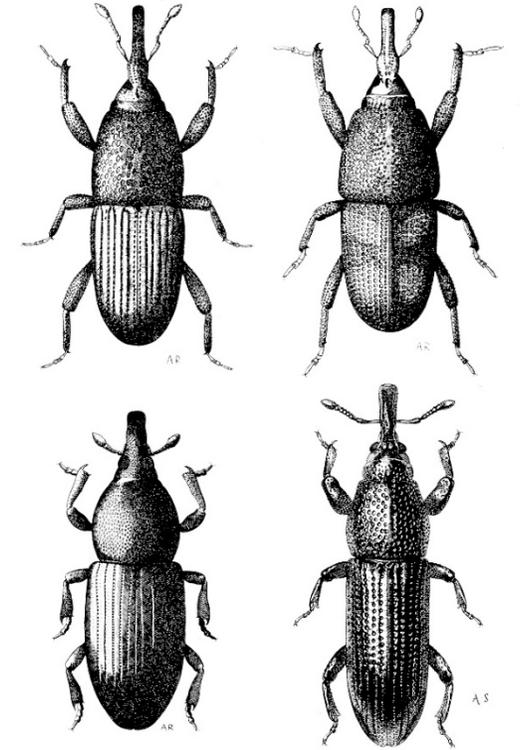


ACE Preparation Course

INSECT CLASSIFICATION, BIOLOGY AND MORPHOLOGY
(PART OF INSPECTION AND IDENTIFICATION 45%)





What are insects and mites?

Animals that belong to the Phylum Arthropoda

- hard outer exoskeleton
- segmented bodies
- jointed legs
- Bilateral symmetry

Arthropod classes



Insect Characteristics

Three main body regions

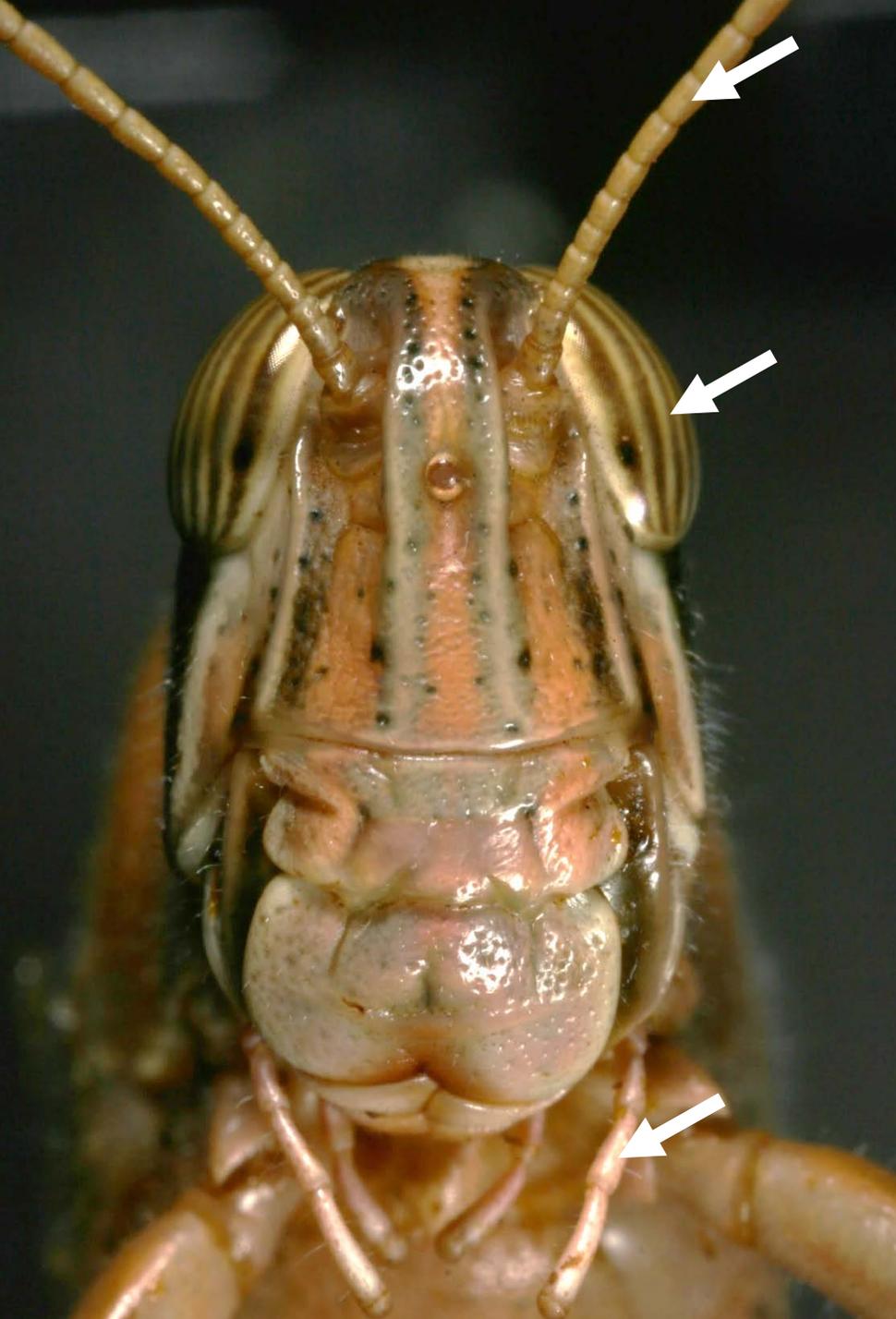
- Head, thorax, abdomen

Six legged

Antennae

Metamorphosis usual





Head: Center for sensory perception

Eyes

- vision

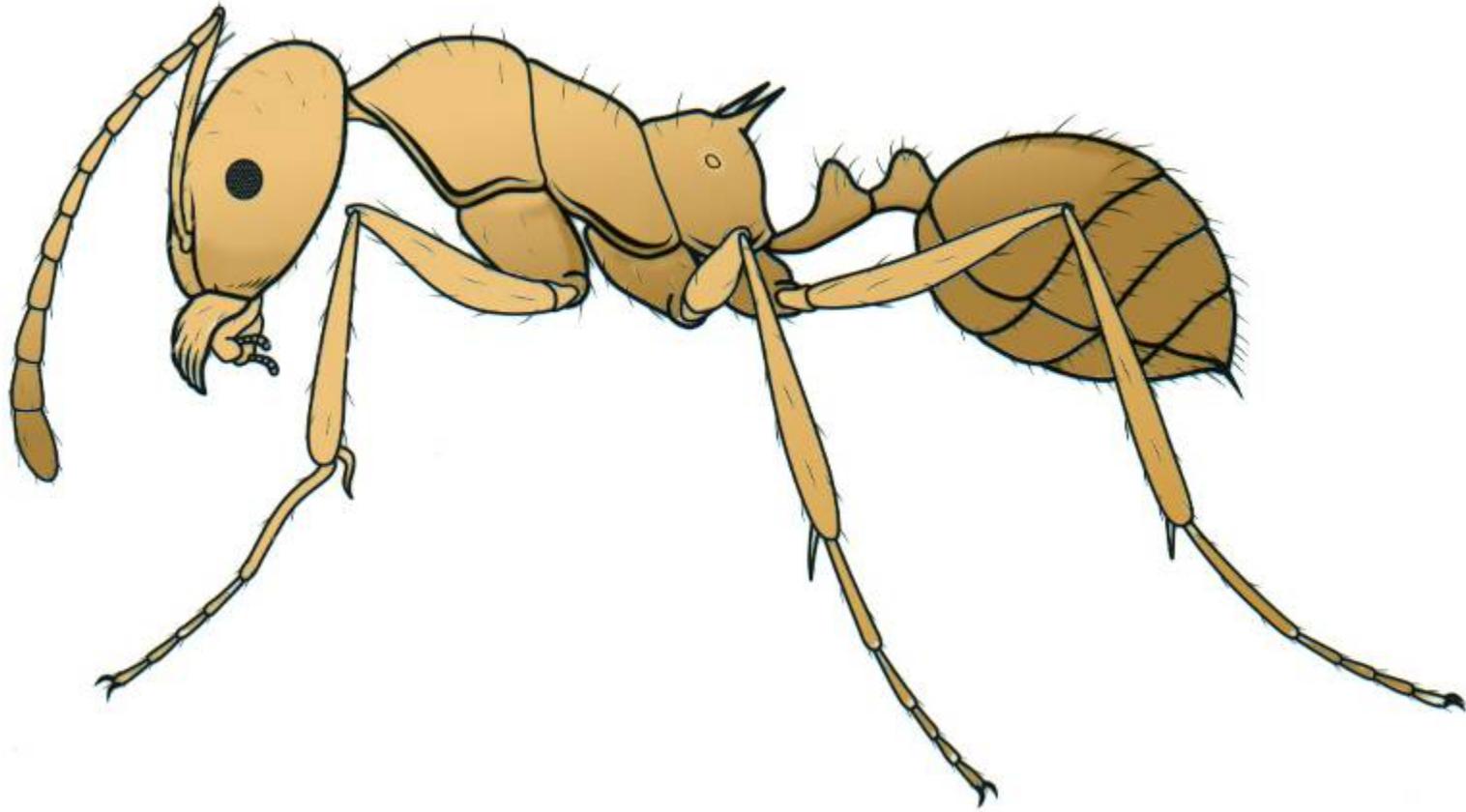
Palpi

- Taste, touch

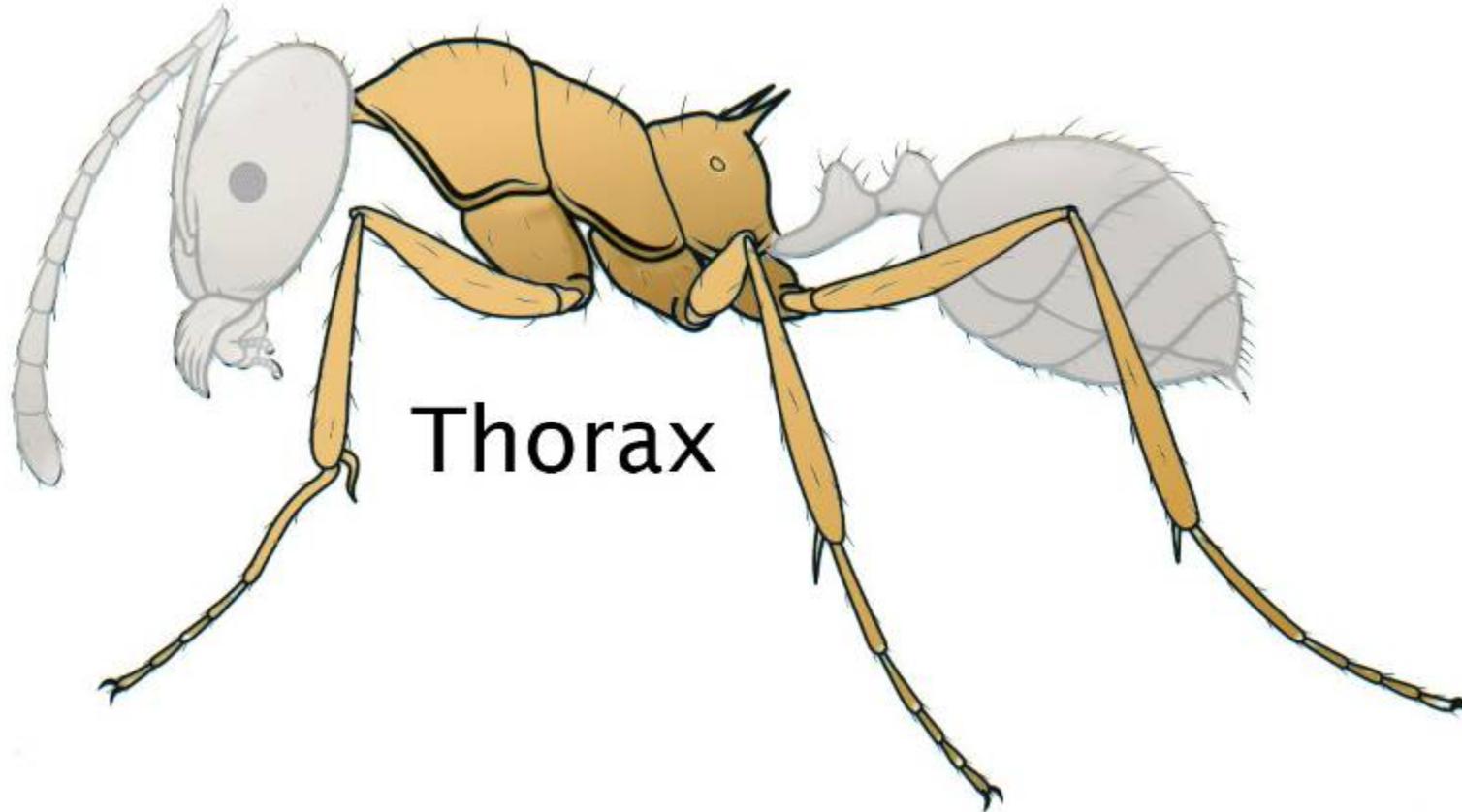
Antennae

- Smell, touch, temperature, water detection

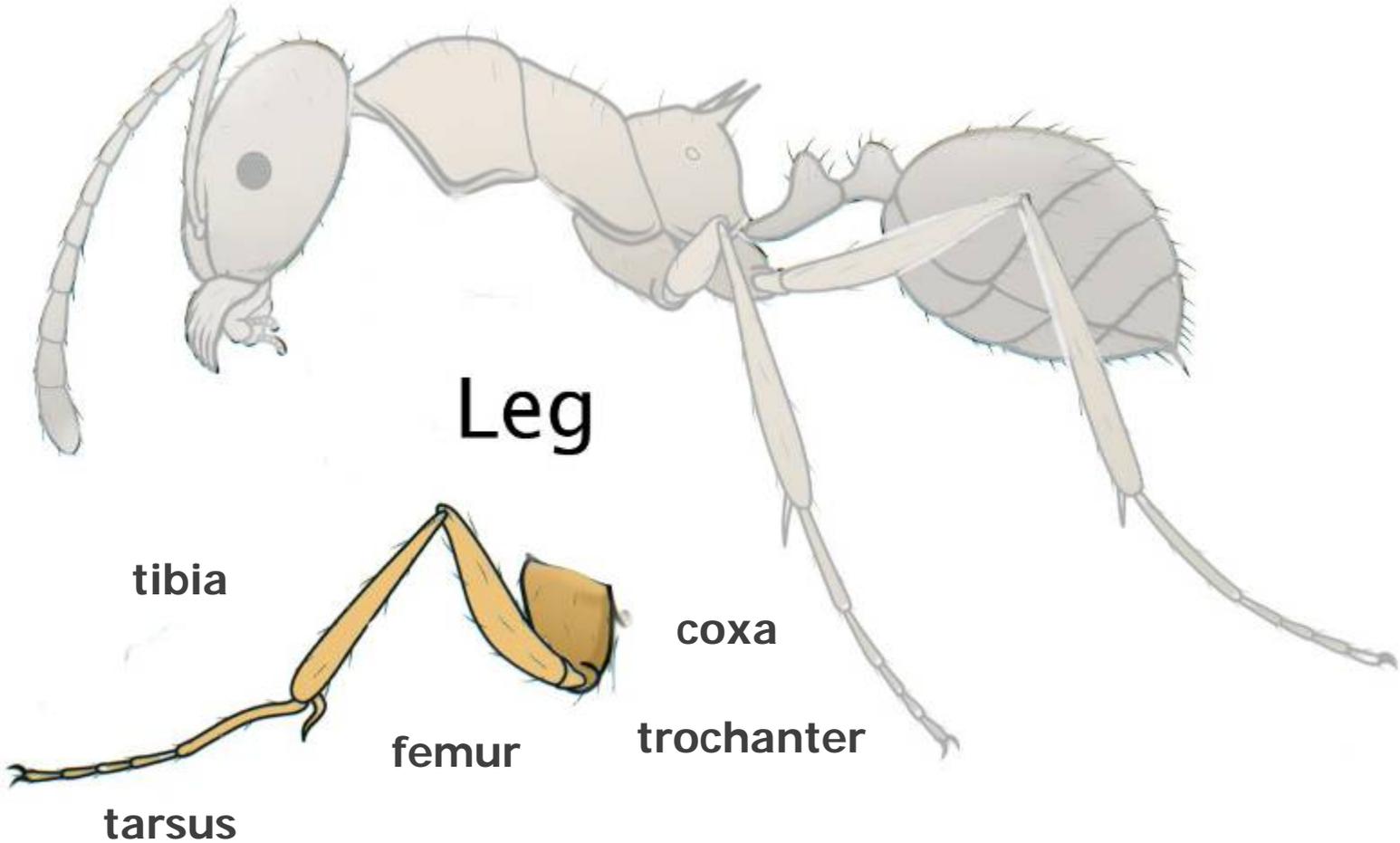
Thorax: Center for movement



Thorax: Center for movement



Thorax: Center for movement



Wings



Abdomen:

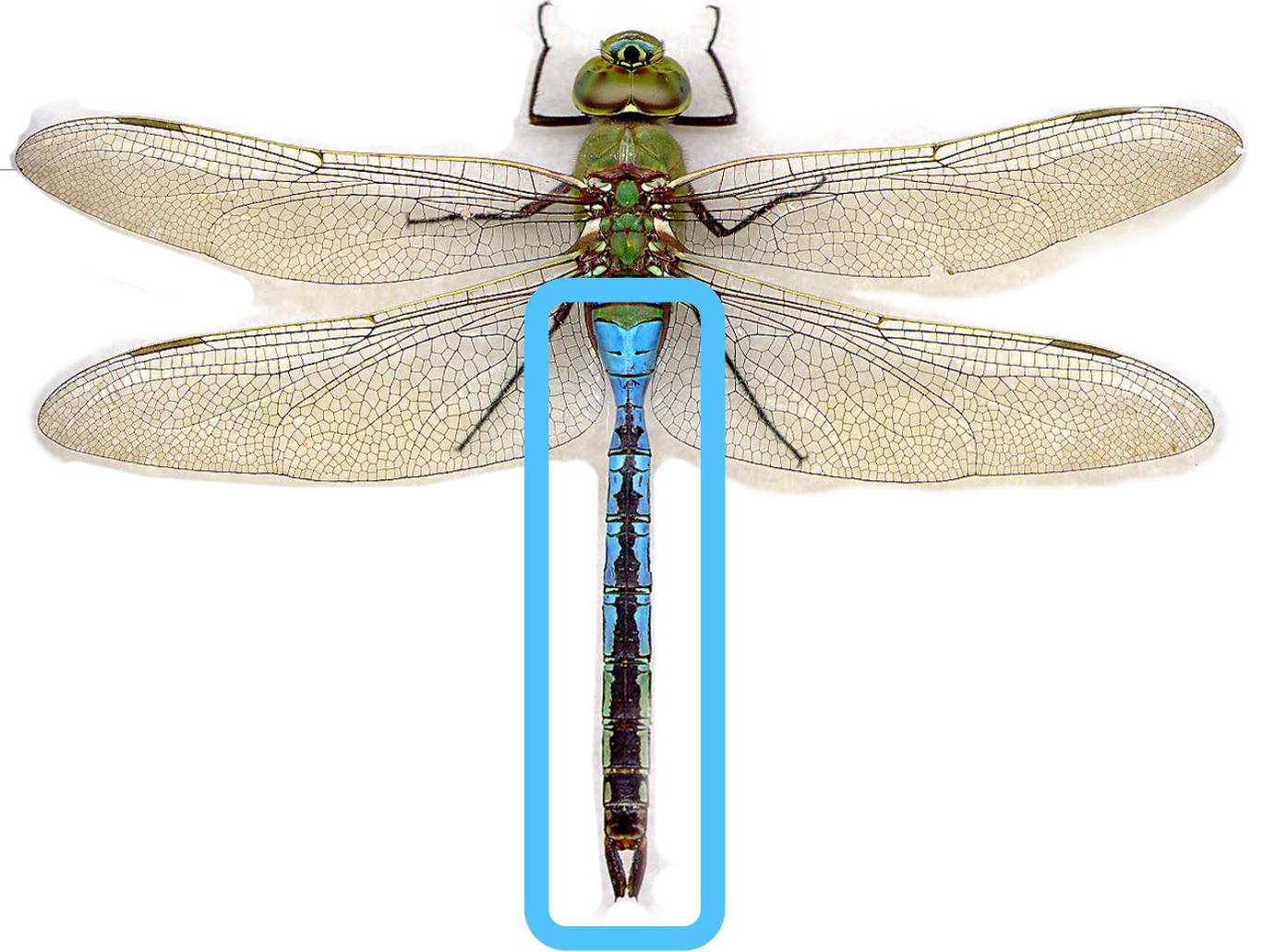
Digestive tract

Communication glands?

- pheromones

Reproductive organs

- Genitalia
- Ovipositor





Modified ovipositors in some insects are stingers



Insect exoskeleton

Made of the protein chitin

- Strong
- lightweight
- resilient
- ideal for small organisms

Covered with wax layers for waterproofing

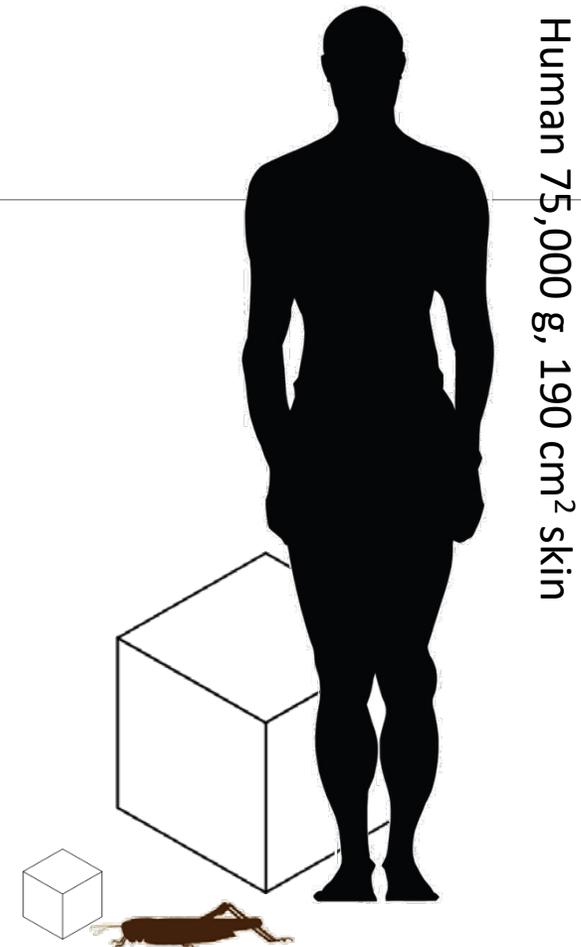
On being small...

As size of an animal decreases, its volume and weight decrease by the cube of the object's length (volume is 3-dimensional)

...but surface area decreases only by the square of its length (area is two dimensional)

Therefore, insects have at least a 6000X higher surface area to volume ratio than humans

AND insects lose water > 6000X than humans



Large grasshopper 0.25 g, 4 cm² cuticular surface

Pesticides designed to affect insect skeletal systems:

Diatomaceous earth

- Abrades insect cuticles

Silica aerogels

- Absorbs waxes from exoskeleton

Note: Desiccants only highly effective in dry environments.



Insect respiratory system

Simple series of tubes and
openings

- Spiracles
- Tracheae





Respiratory system

Oils block insect spiracles

Especially effective on small insects

Oil types:

- Horticultural oil
- Vegetable oils
- Mineral oils





How insects grow and develop

Molting occurs during immature stages

Stages between molts called “instars”



Cockroach nymph final molt

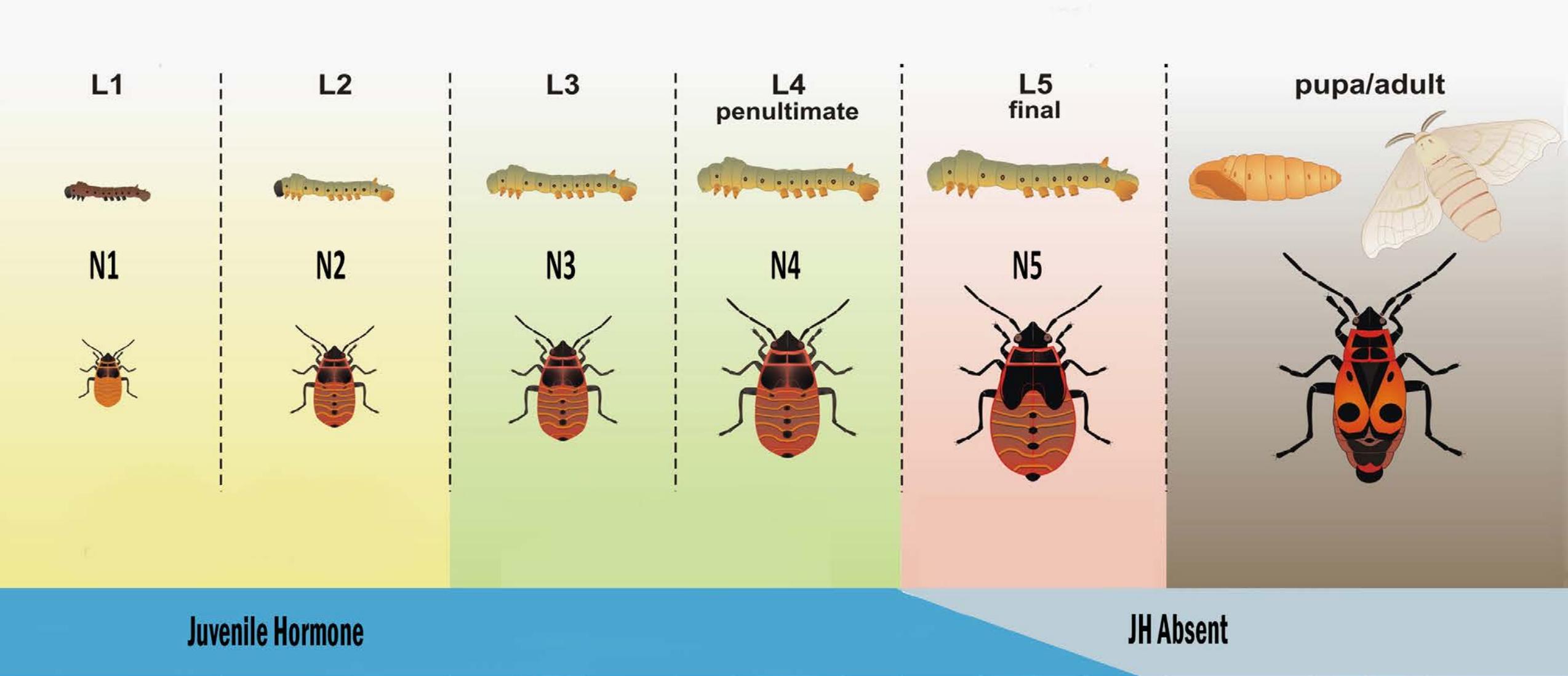


Diagram modified from Smykal et al.

Hormones regulate the metamorphic process

Insect Growth regulators

Juvenile hormone (Peter Pan hormone)

- Prolong juvenile stage
- Prevents reproduction
- Sterilizes eggs

Chitin synthesis inhibitors

- Insecticides that disrupt the formation of insect exoskeletons during molting
- Effective when immature insects exposed

Dead brown marmorated stink bug nymph after unsuccessful molting from feeding on a diflubenzuron-treated green bean. Kamminga et al. 2012. Plant Health Progress. Dec.





Metamorphosis: (<Greek) a change in form

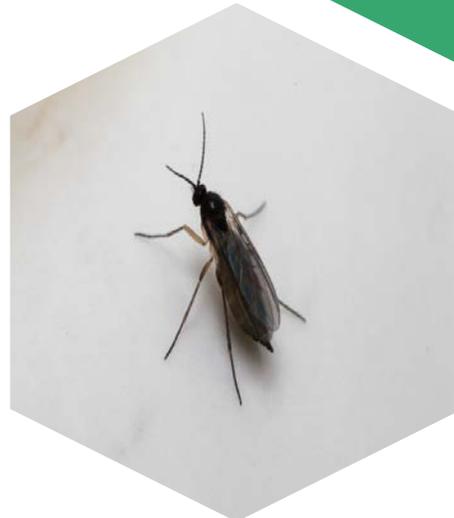
Mysterious process by which the form of an insect changes over the course of its lifespan

metamorphosis



No (or rudimentary) metamorphosis:
silverfish,
springtails

Gradual metamorphosis:
grasshoppers,
cockroaches,
termites, thrips,
dragonflies



Complete metamorphosis:
beetles,
butterflies and
moths, flies,
bees and wasps,
ants, fleas

Gradual metamorphosis

Three life stages

Immatures called
“nymphs” share a
resemblance to the adult

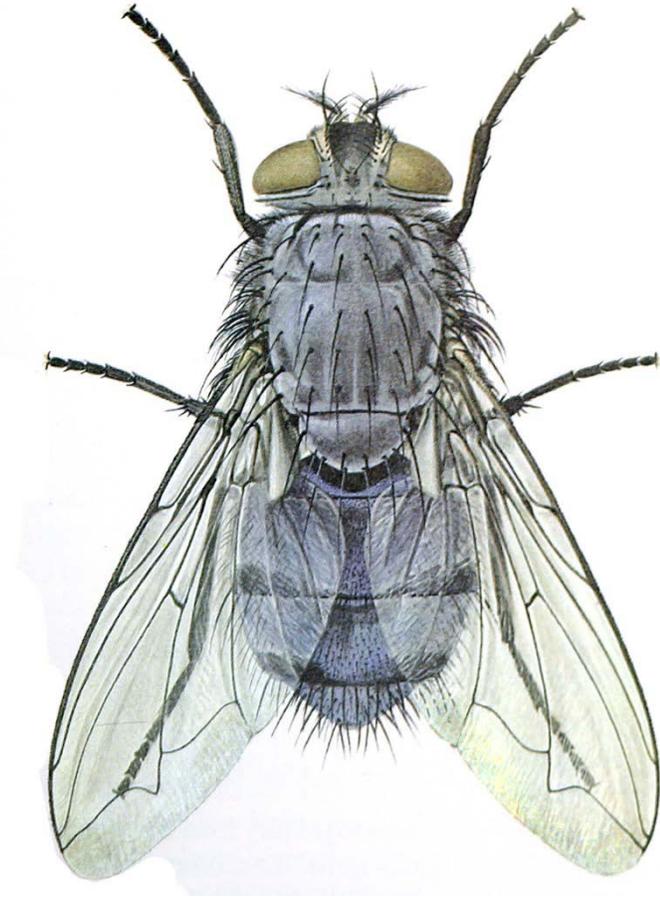
Developing wing pads
may be visible in later
nymph stages (instars)



Photo courtesy Univar



Gradual
metamorphosis



Complete metamorphosis means a complete change in form

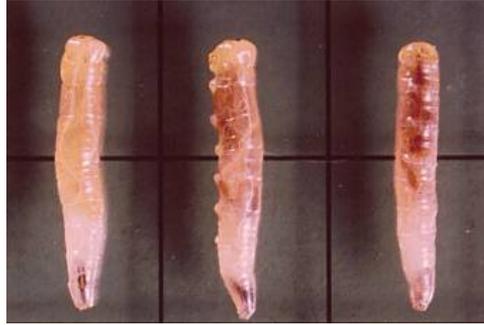
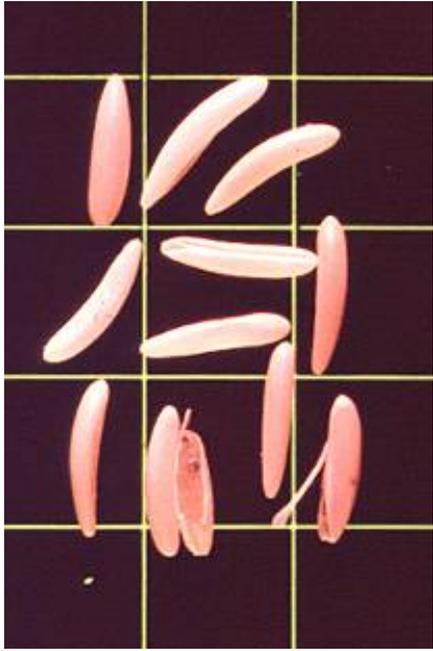


Complete metamorphosis

Most complex form of development

Four life stages

Immature form called “larva”



Complete metamorphosis



Types of mouthparts

Chewing

crickets, termites,
beetles,
caterpillars

Piercing/sucking

plant bugs, fleas,
lice, mites,
hoppers

Sponging

some flies

Siphoning

moths and
butterflies



Chewing mouthparts

Side to side movement

- Upper lip: labrum
- Jaws: mandibles, maxillae
- Tongue: hypopharynx
- Lower lip: labium

Piercing/sucking mouthparts

Microscopic food channel for liquids

Mouthparts usually folded under head, between legs

sap feeders, blood suckers, predators





Sponging mouthparts

Sponge-like *labella* on certain flies

Capable of feeding only on exposed liquids such as nectar or sap

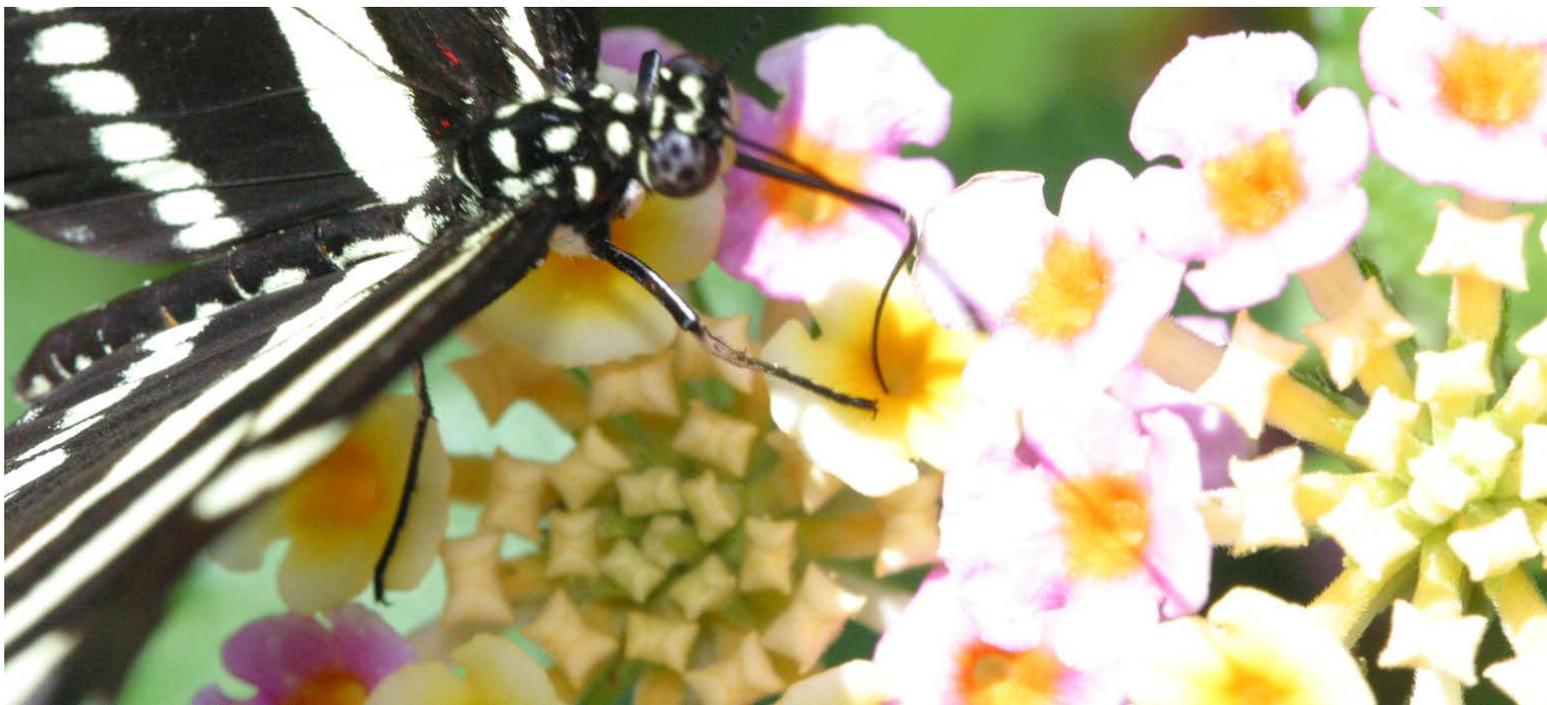
Capable of transmitting pathogens in the house fly & blow fly

Siphoning mouthparts

Flexible maxillae form soda-
straw like mouthparts

Incapable of piercing skin or
plant surfaces.

Moths and butterflies



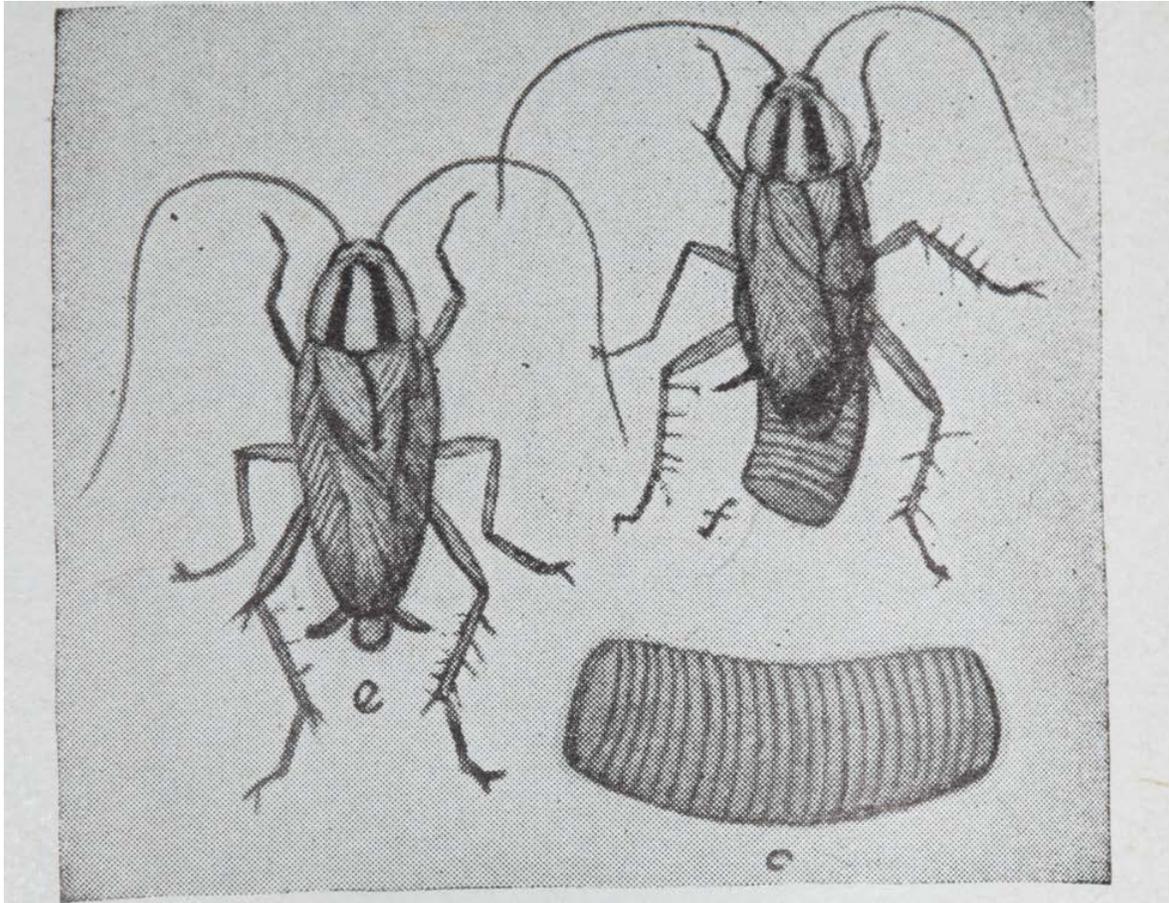
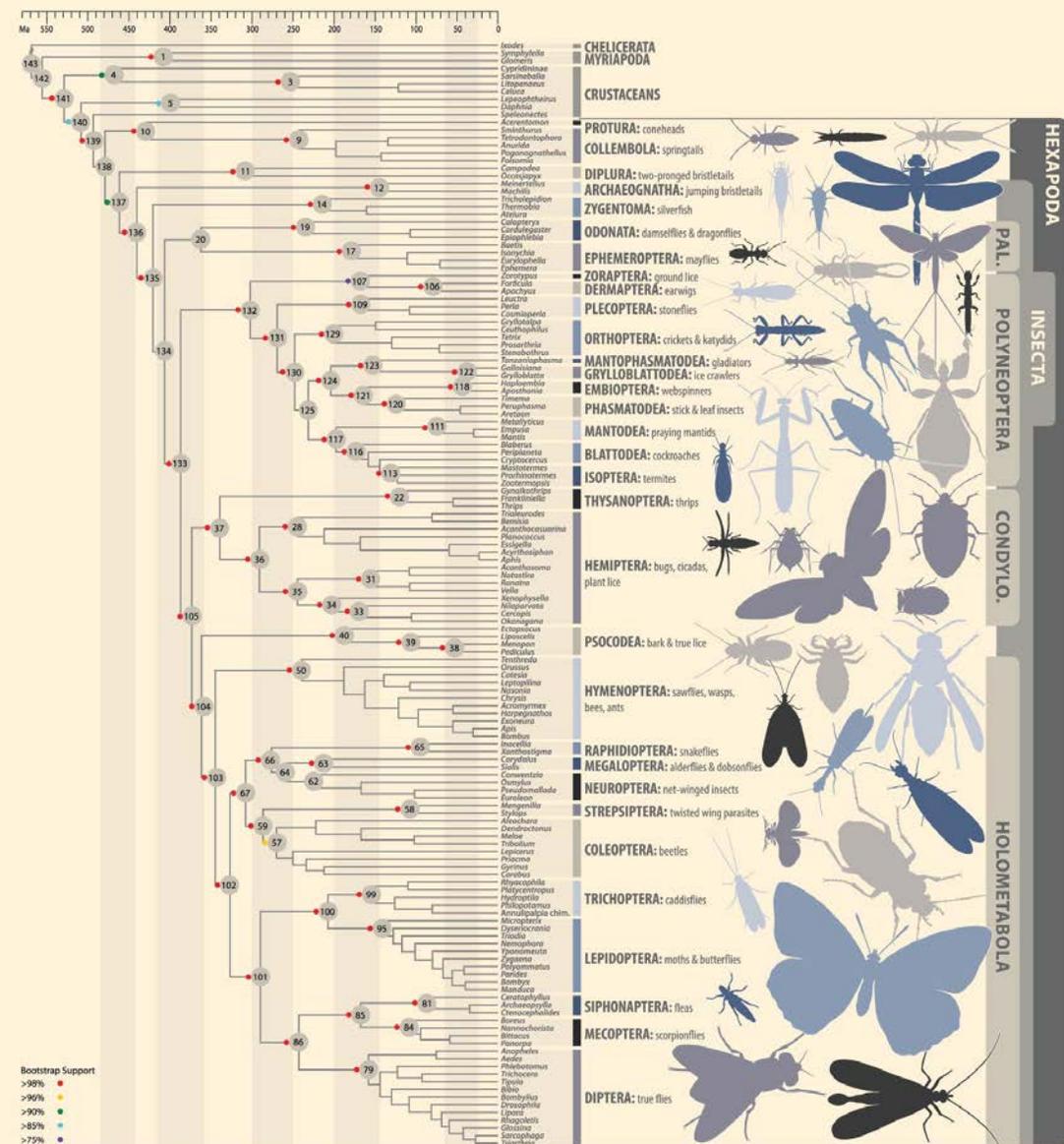
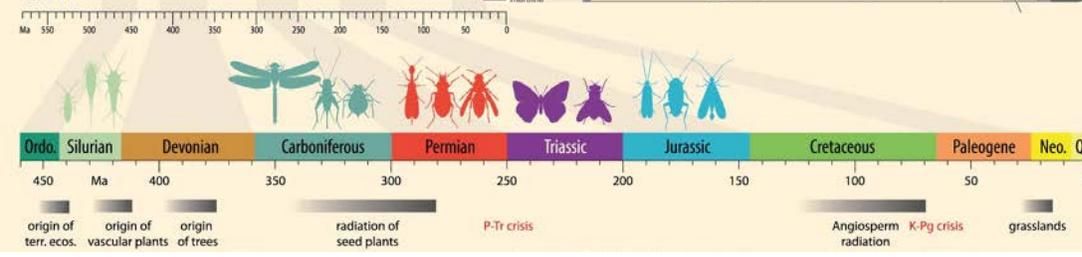


FIG. 50.—German cockroach or
Croton bug (*Blattella germanica* L.):

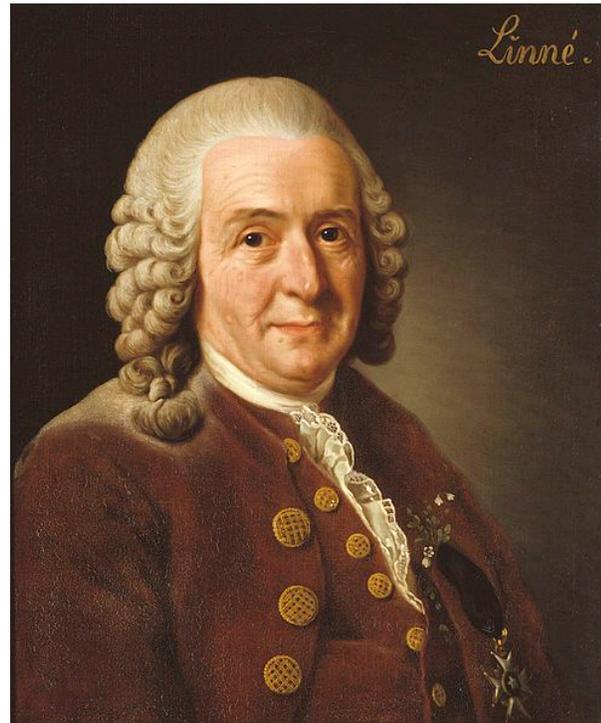
How
insects are
classified
and named



How we classify insects



How we classify insects



The Linnaean classification system

Kingdom: Animal

Phylum: Arthropoda

Class: Insecta

Orders: 30 orders

Families: approximately 1,000

Genera: approximately 12,500

Species: approximately 1 million



A word about scientific names..
Blatella germanica (Linnaeus)
Genus species Author

Common names:

- croton bug (NY)
- German cockroach (U.S.)
- steamfly (U.S.)
- waterbug (U.S.)
- cucaracha (Spanish)
- küchenschabe (German)
- *&#@\$!!* (universal)

Insect Orders

30 total, 11 most important for PMPs

Collembola

Zygentoma
(Thysanura)

Orthoptera

Blattodea

Dermaptera

Hemiptera

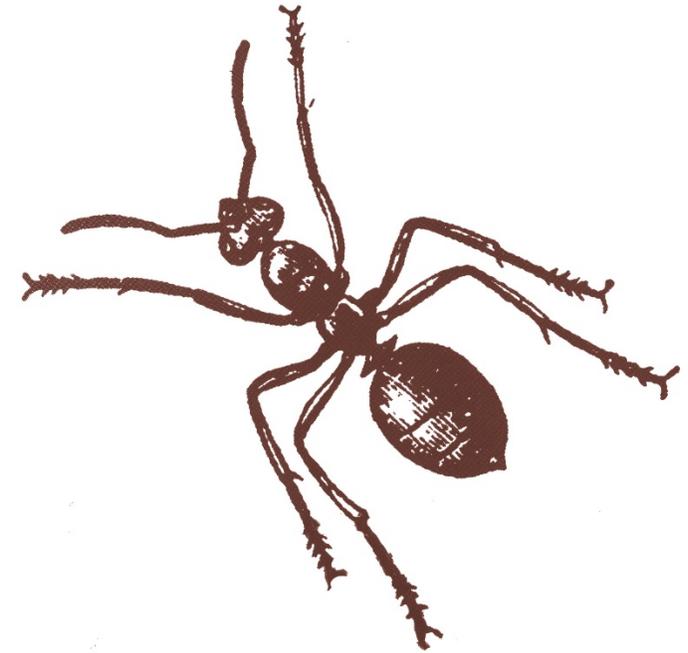
Coleoptera

Siphonaptera

Diptera

Lepidoptera

Hymenoptera





Collembola: Springtails

Name:

kolla = glue, *embolon* = bolt (Latin)

Metamorphosis: none

Mouthparts: chewing

Food: decaying plant material, fungi, bacteria

Notes: Mostly nuisance pests, very small (0.25 - 0.6 mm).
Sometimes found floating in swimming pools and entering homes.





Zygentoma: Silverfish

Name: formerly *Thysanura*
thysan = bristle, *ura* = tail

Metamorphosis: none

Mouthparts: chewing

Food: starchy foods

Notes: Three tail-like appendages.
Some species economically important. Feed on books, pastes, starched fabrics,
(up to 15 mm)



Dermaptera: earwigs

Name: *derma* = skin,
ptera = winged

Metamorphosis: gradual

Mouthparts: chewing

Food: mostly decaying plants

Notes: Mostly nocturnal. Large
pinchers can pinch, generally
harmless (less than 2 cm)



Orthoptera: Grasshoppers, crickets, katydids

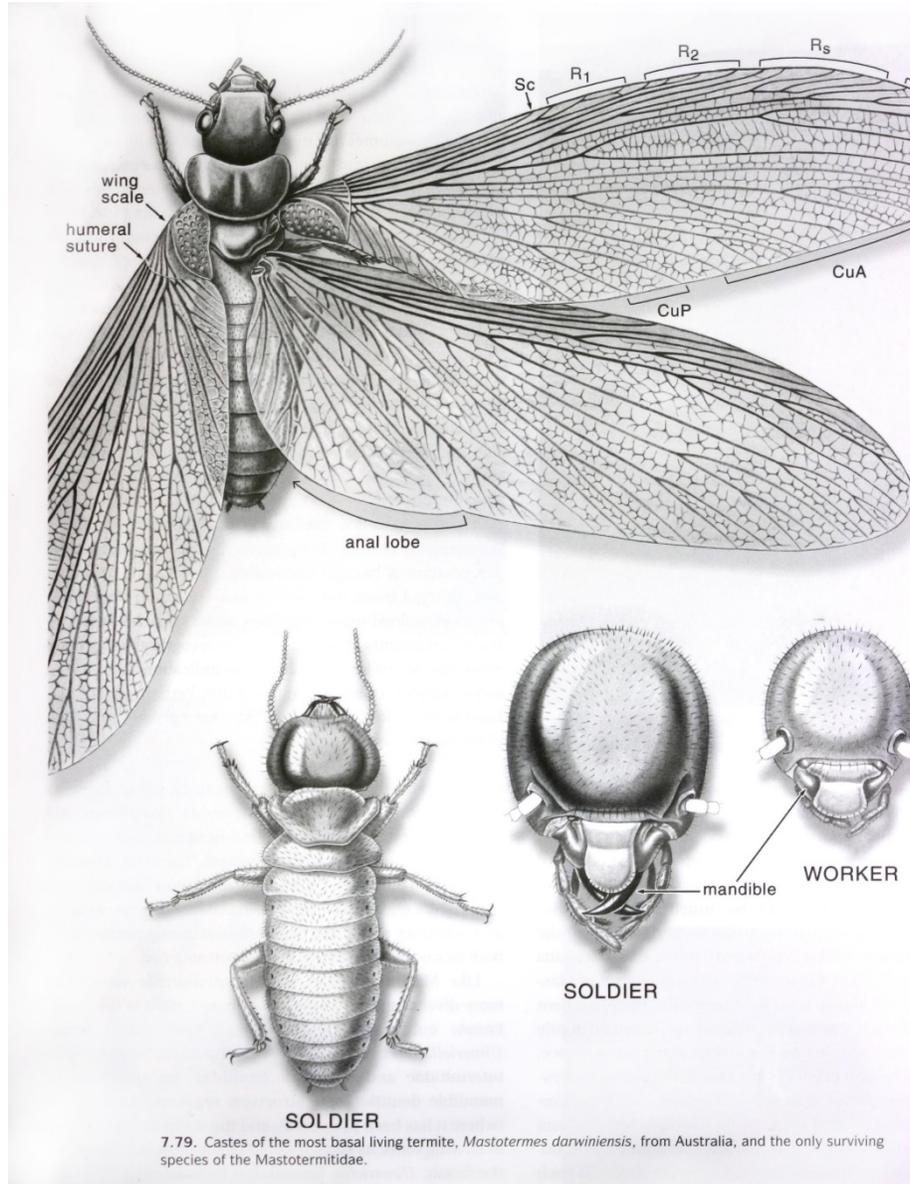
Name: *ortho* = straight,
ptera = winged

Metamorphosis: gradual

Mouthparts: chewing

Food: various plant material

Notes: Some species economically important.
Can produce sound. (medium to large sized)



Blattodea: Cockroaches & termites

Name: *blatta*, Latin for cockroach

Metamorphosis: gradual

Mouthparts: chewing

Food: cellulose and a variety of other foods

Notes: Recent genetic analysis has concluded that termites and cockroaches belong to the same taxonomic order

Now in separate suborders/infraorders

Termites

Infraorder Isoptera

Name: *iso* = equal,
ptera = winged

Metamorphosis: gradual

Mouthparts: chewing

Food: cellulose

Notes: Symbiotic relationship with cellulose-digesting protozoans, highly social. (generally small, less than 1 cm)



Cockroaches

Superfamilies Blattoidea,
Blaberoidea, Corydioidea

Name: *blatta*
Latin for cockroach

Metamorphosis: gradual

Mouthparts: chewing

Food: omnivorous

Notes: Medium to large sized. Mostly nocturnal. Some produce ootheca (egg cases)



Australian cockroach



True bugs and relatives: Hemiptera

Name: *hemi* = half,
ptera = winged

Metamorphosis: gradual

Mouthparts: piercing/sucking

Food: plant feeders, predators

Notes: Two sub-orders: Heteroptera,
Homoptera



Suborder Heteroptera

True bugs

only outer half of wings membranous, held flat over the body

Bed bugs, stink bugs, plant bugs, kissing bugs, assassin bugs, leaf-footed bugs, etc.)

Both predators and plant feeders



Bed bug



Suborder Homoptera

Fully membranous wings held roof-like over
body

All are plant feeders, a few occasional invaders

Many important plant pests





mealybugs



aphids



treehoppers



scales

Coleoptera: Beetles

Name: *Coleo* = sheath,
ptera = winged

Metamorphosis: complete

Mouthparts: chewing

Notes: Only 2nd pair of wings used in flight.
Most diverse insect order. Many important
pests of outdoor plants, stored grains and wood.



Saw-toothed grain beetle,
Oryzaephilus surinamensis

Cat flea,
Ctenocephalides felis



Siphonaptera: fleas

Name: *siphon* = a tube,
aptera = wingless

Metamorphosis: complete

Mouthparts: sucking

Notes: Parasitic, jumping. Require furred animals for survival and reproduction.

Diptera: Flies

Name: *di* = two,
ptera = winged

Metamorphosis: complete

Mouthparts: sponging, piercing/sucking

Notes: Excellent fliers. Larvae are legless and generally found in water or around wet environments. Many important indoor and outdoor pests.



Dark-eyed fruit fly

Lepidoptera: moths and butterflies

Name: *lepto* = scale,
ptera = winged

Metamorphosis: complete

Mouthparts: sucking/siphoning

Notes: Scaly wings, often colorful. Some important pests of fabric, stored products.



Indian meal moth,
Plodia interpunctella

Hymenoptera: Bees, wasps and ants

Name:

humen = membrane,
pteron = wing

Metamorphosis: complete

Mouthparts: usually chewing

Notes: Constriction between abdomen and gaster (part of thorax). Many social species.



What growth process does an insect use to cope with a rigid exoskeleton that does not grow with its body ?

pupation

thigmotaxis

trophallaxis

molting



What type of mouthpart would you find on a bed bug?



chewing

piercing/sucking

siphoning

sponging



Insects with complete metamorphosis go through four life stages which are:

egg, nymph, adult

egg, larvae, adult

egg, larvae, spiracle, adult

egg, larvae, pupae, adult

Biology/morphology quiz questions:

What growth process does an insect use to cope with a rigid exoskeleton that does not grow with its body ?

- a) pupation
- b) thigmotaxis
- c) trophallaxis
- d) molting

d) Molting

Biology/morphology quiz questions:

What type of mouthpart would you find on a bed bug?

- a) chewing
 - b) piercing/sucking
 - c) siphoning
 - d) sponging
-
- b) piercing/sucking

UNLESS OTHERWISE INDICATED,
PHOTOS BY MIKE MERCHANT

Questions