LECTURE NOTES

ON

PRINCIPLES OF ENTOMOLOGY

&

PRODUCTIVE ENTOMOLOGY

(DA – 131)

Dr. B. Dileep Kumar,
Ph.D (Entomology)

AGRICULTURAL POLYTECHNIC

Jammikunta, Karimnagar-505122

PROFESSOR JAYASHANKAR TELANGANA STATE AGRICULTURAL UNIVERSITY

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Detailed Lecture Outline

DA-131 (Principles of Entomology and Productive Entomology)

Theory:

1. Introduction of Entomology
2. Characters of class Insecta – Division of class Insecta into subclasses – pterygota, Apterygota, their characters, classifications and examples
3. Characters of Orthoptera
4. Orthoptera – Head, antenna, mouth parts, thorax, characters of wings, abdomen. Examples of agricultural importance.
5. Characters of Thysanoptera
6. Thysanoptera – Segmented antenna, compound eyes, asymmetrical mouth parts, wing characters, parthenogenetic type or reproduction.
7. Thysanoptera – example of agricultural importance.
8. Order Hemiptera Sub order Heteroptera characters
9. Heteroptera – 4 to 5 segmented antenna, well developed compound eyes, sucking type of mouth parts, large pronotum, wing characters.
10. Sub Order Homoptera Characters
11. Homoptera – Head, compound eyes well developed, 3 to 10 segmented antenna. Piercing and sucking type of mouth parts. Thoracic characters, wing characters.
12. Homoptera – insects sexual and parthenogenetic reproduction
13. Homoptera – Examples of agricultural importance.
14. Order Lepidoptera Characters
15. Lepidoptera – Mouth parts, head, compound eyes, characters of wings.
16. Lepidoptera – Differences between moths and butterflies
17. Lepidoptera – examples of agricultural importance.
18. Order Coleptera characters
19. Coleptera – antenna, bitting type of mouth parts, thoracic characters, wing characters
20. Coleptera - larval and pupa exarate
21. Coleptera - examples of agricultural importance
22. Order Hymenoptera characters
23. Hymenoptera – Head, well developed compound eyes, antenna, mouth parts, wing characters, trochanter 1 or 2 segmented, abdominal characters
24. Hymenoptera – larval and pupal characters
25. Hymenoptera - examples of agricultural importance
26. Order Diptera characters
27. Diptera – Head, eyes, antenna, mouth parts, thoracic characters, wings, halters tarsus 5 segmented
28. Diptera – larval and pupal characters
29. Diptera - examples of agricultural importance
30. External characters of cockroach

31. Cockroach – segmentation, body regions, head, throax, abdomen, head, mouth parts
32. Cockroach- thorax – prothorax, mesothorax and metathorax,
33. Cockroach- legs and wings. Abdomen-anal ceric and styles.
34. Kinds of insects mouth parts
35. Biting and chewing type, sucking type, Rasping and sucking type
36. sponging and sucking type.
37. Different Types of injuries caused by insects
38. Different types of injuries and damage symptoms caused by insects
39. Introduction to Integrated Pest Management
40. Importance, concepts and principles of IPM
41. Bio agents – parasitoids and predators
42. Chemical control – Importance of pesticides
43. Classification of insecticides
44. Different formulations of insecticides
45. Study of important group of insecticides and their examples
46. Botanical insecticides – cyclodienes, organo phosphates, carbamates, synthetic pyrethroids, novel insecticides nematicides, rodenticides, acaricides, antifeedants, attractants, sex pheromones
47. Compatibility of insecticides – insecticides mixtures, phytotoxicity

Practical:

1. Methods of collection and preservation of insects including immature stages
2. External features of a grass hoper / Cockroach
3. Study of characters Orthoptera, Thysanoptera, Hymenoptera, Homoptera
4. Identification of different insects in order Lepidoptera, Coleptera, Hymenoptera and Diptera
5. Study of important insecticide formulations and calculation of doses / concentrations of different insecticide formulations
6. Growing of mulberry – land preparation, preparation of planting material for irrigated and rainfed and planting
7. Maintaince of mulberry garden, cuttings of branches, fertilizers, irrigations and leaf cutting
8. Pests and diseases of mulberry
9. Silkworm rearing room – rearing equipment and apparatus, resistance and hygiene
10. Rearing of early and last stage larvae of silkworm
11. Pests of silkworm
12. Diseases of silkworm
13. Different types of honeybees and their enemies
14. Different types Honey combs and their equipment, collection of honey
15. Study of lac insects and biology
16. Pests and diseases of lac insects

Introduction of Arthopoda

Arthropoda is a largest phylum in animal kingdom. The word Arthopoda was taken from from Greek. *Arthropods are animals that lack a backbone*. Such animals are said to be **invertebrates**. The invertebratesincludes animals such as snails (molluscs), crabs (crustaceans) and, of course, insects.

The arthropod body is supported by an hard, outer layer. This acts as an external skeleton - or **exoskeleton**. The body muscles are attached to the inside of this exoskeleton. It is made up of rings (called segments) which are attached to one another by flexible membranes. This allows movement of the body to take place. The name arthropod refers to their jointed limbs, which are their chief characteristic. (Arthros = joint, Podium = foot).

Arthropods are characterized by their jointed limbs and cuticle made of chitin, often mineralised with calcium carbonate. The arthropod body plan consists of segments, each with a pair of appendages. The rigid cuticle inhibits growth, so arthropods replace it periodically by moulting. Arthropods are bilaterally symmetrical and their body possesses an external skeleton. Some species have wings.

General Character:

1. Cosmopolitan in distribution found in aquatic, terrestrial and aerial forms. *Some are ectoparasitic and vectors of disease.*
2. Body have jointed appendages or legs *(which are modified to different structures to perform different functions like jaws, gills, walking legs, paddle)*. There may be 3 pairs, 4 pairs, 5 pairs, many pairs.
3. Body is triploblastic.
4. Bilaterally symmetrical.
5. Organ system level of organization.
6. Body is divisible into head, thorax and abdomen.
7. This is the first group to develop a true head, which contains sense organs and feeding organs specialized for their particular habitats.
8. Body is covered with chitinous exoskeleton.
9. They are haemocoelomate. Coelom i.e. body cavity is filled with blood or fluid.
10. Head bears a pair of compound eyes and antenna.
11. Locomotion takes place by jointed appendages.
12. Digestive system is complete, straight and well developed. *The mouth bears mouth parts for ingestion of foods. Mouths are modified for chewing, biting, sponging, piercing, siphoning.*
13. Respiration takes place by general body surface or gills (in Crustaceans) or trachea (in insects, diplopoda and chilopoda) or booklungs (Arachnida) and book gills (in king cobra).
14. Circulatory system is of open type *i.e. do not have blood vessels and enters directly into the body chambers. The blood is colorless.*
15. Excretion takes place through Malphigian tubules (in terrestrial form) or green glands or coxal glands (in aquatic forms). Nervous system is of annelidian type, which consists of brain and ventral nerve cord.
16. Unisexual i.e. sexes are separate.

17. Fertilization is internal or external.
18. They are either oviparous or ovoviviparous.
19. Development may be direct or indirect.
20. Sensory organ include antennae, sensory hairs for touch and chemoreceptor, simple and compound eyes, auditory organs (in insects) and statocysts (in crustacean).

Clasification of Arthopoda

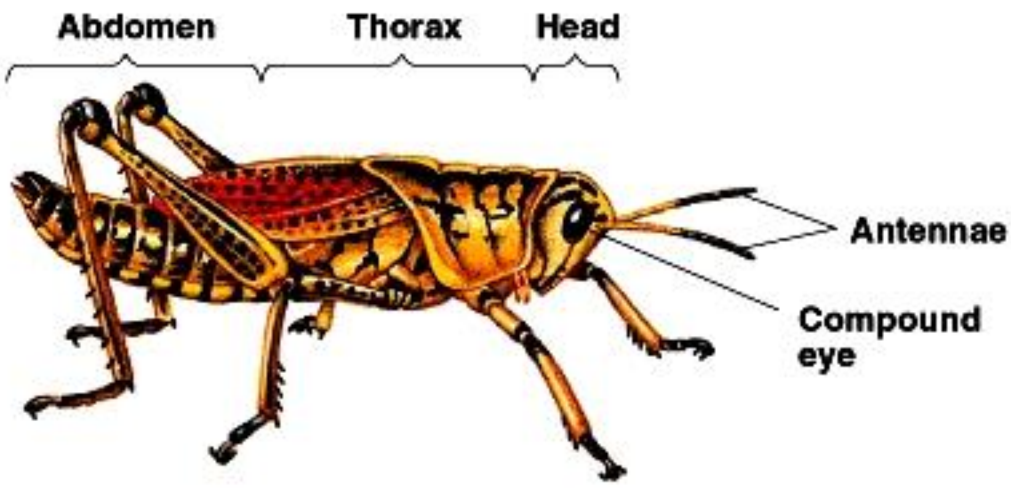
It is the largest phylum in the animal kingdom. Besides insects, many creatures like crayfish, crabs, lobsters, centipedes, millipedes, spiders, mites, ticks, scorpions etc come under this category.

Phylum arthropoda is classified into 7 classes viz

1 .Onychophora (claw bearing): eg: peripatus
2. Crustacea (crusta-shell): eg: prawns, crabs, wood louse
3.Arachnida (Arachine-spider): eg:scorpion, spider, ticks, mites
4.Chilopoda (chilo-lip,poda-legs): eg:centipedes
5.Diplopoda (diplo-two,poda-legs):eg:millipedes
6.Trilobita (an extinct group)
7.Hexopoda (hexa-Six; poda-legs) eg.insects, Insecta (in-internal ;sect-cut)

Character of Insecta

Insects have segmented bodies, jointed legs, and external skeletons (exoskeletons). Insects are distinguished from other arthropods by their body, which is divided into three major regions:
1. The head, which bears the mouthparts, eyes, and a pair of antennae,
2. The three-segmented thorax, which usually has three pairs of legs (hence “Hexapoda”) in adults and usually one or two pairs of wings.
3. The many-segmented abdomen, which contains the digestive, excretory, and reproductive organs.



The Insect Head

The insect's head is sometimes referred to as the head-capsule, and is the insect's feeding and sensory centre. It supports the eyes, antennae and and jaws of the insect. (Note -: insects do not breath through their mouths but through their thoracic and abdominal spiracles) The upper-mid portion of an insects face is called the 'frons' below this is the 'clypeus' and below this the 'labrum' to either side of which may be seen the edges of the 'mandibles' in some insects various aspects of the 'maxilliary' palps may extend beyond and or below these even when viewed from front on.

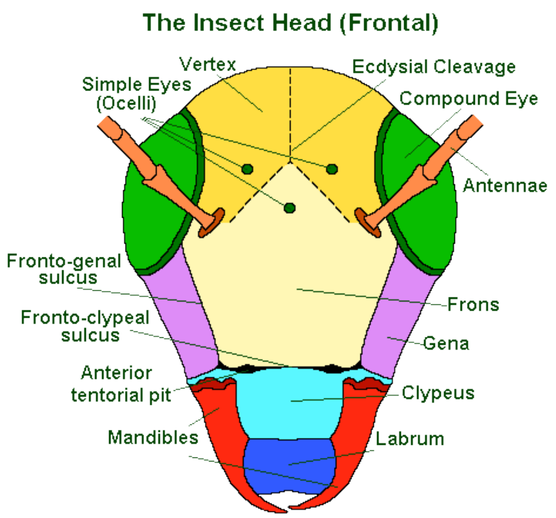
The 'frons' = that area of the face below the top two 'ocelli' and above the 'frontoclypeal sulcus' (if and when this is visible) and in between the two 'frontogenal sulci', it supports the 'pharyngeal dilator' muscles and in immature forms it bears the lower two arms of the ecdysial cleavage lines.

The 'clypeus' = that area of the face immediately below the frons (with which it may be fused in the absence of the frontoclypeal sulcus) and the frontoclypeal sulcus. It supports the 'cibarial dilator' muscles and may be divided horizontally into a 'post.' and 'anteclypeus'.

The 'labrum' = is equivalent to the insect's upper lip and is generally moveable, it articulates with the clypeus by means of the 'clypeolabral suture'.

The rest of the front of the head: that bit which is above the frons is known as the 'vertex'; the sides of the head are known as the 'gena'.

<u>The Insect Head:</u>



Neck:

The Neck grease is a short slender feature that attacks to the head. The base is supported by a pair of posterior and two greiva plaques in the abdomen the muscles of the neck help the head. To rotate all the sides

The Thorax

The thorax is the midsection (tagma) of the insect body. It holds the head, legs, wings and abdomen. It is also called mesosoma in other arthropods.

It is formed by the prothorax, mesothorax and metathorax and comprises the scutellum; the cervix, a membrane that separates the head from the thorax; and the pleuron, a lateral sclerite of the thorax.

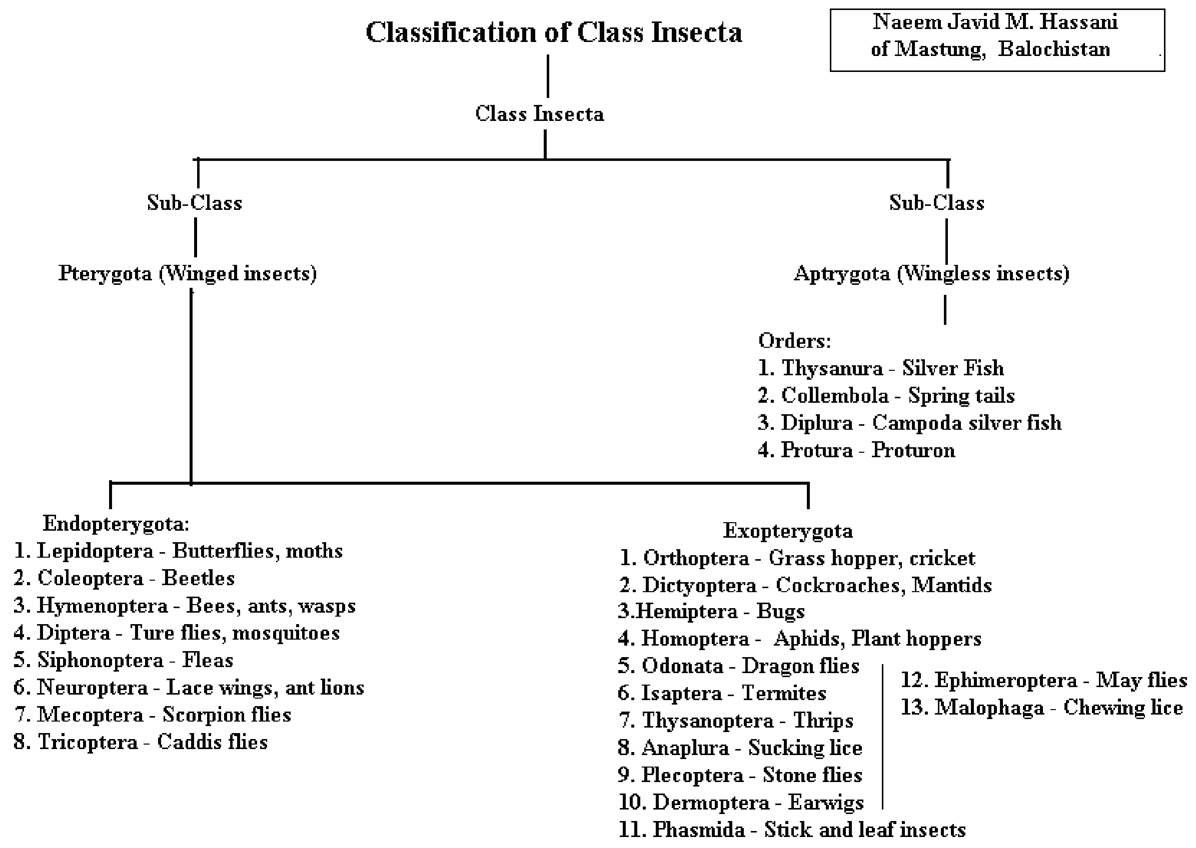
Abdomen

Most insects have a segmented abdomen that contains most of their internal organs, and roaches are no exception. Inside a roach's abdomen, a tube-like heart moves blood to organs and tissues. Unlike human blood, a roach's blood doesn't use hemoglobin to carry oxygen, so it is colorless instead of red. The blood also doesn't travel through an extensive circulatory system. Although an aorta carries blood to specific organs, much of the blood travels through a network of spaces called a hemocoel. Roaches also store fat a little differently than people do. Instead of spreading it throughout most of their physical structure, they store it in one centralized location called the fatbody.

A roach's digestive system is located in its abdomen, and much of it resembles a simplified version of a mammal's digestive system. However, a roach's digestive system has a few modifications that let it eat cellulose and other tough materials. One of these is a crop, which holds swallowed food until a toothy section of the digestive tract, called the proventriculus, can pulverize it. Sacs called the gastriccacea hold enzymes and microbes that continue to digest the food. This extra digestive help is particularly important if the roach eats cellulose or wood. Only after the material is thoroughly broken down can the roach's midgut absorb the food's nutrients.

Two segmented cerci lie on the exterior of the lower part of a roach's abdomen. These somewhat resemble antennae, and they can behave as sensory organs. A nerve inside the roach allows it to detect air movement around its cerci. This is one reason roaches can move out of the way very quickly if you try to catch or crush them.

Roaches' reproductive systems are also located in their abdomen.



The class insecta has two subclasses viz., Apterygota and Pterygota.

	Apterygota	**Pterygota**
1.	Primarily wingless evolved from wingless, ancestors	Winged or secondarily wingless. Evolved from winged ancestors. E.g. Flea, headloushe, bed bug.
2.	Metamorphosis is totally absent or slight	Present
3.	Mandibular articulation in head is monocondylic i.e., single	Dicondylic i.e., double
4.	Pleural sulcus in thorax is absent	Present
5.	Pregenital abdominal appendages Present	Absent

PTERYGOTA

Pterygote has two sub classes 1. Exopterygota, 2. Endopterygota

Exopterygota

The **Exopterygota**, also known as **Hemipterodea**, are a superorder of insects of the subclass Pterygota in the infraclass Neoptera, in which the young resemble adults but have externally developing wings. They undergo a modest change between immature and adult, without going through a pupal stage. The nymphs develop gradually into adults through a process of moulting.

Exopterygota has 16 orders

1. Ephemeroptera, Ex: May flies
2. Odonata, Ex: Dragon flies
3. Plecoptera Ex: Stone flies
4. Grylloblattoidea Ex: Mole cricket
5. Orthoptera Ex: Grass hoppers
6. Phasmida Ex: Walking sticks
7. Dermptera Ex: Ear wigs
8. Embioptera Ex: Web spinners
9. Dictyoptera Ex: Cockroach
10. Isoptera Ex: White ants
11. Zoraptera Ex: Zorapterans
12. Psocoptera Ex: Book lice
13. Mallophaga Ex: Bird lice
14. Siphunculata Ex: Fleas
15. Hemiptera Ex: Bugs
16. Thysanoptera Ex: Thrips

Endopterygota

Endopterygota (from Ancient Greek *endon* “inner” + *pterón*, “wing” + New Latin -*ota* “having”), also known as **Holometabola**, is a superorder of insects within the infraclass Neoptera that go through distinctive larval, pupal, and adult stages. They undergo a radical metamorphosis, with the larval and adult stages differing considerably in their structure and behaviour. This is called holometabolism, or complete metamorphism.

Endopterygota has 9 orders

1. Neuroptera Ex: Ant lions
2. Mecoptera Ex: Scorpion flies
3. Lepidoptera Ex: Butter flies
4. Trichoptera Ex: Caddish flies
5. Diptera Ex: House fly
6. Siphonoptera Ex: Head lous
7. Hymenoptera Ex: Ants

8. Coleoptera Ex: Beetles
9. Strepsiptera Ex: Strepsipterans

Some Important insecta orders – characters

Orthoptera:

Characteristics

Grasshoppers, crickets, katydids and locusts all belong to the order Orthoptera which means 'straight wings'. Most are easily recognisable by their hind legs, which are usually enlarged for jumping. They are often easily seen jumping away when disturbed or heard 'singing' at night. They are mainly medium to large insects with some species in Australia growing to a length of 10 centimetres. There are about 3000 species in Australia and all can be distinguished from other insects by the following features:

- 2 pairs of wings. The forewings are narrower than the hind wings and hardened or leathery at the base. They are held roof-like overlapping the abdomen at rest. The hind wing is membranous and held folded fan-like under the forewings when at rest
- Mandibulatemouthparts
- Large compound eyes
- Antennae may be short to very long depending on the species. Grasshoppers have relatively short antennae while crickets and katydids generally have long antennae
- Hind legs are enlarged and modified for jumping

The general appearance of this order makes it difficult to confuse with other insects. The young of Orthoptera look like small wingless adults. Many orthopterans can produce sound by rubbing their legs, wings or abdomen together. It is predominantly males that produce these sounds to attract females.

Life Cycle

Orthopterans develop by incomplete metamorphosis. The majority of orthopterans lay their eggs in the ground or on vegetation. The eggs hatch and the young nymphs resemble adults but lack wings and at this stage are often called hoppers. Through successive moults the nymphs develop wings buds until their final moult into a mature adult with fully developed wings. The number of moults varies between species but grasshoppers may have up to 6 while crickets may have up to 10. Growth is also very variable and may take anywhere from a few weeks to many months depending on such things as food availability and weather conditions.

Feeding

Most orthopterans are herbivorous feeding on a variety of plant materials including roots. Most short-horned grasshoppers feed on grasses while many long-horned grasshoppers (such as katydids) and crickets tend to be more omnivorous. Some species are even scavengers or predators.

Habitat

Orthopterans are found in all terrestrial habitats across Australia. They are commonly in association with vegetation, from ground level to the canopy, in burrows in the soil or moving across open ground, depending on the species. Most are active during the day, feeding on vegetation and others such as mole crickets spend most of their time in underground burrows. Orthopterans are usually found singularly or in small numbers, however a few species sometimes increase in numbers forming plagues that can cause much damage and huge crop losses, such as the Australian plague locust pictured below.

Chortoicetesterminifera (Australian plague locust)

Thysanoptera

Life History & Ecology

Thrips are generally small insects (under 3 mm). Most species feed on plant tissues (often in flower heads), but some are predators of mites and various small insects (including other thrips). Many species are parthenogenetic. Adults may be winged or wingless. When present, the wings are slender and rod-like with a dense fringe of long hairs.

Although Thysanoptera are hemimetabolous, many species undergo an extended metamorphosis in which the final immature stage is quiescent, non-feeding, and sometimes even enclosed in a silken cocoon. This developmental stage, usually called a "pupa", has aroused a great deal of speculation by some entomologists who claim that thrips represent an "intermediate" stage between hemi- and holometabolous development. A close examination of the thysanopteran "pupa", however, reveals that it does not undergo any internal transformation. Without additional evidence to support a phylogenetic link to the Holometabola, it would appear that this "pupal stage" may be nothing more than a curious coincidence of convergent evolution.

Physical Features

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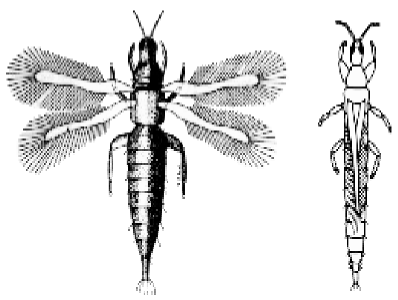
<td></td>
<td>Adults
Antennae short, 6-10 segments
Head narrow anteriorly forming a conical mouth opening
Body cylindrical or spindle-shaped
Front and hind wings slender, rod-like, with a dense fringe of long hairs. Many species are secondarily wingless.
Tarsi 1-2 segmented, with eversible adhesive bladders apically
Immatures
Structurally similar to adults
Always wingless</td>
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Economic Importance

Many thrips are destructive pests of plants, especially grain crops, fruits and vegetables, and ornamentals. Feeding activities result in plant deformities, scarring, loss of yield, and in some cases, transmission of plant pathogens. Predatory thrips are beneficial species that may control mites and other small insects.

Major Families

- **Aeolothripidae** (Predatory Thrips) -- mostly beneficial species.
- **Thripidae** (Common Thrips) -- herbivores, including many pests such as the flower thrips (*Frankliniellatritici*), and the soybean thrips (*Sericothripsvariabilis*).

- **Phlaeothripidae** (Tube-tailed thrips) -- largest faimly in the order; contains numerous pests as well as a few beneficial species (e.g., the black hunter, *Leptothripsmali*).

The word "thrips" is both singular and plural. There is no such thing as a "thrip". Thrips are the only insects that have asymmetrical mouthparts. Of the three feeding stylets, two are derived from the maxillae and one is derived from the left mandible. The right mandible disappears during embryogenesis. Thrips are able to walk on glassy smooth surfaces because they have an eversible adhesive pad located on the tip of each foot, between the claws.

Hemiptera

The Hemipteraor true bugs are an order of insects comprising some 50,000 to 80,000 species of groups such as the cicadas, aphids, planthoppers, leafhoppers, and shield bugs. They range in size from 1 mm (0.04 in) to around 15 cm (6 in), and share a common arrangement of sucking mouthparts. The name "true bugs" is sometimes limited to the suborder Heteroptera. Many insects commonly known as "bugs" belong to other orders; for example, the lovebug is a fly and the May bug and ladybug are beetles.

Most hemipterans feed on plants, using their sucking and piercing mouthparts to extract plant sap. Some are parasitic while others are predators that feed on other insects or small invertebrates. They live in a wide variety of habitats, generally terrestrial, though some species are adapted to life in or on the surface of fresh water. Hemipterans are hemimetabolous, with young nymphs that somewhat resemble adults. Many aphids are capable of parthenogenesis, producing young from unfertilised eggs; this helps them to reproduce extremely rapidly in favourable conditions.

Humans have interacted with the Hemiptera for millennia. Some species, including many aphids, are significant agricultural pests, damaging crops by the direct action of sucking sap, but also harming them indirectly by being the vectors of serious viral diseases. Other species have been used for biological control of insect pests. Hemipterans have been cultivated for the extraction of the dyestuff cochineal (also known as carmine) and for shellac. The bed bug is a persistent parasite of humans. Cicadas have been used as food, and have appeared in literature from the *Iliad* in Ancient Greece.

Diversity

Hemiptera is the largest order of hemimetabolous insects (not undergoing complete metamorphosis; though some examples such as male scale insects do undergo a form of complete metamorphosis) containing over 75,000 named species; insect orders with more species all have a pupal stage (i.e. they do undergo complete metamorphosis or "holometabolism"), Coleoptera (370,000 described species), Lepidoptera (160,000), Diptera (100,000) and Hymenoptera (100,000).

The group is very diverse. The majority of species are terrestrial, including a number of important agricultural pests, but some are found in freshwater habitats. These include the water boatmen, pond skaters, and giant water bugs.

Taxonomy and phylogeny

Fossil planthopper (Fulgoromorpha) from the Early Cretaceous Crato Formation of Brazil,

The fossil record of hemipterans goes back to the Carboniferous (Moscovian). The oldest fossils are of the Archescytinidae from the Lower Permian and are thought to be basal to the Auchenorrhyncha. Fulguromorpha and Cicadomorpha appear in the Upper Permian, as do Sternorrhyncha of the Psylloidea and Aleurodoidea. Aphids and Coccoids appear in the Triassic. The Coleorrhyncha extend back to the Lower Jurassic. The Heteroptera first appeared in the Triassic.

The present members of the order Hemiptera (sometimes referred to as Rhynchota) were historically placed into two orders, the so-called Homoptera and Heteroptera/Hemiptera, based on differences in wing structure and the position of the rostrum. The order is now divided into four or more suborders, after the "Homoptera" were established as paraphyletic (now the Auchenorrhyncha and the Sternorrhyncha). The cladogram is based on one analysis of the phylogeny of the Paraneoptera by Hu Li and colleagues in 2015, using mitochondrial genome sequences and homogeneous models. It places the Sternorrhyncha as sister clade to the Thysanoptera and the lice, making the Hemiptera as traditionally understood non-monophyletic. However, when heterogeneous models were used, Hemiptera was found to be monophyletic. The result where Hemiptera was found to be non-monophyletic is likely due to phylogenetic artifacts, such as elevated substitution rates in Sternorrhyncha compared with the other suborders of Hemiptera. English names are given in parentheses where possible.

Mouthparts

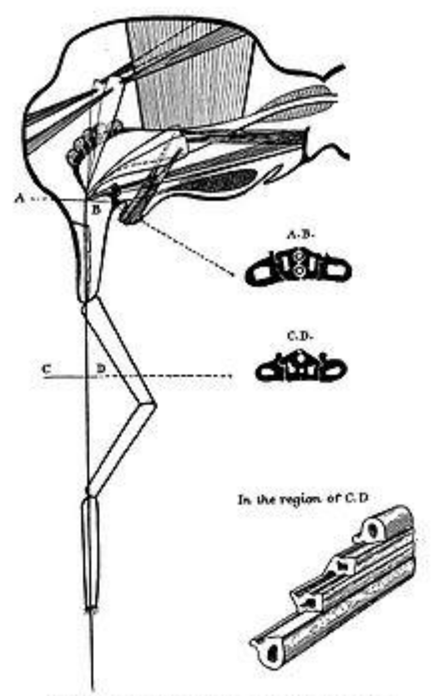


Diagram of *Hemipterous* mouth-parts. Shows the appearance, if it could be seen in perspective, with successive layers removed.

Hemipteran mouthparts are distinctive, with mandibles and maxillae modified to form a piercing "stylet" sheathed within a modified labium.

The defining feature of hemipterans is their "beak" in which the modified mandibles and maxillae form a "stylet" which is sheathed within a modified labium. The stylet is capable of piercing tissues and sucking liquids, while the labium supports it. The stylet contains a channel for the outward movement of saliva and another for the inward movement of liquid food. A salivary pump drives saliva into the prey; a cibarial pump extracts liquid from the prey. Both pumps are powered by substantial dilator muscles in the head. The beak is usually folded under the body when not in use. The diet is typically plant sap, but some hemipterans such as assassin bugs are blood-suckers, and a few are predators.

Both herbivorous and predatory hemipterans inject enzymes to begin digestion extraorally (before the food is taken into the body). These enzymes include amylase to hydrolyse starch, polygalacturonase to weaken the tough cell walls of plants, and proteinases to break down proteins.

Although the Hemiptera vary widely in their overall form, their mouthparts form a distinctive "rostrum". Other insect orders with mouthparts modified into anything like the rostrum and stylets of the Hemiptera include some Phthiraptera, but for other reasons they generally are easy to recognize as non-hemipteran. Similarly, the mouthparts of Siphonaptera, some Diptera and Thysanoptera superficially resemble the rostrum of the Hemiptera, but on closer inspection the differences are considerable. Aside from the mouthparts, various other insects can be confused with Hemiptera, but they all have biting mandibles and maxillae instead of the rostrum. Examples include cockroaches and psocids, both of which have longer, many-segmented antennae, and some beetles, but these have fully hardened forewings which do not overlap.

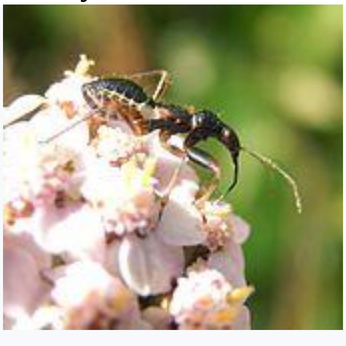
Wing structure

The forewings of Hemiptera are either entirely membranous, as in the Sternorrhyncha and Auchenorrhyncha, or partially hardened, as in most Heteroptera. The name "Hemiptera" is from the Greek (*hemi*; "half") and (*pteron*; "wing"), referring to the forewings of many heteropterans which are hardened near the base, but membranous at the ends. Wings modified in this manner are termed *hemelytra* (singular: *hemelytron*), by analogy with the completely hardened elytra of beetles, and occur only in the suborder Heteroptera. In all suborders, the hindwings – if present at all – are entirely membranous and usually shorter than the forewings. The forewings may be held "roofwise" over the body (typical of Sternorrhyncha and Auchenorrhyncha), or held flat on the back, with the ends overlapping (typical of Heteroptera). The antennae in Hemiptera typically consist of four or five segments, although they can still be quite long, and the tarsi of the legs have two or three segments.

Many hemipterans can produce sound for communication. The "song" of male cicadas, the loudest of any insect, is produced by tymbal organs on the underside of the abdomen, and is used to attract mates. The tymbals are drumlike disks of cuticle, which are clicked in and out repeatedly, making a sound in the same way as popping the metal lid of a jam jar in and out.

Stridulatory sounds are produced among the aquatic Corixidae and Notonectidae (backswimmers) using tibial combs rubbed across rostral ridges.

Life cycle



An ant-mimicking predatory bug *Myrmecorisgracilis*

Hemipterans are hemimetabolous, meaning that they do not undergo metamorphosis, the complete change of form between a larval phase and an adult phase. Instead, their young are called nymphs, and resemble the adults to a greater or lesser degree. The nymphs moult several times as they grow, and each instar resembles the adult more than the previous one. Wing buds grow in later stage nymphs; the final transformation involves little more than the development of functional wings (if they are present at all) and functioning sexual organs, with no intervening pupal stage as in holometabolous insects.

Parthenogenesis and viviparity

Aphid giving birth to live female young

Many aphids are parthenogenetic during part of the life cycle, such that females can produce unfertilized eggs, which are clones of their mother. All such young are females (thelytoky), so 100% of the population at these times can produce more offspring. Many species of aphid are also viviparous: the young are born live rather than laid as eggs. These adaptations enable aphids to reproduce extremely rapidly when conditions are suitable.

Homoptera

Homopteran, (order Homoptera), any of more than 32,000 species of sucking insects, the members of which exhibit considerable diversity in body size. All of the Homoptera are plant feeders, with mouthparts adapted for sucking plant sap from a wide assortment of trees and wild and cultivated plants. Many homopterans cause injuries or destruction to plants, including fruit trees and grain crops, and can be vectors of plant diseases. A few provide secretions or other products that are beneficial and have commercial value. Most members of the Homoptera fall into one of two large groups; the Auchenorrhyncha, which consists of the cicadas, treehoppers, froghoppers or spittlebugs, leafhoppers, and planthoppers or fulgorids; and the Sternorrhyncha, which includes aphids or plant lice, phylloxerans, coccids, scales, whiteflies, and mealybugs.

General Features

Size range

Most homopterans range from 4 to 12 mm ($^{1}/_{6}$ to $^{1}/_{2}$ inch) in length. There are certain species of cicadas in Borneo and Java, however, that are 8 cm (3.1 inches) long with wingspreads of 20 cm (7.9 inches). The large fulgorid or lanternfly can attain this size also. On the other hand, some of the tiniest scale insects are only 0.5 mm (0.02 inch) in length.

Distribution and abundance

Although Homoptera species are distributed throughout the world, the relative numbers of individual species vary in a given locale. Only one cicadid species is known in Great Britain, and fewer than 12 in all of Europe. However, more than 200 cicadid species are known in North America, and about 180 in Australia.

The abundance of any species in a given environment depends upon the biotic potential of the insect, the abundance of the food plant, and other factors favourable for development of large populations. Certain species never reproduce in excessive numbers, while others, considered pests, produce many offspring. Insect species that feed on available crops or other plants present in quantities sufficient to support them normally develop large populations; for example, the oyster shell scale (*Lepidosaphesulmi*) on fruit trees and ornamentals; the greenbug (*Toxopteragraminum*) on wheat; and the potato leafhopper (*Empoascafabae*) on potatoes, beans, and alfalfa. Grape leafhoppers (*Erythroneura*) frequently develop large populations that result in heavy plant losses.

Importance

Homopterans, because all species feed on sap sucked from plants, often cause injuries or destruction to the plants that nourish them. When such plants are cultivated crops (e.g., grains or fruit trees) or valued ornamentals, the economic loss resulting from infestations is severe. In addition, some homopteran species act as vectors of virus- and bacteria-caused diseases of their plant hosts. The check exerted upon insect pests by other insects is an important mechanism of natural control of populations. Predacious insects feed on small, weak species; parasitic insects live on or in a host and feed at its expense. Aphids, for example, are parasitized principally by members of the Hymenoptera; two important aphid predators are ladybird beetles and lacewings. Pests also may be controlled by chemical and biological methods (e.g., development of resistant plants, as with European grapevines).

The homopterans are responsible for injuring numerous plants of economic importance. Cicadas or dogdayharvestflies, sometimes mistakenly called locusts, are well-known pests that have an annual life cycle. They are characterized by their large size and the strident song of the male. Periodical cicadas emerge every 13 or 17 years in large numbers, swarm in trees, mate, and lay eggs in green twigs. Permanent damage to fruit twigs is caused by the egg deposition slits; when the weakened twigs mature into fruit-bearing limbs, they break under the weight of the fruit, and the crop is lost. Failures of this sort can be avoided by not planting young fruit trees in years of cicada emergence.

Leafhoppers cause various types of plant injury by interfering with the normal physiology of the plant. The salivary secretion of the potato leafhopper, for example, causes leaf cell hypertrophy that impairs transport of sugars. The resulting sugar accumulation in the leaves destroys chlorophyll and causes the leaves to turn brown and die. This injury, termed “hopper burn,” can result in complete loss of a potato crop if not controlled. Another type of injury is caused by leafhoppers that feed upon plant mesophyll tissue. In addition to removing excessive amounts of sap, these insects also destroy the plant’s chlorophyll, resulting in yellow spots on the leaves, which eventually turn yellow or brown. *Erythroneura, Typhlocyba*, and *Empoasca* species cause this injury to apple trees and grapevines. Grape leafhoppers reduce growth and foliage function and cause formation of grapes that are inferior in size, colour, flavour, and sugar content. Plants also are injured when insects lay eggs in green twigs. The egg punctures of several leafhoppers and treehoppers reduce the flexibility of plant limbs. Plant stunting and severe curling of leaves occur when the leafhopper *Empoascafabae* punctures the undersurfaces of leaves and veins of bush beans and inhibits growth. This leafhopper also feeds on alfalfa and causes leaves to turn yellow and drop off. In the same way, aphids and mealybugs cause leaf curling on potatoes and many ornamental plants, and the potato psyllid feeds on potato leaves and causes curling and yellowing known as “potato yellows.”

The froghoppers, often called spittlebugs because immature stages live in spittlelike masses, feed on a variety of plants. One important species, the meadow spittlebug (*Philaenusspumarius*), feeds extensively upon clover and alfalfa and causes severe stunting that can result in loss of up to 50 percent of a crop. Scale insects, unless parasitized, produce enormous populations on green twigs, young limbs, leaves, and fruit; when tree bark or shrubs become encrusted with one or more layers of scales, the entire plant often dies. Damage is caused to apples by the rosy apple aphid. Females of the third seasonal generation remain on the apple leaves until after small apples have formed. Many aphids crawl onto these tiny apples and puncture them causing dimpling of the fruit and normal incision of tiny apples. The cluster of apples, known as aphid apples, are small and gnarled.

More than 100 species of leafhoppers are known organisms causing plant diseases. Some important plant disease viruses transmitted by leafhoppers are aster yellows (transmitted by *Macrostelesfascifrons*); potato yellow dwarf (several species of *Aceratagallia* and *Agallopsis*); and phony peach disease and Pierce’s disease of grape (species of *Cuerna, Homalodisca*, and *Oncometopia*). Corn stunt is transmitted by species of *Dalbulus*; curly top of sugar beet by *Circulifertenellus*; eastern and western x-disease by species of *Colladonus*; and elm phloem necrosis by *Scaphoideusluteolus*. One species of spittlebug is a vector for a yellow virus of peaches. Aphids are vectors for several virus mosaic disease organisms. A membracid species transmits the virus that causes pseudocurly top of tomato and tobacco, and two species of fulgorids are vectors of virus disease organisms of rice. The whitefly *Bemisiatabaci* transmits the virus that causes tobacco leaf curl, and species of mealybugs are vectors of the virus that causes pineapple wilt. The bacteria that cause fire blight disease on pear, apple, and quince trees are transmitted by several types of insects including leafhoppers. The bacterial pathogen, *Neofabraeaperennans*, that causes perennial canker of apple is transmitted by the woolly apple aphid.

Because homopterans suck more sap from plants than they need, the surplus is excreted from the tip of the abdomen as sweet droplets known as honeydew. If the insect is feeding on apple foliage and honeydew falls on apples, a sooty fungus (sooty mold) grows in each droplet. The apples become black spotted and are no longer marketable. Many other homopterans also produce honeydew, with sooty mold growing on whatever the honeydew lands on.

Of great economic importance are insects that secrete lac on twigs in tropical and subtropical regions. The lac is refined and used in preparing shellac and varnishes. More than 4 million pounds of lac are refined annually. Other waxes secreted by aphids and scale insects are used in candlemaking, medicines, and candies.

Although few homopterans produce food for man, the tamarisk manna scale, *Trabutinamannipara*, is thought to have produced the biblical manna for the children of Israel. The females produce large quantities of honeydew that solidify in thick layers on plant leaves in arid regions. This sugarlike material, still collected by natives of Arabia and Iraq, is considered a great delicacy. The term manna often refers to plant products also. Certain species of scale insects produce a gum that was used as chewing gum by tribes of North American Indians. Female root-inhabiting scale insects (species of *Margarodes*) enclose their bodies in gold and bronze coloured wax cysts that are used in strings of beads. Certain colour patterns and designs of the forewings of tropical species of leafhoppers and planthoppers have been used in artwork by various peoples. For many generations the Mexican Indians have used a black, white, and red colour design in their art. The design is that of the forewings of a brilliantly coloured *Agrosoma* leafhopper, found on bushes along streams.

The scales of several species of scale insects, including the Old World kermes and New World cochineal, have been used to produce red dyes for clothing, foods, and medicines and in emulsions to colour film.

Life cycle

Generally, homopterans are bisexual, with mating occurring prior to the production of eggs. However, individual life cycles vary in length and complexity. Metamorphosis is simple or gradual, with immature stages resembling adults except that the latter usually have wings. The life cycles of most homopterans are short. A typical example is the common meadow spittlebug, *Philaenusleucophthalmus*, which has one generation a year. Eggs are laid in late summer on stems or sheaths of host plants and hatch the following spring. Over the next 4 to 6 weeks, the larvae develop into adults and begin producing eggs that will overwinter.

Leafhopper

Many leafhoppers (e.g., *Empoascamaligna*, *Gyponanamali*) have cycles that involve passing the winter as eggs inserted in apple twigs. Other leafhoppers, however, such as *Empoascarecurvata* and *Erythroneura*, hibernate as adults during the winter.

The sugarbeet leafhopper, *Circulifertenellus*, winters as an adult in desert areas and produces an early spring generation on desert plants. As desert plants become unfavourable for feeding, the leafhoppers migrate to available cultivated plants where from one to four summer generations are produced. When the crop is harvested or the plants become unfavourable for feeding, the leafhoppers return to desert plants. Although definite alternation of desert and cultivated host plants occurs in this life cycle, no specific plant serves as a primary or secondary host. Plant selection by migrating leafhoppers is determined largely by the amount of rainfall and succulence of both wild and cultivated plants. While most species have one generation a year, a few have two or three. The life cycle of planthoppers and fulgorids is similar to that of leafhoppers, while the pear psylla, *Psylla pyricola*, hibernates as an adult and can produce four generations of nymphs.

Whiteflies

The whiteflies, common on citrus trees and in greenhouse plants, do not survive winter out of doors in the North but produce several generations a year in the South. The metamorphosis of whiteflies varies from the typical gradual form. In the first instar (interval between molts) the young are active, wingless forms and are usually called larvae. During three subsequent instars, the immature insects become sessile and scalelike and are called nymphs. During these three instars, internal wing development occurs. The molt from last larval instar to pupa occurs inside the last larval skin, which forms a puparium. At this point, whitefly metamorphosis is essentially complete.

Aphids

The aphids or plant lice, soft-bodied insects that develop large populations, have several types of complex life cycles. Generally aphids overwinter in the egg stage on twigs or plant buds, usually designated as the primary host. In the spring the eggs hatch into females that reproduce parthenogenetically, giving birth to living young. Several generations may be produced during the season in this way. Early generations are usually wingless, but by the third generation winged individuals appear. In many species these winged forms migrate to a secondary host plant, usually an annual plant, and the same type of asexual reproductive process continues. In the latter part of the season, winged aphids of both sexes appear and migrate back to the primary host where mating occurs, and the females lay the overwintering eggs. There are two distinctive characteristics in the aphid life cycle: first, seasonal alternation of food plants involving a primary host (typically a perennial) during the winter and a secondary host (an annual) during the summer; second, there is alternation between sexual and asexual cycles, with eggs resulting from sexual mating and living young, usually females, being produced asexually.

Scale insects

The scale insects also have modified life cycles. For example, the oyster shell scale, *Lepidosaphesulmi*, typically passes the winter as an egg beneath a secreted scale covering, whereas the San Jose scale *Quadraspidiotusperniciosus* produces living young. In either case newborn young, called crawlers, leave the scale covering to search for food. After a few days they molt, losing their legs, antennae, and anal spines, and retaining poorly developed eyes. They secrete a hard scale about their soft bodies, insert their mouthparts into a plant, and remain sessile. As the females mature, they increase in size, enlarging the scale covering periodically, but do not change form or develop wings.

Young males also have a crawler stage but become sessile and inactive after the second molt, passing through a more complete metamorphosis beneath the scale covering. The last preadult instar has two external wings and is called the pupa. Adult males have two wings and two small knobs or halteres where the second pair of wings would normally develop. Some males have three pairs of eyes. Adult males seek out wingless females, concealed beneath the scale covering, and mate with them. As many as three males may mate simultaneously with one female.

Reproduction and growth

Reproduction is bisexual among the homopterans, although asexual reproduction occurs in the aphids, in a few primitive leafhoppers, and possibly in species whose life cycles are not known in detail. An unusual situation occurs in the normally hermaphroditic cottony cushion scale *Iceryapurchasi*, in which both male and female sexual organs are present in one individual and the eggs of any individual may be fertilized by its own sperm.

Growth is gradual and is accompanied by periodic molting. The nymphal stages, or instars, between egg and adult usually number five in leafhoppers and related species. Wings, if present, develop when the fifth instar molts and the adult emerges.

Lepidoptera

Butterflies / Moths

The name Lepidoptera, derived from the Greek words *"lepido"* for scale and *"ptera"* for wings, refers to the flattened hairs (scales) that cover the body and wings of most adults.

Classification & Distribution

Holometabola

- complete development (egg, larva, pupa, adult)

Several classification systems have been proposed for dividing the Lepidoptera into suborders. Regardless of the system used, all of the larger and more economically significant families are members of a single suborder (Frenatae or Ditrysia).

Distribution: Common worldwide.

	North America	***Worldwide***
Number of Families	**75**	**135**
Number of Species	**11,286**	**>112,000**

Life History & Ecology

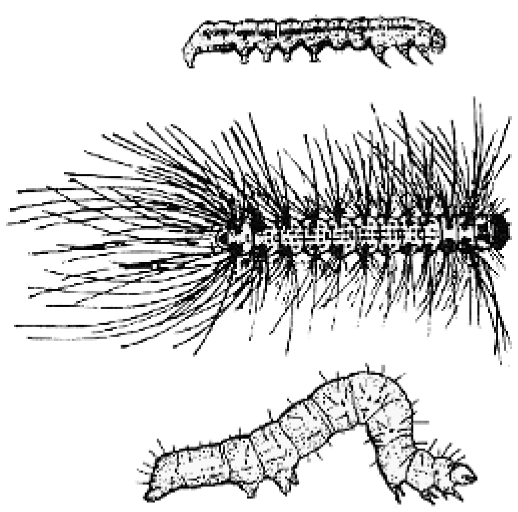
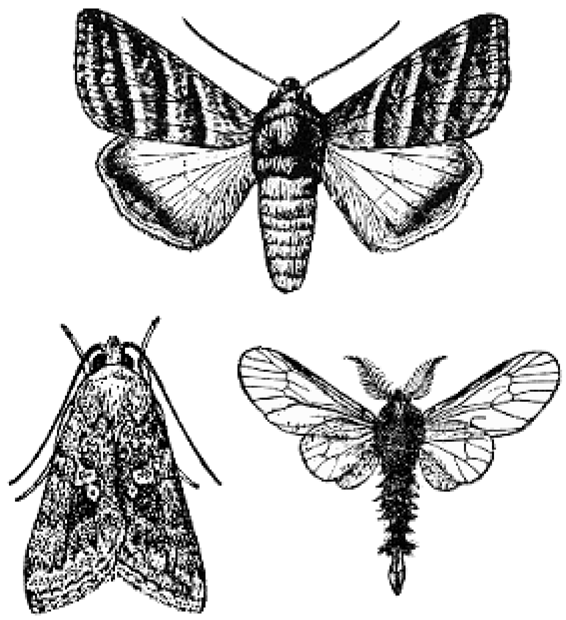
Lepidoptera (moths and butterflies) is the second largest order in the class Insecta. Nearly all lepidopteran larvae are called caterpillars. They have a well-developed head with chewing mouthparts. In addition to three pairs of legs on the thorax, they have two to eight pairs of fleshy abdominal prolegs that are structurally different from the thoracic legs. Most lepidopteran larvae are herbivores; some species eat foliage, some burrow into stems or roots, and some are leaf-miners.

Adults are distinctive for their large wings (relative to body size) which are covered with minute overlapping scales. Most entomologists believe that these scales are structurally related to the hair (setae) covering adult caddisflies. Lepidopteran wing scales often produce distinctive color patterns that play an important role in courtship and intraspecific recognition.

Although moths probably diverged from caddisflies in the early Triassic period, about 230 million years ago, adults in a few primitive families (e.g., Micropterygidae) still retain evidence of chewing mouthparts. In all other lepidopteran families, the mouthparts are vestigal or form a tubular proboscis that lies coiled like a watch spring beneath the head. This proboscis is derived from portions of the maxillae. It uncoils by hydrostatic pressure and acts as a siphon tube for sipping liquid nutrients, such as nectar, from flowers and other substrates.

From a taxonomic standpoint, the distinction between moths and butterflies is largely artificial -- some moths are more similar to butterflies than to other moths. As a rule, butterflies are diurnal, brightly colored, and have knobs or hooks at the tip of the antennae. At rest, the wings are held vertically over the body. In contrast, most (but not all) moths are nocturnal. They are typically drab in appearance, and have thread-like, spindle-like, or comb-like antennae. At rest, their wings are held horizontally against the substrate, folded flat over the back, or curled around the body.

Physical Features

	
Immatures	**Adults**
Eruciform (caterpillar-like) Head capsule well-developed, with chewing mouthparts Abdomen with up to 5 pairs of prolegs	Mouthparts form a coiled tube (proboscis) beneath the head Antennal type: o Butterflies: knobbed or hooked at tip o Moths: thread-like, spindle-shaped, or comb-like Front wings large, triangular; hind wings large, fan-shaped Body and wings covered with small, overlapping scales

Economic Importance

Although many Lepidoptera are valued for their beauty, and a few are useful in commerce (e.g., the silkworm, *Bombyx mori*), the larvae of these insects are probably more destructive to agricultural crops and forest trees than any other group of insects.

Major Families

Butterflies:

- **Nymphalidae** (brushfooted butterflies) -- front legs reduced in size. This is the largest butterfly family; it includes the fritillaries, admirals, emperors, and tortoiseshells.
- **Danaidae** (milkweed butterflies) -- adults are reddish-orange with black and white markings. Larvae feed on various species of milkweed. Includes the monarch (*Danaus plexippus*).
- **Pieridae** (whites and sulfurs) -- adults are predominantly white or yellow with black markings. The imported cabbageworm (*Pieris rapae*) is a pest throughout the world.
- **Papilionidae** (swallowtails) -- hind wings have a tail-like extension. The tiger swallowtail (*Papilioglaucus*) is a cosmopolitan species.
- **Lycaenidae** (blues, coppers, and hairstreaks) -- small butterflies with fluted hind wings. Some species are extinct or nearing extinction, others are very common.
- **Hesperiidae** (skippers) -- antennal club is hooked at the tip. The silverspotted skipper, *Epargyreusclarus*, is a common species.

Moths:

- **Tineidae** (clothes moths) -- some larvae construct cases and feed on natural fibers. Pests include the webbing clothes moth (*Tineolabisselliella*) and the casemaking clothes moth (*Tinea pellionella*).
- **Gelechiidae** -- one of the largest families of micro-lepidoptera. These larvae feed on plants or plant products. Pests include the Angoumois grain moth (*Sitotrogacerealella*) and the pink bollworm (*Pectinophoragossypiella*).
- **Sesiidae** (clearwing moths) -- diurnally active adults mimic wasps. Many pests of fruit and vegetable crops, including the peachtree borer (*Synanthedonexitiosa*) and squash vine borer (*Melittiacucurbitae*).
- **Tortricidae** -- fourth largest family of Lepidoptera. Larvae feed inside stems, leaves, and fruit. Contains many pest species, including the codling moth (*Cydiapomonella*) and the oriental fruit moth (*Grapholitamolesta*).
- **Pyralidae** (snout moths) -- second largest family of Lepidoptera. Pests include the European corn borer (*Ostrinianubilalis*), the Indianmeal moth (*Plodia interpunctella*), and the greater wax moth (*Galleria mellonella*).
- **Geometridae** -- third largest family of Lepidoptera. Larvae are often called inchworms or spanworms. Includes the winter moth (*Operophterabrumata*) and the fall cankerworm (*Alsophila pometaria*).
- **Lasiocampidae** (lappet moths) -- larvae feed on the leaves of trees and some spin large webs or tents on the foliage. Pests include the eastern tent caterpillar (*Malacosoma americana*) and the forest tent caterpillar (*M. disstria*).
- **Saturniidae** (giant silk moths) --- large, colorful moths. Larvae feed on a wide range of trees and shrubs. Well-known species include the cecropia moth (*Hyalophora cecropia*) and the luna moth (*Actias luna*).
- **Sphingidae** (hawk moths) -- medium to large adults with long proboscis for collecting nectar. Larvae are frequently called hornworms. Pests include the tobacco hornworm (*Manduca sexta*) and tomato hornworm (*M. quinquemaculata*).

- **Arctiidae** (tiger moths) -- distinctive adults, usually white with black, red, yellow, or orange markings. Many larvae are covered with long hairs (woollybears). Includes the fall webworm (*Hyphantriacunea*).
- **Lymantriidae** (tussock moths) -- larvae are characterized by tufts of hair along the body. Adults do not feed. Pests include the gypsy moth (*Lymantria dispar*) and the browntail moth (*Euproctischrysorrhoea*).
- **Noctuidae** (loopers, owlet moths, and underwings) -- this is the largest family in the Lepidoptera. Larvae are leaf feeders and stem borers. Many species are pests, including the fall armyworm (*Spodopterafrugiperda*), the black cutworm (*Agrotisipsilon*), and the cabbage looper (*Trichoplusiani*).

Coleoptera

(beetles and weevils)

Characteristics
Beetles constitute the largest and most diverse order of insects on earth, making up about 30% of all animals. There are over 300 000 species of beetles worldwide and over 28 000 species spread across 117 families in Australia. Beetles come in a variety of shapes and colours and can range from 0.4 to about 80 millimetres in length. Due to the variation within the order it is difficult to give a general description however all beetles characteristically have the following features:

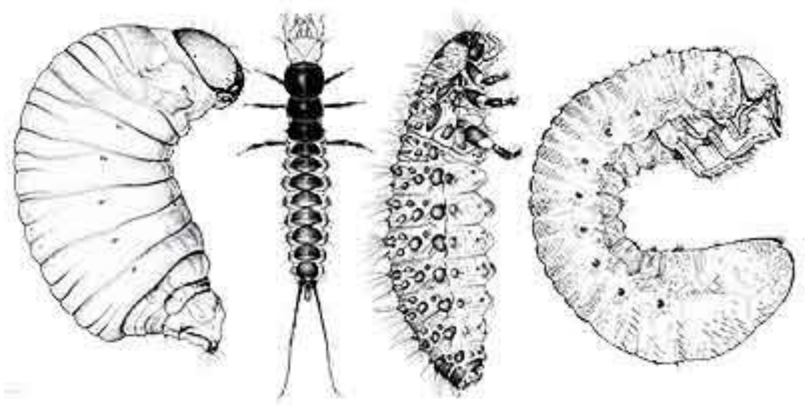
Elytra raised to reveal the membranous hindwings

- 2 pairs of wings. Forewings hardened, hind wings membranous
- Mandibulate mouthparts which are designed for biting and chewing
- Antennae present in a variety of forms
- Compound eyes in a variety of sizes and shape

The forewings of beetles are heavily sclerotised and form protective covers over the hind wings. The forewings are called elytra and Coleoptera means 'sheath wings' i.e. the hard sheath-like elytra over the soft hind wings. The elytra are not used in flight but are lifted out of the way of the hind wings. At rest the elytra meet in a straight line down the middle of the back. The elytra may completely cover the abdomen or may be shorter exposing part of the abdomen. The hind wings are membranous and are used for flight. At rest they are folded protectively under the elytra. Some species do not have hind wings and their elytra are generally fused together.

Coleoptera are the only order of insects that have elytra. This adaptation has enabled them to expand into many habitats such as leaf litter, logs and soil, that would otherwise damage the wings of less well protected insect groups. At first glance beetles may appear to have only 2 body segments because the elytra may cover most of the thorax and abdomen. However if you capture a beetle and turn it over you will be able to see the segments that are hidden by the elytra.

Larval Characteristics: The larvae of beetles also come in a variety of shapes and sizes depending on where they live and what they eat. Larvae generally appear grub-like with a well-defined head capsule, which may be highly sclerotised. They have short antennae and usually have chewing mouthparts. The legs may be present or absent.



Various larval types: Curculionidae, Carabidae, Chrysomelidae, Scarabaeidae

Beetles are often confused with cockroaches (Blattodea) or bugs (Hemiptera) but can be distinguished from the former by their forewings which are modified into elytra and meet in a straight line down the back and from the later by their chewing rather than sucking mouthparts.

Life Cycle

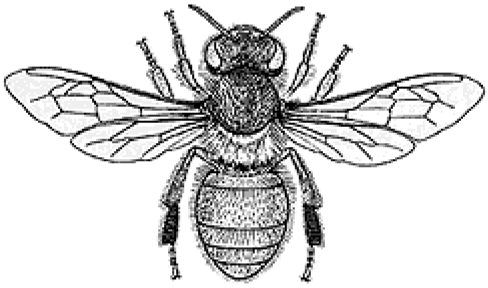
Beetles have a complete life cycle and development may take anywhere from a few weeks to several years. Eggs are usually laid on or near the food source such as in the soil or on a host plant, depending on the species. The number of eggs laid will depend on the species and may range from one or two up to hundreds. After hatching the larvae develop through a series of growth stages known as instars (usually 3 to 5) before pupating into adults.

Feeding

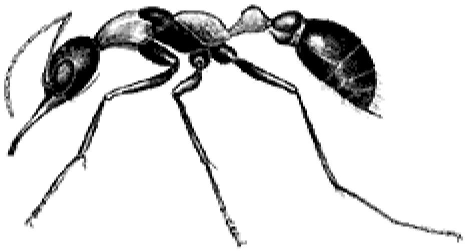
Beetles are generally herbivores, scavengers or predators, although some adult beetles do not feed at all. The greatest numbers are plant feeders in one form or another, such as nectar feeders (some Buprestidae), foliage eaters (Chrysomelidae), seed-eaters (many Curculionidae) or timber (Cerambycidae) or bark borers (Scolytidae). Others may feed on rotting wood (Lucanidae), carrion (Silphidae), dung (some Scarabaeidae), fungi or leaf litter. Some species are also predators (Carabidae) of other invertebrates. The feeding habits between larvae and adults may be the same or can vary. For example some beetle species are predatory when in the larval stage and plant-feeders when adults.

Hymenoptera

(ants, bees and wasps)



Apis mellifera (European honeybee)



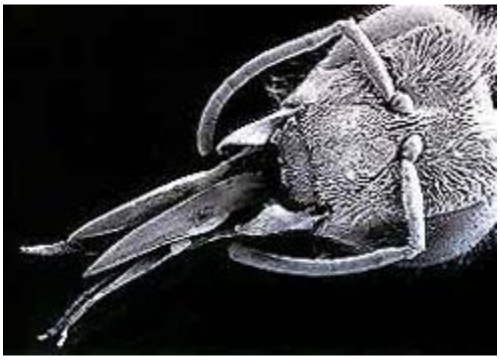
Myrmecianigrocincta

Characteristics

There approximately 14 800 Hymenoptera species in Australia and it is estimated that 4000 of these are ant species. The name Hymenoptera means 'membrane wings'. This order is large and diverse and includes groups of insects, which may appear to be unrelated due to their differing appearances. However all hymenopterans share the following characteristics:

- Two pairs of membranous wings, although some may be wingless such as some species of female wasps and the worker caste of ants
- The forewings are larger than the hind wings and are held together by small hooks (see below)
- Females usually have a hardened ovipositor, which may be modified for sawing, piercing or stinging
- Most hymenopterans have a constriction between the first 2 segments of the abdomen, which is known as a 'wasp waist'
- Chewing (mandibulate) mouthparts, although in some species such as bees the lower lip is modified to form a tongue
- Compound eyes, usually large

The larvae of hymenopterans lack many of the above external features. They vary in body shape and size depending on the species. Some display a distinct head,a thorax with 3 pairs of legs and an abdomen, although most are grub-like with no legs.

 Wing hooks of a wasp	 Bee tongue
The wing hooks of Hymenoptera enable the wings to be coupled together during flight, which gives these insects well controlled, rapid flight. These tiny hooks can be easily seen with the aid of a dissecting microscope.	The mouthparts of bees have been slightly modified to form a long tube and a hairy tongue which is used for sucking up nectar from flowers. The mouthparts of honey bees are classified as chewing and lapping types and consist of a pair of mandibles on either side of the head and a long tongue.

The Hymenoptera is divided into 2 suborders. The Symphyta (sawflies) who have no discernible waist and the Apocrita (ants, bees and wasps) who have a distinct waist.

The Hymenoptera are quite a distinctive order and members are unlikely to be confused with other insects. Some of the smaller winged species may appear to only have 1 pair of wings and may be mistaken for flies (Diptera). Sawfly larvae are very caterpillar-like in appearance and may be mistaken for caterpillars (Lepidoptera).

Life Cycle

Hymenopterans have a complete life cycle, which varies slightly depending on the species. Some females can produce young without mating, while others can store sperm and spread out their egg laying to coincide with available food. Most species will lay their eggs on the appropriate host plant or on paralysed food sources they have gathered into specially constructed nests.

A variation of this occurs with social insects such as ants and bees, where special castes provide food for the developing larvae. The larvae will moult several times before they pupate. Development may range from a few weeks for some parasitoids, to much longer in social species.

Feeding

Hymenopterans feed on a wide range of foods depending on the species. Adult wasps mostly feed on nectar and honeydew and can often be seen at flowers. Some species are predators or parasites and spend their time searching out invertebrate hosts to lay their eggs on. The feeding habits of adult ants vary and may range from specialist to generalist predators, scavengers and omnivores, to seedeaters, fungus feeders or honeydew feeders.

Habitat

Hymenopterans are found in nearly all terrestrial habitats throughout Australia and may occur in soil, leaf litter and a range of vegetation types, especially flowers. Some species are often observed drinking at the edges of water or gathering mud that is used to construct nests, often in man-made environments.

For information on some of the more common species of Hymenoptera in Australia visit the Entomology Fact Sheets pages.

Diptera

(flies and mosquitoes)

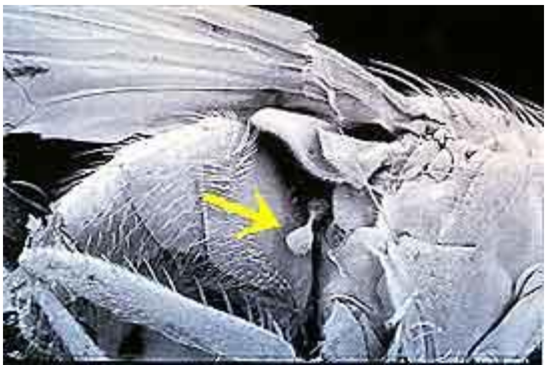
Characteristics

This is one of the largest insect orders in the world and includes many familiar insects such as mosquitoes, midges, sand flies, house flies and blowflies. Many species of Diptera are important due to the role they play in disease transmission, which includes such things as mosquitoes that spread malaria in many underdeveloped countries. Diptera can be distinguished by the following features:

Comptosia insignis (BOMBYLIIDAE)

- One pair of membranous wings
- Hind wings are reduced to small club like structures called halteres. The halteres are used as stabilisers during flight
- Sucking mouthparts, sometimes adapted for piercing e.g. mosquitoes
- large compound eyes
- short simple antennae, frilled or bushy in mosquitoes and crane flies

Comptosia insignis is a member of the BOMBYLIIDAE family. These flies superficially resemble bees due to their stoutly built bodies which are covered in hair and their long thin proboscis. This along with their flight habits have earned them the common name of bee flies. Adults can often be seen resting on or hovering over blossoms or patches of bare ground in sunny locations. Adult bee flies feed on nectar from a wide variety of flowers and may be important plant pollinators. Although little is known of the Australian species, the larvae of bee flies are believed to parasitise the larvae of other insects and may prey on the eggs in egg-masses of grasshoppers and locusts.



The small club-like halteres, as seen here are situated behind the much larger forewings. The base of halteres are flexible and when they are moved a fly or mosquito is able to control its flight. As the haltere bends at the base, a fly or mosquito can change flight speed or direction making them more manoeuvrable compared to many other flying insects.

Life Cycle

Flies have a complete life cycle and will mate while flying. The eggs are usually laid into suitable substrate or close by an appropriate food source. The larvae complete their development and pupate in the substrate where they were laid, which may be soil, organic matter, water, plant tissue or animal tissue.

Feeding

Adult flies are only able to ingest liquid foods due to their sucking and/or piercing mouthparts. In most species digestion is partially external and salivary secretions are introduced to liquefy the food and then the softened product is mopped up. Species such as mosquitoes and March flies pierce the skin of their prey with their proboscis and then suck up the blood.

The larvae of this insect order mostly feed on moist, decomposing food items such as carrion, fungi, dung and rotting vegetable matter although some are predators or parasites of other animals.

Habitat

Members of this order of insects are found in almost all types of terrestrial and freshwater habitats across Australia with forests and the margins of water bodies having the greatest diversity of species.

Cockroach

(Periplaneta Americana) External Characters

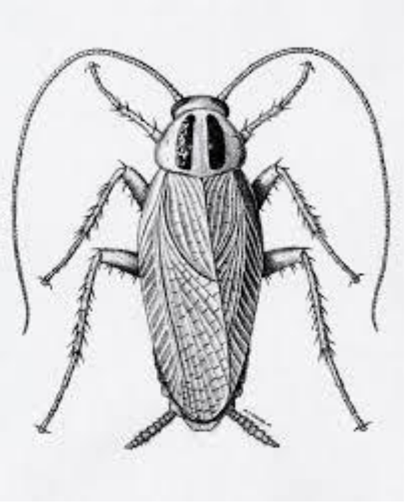
Periplaneta Americana linneyan (1758) named as blatta Americana. Barmyster proposed to Perniplaneta order. It expansion to all over world. It is a scavenger insect. It can eat all types food.

Classification

Category	:	Orthopoda
Section	:	Insecta
Order	:	Orthoptera

It is a flattening insect. It is hidden without lighting dark places, crack rooms. It has head, Chest, Abdomen which are called Tegmotas. It has a flexible neck which combines Head and Chest.

Cockroaches (Order: Blattodea)



Introduction

Cockroaches first evolved around 350-300 million years ago and are probably one of the most despised of all insects. For some people the mere mention of cockroaches will send them running for cover. However, there are roughly 4,500 described species of cockroaches and only about 25 are considered to be pests. The rest of the order are extremely beneficial insects in a variety of ecosystems.

However, when you mention the name cockroach, most people will think of the relatively small number of species that infest homes and other dwellings. Cockroaches seek out warm places and often enter homes or business premises. In these sheltered areas they breed and populations can become very large indeed.

Main characteristics of Cockroaches

Most species of cockroach are omnivorous (that is, they'll eat almost anything from plants, dead animals and even glue) and are predominantly found in tropical and sub-tropical regions.

Adult cockroaches are small to large insects (3 - 90mm in length) and usually have a broad flattened body. The pronotum (a shield-like structure on the top of the thorax behind the head) often overhangs the body on either side and covers the head.

Not all species have wings but, when these are present, the fore wings are thick and leathery and the hind wings are thin and fan-like.

Life-history

In most species of cockroach the female produces a hardened egg case called an ootheca. Commonly this is carried by the female and, in some species, the ootheca may be carried inside the abdomen and not visible. The ootheca can contain 10-50 eggs depending on the species. Cockroaches undergo incomplete metamorphosis with nymphs looking like small versions of the adults. In the winged species, the wings appear at the final moult.

Most species of cockroach have little to do with their young once they hatch from the oothecae. However, some species show a significant amount of parental care. In some species, the nymphs are carried on the back (underneath the wings) of the female cockroach and the nymphs feed on liquid secretions from pores on her back and even by piercing the membrane between her abdominal plates and feeding on the haemolymph (insect blood) coming from the wound.

In some species, and warm conditions, adulthood is reached within 40 days but in colder climates this can take over a year. However, many cockroach species are reasonably long lived and commonly kept pet species, like Madagascan Hissing Cockroaches, may live for up to three years.

Body segmentation of Insect

In general, insect body is divided in to a series of segments, which in primitive arthropods are known as “somites” or “metameres**”.** During the process of evolution, these somites gets fused with each other in different ways forming the body parts of the existing arthropods.

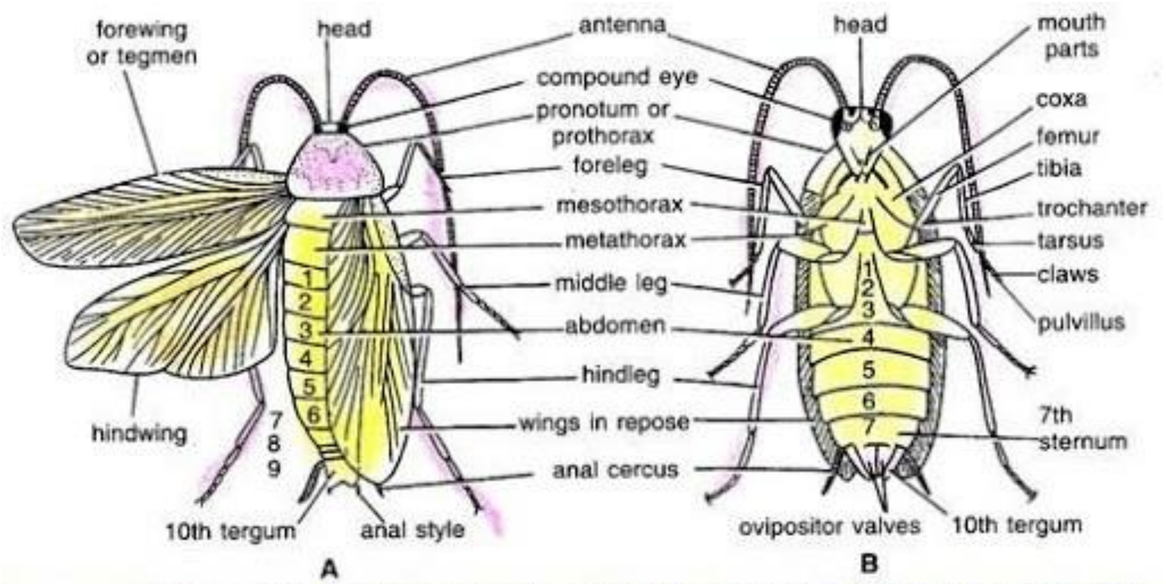
The type of arrangement of these body segments in embryonicstageis known as primarysegmentationwhile in adultinsectsis known as the secondary segmentationwhich differ from primary in having a sclerotized membranous intersegmental region.

Insect body is divided in to three regions or tagmatanamely head, thorax and abdomen. This grouping of body segments in to regions is known as tagmosis**.**

Head consists of mouthparts, compound eyes, simple eyes (ocelli) and a pair of antennae.

Thorax consists of 3 segments i.e. prothorax, mesothorax and metathorax, Meso and metathorax are together known as pterothorax. All the three thoracic segments possess a pair of legs and meso and meta thorax possess one pair of wings.

Abdomen has 7-11 segments with genital appendages on 8th and 9th segments.



Periplaneta. External features. A—Male in dorsal view; B—Female in ventral view.

Head Capsule

1. The head capsule of cockroach is formed by the union of six sclierites. Only faint sutures are exhibited between the sclierites.
2. The head capsule has both paired and unpaired ssclierites. They are
*Two epicranialplates :- Present between the two eyes on the vertex . They are connected by lambda shaped epicranial suture.
*Alarge unpaired scleiritecalledFrons,lies below the epicranium. The Frons is the largest sclierite of the head.
* Below the Frons lies a sclierite called Clypeus.
A pair of cheek sclierites called genae lie below the two compound eyes and on the lateral sides of the frons and clypeus.
3.The sclierites of the head are immovably articulated.
4.The opening on the posterior side of the head is called occipital foramen. It is bordered by a sclierite called Occiput. Oesophagus, aorta, nervecord and tracheae pass through the occipital foramen.
5.The orientation of the head in cockroach is called Hypognathous because it is bent right angles to the longitudinal axis of the body, as a result of which the jaws are directed downwords.

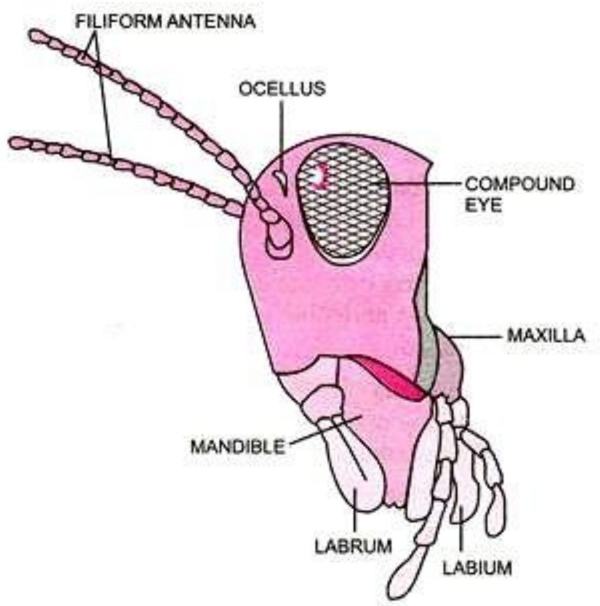


Fig. 7A.17. Head of cockroach in side view.

The head of the cockroach has a distinct triangular shape. It is formed by the fusion of six segments. The head shows great mobility due to the presence of a flexible neck. A pair of compound eyes is present on the head. In front of the eyes, membranous sockets are present, out of which two antennae protrude out.

The antennae monitor the surrounding environment with the help of the sensory receptors. The head also has appendages that bear similarity to the mouthparts, such as labrum, a pair of mandibles, a pair of maxillae and a labium. There is also flexible lobe called the hypopharynx that acts as a tongue.

Ventrally, an opening called mouth is present on the head that remains surrounded by the mouth parts consisting of a pair of mandibles, first maxillae, labium or fused second maxillae, hypopharynx and labrum. The mouth parts of the cockroach help in 'biting and chewing' its food. Functions of the mouth parts:

1) LABRUM:-

1) The mouth is covered by a labrum OR UPPER LIP.
2) It is attached to the lower edge of the clypeus.
3) The labrum bears gustatory sensilla on its inner surface.
4) The labrumhelpa in tasting and handling the food.

2) MANDIBLES:-

1) A pair of triangular, hard, unjointed, stout, chitinised structures called mandibles is present, one on either side of mouth behind the labrum.
2) The inner margins of mandibles have teeth like structures. These teeth help to masticate the food.

3) Each mandible bears a sensory lobe called prostheca near its base.
4) Two pairs of muscles called adductor and abductor muscles help in the movement of the mandibles.

3) FIRST PAIR OF MAXILLAE:-

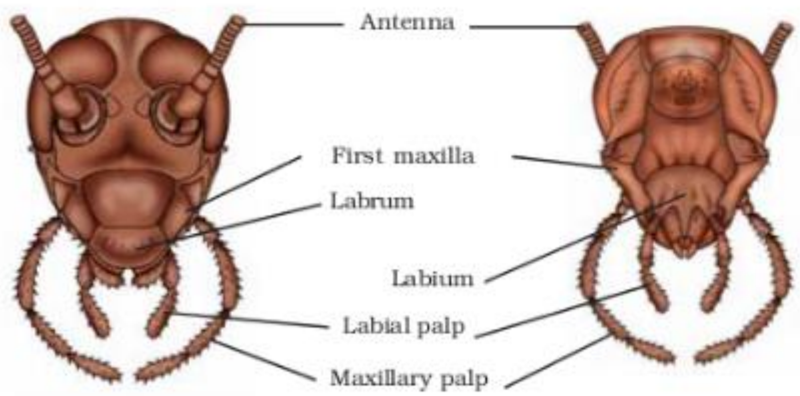
1) A pair of first maxillae lies behind the mandibles on each side of the mouth.
2) The first pair of maxilla has two basal segments called cardo and stipes.
3) Stipes attached to head capsule. Stipes is attached to cardo.
4) Stipes bears a small scleirite called palpifer on its outer margin.
5) Palpiferbeara a five segmented structure called maxillary palp.
6) Two chitinous lobes inner lacinia and outer galea are attached to the inner margin of the stipes.
7) Lacinia is pincer like with two terminal denticles. Galea is the outer, soft, blunt and hood like structure. Galea covers the lacinia.
8) The maxillary palps are used for cleaning the antennae and the front pair legs.

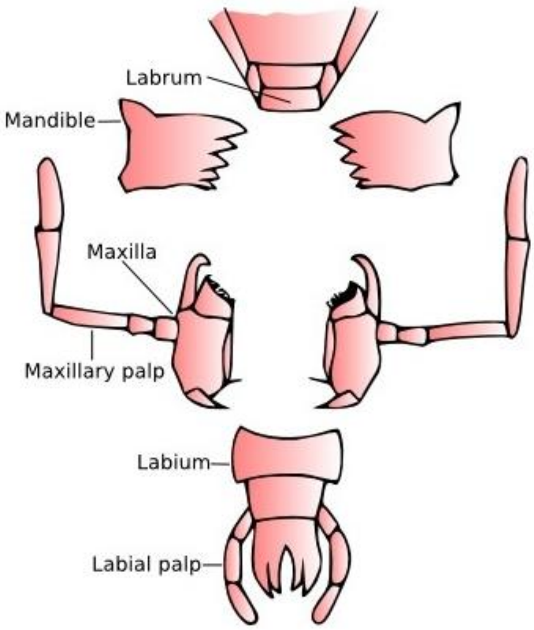
4)LABIUM or LOWER LIP:-

1) The labium or lower lip is considered to be formed by the fusion of the second pair of maxillae.
2) The labium has two segments, the basal segment-Postmentum and the anterior segment-Prementum.
3) The postmentum includes two segments, a broad rectangular -Submentum and a triangular -Mentum.
4) A small sclerite called Palpiger is present on either side of the prementum. Each palpiger bears three segmented Labial palp.
5) The distal end of the prementum bears a pair of paraglossae (comparable to galeae) and a pair of glossae (comparable to lacineae).
6) The glossae and paraglossae together constitute the Ligula.

5)HYPOPHRYNX or LIGUA:-.

1) Hypophrynx is a chitinous, grooved, rodlike structure hanging into the preoral cavity.
2) Hypopharynx is also called lingua or tongue.
3) Hypopharynx divides the proximal part of the preoral cavity into a larger anterior – cibarium and a posterior – salivarium.
4) The salivary duct opens into the salivarium, at the base of the hypopharynx.





Neck:

The Neck grease is a short slender feature that attacks to the head. The base is supported by a pair of posterior and two greiva plaques in the abdomen the muscles of the neck help the head. To rotate all the sides

Thorax

It is the middle part of the body consisting of three segments each possessing a pair of legs and a pair of wings on meso and meta thoracic segment. Meso and meta thoracic segments together known as pterothorax. Sclerite of dorsal region of thorax is tergumornotumin case of winged, insect, ventral region is called sternumand lateral region is called pleuron.

Leg of cockroach

A cockroach's **thorax** attaches three pairs of legs. Each of the three pairs of legs is named after the region of the thorax to which it attaches:

The **prothoracic legs** are closest to the cockroach's head. These are the shortest legs, and they act like brakes when the roach runs. The middle legs are the **mesothoracic legs**. They move back and forth to either speed the roach up or slow it down.

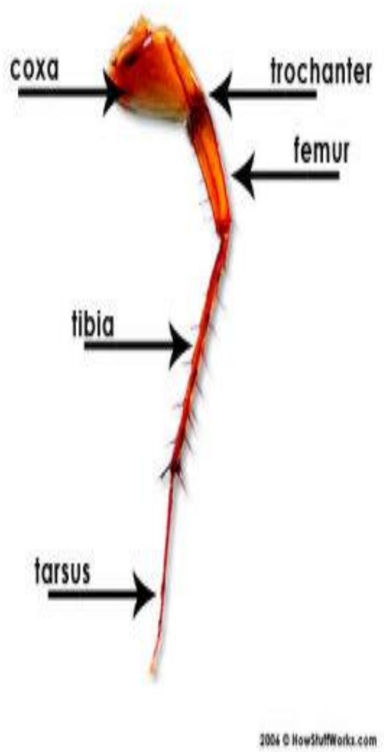
The very long **metathoracic legs** are the cockroach's back legs, and they move the cockroach forward.

These three pairs of legs, are substantially different in lengths and functions, but they have the same parts and move the same way. The upper portion of the leg, called the **coxa**, attaches the leg to the thorax. The other parts of the leg approximate parts of a human leg:

The **trochanter** acts like a knee and lets the cockroach bend its leg.

The **femur and tibia** resemble thigh and shin bones.

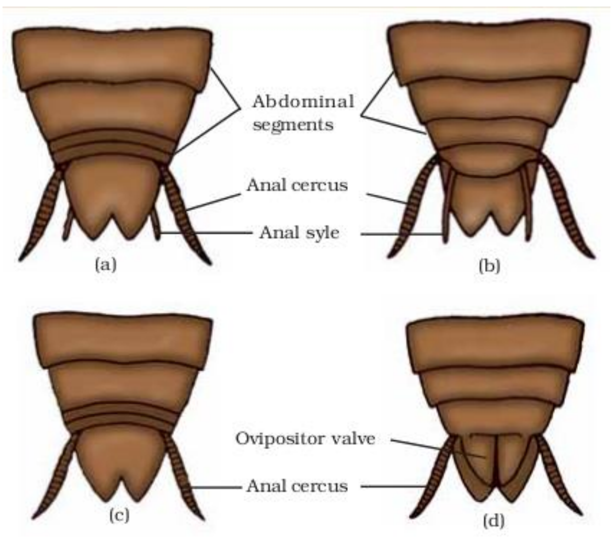
The segmented **tarsus** acts like an ankle and foot. The hook-like tarsus also helps cockroaches climb walls and walk upside down on ceilings.



Wings:

The cockroach has three pairs of jointed appendages and two pairs of wings. The fore wings are mesothoracic and are called wing covers or tegmina or elytra. ... The hind wings are large, thin, membranous and transparent. They are kept folded below the tegmina and are used for flying.

Abdomen:



- The alimentary canal present in the body cavity is divided into three regions: foregut, midgut and hindgut.
- The mouth opens into a short tubular pharynx, leading to a narrow tubular passage called oesophagus, opens into a sac like structure called crop.
- Crop has an outer layer of thick circular muscles and thick inner culicle forming six highly chitinous plate called teeth.
- A ring of 6-8 blind tubules called hepatic or gastric caecae is present at the junction of foregut and midgut, which secrete digestive juice.
- At the junction of midgut and hindgut is present another ring of 100-150 yellow coloured thin filamentous Malphigian tubules.
- Hindgut is differentiated into ileum, colon and rectum and the rectum opens out through anus.
- Blood vascular system of cockroach is an open type and blood vessels open into haemolymph.
- The haemolymph is composed of colourless plasma and haemocytes.
- The respiratory system consists of a network of trachea, that open through 10 pairs of small holes called
- The opening of the spiracles is regulated by the sphincters and exchange of gases take place at the tracheoles by diffusion.
- Excretion is performed by Malpighian tubules, which are lined by glandular and ciliated cells and absorb nitrogenous waste products and convert them into uric acid, hence the organism is uricotelic.
- The nervous system of cockroach consists of a series of fused, segmentally arranged ganglia.
- The brain is represented by supra-oesophageal ganglion which supplies nerves to antennae and compound eyes.
- The sense organs are antennae, eyes, maxillary palps, labial palps, anal cerci, etc.
- Each eye consists of about 2000 hexagonal ommatidia, due to a cockroach can receive several images of an object, which is known as mosaic vision or nocturnal vision.
- Male reproductive system consists of a pair of testes lying one on each lateral side in the 4th-6th abdominal segments.
- From each testis arises a thin vas deferens, which opens into ejaculatory duct through seminal vesicle and the ejaculatory duct opens into male gonopore situated ventral to anus.
- In the 6th-7th abdominal segments there is an accessory reproductive gland.
- The sperms are stored in the seminal vesicles and are glued together to form spermatophores.
- The female reproductive system consists of two large ovaries in the 2nd – 6th abdominal segments.
- Each ovary is formed of a group of eight ovarian tubules or ovarioles, containing a chain of developing ova.
- Oviducts of each ovary unite into a single median oviduct.
- Sperms are transferred through spermatophores.
- Their fertilized eggs are encased in dark reddish to blackish brown capsule called oothecae.

- The development of P. americana is paurometabolous, in which development takes place through nymphal stage.
- Frogs are beneficial for mankind because
- they eat insects and protect the crop
- maintain ecological balance
- the muscular legs of frog are used as food by man.

Mouth parts of insects

These are the organs primarily concerned with the uptake of food. Typical mouthpart of an insect consists of the following parts.
(i) Labrum (upper lip) (ii) A pair of mandibles (iii) A pair of maxillae (iv) Labium (lower lip) (v) Hypopharynx (tongue)
The mouth parts of insects can be basically grouped in to following types based on the type of food and method of feeding.

Type of Mouth parts Examples

I **Biting and chewing type** Grasshoppers, cockroaches

II **Sucking type / Haustellate type**

1.Piercing and sucking type Plant Bugs and Mosquitoes
2.Rasping and sucking type Thrips
3.Sponging type Adult Houseflies
4.Chewing and lapping type Honey bees
5.Siphoning type Butterflies and moths

III **Other types**

1. Mask type Naids of Dragonflies
2. Degenerate type Maggots of Diptera

I.Biting and chewing type of Mouth Parts:

This type is considered as primitive and found in Orthoptera, Isoptera and Coleoptera, larvae of Lepidoptera and Neuroptera etc. The mouth parts include following parts

a. Labrum: It is a small sclerite that forms the upper lip of the mouth cavity. It protects the mandibles and helps in closing of the mouth cavity and guide the food in to mouth. On its inner surface, labrum consists of lobe like structure called labrum – epipharynxwhich is well developed in Hymenoptera. Labrum hangs down from the clypeus through a clypeo-labralsuture.

b. Mandibles : These are the paired, unsegmented, strongest and sclerotized structures called jaws. They are attached to the head capsule by means of two joints known as ginglymusand condyle. They possess teeth like molarsand incisors that help in the process of cutting the food material. Each mandible is moved by powerful Abductorand adductormuscles.

c. Maxillae: These are paired homologous structures with basal triangular ‘cardo’**,** middle rectangular ‘stipes’and the lateral ‘palpifer’bearing maxillary palpi and lobe like inner ‘lacinia’and outer ‘galea’. Maxillary palps possess olfactoryand gustatorysense receptors and function as sensoryorgans . These. Galea and lacinia helps in holding the food material along with the mandibles.

d. Labium: It is known as lower lip and is also called as second maxillae. It closes the mouth cavity from below. It is divided in to proximal prementum. central mentumand distal submentum Near the base of pre mentum, on either side lobe like ‘palpiger’ is present which bears labial palps. Prementum has four terminal lobes. The median pair is ‘glossae’ and outer **‘**paraglossae’together called ligulathat function mainly as gustatory sense organs.

e. Hypopharynx : It is a tongue like structure situated between labrum and labium and ducts of salivary glands open on or near its base.

II. Sucking type of Mouth Parts:
This is considered as advanced type where the oral appendages get modified differently.

1. Piercing and sucking type
e.g.: plant bugs, mosquitoes

They are mainly adopted for piercing the tissues and sucking either plant sap or the nectar or blood from the host. Mouth parts are represented by rostrum/beakwhich is a modification of Labium**.** It acts as a pouch for protecting the mandibularand maxillarystylets. Mandibles and maxillae are modified in to sharp needle like stylets. The mandibular stylets form the outer pair and possess serrated margins at their tip. The maxillary stylets forms the inner pair having smooth curved tips and combine together enclosing a foodchannel. The food channel is divided in to an upper cibariumand lower salivariumwith the help of the grooves present inside the maxillary stylets. Salivarium is used for releasingthesalivaand cibarium is used for suckingthesap. The hypopharynx is modified in to a pharyngealpumpand is situated at the tip of the food channel. Llabrum is modified into a small flaplikestructure at the base of rostrum. Insects with these type of mouthparts pierce the tissues with the mandibular stylets and suck the contents (sap/ blood / nectar) through cibarium with the action of pharyngeal and cibarial muscles.

2. Rasping and sucking type of Mouth Parts : e.g. thrips

These are called asymmetrical type , since rightmandibleis rudimentary . They are in between the biting – chewing type; and piercing - sucking type. Mouth parts are represented by mouthconewhich is formed by the labrum and clypeus above and labium below. With in the beak/mouth cone hypopharynxand leftmandibleis present. Right mandible is absent where as the left mandible is modified in to a mandibular stylet. Maxillae are modified in to maxillary stylets which are mainly useful for sucking the sap that is released outside due to the rasping of tissues by the left mandible.

3. Sponging type of Mouth Parts: eg: housefly

These mouthparts are represented by proboscisformed from the labium. The proboscis is divided into a basal rostrum, middle haustellumand a distal labellum**.** The labellum is a sponge like structure. It is traversed by a number of narrow transverse channels called pseudotracheawhich converge at one point in the centre of the labellum. From this point, the food enters in to food channel which is formed by the labrum**-** epipharynxand hypopharynx. Mandibles are absent (reduced) maxillary palpi are 1-3 segmented During feeding, the proboscis is pressed over the food material. The pseudotracheagets filled with the food material by the capillaryaction and is sucked up from the central point in to the oesophagus.

4. Chewing and lapping type of Mouth Parts : e.g**.** : honey bees

The labrum and mandibles are **biting type** whereas maxillae, labium and hypopharynx combine together to form a sucking **proboscis** . The mandibles are dumbbell shaped, non-trophic and industrial in function . The cardo of maxillae unite with submentum of labium forming an inverted "V" shaped **lorum**. The maxillary palpi are very small or reduced. Galea and lacinia of maxillae remain suspended from the cranial wall and attached at the lorum. Labial palpi are conspicuous and 4- segmented. Elongated central organ of the proboscis is the glossa and at the base of glossae are two small concealed lobes are paraglossae. Glossae is provided with long hairs and a small spoon shaped lobe, called **flabellum** or **bouton** at its apex. The side walls of glossae are inclined downwards and inwards until they almost meet along the mid ventral line and form the boundaries of a central cavity. At rest, mouth parts are folded beneath the head against stipes and mentum. During feeding they are straightened with labial palpi closely applied to glossa and partly embraced by the ensheathing of galea and lacinia. Glossa is very active while food is being imbibed retracting and protruding from the base of mentum. The liquid food (nectar) ascends by means of capillary action in to the central channel of glossae and enters in to the space between paraglossae and in to the mouth cavity.

5. Siphoning type of Mouth parts :eg: butterflies

These are specially modified for taking nectar from the flowers. The galea of maxilla form into a slender, hollow, tubular structure which remains as an elongated coiled proboscis underneath the head during non feeding. Mandibles are totally absent. The labrum and maxilla palpi are reduced. Labium is modified in to a small basal plate possessing a 3 segmented labial palpi. The food channel is formed by the fusion of both the galea . The nectar will be sucked from the flowers through muscular action.

Other types

1. **Mask type of Mouth Parts** : e.g. Naids of dragon flies.

Mainly useful for catching the prey. **Labium** is modified in to a mask where the prementum and post mentum forms in to an elongated structure with a joint. The labial palpi are represented as teeth like structures / spines at the tip of the labium that are helpful for catching the prey. All other parts remain rudimentary (reduced). During resting period, when the insect is not feeding, the mouthparts cover a part of the head. Hence it is called mask type.

2.**Degenerate type of Mouth Parts** :e.g.:Maggots of Diptera.

In apodous maggots a definite head is absent and mouth parts are highly reduced and represented by a mouth hooks/ Spines .

Damage symptoms of Pest and kinds of losses

Insects damages plants directly or indirectly for food. Insects attacks and damages every part of the plant like Roots, Stem, Bark, Branches, Leaf, Flowers and fruits.

Damage symptoms of plants by pests are classified below:

1.ROOT GRUBS:

Some types of Larva damages roots by eating and some others Nymphs and mature worms sucks liquid from roots.

Simultaneously plant growth decreases and tillers failure and even some plants can die.

Ex: grubs, paddy, jowar, black gram, groundnut root grubs .

2. STEM BORRER:

Larva attacks stem or enter into tillers and damages by eating internal parts .

Because of this the damaged part separated from stem.Consequently damaged part will drain and dies.Those symptoms are (movvuendatam/panicle drains / panicle death white ear head, bunchy top movvuchavatam/thellakanki/bunchytop)

EX: Paddy, Food grains, sugarcane, brinjal ,stem weave worm.

3.SHOOT BORRER:

Larva attacks on matured branches while they are in growing stage it enters into branches and damages. In the result new shoot and fruit borer, soyam shoot fly branches will drain and dies.

EX: Brinjal, lady's finger, cotton, castor, branch weave worm, sorghum shoot fly.

4. TREE BORRER

Larva enters deeply into the tree stem, makes zig zag ways and eats particles. Conseqyently it stops the flow of food and water from bottom to top of the tree. Because of this leafs of the tree changes it color to yellow and dries, branches also dries and tree will dries completely . sometimes gummy like substance oores by of pest attacked plant .

Ex: mango , cashew , coconut coconut red weevel worms .

5. COCONUT RED WEEVD

Larva enters sideways of branches and below bark makes small ways to build the nest with silk and damages the bark for their food.

EX: lemon, mango, guava bark weevel.

6. GALLS

Larva attacks stem / tillers / leaves / flowers and eat because of this wounds develops more in pests attacked places. Growth becomes unstable. Consequently plant produce extra tillers, growths like onion stem, stem / leaf buds will have wounds.

EX: Rice gall midge, tobacco leaf worm, inflorescence midge.

7. LEAF SOLLAR

Larva attacks leaves in a manner from first to last at curves to fold leaves and makes like nest to eat chlorophyll from inside the leaf.

EX: paddy , cotton leaf roller.

8. LEAF BORRER

Larva enters to middle of the leaf layers to damage or eat chlorophyll. In a result leaves get transparent white marks or makes zig zag ways n the leaf.

EX: Lemon , cashew leaf borrer , rice hispa.

9. LEAF WEBBER

Larva using silk to make nest with leaves and while webber it will eating chlorophyll from leaves. Because of this leaves become mesh.

Ex: c, groundnut, sapota, mango leaf nest worms.

10. LEAF EATERS

Larva attacks leaves and eats completely. Because of this on some leaves only soles will left. on some leaves there wiil be percolate type holes.

Ex: caustorsemi looper, red hairy cater pillar , tobacco cater pillar , brinjal henosepilachna.

11. BOLL WORMS

larva attacks fruits while it is in Crop harvesting stage to eat from inside the fruit , some pest make nest with silk and their excreta to damage from inside.

Ex: caustor and sesamum capsule worms, cotton bollworms

12.FRUIT BORER

Larva attack on fruits and eats total pulp

- Bore holes on shoots and fruits plugged with excreta
- Shedding of flower buds
- Withering and drying of leaves

Ex: brinjal, lady’s finger, tomato fruit borers.

13. STORAGE PEST

In storaged wheat larva attacks seeds from inside or out side damages the seed by making web.

Ex: rice and pulses storage pests .

14. SUCKING PEST

Some pest in different stages attacks different puts of plants and sucks liquid form of food and damages the plant **.**

Types of sucking pest:

A) SEEDS

Nymphs and there mature worms attacks developing seeds and sucks liquid food**.** Because of this seeds will not become hardy**.**

EX: paddy and jowar sucking pest**.**

B) PLANTS TENDER PARTS /LEAVES

Nymphs and mature worms attacks fresh leaves/ branches/stem and sucks the liquid food , because of this growth of plants decreases and becomes dwarf plant**.**
When the number of pest is massive and the damage will be more, In that situation honey type liquid flows on the parts of the plant**.** Because of this the damaged part will be covered with black soot

DAMAGE SYMPTOMS WITH EXAMPLES :

1.Soodi thegulu ,plant dry completely in different areas on crop.
EX: paddy, wheat, leaf hoppers
2. there will be folds on Edges of leaves/ red colour marks.
EX: cotton leaf hoppers.
3. leaf upper winkle
Ex: chili thrips
4. leaf lower winkle.
Ex: chili mite.
5. on leafs end to start will dry.
Ex: thrips.
6. white and yellow stripes on upper part of the leafs.
Ex: castor , coconut , lady's finger mites
7. Dwarf Plant / Black Soot / Flowers Fall down
Ex: White Fly
8.Yellowish leaves / folded leaves
Ex: Ground nut / pulses thrips
9. Growth of plant decreases / yellowish leaves / soot
Ex: Aphids
10. Holes on fruits / covered by excreta
Ex: fruit Flys
11. Decomposing of Fruits / Brown marks on fruits
Ex: Fruits sucking pest

INTERGRATED PEST MANAGEMENT

If a harmful pest grows on the one hand in nature, then the natural worms that feed on them on the other hand will also grow and be balanced with the offspring of natural ready-to-eat worms. man must constantly strives to environmental balance. in addition, the disturbance of the natures equilibrium for its selfishness can cause many problems.

Hybrid varieties have been developed and cultivated in many pears for higher production. large amounts of chemical fertilizers are used for high yield hybrid verities. pests are more vulnerable to these high yielding varieties compared to indigenous varieties. the use of pesticides is of paramount importance in our efforts to curtail this loss. this process attracts farming more.

The use of pesticides has become popular due to the availability of various types of pesticides, the financial resources available to most farmers and the need to control worms in short span of time. Farmers who harvest crops use toxic pesticides indiscriminately. The first and most important of meanings is climate pollution. We need to breathe, drink water and eat food poisoning, which can endanger the health of humans and livestock and threaten their survival. If the pesticides is used in large doses and the correct dosage is not used, the worms can increase the pesticides toxicity.1986-87 years. it is well known fact that helicoverpa mite, which damages cotton wool in some varieties, does not cure a human being with a certain temperament. toxic chemicals are parasiticized by parasites. This will reduce the natural resistance of the insect and cause insect worms to thrive.

Although the temporary effects of high yields may be attributed to the use of pesticides, pear production may fall drastically in the future due to the aforementioned side effects. The power of medication is finally wiped out and the new types of pest worms poison our head and cause us mental agony.

Integrated pest management or comprehensive pest management is a program that helps to preserve the balance of natural organisms by incorporating various practical measures available to us to regulate the use of toxic chemicals use for pesticide control.

An important step in comprehensive pest management is to keep growth of pest in control.

IPM CONTROL METHODS:

In **IPM** There are two types of control methods

1.NATURAL CONTROL:

(a).Climatic conditions :

Climatic conditions are very important for natural control of pests. Are effectively .Rains , the resulting soft soil , some types of caterpillar , are needed for the transition to the infant stage and their adults . however, heavy rains can reduce the sucking pest like thrips damage. Similarly, if the air temperature humidity is not favourable, pest infestation will reduce.

(b).Natural enemies :

Each insect has many natural bodies in nature. They can feed on insects and control them. We treat them as predators , parasites. Some types of viruses, such as bacteria and fungi, can infect insects and cause infections. Therefore , the natural of insect progeny is avoided .

(c).Natural barriers :

Geological conditions mean landslides, the oceans can be trapped in different areas of the ocean. Soil type can also prevent the development of worms for example, earthworms are more common in hight soils, red soils, but in blank clay soils will not survive.

2. Artificial control :

Control in nature, worms are kept under comtrol, whithout human efforts . insecticidal insects, which are capable of escaping these natural insects and harming pears, can be controlled using a variety of artificial control.

Artificial control methods are divided into 6 types given below

1. Farming methods /Mechanical methods
2. Mechanisms cultivation
3. Biological processes
4. Jurisprudence processes
5. Chemical pesticides

1.Farming methods /Mechanical methods:

Pest worms need to remember the way they are sprayed and changes certain conditions without damaging them. Doing this will help to prevent the risk of pest infestation. There is no cost to adopt these methods .

(a). Summer ploughings:

If the land is deeply plowed in the absence of crop, in summer we can prevent the worms that lives inside the ground .

Ex: groundnut root grubs, helicoverpa, pupa stage , spodaptaralitura pupa stage , grasshopper eggs . while cultivating the land , these insects comes out from ground and damages the crop . so summer tillage are essential .

(b). keeping the farm clean:

Cotton farmers, even when the cotton picking are finished farmers leaving the moulds in the farm . so when the monsoon start they do not removing before ploughing. Those moulds give nest for many insects . if the moulds are removed while the cotton seeds are in place, the pest count can be reduced. Removing steam in paddy by destroying the stalks in the field after harvesting the rice leaves and rejuvenating the eggplant after the completion of the harvest .

(C).CROP ROTATION:

Planting two similar crops in successive years tends to increase pest problems. Many vegetables are closely related and have the same pests and diseases. Some insects hibernate in the soil or litter around plants or lay eggs in or on the host plant. Do not grow the same kind of vegetable in the same place each year. Use related crops in a site only once every three or four years. The rotation period for avoiding some tomato diseases may be five to seven years. Another type of crop rotation is to avoid planting root crops in consecutive years in the same row. Crop rotation

EX: if we cultivate one year of cotton should be worn another year

(d) .TRAP CROP/ PROTECTION CROP

Pest are more susceptible to certain crops. If such crops are planted around the field, the pest infestation will reduce.

EX: tobacco worms are more susceptible to castor oil than cotton during the adult stage. Therefore, if the cotton seed is rounded, castor leaves once or twice will be placed on castles. Then pest attack to cotton will reduced. Protect the cotton as a safety net. However, it is important to keep a close eye on the castor oil and the pesticide. If the beetle is raised at the tender stage in the cotton wood, the green mosquito will most likely leave the cotton, expecting the bender. okra finger can be used as bait for cotton.

(e).**HEALTHY SEEDS:**

Pest diseases free seeds and fiber should used. A healthy seed or seedling should be used as (nematodes) and so on can be spread through the seed and into the field.

EX: Nematodes should not be used as an expectant egg or tomato plant or as a worm.

(f).CROP SOWING TIME

Based on past year`s experience, the crop can be protected from pests by adjusting the time of sowing to observe when the crop is expecting.

EX: In sorghum sarva in June and in the second part of maghi in November, the shoot fly will decrease. Early sowing field can be protected from gall midge of the onion cord, pre planted in sarva. If the sarva is planted in July and rabi in Warangal area, the gall midje can be avoided by white earhead clutches. If the sesamum sarva is in may and rabi in January ,the (phyllodi) rot is not expected. If the cotton swab is placed in June and July, the worm`s alertness will be reduced.

(g).FERTILIZERS USAGE: Pest infestation to plants crops, depend application of important fertilizers such as nitrogen, phosphorus and potash applied in the field. Excessive use of nitrogen fertilizers will make the tillage more susceptible to insect infestation . however, excessive use of potash fertilizers can increase the insecticide resistance. Therefore , fertilizer should be used in tablets and in recommended doses.

EX: when nitrogen is used, rice mosquitoes , leaf blight , mildew ,cotton swabs, chili leaf blight, lice.

(h).CULTIVATION OF PEST TOLERENCES:

If pest to lerance, high yielding vermietics are cultivated, can assest the pest inf festation to some extent.

EX: phalguna, surekha, vikram, shakti, kakatiya, danyalakshmi, vajram, chaithanya, nagarjuna and prathiba are ullikodu insect resistant.

L-P-S 141,L.K 861,S.V.1280 these are cotton white fly resistant.

2.Mechanisms cultivation

Mechanisms are the use of small equipment or hand implements to prevent insect worms.

Trap

1.(a).Lamp tramp

Paddy stem borrer, BPH, gall midje are attracted by light traps. Therefore, the lamps in the farms can be reduced to some extent of the pests. However, the hole farmers in the area should be used in the lamp.

(b).Fire

The red hairy caterpillar of the groundnut is attracted to the flames. With the help of garbage, tires that are not in used can be used for fire.

2.**(a).Pheromone traps**

Reduce the pest incident by putting poison bait containing peanut butter, tobacco clover and sex chemicals. Putting 4 or 5 baskets per acre reduces insect attack by approximately 30%. Male-winged insects are attracted to these baits and captive. Females will die by interruption in mating. The presence of worms can also be assessed by these bait.

3.(a)Yellow sesame traps

The presence of a white flies in cotton can be determined by using the castor oil applied yellow sticky traps.

(b).Picking / Removing

Adults of spodoptera will lies the eggs on clusters/mass in cotton, tobacco, and chillies. These egg masses can easily identified mainly these egg masses present under leaf sheath, should diagnose and destroy immediately because the larva emerges from the eggs will eat away chlorophyll content of the leaf, resulting to leaf turns to like sieves. These pest infestation can be controlled by picking / removing the infested leaf or by spraying of chemicals. Similarly, rhinocerous beetle in coconut can be controlled / killed by using an iron rod for pulling out.

4.(a). Poisonous Bates

When tobacco catterpiller get older, they can hide in the ground throughout the day and in the evening and at night, they will come to the top and damages the crop. Therefore, position mixed bran balls should place in the evening to control red harry catterpiller (by eating the position bates) 0.5 kg Carbaryl

(Sevin 50%) powder should mixed with 0.5 kg Jagger and 10 kg bran with approximate water to prepare balls (position bates) for 1 acre of field.

5.Pits/ Trenches

Red catter pillar and Tobacco catter pillar, mobs move from one farm to another. In such a situation, dig a deep plow or trench around the farm and b. H. C, D. D. If you apply a powder pesticides, such as T, carbaryl or falidol, the worms will fall into the trench and die of poison.

6.Barrier

Mango trees can be applied gum around the stem and wrapped in wax paper and rolled from the tree to the top of the tree. Similarly, in order to prevent rodents from climbing coconut trees, iron strings or iron foil should be placed at the beginning of the stem.

3.Physical methods

These methods are mainly used to prevent storage pests. Grain worms can be prevented if a silicogel called "dry dye" is added to the grain. As the dry worm enters the body, the worm loses more moisture in the form of steam. As a result! The worms perish. This material is used in America. In the same way, activated clay can prevent mites. 557 cm of grain. Gray temperature at 3 h. The worms kept by the s will be destroyed. Similarly, using X Ray and Gamarous also prevents worms from damaging them.

4.biological process

The famous saying is that the "diamond should be cut with the diamond." Similarly, insects are easier to deal with and less expensive. As well as harmful insects, there are also pests and microbes that eradicate them in nature. These are the natural enemies of pests. Biological control or biological control is the use of natural enemies to control insect worms. The use of natural enemies for the protection of the realm is from euthanasia. In China, fruit trees were used as a kind of ants to protect the caterpillars. As early as 1762, Mauritius imported bison to feed locusts. In 1873 a separate worm was brought from the Americas to contain a worm (filoxara) in France. In 1888 an axial worm (Rodolia cardinalis) was imported from Australia to prevent cotton swabs in California

Natural enemies can divided into 3 types

1) **Parasites**
2) **Predators**
3) **Disease cause microorganisms**

1. Parasites

They enter the insect or the top of it and they kills the pests. Pests in different stages, such as the oviduct, the caterpillar stage, the pupa stage, and the winged insect stage, are attacked by natural enemies and controls the pests. Trichogramma, a parasite, develops on the eggs of the cotton bollworm. Trichogramma lays the eggs on eggs of cotton bollworm the unmatured larva of Trichogramma feeds if eggs of cotton bollworm with in 3-4 days the eggs will turns to black colour. After words the insect larvae emerge from the parasitoid maturing stages in four to five days after they turn black,.

Using procedure

As soon as the pests begin observed in the sex traps, immediately, paracitoides must be released. By doing this, the trichogramma worms destroy the eggs of car worms before the larvae emerge. These parasitoids are available in the form of trichocards. Each card contains twenty thousand trichogramma worms. Five tricho cards per acre, one lakh shoots of cytoids per 10 - 15 days should be used as two and three doses. Release the shovels a few more times as needed.

Benefits

Trichogramma insects seek out the eggs of the pests and increase their species. In this way, these shovels can be destroyed before the insect is born and the larval stages prevent damage to the crop. It is considered a viable defense in all respects because of its usefulness and its low cost.

- **(a).**Parasites that are enters / kills in the egg stage belong to the genus Trichogramma, Telenomus, and Tetrastricus.
- **(b).**The parasites kills in the caterpillar stage belong to the genus Amphatelis, Brachus, Kilonus, and Euclitoria.
- **(c).**Parasites that are kills in the infancy stage belong to the Brachia maria and Pimpla species.

2. Predators

We know that frog and lizard eat certain kinds of insects, as well as certain types of pest that are harmful to the farmer. Notable among them are the spider, the coccinellede, the priming mantis.

3. Disease cause microorganisms

Just as humans get sick, so do the pest. Insects dies due to these ilmentes. Bacteria, fungi and viruses can infect insects. Insecticides can be controlled by worms. The pathogen is not harmful beyond an insect species. So it will not cause any other damage. Pathogenic microorganisms can be easily grown in the laboratory. No cost, no pollution. The worms are not immune to insecticides and cannot be immunized. Pathogenic microorganisms can also be sprayed with insecticides.

(a).Bacteria

The pests gets infected only when it is taken by mouth. Symptoms can be seen within 7 hours of entering the body. The pest get paralyzed. The body becomes soft and dry. The inside of the body pest turns black and smells bad. Sometime the fluid in the body expels. When the bacteria of the genus Ceresia attacks, the body fluid turns red. The worms are caught with leaves and twigs on their legs before they die. Bacillus thuringensis, b. Lentimarbus, b. cerious are examples for disease causing Bacteria.

(b).Fungus

Fungi attack the worm's body and enter it. Depending on the type of fungus with attacks, the mould forms white, black or red on the worm's body. This mould occurs inside and outside the body. The worm body becomes stiff.

(c).Virus

The specius Buculo viride family attacks the insects and cause disease. Viruses have been isolated from nearly 800 species of insects. These viruses fall into three categories. They are the Nuclear Polyhydrosis virus. N.P.V Cyto Plasmic Polyhydrosis Virus (C. P. V) Granulosin Virus (G V). This micro-organism of the genus Nuclei Poly Hydrosis produces only the larval stages of the worm and causes disease. For different type of N.P.Vs to be used to different types of pests. Since anti viral activity is limited to different species of NPVs. When lava eats plant parts, NPV enters into larva and develop faster in insect body. These NPV infested larva takes less feed and dies with in 5-6 days. The larva climb upper parts of plant before dying, and hangs inversely to the plant parts. These pests gradually rot release NPV causes disease in new larvae of pest.

Using procedure

When the larval stages of the *Helicoverpa* and tobacco caterpillar appears in the crop, different NPV should be used. NPV microorganisms are available in the form of thick liquid. 100 - 200th per acre. . (Larval Equivalent) n. P. V liquid should be sprayed with water in recommended doses, respraying as needed pest larvae cause more damage to the crop at night. Therefore, evening spraying of NPV will get more results. NPV should store in cool places, refrigerator for a few days.

Precautions to be taken to develop natural enemies

1. The use of pesticides can be reduced by predicting the number of worms that are affected by the crop. This will save natural enemies.
2. Endosulfan and fasalone pellet medications that are not harmful to natural enemies should be used as needed.
3. Cultivation of bait (bait lure) before the main crop can develop natural enemies.
4. Instead of intensifying the insect's pests, proper farming practices should be adopted to promote natural enemies.

5. Judicial processes / legal practices to plant a different state

Supply of plants from one state to another or from one country to another can cause considerable damage to the plant and the pest infestations that can spread to the state or country. Phylloxera, an insect that destroyed the grapes from the US in 1860, entered France with plants and caused damage. Therefore, the US first introduced the Quarantine Act in 1905. As a result, in order to import any plants or seeds into the US, entomologists at the country's docks and airports must inspect and certify that there is no insect or pest on the plants. There are currently 5 different types of laws that are applicable in different countries.

(a).Laws that prevent the spread of other countries' plagues in the new country

In order to prevent the spread of insects and micro organisms into the country, the central government enacted the anti-predatory act of 1914.

(b). LAWS THAT PREVENTS THE COUNTRY`S PESTS FROM ONE REGION TO ANOTHER:

For the first time in our country, the madras state government enacted the madras agricultural pesticides act in 1919. Under the law, the government is empowered to identify an insect as a pest and take measures to prevent it. If the farmer does not comply with the instructions of the agricultural authorities, the agricultural authorities have the right to take preventive measures and collect the cost from the farmer.

(c).Laws to implement effective preventive measures to prevent pests:

Farmers are not taking the preventive measures recommended by the black cotton worm on coconut within 5 miles of Mangalore, South Kanara. Thus, on January 1, 1923, the law was enacted in the worm-holed area. According to the law, the black moth worm leaves the desired leaves.

(d).Anti-pesticides laws

In our country, the Insect Pesticides Act 1968 (No. 46 Plant 1968) has been in force since September 2, 1968. It regulates the import, manufacture, sale, distribution and use of pesticides. The Central Pesticides Agency was established to provide technical advice to the Central and State Governments on the implementation of the Act.

(e).Laws to regulate the actions of caregivers:

Since worms are toxic, proper care must be taken when using them.

Importance of pesticides:

Proper nourishment should be used to prevent worms and pests from damaging various crops. However, selecting the right equipment to spray these pesticides on the crop is also a major factor in crop protection. However, the selection of a protective device depends on the degree of stress and pest resistance of the worms in the soil. The use of pesticides is a must in comprehensive care, but they should only be used as a last resort. If the nature of the insect is not known, adverse effects can occur. Today, various business organizations are producing millions of tonnes of sewage, and their importance in aquaculture.

Storing insecticides

1. The appropriate labels for the pesticide should be pasted and locked in a cool, dry room that is not accessible to children.
2. Before thoroughly understanding the information on the label before making the pesticides, mix the pesticides and water at the prescribed dosage using the appropriate measurements.
3. Under no circumstances should the chemical / pesticide come in handy.

4. Care should be taken not to prepare the mixture or the filling in the tank.
5. When they are in the air, wear proper clothes and gloves and spray the pesticides. Make sure that no part of the body is exposed to pests.
6. Pesticides should not spray in windward direction.
7. When spraying pesticides should not be eaten bundles, drinking beedi, cigarettes and chewing tobacco.
8. Regular inspection of spraying equipment should be carried out regularly. Sprayer nozzles should not blow with mouth.
9. The rest of the mixture and equipment should not be cleaned in ponds or drains. Doing so will contaminate the water.
10. Empty medicine bins must be destroyed immediately or buried in a place in the ground.
11. Take a clean bath immediately after spraying and take care of any pesticide residues.
12. They should be informed to prevent other farmers' cattle from entering the farm sprayed with pesticides.

Techniques in the effective use of pesticides:

1. Spray wormwood spray due to lack of plant growth and expansion in the earliest stage. Instead of wasting the pesticides, spray only as needed using a hand pump The sprayer should be sprayed on the spread sprayer during the extended phase.
2. 'In the pears of chilli, cotton, vegetables, etc., such as eczema and red pepper, suckers from the underside of the leaves. To prevent them, spray the nose to the side and spray the nozzle to completely wet the bottom of the leaves.
3. The pesticides should be carefully instilled in the form of water droplets, under the leaves, in the form of ice droplets on the top, in small, bulky plants, on coatings and on worms. Good nozzle selection is very important.
4. The amount of pesticides water will fall on the same crop, and the wider the plants, the more it will depend on the nozzles we choose.
5. The leaves of some pears are thin. Spraying on them does not stop and slips. So you have to mix the ingredients such as Dilulasandovit or Teapal.

6. Some insects are in the infancy stage of plants. To prevent these, dry matter such as carbaryl in the soil should be mixed at the roots of the plants.
7. Whenever possible, spray the two types of insecticides together with chemical reactions in the mixture and do not spray the pesticides. Some medication stakes. In this regard, following the advice of the experts in the field of agriculture, the best solution is to disinfect the spray.
8. In order to increase the efficacy of the insecticide medication in accordance with the suggestions of the worms, the spray should be sprayed as far as possible in the evening. At the time, the pesticideswas exposed to sunlight as long as possible, causing the worm to penetrate to the inside of the leaves and poison the entire leaf.
9. Also, many varieties of larvae can damage the crop at night and cause damage. Therefore, spraying at midday in the evening can help the worms work effectively on the worm.
10. Wear clothing, mask , gloves and eyeglasses must be worn to keep the body hydrated.
11. Before spraying, it is important to add water to the pesticides. Sprayer should not use sewage, mud, rotten leaves, salt water and salt water. Good water with good lighting results.
12. Farmers should only buy the pesticides from licensed stores each time.

Pesticides are mainly divided into <u>two (2)</u> types:

Based on its speed of action

1. **The fastest ones**
2. **Slower ones**

These drugs enter the human body in three ways and cause illness.

1. By inhaling intoxicated vapors (through the mouth) of the skin
2. By inhaling (by touching) the skin through the mouth.
3. By entering through mouth, ociophagus and contaminated food / chemical mixed food.

The last of the above three is the most dangerous of the insecticides which was introduced by the method. Denoted in g / kg. The amount of drug needed to kill an animal weighing 1 kg is determined by measuring. The dose is determined by the amount of lethal dose - 50 per cent of the animals die at various times due to the skin, mouth, and toxins of the animal. The same drug has different effects on different animals. Therefore their l. D. There are also differences in the 50 values. For The main reason sun protection medications have a specific toxic effect is that they can be divided into 4 types, depending on the severity of the poison.

1.	Most poisonous	L.d.50	1-50m.g/kg body weight
2.	More poisonous	L.d.50	51-500 m.g/kg body weight
3.	Medium poisonous	L.d.50	501-5000 m.g/kg body weight
4.	Low poisonous	L.d.50	5000 m.g/kg body weight

In order to make the farmer understandable, pharmaceutical manufacturers print colored markers on their products to determine the severity of the drug. The guru should have a diamond-shaped label on the preservative, rather than the 165th of the entire area. Medicine. The colors in the diamond are determined by the severity of the poison. Four colors are specified.

INSECTICIDES CLASSIFICATION

Pest management insecticide are classified based on given below

1.BASED ON TOXICITY

2. BASED ON MODE OF ENTRY

3. BASED ON MODE OF ACTION

4. BASED ON CHEMICAL NATURE

1.BASED ON TOXICITY :

The chemical which can make changes in pest life cycle that chemical called poison. it is measured as $L.D._{50}$. The Value of L.D.50 for a substance is the dose required to kill half members of a tested population after a specified test**.** These are two types

I.
(a) L.D. 50 ORAL : by mouth
(b) L.D. 50 Dermal : by contact

II. when quantity along with the dose is also preferred as **two types**

(a) **ACUTE TOXICITY:** Acute toxicity describes the adverse effects of a substance that result either from a single exposure or from multiple exposures in a short period of time. To be described as acute toxicity.

(b) **CHRONIC TOXICITY:** Chronic toxicity is the development of adverse effects as the result of long term exposure to a toxicant or other stressor.

2. BASED ON MODE OF ENTRY :

Depending on the manner in which chemical enter the body of the insects are **three types.**

(a) **STOMACH POISION :** Stomach poison. A pesticide that is ingested by a pest and absorbed into its body, causes its death.
Ex: DDT , BHC **.**

(b) **CONTACT POISIONS :** Contact poisons are those chemicals which injure the target organism by physical contact or skin absorption, rather than inhalation or indigestion.
Ex: led arsenate , calcium arsenate

(c) FUMIGANTS : Fumigation is a method of pest control that completely fills an area with gaseous pesticides—or fumigants

Ex: EDCT , EDB , HCN , AL2(PO4)3 , SO2

3. BASED ON MODE ACTION :

Depending on the way of chemicals works in the body of the insects are **four types**

(a). Physical poison :

Physical toxicants are substances that, due to their physical nature, interfere with biological processes. Corrosive chemicals possess physical toxicity because they destroy tissues, but they're not directly poisonous unless they interfere directly with biological activity.

Ex: aluminumoxide - affect above the cuticle cause water vapour to accumulate inside .

Charcoal - inside of insect, that sucks the wet and harm

(b). Protoplasmic poisons :

A protoplasmic poison is a substance or material that can damage or kill living cells. Specifically, a protoplasmic poison affects the organelles

Ex: Arsenical material .

(c). Respiratory poisons :

Respiratory poisons. A wide variety of different compounds act as respiratory poisons, and inhibit the oxidation of metabolic fuels linked to the phosphorylation of ADP to ATP. Ex: HCN , CO

(d).Nerve poisons :

a toxic, usually odorless organophosphate (such as sarin, tabun, or VX) that disrupts the transmission of nerve impulses by inhibiting cholinesterase and especially acetylcholinesterase

Ex: organo phosphates

(e).Based on chemical nature :

BOTANICAL INSECTICIDES

1.NEEM :<u>Azadiractaindica</u>

Source. Neem products are derived from the neem tree, *Azadirachta indica*, that grows in arid tropical and subtropical regions on several continents. The principle active compound in neem is azadirachtin, a bitter, complex chemical that is both a feeding deterrent and a growth regulator. Meliantriol, salannin, and many other minor components of neem are also active in various ways. Neem products include teas and dusts made from leaves and bark, extracts from whole fruits, seeds, or seed kernels, and an oil expressed from the seed kernel.

The product known as “neem oil” is more like a vegetable or horticultural oil and acts to suffocate insects. Neem and neem oil are often confused.

Mode of action. Neem is a complex mixture of biologically active materials, and it is difficult to pinpoint the exact modes of action of various extracts or preparations. In insects, neem is most active as a feeding deterrent, but in various forms it also serves as a repellent, growth regulator, oviposition (egg deposition) suppressant, sterilant, or toxin.

As a repellent, neem prevents insects from initiating feeding. As a feeding deterrent, it causes insects to stop feeding. As a feeding, either immediately after the first “taste” (due to the presence of deterrent taste factors), or at some point soon after ingesting the food (due to secondary hormonal or physiological effects of the deterrent substance). As a growth regulator, neem is thought to disrupt normal development interfering with chitin synthesis. Susceptibility to the various effects of neem differs by species.

Ex: neem seed powder (1-2 cups) for wheat seeds (100 cups) brushing can effectively prevent storage grains from insects that are expected for up to 9 months

2.TOBACCO :<u>Nicotianarustica</u>

Structure. $C_{10}H_{16}N_2O_4S$
Source. Nicotine is a simple alkaloid derived from tobacco, *Nictiana tabacum*, and other Nicotiana species. Nicotine contitutes 2-8% of dried tobacco leaves. Insecticidal formulations generally contain nicotine in the form of 40% nicotine sulfate and are currently imported in small quantities from India.
Mode of action. In both insects and mammals, nicotine is an extremely fast-acting nerve toxin. It competes with acetylcholine, the major neurotransmitter, by bonding to acetylcholine receptors at nerve synapses and causing uncontrolled nerve firing. This disruption of normal nerve impulse activity results in rapid failure of those body systems that depend on nervous input for proper functioning. In insects, the action of nicotine is fairly selective, and only certain types of insects are affected.
Mammalian toxicity. Despite the fact that smokers regularly inhale small quantities of nicotine in tobacco smoke, nicotine in pure form is extremely toxic to mammals and is considered a Class I (most dangerous) poison. Nicotine is particularly hazardous because it penetrates skin, eyes, and mucous membranes readily both inhalation and dermal contact may result in death. Ingestion is slightly less hazardous due to the effective detoxifying action of the liver.
Symptoms of nicotine poisoning are extreme nausea, vomiting, excess salivation, evacuation of bowels and bladder, mental confusion, tremors, convulsions, and finally death by respiratory failure and circulatory collapse. Poisoning occurs very rapidly and is often fatal. Treatment for nicotine poisoning is symptomatic, and only immediate treatment, including prolonged artificial respiration, may save a victim of nicotine poisoning. Nicotine has been responsible for numerous serious poisonings and accidental deaths because of its rapid penetration of skin and mucous membranes and because of the concentrated form in which it is used.

Pyrethrum and Pyrethrins (Chrysanthemum cinerariaefolium)

Source. Pyrethrum is the powdered, dried flower head of the pyrethrum is daisy, Chrysanthemum cinerariaefolium. Most of the world’s pyrethrum crop is grown in Kenya. The term “pyrethrum” is the name for the crude flower dust itself, and the term “pyrethrins” refers to the six related insecticidal compounds that occur naturally in the crude material, the pyrethrum flowers. They are extracted from crude pyrethrum dust as a resin that is used in the manufacture of various insecticidal products.
Mode of action. Pyrethrins exert their toxic effects by disrupting the sodium and potassium ion exchange process in insect nerve fibers and interrupting the normal transmission of nerve impulses. Pyrethrins insecticides are extremely fast acting and cause an immediate “knockdown” paralysis in insects. Despite their rapid toxic action, however, many insects are able to metabolize (break down) pyrethrins quickly. After a brief period of paralysis, these insects may recover rather than die. To prevent insects from metabolizing pyrethrins and

recovering from poisoning, most products containing pyrethrins also contain the synergist, piperonyl butoxide (PBO). Without PBO the effectiveness of pyrethrins is greatly reduced.
Mammalian toxicity. Pyrethrins are low in mammalian toxicity (see Table), and few cases of human poisonings have ever been reported. Cats, however, are highly susceptible to poisoning by pyrethrins, and care must be taken to follow label directions closely when using products containing pyrethrins to treat cats for fleas.
When ingested, pyrethrins are not readily absorbed from the digestive tract, and they are rapidly hydrolyzed under the acid conditions of the gut and the alkaline conditions of the liver. Pyrethrins are more toxic to mammals by inhalation than by ingestion because inhalation provides a more direct route to the bloodstream. Exposure to high doses may cause nausea, vomiting, diarrhea, headaches, and other nervous disturbances. Repeated contact with crude pyrethrum dusts may cause skin irritation or allergic reactions. The allergens that cause these reactions are not present in products containing refined pyrethrins. Tests indicate that chronic exposure to pyrethrins does not cause genetic mutations or birth defects.
There is no single antidote for acute pyrethrin poisoning. Treatment of poisoning is symptomatic, i.e., the various symptoms of poisoning are treated individually as they occur because there is no way to counteract the source of the poisoning directly.

4. Rotenone

Source.

Rotenone is insecticidal compound that occurs in the roots of *Lonchocarpus* species in South America, Derris species in Asia, and several other related tropical legumes. Commercial rotenone was at one time produced from Malaysian Derris. Currently the main commercial source of rotenone is Peruvian *Lonchocarpus*, which often is referred to as cube root.
Rotenone is extracted from cube roots in acetone or ether. Extraction produces a 2-40% rotenone resin which contains several related but less insecticidal compounds known as rotenoids. The resin is used to make liquid concentrates or to impregnate inert dusts or other carriers. Most rotenone products are made from the complex resin rather than from purified rotenone itself. Alternatively, cube roots may be dried, powdered and mixed directly with an inert carrier to form an insecticidal dust.

Mode of action.

Rotenone is a powerful inhibitor of cellular respiration, the process that converts nutrient compounds into energy at the cellular level. In insects rotenone exerts its toxic effects primarily on nerve and muscle cells, causing rapid cessation of feeding. Death occurs several hours to a few days after exposure. Rotenone is extremely toxic to fish, and is often used as a fish poison (piscicide) in water management programs. It is effectively synergized by PBO or MGK 264.

Mammalian toxicity.

Although rotenone is a potent cell toxin, mammals detoxify ingested rotenone efficiently via liver enzymes. As with pyrethrins, rotenone is more toxic by inhalation than by ingestion. Exposure to high doses may cause nausea, vomiting, muscle tremor, and rapid breathing. Very high doses may cause convulsions followed by death from respiratory paralysis and circulatory collapse. Direct contact with rotenone may be irritating to skin and mucous membranes. Treatment of poisoning is symptomatic. Chronic exposure to rotenone may lead to liver and kidney damage. Although some rodent testing has shown that chronic dietary exposure to rotenone may induce tumor formation,the most recent US EPA registration standard considers rotenone to be noncarcinogenic.

Rotenone is one of the more acutely toxic botanicals. As a matter of comparison, pure, unformulated rotenone is more toxic than pure carbaryl (Sevin®) or malathion, two commonly used synthetic insecticides. In the form of a 1% dust, rotenone poses roughly the same acute hazard as the commonly available 5% Sevin dust. Commercial rotenone products have presented little hazard to man over many decades. Neither fatalities nor systemic poisonings in humans have been reported in relation to ordinary use.

5.SABADILLA :

Sabadilla (veratrine alkaloids)

Source.
Sabadilla is derived from the ripe seeds os *Schoenocaulon officinale*, a tropical lily plant which grows in Central and South America. Sabadilla is also sometimes known as cevadilla or caustic barley.
When sabadilla seeds are aged, heated, or treated with alkali, several insecticidal alkaloids are formed or activated. Alkaloids are physiologically active compounds that occur naturally in many plants. In chemical terms they are a heterogeneous class of cyclic compounds that contain nitrogen in their ring structures. Caffeine, nicotine, cocaine, quinine, and strychnine are some of the more familiar alkaloids. The alkaloids in sabadilla are known collectively as veratrine or as the veratrine alkaloids. They constitute 3-6% of aged, ripe sabadilla seeds. Of these alkaloids, cevadine and veratridine are the most active insecticidally.
European white hellebore (*Veratrum album*) also contains veratridine in its roots. Hellebore was once commonly used in Europe and the U.S. for insect control, but is now unavailable commercially and is not registered by the US EPA.

Mode of action.
In insects, sabadilla’s toxic alkaloids affect nerve cell membrane action, causing loss of nerve cell membrane action, causing loss of nerve function, paralysis and death. Sabadilla kills insects of some species immediately, while others may survive in a state of paralysis for several days before dying. Sabadilla is effectively synergized by PBO or MGK 264.

Mammalian toxicity.
Sabadilla, in the form or dusts made from ground seeds, is the least toxic of the registered botanicals. Purified veratrine alkaloids are quite toxic, however, and are considered on a par with the most toxic synthetic insecticides. Sabadilla can be severely irritating to skin and mucous membranes, and has a powerful sneeze-inducing effect when inhaled. Ingestion of small amounts may cause headaches, severe nausea, vomiting, diarrhea, cramps and reduced circulation. Ingestion of very high doses may cause convulsions, cardiac paralysis, and respiratory failure. Sabadilla alkaloids can be absorbed through the skin or mucous membranes. Systemic poisoning by sabadilla preparations used as insecticides has been very rare or nonexistant.

6.TEHPROSINE :

Tehprosiavogelli (leafs and seeds)
Tehprosiatoxicaria(roots)

Tehprosiamacropoda(stem)

7. Ryania

Source.
Ryania comes from the woody stems of *Ryania speciosa*, a South American shrub. Powdered Ryania stem wood is combined with carriers to produce a dust or is extracted to produce a liquid concentrate. The most active compound in ryania is the alkaloid ryanodine, which constitutes approximately 0.2% of the dry weight of stem wood.

Mode of action.
Ryania is a slow-acting stomach poison. Although it does not produce rapid knockdown paralysis, it does cause insects to stop feeding soon after ingesting it. Little has been published concerning its exact mode of action in insect systems. Ryania is effectively synergized by PBO and is reported to be most effective in hot weather.

Mammalian toxicity.
Ryania is moderately toxic to mammals by ingestion and only slightly toxic by dermal exposure. Ingestion of large doses causes weakness, deep and slow respiration, vomiting, diarrhea, and tremors, sometimes followed by convulsions, coma, and death. Purified ryanodine is approximately 700 times more toxic than the crude ground or powdered wood and causes poisoning symptoms similar to those of synthetic organophosphate insecticides. (Depending on exposure, organophosphate poisoning symptoms may include sweating, headache, twitching, muscle cramps, mental confusion, tightness in chest, blurred vision, vomiting, evacuation of bowels and bladder, convulsions, respiratory collapse, coma, and death.)

ORGANO CHLORINS :
Organochlorine pesticides are chlorinated hydrocarbons used extensively from the 1940s through the 1960s in agriculture and mosquito control. Representative compounds in this group include DDT, methoxychlor, dieldrin, chlordane, toxaphene, mirex, kepone, lindane, and benzene hexachloride.
Ex: DDT , HCH

CYCLODINES :
Cyclodiene Insecticides. Chlorinated insecticides are based on the cyclodiene ring structure and were formerly widely used for the control of agricultural pests and for structural pest control. Due to their great chemical stability, stored cyclodiene insecticides may be the cause of poisoning.
Ex: Chlordine , heptachlor , aldrine , diacridine , endosulphan

ORGANO PHOSPHATES :
Organophosphates (OP) are chemical substances that are produced by the process of esterification between phosphoric acid and alcohol. Organophosphates can undergo hydrolysis with the liberation of alcohol from the esteric bond. These chemicals are the main components of herbicides, pesticides, and insecticides.
Ex: Phosphamidan ,chloriphiriphas , dimithoate .

CARBAMATES :

Carbamates are a class of insecticides structurally and mechanistically similar to organophosphate (OP) insecticides. Carbamates are N-methyl Carbamates derived from a carbamic acid and cause carbamylation of acetylcholinesterase at neuronal synapses and neuromuscular junctions. which includes three (3) sections .

(a).Heterocyclic carbamates : Ex: isolan , pyrolan
(b).Phenyl carbamates : Ex: carbaril , prophaxar , carbopuran
(c). oxime carbamates : Ex : aldicarb , mithomil , thaodicarb
In n this group insecticides are by contact , stomach and intrinsic .

Synthetic pyrethroids :

Synthetic pyrethroids are pesticides derived from naturally occurring pyrethrins, taken from pyrethrum of dried Chrysanthemum flowers

NOVEL INSECTICIDES :

(a). Neonicotinoids:

Neonicotinoids are a new class of insecticides chemically related to nicotine. The name literally means "new nicotine-like insecticides". Like nicotine, the neonicotinoids act on certain kinds of receptors in the nerve synapse. They are much more toxic to invertebrates, like insects, than they are to mammals, birds and other higher organisms..

Ex : Imidacloprid - mango sucking pest
Asitamiprid- white fly
Thaochloprid- sucking pest , white fly , aphids and thrips

(b). Juvenile hormone

In insects, JH (formerly called **neotenin**) refers to a group of hormones, which ensure growth of the larva, while preventing metamorphosis.
Ex: phenaxicarb ,phyriphraxifen they keeps the insects in the larva stage and there is no Adult satge .

In mosquitoes Adult stage is harmful but Maggots stage is not harmful because it effect on the moulting and kill them

(c). Spinosines :

Spinosyns are a class of insecticides with a broad range of action against many insect pests belonging to different orders, noxious to a wide variety of agricultural crops
They are extracted from the fungus of sacazropalisporaspinosa .
Ex: spoinosad 45 SC 75 – 100 g.a.i/ha
25 SC 15 g.a.i./ha
This is influenced on nerves system , and activate Asitail Collin then kill the insects .
Ex: diamond backmath .
spotted pod borer .

(d).Avarmektins :
They are produced from the micro organisms present in the earth Streptomysisavarmetilis
Ex: Abamectine- cabbage (D.B.M)
Tomato (Serpentine leaf miner)
They prevent (GABAgatedchloridechannels) from paralysis and kill insects .

(e).Oxadiazines :
They act as sodium channel blockers in the nerves system and kill insect
Ex: indaxacarv 14.5 SC 75 – 100 g.a.i/ha
Helicoverpa and spodaptalitura

(f).phenylephyrajolse :
They block GABA chloride channels in the nerves and kill insects
Ex: pipronile- 55 C 10L.D . 200 – 300 g.a.i/ha
Paddy leaf folder , cabbage D.B.M

(g).Pyridin-azomethine :
These effectively work on the aphids. When it is sprayed it will works on labium of the insects and destroy it .
Ex: Pymiprogine- 50 WD + 100 – 300 g.a.i/ha
White fly (tomato)
Aphids (cotton)

(h). Benzyl urea:
Asityle colineestarage enzyme stop work of plant and kills the insect.
Ex: novaluron - 10 EC - 75 – 100 g.a.i/ha
Green leaf hopper

(i).Thiourea :
These will make the ATP products less in Mitochondria
Ex: Diphanthiourea - it becomes carbo dimade when sun rays fall on the chemical , it also work well for mites as an insecticides later it is evaporate in a few days by photolysis
- 400 SC 300 - 400 g.a.i/ha
- 50 WP 30 - 40g.a.i/ha
-

(j).Di – azylehydrogenes :
This stops the moulting and kills the insects
Ex: Tebufenazyde - 50 – 250 g.a.i/ha
- semi-looper

(k).Keto enols :
It effects the power of laying eggs in mites and white flyes .
Ex: sphiromecifen - 240 100 – 50 g.a.i/ha

(L).Chrysanthemum:

They effect the central nerves system and pheripheral nerves system and cause paralysis and kill the insects

Ex: Phenpropethrin- 30 EC - 75 – 100 g.a.i/ha

- fruit borer (cotton)
- white fly (orange)

NEMATICIDES :

A **nematicide** is a type of chemical pesticide used to kill plant-parasitic nematodes. **Nematicides** have tended to be broad-spectrum toxicants possessing high volatility or other properties promoting migration through the soil.

Ex: **1.Aldicarb :**

Aldicarb is a carbamate insecticide which is the active substance in the pesticide Temik. It is effective against thrips, aphids, spider mites, lygus, fleahoppers, and leafminers, but is primarily used as a nematicide. **Aldicarb** is a cholinesterase inhibitor which prevents the breakdown of acetylcholine in the synapse.

2.Carbofuran :

Carbofuran is one of the most toxic carbamate pesticides. It is marketed under the trade names Furadan, it woks on sucking pest, Nemoticides and Midge.

Rodenticides :

Rodenticides are pesticides that kill rodents. Rodents include not only rats and mice, but also squirrels, woodchucks, chipmunks, porcupines, nutria, and beavers. Although rodents play important roles in nature, they may sometimes require control. these are three (3) types

1. Acute poison Ex: zinc phosphide ,aluminumphosphade
2. Anti coagulants Ex: bromadialon
3. Fumigants Ex: methyl bromide

1. **Zinc phosphide:**

   This chemical is in the form of black powder and has a kind of smell . pre-baiting must be done . first u have to Taunt Rats (7-8) days after that hominy (96 cups) take 2 cups of chemical and mix it then use it as poison bait .

2.Aluminumphosphade :

It should be closed in a burros with Rats and then the phasphin gas release from it . this gas kills the Rats . it is available in the name of <u>Sclfan</u>

3.Bromadiolone :

this can be used as a poison bait . it can kills upto 90% of Rats it is available in the market like Roboncake . it should be 100 grm weight and 6 pieces . after using this with in 4-7 days the Rats will die .

Acaricides :

Which chemicals can kills the mites are known as Acaricides .organochlorines .dicofol .organo phosphates chemicals are works as a Acaricides .

Ex: Sulphur - Saltaf .thaovit

Dicofol - kelthen – this chemical formula looks like D.D.T. D.D.T. contains

'H' part and 'OH' that's why Dicofol kills the miyte . this is not Harmful to honey bees .

Antideedants / feeding deterrants :

When the chemical sprayed on the surface on a plant body it will not harm the insects but they are natures's from repelled away from eating leafs . this are called Antideedants / feeding deterrants .

Ex: Triazines - 4asitanilyde - red headed catter pillar

Organotin (Brestan) Triphenyltins- potato rhizome weevil

Carbamate (Aprocarb) - cotton weevil

Advantages : Allied worms are not harmful to the parasites and transitions so , in **IPM** they have crucial place

Dis-advantages:it is disadvantages for sucking pest because it won't prevent newly formed shoot .

Attractants:

Some types of chemicals attract the insects and bring them closer together . so they mainly works based on smell .

Ex: ziraniyal and uzinole (1:1) is prevents shell worms .methyl uzinole will attract the fruit fly . so we use it as a poison bait .

Sex pheromones :

Sex pheromones are **pheromones** released by an organism to attract an individual of the opposite **sex**, encourage them to mate with them, or perform some other function closely related with **sexual** reproduction..

Ex: boll weevil – Male insects release to attract female insects

The following sex pheromones have been full filled .

1. Silkworms trans - 10 - cis – 12 – decadaienol
2. Gypsymoth 10 acetoxy - cis - 7 - hexadecinol

In (IPM):

Monitoring : to detect their presence in sex baskets .

Mass trapping :it is useful for traping male insects.

Mating disruption:contribute to non-mating .

Insecticides formulations :

1. Pesticides are available in various "formulations". A formulation is simply the form of a specific product that you use. Some insecticide formulations include dusts, gels, granules, liquids, aerosols, wettable powders, concentrates, and pre-mixed solutions.

   A pesticide formulation typically consists of an active ingredient, plus several inactive materials called adjuvants, or additives. The main purpose of additives is to increase the effectiveness of the active ingredient. Some common additives include spreaders, stickers, wetting agents, compatibility agents, and foaming agents.
2. **DUSTS :**
   - Ready to use for formulation
   - There visible when they are in powder form

- Which of these is the concentration of toxicant form 0.65 – 25%
- If they decrease in size, then it increases toxicity

  Ex: DDT = 10%

  BHC = 10%

Advantages

1. They are very easy to use .
2. There is less use of labours .
3. They can be effectively used in areas where water is draught .

Disadvantages

- When there is air it is not possible to use .

2.GRANULES:

* it also Ready to use for Formulations

* These are available in the form of pellets

* Capacity of these granules is 0.25 – 2.38 mm

* The concentration of toxicity is 2-10%

* These can be effectively prevented by frost worms and ground borne worms by watering or simply grounding in .

Ex: carbofurnan – 3G

Phoret - 10G

Uses:

- there is no problem wuth drift
- Residues of insecticides will no longer remains
- Very easy to use
- They don't need water to use
- Not harmful for natural enemies

3.Vettable powders :

- They are available in powder form
- They are not ready to use for formulations . they should be mixed with appropriate water
- The toxicity is between 15 – 95 %
- These formulation last for several days and is introduced in to the plant and should not buy

  Ex: DDT = 50%WP

BHC = 50%WP

4.Concentrated solutions :

- Not all the types of pesticides are present in water. But non-organic solvents (i.e. amylacetate , kerosene , phynice , fineoil , ethylene dichloride are used together
- There fore some types of poisonous insecticides are mixed with tanicant and used to control insects living in homes

  Ex: Bagan (spray cockroach) - it is available in red color bottle

  Mosquitoes spray - it is available in black color bottle .

5.Emulsifable concentrate :

* these include toxicity , solver and emulsifying agents

***** these are mixed with water and sprayed on plant ,solven evaporated and toxicity are on plants

* Certain types of proteins carbohydrates ,organicamines and saponins act as emulsifying agent

Ex: Malathian 50 E.C

Endosulfan 35E.c

Advantages

They are used as emulsifying agents and helps to keep the insecticides on the plant for a long time , killing the insects on top layer

6.Concentrated insecticides liquids :

* using a highly concentrated insecticides in combination with non-volatilc material on plants in the form of droplets

Advantages

- **Residues are high and insects die .**
- **Evapourate Quickly**

Ex: Malathian

Dimethate

Phosphamidon

7.Erosols:

***** toxicity is made of ice like air these are 0.1-20m , it contains toxicity in liquid from by spraying through a small hole with gas , the particles of these air in the liquid steam

Ex: evaporates by using of (ULV) sprayers

8.Fumigants

* some chemicals substance are known to evaporate in the room chamber environment . they can also harm some insects
* they are mainly used to prevent insects in the ground and to the rats . Ex: EDB , EDCT , SO_2 , CO…..

COMBINATION OF INSECTICIDES

There may be a time when you want to combine and apply two or more pesticides plus fertilizer for either convenience, to save money, or to reduce equipment wear. When you do combine ingredients you are creating what is known as a tank mix. Tanks mixes can consist of a fungicide and an insecticide to control both a fungus and insects at the same time. Sometimes you may want to mix a pesticide with fertilizer, or mix two herbicides together to increase weed control. Tank mixes save time, labor, money, equipment wear, and crop damage. However if you mix with Improper combinations you can cause phytotoxicity to crops or ornamental plants, damage equipment and in the long run spend more money.

1. **Chemical incapability:**

   Reaction between two or more substances which lead to change in chemical properties of pharmaceutical dosage form.

2. **Phytotoxic incapability:**

   Both chemicals are not harmful by themselves , but when combined , can cause harm to the plant

3. **Physical incapability :**

   Chemicals loses their physical appearances and stability and become hazardous to used

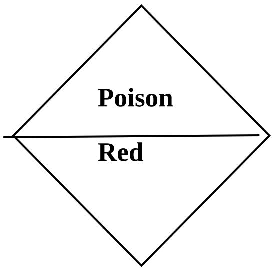
INSECTICIDES COMBINATIONS :

The combined emulsion of two insecticides , combines with the use of each insecticides in particular , can increase the plants effectiveness and prevent the
spared of various insects

	Name of pesticides	Trade name	Recommended for pest
1	Chlorifirifus 50% Sypermethrin 5%	Noorel –D 505	Leaf minner , fruit borer (2m*l/l)*
2	Phrophenophus 40 % +	Palithrin	Fruit borer , sucking pest

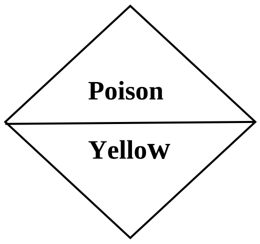
	Sypermethrin 5%		(300-400m*l/l)*
3	Trizophers 35% + Deltamethrin 1%+	spark	Whithe fly and leaf miner (300-400m*l/l)*

This insecticides are classified into 4 types according to poision intensity



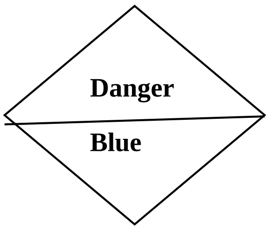
L.D.50 value 51-500

More poison



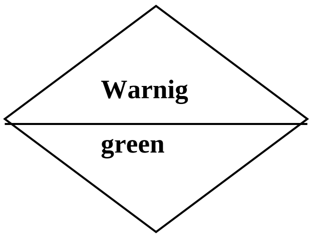
L.D. 50 value 501-5000

Medium poison



L.D.50 value greater than 5000

Less poison



- Colors in the diamonds depending on the toxic intensity

INSECTICIDES

s

INORGANIC

1. Orsenicals – led Orsinate
2. Florides Sodium floride
3. Sulpher
4. Zinc Phasphyd

ORGANIC

1. Hydrocorbon oils
 - petroleum oils
2. Animal related
 - neleantaxin
3. Trees related
Eg.Pyrithram, neem
Rotinosa, Nicotin

SYNTHETIC ORGANIC

1. Organometal compound
Eg. Faris green
2. Phinalic compound
Eg.Dinocrop
3. Thayosayano compound
Eg.Thanite
4. OrganoClorins
Eg. D.D.T, B.H.C
5. Organophasparascompun
Eg.Phasphamidan
6. Carbomates
Eg.Carbaril
7.Navel