

# Introduction to Insect

- **What is Entomology**

- Study of insects
- All relationships dealing with insects
- Sometimes includes other arthropods – ticks and mites

- **Entomologist**

- Person who studies insects or related organisms
- Studies relationships
- Studies for criminology
- Studies as a hobby
- Studies for pest control

# Introduction to Insects

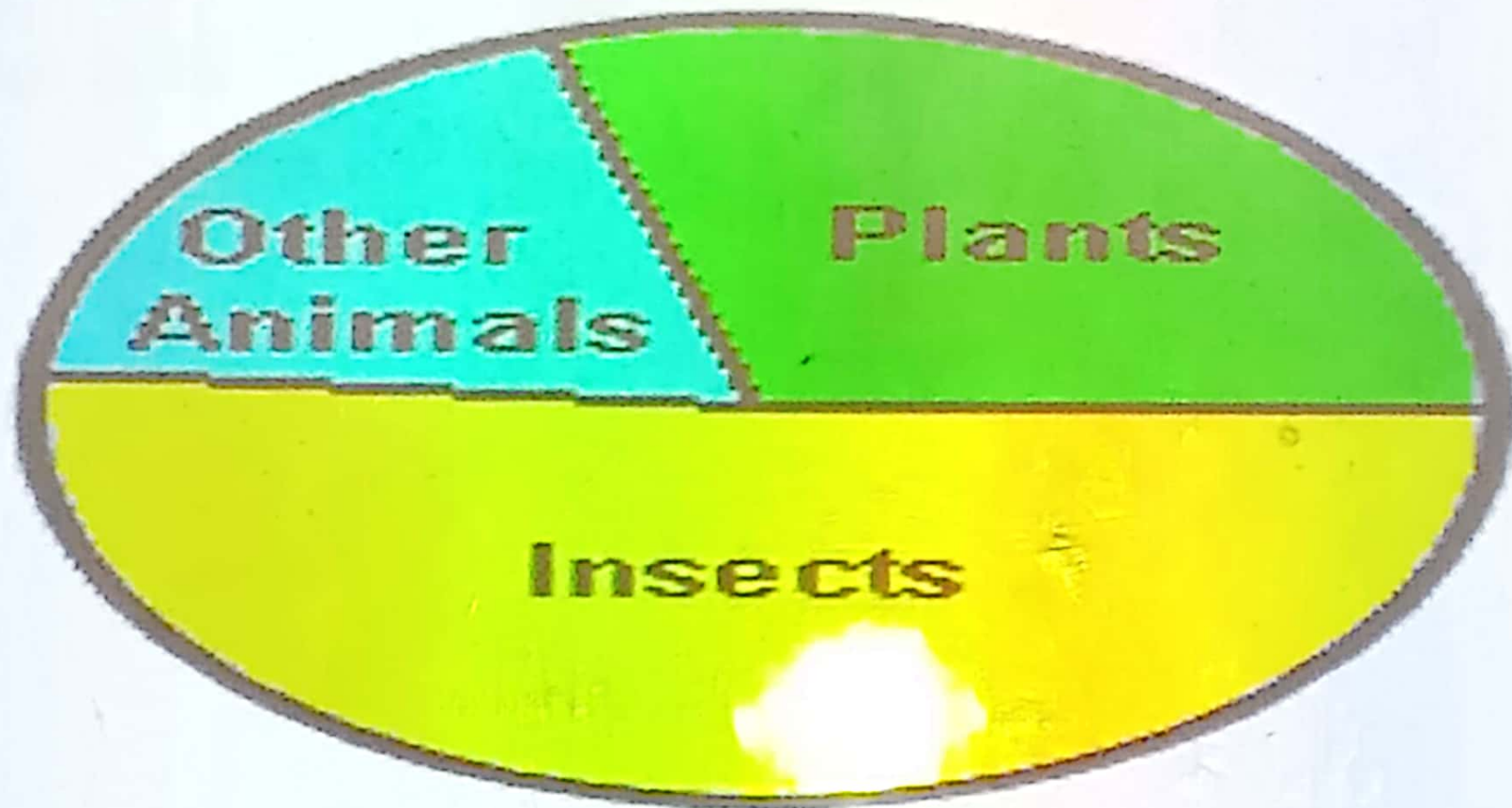
- **What are Insects?**
  - Are **Arthropods**
  - Arthropoda means “jointed feet”
- **General Characteristics of insects**
  - Have segmented bodies
  - Paired, segmented appendages
  - Bilateral symmetry
  - Exoskeleton
  - Dorsal heart and open circulatory system
  - Ventral nerve cord

# Introduction to Insects

- **Why Study Insects?**
  - Most numerous creatures on Earth
  - More than 1 million species of insects
  - Represent greater than  $\frac{3}{4}$  species in Animal Kingdom
  - 1 human being/200 million insects
  - 40 million insects/acre of land
  - Less than 3% are significant pests

# Introduction to Insects

Insect make up 53% of organisms on earth



# Introduction to Insects

- **Why Study Insects?**

- Because they dominate all terrestrial environments that support human life, insects are usually our most important competitors for food, fiber, and other natural resources.
- Insects play important ecological roles that support our human and animal life
- Insect also transmit disease causing pathogens to crops, animals and humans

# Introduction to Insects

- **Why Study Insects?**

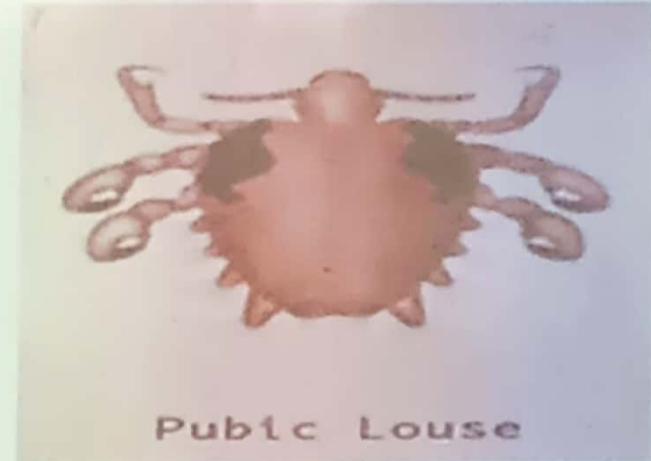
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# Introduction to Insects

- **Impact of insects**
- Have a direct impact on agricultural food production by chewing the leaves of crop plants, sucking out plant juices, boring within the roots, stems or leaves, and spreading plant pathogens.
- Feed on natural fibers, destroy wooden building materials, ruin stored grain, and accelerate the process of decay.

# Introduction to Insects

- **Impact of insects**
- They also have a profound impact on the health of humans and domestic animals by:
  - causing annoyance,
  - inflicting bites and stings, and
  - transmitting diseases such Malaria etc



# Introduction to Insects

- **Impact of insects**
- The **economic impact** of insects is measured not only by the market value of products they destroy and the cost of damage they inflict but also by the money and resources expended on prevention and control of pest outbreaks.

# Introduction to Insects

- **Benefits from insects**
- But despite the tremendous economic losses they may cause, it is not entirely fair to cast the members of **Class Insecta** as villains who rob us of our food and livelihoods.
- They are also cherished allies on whom we depend to keep the natural environment clean and productive.

# Introduction to Insects

- **Benefits from insects**
- Insects supply unique natural products,
- They regulate the population densities of many potential pest species,
- They dispose of our wastes, bury the dead, and recycle organic nutrients.
- Indeed, we seldom stop to consider what life would be like without insects and how much we depend on them for our very survival.

# Introduction to Insects

- **Food Source**
- Insects represent an important **food source** for a wide variety of other animal species.
- Freshwater fish such as trout, bass, and bream feed extensively on aquatic insects like mayflies, stoneflies etc.
- Artificial "flies" used by anglers are often made to resemble a fish's natural prey.
- Many toads, frogs, turtles, snakes, chameleons and lizards also consume insects as a major part of their diet.

# Introduction to Insects

- **Food Source**
- Insectivory is common among land-dwelling birds. Purple martins, barn swallows, vireos, warblers, flickers, whippoorwills, and swifts, for example, survive almost exclusively on insects.
- There are also some insectivorous mammals: shrews, moles, bats, armadillos, and anteaters, for example that depend on insects.

# Introduction to Insects

- **Food Source**
- Insects were undoubtedly an important **source of nutrition** for humans also.
- Insects are high in protein and low in fat,
- e.g. Caterpillars, grasshoppers, Katydid, Termites, cicadas, crickets etc

# Introduction to Insects

- **Decomposers**
- Insects as **consumers, scavengers, and decomposers**, play a vital role in the biogeochemical cycling of nutrients.
- Insects help aerate the soil, improve its retention of rainwater, and enhance its tilth.
- They turn more soil than earthworms and redistribute nutrients within the root zone as they burrow and nest in the ground.

# Introduction to Insects

- **Decomposers**
- Within the ranks of **scavengers**, and **decomposers**, they are several major groups:
  - those that feed on dead or dying plant tissues
  - those that feed on dead animals (carrion), and
  - those that feed on the excrement (feces) of other animals.

# Introduction to Insects

- **Parasitoids and Predators**
- **As parasitoids and predators** of other organisms, insects are part of a natural system of checks and balances that strengthens community stability and prevents explosive population growth from overrunning natural resources.
- So far, over 6000 insect species have been tested and released as biological control agents to fight insects and weeds that we regard as pests.
- But there are also countless other species that work for us as population regulators, often unnoticed until they are accidentally destroyed by a natural disaster or human intervention.

# Introduction to Arthropods

## B. Arthropods

– Five Classes

### 1. Class Crustacea

- a. Shrimp, crabs, lobsters, pillbugs
- b. Mostly Aquatic
- c. Fill marine niches where insects are not found
- d. Most breathe with gills and have hard outer shell.
- e. Body has two regions - cephalothorax and abdomen
- f. 2 pair of antennae, legs for swimming
- g. Beneficial - exceptions pillbugs, sowbugs and barnacles.

# Introduction to Arthropods

## 2. Class Diplopoda

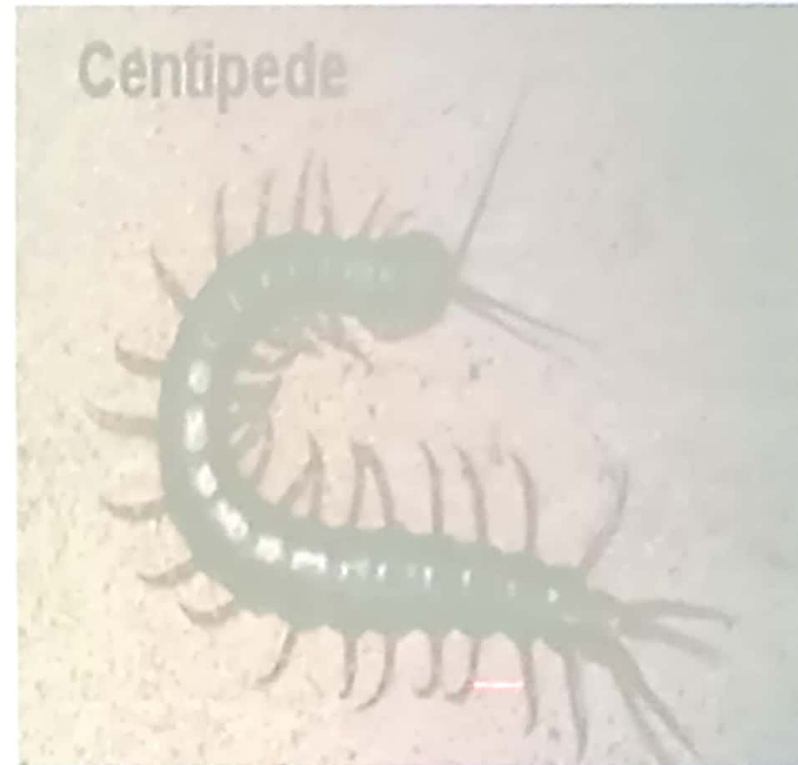
- a. Millipedes
- b. Cylindrical with 25 to 100 segments
- c. Most segment have 2 pairs of legs
- d. Beneficial - eat decaying matter



# Introduction to Arthropods

## 3. Class Chilopoda

- a. Centipedes
- b. Flattened body with many segments
- c. 1 pair of legs per segment
- d. Beneficial - eat invertebrates
- e. Some can inflict painful bite and inject venom



# Introduction to Arthropods

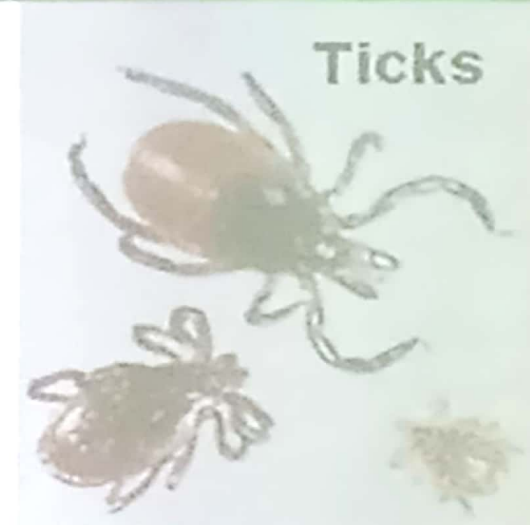
## 4. Class Arachnida

a. Major - Spiders, Mites, Ticks, Scorpions

b. Most diverse next to insects

c. 2 body regions - cephalothorax and abdomen

d. No antennae



# Introduction to Arthropods

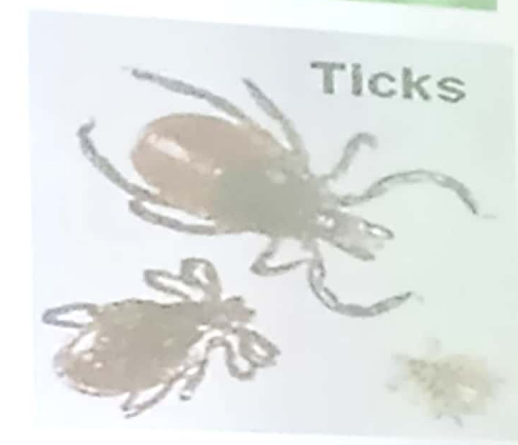
## Spiders - Order Araneae

1. Unsegmented abdomen connected to cephalothorax by a thin stalk or pedicel
2. Eight legs
3. Mouthparts for crushing prey and sucking out juices
4. Silk spinning organs
5. Beneficial
6. Some poisonous

# Introduction to Arthropods

## Mites and Ticks - Order Acari

1. Pests of man, animals and plants
2. Unsegmented abdomen to broadly joined cephalothorax
3. Piercing sucking mouthparts
4. Mites
  - a. feed on plants, animals and organic debris
  - b. Scabies, plant pests
5. Ticks
  - a. Feed on animals
  - b. Transmit disease



# Introduction to Arthropods

## 5. Class Insecta or Hexapoda

### General characteristics of insects:

- The body is comprised of 3 distinct body regions -- head, thorax, and abdomen
- The thorax of adults bears 3 pairs of legs and 2 pairs of wings



# Reasons for Insect Success

1. Exoskeleton
2. Ability to fly
3. Small in size ←
4. High reproductive potential
5. Adaptability
6. Complete metamorphosis  
(Holometabolous) ←  
Hemimetabolous - incomplete

# Reasons for Success

- In brief, these attributes include:
  - an exoskeleton,
  - small body size,
  - ability to fly,
  - high reproductive potential,
  - complete metamorphosis, and
  - adaptability in an ever-changing environment.

# Reasons for Success

## Exoskeleton

- Unlike vertebrates, an insect's supporting skeleton is located on the outside of its body.

This exoskeleton is a marvelous structure that:

- gives shape and support to the body's soft tissues,
- provides protection from attack or injury,
- minimizes the loss of body fluids in both arid and freshwater environments,
- assures mechanical advantage to muscles for strength and agility in movement.

# Reasons for Success Exoskeleton

- The exoskeleton is a "suit of armour", that resist both physical and chemical attack.
- It is covered by an impervious layer of wax that prevents desiccation.

# Reasons for Success

## Small size

- In general, the insects are marvels of miniaturization.
- Most species are between 2 and 20 mm (0.1 - 1.0 inch) in length, although they range in size from giant moths that would nearly cover your computer screen to tiny parasitic wasps
- *Dichomorpha echmepterygis* is the smallest of the small. Discovered in 1997, this Costa Rican wasp (family Mymaridae) is a parasite of other insects' eggs.
- Adult males may be only 0.139 mm (0.00055 inch) in length -- nearly 1/3 smaller than some single-celled protozoa (e.g., *Paramecium caudatum*).

# Reasons for Success

## Small size

- Another advantage of small size is the minimal resources needed for survival and reproduction.
- A crumb is a feast; a dewdrop quenches thirst; a pebble provides shade.
- In some cases, food requirements are so modest that an insect may live on a single plant or animal for its entire life and never exhaust its food supply.

# Reasons for Success

## Small size

- Finally, small size is a big advantage to insects that must avoid predation.
- They can hide in the cracks of a rock, beneath the bark of a tree, behind the petal of a flower, or under a blade of grass.
- The exoskeleton is hard enough for them to burrow between individual grains of sand, yet flexible enough to let them squeeze through the tiniest of cracks.
- Small size, together with adaptations in body shape and coloration, gives many species the ability to blend so well with their environment that they become virtually undetectable.

# Reasons for Success

## Ability to Fly

- The forces of natural selection have shaped insect flight into a remarkably efficient process employing principles of aerodynamics that human engineers do not yet fully understand.
- Although the metabolic cost of flight (calories per unit of lift) is similar to that of birds and bats, an insect's flight musculature produces at least 2X more power per unit of muscle mass.
- This high efficiency is largely due to elasticity of the thorax -- 90-95% of the potential energy absorbed by flexion of the exoskeleton is released as kinetic energy during the wing's down stroke.

# Reasons for Success

## Ability to Fly

- Insects are the only invertebrates that can fly.
- Flight give insects a highly effective mode of escape from predators.
- It is also an efficient means of transportation, allowing populations to expand more quickly into new habitats and exploit new resources.



# Reasons for Success

## Ability to Fly

- Efficient use of energy allows some insects to travel great distances or remain airborne for long periods of time.
- More than 200 species, including moths, dragonflies, locusts, flies, and beetles are known to migrate over long distances by air.
- The migratory locust, *Schistocerca gregaria*, can fly for up to 9 hours without stopping.
- Large swarms occasionally traverse the Mediterranean Sea.

# Reasons for Success

## High Reproductive Potential

- Reproductive success is one of the most significant measures of an organism's fitness. In insect populations, females often produce large numbers of eggs (high **fecundity**), most of the eggs hatch (high **fertility**), and the life cycle is relatively short (often as little as 2-4 weeks). Together, these three characteristics enable insects to produce remarkably large numbers of offspring.

# Reasons for Success

## High Reproductive Potential

- A typical female lays 100-500 eggs in her lifetime, but numbers in the thousands are not uncommon.
- The queen of an African termite colony may be the mother of more than ten million workers during her 20-25 year lifespan.
- Blow flies reared on a diet of owl meat produced an average of 144 progeny: half male, half female.
- Using this data (and assuming no mortality), a single pair of flies could give rise to 10,368 offspring in the third generation, 746,496 in the fourth generation, 53,747,712 in the fifth generation, and 3,869,835,264 in the sixth generation.

# Reasons for Success

## High Reproductive Potential

- Since most insects die before they ever have an opportunity to reproduce, a high reproductive potential is the species' best chance for survival.
- Many adaptations help maximize this potential.
- Most females, for example, can store sperm for months or years within the spermatheca, a special region of the reproductive system.
- A single mating can supply a female with enough sperm to fertilize all the eggs she will produce in her lifetime.

# Reasons for Success

## High Reproductive Potential

- An unbalanced sex ratio, where females outnumber males, is another way to maximize reproductive potential.
- Since most insects are not monogamous, a few males can supply sperm for a large number of females.
- And finally, there are many species (e.g. aphids, scale insects, thrips, and midges) where males are entirely absent -- all members of the population are female and contribute offspring through a process of asexual reproduction - **parthenogenesis**

# Reasons for Success

## Complete Metamorphosis

- Most insects undergo significant developmental changes as they grow from immatures to adults.
- These changes, collectively known as **metamorphosis**, may involve physical, biochemical, and/or behavioral alterations that promote survival, dispersal, and reproduction of the species.

# Reasons for Success

## Complete Metamorphosis

- In the more primitive insects, most of these changes occur gradually as the animal matures: organs of reproduction and flight develop incrementally during the immature stages and become functional only in adults.
- Since this transformation process is slow and does not include all body tissues (**incomplete metamorphosis**) the immatures and adults share many characteristics -- they often live in similar habitats and feed on similar types of food.

# Reasons for Success

## Complete Metamorphosis

- More advanced insects, however, undergo **complete metamorphosis** -- a dramatic transformation in form and function between the immature (larval) and adult stages of development.
- In these insects, a larva is primarily adapted for feeding and growth.
- It assimilates energy reserves which, in some cases, will sustain the insect for the rest of its life.
- When fully grown, a larva molts into a transitional stage, called the pupa, and begins a period of massive internal and external reorganization.
- An adult insect (imago) eventually emerges from within the pupal exoskeleton bearing little or no resemblance to its larval form.
- Its primary function is dispersal and reproduction.

# Reasons for Success

## Complete Metamorphosis

In the class Insecta, only 9 out of 28 orders undergo **complete metamorphosis**, yet these 9 orders represent about 86% of all insect species alive today.

The obvious advantage to this type of development lies in the compartmentalization of the life cycle.

Through natural selection, larval form and function can be optimized for growth and feeding without compromising adaptations of the adult for dispersal and reproduction.

Each stage of the life cycle is entirely free to adapt to its own ecological role.

In some cases, this means that immatures and adults may consume different types of food, exploit different environmental resources, and even occupy different habitats.

# Reasons for Success

## Adaptability

- A combination of large and diverse populations, high reproductive potential, and relatively short life cycles, has equipped most insects with the genetic resources to adapt quickly in the face of a changing environment.
- Their record of achievement is impressive:
  - they were among the first creatures to invade the arid expanses of dry land and exploit green plants as a source of food,
  - they were the first animals to use flight as an escape from predators, and
  - they were the first organisms to develop a complex social hierarchy with division of labor and cooperative care of the young.

# Reasons for Success

## Adaptability

- Adaptation is an ongoing process.
- Populations must continually change as new resources appear and old ones disappear.
- Insects have acquired a taste for new products that were not part of their "natural" environment: e.g., glue and wallpaper paste, book bindings, cardboard, tanned leather products, mummies, stuffed museum specimens, chocolate, ginger, yeast cakes, tobacco, pepper, and even potent drugs like marijuana and opium.

# Reasons for Success

## Adaptability

- But a few resistant flies managed to survive because they were endowed with an enzyme that could detoxify DDT.
- These survivors reproduced and passed this resistant trait to their offspring.
- Eventually, DDT-resistant flies repopulated their environment and the species now appears to be living happily ever after!

# Introduction to Insect Classification

Phylum: Arthropoda

Class: Hexapoda/Insecta

Order: 28 eg. Diptera

Family: Muscidae

Genus: Musca

Species: domestica

# Insect Classification

- Insects are used in:
  - diversity studies,
  - ecological projects,
  - biological control projects, and
  - monitoring of environmental change,
- It is therefore important to identify and understand the biology of the insects you are dealing with.
- If the identifications are not accurate, then any science that relies upon those determinations will be flawed.

# Insect Classification

- **Taxonomy:** the study of the principles of scientific classification.
- Insect Taxonomists have come with a system of classifying insects

# Insect Classification

- Ways of identifying insects:
  - Sending it to an expert to identify it
  - Comparing it with labeled specimen in collection
  - Comparing it with pictures
  - Comparing it with descriptions
  - Using an analytical key or dichotomous key (step wise eliminations) and
  - Combination of above

# Insect Classification

- **Elements of Classification**
- The procedure of modern Systematists { "the science of the diversity of organisms} was began in 1758 by Swedish botanist –**Carolus Linneaus**
- He is considered father of modern Taxonomy
- He proposed the system of **binomial nomenclature**
- Every organism can be assigned a specific name using a two name system
- Binomial name made up of **genus** and **species** name.

# Insect Classification

- **Elements of Classification**
- Scientific names (**genus, species and subspecies**) are italicized or underlined with the genus (first) name capitalized.
- Names of the authors of species follow.
- These names are in parentheses if the classification of the species has changed since it was described.

# Scientific names

- The scientific naming of animals follows certain rules, which are outlined in the **International Code of Zoological Nomenclature**.
- One of the first and important rules requires that scientific names be always printed in **italics**. If written or typewritten, italics are indicated by underlining. Scientific names are latinized, but may be derived from any language or from the names of people or places or colour descriptions. Most scientific names are from Latin or Greek words and usually refer to some characteristic of the animal or group named.

# Scientific names cont.

- One important rule in scientific names is that the **genus**, **species** and **subspecies** names should be written in **italics** or **underlined** to show their origin as latin words. These names are then followed by the name of the author, the person who first determines an organism to be a species or subspecies. Authors' names should not be in italics.
- For example, the name *Musca domestica* Linnaeus for the house fly shows Linnaeus to have been the person that described this particular insect. The names of authors are often abbreviated, for example, the name Linnaeus is often abbreviated just L.

# Scientific names cont.

- Continuing with the rules of scientific nomenclature, the names of genera (genus) and higher categories always begin with a **capital** letter. Species and subspecies names do not start with a capital letter.
- If the author's name is in parentheses, it means that he described the species or subspecies in some genus other than the one in which it is now placed. For example, in the name *Prostephanus truncatus* (Horn), it means that the species *truncatus* was described by Horn in some genus other than *Prostephanus*.

# Scientific names cont.

- A species referred to but not named is often designated simply by **sp.** For example, *Oothecca* sp refers to a species of *Oothecca*. More than one species may be designated by **spp.** For example, *Oothecca* spp. Refers to two or more species of *Oothecca*.

# Scientific names cont.

- If there are two similar names of an individual the first one is considered correct while the second one is designated as the **synonym**. No two genera of individuals may have the same name. No two species in the same genus may have the same name.
- When listing several species from the same genus it is usual to give genus name in full only once and thereafter use just the first letter, i.e., *Ophiomyia phaseoli*, *O. spencerella*, *O. centrosematis*.

# Insect Classification

- **Elements of Classification**
- An insect name is complete if the **genus, species** and **author names** are given.
- The author is the person who first described the species as new to science.
- **Law of Priority.** -- This states that the first name given to a species is preferred if it is later described under another name.
- The later name for the same species is then called a **synonym**.

# Insect Classification

- **Elements of Classification**
- **Common Name System.**
- This is used as a substitute for the names of orders and families, e.g. beetles, locusts, grasshoppers, crickets, leafhoppers, etc.
- It applies to a segment of an order.
- However, scientific names are more valuable in international discourse.

# Common names

- Many common names of insects refer to groups such as subfamilies, families, suborders, or orders rather than to individual species.
- Most common names of insects that consist of a single word refer to the entire order e.g., the common name beetle refers to the order Coleoptera; fly refers to Diptera; and bug to Hemiptera, with only a few that refer to families, like ants to Formicidae and Mantids to Mantidae.

# Common names cont.

- The names **fly\_** and **bug** are used for insects in more than one order, and the way the names of these insects are written may indicate the order to which the insect belongs.
- For example, when a fly belongs to the order Diptera, the **fly** part of the name is written as a separate word, as in **black fly, house fly, horse fly, and tsetse fly**. When the insect belongs to another order, the **fly** part of the name is written together with the descriptive word, as in **butterfly, dragonfly, sawfly, and damselfly**.

## Common names cont.

- When a bug belongs to the order Hemiptera, sub-order Heteroptera) the **bug** of the name is written as a separate word, as in **stink bug**, **Assassin bug** and **damsel bug**. When it belongs to another order, the **bug** part of the name is written together with the descriptive word, as in **mealybug** and **junebug**.

# Insect Classification

- Classification- Ordering into a hierarchy of categories
- The **Taxonomic Hierarchy**- start with most inclusive to the least
  - Kingdom:
  - Phylum:
  - Class:
  - Order:
  - Family :
  - Genus :
  - Species :
- Each can be sub-grouped- i.e. Super or Sub

# Insect Classification

- These groups often use a prefix of super- (above) or sub- (below) to indicate the position of the new group in the above list.
- Thus, superfamily groups fall between order and family while subfamily groups fall between family and genus.