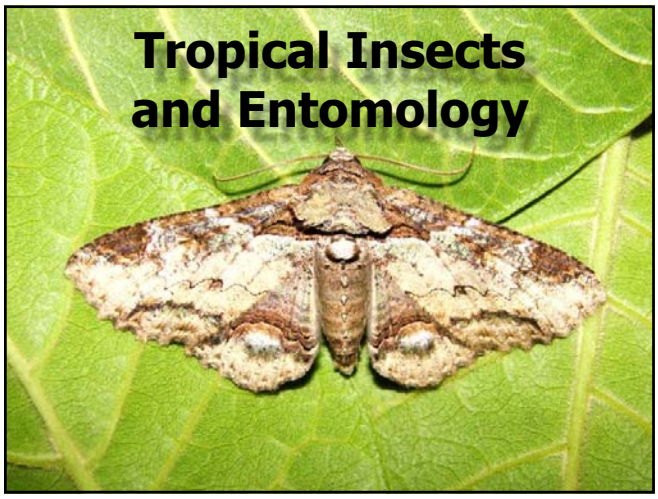


Tropical Insects & Entomology

Insect-pollination in USA = $15 billion (bees = $11.7b)

Worldwide value > $200b *(bees: ~1/3 of human diet)*

Ants outweigh humans! 10,000 trillion ants

All bugs: ~10 quintillion bugs (10^{19} = 10,000,000,000,000,000,000)

50% of world infected by vector-borne disease -- mostly arthropods

>1000 spp eaten as food

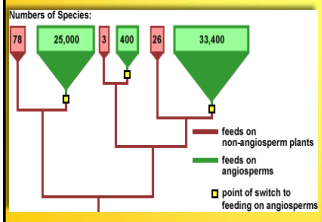
Diversity

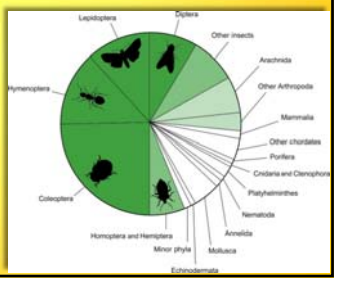
Approximately 1.1 million insect species described

1/2 of all known species on Earth

Biggest groups: beetles, ants/wasps, butterflies, flies

Angiosperm Radiation (140-100 mya)





Beetle diversity (Farrell 1998)

Diversity

Approximately 1.1 million species described

40% in tropical forests

40% are beetles *(+2300 new spp/y)*

Total Diversity (estimated):

10-20 million spp.

Terry Erwin canopy fogging:
>100,000 spp/ha in Amazon

Taxonomy

Phylum Arthropoda

Class Insecta (=Hexapoda)

6 legs
2 antennae
3 body segments (usually)
4 wings (usually)

best understood by Order

Other Arthropods:

Class Crustacea

Cl. Arachnida

Order Diplopoda

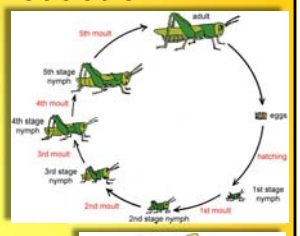
Or. Chilopoda

Growth & Reproduction

Incomplete (Gradual) Metamorphosis

immatures resemble adult, lack wings

terrestrial *"nymphs"*
aquatic *"naiads"*

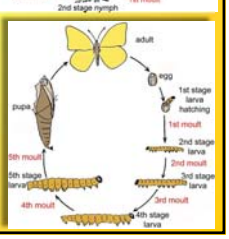


Complete Metamorphosis

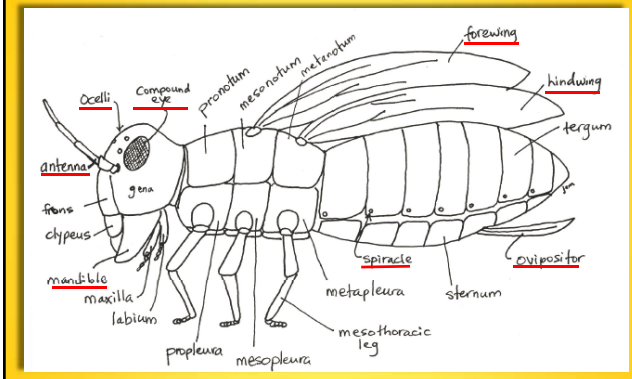
immature completely different

butterflies = *"caterpillars"*
flies = *"maggots"*
beetles = *"grubs"*

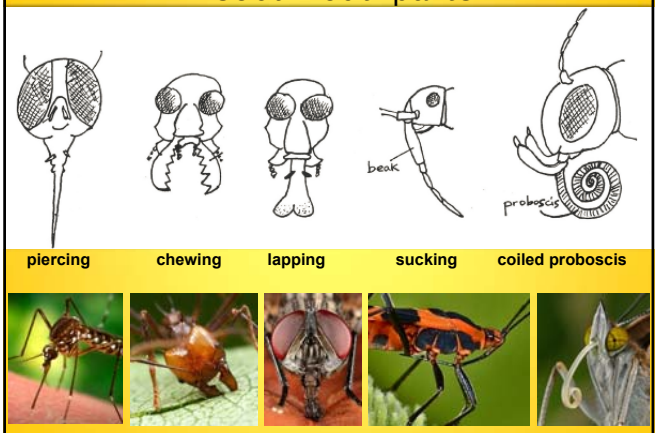
pupates to adult



Insect Body Plan



Insect Mouthparts



COLEOPTERA - beetles

Chewing • Complete

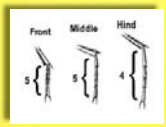
~375,000 spp. (or 4,000,000!)

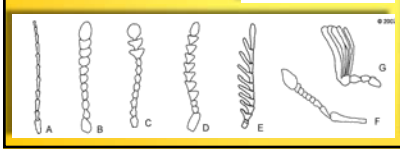
Elytra: hardened, valve-like forewings close with central suture

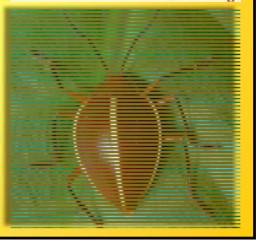
Larvae: grubs

Antennae shape

Tarsal formulae







COLEOPTERA - Scarabaeidae

scarab beetles

Antennae: elbowed, clubbed (lamellate)

Larvae: C-shaped

Dung Beetles: *Canthon* spp.

Rhinoceros beetle

Goliath beetle

VIDEO - Dung Beetle ***(Canthon)***

COLEOPTERA - Elateridae

click beetles

Shape: elongated, parallel-sided

thorax corners pointed

Click: thoracic spine, abdominal groove

release under pressure = Click

Headlights: glowing 'shoulder' spots

luciferin + luciferase

COLEOPTERA - Cerambycidae
long-horned beetles

Antennae: > 1/2 body length, mostly >>>

Phoresis: mites often "ride" under elytra
phoretic parasitism

Harlequin beetle
Giant jawed sawyer
Titanic longhorn

many wood eaters



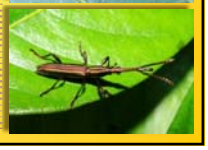

COLEOPTERA - Curculionidae
weevils

Head: elongated, curved "snout"
elbowed antennae on snout

Plant feeders: mandibles drill holes
suck plant/seed juices
agricultural pests

Plant Defenses: latex, 2° compounds
co-evolution





LEPIDOPTERA - butterflies & moths

Coiled Proboscis • Complete

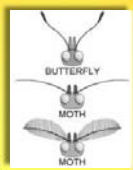
~ 175,000 spp

Wings: covered in fine scales

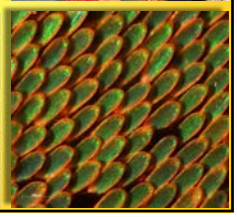
Antennae: knobbed -- butterflies
brushy (or threadlike) -- moths

Larvae: caterpillars

Important pollinators





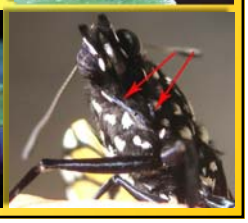
LEPIDOPTERA - Nymphalidae
brush-footed butterflies

Legs: appear to have four
anterior pair tiny, under head

Diversity: ~85% of all butterflies

Morpho, head-for-tails, clear-wings, 69 butterfly



Heliconius mimicry complex

Passiflora: toxins = cyanogenic glycosides

***Heliconius*:** caterpillars accumulate toxins
adults poisonous
spp similar = Müllerian mimicry

***Passiflora*:** stipules mimic eggs
▼ laying = Gilbertian Mimicry




LEPIDOPTERA - Sphingidae
sphinx moths & hawk moths

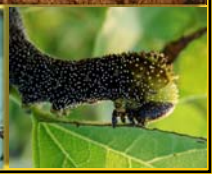
Shape: cigar-shaped body
"bomber plane" wing shape

Flight: hover on rapid wing beats
resemble hummingbirds!

Caterpillar: single large (fleshy) spine
fold head under thorax
raise abdomen = "sphinx"







HYMENOPTERA - bees, wasps, ants

Chewing • Complete

~ 130,000 spp

Wings: four, membranous

Antennae: usually long

Waist: constricted in most

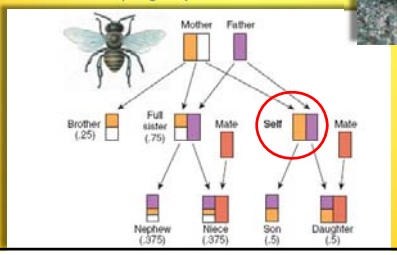
Colonial & Eusocial

HYMENOPTERA - Eusociality

Eusocial: 1. single reproductive queen
2. division of labor in castes
3. overlapping generations
4. cooperative care of young

Trophallaxis: sharing food - promotes sociality

Haplo-diploidy: **XX** = female, **X** = male
"SusperSisters" share 75% genes
offspring only 50%



HYMENOPTERA - Pompilidae
tarantula hawks

sting & paralyze tarantulas

drag to nest chamber, lay eggs

larvae consume (live) tarantula

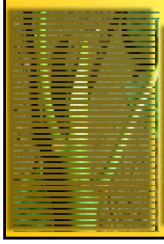
pupate & emerge as adults

parasitoid *vs. parasite*

HYMENOPTERA - Formicidae
ants

Atta: leafcutters
collect leaves for fungus garden
eat fungus

Azteca: fiercely stinging
defend *Cecropia* and others
"quita calzoncillos"



HYMENOPTERA - Formicidae
ants

Eciton: army ants (incl other genera)
colony guest (Wasmmannian Mimicry)

Ponerine ants (e.g., *Paraponera*):
constriction of abdomen
hunters, fierce sting ("bala")

VIDEO - Army Ants ***(Eciton burchellii)***

DIPTERA - flies, mosquitos, midges ...

Piercing or Lapping • Complete

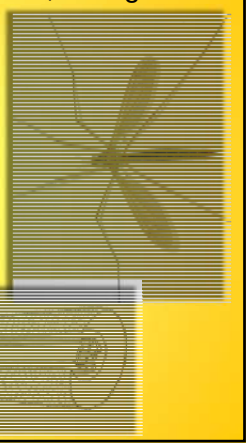
~ 125,000 spp

Wings: two, membranous

Mosquitoes: long antennae (M-plumose)
long legs, thin bodies

Flies: bristle-like antennae
shorter legs, heavier bodies

Disease vectors

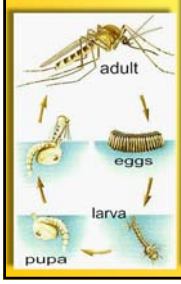


DIPTERA - genera

Anopheles: malaria (*Plasmodium falciparum*)

Aedes: yellow fever, dengue, Chikungunya, Zika

Dermatobia hominis: Bot flies



VIDEO - Botfly ***(Dermatobia hominis)***

Or. HEMIPTERA, SubOr. Heteroptera
true bugs

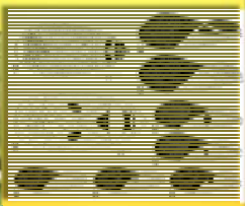
Sucking • Incomplete

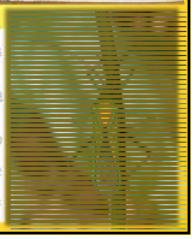
~ 30,000 spp

Wings: forewings half-leathery; held flat

Plant Feeders: mouthparts stab & suck

Plant Pests





HETEROPTERA - Reduviidae
assassin bugs & kissing bugs

narrowly attached, elongated head

many brightly colored (Aposematic) warning: painful & venomous bite

Kissing bugs spread Chagas (*Trypanosoma cruzi*) thru feces

HEMIPTERA, SubOr. Homoptera
hoppers, wax bugs

Sucking • Incomplete

~ 50,000 spp

Wings: membranous, homogenous; held tent-like

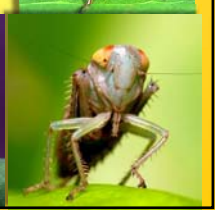
Hopping: trigger flexed muscles, like catapult

Wax: most taxa with wax glands

Phytophagous

2˚ compounds:

latex

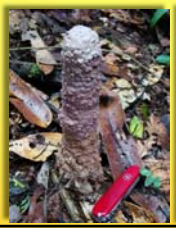


HOMOPTERA - Cicadidae
cicadas

Sound: taut membranes (tymbals) vibrate rapidly

Nymphs: burrow & feed on root sap
powerful forelimbs

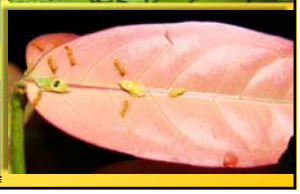
Chimneys: *Fidicina chlorogena* (+ others)
dig deep burrows
characteristic chimneys



HOMOPTERA - Aphididae
aphids

Pests: tiny plant feeders
release sweet "honeydew"
skim sugars from plant juices

Ants: "tend" aphids -- guard & herd
eat honeydew -- mutualism



HOMOPTERA - Membracidae
treehoppers

ISOPTERA - termites

Chewing • Incomplete

~ 2,100 spp

Wings: most adults wingless

2 Segments: abdomen & thorax fused

Sub-Social

Wood Decomposers (symbionts)

ISOPTERA - *Nasutitermes*
"ball nest" architects

"Nasute" - defensive caste

ISOPTERA - *Nutrient Cycling*

Africa: large termitaria mounds

Important in soil turnover

Earthworm role

OTHOPTERA - grasshoppers, katydids

Chewing • Incomplete

~ 23,000 spp

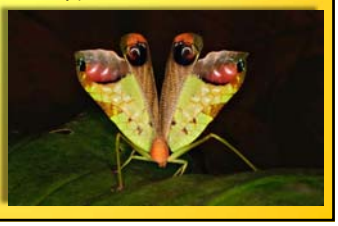
Legs: enlarged femur (for muscles)

Jumping: rapid flexing (not like planthoppers)

Wings: forewings leathery; hindwings brilliantly patterned

Females: sword-like ovipositor

Males: claspers



Phytophagous

Abundant prey items

ORTHOPTERA - Tettigoniidae
long-horned "grasshoppers", katydids

Antennae: more than length of body

Sound: file & scraper on legs
earliest animal sounds
tympanum = auditory organ

Leaf Katydids -- incredible crypsis

ORTHOPTERA - Acrididae
short-horned, grasshoppers

Antennae: <1/2 body length

Locusts: cyclical plagues
prime numbers

MANTODEA - praying mantis

Chewing • Incomplete

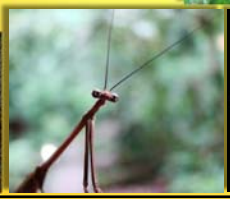
~ 2,000 spp

Head: triangular, large eyes

Forelegs: raptorial, held "praying"

Sit-and-wait predators

Often cryptic



PHASMIDA - walking stick
aka Phasmatodea

Chewing • Incomplete

~ 2,000 spp

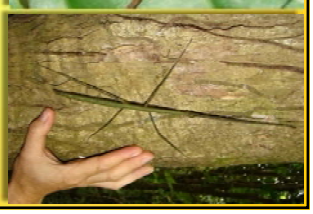
Head: blocky

Forelegs: not raptorial

Wingless & winged

Nocturnal plant feeders

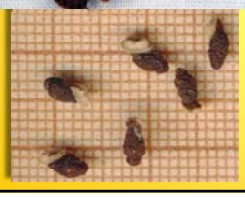
Often cryptic (visually & chemically)

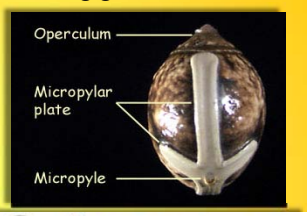


PHASMIDA Eggs

Arillate Seed

waxy, fat-rich "cap"





ODONATA - dragonflies, damselflies

Chewing • Incomplete

~ 5,500 spp

Wings: 4, translucent

Abdomen: elongate

Eyes: bulbous, many ommatidia

Adults: aerial predators

Naiads: aquatic predators

ODONATA - SubOr. Anisoptera
dragonflies

wings flat at rest

hindwings deeply notched

swift, agile fliers

naiads w/ internal gills

ODONATA - SubOr. Zygoptera
damselflies

wings held aloft at rest

hindwings similar to forewings (not notched)

naiads w/ abdominal gills

ODONATA - Helicopter Damselfly

wingspan to 7.5"

predators on spiders, plucked from webs

**explains unique flight pattern*

rarely, kleptoparasites of spider webs

VIDEO - ***Megaloprepus caerulatus***

BLATTODEA - cockroaches

Chewing • Incomplete

~ 4,200 spp

Head: obscured by shield-like pronotum

Wings: leathery, folded (diagonal margin)

Antennae: long, filamentous

Detritivores:
nutrient cycling

~~Disease vectors~~