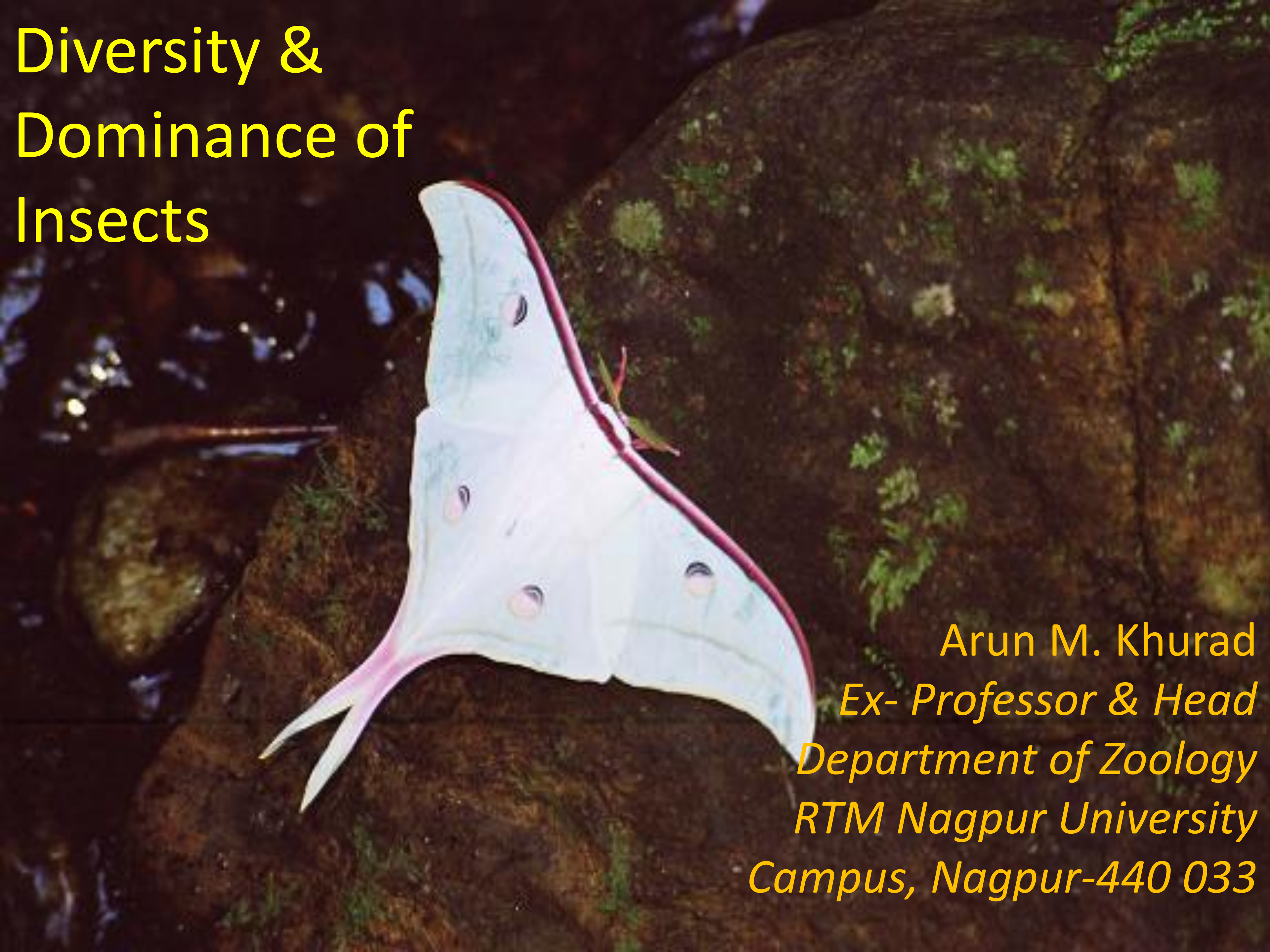
Diversity & Dominance of Insects



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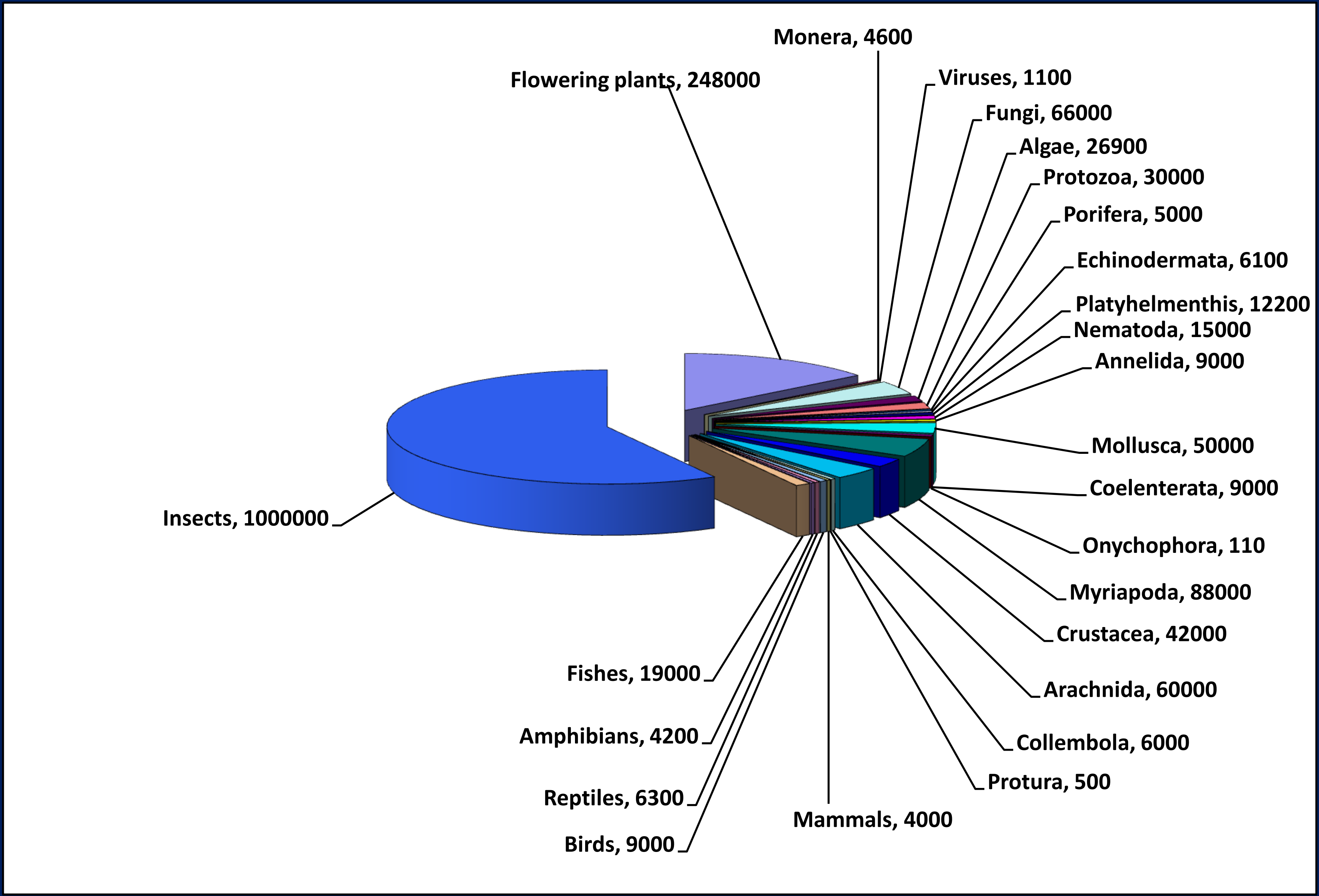
Campus, Nagpur-440 033

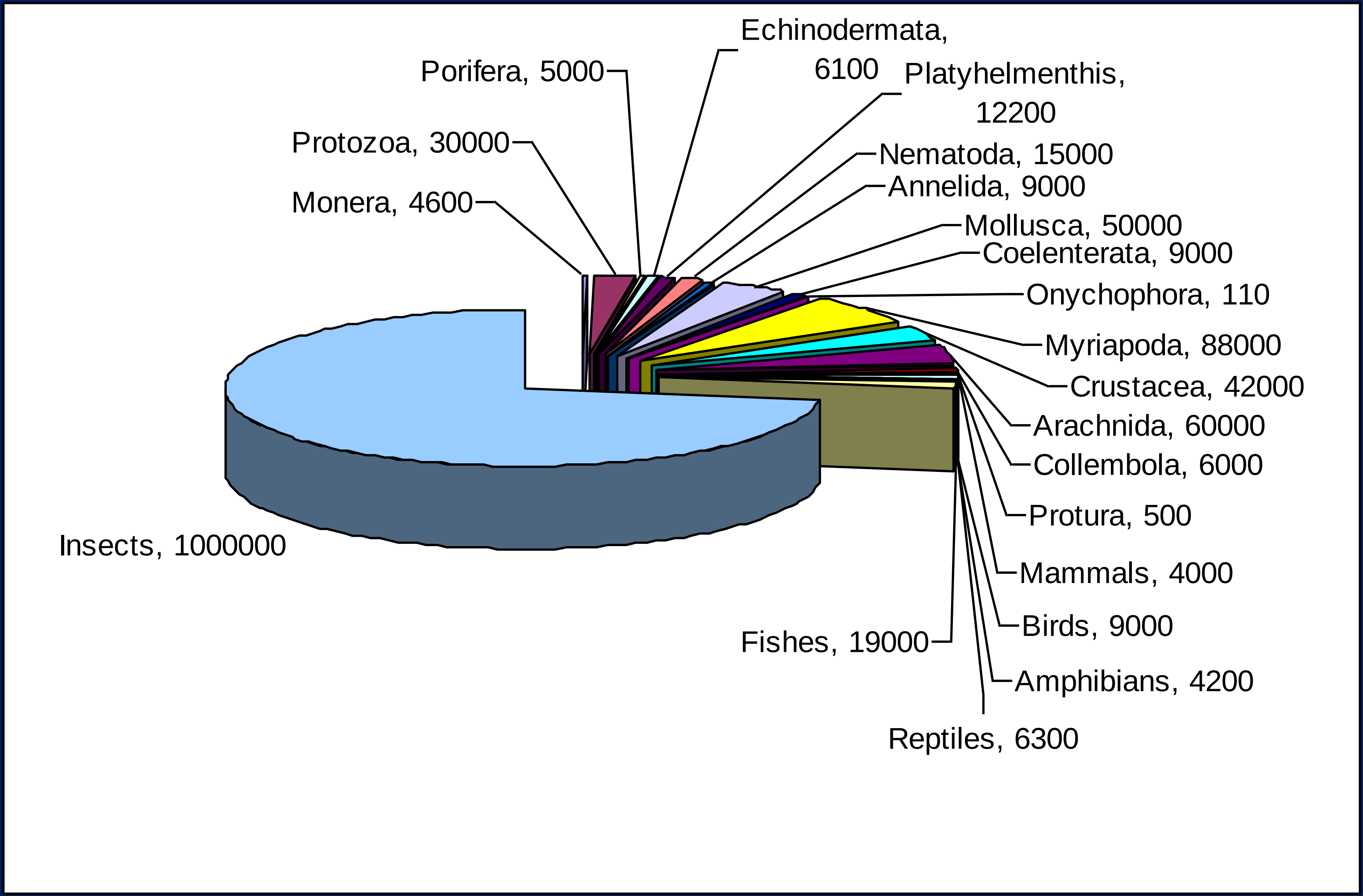
Evolution of Life

- Earth originated 4,500 my ago
- Life 3,750 my ago
- Insects 400 my ago
- First Hominid 4.00 my ago
- *Homo habilis* 2.18 my ago
- *Homo sapiens* 0.16 my ago

Of the 1.75 million life forms on Earth, that have been described & named so far, over 1 million are insects



Of the 1.4 million Animals, 1 million are insects



TAXONOMIC POSITION OF INSECTS

Kingdom Animalia

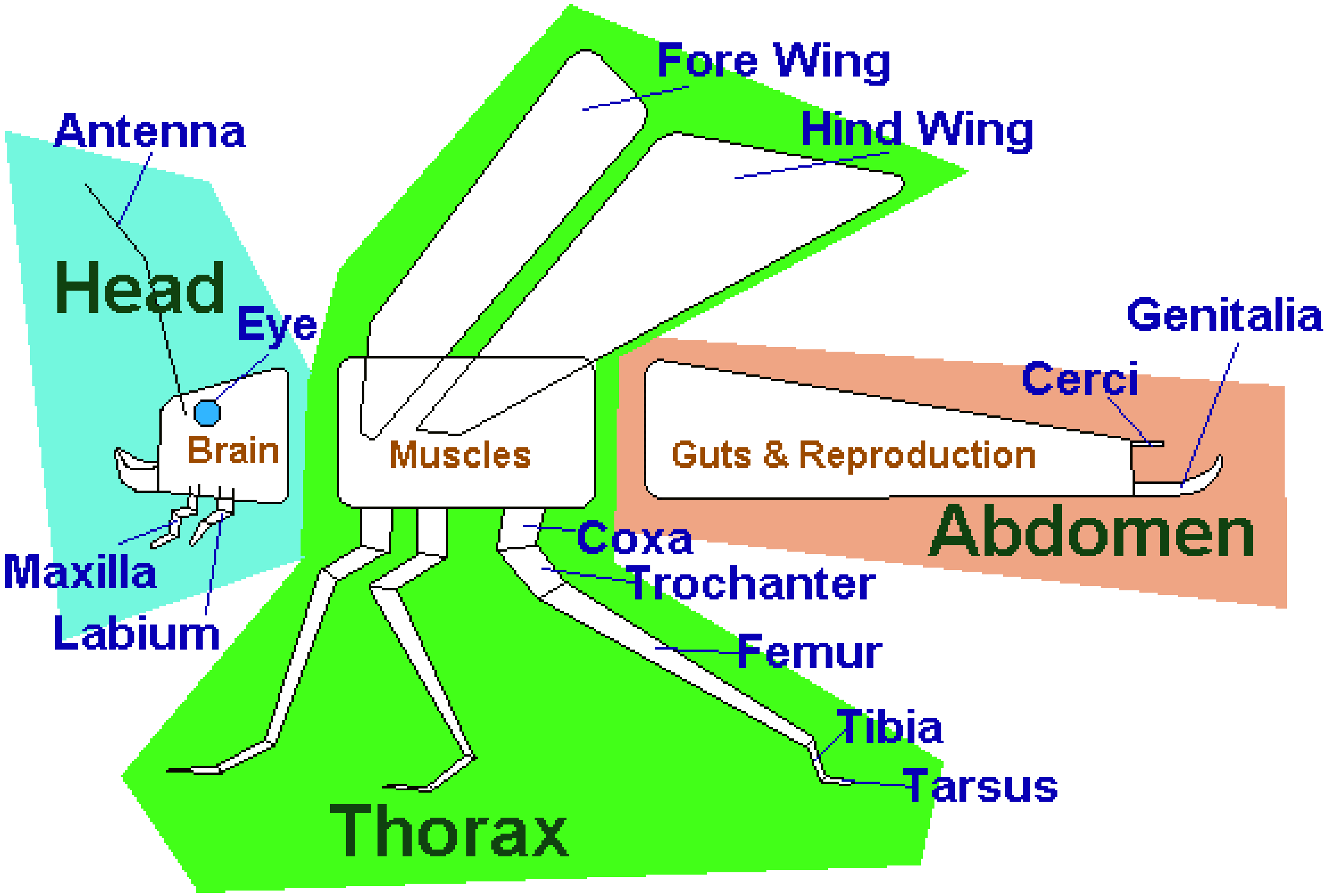
Phylum Arthropda

Subphylum Mandibulata

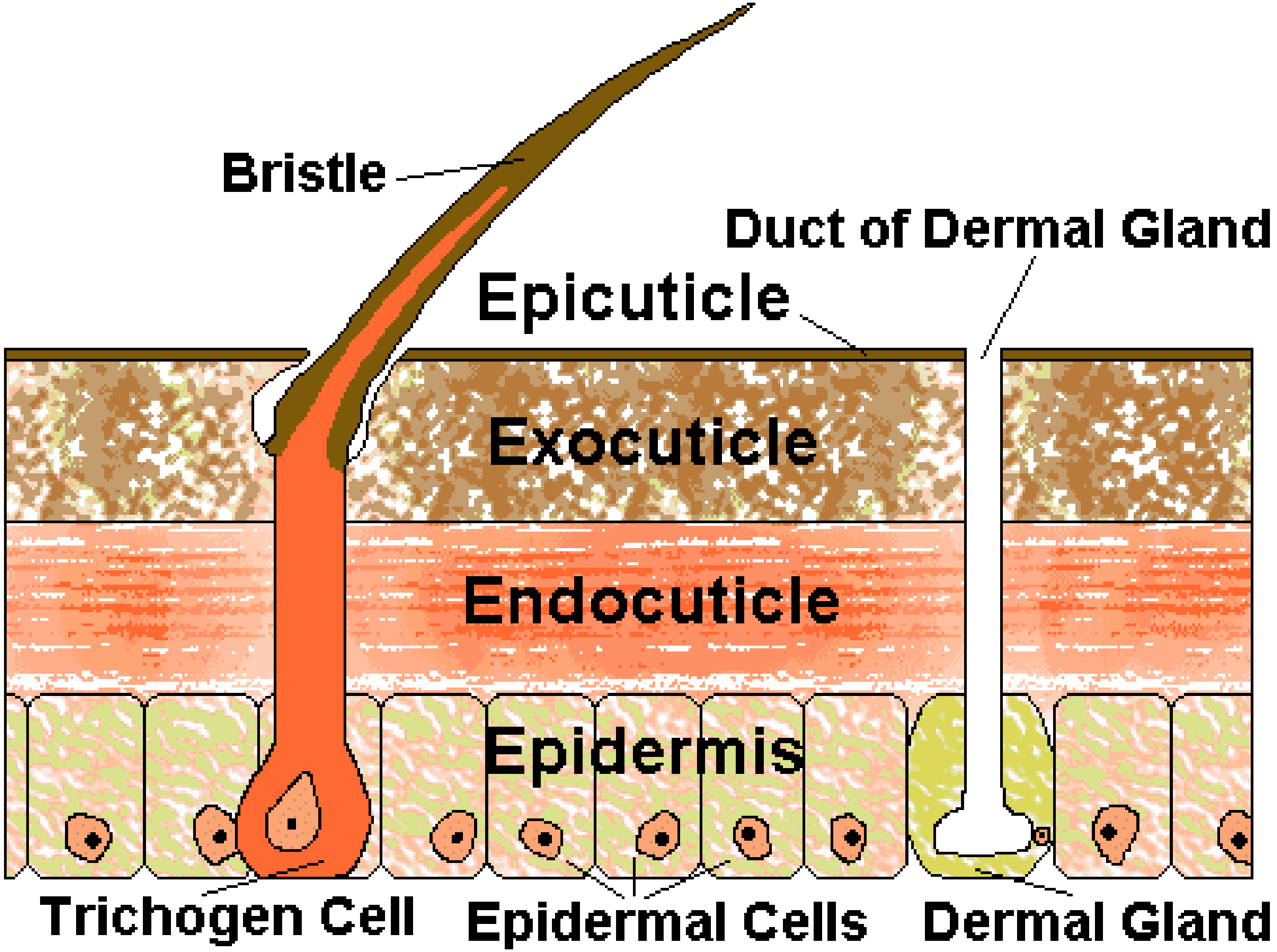
Superclass Hexapoda

Class Insecta

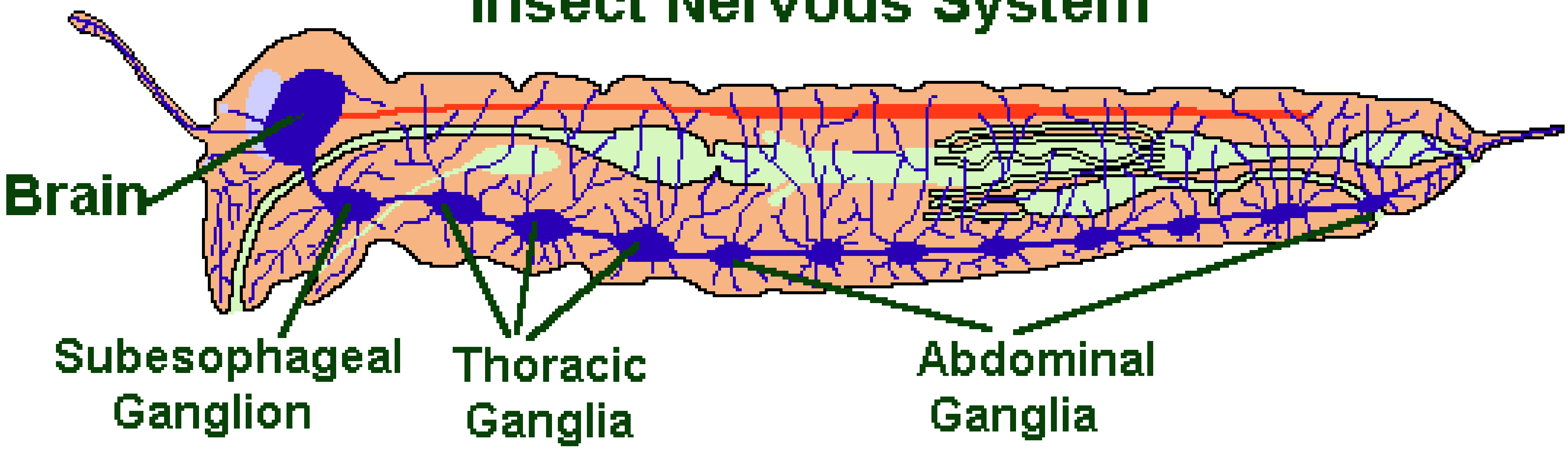
The Insect Body



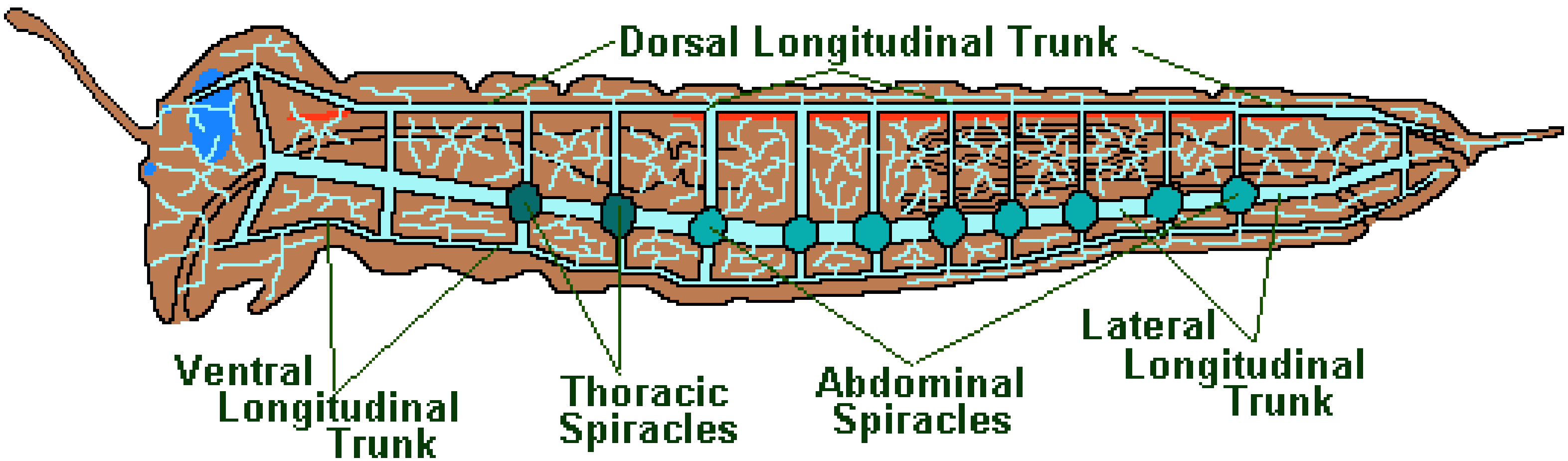
The Insect Integument



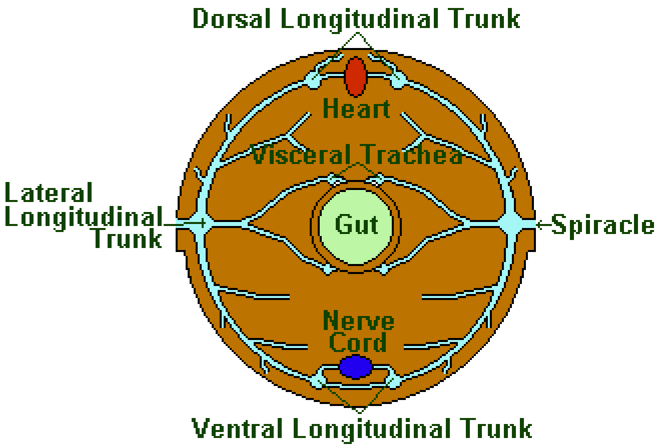
A Diagramatic Representation of the
Insect Nervous System



Diagramatic Representation of the Insect Tracheal System



Diagramatic Representation in TS of the Insect Tracheal System



Class Insecta

Subclass Apterygota

Thysanura

Collembola

Protura

Diplura

Subclass Pterygota

Paleoptera

Ephemeroptera
(Mayflies)

Odonata
(Dragon/Damselflie

Neoptera

NEOPTERA

Polyneoptera

a) Plecoptera
b) Grylloblattodea
c) Orthoptera
d) Phasmida
e) Mantophasmatodea
f) Dictyoptera
g) Dermaptera
h) Embioptera
i) Isoptera
j) Zoraptera

Paraneoptera

a) Psocoptera
b) Mallophaga
c) Siphunculata
d) Hemiptera
e) Thysanoptera

Oligoneoptera

a) Mecoptera
b) Neuroptera
c) Megaloptera
d) Trichoptera
e) Lepidoptera
f) Siphonaptera
g) Diptera
h) Strepsiptera
i) Coleoptera
j) Hymenoptera

SERIES- PARANEOPTERA

Psocoptera
(Book lice)

Mallophaga
(Chewing lice)

Siphunculata
(Sucking lice)

Hemiptera (Bugs, hoppers, aphids)

Thysanoptera (Thrips)

SERIES- POLYNEOPTERA

Plecoptera
(Stoneflies)

Grylloblattodea
(Ice crawlers)

Mantophasmatodea
(Gladiators)

Zoraptera
(Angel insects)

Embioptera
(Webspinners)

Phasmida
(Stick/leaf inects)

Orthoptera
(Grass hoppers)

Dictyoptera
(Mantids /cockroaches)

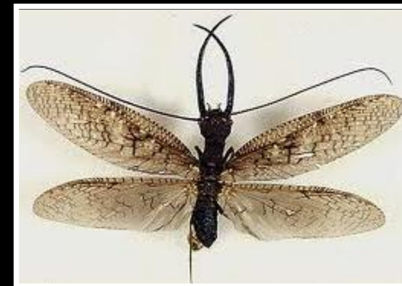
Dermaptera
(Earwigs)

Isoptera
(Termites)

SERIES-OLIGONEOPTERA

Mecoptera
(Scorpion flies)

Neuroptera
(Lacewings)



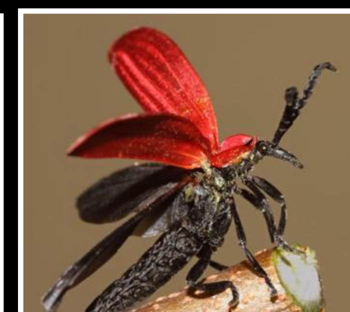
Megaloptera
(Alderflies/Snakeflies)

Siphonaptera
(Fleas)

Diptera
(Flies)

Trichoptera
(Caddisflies)

Lepidoptera
(Moths and butterflies)



Coleoptera
(Beetles)

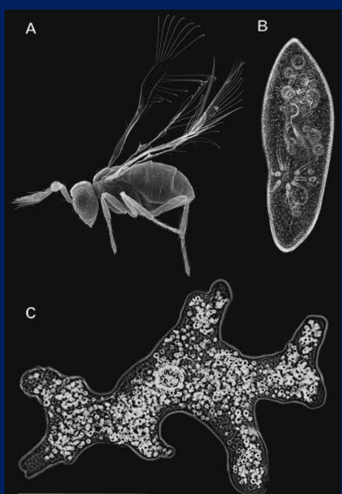
Strepsiptera
(Stylopids)

Hymenoptera
(Bees, wasps)

Extremes in the world of Insects

Smallest Insect

Fairy fly
Dicopomorpha echmepterygis
(Mymaridae: Hymenoptera)
Size: 0.139 mm



Parasitic wasp genus
Megaphragma mymaripenne
(Hymenoptera: Trichogrammatidae)
Scale=200 µm

Insect can be as small as a fairy fly & parasitic wasp and as big as Acteon beetle

Largest Insect

Acteon beetle, *Megasoma acteon*
(Scarabaeidae)
Size: 9 cms

Longest Insect

Phobaeticus chani
56.6 cms

Population size of individual species

Human:- 6-7 thousand million in the world

Mustard aphid- 40 million per acre!!!

Why insects are dominant?




A. Structural perfection

1. A strong Exoskeleton: protects them from sun, rains and extremes of weather

a) **Small Size**: easy to hide from predators; require little food/individual

b) **Quicker speciation**

B. Two pairs of Wings: to escape from predators & to migrate to better habitats

C. Hexapodous locomotion

D. Compound eyes

E. Scattered Sense organs

Why insects are dominant?

G. Decentralized nervous system

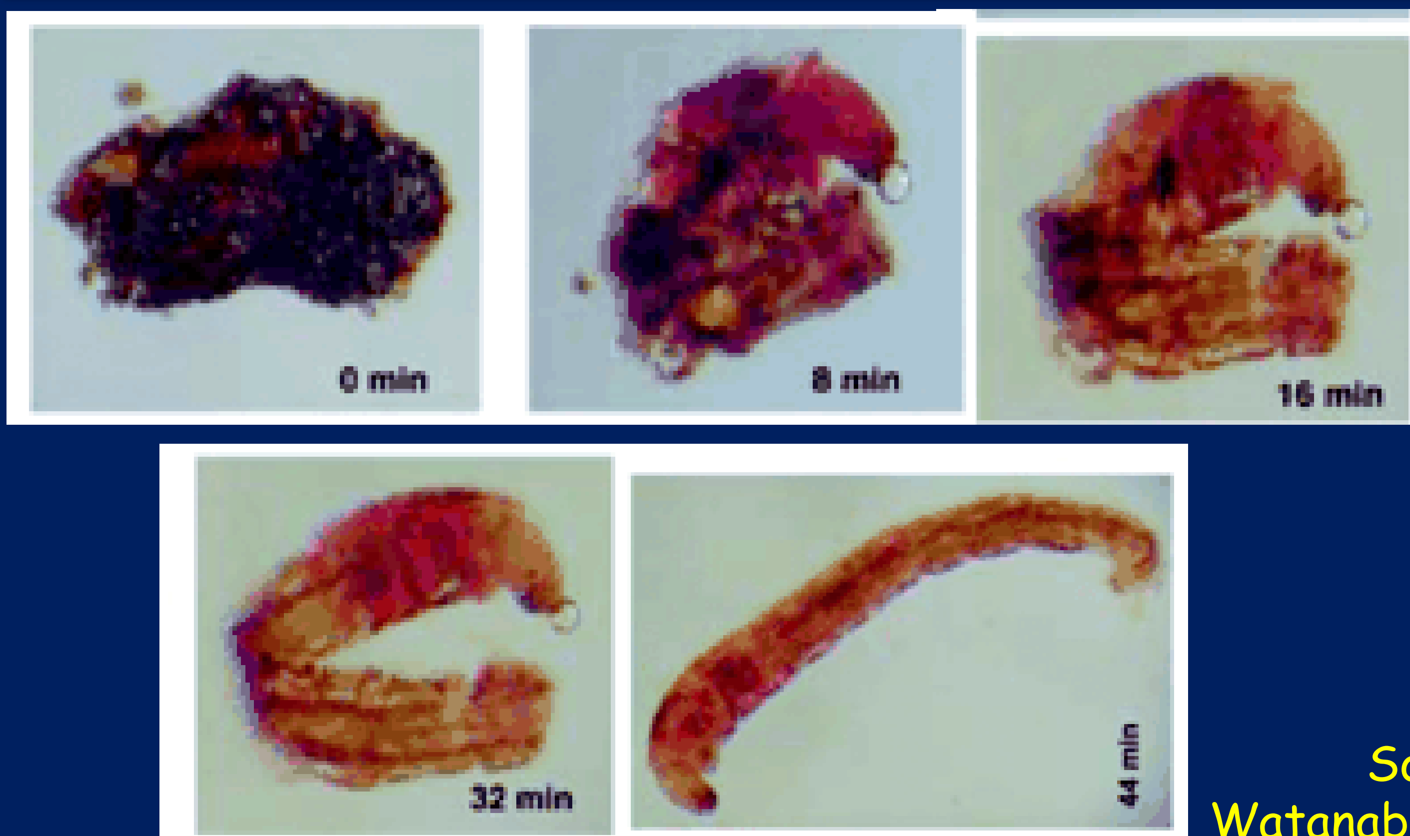
- ✓ **Resource partition (Eg: Antlions)**
- ✓ **Reproduction**: short life cycle; capacity to lay large number of eggs; and produce many offsprings per unit time
- ✓ **Specialized offence and defense mechanisms (Osmeteria in Papilionidae)**

Adaptive mechanism-Cryptobiosis

Cryptobiosis: Insect stops all its metabolic activities **(Diapause)**

Eg- Larvae of chironomid midge, *Polypedilum vanderplanki* Hint shows high thermal tolerance from –270°C to +106°C and can tolerate dehydration

Recovery of larva of *P. vanderplanki* from cryptobiosis



Source:
Watanabe *et al*, 2002

Protective mechanisms-Morphological

MIMICRY

Hemeroplanes sp. (Sphingidae)

Deilephila elpenor

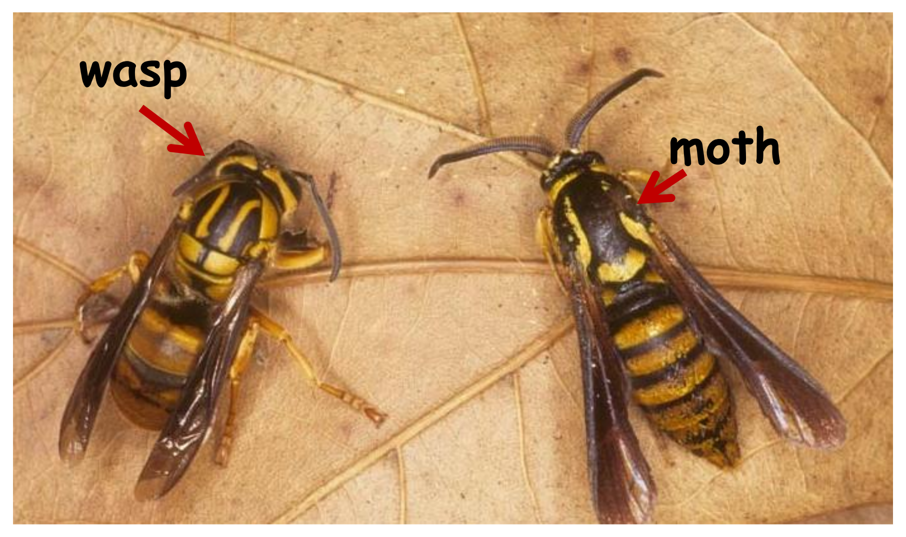
Green parrot snake

Larvae of Sphingid moths mimics snake by inflating its thoracic segments in order to avoid predation and to scare its predators

MIMICRY

Lantern fly (Fulgurodidae): The head and thorax are modified and it resembles the face of alligator

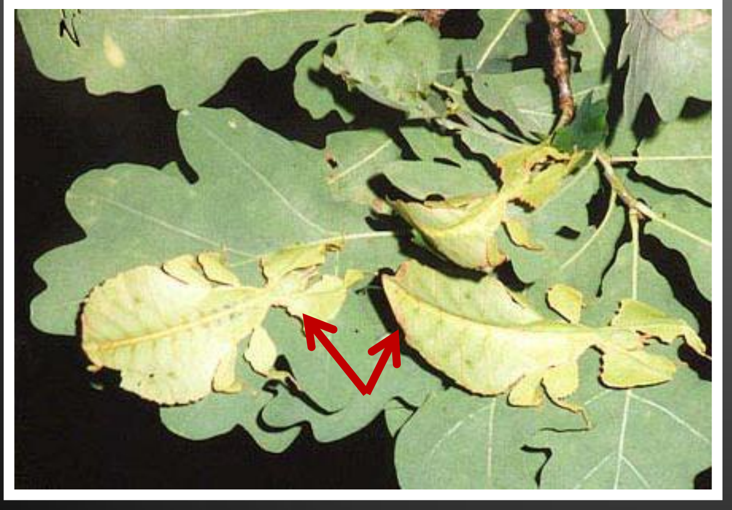
Clear wing moths mimicking yellow jacket wasps in order to avoid predation



Camouflage

Stick insect

Leaf insect



Behavioural adaptations

a) Stinging Hymenoptera

b) Secretion of offensive liquid

c) Feigning/dodging behaviour

Varied modes of reproduction in Insects

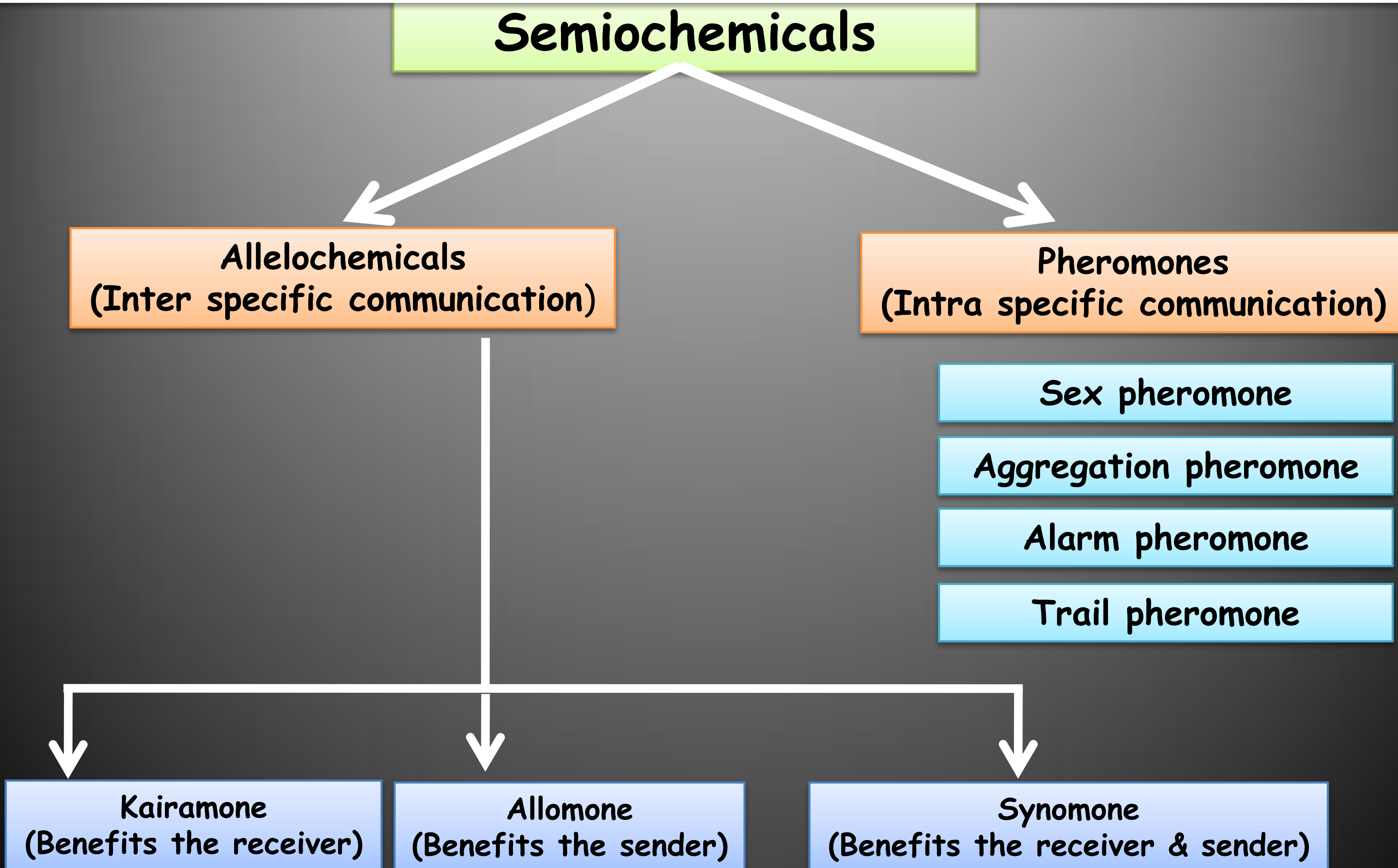
Oviparity: Insects deposit eggs, embryonic development takes place inside eggs
Eg: Butterflies, fruit flies

Ovoviviparity: Embryonic development takes place in the body of the mother and eggs are deposited in substrate before hatching
Eg: *Blaptica rubia* (Cockroach)

Viviparity: Direct deposition of young ones instead of eggs
Eg: Tse Tse fly, *Glossina palpalis*

Parthenogenesis: Development of young ones in the unfertilized eggs
Eg: Aphids

Insect Communication



Insect can produce light!

Bioluminescent Insect- Fireflies and Glow worms (Lampyridae)

Light is produced by the reaction of Luciferin, a pigment with oxygen mediated by enzyme Luciferase

$$\text{Luciferin} + \text{Oxygen} \xrightarrow{\text{Luciferase}} \text{Light}$$

Ant -Homoptera Interaction

Ant-Mealy bugs

Ant-Cow bugs

Ant-Aphids

Ants attend and transport hompoterans particularly mealy bugs, aphids, cowbugs and offer protection. In turn they receive honeydew from the homopterans

Insects and Humans

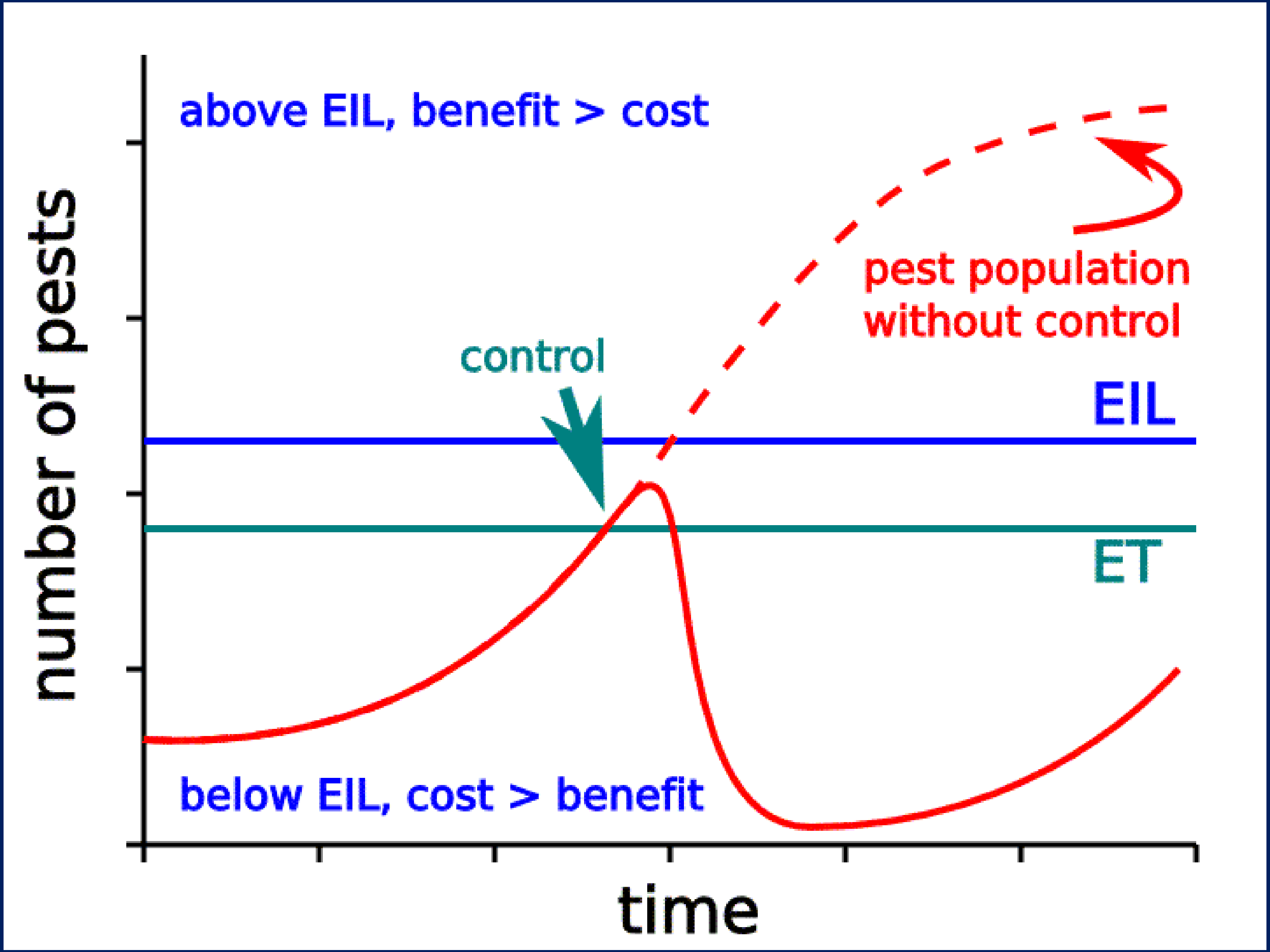


Insects can be

- ✓ Pests
- ✓ Beneficial
- ✓ Productive

All these terminologies are anthropocentric!

When an Insect is called **PEST**?



Insects as Pests

Notorious pests of various crops

American bollworm
Helicoverpa armigera

Oriental fruit fly
Bactrocera dorsalis

Diamond backmoth
Plutella xylostella

Brinjal fruit and shoot borer
Leucinodes orbonalis

Migratory locust, *Scistocerca migratoria* a polyphagous pest of crops

<u>Vectors of deadly diseases of cultivated crops</u>

Diaphorina citri- Citrus Greening

Nephotetix virescens-Rice Tungro

Pentalonia nigronervosa-Bunchy top of Banana

Hishimonus phycitis – Little leaf of Brinjal

Citrus psylla-*Diaphorina citri*

Adult

Nymphs

Infestation

Citrus thrips-*Scirtothrips* spp.

Adult

Infested fruit

Infested leaves

Citrus leafminer, *Phyllocnistis citrella*

Adult

Larva

Infested leaves

Citrus blackfly, *Aleurocanthus woglumi*

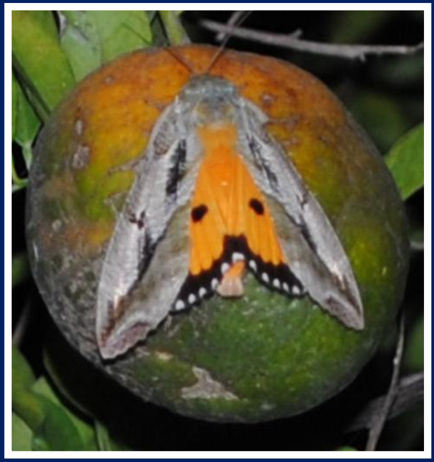
Adult

Nymphs

Pseudopupae

Infested leaves

Fruit piercing moths, *Eudocima materna*



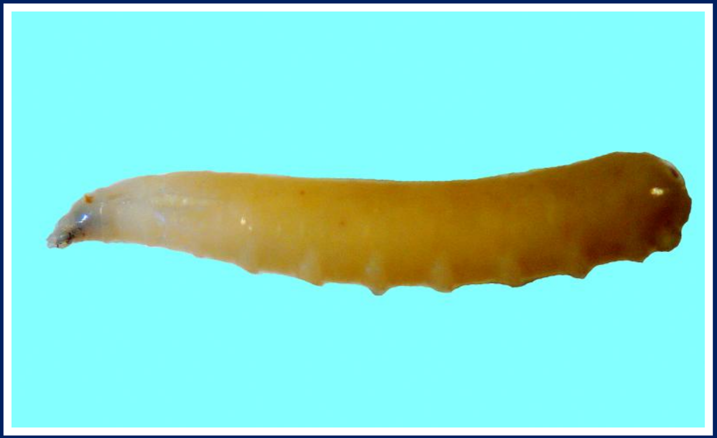
Adult

Larva

Infested fruits

Fruit flies, *Bactrocera dorsalis*

Adult



Larva

Infested fruits

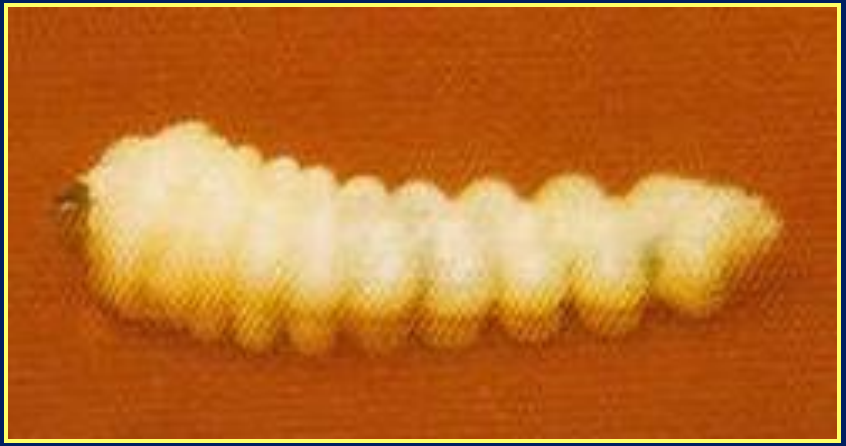
Bark eating caterpillar

Infestation

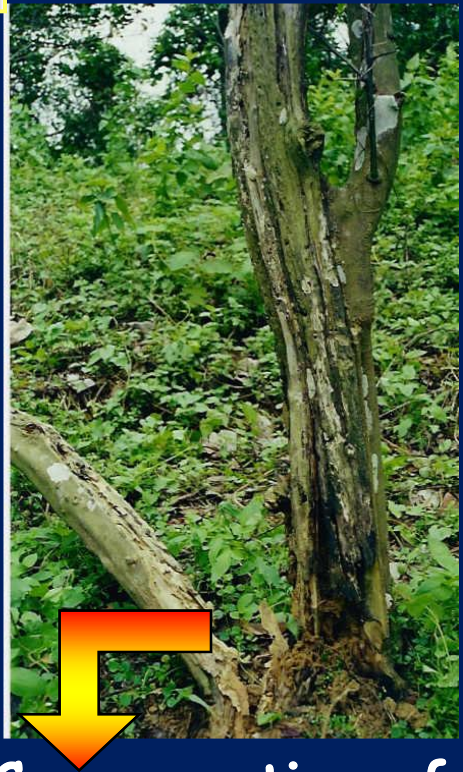
Bark eating caterpillar on infested part

TRUNK BORER

Monohammus versteegi



Stem borer Larva



Cross section of larval tunnel

Trunk borer entry hole

Beneficial Insects

PREDATORS

Mallada boninensis

Isyndus heros

Ischiodon scutellaris

Anegleis cardoni

PARASITOIDS

Tamarixia radiata parasitise citrus psylla nymphs

Epiricania melanoleuca parasitise *Pyrilla perpusilla*

Peribaea orbata parasitise *Spoodoptera litura* larvae

Aenasius bambawalei against cotton mealy bug, *Pheanococcus solenopsis*

Approaches in Biological Control

- ✓ Introduction (Classical Biological Control)
- ✓ Augmentation (Mass multiplication)
  - a) Inundative release
  - b) Inoculative release
- ✓ Conservation

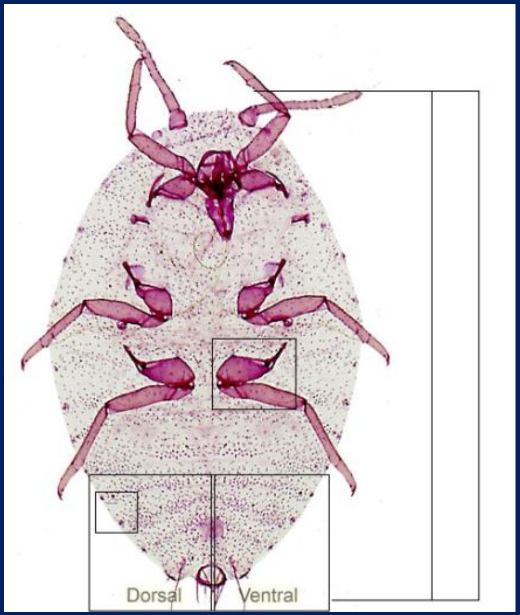
Classical Biological Control

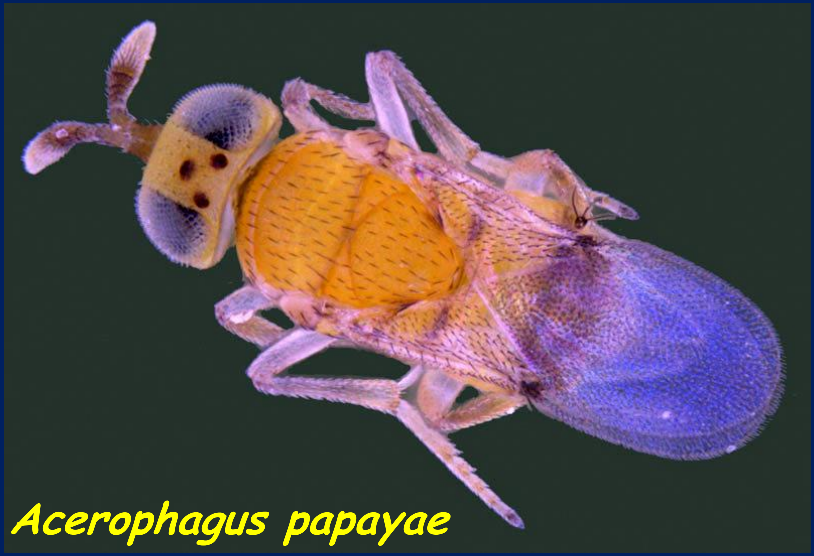
Cottony cushion scale
Icerya purchasi

Rodolia cardinalis

In 1888 Vidalia beetle, *Rodolia cardinalis* was introduced from Australia to California for the management of cottony cushion scale in citrus, *Icerya purchasi*

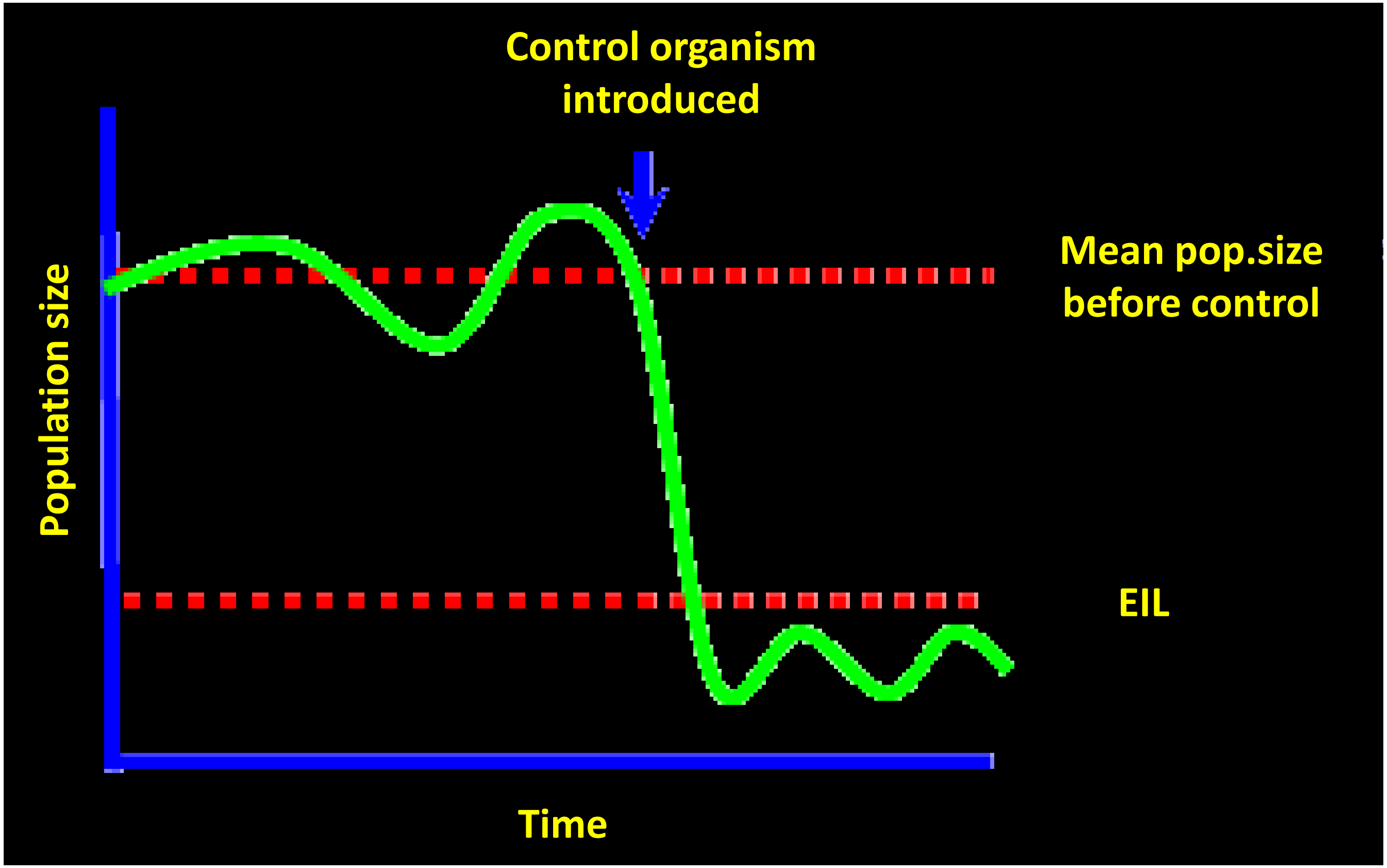
Papaya mealybug, *Paracoccus marginatus*





Acerophagus papayae Noyes & Schauff (Encyrtidae), a solitary endoparasitoid was imported from Mexico to India in 2010 against papaya mealy bug, *Paracoccus marginatus* Williams & Granara de Willink.

Augmentation

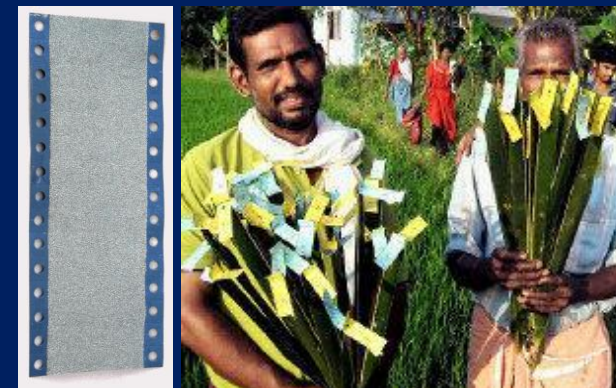


Examples of Augmentation

Trichrogramma japonicum- Rice stem borer, *Scirphophaga incertulus*

Trichrogramma japonicum

Scirphophaga incertulus



Trichocards

Micromous igorotus-Sugarcane wooly aphid, *Ceratovacuna lanigera*

Micromous igorotus

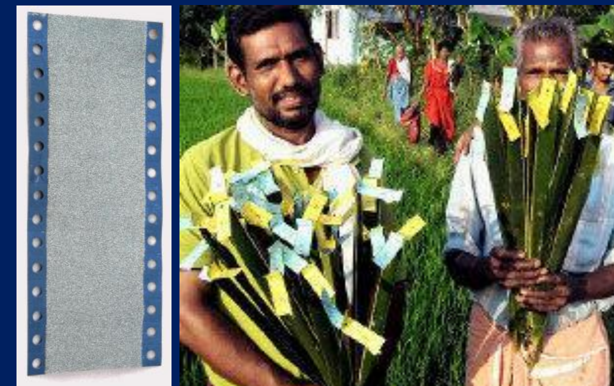
Ceratovacuna lanigera

Examples of Augmentation

Trichrogramma japonicum- Rice stem borer, *Scirphophaga incertulus*

Trichrogramma japonicum

Scirphophaga incertulus



Trichocards

Micromous igorotus-Sugarcane wooly aphid, *Ceratovacuna lanigera*

Micromous igorotus

Ceratovacuna lanigera

PRODUCTIVE INSECTS




HONEY BEES

Rock bee-*Apis dorsata*

European bee-*Apis mellifera*

Indian bee-*Apis indica*

Stingless bee- *Trigona iridipennis*

Dwarf bee- *Apis florea*

Well defined castes-worker, queens and drone.

The worker bees-housekeeping job during its first phase and foraging in second phase of its total life.

Drones have only the function of mating and fertilizing the queens.

A colony has a single queen which keeps the worker bees sterile by the secretion of queen substance.

The typical hexagonal symmetry of the honeycomb is a typical example of natural architecture.

Karl Von Frisch- unraveled the meaning round dance and wag tail dance and its implication in foraging behavior.




SILKWORMS

Silk, a natural protein fibre is obtained from the cocoons of silkworms.

Mulberry silkworm, *Bombyx mori* L., is the most commercially exploited species contributing to 95% of silk production.

B. mori is reared on mulberry

Wild silkworms

Eri silkworm, *Philosamia ricini* -Castor
Tassar silkworm , *P. cynthia*- Oak
Muga silkworm , *Antheraea assama- Terminalia*

India is the second largest producer of silk in the world followed by China.

LAC INSECT

LAC INSECT, Kerria lacca
Family Kerridae
Superfamily: Coccoidea

- **Thrive only well in specific trees called lac hosts namely ber (*Zizyphus mauritiana*) and palas (*Butea monosperma***
- **Kusumi and Rangeeni are the two strains**
- **India is the largest producer**
- **Cosmetics, pharmaceutical, paint and varnishes manufacturing**


Thank You