GENERAL ENTOMOLOGY

PG & RESEARCH DEPARTMENT OF ZOOLOGY,

GOVERNMENT ARTS COLLEGE (AUTONOMOUS),

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SCOPE OF ENTOMOLOGY

Entomology is the study of insects. Entomology deals with the development, diversity and the applied nature of the insects. Entomology emerged as a distinct field of study in the early 19th century. The scope of entomology typically includes the study of any terrestrial and aquatic insects belonging to the phylum Arthropoda.

Entomology is one of the subjects in zoology. Zoology is the study of animals and their behavior. Zoologists may study a particular species or group of species, either in the wild or in captivity. Zoologists study animals and their interactions with ecosystems. They study their physical characteristics, diets, behaviors, and the impacts humans have on them.

Majoring in biology with an emphasis on entomology is a great idea since undergrad is all about getting a broader education. Knowledge in the field of entomology gives variety of works includes:

Entomologist

Agronomist

Field Scientist

Forensic Entomologist

Lab Technician

Pest Control Technician

Plant Scientist

Industrial Entomologist

Careers in Entomology

A master degree is the minimum level of education needed to obtain an entry-level position in this field. Aspiring entomologists can pursue bachelor's degrees in biological sciences, though some universities offer programs specifically in entomology.

Professional entomologists contribute to the betterment of humankind by detecting the role of insects in the spread of disease and discovering ways of protecting food and fiber crops, and livestock from being damaged. They study the way beneficial insects contribute to the well being of humans, animals, and plants. Important fields which give various job opportunities in entomology are,

Pest control practices

Medical and Veterinary Entomologist

Agricultural, biological or genetic research

Forensic entomology

Public health

Consulting in agricultural, environmental, public health, urban, food processing

Conservation and environmental biology

Pharmaceutical industry

Natural resources management

BRANCHES OF ENTOMOLOGY

Introduction

The word Entomology is derived from a Greek word “entomone” and “logia”. Entomology as the branch of zoology that deals with the scientific study of insects. It also explores the linkages between insects themselves and also the relationship of insects with other organisms including plant and animal on earth. This enables the scientists to divide entomology into various branches of entomology for easy understanding of the subject and also to classify insects in their particular groups based on their characteristics.The important branches of entomology are as follows.

Insect Taxonomy

Insect Morphology

Insect Pathology

Insect Physiology

Insect Toxicology

Industrial Entomology

Medical and Veterinary Entomology

Biological Control Entomology

Forensic Entomology

Forest Entomology

Crop Protection Entomology

Insect Ecology

Insect Taxonomy

Taxonomy is the naming and classification of organisms. So, insect taxonomy is the practice as well as theory of naming the insects. It is a continuous process as there are many unidentified insects still roaming on the planet earth.

Insect Morphology

The study of insect body parts as well as their function is studied in this branch of entomology. This branch deals mostly with the external body parts of an insect.

Insect Pathology

The diseases that may harm or effect the health of insects is studied in this branch of entomology. In this, scientist uses disease agents or vectors to get rid of certain pests that may harm useful insects. It also include, getting rid of those pests that harm agriculture.

Insect Physiology

This branch of entomology deals with various functions and behavioral systems present inside the insect body. It also includes the study of behavior of different insects with their environment or ecosystem.

Insect Toxicology

This branch of entomology deals with how the insecticides and other chemical affect the insect's physiological functions. We can say that this branch deals with the field of controlling insects and pest management.

Industrial Entomology

The branch of entomology deals with the study as well as rearing of insects for business or beneficial purposes. This includes honeybee or apiculture, bumblebees, butterflies, silkworms etc. This branch of entomology actually deals with benefit of mankind. On the other hand, it also deals with the removal of harmful insects like termites, cockroaches, houseflies etc. from the houses.

Medical and Veterinary Entomology

Insects not only harm humans, but also animals. This branch of entomology deals with the insects that harm not only humans but effect animals also. It deals everything about medical public health, and veterinary importance such as Malaria, Dengue etc.

Biological Control Entomology

This branch deals with using insects against harmful insects. In other words, friendly insects are used to cater harmful insects thus called as biological control insects. For example, Ladybird eats aphids which destroy wheat crop. Similarly, dragonfly eats those insects that damage crops.

Forensic Entomology

In this branch, the focus is on using the insects to determine or estimate the time, place of human health for legal purposes. Forensic entomology is the scientific study of the invasion of the succession pattern of arthropods with their developmental stages of different species found on the

decomposed cadavers during legal investigations. It is the application and study of insect and other arthropod biology to criminal matters.

Forest Entomology

This branch of entomology deals with the trees and insects. In other words, in this branch, we study the impact of insects on forests and forest products and design solutions to safeguard trees from serious damage.

Crop Protection Entomology

The branch of entomology that deals with the study of controlling insects from damaging the crops in the fields in called as crop protection entomology. Sometimes, it is also called as agricultural entomology.

Insect Ecology

This branch of entomology deals with the relationships of insects with their environment. This branch focuses on the study and analysis of presence of insects in an ecosystem. The aim is the preserve the insects not to remove or eradicate them.

OUTLINE CLASSIFICATION OF CLASS INSECTA

Class; Insecta

Insects are the largest group of animals, which constitute 75% of all living animals. There are more than one million living species in the world and many more yet to be discovered. They were the first flying creatures and still the only invertebrates that can fly. They are the most successful animals inhabiting every conceivable ecological condition.

Although only 2% of the insect species are obnoxious to man, they are enough to cause heavy damage to crop, livestock and man himself. That makes them very important for human attention. Pest species are difficult to control and in spite of about a century of constant efforts, cockroaches, flies and mosquitoes are as abundant as ever.

Insect bodies are extremely tough due to exoskeleton and they possess enormous muscle power. They are endowed with the capacity to survive in the most inhospitable situations.

Insect body is divided into head, thorax and abdomen. They have 3 pairs of legs and hence sometimes called Hexapoda. One pair of antennae functions as sensory organs. One pair of compound eyes and one to three pairs of ocelli (sometimes absent) may be present.

Mouthparts are variously adapted depending on the mode of feeding. Breathing is by tracheal system. Circulatory system is open type. They excrete uric acid through malpighian tubules. Nervous system includes a circumpharyngeal ring and a ventral nerve cord. Sense organs are very well developed. Reproductive capacity is enormous and larval stages grow by molting (ecdysis). In majority of them larval stage is different from the adult and there is a distinct metamorphosis.

Class Insecta is divided into two subclasses, namely, Apterygota and Pterygota.

Subclass Apterygota (=Ametabola)

Primitively wingless insects, without metamorphosis. Head is prognathous. Abdominal appendages may be present. Ectognathous mouthparts, with mandibles attached at one point. There is no metamorphosis as nymphs are similar to adults. The subclass has 4 orders.

1.OrderProtura (Telson tails)

2. Order Diplura (Campodeids and Japygids)

3. Order Collembola (Spring tails and Snow fleas)

4. OrderThysanura (Silver fish)

Subclass Pterygota (=Metabola)

Winged or secondarily wingless insects, with prognathous or hypognathous head. Mouthparts endognathous. Metamorphosis either incomplete without a pupal stage or complete with a pupal stage. This subclass is divided into two superorders or divisions, namely, Exopterygota and Endopterygota.

Division Exopterygota (=Hemimetabola)

Wings develop externally during the larval growth and there is no pupal stage. Nymphs possess compound eyes and have similar habits and habitats as the adults. There are 16 orders in this group.

1. Order Ephemeroptera (May flies)

2. Order Odonata (Dragon flies and Damsel flies)

3. Order Orthoptera (Grasshoppers, Locusts, Crickets, Mole crickets)

4. Order Dictyoptera (Cockroaches and Mantids)

5. Order Phasmida (Leaf insects and Stick insects)

6. Order Plecoptera (Stone flies and Salmon flies)

7. Order Isoptera (Termites)

8. Order Zoraptera (Zorotypus)

9. Order Embioptera (Web-spinner)

10. Order Dermaptera (Earwigs)

11. Order Psocoptera (Book lice and Bark lice)

12. Order Mallophaga (Bird lice)

13. Order Anopleura (=Siphunculata) (Sucking lice)

14. Order Thysanoptera (Thrips)

15. Order Hemiptera (Bugs, Hoppers, Cicadas, White flies, Scale insects)

16. Order Grylloblattoidea (Grylloblatta)

Division Endopterygota (=Holometabola)

Wings develop internally inside the pupal case. Larva is very different in appearance and habits from the adult, has simple eyes and there is a distinct pupal stage. There are 9 orders in this group.

1. Order Neuroptera (Ant-lions and lacewings)

2. Order Coleoptera (Beetles and Weevils)

3. Order Strepsiptera (stylopids)

4. Order Mecoptera (Scorpion flies)

5. Order Trichoptera (Caddis flies)

6. Order Lepidoptera (Butterflies and Moths)

7. Order Hymenoptera (Wasps, Bees, Ants, Sawflies)

8. Order Diptera (True flies, Mosquitoes, Sandflies, gnats)

9. Order Siphonaptera (Fleas)

INSECT ORDERS

ORDER : THYSANURA

INTRODUCTION:

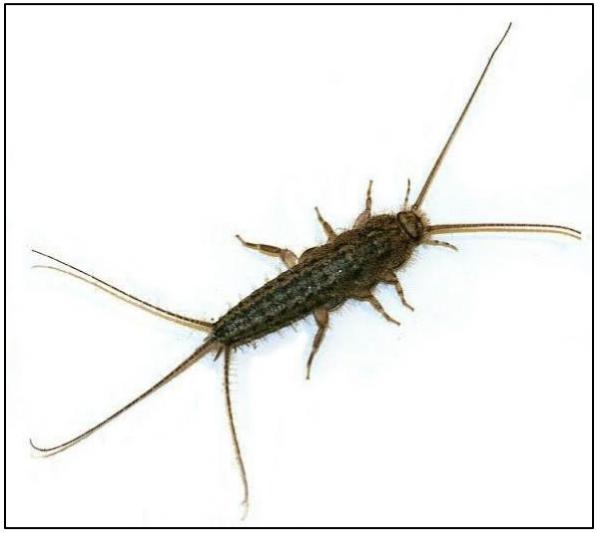
- **INSECTS ARE THE LARGEST GROUP OF ANIMAL.**
- **MORE THAN ONE MILLION LIVING SPECIES IN THE WORLD.**
- **FIRST FLYING CREATURES AND STILL THE ONLY INVERTEBRATES THAT CAN FLY.**
- **THYSANURA → PRIMITIVE BUT WELL ADAPTED, SURVIVE IN BASEMENTS AND ATTICS.**
- **THEY ARE NOCTURNAL SCAVENGERS.**
- **THEY PREFER ALGAE,LICHENS OR STARCY VEGETABLE MATTER.**

COMMON NAMES:

- BRISTLETAILS.
- THEY THOUGHT TO BE LINKING ORDER BETWEEN WINGED AND WINGLESS INSECTS.
- SILVERFISH.
- FIREBRATS.

GEOGRAPHIC DISTRIBUTION:







- **WORLD WIDE IN DISTRIBUTION.**
- **WHERE THEIR FAVOURABLE HABITATS EXIST.**

HABITAT:

- SOIL,LEAF LITTER,HOUSES AND TERMITE NEST.
- SILVERFISH NATURAL AND MANMADE.
- NATIVE SPECIES BARK OF TREES ,UNDER ROCKS,LEAF LITTER.
- SOME SPECIES IN CAVES.
- MOST SPECIES CUPBOARDS, BOOKSHELES.





IDENTIFICATION:

- **APTERYGOTE.**
- **BODY FLAT,TAPERED,OFTEN COVERED WITH SCALES.**
- **COMPOUND EYES SMALL OR ABSENT.**
- **ANTENNAE LONG ,MULTI SEGMENTED,THREAD LIKE.ABDOMEN TEN COMPLETE SEGMENTS.**
- **ELEVENTH ABDOMINAL SEGMENTS MEDIAN CAUDAL FILAMENT.**
- **CERCI PRESENT.**

FAMILIES:

- **STYLIFORM APPENDAGES ABDOMINAL SEGMENTS.**
- **BROWN OR TAN IN COLOUR.**
- **12mm IN LENGTH.**

LEPIDOTRICHIDAE.

TRICHOLEPIDION GERTSCHI.

NICOLETIIDAE.

NICOLETINAE & ATELURINAE.

LIFE CYCLE:

LEPISMATIDAE.

COMMON SPECIES OF SILVERFISH AND FIBRATS.

- **SEXUAL REPRODUCTION MALE DEPOSITING A SPERM POCKET. ➢DEPENDS UPON THE SPECIES THE FEMALE MAY LAY EGGS.**
- **YOUNG DEVELEP SERIES OF MOULTS,3 MOTHS TO REACH MATURITY.**
- **SILVERFISH COUNTINUE TO MOULT.**

- **LIFE SPAN MINIMUM 4 YEARS.**
- **NYMPHS ADULT BUT SMALLER IN SIZE.**


Adults mature in
3 to 4 months
Adult
Live 5 -7 years
Eggs
Hatch in
Silverfish
Life Cycle
Nymph 4
Nymph 1
Nymph 3
Nymph 2

HOW TO ENCOUNTER:

- INDOOR SPECIES FORCEPS OR MOISTENED BRUSH.
- OUTDOOR SPECIES ROCKS,WOOD,LEAF LITTER AND SOIL.
- DOMESTIC SPECIES CONTROL MAY BE NOT NECESSARY.
- ELIMINATING MOISTURE CONDITION.
- INSECTICIDES SPRAYS,DUSTS,BAITS.
- BORIC ACID DUST.



Essential Oils
to Repel Silverfish

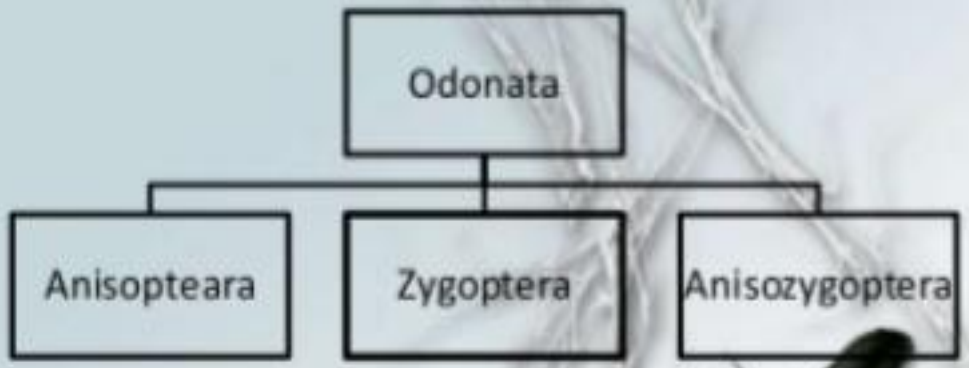
1. Lavender
2. Cinnamon
3. Clove
4. Basil
5. Peppermint
6. Rosemary
7. Tea tree
8. Orange
9. Lime
10. Lemon

ORDER : ODONATA

Scientific classification of Odonatas

- Dragonflies and damselflies which are belong to the Odanata order included with ancient beautiful insects and the large flying invertebrates ever in the world.
- Order Odonata can be classified into three sub-orders.

- **Kingdom :- Animalia**
- **Phylum :- Arthropoda**
- **Class :- Insecta**
- **Sub class :- Pterygota**
- **Infra class :- Palaeoptera**
- **Super order :- Odonatoptera**
- **Order :- Odonata**



There are nine families in order Odonata



Order: Odonata

- Odonata are paleopterous, exopterygote aquatic insects, related to the Ephemeroptera Dragonfly adults are predaceous, relatively long-lived insects.
- Their large compound eyes, strong chewing mouthparts, long legs, and unparalleled flight capabilities are ideal adaptations for catching and consuming insect prey.
- The larvae are aquatic and are usually much longer lived.

Characteristics

- chewing mouthparts,
- large compound eyes, three ocelli,
- small setaceous antennae,
- a small prothorax,
- the meso- and metathoracic segments fused into a large pterothorax,
- long legs with three-segmented tarsi,
- two pairs of elongate wings,
- elongate abdomen,
- accessory male genitalia including the intromittent organ on the venter of the second abdominal segment.

Suborder Anisoptera (Dragonflies)

- Dragonflies are characterized by the following structural features:

  - fore and hind wings dissimilar in shape and venation,
  - wing holding is horizontally outspread at rest,
  - eyes adjacent or nearly so; and
    - larvae stout and without caudal lamellae,

Suborder Zygoptera (Damselflies)

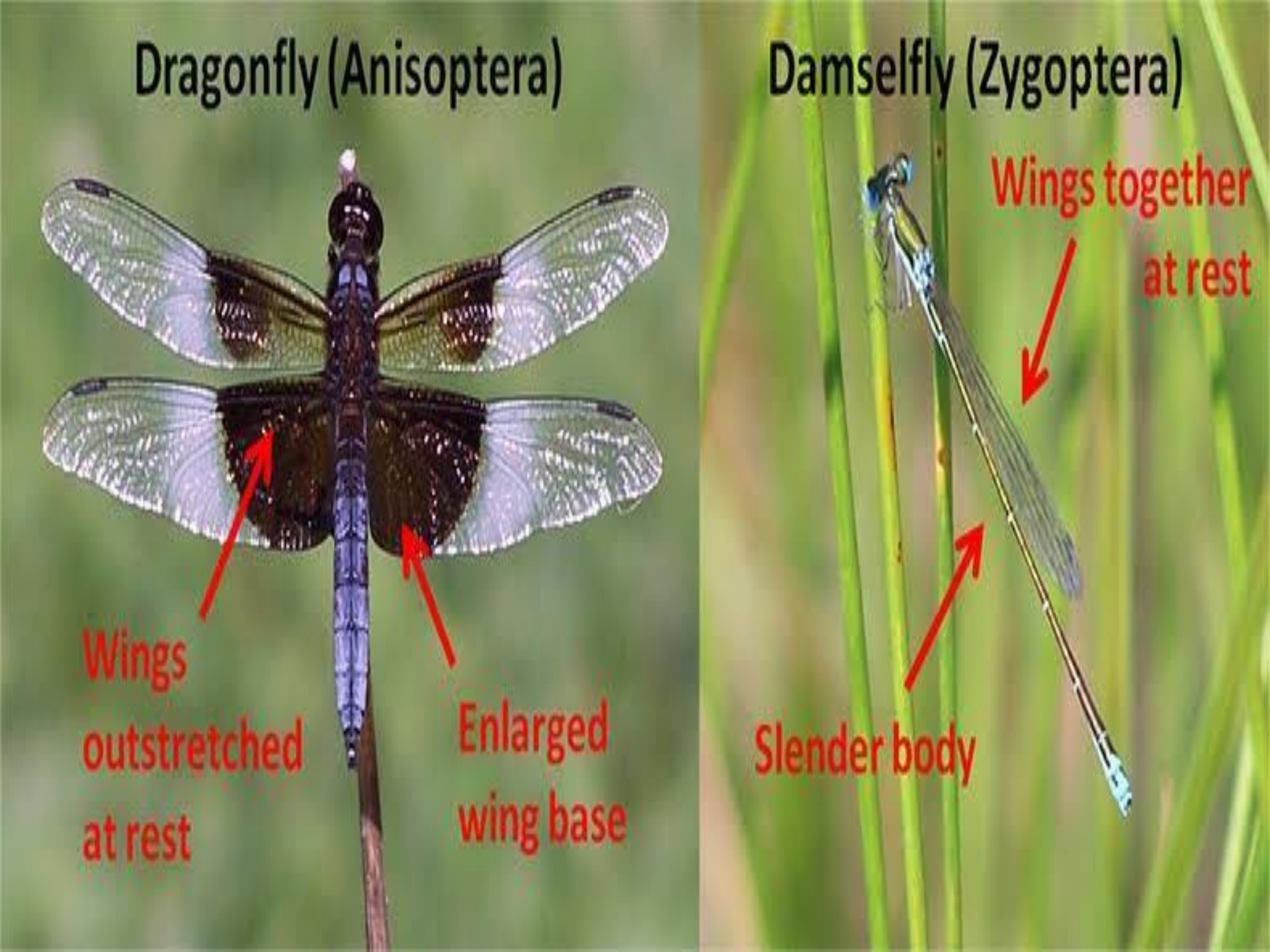
- Damselflies are characterized by the following structural features:

  - fore and hind wings almost identical in shape and venation,

  - wing holding is vertically upward at rest,

  - eyes far apart, and

  - larvae with three (rarely two) caudal lamellae (Caudal Gills).


Dragonfly (Anisoptera)
Wings outstretched at rest
Enlarged wing base
Damselfly (Zygoptera)
Wings together at rest
Slender body

Suborder Anisozygoptera

- considered intermediate between dragonfliesand damselflies
- mainly because the hind wings are very similar in size and shape to the forewings and held back over the body at rest, as in damselflies.

Geographic Range

- Odonates inhabit every continent except Antartica
- They are found in habitats where fresh water is present.
- 5,000 described species,

450 in North America



Habitat

- Dragonflies can be found near lakes, ponds, rivers, and swamps. Anywhere where there is water.
- They require water, sunlight, shelter, plants, and a source of food.
- Dragonflies usually are found near unpolluted water.



Feeding Habits

- Prey includes: Midges, flies, mosquitos, and other flying insects.
- Capture prey in mid air
- Nymphs feed on insect larvae and worms
- Can fly up to 60 mph





Reproduction

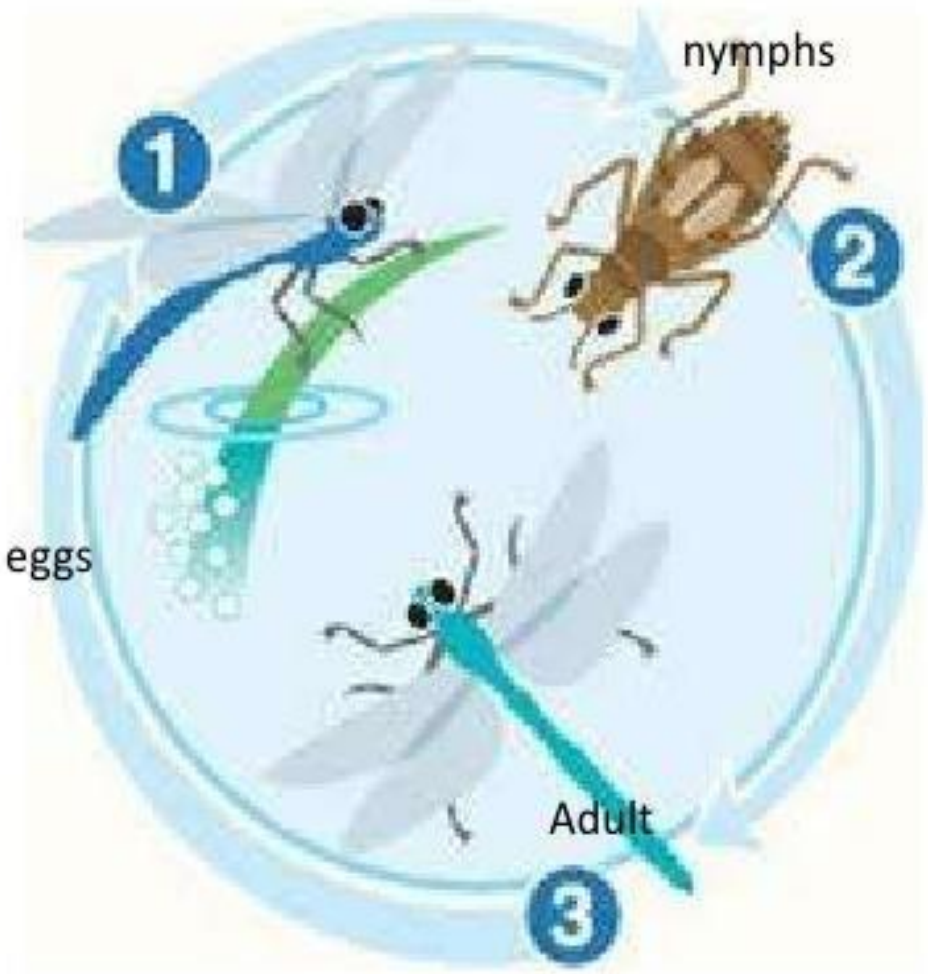


- Male has 2 sets of sexual organs
- Male must first charge his secondarycopulatory apparatus with sperm
- They assume the "wheel" position
- The females sexual apparatus joins the males secondary copulatory apparatus
- Lasts several minutes to several hours



Life Cycle

- Dragonflies lay there eggs in water.
- Nymphs then spend some time in the water to continue its metamorphosis.
- Once nymphs shed there skin, they spend there rest of their life out of the water.



Lifecycle

Mating usually takes place on the wing and the male dragonfly (or Damselfly) guards the female as she fly's over the surface of the water depositing her eggs. The nymph (The baby) spend mostly their whole life under water and then they moult nearly up to 15 times before they emerge into a full adult Dragonfly(or damselfly).



Dragonfly Nymph



Dragonfly nymph shedding skin

When fully mature the final instar come and crawl onto overhanging rock(pebbles) or vegetation(plants) where they go to shed they're last nymphal skin and emerge as a adult getting ready to hunt and mate.

Nymph



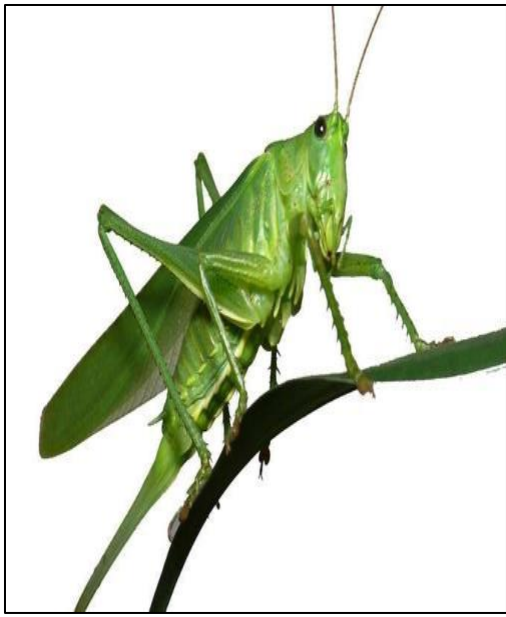


- Prey on invertebrates
- Fish prey on them
- Molts 6 to 15 times

- Hemimetabolous Metamorphosis

ORDER : ORTHOPTERA

SCIENTIFIC CLASSIFICATION



- KINGDOM :Animalia
- PHYLUM : Insecta
- SUB CLASS : Pterygota
- INFRA –CLASS : Neoptera
- SUPER ORDER :Orthopterida
- ORDER :Orthoptera
- SUB –ORDER : Ensifera, Caelifera.

GENERAL CHARACTERS.

- Orthoptera derived from the two greek word.
  Ortho meaning straight and petra meaning wing.
- Body minute to very large body from variable.
- mouthparts – chewing type all gradation between hypognathus and opisthognathus.
- Eyes & ocelli –compound eye developed some have 2 or 3 ocelli.
- Antennae –various from filli for in many insects.
- Medium to large sized insect.
- Head is generally hypognathus rarely prognathous bearing a large compound eyes, normally 3 ocelli are distinct but absent in the wingless species or reduced 2 in some long horned grasshoppers.
- Tentorium is x – shaped and distinct.
- Antenna is filiform in teltigonids but shorter and more moniliform in the short horned grasshoppers.

- Mouthparts are Mandibulate. 5 segmented maxillary palps 3 segments labial palps.
- Head is broadly articulated to the thorax.
  - Prothorax is large. Pronotum is curved.
  - Ventrally convering the pleural region. Meso & metathorax are comparatively much shorter.
- Hind legs are saltatorial. In mole crickets the hidlegs are normal but for legs are fossorial.
- Tarsi 3 or 4 segmented, rarely 5 to 2 segmented.

- For wing is leathery, thickened and known as tegmina, they are capable of brnding without breaking . Hind wings are membranous with large anal area. The are folded by longitudinal pleats between veins and kept beneath the tegmina.

- Carci are short and un –segmented. Ovipositor is long &needle like and wanting in gryllotalpids.

- In many orthoptera is newly hatched first instars nymphs are covered by loose cuticle and are called pronymphs. Wing pads of nymphs undergo reversal during development.
- Specialised stridulatory (sound – producing) and auditory hearing organs are present metamorphosis slight.

- Common name : Grasshoppers, locust, katydid, cricket, mole cricket.

- ORTHROPTERA IS DIVIDED INTO TWO SUB ORDERS:

1.Ensifera (long – horned grasshoppers)

2.Caelifera (short – horned grasshoppers)

- All members of this family with the exception of the shield – backed grasshoppers , are green in colour have long wings.

- Tettigonids are distinguished by having the hearing organs (tympanums). Located on the front legs.

- When the male rubs his wing covers together he produces a song that is used to attract females.
- Each species has its own characteristic song.
- Most long – horned grasshoppers spend the winter in the egg stages.
- Tarsus are four segmented
- e.g = surface grasshopper conocephailus indicus.
- Tarus are three segmented.

LIFE CYCLE.

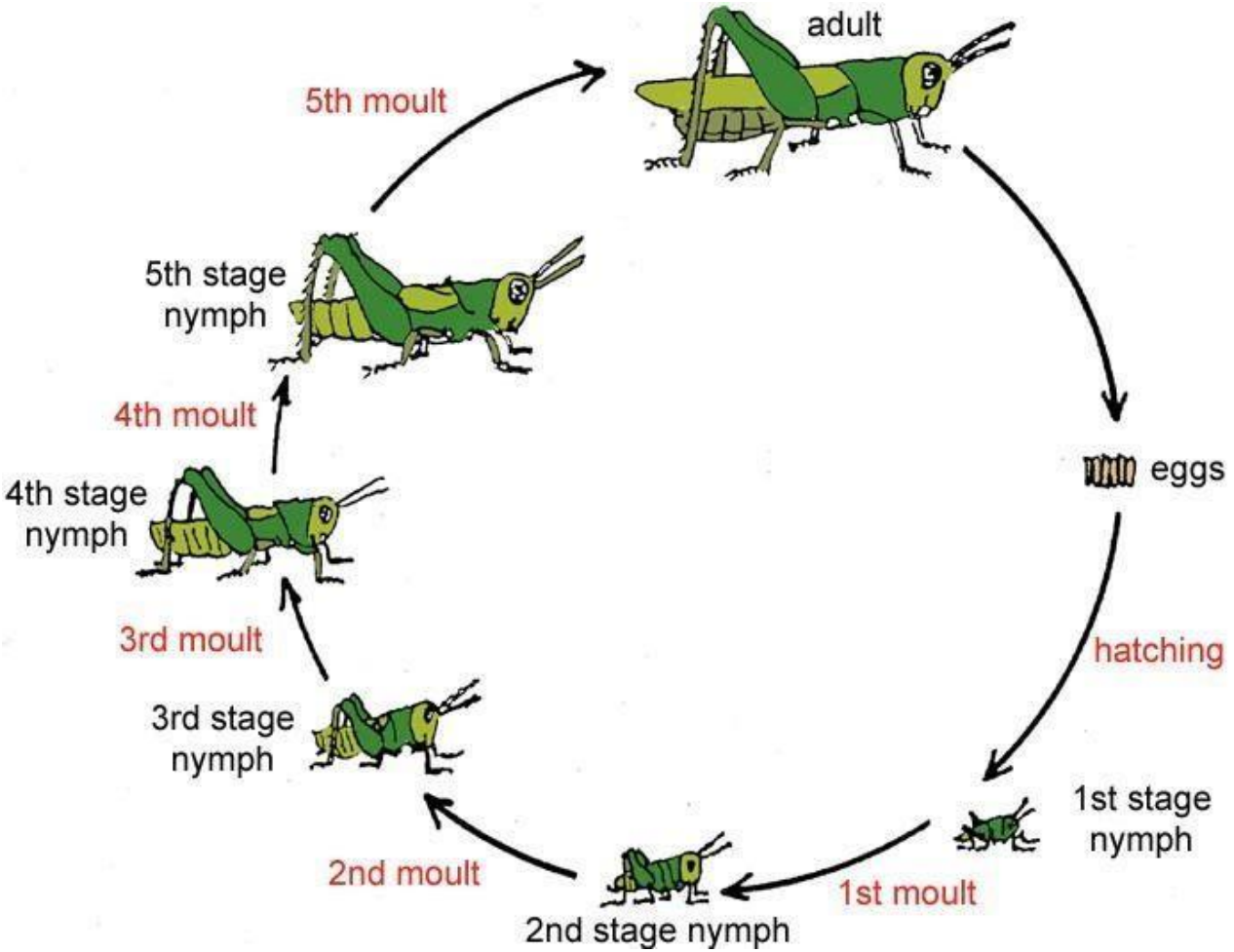
- They are herbivorous and include some of the most destructive agricultural pests known.
- The plague or migratory species are called locusts.
- Hind legs are adapted for jumping with greatly enlarged formurs.
- Most species have a pair of tympanal hearing organs at the base of the abdomen.

  e.g = cotton grasshoppers , rice grasshoppers.
- Orthoptera have only 3 life stages.

  (incomplete metamorphosis)

1. Egg
2. Nymph
3. Adult

- Some species lay eggs in the form of groups while others lay a single egg at one place.
- Those who lay eggs in group also endose their eggs inside an egg pod.
- Number of nymphal instars various from species to specie.
- Adult have fully developed wings where as nymphs don’t have wings or either in developing phase.


adult
5th moult
5th stage nymph
4th moult
4th stage nymph
3rd moult
3rd stage nymph
2nd moult
2nd stage nymph
1st moult
1st stage nymph
hatching
eggs

FAMILY : Acrididae (short horned grasshoppers & locust).

- Members of this family are often destructive to crops and vegetation.
- Antennae is short.
- Tarsus is 3 segmented.
- Ovipositor is short and horny.
- Tympanum is located one on either side of the first abdominal segment.
- Sound is produced (stridulation) by fermoro – alary mechanism.
- (e.g) short horned grasshoppers (non – migratory)
- Winged or wingless forms, when wing present left tegmina overlap right one.
- In males cubito – anal region of tegmia modified for stridulation.

FAMILY - Gryllidae (crickets)

- Antennae is long, slender as long as or loger then body.
- Tarsus is four segmented.
- Ovipositor is very long even exceeding the body length sword like or sickle shapped.
- Antenna long tarsurs in 3 segmented. Ovipositor is slender and needle like.
- Forewing are abrupthy bent down to cover the slides of body.
- Hind wings are acuminate.
- Cerci are long and un segmented.
- Auditory organs are located on the fore tibiae and stridulatory organs are similar to the long horned grasshoppers.
- They produce a shirill chirping noise during night.

FAMILY – Gryllotalpidae (mole cricket)

(e. g) gryllus campestris, Acheta domesticus.

- They are brown colored insects found inside the burrow.
- Eyes are reduced.
- Tibiae are expanded. Tarsi 2 or 3 segmented.
- Hind wing are extended beynond the tegmina as a pair of process. Sprcial stridulatory organs are absent , a humming sound is produced by the vibration of wings.
- A pair of tympanum is found under surface of the tibae.
- Ovipositor is vestiginal.

  (e. g) Gryllotapa africana, G. Gryllotalpa.
- Orthoptera is one of the largest and most important group of plant feeding insects.

DAMAGES.

- These insects feed on all types of plants and often cause serious economic damage.

- Grasshoppers have chewing and biting type mouthparts so the damage is similar to caterpillars.
- Grasshoppers are herbivorous Cricket are omnivorous.
- Cricket can even eat their mates if hungry.
- Some species are even scavengers or predators.
- Both nymphs and adult cause damage.
- The main damage done by them is direct.
- Consumption of plants not by vectoring diseases.

ORDER : COLEOPTERA

INTRODUCTION

Coleoptera is an order of insects commonly known as '*beetles*'.

- The word coleoptera is from the greek word '*keleos*' meaning '*sheath*' and '*pteron*' meaning '*wing*' thus "*sheathed wing*".
- The reason for the name is that most beetles have two pair of wings, the front pair, the 'elytra' being hardened and thickened into a sheath like or shell like protection for the rear pair and for the rear part of the beetles body.
- This is the largest order in the class insecta with over 4.00,000 described species.
- The order coleoptera constitute almost 25% of all known life forms.

- About 40% of all described insect species are beetles and new species are discovered frequently.
- They are found in all major habitats, except marine and polar regions.
- Coleoptera are found in nearly all natural habitats, that is vegetative foliage, from trees and their bark to flowers, leaves and underground near roots, even inside plants like galls, tissues, including dead or decaying ones.



European rhinoceros beetle
(*Oryctes nasicornis*)



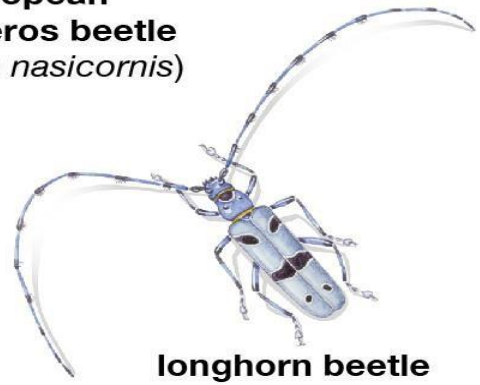
clover seed weevil
(*Apion apricans*)



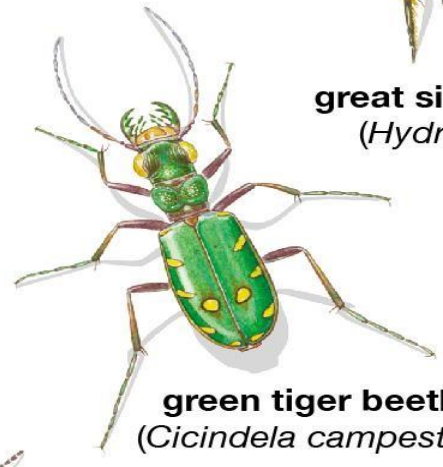
great silver water beetle
(*Hydrophilus piceus*)
male



violet ground beetle
(*Carabus violaceus*)



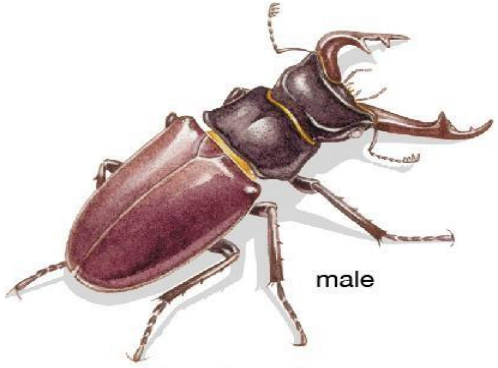
longhorn beetle
(*Rosalia alpina*)



green tiger beetle
(*Cicindela campestris*)

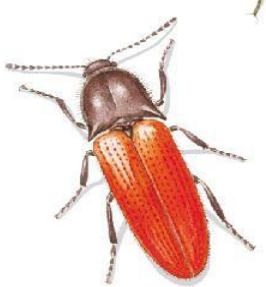


seven-spotted ladybug
(*Coccinella septempunctata*)



male

stag beetle
(*Lucanus cervus*)



click beetle
(*Ampedus sanguineus*)



deathwatch beetle
(*Xestobium rufovillosum*)



glowworm
(*Lampyris noctiluca*)

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DISTINGUISHIN CHARACTERS OF COLEOPTERA

- The main distinguishing characteristic of the order coleoptera is the **hardened forewings**, **six legs,** and **antennae.**
- **Sheath** refers to the elytra which forms a protective covering over the membranous hindwings and the relatively soft dorsal abdominal wall. The mouth parts are adapted for chewing and biting.
- All beetles have complete metamorphosis.
- In addition to providing food for amphibians, reptiles, fishes and mammals, a role which they share with

other insects, beetles play other important roles in the environment.

Eg: dung beetles feed on and reproduce in the dung of herbivores, thereby removing millions of tons of dung that would accumulate and destroy valuables pastureland and natural areas.

DISTRIBUTION

- The coleopteron’s are found in nearly all climate and latitude, except in extreme environments as those in Antarctica and at the highest altitudes.
- They are found on sub antarctic islands, close to the nothern extremes in the Arctic and on many mountain tops.
- Although many species occur in temperate environments, the number of species is greatest in the tropics.

- Individuals of a species are most abundant in temperate areas and fewer individuals of more species are found in tropics.
- Some species are solitary, others occur in aggregation.
- Predators such as the ground beetles are more apt to be found alone.
- Lady bugs, leaf beetles, pleasing fungus beetles, bess beetles, some species of scarab beetles are often found in aggregations of one or several different species.

POLYPHAGA

- The four living sub-orders of coleoptera diverged from one another in the permian and early triassic and are substantially different from one another.
- Adults differ in the structure of the prothorax, hind wing, abdomen, ovary, testis and so on.
- The major differences are summarised as follows;
- Polyphaga is the largest and most diverse suborder of beetles.
- It comprises 144 families in 16 superfamilies and displays an enormous variety of specialization and adaptation, with over 3,50,000 described species, or

approximately 90% of the beetle species so far discovered.

- The name polyphaga is derived from two greek words: poly meaning ‘many’ and phagein, meaning ‘to eat’, so the suborder is called the ‘*eaters of many things’*.
- The five infraorders of polyphaga are as follows;
    - Bostrichiformia- including furniture beetles and skin beetles.

- Cucujiformia - includes lady beetles, longhorn beetles, weevils, checkered beetles and leaf beetles.
- Elateriformia – includes click beetles and fireflies.
- Scarabaeiformia – includes scarab beetles, stag beeles and dung beetles.
- Staphyliniformia- includes rove beetles and water scavenger beetles.

- The superfamilies under polyphaga includes the following;
    - Hydrophiloidae.
    - Staphylinoidae.
    - Scarabaeoidea
    - Buperstoidea.
    - Byrrhoidea.
    - Elateroidea.
    - Bostrichoidea.









Classification of Coleoptera

- Four suborders
  - Adephaga
  - Archostamata
  - Myxophaga
  - Polyphaga



Adephaga



Archostemata



Myxophaga



Polyphaga

ADEPHAGA

- The adephaga are suborders with more than 40,000 recorded species in 10 families, of highly specialized beetles and the second largest suborder of the coleoptera.
- Members of this suborder are adephagans, a term which notably include ground beetles, tiger beetles, predacious diving beetles and whirligig beetles.

FAMILIES UNDER ADEPHAGA

- The majority of the species belongs to the family carabidae.
- The following are the families that comes under the suborder Adephaga. They are
  - Amphizoidae, Aspidytae, Carabidae, Dytiscidae, Gyrinidae, Haliplidae, Hygrobiidae, Meruidae, Noteridae, Rhysodidae, Trachypachidae, Colymbothetidae, Coptoclavidae, Liadytidae, Parahygrobiidae, Triaplidae.

WATER BEETLE



MYXOPHAGA

- Myxophaga is the second smallest suborder of the coleoptera after archostemata, consisting of roughly 65 species of small to minute beetles in four families.
- The members of this suborder are aquatic and semi aquatic and feed on algae.
- It consists of the following families;
  - Hydroscaphidae.
    - Lepiceridae.
    - Sphaeriusidae.
    - Torridincolidae.

HYDROSCHAPHIDAE



ARCHOSTEMATA

- The archostemata are the smallest suborder of beetles, consisting 45 living species in five families.
- They are an ancient lineage with a number of primitive characteristics.
- They are similar in morphology to the first beetles, which appear in the fossil record about 250 million years ago.

- Antennae may be thread shaped or like string of beads.
- This suborder also contains the only beetles where both sexes are paedogenic.
- It consists of five families which are as follows;
    - Crowsoniellidae.
    - Cupedidae.
    - Jurodidae.

- Micromalthidae.
- Ommatidae.

CUPEDIDAE



ECONOMIC IMPORTANCE

- Many species are pests of crops, stored products, garments, wool, fur, museum specimens.
- Useful as bio control agents.
- Many are useful in pollination. Eg: oil palm weevil
- useful as scavengers- dung beetles are imported to Austraila.

ORDER : LEPIDOPTERA

SCIENTIFIC CLASSIFICATION

DOMAIN:	EUKARYOTA
KINGDOM:	ANIMALIA
PHYLUM:	ARTHROPODA
CLASS:	INSECTA
ORDER:	LEPIDOPTERA LINNAEUS, 1758

LEPIDOPTERA



- **The term lepidoptera was firstly introduced by Linnaeus in 1758.**
- **Greek meaning "Lepido" = " Scales " and ptera"= "Wings".**
- **It is the second largest order in the class insecta.**
- **Order lepidoptera includes butterflies, moths and skippers.**
- **About 180000 species of this order**

described in 126 families and 46 super-familes.



- 6-11% butterflies.
- 90% moths.
- 3500 species of skippers.
- 10% of the total described species of living organisms.
- Most widespread





SALIENT FEATURES

and broadly recognized order in the world.

- **Bright coloured.**
- **Body divided into 3 sections - Head, Thorax & abdomen.**
- **Siphoning type mouth parts.**
- **Large compond eyes. One ocelli with simple lens, present above each eye.**
- **Knob (or) club like antennae.**

- **Scales are modified , hairy and give butterflies and moths variety of colors and patterns.**
- **Adults have four membranous, transparent and brightly coloured wings.**
- **Hindwings are usually smaller than forewings both largely (or) entirely covered with scales.**
- **Complete metamorphosis.**

- **Holometabolous insects (butterflies and moths)**
- **Proboscis is usually in the form of a coiled tube.**
- **4 sub-orders ,**
- **1. Zeugloptera 2. Aglossata**
- **3. Heterobathmiina**
- **4. Glossata**
- **1. Lycaenidae (blues, coppers & hairstreaks)**

FAMILIES

- **2. Nymphalidae(brushfoted butterflies)**
- **3. Pieridae (whites & sulfurs)**
- **4. Papilionidae(Swallowtails)**
- **Small butterflies with fluted hind wings.**

1.LYCAENIDAE

- **Some species are extrinct (or) nearing extinction, others are very**





common.



- **• Front legs reduced in size.**

2.NYMPHAIDAE

- • This is the largest butterfly family.
- • It include the fritillaries, Admirals, emperors and tortoiseshells.



- • Adults are predominantly white (or) yellow with black markings.
- • The imported cabbageworm is a pest throughout the world.
- • Hind wings have a tail -like extension.
- • The tiger swallow tail (papilio glaucus) is a cosmopolitan species.

- **Survival strategies of butterflies and their earlier stages include camouflage.**
- **• A female may lay only a few eggs (or) tens of thousands.**

- **• After the caterpillars hatch, they usually develop through 4 to 7 instars over a period of a few weeks.**
- **• When the caterpillar is ready to pupate , they generally find shelter to spin their cocoons.**



- **• Butterflies have clubbed antennas and the habit of holding their wings vertically when at rest.**
- **• Moths sit with their wings flat.**

ORDER: HYMENOPTERA

Classification of hymenoptera

Kingdom:Animalia

Phylum: Arthropoda

Class: Insecta

Super order: Hymenopterida

Order: hymenoptera

Salient features of Hymenoptera

- Holometabolous- small inscets- transparent, membranous large forewings and small hind wings.
- Mouthparts- biting, lapping or sucking. Abdominal first segment fused with metathorax and second one may or may not
  modify into petiole- ovipositor adapted for sawing
- Metamorphosis- completed- egg, larva, pupa and adult
- Sex- determined by whether or not an egg fertilized- fertilized egg- females,unfertilized egg- males
- Large order of insects- more than 115,000 species- ants, bees, ichneumons, chalcids, sawflies, wasps and lesser known types
- Large number- undiscovered- severe parasitic mode of life
- Free-living, phytophagous, predatory, entomophagousparasitic or social insectsbees and ants

- Trophallaxis

  Mutual exchange of food between adults and larvae- ants and wasps
- Hyperparasitism one parasitic species attracted another parasitic species
- Polyembryony

  Develpoment of many individuals from a single egg

  Unusual phenomenon occurringchalcididae, proctotrupidae

Habitat

- Most ant species live in the soil- carpenter ants- live in wood(not eat wood)- live in cavities made inside plants- acrons, twigs, galls
- Some species- observed drinking at the edges of water or gathering mud- construct nests
- Honey bees-thrive in natural or domesticated environments- live in gardens, woodlands, orchards, meadows.
- Natural habitat,honey bees build nests inside tree cavities & under edges of objects- hide from predators.

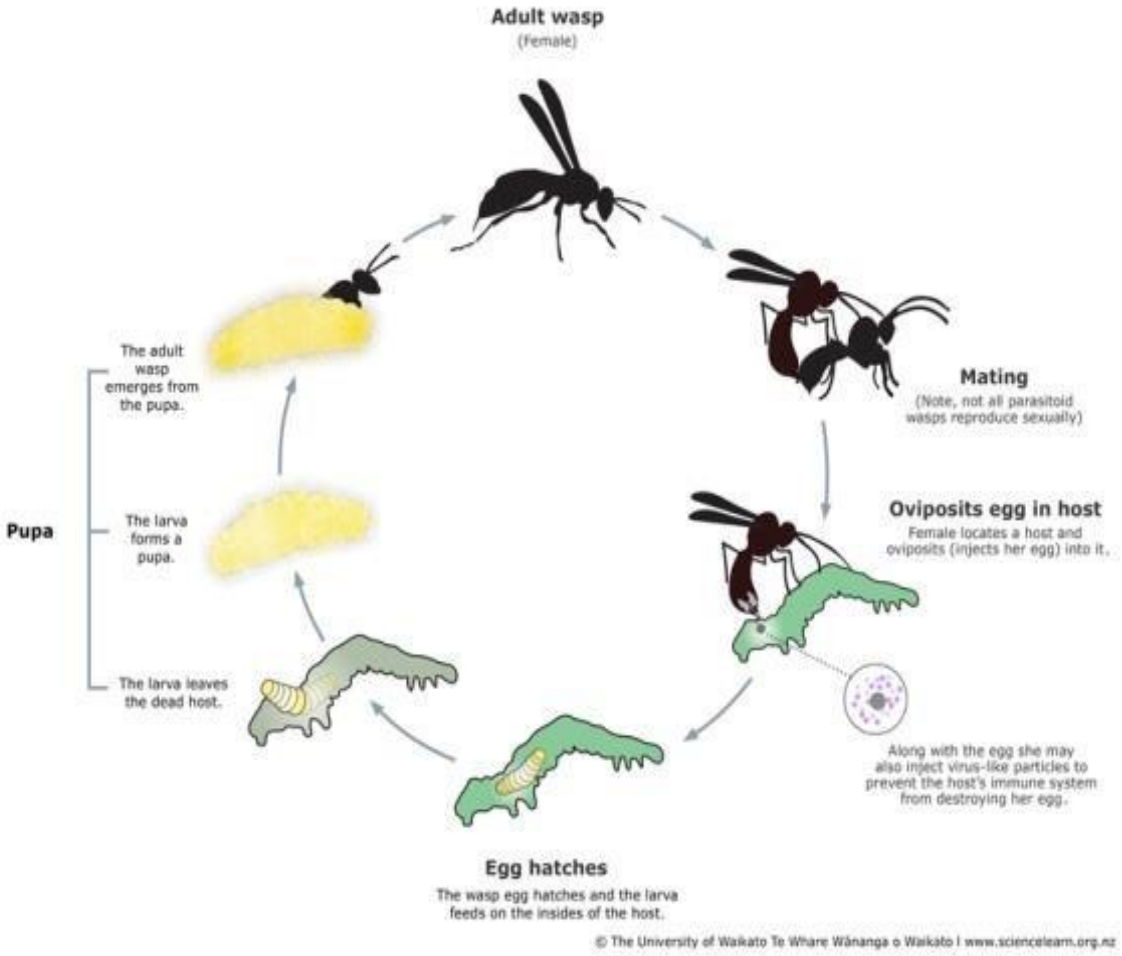
Lifecycle

Complete metamorphosis- egg, larva, pupa, adult

Female wasps- deposit eggs- larvae or pupae of host cells- wasps larvae hatch from these eggs- feed body fat & fluids of host until fully grown

Larvae spin silken cocoons, within which pupate feed- adult parasite emerge

Life cycle of wasps



Parthenogenesis of hymenoptera

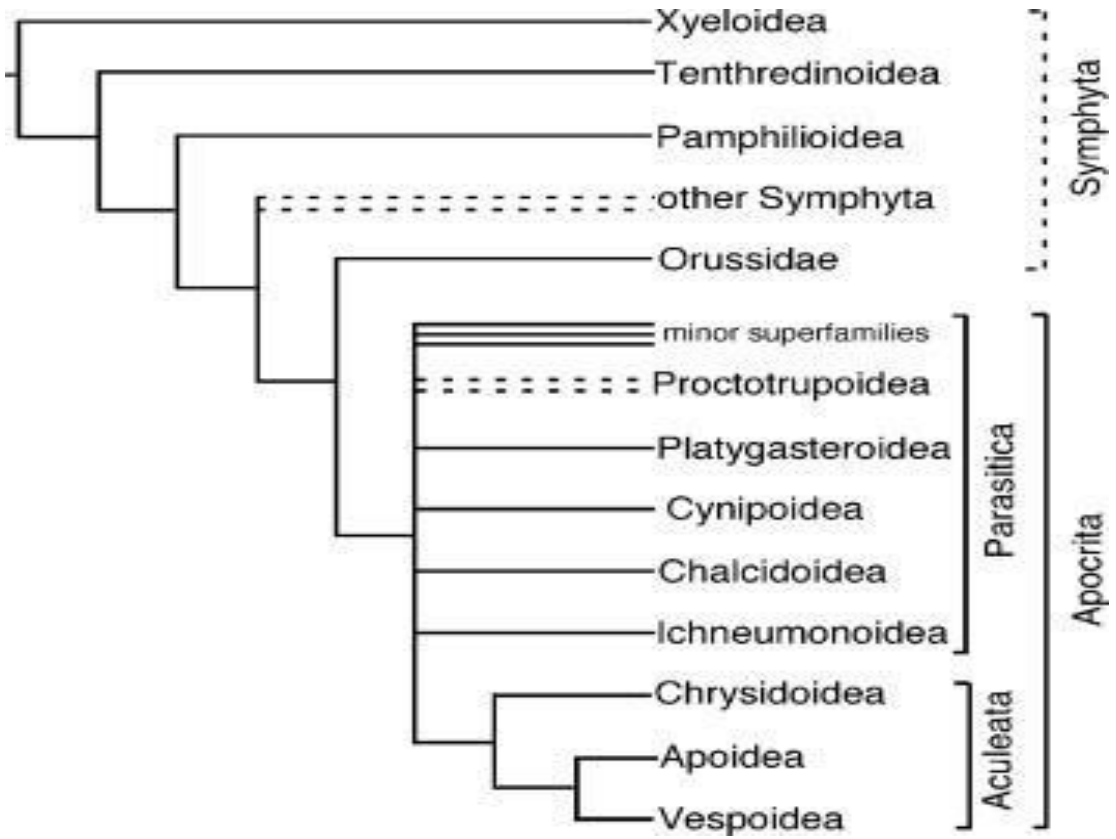
- Asexual reproduction- growth & development of embryos- without fertilization by sperm(unfertilized egg)
- Hymenoptera occurs- alternation generation
- In chalcids-

1st generation-male & female-producesfemales

2nd generation- female-lay unfertilized egg-produces-male & female

Synopsis of classification of hymenoptera

- 2 suborders, 4 divisions, 21 superfamilies, 72 families
-



Family - Apidea

- Largest family-containing 5700 species of bees
- Bumble-bee,honey bee, stingless bees, carpenter bees, orchid bees, cuckoo bees
- Many are valuable pollinators- natural habitats and agricultural crops
- Have modified mouthparts in the form of a tongue- sip nectar- have hairy legs, pollen baskets

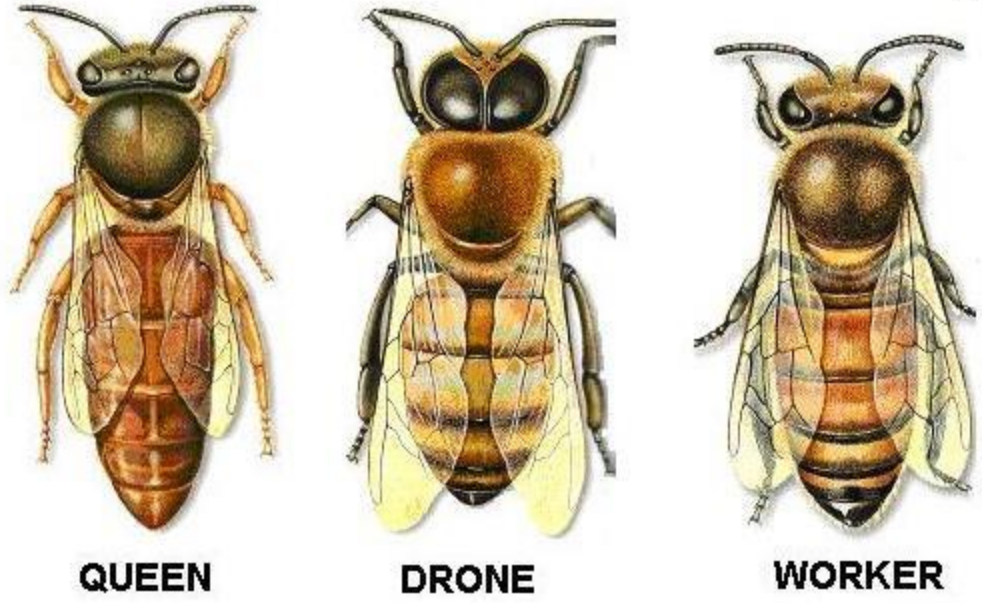
Honey bees

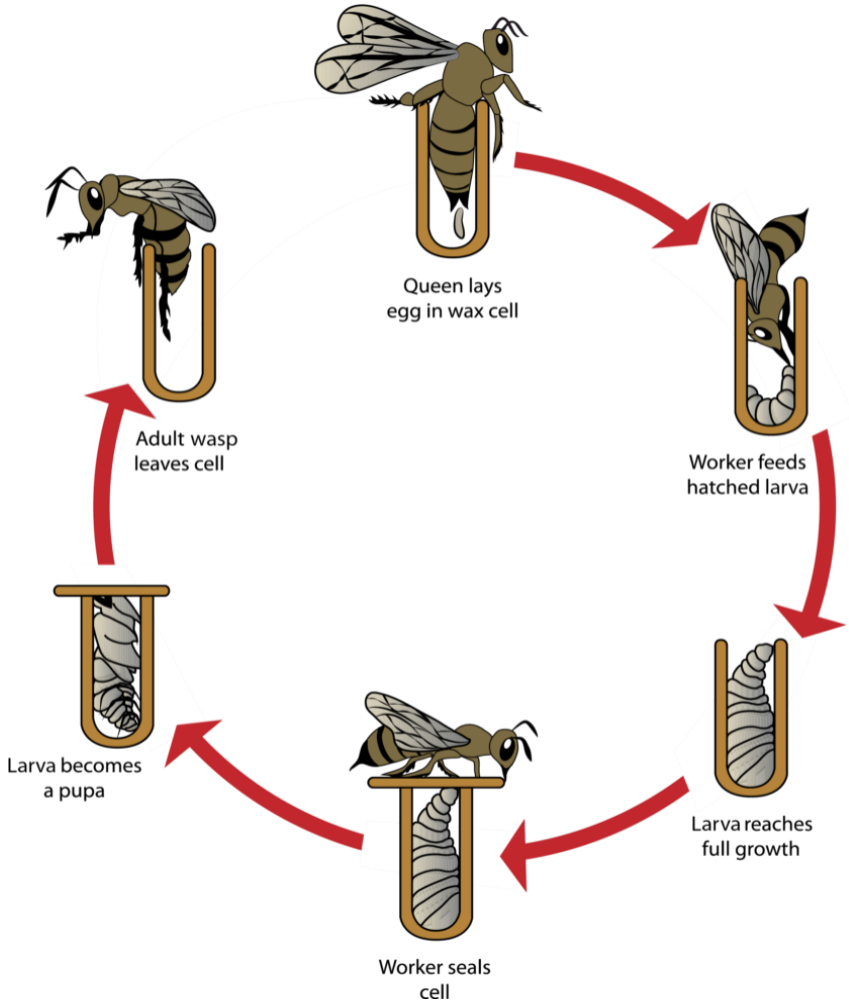
- Social insects & construct hives- consist three type of individuals

  Queen – laying eggs

  Workers – Sterile female- build the nest & tend to the larva

  Drones - Fertile males- mate with new queens


QUEEN
DRONE
WORKER


Queen lays egg in wax cell
Worker feeds hatched larva
Larva reaches full growth
Worker seals cell
Larva becomes a pupa
Adult wasp leaves cell

Bumble bees

- Large fuzzy insects- short, stubby wings
- Larger then honey bees- don't produce much honey
- Important pollinators



Stingless bees

- Stingless honey bees or simply meliponines

- Meliponines have stingers- highly reducedcannot be used for defensive behaviors & mechanisms
- Not only stingless bees- all male & many female-Andrenidae- cannot sting- some stingless bees have painful & powerful bites



Family - Cynipoidea

- Gall wasps(gall flies)- have distinctive body shape- called wasp waist
- Parasitoids- long, hardened egg laying tube (ovipositor)- bore into the gall- lay an egg helpless gall marker-Parasitoids may turn preyed- other wasps.

Family - Cephoidea

- Small super family within the symphyta - 105 species in a single family

Sawflies

- Related to wasps & bees- attack trees and shrubs
- Larvae emerge- early spring and damage plants- eating leaves

- Adults emerge – spring or early summerdamage affects – appearance of trees or shrubs- not affect plant health
- Adult – small, stout-bodied, non stinging wasps like other insects
- Saw like egg laying structure of adult females



Thank you