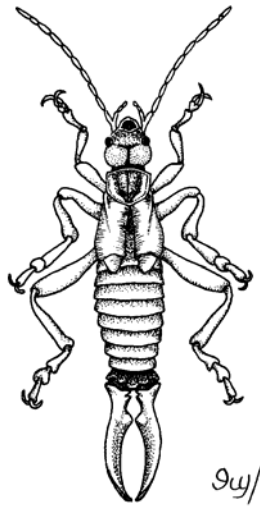
abdomen
no appendages

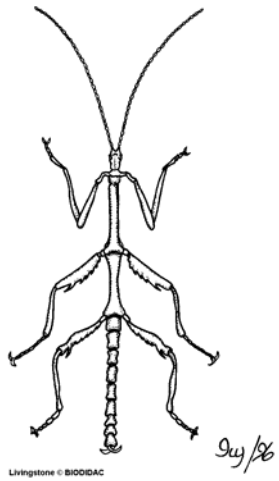

Ivy Livingstone © BIODIDAC
Ivy/96


Ivy/99
Livingstone © BIODIDAC


Ivy/96


Ivy/02
© BIODIDAC, Livingstone


Ivy/96
Livingstone © BIODIDAC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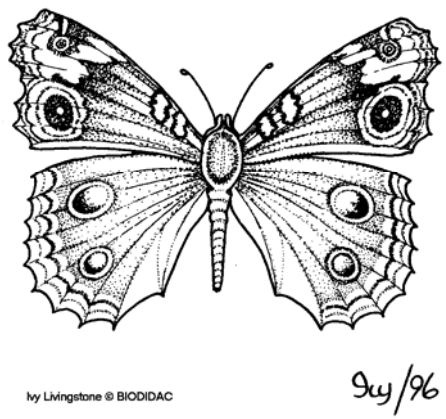
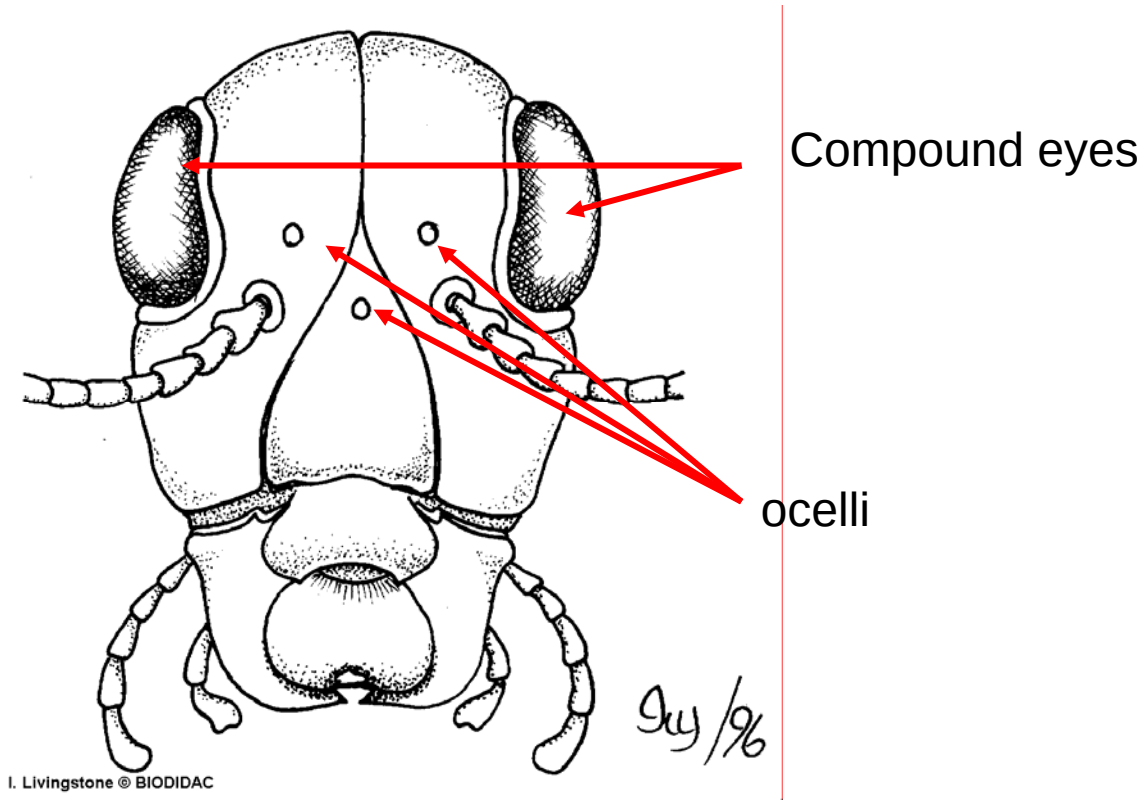
Livingstone © BIODIDAC


Ivy Livingstone © BIODIDAC
Ivy/96

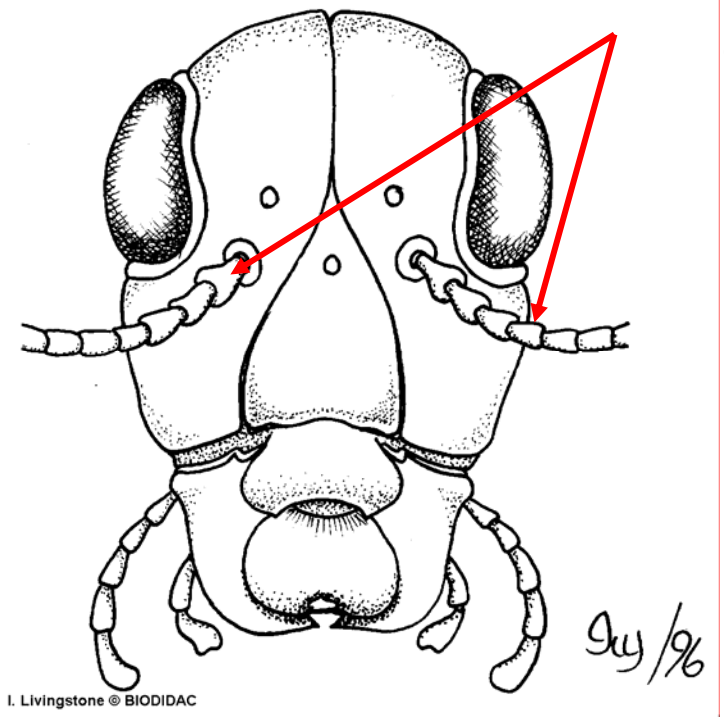
Class Insecta Characteristics

- a pair of large compound eyes, and usually 3 ocelli on the head

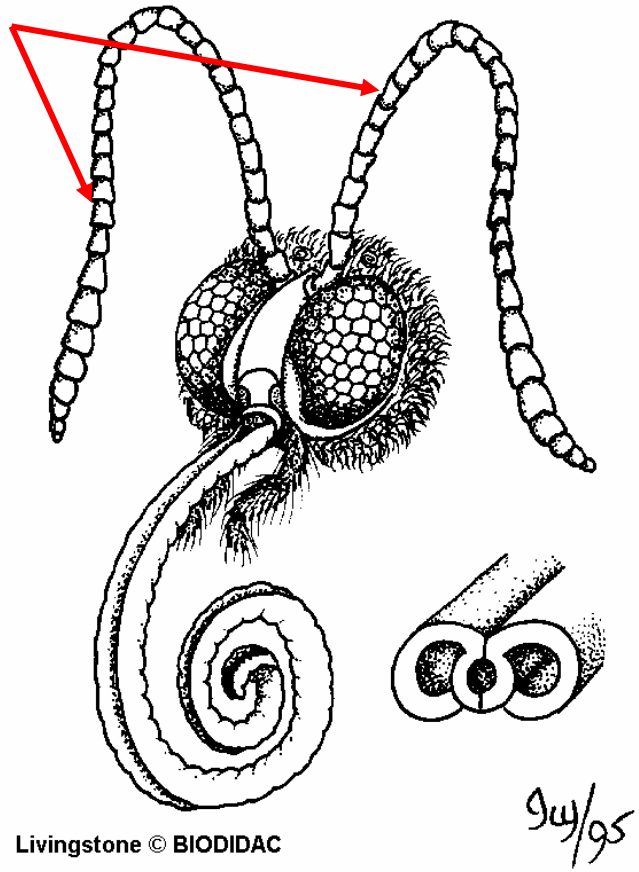


Class Insecta Characteristics

- a pair of antennae



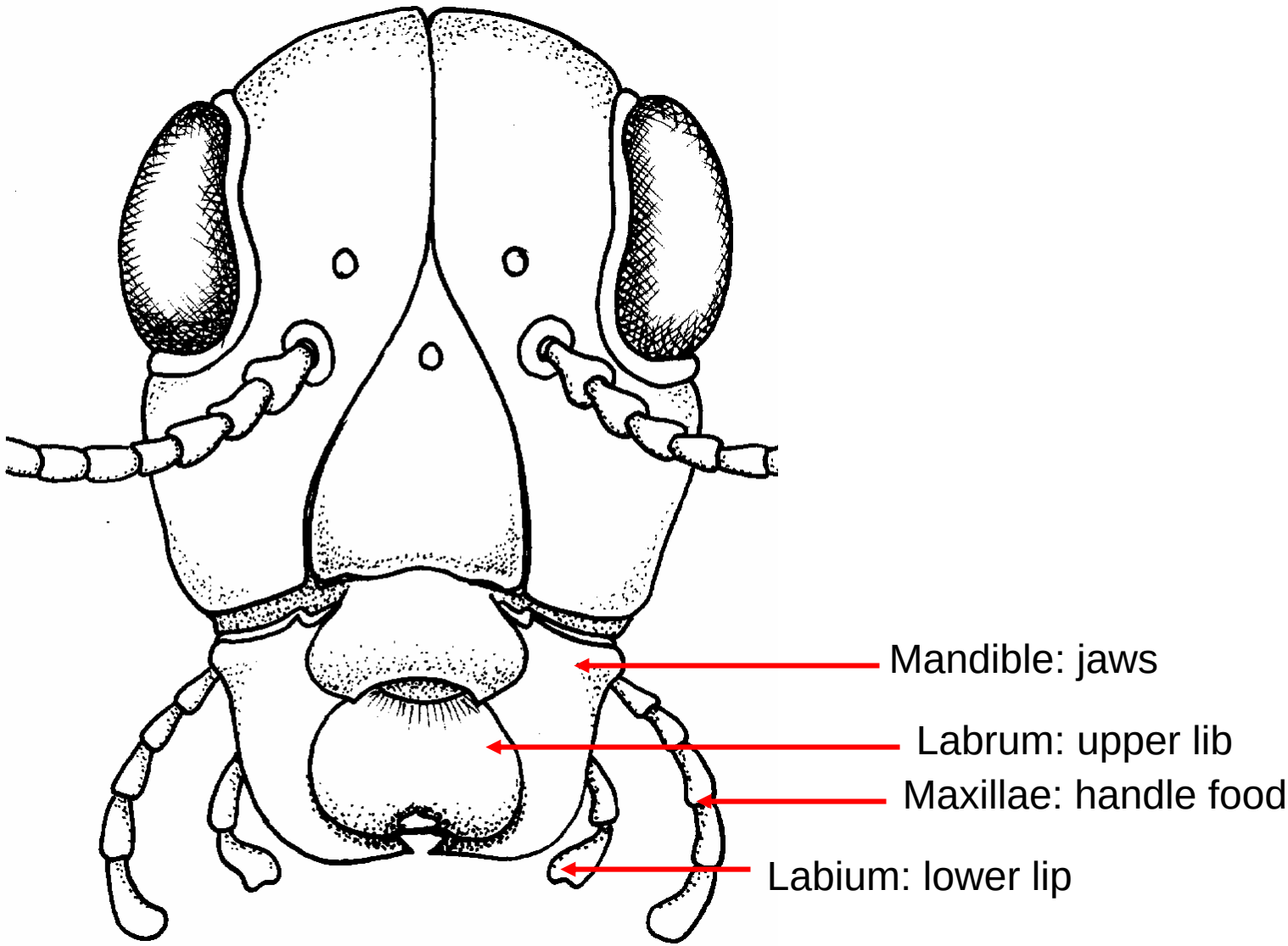
antennae



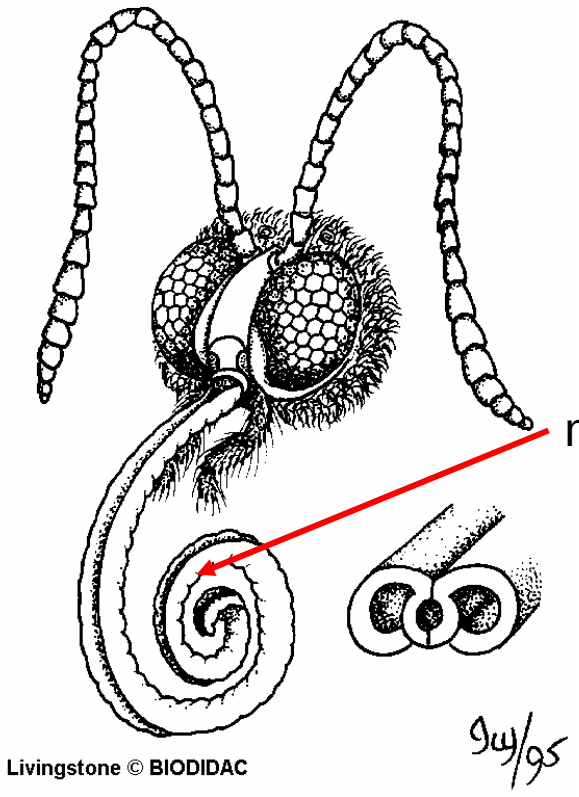
Class Insecta Characteristics

- characteristic mouthparts

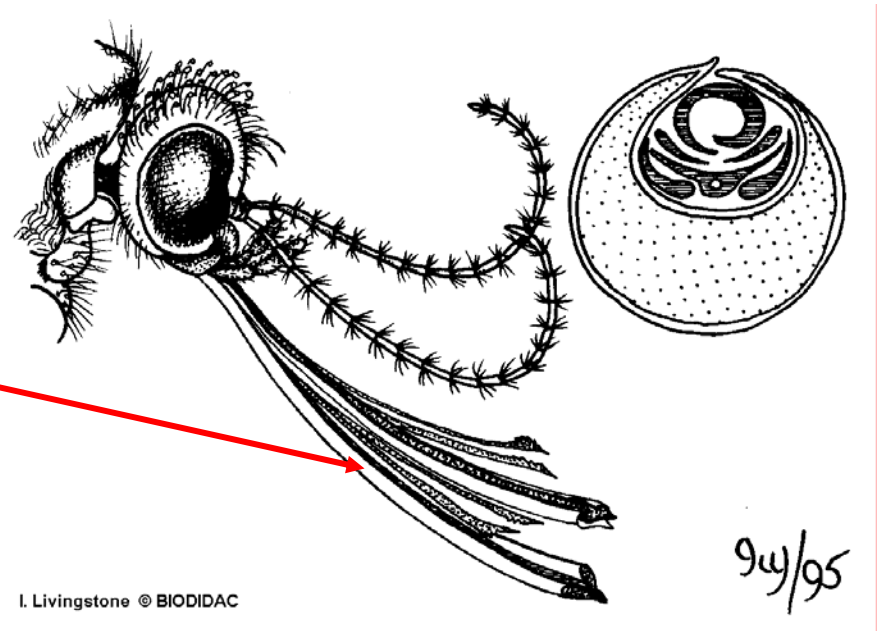
1. A labrum
2. A pair of mandibles
3. A pair of maxillae
4. A labium
5. A hypopharynx (tongue)



These mouthparts are highly modified for different types of feeding:



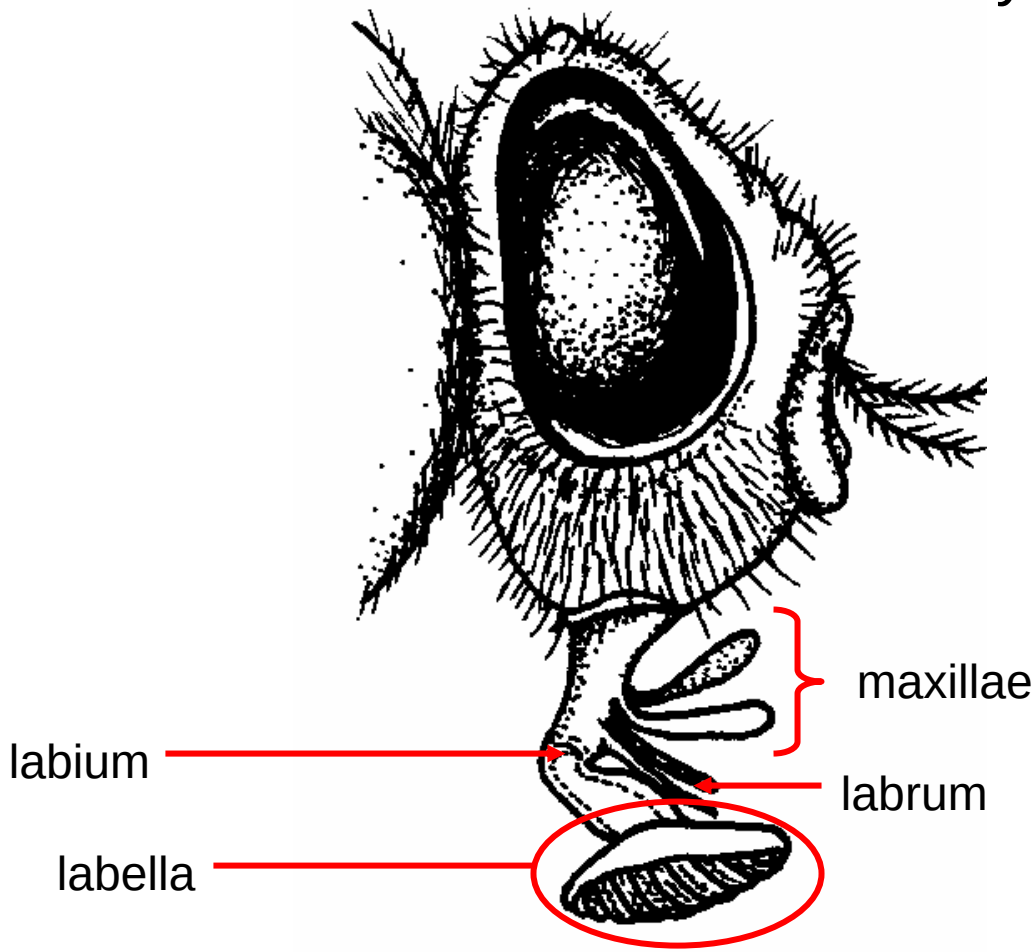
maxillae



Butterfly: siphoning

Mosquito: piercing and sucking

Horsefly: sponging

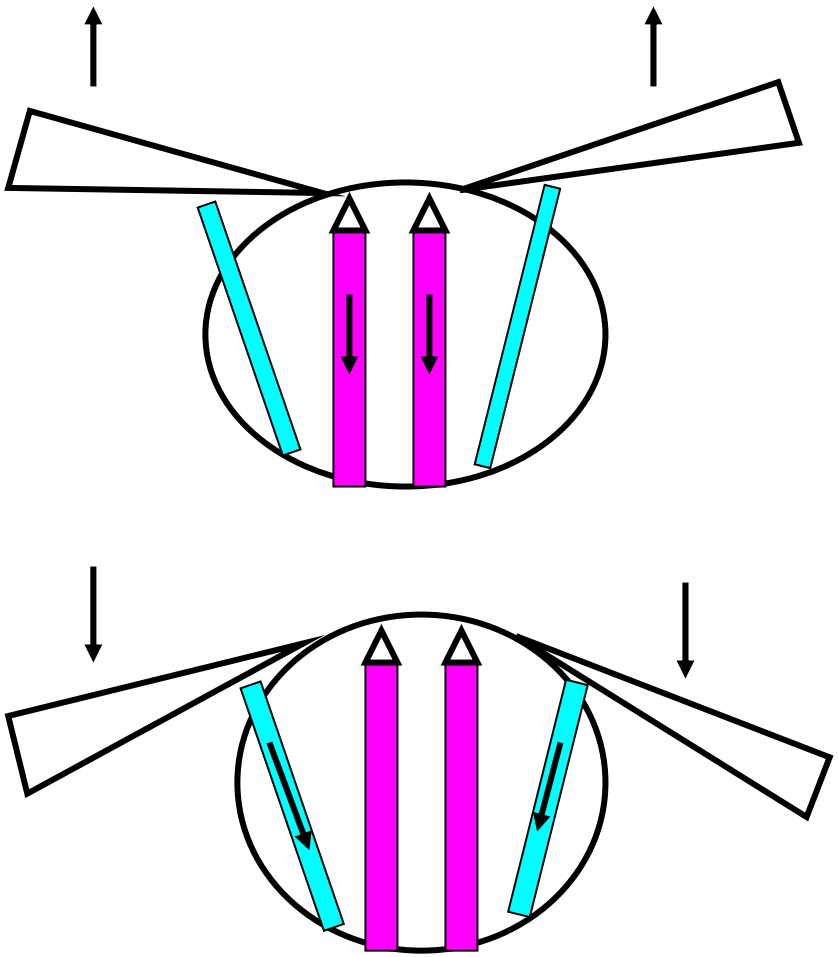


Class Insecta Characteristics

- Wings

Most insects have 2 pairs of wings on the thorax

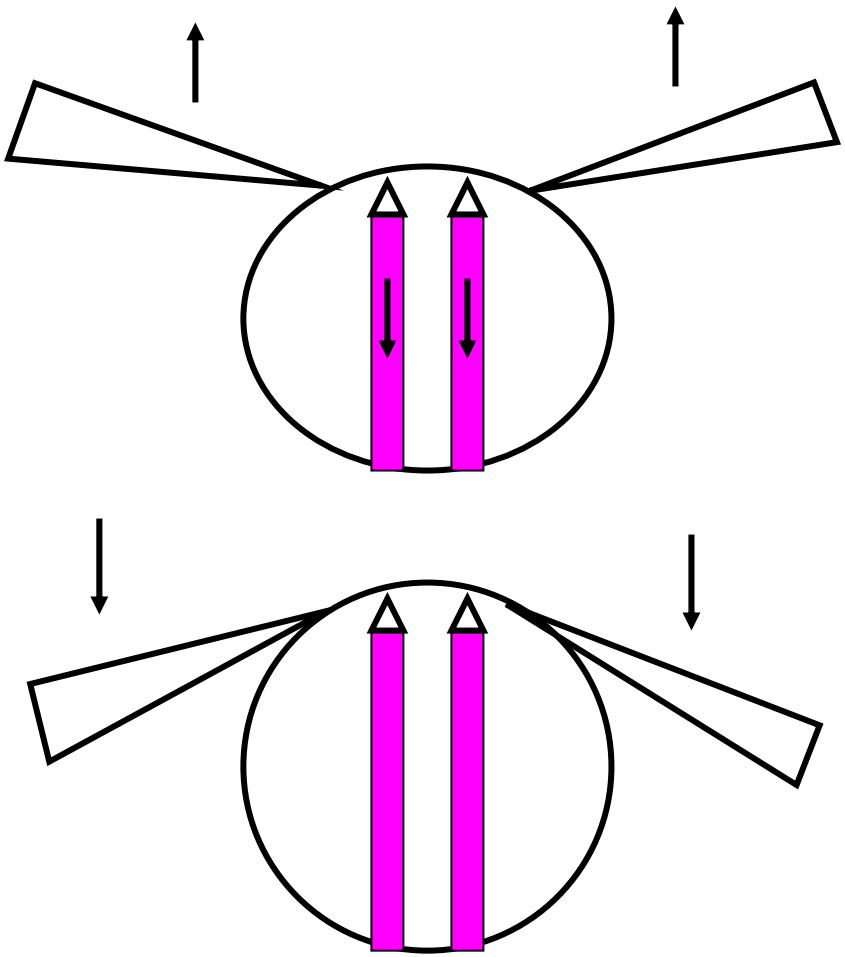
The wings are derived from outgrowths of the boy wall and are made of the cuticle



Some insects have both direct and indirect flight muscles (e.g. Orthoptera, Odonata).

- indirect muscles pull body wall down and lift wings
- direct muscles pull the wings down

direct **indirect**



Some insects have only indirect flight muscles (e.g. Diptera, Hymenoptera).

In these insects, the wings are moved by altering the shape of the thorax.

indirect

Class Insecta Characteristics

- Most insects undergo metamorphosis:

growing
non-reproducing
larva or nymph

no wings

non-growing
reproducing
adult

usually have wings

Insects are separated into 2 subclasses based on whether they undergo metamorphosis and develop wings.

Subclass Apterygota

- primitive insects that do not have wings

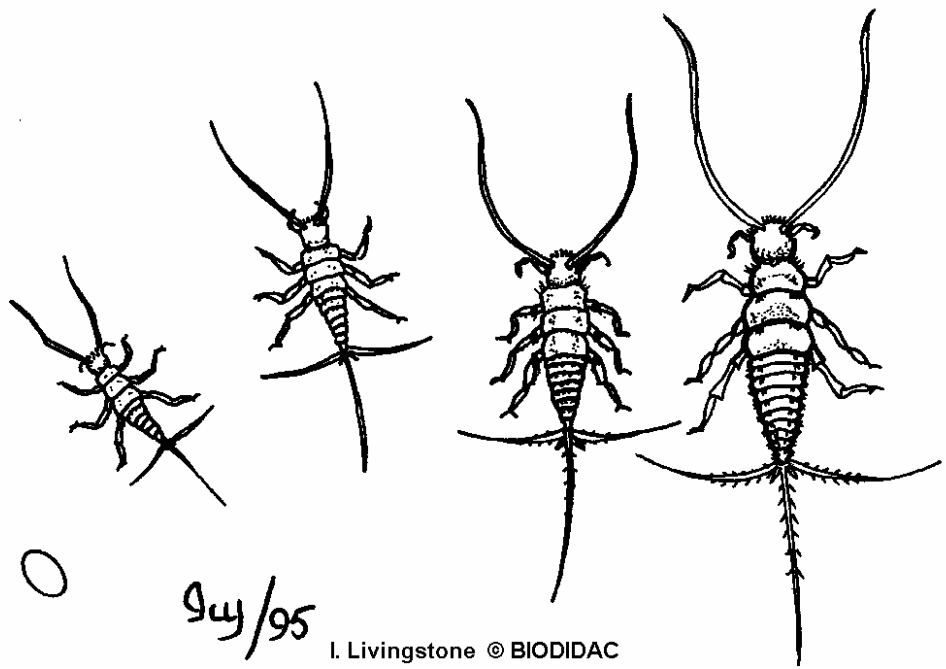
silverfish

Subclass Pterygota

- insects that develop wings via 2 types of metamorphosis

Class Insecta
Subclass Apterygota

Direct development: no metamorphosis, no wings



Class Insecta
Subclass Pterygota

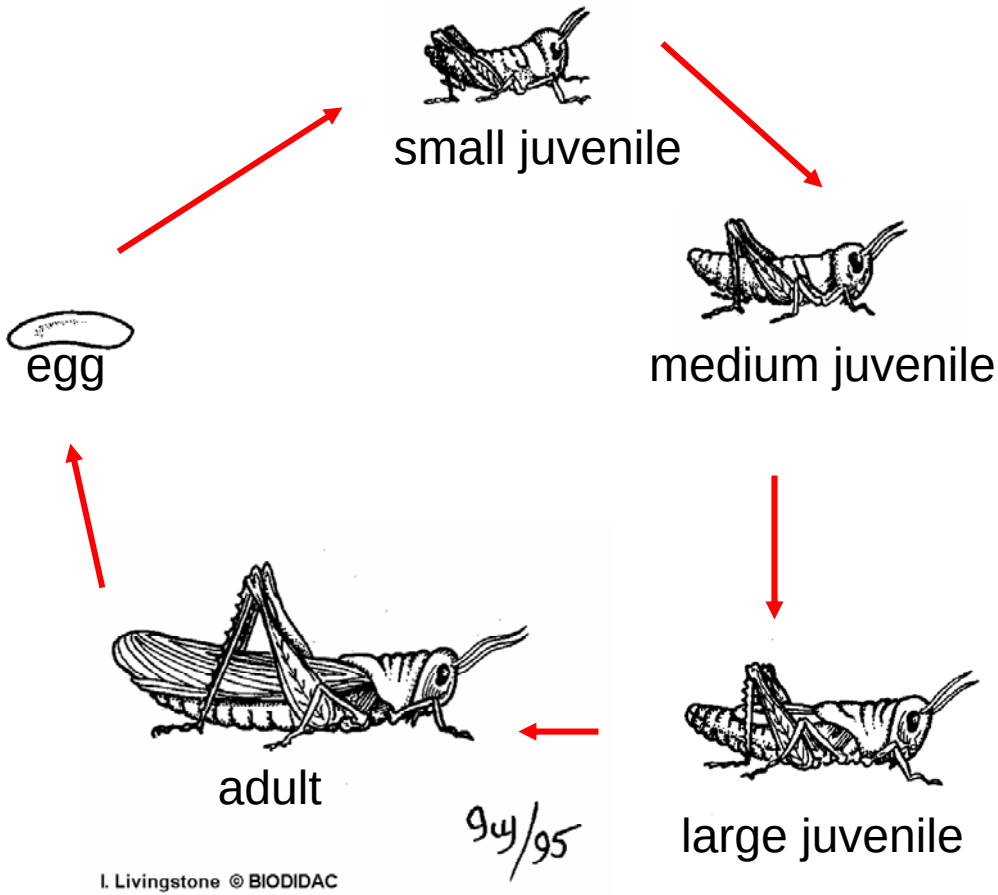
2 types of Metamorphosis:

Division Exopterygota — Hemimetabolous (incomplete metamorphosis)

Division Endopterygota — Holometabolous (complete metamorphosis)

Class Insecta, Subclass Pterygota

Division Exopterygota



Hemimetabolous
(incomplete metamorphosis)

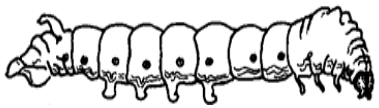
-wings develop on the outside
-adults reproduce but do not grow

Class Insecta, Subclass Pterygota

Division Endopterygota

Holometabolous
(complete metamorphosis)

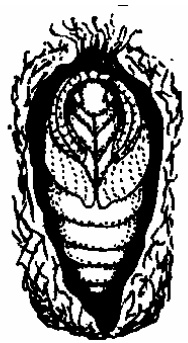
young larva



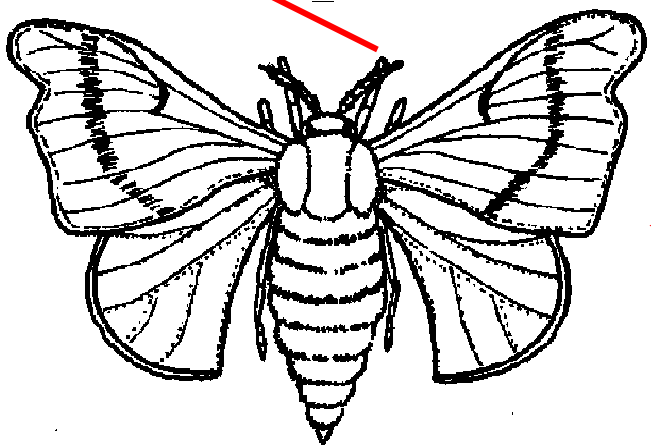
terminal larva

-wings develop on the inside
-adults reproduce but do not grow

egg



pupa



adult

Class Insecta, Subclass Pterygota

Division Exopterygota

Hemimetabolous
(incomplete metamorphosis)

5 ORDERS:

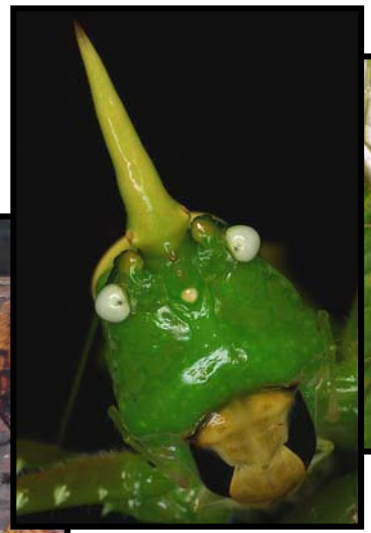
- **Order Orthoptera**
- **Order Isoptera**
- **Order Odonata**
- **Order Hemiptera**
- **Order Homoptera**

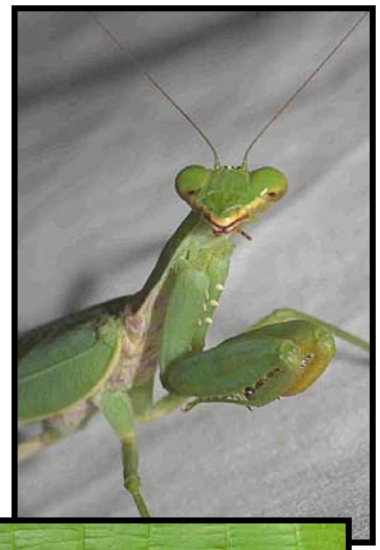
Class Insecta, Subclass Pterygota

Division Exopterygota

Order Orthoptera

crickets, grasshoppers, roaches, mantids



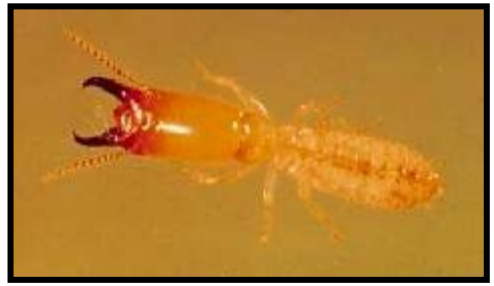


Class Insecta, Subclass Pterygota

Division Exopterygota

Order Isoptera

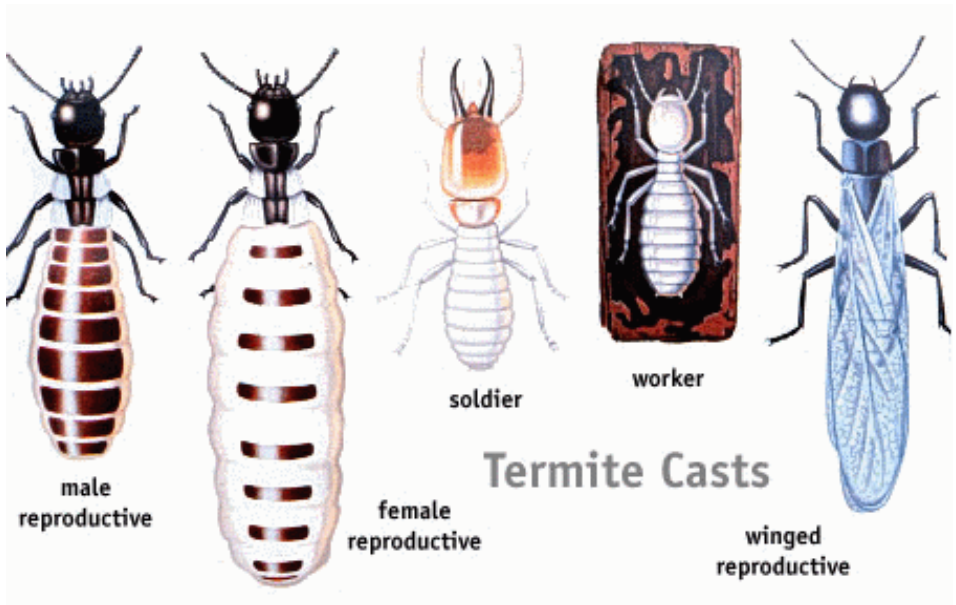
termites



Ecology

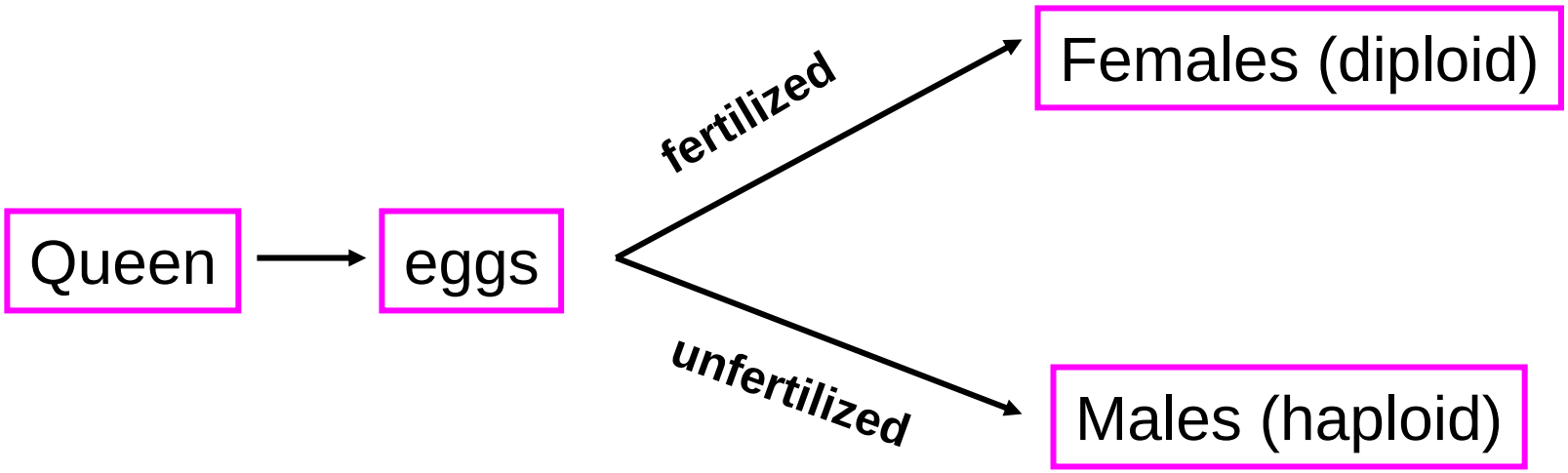
Eusocial (truly social) insects (Hymenoptera and Isoptera) live in societies characterized by:

- **Cooperative care of young**
- **Overlap of generations**
- **Polymorphism (caste system)**



Ecology

Haplodiploid Sex Determination



This method of sex determination along with the ability of queens to store sperm, allows the queen to control the sex of her offspring

Class Insecta, Subclass Pterygota

Division Exopterygota

Order Odonata

dragonflies, damselflies







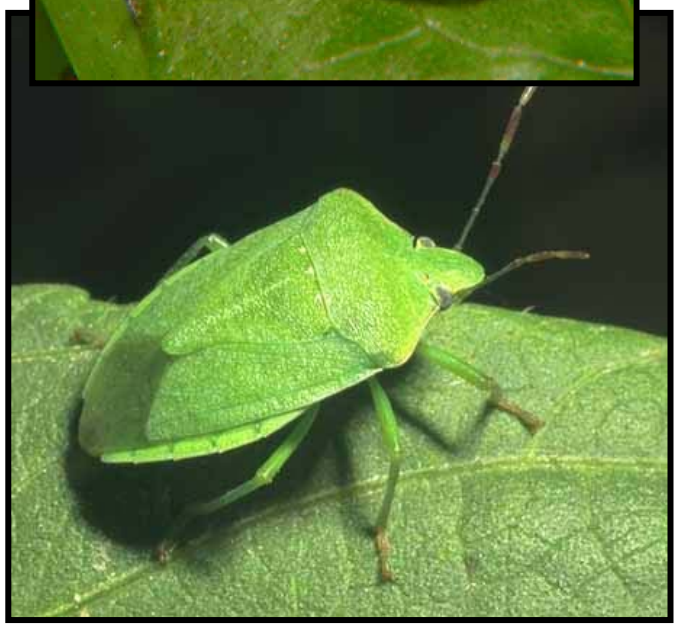


Class Insecta, Subclass Pterygota

Division Exopterygota

Order Hemiptera

True bugs: assassin bugs, bedbugs



Class Insecta, Subclass Pterygota

Division Exopterygota

Order Homoptera

cicadas, aphids, leaf hoppers

Class Insecta, Subclass Pterygota

Division Endopterygota

Holometabolous
(complete metamorphosis)

4 ORDERS:

- **Order Coleoptera**
- **Order Lepidoptera**
- **Order Hymenoptera**
- **Order Diptera**

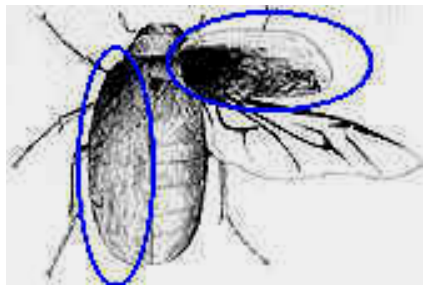
Class Insecta, Subclass Pterygota

Division Exopterygota

Order Coleoptera

beetles

-top pair of wings is modified into an armor-like covering called an elytra



There are at 350, 000 described species of beetle:

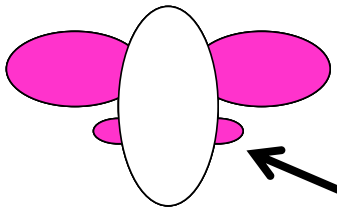
When asked what his studies of nature had revealed about God, J.B.S. Haldane, the renowned British physiologist and philosopher, is said to have replied: “an inordinate fondness for beetles."

Class Insecta, Subclass Pterygota

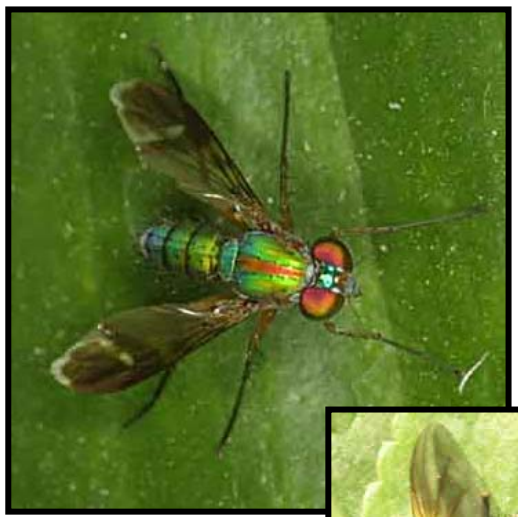
Division Exopterygota

Order Diptera

Flies, mosquitoes



-have only 1 pair of flying wings
-2nd pair of wings are reduced to halteres + used in balance



Class Insecta, Subclass Pterygota

Division Exopterygota

Order Hymenoptera

bees, wasps, ants

Class Insecta, Subclass Pterygota

Division Exopterygota

Order Lepidoptera

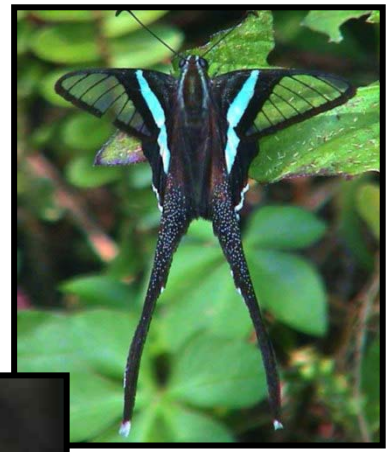
butterflies, moths











Class Insecta, Subclass Pterygota

Division Exopterygota

Order Lepidoptera

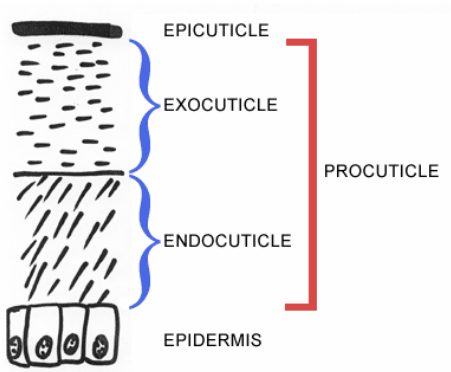
butterflies, moths

What characteristics have enabled Insects to be so successful?

1. Desiccation resistance

Insects have several adaptations that prevent them from dehydrating on land:

a. Waxy epicuticle
b. Resistant egg shells
c. Trachael system



2. Wings:

Wings have enabled insects to access food and resources they wouldn’t be able to reach otherwise

Wings have also allowed insects to disperse great distances and colonize new habitats

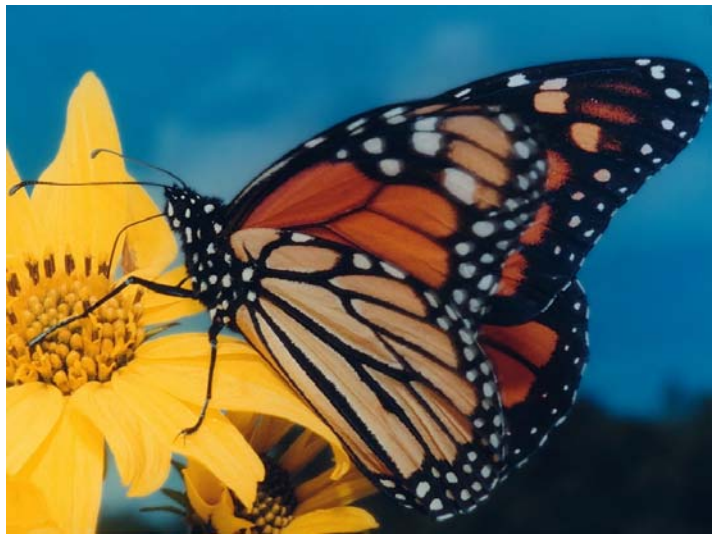
Primitively, insects held their wings outstretched (like a dragonfly)

The ability to fold the wings, allowed insects to access areas they couldn’t previously

5. Metamorphosis

Metamorphosis reduced competition between larvae and adults

Larvae feed on milkweed leaves



Adults feed on milkweed flowers

Plant Insect interactions

Insects are important pollinators

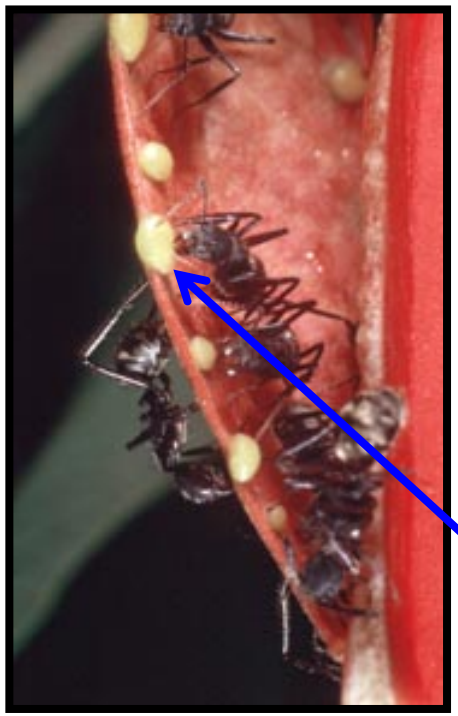
Many flowering plants have evolved to exploit insects as pollinators

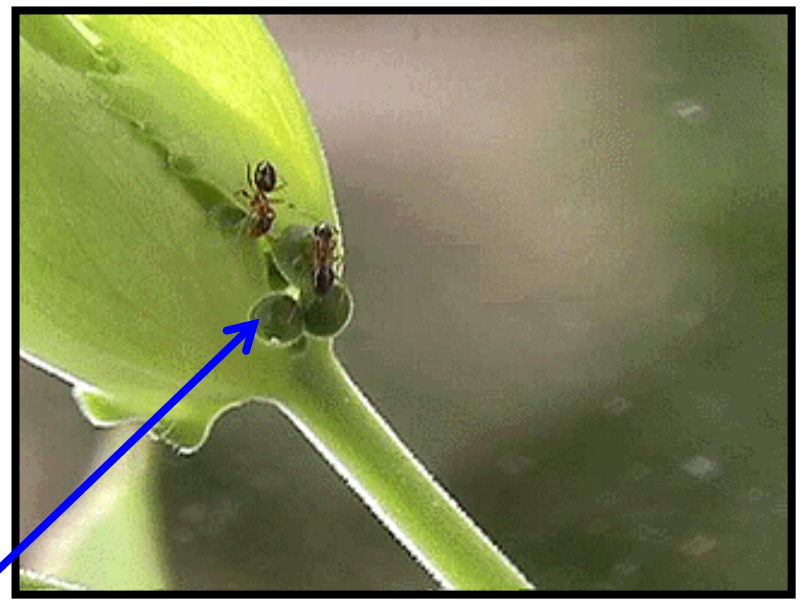
Sexually deceptive orchids

Plant Insect interactions

Insects are important pollinators

Many flowering plants have evolved rewards to attract pollinators (nectar)…



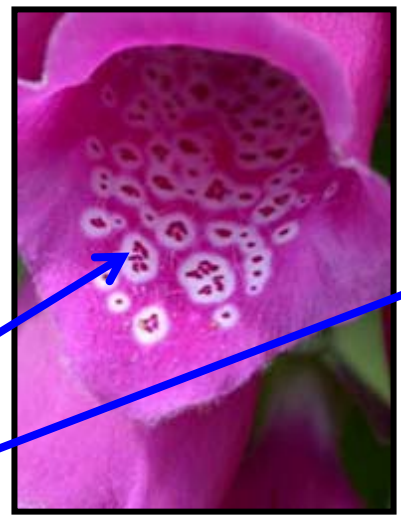


Extrafloral nectaries

Plant Insect interactions

Insects are important pollinators

- … and displays to advertise these rewards.



Nectar guides

Visible light
(what we see)

UV light
(what a bee sees)

Plant Insect interactions

Mutualisms

Some insects are involved in obligate mutualisms (both partners require one another). These are often plant-pollinator relationships.

Figs and fig wasps

Yucca and Yucca Moths

Plant Insect interactions

Herbivory

Some insects feed on plant materials without benefiting the plant

Faculty Research on Plant-Insect Interactions

Dr. Brian Inouye: Host parasitoid interactions in gall forming wasps

Dr. Nora Underwood: Plant resistance and herbivore population dynamics

Galls: irregular plant growth induced by an insect or mite.

The galls are the result of an interaction between plant hormones and growth regulating compounds produced by the insect.

The insect lives within the gall which provides nutrients and shelter

Some gall forming insects are involved in mutualisms with ants.

Gall former induces plant to secrete a sweet substance

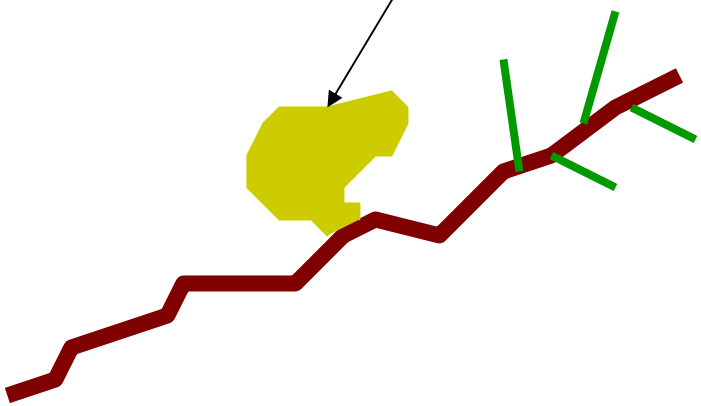
↓

Ants feed on the sweet substance and protect the gall from parasitoids

How do these ants affect *Disholcaspis,* and the community of parasitoids that parasitize them?

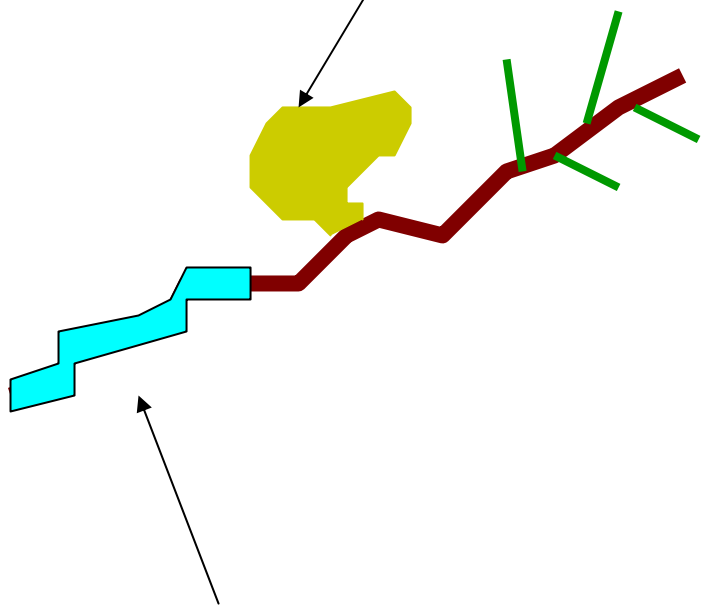
Control

gall

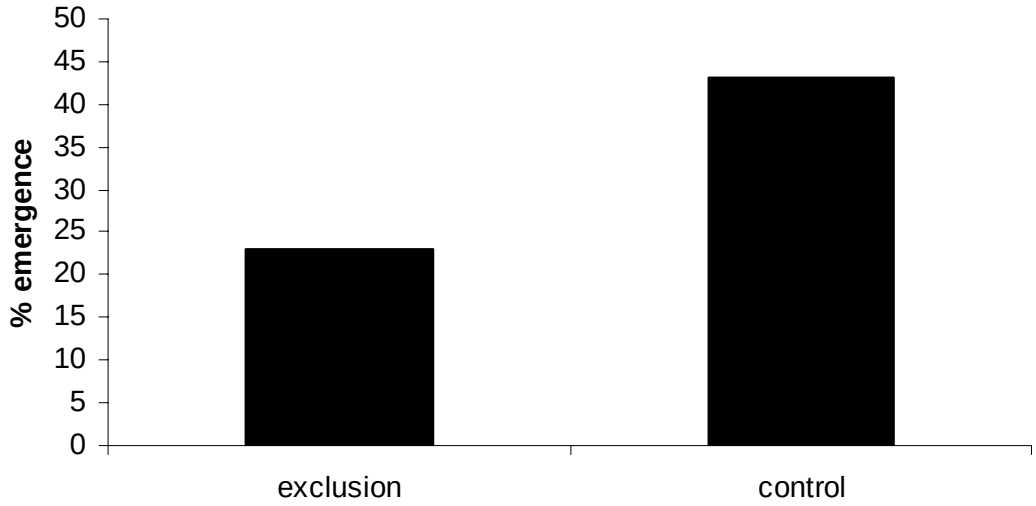


Exclusion

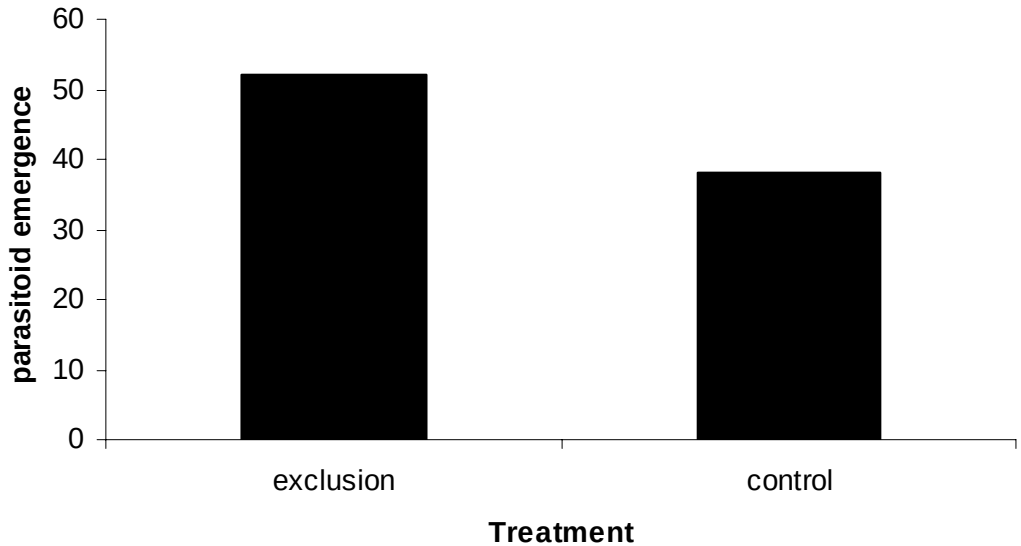
gall



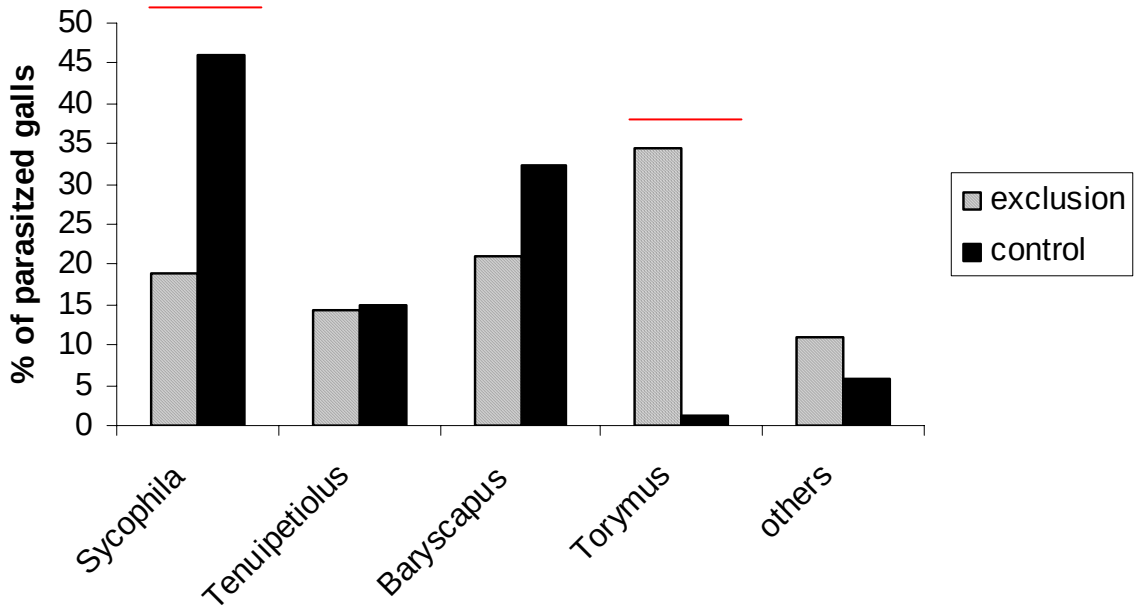
Tanglefoot: sticky substance that traps insects
The treatment is effective in excluding ants.



Ant tended galls have higher emergence rates



Ant tended galls have lower rates of parasitoid attack



Tending ants affect the community of parasitoids emerging from *Disholcaspis* galls