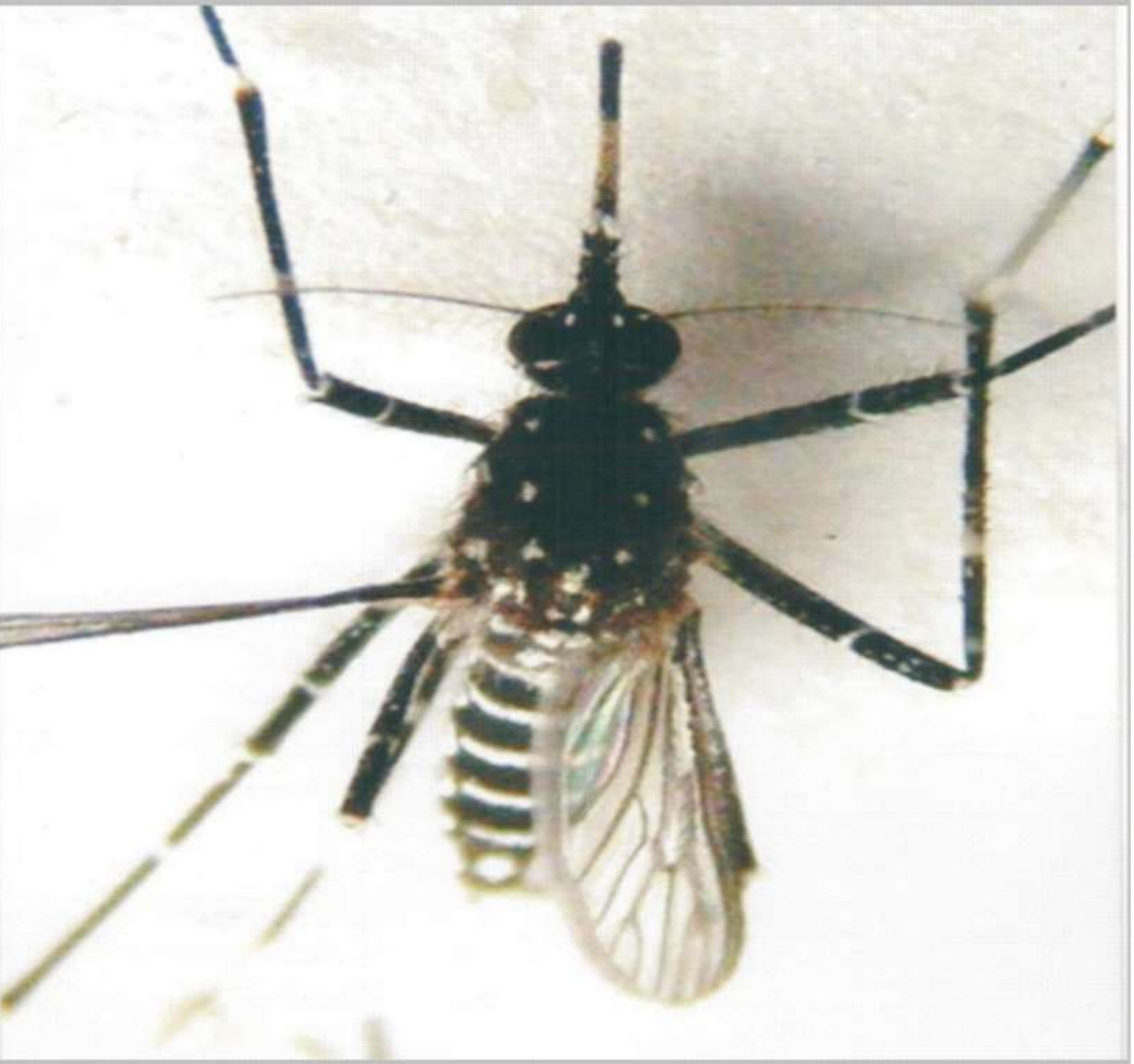
Terminology of Entomology
A Brief Dictionary

-Dr. Neetu Kachhwaha



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Terminology of Entomology

A Brief Dictionary

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Preface

The branch of biology dealing with the insects refers to the Entomology and it is a unique branch having many terms which are not known to the students. Therefore, this e-book is proposed to help the students in the form of dictionary. This is a kind of handbook which could be efficiently used in determining the terms of entomology online. The text is designed in an easy way for M.Sc. students, where entomology is a special branch in Masters in Zoology, also the students of M.Sc. Entomology and for the students facing competitive examinations. This book has been divided into various sections; Section I – Terminology of Entomology, Section II- Some interesting facts about insects, Section III- Order name and a brief classification, Section IV- Various Important Diseases and Section V- Contribution of scientists. All, the terms are arranged from A to Z for the easy approach to the students.
I have made an attempt to make an arrangement of brief areas of Entomology in a coherent manner.

I shall welcome all the criticisms and comments from the readers.

I am thankful to my children for cooperation and encouragements without which it was impossible to accomplish this task. At the end, I would like to thank the publisher who undertook the task of publishing the e-book.

Contents

A

Abdomen: The third major tagma or body division of insect consists of 6-11 segments.

Absolute Estimate: It is defined as the total number of insects per unit area.

Accessory Glands (in Male Reproductive System): There may be one or two pairs associated glands, mesodermal or ectodermal in origin, connected by small ducts into lower vasa deferens or ejaculatory duct contributing in the formation of seminal fluid or spermatophore.

Accessory Glands: There may be one or more pairs of accessory glands which supply lubricants for the ovipositor and play role in secreting a protein-rich egg shell (chorion) that surrounds the entire egg. The accessory gland opens into the common oviduct or the bursa copulatrix.

Accoustical Devices: The sound producing device which helps in negative orientation of the birds, monkeys and wood boring insects.

Acephalous Larvae: The apodous larvae do not possessing head capsule and having protrusible mouth hooks e.g., wrigglers of mosquito.

Acephalous: It is a type of apodous larvae lacking head capsule e.g., housefly (Diptera: Cyclorrypha).

Acetylcholine: It is a kind of neurotransmitter found at the synaptic junction.

Acetylcholinesterase: It is the enzyme which dissociates acetylcholine into an acetyl and choline.

Acid Gland: The accessory glands in the reproductive system of the females in worker bee are modified into acid gland/ poison gland containing poison apitoxin.

Acone: It is the type of compound eye where cone is totally absent e.g., Hemiptera, Dermaptera.

Acoustical Communication: It is the mode of communication between the same members of the species by sound and hearing.

Acquired/Induced Immunity/ Humoral Immunity: When antigen or foreign body enters the host the immunity is induced, non specific in nature, does not have memory cells and immunogens are not made up of proteins and may be inducible or non inducible.

Activation Centre: It is the centre of the fertilized egg from where cleavage cell starts showing growth and development.

Adecticious: It is a type of exarata or obtect pupae with articulated mandibles which may be functional or reduced.

Adenotrophic Viviparity: The eggs consists of chorion and yolk; but eggs hatched and offsprings are carried in expanded structure called uterus where the nourishment is provided by uterine milk secreted by the accessory glands e.g., *Glossina sps.*

Adjuvant: The inert ingredient that is added to the active ingredient to increase the effectiveness of spreading.

Adrenaline: The insect hormone which can accelerate the heart beat due to indolalkylamine.

Aedaegus: When the development of phallic lobes takes place it differentiates into an inner mesomere and outer paramere. The mesomere unites to form the external male genitalia which is equivalent to penis of higher animals.

Aeropyles/ Air Channels: The shell of the egg is porous having many tiny holes from which air enters directly from outside but are absent in aquatic insects.

Aerosols (A): When insecticides are mixed with volatile petroleum solvents.

Afferent (Sensory) Neurons: The bipolar or multipolar neuron having dendrites associated with sense organs or receptors which carry information toward the CNS.

Air Bubbles: Some aquatic insect carry a bubble of air held under the elytra (wing covers) or trapped against the body by specialized hairs during they dive beneath the water surface. An air bubble only provides short supply of oxygen whenever needed by an insect.

Air Sacs: Swollen areas are present in certain parts of the trachea where taenidia are absent meant for the storage of air temporarily which supplies air during high evaporative stress (in terrestrial insect), regulation of buoyancy (in an aquatic insect), uses the stored air under water and during moulting.

Airplane Sprayer: The large amount of insecticidal solution 225 l to 2070 l applied in a field, forest, and shade areas with the help of airplane. They have advantages like covers large area 200-800 ha, economic, easily accessible and disadvantages like less under coverage, depend upon weather conditions and high elements of risk.

Alarm Pheromone Glands: The glands which are associated with honey tube which secretes alarm pheromones due to stress having sesquiterpene, beta farnesene.

Alary Muscles: The muscles attached laterally to the walls of each chamber to keep the heart or chambers in position and create peristaltic contractions which force the hemolymph in the forward direction from one chamber to other.

Aldicarb: It is a synthetic carbamate insecticide.

Aldrin: It is a synthetic chlorinated hydrocarbon insecticide**.**

Allantoni: It is a chemical substance obtained from the maggots of the housefly and used in the treatment of healing wounds.

Allelochemics/ Allelochemicals: The term was given by Whittaker (1970) referred to the chemicals originated from one organism which elicit interspecific communication affecting the behavior, physiological condition of different species. There are certain types known as allomones, kairomones, synomones, antimones.

Allergens: Some insect secretes mostly the protein which causes allergic reaction in the victim.

Allergic Reactions (Anaphylaxis): When bees and wasp stings it causes hypersensitivity in human beings due to toxin present in their venom (bee venom contains mellitin and wasp venom contains kinin).

Allomone: The compound which is released by one organism to provoke a reaction in other individual of different species which is significant for the emitter but not the receiver e.g., repellents.

Allotropus: It is a mutual behavior between insects and plants in which the pollen disperses accidently e.g ants, beetles, thrips. They do not have special organs for carrying pollen, but it disperses by mouth parts, legs, antenna, and hairy body by simple transportation. Here, plants are having open nectaries provided to all types of insects.

Alphins: It is the pigment may be of red, orange, or yellow in color found in aphids.

Alter Target Site Resistance: It is the resistance of the insect against the insecticide achieved by modification of the target site so that the action of insecticide can be prevented.

Ameiotic Thelytoky: In meiotic division when the reductional division is completely suppressed by some factors, and a condition similar to mitosis restoring the diploid condition e.g., *Daphnia pulex* and long horn grasshoppers.

Ametamorphosis: Apterygote insects which do not undergo any change in form; larvae differ from the adult only in size, gonad development and external genitalia sharing a common habitat e.g silverfishes.

Amnion: It is an extra embryonic membrane continuous layer with the germ band covering only the embryo. In Strepsiptera only the amnion is present and serosa is absent.

Amound Nest: The termitaria that builds above the ground.

Amphineustic: It is a kind of oligopneustic respiratory system containing one meso thoracic and one abdominal pairs of spiracles e.g., moth fly larvae.

Anamorphosis: A metamorphosis in which the abdominal segments are added at the posterior end as the insect matures e.g., Protura.

Anatrepsis: A series of embryonic movements where immersion of the germ band during embryogenesis takes place e.g., Paleopterans, most Orthopterans and Hemipterans.

Androconia: The Lepidopterans are having specialized scales which are linked with the sex producing pheromones on their wings e.g. male moths and butterflies.

Anemophilous: When the pollen grains are transferred through physical factor wind.

Aners: The fertile male of the ant colony having well developed reproductive system with small head and reduced mandibles.

Ant plants: An interesting mutual relationship between the ants and plants which lives inside the hollow stems, thorns and eat upon phytophagous insects

Ant Venom: The red ants, *Oecophylla smaragdina* contains alkaloid (methyl-n-piperidines) that inhibits sodium potassium pump of muscle cell resulting into a neuromuscular blockage.

Antagonists: The pesticidal interaction in which the toxic insecticide is mixed with non toxic or toxic substances which together decreases the toxicity or lethality and shows incompatibility with each other. For example, Piperonyl Butaoxide (PBO) mixed with methyl parathion acting as antagonists.

Antenna: They are paired, segmented, present in the middle of compound eyes; sensory, detects perception of the external stimuli (odor, sound, humidity, vibrations, motion, orientation, chemicals, pesticides, pressure etc.).

Antibiosis: It is a mechanism of HPR by which colonized plant is resistant as it causes adverse antibiotic effect (due to toxins, growth regulators, reproductive inhibitors) on the insect development, reproduction, fecundity, vigor, or survival.

Antifeedants/ Feeding Deterrents: Given by Wright in 1963; are the compounds which inhibit the insects to feed on the treated material or plant without killing.

Antimetabolites: They are the chemical which resembles the essential nutrients required for the insects and hence, interfere with the insect metabolism when taken up. For example, amethopterin which is a folic acid analogue interferes with the formation of vitamin folic acid in insects.

Antimone: The compound which is released by one organism to provoke a reaction in other individual of different species which is maladaptive to both emitter and the receiver. Example, honey feeding upon flowers of California buckeye, *Aesculus californica* and death canas, *Zigadenus venenosus* contains toxic component which can destroy the entire colony of honey bees when they return to the hive.

Antixenosis: It is one of the mechanisms of host plant resistance where the plant deters the colonization by the insect due to biochemical or morphological deterrent or both.

Aorta: The anterior part of the dorsal vessel lacking valves and drain out the hemolymph near the brain.

Aphrodisiac Scent Glands: The glands associated with the scale of butterflies and moths present on the wings, legs, or abdomen and the secretion used for mating to attract the partner.

Apiculture: It is a term used for the culture of bees for the production of honey, wax, propolis etc. or in simple terms refers to the rearing of bees, *Apis mellifera.*

Apiologist: The entomologist who is restrictly concerned and study about bees.

Apneumone: A compound released by non living substances which is beneficial to the receiver but detrimental to another organism to that substance.

Apneustic: When the spiracles are absent in an organism having closed tracheal system.

Apodous larvae: The larvae having no legs.

Apolysis: The term is used to indicate the separation of older cuticle from the new one.

Apomictic: During parthenogenesis when meiosis does not take place.

Aposematic/ Warning Coloration: Insects are unpalatable or produces disagreeable odor to a predator, and they start avoiding such insects. Monarch butterfly feeds on milkweed plants therefore, contains chemical such as cardiac glycosides in their hemolymph.

Apparent Resistance/ Ecological Resistance/ Pseudoresistance: This resistance is not true as it is not genetically control but the characteristic of this type resistance is temporary. It includes host evasion, induced resistance, host escape.

Apposition Image/ Photopic Ommatidium: The image is formed when ommatidium pigment cells are extended resulting in isolation of the ommatidium so that the light rays can pass through the central axis. The final image is formed by many points forming a single mosaic of points while diagonal light rays get absorbed e.g., diurnal insects such as flies, bees, wasp, dragonfly.

Apterygota: It is a subclass of class Insecta that consists of primitive wingless insects having no metamorphosis and adults are same as that of the larval stages except for the size.

Arachnida: It is the class of phylum Arthropoda where the body is divisible into a cephalothorax and abdomen, having antenna and simple eyes with four pairs of legs e.g., spiders, ticks, mites**.**

Arboreal Nest: The termitaria that builds hanging on a tree branch.

Arolium: It is a pad found between the claws meant for the adhesion of the insect on the substratum.

Arrhenotoky: During parthenogenesis when only males are produced e.g., bees.

Arsenicals: The inorganic chemical compounds having arsenic elements which are soluble, acts as stomach poison and toxic to plants e.g., lead arsenate, calcium arsenate, Paris green, arsenic trioxide.

Arthropod Borne Infections: The members of the Arthropods which directly or indirectly causes diseases in human e.g., malaria, dengue, taluremia, kala azar.

Arthropodin: It is non chitinised and soluble protein of insect integument.

Asphyxiation: The method of controlling insects with the help of oils which blocks the spiracles, and restricts respiration.

Aspirator: It consists of a glass tube attached to the long rubber tube having a net at the junction of two tubes and used to collect tiny insects like mosquito, aphids, white flies, jassids etc.

Atrial aperture: It is the opening of the atrium outside towards the spiracle.

Atriate Spiracles: The kind of spiracles having closing valves at the inner side of the atrium e.g., cockroach.

Atrium: It is the spiracular chamber associated with the trachea where it opens.

Attractants: They are the chemicals or compounds which makes the oriented movement of the insects towards them so that they can be easily trapped. This technique is useful for population survey, surveillance purposes, control measure, study of migration and dispersal. For example, the potent synthetic sex pheromone gyplure (naturally secreted by the female gypsy moth) used to trap gypsy moth male. Other attractants are gyplure, singlure, butyl sorbate, anethol, formaldehyde, methyleugenol, muscemone

Audioreceptors: The sound waves are received by audio receptors present on the body parts like antenna and cerci called as sensilla trichodea. Some special organs associated with audio receptors such as Johnston's organs in an antenna; tympanal organ which sense air borne vibrations; subgenual organ which sense solid vibrations.

Augmentation: It is a part of biological control which manipulates the environment (providing alternate nutrients, nesting habitats) or all activities that are designed to increase in the number of natural enemies. It can be either incoculative or inundative release.

Auricle: The tip of the tarsus has a small lobe like structure consisting of long hairs used to clean the antenna with pecten.

Automictic: During parthenogenesis when meiosis takes place.

Autotomy: It is found in some insects where part of the insect body undergoes auto-amputation if imprisoned by the predator e.g., Praying mantis escape by auto-amputation of meso or metathoracic leg.

Axonic poisons: The chemicals which interefere with the axonic transmission e.g., cyclodienes, pyrethroids.

B

Bark and Wood Feeder: The beetles and weevils which feed by making tunnels between the bark and wood of the trees e.g., bark eating caterpillar, *Inderbela quadrinotata.*

Basement Membrane: This is the last and lower most membrane of the integument, 0.5µm thick and made up of neutral mucopolysaccharides secreted by haemocytes.

Basisternum: Sternum of mesothorax.

Batesian Mimicry: When one palatable insect mimics with the other unpalatable model e.g., viceroy butterfly mimics the monarch butterfly.

Bee forage/ Pasturage: The plant that yields pollen and nectar both are the forage for the bees.

Bee Venom: Venom of the honey bee, bumble bee *Bombus spp*. contains protein, enzymes, peptides like melittin (containing 26 amino acids), apamin that hydrolyze the cell membrane which results in changing the permeability and pain.

Beeswax: The bee secretes yellowish white solid waxy material by the epidermal glands of the abdominal sterna used to build the hive. It is commercially used in cosmetics, candles, polishes, pharmaceuticals, dental wax, museum wax etc.

Behavioural Resistance: It is the resistance of the insect against the insecticide by showing some changes in the behavior e.g., *Anopheles gambiae* which was endophillic (feeds indoor) susceptible to DDT spray now becomes exophilliic (feeds oudoor).

Berlese Funnel: It is the equipment used to collect insect from soil, litter, debris etc.

Biochemical Resistance: It is the resistance of the insect against the insecticide as they can detoxify them by one or more enzymes before it reaches to the target site e.g., Mixed Function Oxidases (MFO) Enzyme.

Biological Control Organization: Many countries have biological control stations that collaborate with each other to solve the problem of pest control through the use of natural enemies. CIBC (Commonwealth Institute of Biological Control) of India (Bangalore), CIBC of California (Fontana).

Biological Control: It is a control measure which uses the natural enemies such as predators, parasitoids, pathogen, and phytophagous species to control pests (Smith, 1919). Example, *Oecophylla sps*. used to control foliage feeder caterpillars.

Biological Gills: In insects, gills are the outgrowths of the tracheal system covered by a thin layer of cuticle and permeable to both oxygen and carbon dioxide e.g., *Dyticus, Notonecta*.

Biological Transmission/Circulatory Transmission: When the pathogen is supported by the vector in completing their life cycle either reproduces, undergoes developmental changes, or both in the vector. They are effective, causes epidemic and of persistent type e.g., *Plasmodium* sp.

Biotropic Parasites: The parasites that do not cause serious damage to the host by maintaining host viability.

Biotype: The group of individuals which are genetically similar in respect to virulence e.g. aphids.

Bivoltine Species: The species which have two generation per year.

Blastoderm: The syncytial cleavage rapidly divides up to 6000 nuclei moves to periphery after 64 energid stage; in some after 1024 energid stage forming a continuous layer surrounding the yolk is known as blastoderm.

Blood Sinuses: The presence of dorsal and ventral diaphragm divides the abdominal cavity into three compartments perineural, perivisceral and pericardial sinus collectively called the blood sinuses.

Bonus Effect: The sterilized individual (sterile through chemosterilants or radiation) competes with non sterile individual for mating and has the ability of copulation and hence, results in the declination of the population.

Brachypterous: Some insects are having very short wings.

Brain Hormone Agonist/ Mimics: Proctolin discovered by Staratt and Brown mimics the brain hormone function as neurotransmitter acting on metabolism, maintaining the haemostasis, development, reproduction, muscle movement.

Brain Hormone: Neuro-haemal organs releases neurohormone or brain hormone which diffuses into the blood, and activate other endocrine gland. It is peptidic in nature and stored in the neuro-

haemal organs by binding to the protein molecules (carrier) named neurophysin. It controls all the life processes directly or indirectly like stimulates feeding in blood sucking bug *Rhodnius*, stretch receptor of pharyngeal wall in grasshopper and locust.

Breathing Tubes: Some aquatic insects living under water get air from the surface through hollow breathing tube also called **siphons** e.g. mosquito larvae.

Brood Lac: Removal of the twigs covered with mature male and female and tieing them to the uninfested twigs.

Brood Nest: The nest meant not only for laying eggs but also for the protection of the larvae or immature and has stored food collected by their mother. The nest can be made up of many things including clay, wax, chalk, sand, leaves, fiber, pulp etc. For example leaf cutter bees, *Ceratina* and *Megachile* make their brood nests by cutting of the leaves.

Brood Parasitism/Cleptoparasitism: Smuggling of eggs into the brood nest of other insects and raising their young ones. Example, robber flies (*Miltogramma sp*.) and cuckoo wasp.

Builder Bees: In ten to sixteen days older worker bees the pharyngeal glands atrophied and develop four pairs of abdominal glands located from 4 to 7 segments which secrete wax and builds the hive.

C

Calyx: In some insects the pedicel of the individual ovarioles meets to form the larger space called the calyx e.g., Ephemeroptera and some apterygotes.

Campaniform Sensilla: It is a proprioreceptor homologous to tactile hair except that hair shaft is replaced by a dome shaped plate.

Cantharidin: It is derived from the body of blister beetle, *Mylabris/ Lytta vesicatoria* acts as strong urino-genital irritant and aphrodisiac used to treat urogenital diseases.

Carabeiform Larvae: The oligopod larvae having prognathous head, elongated and flattened body, short thoracic legs, and a pair of antenna, cerci may be present or absent that resembles the larvae of ground beetle, Carabidae e.g., Chrysomelid beetle grub.

Carbamates: They are the organic synthetic compounds derivatives of carbamic acid and having –OCON= group e.g., carbaryl, carbofuran, aldicarb.

Carrying capacity (K): The capacity of the population which can hold the maximum number of individuals.

Category: Members of all the taxon placed in given level of hierarchy.

Caterpillars: The larvae of Lepidopterans.

Caudal Vesicle: An averted structure of hindgut of some endoparasitic insects, e.g., *Cotesia* larva.

Central Body: It is a part of protocerebrum located centrally and connects right and left lobe of protocerebrum. It receives axons from various parts of the brain and a source of premotor outflow.

Central Nervous System: Insects have simple central nervous system with a dorsal brain, and a ventral nerve cord that consists of paired segmental ganglia running along the ventral midline of the thorax and abdomen.

Central Pattern Generator (CPG): Insect locomotion is the under the control of CPG including interconnected neurons which generates the rhythmic motor patterns used during locomotion**.**

Chaetotaxy: The setae are arranged in a definite pattern important for the identification of insect in systematic.

Chapman's Biotic Potential: The Chapman has given the concept of biotic potential which includes two separate factors, the reproductive potential and the survival number. All the eggs laid by insects do not survive due to the limiting factors. The biotic potential is not a constant but increases or decreases due to factors required for the growth.

Chemical Control: When the synthetic chemicals are used to prevent crop infestation or other damages from insect pest e.g., DDT, malathion, parathion.

Chemoreceptors: The receptor that senses taste/gustatory and smell/ olfactory to locate food, mating sites, ovipositional sites, attractants, repellents etc.

Chemosterilants: The chemicals used to sterile the fertile individual by failure of gamete production, death of the gametes or produces genetic disorders during zygote development e.g., Aziridine, sulphuric acid esters, nitrogen mustard, radioactive isotopes, alkylating agents, tepa, thiotepa.

Chewing and Lapping Mouthparts: Both of the maxillary and labial palps are reduced or absent, labium for lapping, mandible and labrum for chewing the food (nectars) e.g., wasp and honey bees.

Chitin Synthesis Inhibitor (CSI): It is used to inhibit the formation of synthesis of chitin. Certain examples are BPU (benzoyl phenyl urea) analogues; DU 19.111 (mixture of dichlobenil and diuron); dimilin {diflubenzuron [1-(4-chlorophenyl)-3-(2,6-difluorobenzoyl) urea]}; plumbagin from African medicinal shrub, *P. capensis*. Dimilin is used against many coleopterans, dipterans, lepidopterans. BAYSIR 8514 and IKI 7899 are the synthesized commercially.

Chitin: It is made up of chain of nitrogenous polysaccharide N-acetyl-D-glucosamine and D-glucosamine linked by β-1,4 glucosidic bonds in the ratio of 9:1. It consists of the 25 to 60% of the dry body weight of exocuticle and endocuticle.

Chlorinated Terpenes: The naturally occurring terpenes are chlorinated and forms the synthetic organic compounds e.g., toxaphene, strobane.

Chordonotal Organs: It is a proprioreceptor having chordonotal sensilla lacking exocuticular component associated with body wall, skeletal structure and trachea.

Chorion/Egg Shell: Eggs are covered by a protective membrane secreted by the follicle cells of the ovary and differentiated into outer exochorion and inner endochorion.

Circadian Rhythms: The daily activity of the insect stimulated by external environment and exogenous in origin.

Circulatory system: A system which deals with the transportation of nutrients gases, hormones, etc. to the cells in the body and help to fight against diseases, stabilize the body temperature and maintain the pH for conducting normal body functioning.

Circumesophageal connectives: A paired loop of nerves around the digestive system to link the brain and subesophageal complex together.

Cladistic/Phylogenetic Classification: Cladistic approach assumes that certain characters have undergone greater evolutionary modification than others, and are given more weightage and the family tree is called **cladograms.**

Clasper or subgenital plate or phallomere or phallic lobe or phallus or gonapophysis: In males movable plate is found on the 9^{th} segment of modern insects and function to grasp the female while mating.

Class Arachnida: It is the class of phylum Arthropods which consists of 4 pairs of legs and body divided into cephalothorax and abdomen lacking antenna and having book lungs e.g., Spiders

Class Chilopoda (*Chila* = margin, *poda* = foot; *centi* = hundred, *pes, pedis* = foot)**:** It is the class of Arthropods commonly called as Centipedes means a hundred legs which are carnivorous e.g., *Scutigera forceps* or house centipede, *Scolopendra gigantea*.

Class Diplopoda (*diplo = two, poda = legs*)**:** It is the class of phylum Arthropoda having 2 pairs of legs in each segment commonly called millipede means a thousand legs found in dark and humid places.

Classification: Thousands of species are classified under animal kingdom to identify the specimen and provides intellectual satisfaction to the taxonomist.

Cleaner bees: One to three day old worker bees meant for the cleaning the empty cells of the hive for reuse.

Cleavage: When a male and female nucleus fuses to form zygote; nucleus moves towards the centre of the fertilized egg and divided by a cleavage initiating at the site called **cleavage centre** which is the future head region.

Closed Tracheal System: The insects mostly parasitic and some aquatics do not have spiracles and consists of a network of trachea covering the general body surface or tracheal gills (mayflies nymph) or rectal tracheal gills (dragonfly nymphs).

Coagulocytes/ Cystocytes: They are hemocyte having scattered granules and help in coagulation.

Coarctate: It is a type of pupa enclosed in a sheath called puparium e.g., Housefly, flesh fly-Diptera (Cyclorrypha).

Cochineal: It is secreted by scale insect, *Coccus cacti* feeding upon prickly pear used in making permanent dye, cake coloration, coloring agent in beverages and medicine. It is also used to relieve pain associated with whooping cough and neuralgia.

Cocoonase: The enzyme which digest the cocoon of the satrurniid and bombylid moths.

Cohort: It is the category between the subclass and superorder in the hierarchy.

Coleopterist: The entomologist which focus upon only the beetles.

Collophore: A special structure present on the ventral side of the first segment of the abdomen.

Commensalism: The association between members of two species where one is neither harmed nor benefited while other is benefitted e.g., microbes associated with insects.

Commissure: They are the nerves that join ganglia within the segment by a short medial nerve.

Complete parthenogenesis: The type of parthenogenesis based on generation where the female insect is homogametic (two X chromosomes) and male insect is heterogametic (XY or XO). The natural parthenogenesis can be complete only when males are unknown and population consists of only females in case of aphids. The diploid females give rise to diploid offsprings.

Compodeiform Larvae: The oligopod larvae having prognathous head, elongated and flattened body, long thoracic legs, and a pair of antenna, cerci that resembles the *Compodea* (member of Diplura) e.g., ant lion grub, lady bird beetle grub.

Compound eyes: A pair of large compound eyes located on the dorsal side of the head; well developed in most of the terrestrial insects. It may be reduced or absent in some parasitic forms like lice, female scale insect, fleas, etc.

Cone cells or Semper's cell: The central crystalline cone of ommatidium is secreted and surrounded by four cone cells.

Congregans: When locust are greater in number**.**

Connectives: They are nerves that join intersegmental ganglia.

Conservation: It is a technique in biological control in which all those control measure are avoided which can destroy the natural enemies such as protection of the inactive stages of natural enemies, safe use of pesticides.

Continuous polymorphism: The forms are slightly different as in the case of locust. The phases depends upon the quantity of the food and number of individuals where low population density, abundant food which enhances solitary phases laying more eggs, short winged, enlarged body, accumulates less fat. On the contrary high population density, low food availability result in gregarious form exhibiting small body, large wings, accumulate more fat and lays fewer eggs.

Corpora Allata: A pair of small and glandular bodies located with the corpora cardiaca on sides of the oesophagus. These are mostly paired but exceptionally single in Dermeptera and Heteroptera order.

Corpora cardiaca- It is present behind the brain on the dorsal part of the foregut associated with cephalic aorta. They also act as neurohaemal glands. It is absent in Collembola.

Corpora Pedunculata/Mushroom Bodies: It is a part of protocerebrum consists of calyx and two lobes α and β lobe.

Cotoxicity Coefficient/ Synergistic Ratio: It is the estimation of increase of toxicity caused by non toxic compound LD50 of toxicant alone/ LD50 of mixture.

Court Disease: The pupae of the silkworm are formed without cocoon formation due to the lack of certain elements in the food.

Coxa: The leg is attached by the base called coxa which fits in a cuplike depression in the body, allowing multidirectional movement.

Coxopodite/Gonocoxae: The gonopod/gonapophysis/valvulae are present on the basal area.

Cranium: It refers to the hardened capsule of the head opening into mouth and thorax.

Crop Fallowing: The field technique where only one plant grows in a single growing season and then left without a crop (fallow period) to build up the moisture and fertility of soil. This kind of short crop fallow period is enough to reduce infestation from the insects, their immature stages and eggs.

Crop Spacing: It is a way of management or alteration of the plant density and the width of the row of a crop to avoid pest population and maximize the yield e.g., control of wheat corn borer, pod borer.

Crop: Esophagous dilated posteriorly to form crop where food is temporarily stored and intima forms spines or ridges for a breakdown of food.

Cross Resistance: It is the resistance of the insect against one insecticide favours the resistance towards other insecticides as well.

Crustacea: It is the class of phylum Arthropoda including a group of a mostly aquatic organism, body divisible into a cephalothorax and abdomen e.g., crayfish, lobsters.

Cryoprotectants or Antifreezing Agents: Haemolymph contains a sorbitol or glycerol in their plasma which prevents them from freezing during the winters and fight against cold stress.

Crypsis: It is character of insect having different form, color, shape, pattern which facilitates hiding from the predator e.g., industrial melanism of *Biston betularia.*

Cryptobiosis: Some insect shows no sign of metabolic activity and able to survive in almost complete dehydration for several years.

Cryptonephridia: It is the distal portion of the malphigian tubule.

Cryptonephridial Arrangement: The arrangement of malphigian tubules where distal end is embedded inside the tissues lies close to the rectum and not hanging freely in the hemolymph e.g., Coleopterans and Lepidopterans. This arrangement provides more efficient mode for the absorption of water.

Cultural control: Since the history cultural control practices are the oldest technique to control pest population in the field by manipulating timings of crop harvesting, irrigation, crop rotation, growing traps crops, crop spacing etc. It is considered as the first line of defense against a pest and prevents economic losses.

Cursorial Leg: Legs modified for running having thin and long segments e.g., cockroach, tiger beetle.

Cuticle: It is the outermost layer of the insect's integument which consists of outer **epicuticle** and inner **procuticle**.

Cuticular Respiration: In some aquatic species respiration takes place by a thin integument through which diffusion of oxygen and carbon dioxide can take place.

Cuticulin: It is a component of epicuticle made up of lipoprotein and polyphenols responsible for resistance against acids, organic solvents and allows expansion during molting.

Cyclic Parthenogensis: The type of parthenogenesis based on generation where sexual generation alternates with parthenogenetic generation. The female produces two or three folds more offspring without involvement of males as compared to the normal sexually reproduced generation e.g., bees and wasp

Cyclodevelopmental Transmission: It is a kind of biological transmission in which the pathogen undergoes cyclic or developmental changes but do not multiply in the vector body e.g., filarial worm, *Waucheria bancrofti* in mosquito *Culex sps*. (Order: Diptera) causes elephantitis/ lymphatic filariasis.

Cyclodiene Insecticides: They are highly chlorinated hydrocarbons having endomethylene bridged structure formed by the reaction of Diels- Alderdiene e.g., dieldrin, aldrin, endrin, chlordane, heptachlor, isobenzan.

Cyclopropagative Transmission: It is a kind of biological transmission in which the pathogen undergoes both cyclic changes and multiplication in the vector body e.g., *Plasmodium* in a mosquito, *Anopheles sps.* (Order: Diptera) causes malaria.

D

DALYs (Disability Adjusted Life Years): The annual losses that occur in several trillions dollars all over the world due to the disease burden e.g., malaria causes disease burden of 2000 DALYs.

Damage Boundary (DB): It refers to the boundary at which minimum amount of damage can be measured due to insects. At, this level the cost of control can justify the injury. It is the zone of no losses.

Dearth Period: The period for the bees when there is no nectar availability, therefore, no honey flow.

Decticious: It is a type of exarata pupa with well developed articulated mandibles meant for the escape from the pupal case present.

Delayed Induced Resistance (DIR): It refers to the resistance of the plants occurred due to the damage caused by insects previously and hence, the fecundity of the insect reduces up to 70 % in the DIR.

Depth action: It is the capacity of the insecticides to penetrate to some extent in the plant.

Dermatosis: It is a disease of the skin or an inflammation of the skin.

Detritus Food Chain: The food chain starts with the detritus as first trophic level. The total efficiency of this food chain is affected by moisture, temperature, and oxygen content of the organic medium.

Deuterotokous Parthenogenesis: In insects where female can produce both the male and female progenies by parthenogenesis e.g., lac insect.

Deuterotoky: During parthenogenesis when both the male and female are produced e.g., cynipid wasp.

Deutocerebrum: It is a part of brain made up second pair of ganglia receives information collected by the antenna.

Development Inhibitors/ Hormone Mimics: The growth and the development of the insects are regulated by messengers called hormone secreted by ductless glands in insects. These hormones are made synthetically and applied to control the insect by either mimics/agonist or acts as antagonists e.g juvenile hormone mimic, juvenile hormone antagonists.

Diapause: It is the sudden arrest of the development which may occur at any stage of the life cycle and may be obligatory or facultative. It occurs due to external conditions or auto intoxication of enzymes or metabolism. This term is given by Beck (1968) e.g., egg diapauses- silkworm; prepupal diapauses- pink bollworm; pupal diapauses- oak silkworm; adult diapauses- Colorado potato beetle.

Diastolic Phase (Relaxation): When the ostia open the inflow of the hemolymph from the body cavity into the chambers takes place.

Digenetic Parasites: The parasites that can complete their life cycle in two hosts.

Dinergates: The soldiers of the ants having modified enlarged head and developed mandibles and protect the colony.

Dinitrophenols: They are the synthetic organic insecticides and derivatives of 4,6-dinitro 2-alkylphenols against scale insects, aphids, ticks e.g., DNOC (4,6-dinitro-O-Cresol), DNOCHP (4,6-dinitro-O-cyclohexylphenol).

Dioptric Apparatus: The cornea, crystalline cone, pigment cells which combine to form this apparatus used to receive the light.

Diploid Parthenogenesis/ Thelytoky: Those insects in which embryos develop from diploid egg but they are unfertilized and differentiated into ameiotic and meiotic thelytoky.

Discontinuous Polymorphism: Various forms those are totally different from each other as in case of termites and aphids.

Dissocians: When locust are lesser in number.

Dorsal Vessel: The largest, longitudinal vessel, fragile, membranous, located on mid dorsal side of the body which collects the hemolymph from abdomen towards the head anteriorly.

Dufour's Gland: The small, simple, and delicate gland opens near the sting of the worker ants that secretes trail pheromones.

Dusters: These are the equipment used for the dispersal of powdered insecticide and are of different types depending upon the area to be covered and type of insect that has to be control. They are plunger duster, rotator crank duster, bellow duster, knapsack duster, and power duster.

Dusts (D): It is the simple formulation of insecticide which is grinded into fine powder and mixed with organic flour such as chalk powder.

Dyar's Law: It is a growth law which states that the width of the head capsule grows in a geometric progression at each moult. It is given by the mathematical expression: x/y=constant (ranging from 1.2 to 1.4) where x is the size of the given instar and y is the size of the previous instar. It is used to find out the number of instar in a life cycle of an insect where it applies.

E

Ecdysis/ moulting: It is the process of shedding of old cuticle during metamorphosis and controlled by hormones. The term arises from the Greek word which means to "take off/ strip off" found in various animal groups like arthropods, nematodes, velvet worms, tradigrades and cephalorhyncha.

Ecdysis: When the older cuticle is separated by apolysis it starts splitting from the midline of the thorax towards the dorsal side.

Ecoclimate: It is the measure of the environmental conditions surrounding the insect where the insect exists.

Economic Injury Level (EIL): It refers to the lowest number of insect population which can cause economic damage (Pedigo, 1991). It is the zone above which economic losses can occurs.

It is measured in this way; EIL= C/ VID where C=cost of management in Rs/ ha, V= market value of the product in Rs/kg, D=damage per unit of injury kg reduction /ha.

Economic Threshold Level (ETL): It is the most important index which determines that at this level control measure must be applied to prevent the economic damage. So if the population reaches the EIL it means no action was taken to control the pest. It is the zone non economic losses.

Ectoparasites: Species that live on other host species e.g., ticks.

Ectosymbiosis: The interspecific interaction between the termite, ants, wasps, and fungus. The association of ambrosia fungus with termites growing in a termitarium is given a separate chamber, and the fungus provides food for the reproductive caste and young ones.

Efferent (Motor) Neurons: The unipolar neurons that conduct signals away from the CNS and stimulate responses in muscles and glands.

Egg diapause: Arrest of development during egg stage due to the external unfavorable condition e.g., silkworm eggs.

Egg: The Insects lays spherical/oval/ barrel shaped/ sausage shaped/ torpedo shaped eggs dependent upon the species as the first stage of their life cycle, singly or in groups or in case ootheca which hatches into next stage larva or nymph.

Ejaculatory Duct: The vasa deferens combine to form a single ectodermal derived tube, cuticle lined, heavily muscular in the midline of the body which opens outside by aedeagus.

Elateriform Larvae: The oligopod larvae having heavily sclerotized body, cylindrical, short legs and hard cuticle e.g., grubs of Elateridae (click beetles)

Elytra (singular elytron): The forewings of Coleopterans are highly hardened and chitinized protects the underlying hind wings e.g., beetle.

Emulsifiable concentrates (EC): The water insoluble insecticides mixed emulsifiable agents to form liquid formulation.

End Cell: The terminal tracheal tube ends into the end cell where oxygen gets diffuses into the cytoplasm of an adjacent cell and carbon dioxide diffuses out.

Endochorion: Sometimes waterproof wax layer between an outer chorion and inner vitelline membrane is found.

Endocuticle: It is the inner layer of the procuticle which is thickest, containing chitin and protein.

Endoparasites: Those insects that acts as internal parasites of host e.g., Dipteran larvae.

Endophallus: The inner wall of aedeagus with an ejaculatory duct and inner passage.

Endoplasm: The centrally placed yolk enriched region not involved in cleavage.

Endopterygota: It is the division of subclass Pterygota where the wing develops internally, with a complete metamorphosis, including a pupal stage e.g., beetles.

Energids: The cleaved nucleus at later stage moves towards a periphery and surrounded by cytoplasm which is called as cleavage energid.

Entognathous: In some primitive insect orders like Protura, Collembola the mouth parts are placed inside a cavity.

Entomochrome: These are the pigments which gives color to the excretory product.

Entomogenous fungi: A group of fungi which are pathogenic to insects e.g., *Beauveria sps*. used as a biological control agent.

Entomology: It is originated from the word *Entomos* a Greek word which means cut into pieces and logia is the study of insects.

Entomophily: When the pollination takes place through the insects by mechanical transfer e.g., bees, butterflies, moths, flies, beetles and many more.

Entomophobia: Some people are having irritational fear from the insects due to anxiety.

Entosymbiosis: Some bacteria lives in the gut of the insects where bacteria derive nourishment from insects and in turn digests the cellulose and other materials for the insects e.g., *Trichonympha sps.* in the gut of termites.

Envenomization: Some of the arthropods inject poison into the body of human beings that can leads to death of an individual e.g., Lepidoptera larvae and some spiders - such as tarantulas.

Environmental Economic Injury level (Env. EIL): It refers to the management tactic, its cost, benefit that is used to control the insect pest with their effects on the environment.

Epicuticle: It is the uppermost layer of cuticle which is 0.03-4 µm thick, devoid of chitin, permeable; contains cuticulin and made up of several layers including cement layer, wax/lipid, polyphenol, sulphur and cuticulin.

Epidermis/ Hypodermis: A single layered living cells resting upon the basement membrane of integument consisting of nerve cells, sensory cells, tormogen cells, trichogen cells, oenocytes and dermal glands. It secretes the cuticle and moulting fluid which dissolves older cuticle layer and forms a new cuticle.

Epimeron: It is the posterior region of pleura.

Epipharynx: It is located at the roof of the mouth and performs the function of tasting the food e.g., grasshoppers, crickets.

Epipleurites: Episternum and epimeron are further subdivided into smaller sclerites at wing base.

Episternum: It is the anterior region of pleura.

Ergates: The workers of the ant which are sterile wingless females having reduced thorax and eyes and perform all duties.

Esophagous: The mouth leads to the tube like longitudinal and narrow esophagous.

Eucephalous Larvae: The apodous larvae having well sclerotized head capsule, developed maxilla and mandibles, a pair of antenna e.g., wrigglers of mosquito.

Eucephalous: A type of apodous larvae with well sclerotized head capsule e.g., mosquito (Diptera: Nematocera), Buprestidae, Cerambycidae.

Eucone: It is the compound eye in which cone cells secrete hard refractive crystalline cone e.g., Orthoptera, Odonata, Coleoptera, Lepidoptera.

Eutropus: It is a mutual relationship between the insects and plants where insects have special apparatus designed to carry pollen e.g. long tongue bees, Sphingidae. Here, plants are having complicated flower mechanism for long tongue bees.

Exarate: A type of pupa where appendages are not glued together e.g., Hymenoptera, Diptera (Brachycera), some Coleoptera.

Excuviae: The empty, dead, and remains of exoskeleton left after moulting.

Excuvial membrane: A transparent, thin and homogenous membrane appearing between the epidermis and the old cuticle.

Exocone- It is the type of compound eye in which the inner surface of cornea extends inside that replaces the crystalline cone totally e.g., some of the Coleopterans.

Exocuticle: It is the outer layer of procuticle which is a highly stabilized, inert, strong, hard, contains chitin and pigmented as sclerotin protein is found.

Exopterygota: It is the division of subclass Pterygota where the wings are developed externally from extension of body wall with a simple metamorphosis and without pupal stage e.g., dragon flies.

Exotic pest: The pests which are introduced from other countries e.g., woolly apple aphid introduced from the USA to Britain.

External respiration: When insects exhale carbon dioxide as a waste product and inhale oxygen.

Extra embryonic membranes: Two extra embryonic membranes outer amnion and inner serosa develops from the ectoderm during gastrulation.

F

Facultative Diapause: Diapause of multivoltine and bivoltine species controlled by environmental conditions in which members of certain generation do not show diapauses in their life cycle.

Facultative parthenogenesis: The type of parthenogenesis based on occurrence where it is not compulsory as a rule to undergo this process but can take place in certain circumstances e.g., bees.

Family: Family is a (Latin word *familia*) is a rank between order and genus subdivided into subfamilies. Family names ended with suffix –"idae" in zoological nomenclature.

Fanner bees: The worker bees which fans the hive to lower the temperature by beating of their wings and hovering around.

Fat Body: It is equivalent to the liver of higher organism, derived from mesodermal walls, located beneath the integument or around a gut; they are the site of protein synthesis, composed of trophocyte and found in some urate cells or mycetocytes.

Feeding Deterrents/ Antifeedants: They are used to eliminating the damage caused due to insects by preventing feeding. They can be of plant origin or made synthetically e.g., ZIP, Fentin acetate, Fentin chloride, Fentin hydroxide, neem formulation, triazenes, calotropis, and mercuric chloride.

Female Attracting Pheromones: The pheromones secreted by the males to attract the females e.g., *Harpobittacus* (Mecoptera).

Femur: The largest part of the leg.

Fenestrae: The dorsal diaphragm is not continuous but has openings through which the hemolymph passes.

Fenestrae: The head of the cockroaches bears a pale region with nerves and brain in place of 3rd ocelli in most.

Fertilization: The sperm enters into the egg and fusion of male and female gamete takes place by syngamy.

First Generation Pesticides: The inorganic compounds and organic compound such as mercury, arsenic, lead, or botanicals used before 1940s

Fledging: The last wingless larval instar of grasshopper which metamorphoses into newly emerged winged adult.

Fledgling: The newly emerged adult of grasshopper which consists of soft wing which soon becomes hardens and starts flying.

Flowables (F): The insecticides which are not dissolved in water or organic solvents are mixed with oil or oil based flowables.

Flunctuate Parasite: If a parasite can live with or without the host e.g., cat fleas are facultative parasites of humans.

Fluorine compounds: The inorganic chemical compounds having fluorine elements which are soluble, stomach poison and toxic to plants e.g., sodium fluoride, sodium fluosilicate, cryolite.

Fontanelle: It is the depression on the dorsum of head and a characteristic feature of termites.

Food Chain: It is the chain of eating and being eaten with unidirectional flow of energy through a net like arrangements of pathways.

Forager/ Field/ Scout bees: After 20 days of emergence worker bees collects nectar, pollen, and water to perform outdoor duties.

Foregut: The first part of the alimentary canal lined with cuticle differentiated into mouth, pharynx, esophagous and crop and proventriculus in which breakdown of the food particles takes place during the ingestion of the food along with saliva.

Forelegs: A pair of leg placed on the prothorax.

Fossorial leg: The legs modified for digging e.g., mole cricket.

Frenate coupling- It is the coupling of the retinaculum of forewing and frenulum with 2-20 bristles fuse to form single stout spine of hindwing e.g., Order Lepidoptera.

Frontal Glands: the glands present in the nasute soldier caste of the termites opens through frontal pores and secretes a defensive sticky material of defensive nature.

Furcula: The abdomen of the springtails consists of the fork shaped structure locked in the tentaculum and used for jumping the insect.

G

Galls: The outgrowth of the plant in which larvae of insects feed, grow and develop e.g gall midges (Order: Diptera) and gall fly (order: Hymenoptera) causes galls.

Gastrulation: After the blastoderm formation it sinks into the gastric groove and differentiated into two regions the anterior stomodeum and posterior proctodeum.

Generations of Pyrethroids: The pyrethroids are divided into generations, Allethrin as 1^{st}, resmethrin as 2^{nd}, permethrin as 3^{rd}, and cypermethrin as 4^{th} generation pyrethroids.

Genetic control: It is a technique used to control insects by manipulating the genes or heredity e.g male sterile method where males are sterilized by irradiation during the pupa stage by gamma rays used against screwworm fly, *Cochliomyia hominivorax* and discovered by Knipling in 1955. It also involves the manipulation of genetic makeup such as hybrid sterility, cytoplasmic incompatibility, introduction of lethal or harmful genes that results in reduction in reproduction, fecundity, vigor, inability to complete metamorphosis. Example tsetse fly, *Glossina morsitans* and *G. swynertoni* by hybrid sterility.

Genital Chamber or Bursa Copulatrix: The lateral oviduct do not directly opens in a median oviduct but a pouch like evaginate chitin lined structure. In, Lepidoptera the bursa copulatrix open outside through the valve.

Genus: Group of species that share common features of a single group.

Germarium (in female reproductive system): It is a part of ovariole in which oogonia derived from primary germ cells.

Germarium (in Male reproductive system): It the distal part of testicular follicle in which spermatogonia are formed from germ cells.

Gizzard/ Proventriculus: It is a part of foregut having highly specialized chitinous teeth like structures to chew the food and it is best developed in chewing insects while absent or reduced in sucking insects.

Gonopod/Gonapophysis/Valvulae: An additional slender process with the stylet in Thysanurans

Granules (G): Some insecticides are enclosed into a coarse particle of porous material.

Granulocytes: They are hemocytes which are the largest cell of all, phagocytic in nature, consist of granules and are acidophilic in nature.

Grasserie disease: It is the disease of the silkworms caused due to the viruses that forms polyhedral bodies.

Grubs: The larvae of beetles.

Guard bees/ Sentinel bees: At about 20^{th} day of bee emergence worker bees guard the hive from the intruders.

Gymnonephridial Arrangement: The arrangement of malphigian tubules where distal end lies freely in the hemolymph e.g., Orthopterans and Hemipterans.

Gynes: The queen of the ant which is fertile females having well developed reproductive system only eggs.

H

Haemocytes/ Blood Cells: It constitutes about 10% of hemolymph, origin from hematopioetic organs (in the developing stages and adults in exopterygote). These cells are different in function and structure prohemocyte, plasmatocyte, granulocyte, oenocytoids, coagulocyte, spherules. Prohaemocytes, plasmatocytes and granulocytes are the basic cells present in all types of insects.

Hair pencil: For the better dispersal of the pheromones some insects are having everted structure which is covered with fine hairs to provide greater surface area.

Hair plate: The proprioceptive trichoid sensilla present on the overlapping areas of the insect body.

Hairy Caterpillar: The polypod larvae having hairs which may be dense, in tufts that causes allergies e.g., red hairy caterpillar.

Halters: The hindwings are reduced into halters in the members of order Diptera and performs the function of balancing of the body e.g., housefle, mosquito.

Hamuli- Rows of hook called hamuli on the costal margin of hindwing which is holded by the fold of forewing in Hymenopterans.

Hand net: It is a 600mm long wooden or metal handle with a circular rim of about 300mm diameter to which mosquito net is attached. It is used to collect aerial insect from the field like butterflies, dragon flies, bees, wasps etc.

Haploid parthenogenesis/ Arrhenotokous: When haploid eggs are produced by normal oogenesis but not fertilized by male gametes the adults, thus, formed are haploid e.g., Hymenopterans (bees and wasps), Homopterans (white fly), Coleopterans and Thysanopterans. In, case of bees two types of eggs are laid fertilized (diploid females develops) and unfertilized (only haploid males develops).

Haustellate mouthparts / Sponging: The insect groups which takes liquid food (blood or sap of the plants) in which stylets (needle like modification of maxilla, mandibles, and the hypopharynx) are present that help in penetrating the plant to animal to take their meal e.g., house flies, blow flies (order Diptera).

Head: The insect head is first divison or tagma which is rigid, sclerotoized and contains compound eyes, antenna, and mouth parts.

Heart Beat: The rate at which the heart beats ranging from 30 to 200 beats per minute depending upon the temperature and hormone secretion e.g., larva of stag beetle, 14 beats/minutes; flies 150 beats/minutes.

Heart: The dorsal vessel is expanded and form chambers at some places segmented and separated by valves and ostia so that the flow of blood takes place is unidirectional.

Helicopter duster: When a large surface area has to be covered helicopters are used with a dusting unit attached to the fuselage behind the cockpit having 95kg capacity and spreads about 14, 00,000 cubic feet/ minute. It has few advantages like slow speed, small area, better distribution and disadvantages like high cost, maintenance and repair is costly.

Hemelytra: The forewing of Heteropterans are hardened and sclerotized up to half and rest of half is membranous e.g., bugs.

Hemicephalous Larvae: The apodous larvae having reduced retractile head capsule, vertically placed mandibles e.g., larvae of horse fly and robber fly.

Hemicephalous: It is a type of apodous larvae with reduced head capsule which can be retracted into thorax e.g., Tipulidae (Brachycera).

Hemimetamorphosis: A type of metamorphosis in which immature instars inhabit aquatic habitat while the adults are either terrestrial or aerial e.g., Exopterygote insects like mayflies, dragonflies and stone flies,

Hemipneustic: It is a kind of polypneustic respiratory system containing one meso thoracic and seven abdominal pairs of spiracles e.g., some fly larvae.

Hemitropus: It is a mutual behavior between the plants and insects where the mouth parts are fitted for sucking and licking and the body is hairy which facilitate the pollen dispersal e.g., short tongue bees (sphecidae), Bombycidae, Syrphidae, many Lepidopterans. Here, plants are having concealed nectaries adapted for short tongue bees.

Hemocoelomic viviparity: It is a kind of viviparity where oocytes are released directly into the hemocoel near ovarioles and fertilization occurs within the body of female where nutrients are absorbed directly from the hemolymph by simple diffusion. Larva after hatching moves outside by the genital pores. It occurs in orders Strepsiptera and Diptera (Family Cecidomyiidae).

Hemoglobin: A respiratory pigment facilitates the capture of oxygen molecules occur only in rare insects e.g., larvae of certain midges (family Chironomidae) bloodworms.

Hemolymph: Like blood of vertebrates insect hemolymph composed of plasma and hemocytes in which all the tissues are bathed.

Herbivore Food Chain: The food chain which starts with the producers as first tropic level, herbivores as second tropic level and one or more levels of carnivores. Insect occupies mostly the second and third trophic level e.g., Willow tree-caterpillars-predacious carabid beetle- insect eating birds- hawks

Hermaphroditic: The individual containing both male and female sex organs.

Heterogonic/ Disharmonic/ Allometric: The insect in which all the parts of the larvae do not grow at the same rate and each part is having its own growth rate.

Hierarchy: A systematic framework for zoological classification with a sequence sets at different levels in which all sets except the lowest one includes one or more subordinate groups. It has nine major taxonomic ranks- Life, Domain, Kingdom, Phylum, Class, Order, Family, Genus, and Species.

High volume spraying: The quantity of the water mixed with insecticide is high 300 to 1000 l e.g 1.2 kg of A.I (0.2% concentration) in 600 l of water per hectare spread by sprayers (mist blower or atomizer).

Hind legs: A pair of leg placed on the metathorax.

Hindgut: It is the last section of alimentary canal, ectodermal in origin, surrounded by a cuticle, differentiated into pylorus, ileum, and rectum.

Holometamorphosis/Complete Metamorphosis: Endopterygote insects in which the immature stages the larvae are completely different from adult and inhabit different environmental situations. Larvae lack compound eyes and having biting and chewing mouth parts, pupal instar between last larval instar and adult is found which is the resting stage protected by a cocoon or puparial case.

Holopneustic: It is a kind of polypneustic respiratory system containing two thoracic and eight abdominal pairs of spiracles e.g., cockroaches.

Holoptic condition: The condition of compound eyes which meet posteriorly in mid dorsal line e.g. dragon flies, male tabanids, horse flies.

Honey Flow period: The period or season in which the numbers of plants are rich in nectar for the bees.

Honey: It is the highly nutritive, colorless, sticky, viscous liquid prepared by the nectars of plants by honey bees *Apis mellifera* and other species. It is made up of sugar levulose, dextrose, water, fatty acids, almost all amino acids, proteins, vitamins, and minerals.

Horizontal resistance: It is the resistance of a host plant against a single important pest due to some phenological, morphological or biochemical characteristics. It is permanent and accumulates in 10 to 12 generations of host as it is not dependent upon genes of pest.

Horizontal Veins: The veins of the insect wing which are horizontally arranged; precosta (PC), costa (C) a convex vein, subcosta (SC) a concave vein divided into SC1 and SC2, radial (R) divided into five branches R1 (convex), R2,R3,R4 and R5 (rest all concave), medial branched into anterior MA1,MA2 (convex) and posterior MP1, MP2, MP3, MP4 (concave), cubitus Cu1 (Cu1a, Cu1b) and Cu2 all convex, anal A1,A2, A3 all convex and jugal J1, J2 may be present.

Hormone: The term Hormone is derived from the Greek word 'hormon' means 'to excite' given by Bayliss and Starling (1902-05). The growth of the insect is regulated by hormones was firstly determined by Kopec while studying CNS of *Lymantria dispar*.

Host escape: When the susceptible plant lacks infestation in a population which consists of infected plant**.**

Host evasion: The apparent resistance in which the plant escapes by showing early maturity to avoid the peak period of damage caused by the pest.

Host Plant Resistance (HPR): It is the resistance of the host plant species, race, clone, or individual against the insect species, race, biotype or individual due to some heritable character which reduces the chances of plant to become a host. Example, Underhill variety of wheat is resistant against Hessian fly, *Mayetiola destructor* (Say) reported in USA, 1782.

Hypermetamorphosis/Heteromorphosis: A kind of metamorphosis where all the larval instars are alike except few minor morphological details e.g., ant-lions, beetles and all species of Strepsiptera.

Hyperparasite/ Epiparasite /Secondary parasite: If a parasite live on an other parasite. Example, *Chalcid perilampus* is a parasite of *microgaster* which is further the parasite of Lepidoptera caterpillars.

Hypognathous: When mouth parts are positioned vertically or downward e.g., Orthopterans.

Hypopharynx: It lies in the preoral cavity somewhat tongue like where salivary glands opens.

I

Idiobiont Parasitoids: The parasitoids which prevent any further development of the host after initial parasitization including mostly immobile stages (an egg or pupa), and almost without exception, they live outside the host.

Ileum: It is the middle part of hindgut which is a narrow tube containing undigested material and in termites (wood eating insect) is modified into **fermentation pouch** where protozoan and bacteria inhabit symbiotically.

Image: The other name of adult.

Imaginal Disc/ Imaginal Buds: The undifferentiated tissue present during the larval stages of insects which may forms the wings, antenna, or legs in adults.

Immunity: Ability of an insect body to fight against diseases which may be natural or induced.

Induced Parthenogenesis: The kind of parthenogenesis based on occurrence where parthenogenesis can be artificially induced by treating them with weak salt solution, organic acids, electric shocks or irradiation.

Induced Resistance: Some environmental conditions like low moisture content, high potash level, high water stress, low nitrogen level in the soil makes the plant more tolerant against insects.

Inducible Immunity: It is a type of humeral immunity which involves the synthesis of RNA and protein e.g., lyzozymes, cercopins, attacins etc. They encapsulate and destroy the internal parasites and produce a distasteful compound which provides a degree of protection against predators e.g., the hairy caterpillar consists of poison in the haemolymph.

Indusium: It is an extra embryonic membrane in Orthoptera as an extra third layer.

Innate/Natural Immunity: It comprises cell mediated immunity such as phagocytosis, encapsulation.

Inoculative Release: It the release of natural enemies once a year to re-establish its population which is killed during the period due to unfavorable condition.

Inquilines: These insects live in the shelter of other insects as permanent residents e.g., ants of different species living together in association.

Insect Growth Regulators (IGR): Hormone word is given by scientist C. M. Williams; also called third generation pesticide or Insect Growth Regulators (IGR). They are the chemical messenger secreted by the endocrine glands, travel through haemolymph and reach the target organ to perform its function.

Insecta /Hexapoda: The members of Arthropoda in which body is cut into three parts head, thorax, and abdomen having six legs or 3 pairs of legs e.g bees, wasp, ants.

Insectivorous plants: The plants which feed upon insects like *Nepanthes, Drosophyllum, Utricularia* etc.

Insemination: There are various modes by which the ejaculated semen is deposited in the female genital tracts. In dragonfly and damselfly the semen is deposited in a specialized organ placed on the second abdominal sternite. Bedbug directly releases semen in the hemocoel, in an other insect deposited in the lateral oviduct or median oviduct or bursa copulatrix of the female reproductive system.

Integument as respiratory organ: Sometimes integument acts as respiratory organ, e.g., *Chironomus* larva.

Integument: It is the outer body wall of the insect which is multilayered and function to protect, forms barrier to external environment, maintains the shape, hardness, excretion and iridescence.

Internal respiration: The exchanges of oxygen and carbon dioxide directly from the cells.

Internuncial (Association) Neurons/ Interneurons: The unipolar neurons having several collaterals and/or branching axons that conduct signals within the CNS.

Inter-specific interaction: The interaction between members of difference species.

Intima: It is the chitinous layer of the foregut, hindgut, and trachea.

Intra-specific interaction: The interaction between members among the same species.

Introduction: It is a step in biological control where natural enemies are introduced from other parts of the country or outside the country. Example, cottony cushion scale of citrus in USA is controlled by Vedalia beetle imported from Australia.

Inundative Release: It is the release of natural enemies after mass culture to suppress the targeted pest population.

Iridescence: Some Coleopterans and Lepidopterans have a special feature of changing color.

Isogonic/ Harmonic: The insect in which all the parts of the larvae grows at the same rate.

Ivermectins: It is a natural product of 16 membered macrocyclic lactones isolated from soil microorganism; mycelia of *Streptomycein ivermectins.*

J

Johnston's organ- The Johnston's organ is located in the pedicel of the antenna in all adults and some of the larval forms. It helps the insect to decide its head position, direction, and orientation of the body. In a male mosquito and chironomids these are functional in locating female while flying to mate. For, this reason male bears much bushier antenna having long hair which vibrate and give information to the organ. The structure of the Johnston's organ is simple consisting of two rings of scolopidia. The inner ring is found parallel to the flagellum while the outer ring is perpendicular to the flagellum. In, comparsion of these two rings the inner scolopidia are found to be more sensitive than outer scolopidia.

Jugate wing coupling- It is the coupling between the jugal lobe of the costal margin of forewing and humeral lobe of the hindwing e.g., order Trichoptera, Mecoptera.

Jugo-frenate coupling- It is the coupling between jugal lobe of forewing and frenular bristles of hindwing e.g., family Micropterygidae.

Juvenile Hormone (JH) Agonist/ mimics: There are varieties of JH which function as JH secreted by insects like methoprene and hydroprene are developed commercially; Juvabione and dehydrojuvabione are the factors present in balsam fir tree, *Abies balsamea* (used to control

Pyrrhocoris bug); Juvocimene from sweet basil herb, *Ocimum basilicum*; Juvadecene isolated from plant, *Macropiper excelsum* (used against milkweed bug *Oncopeltus fasciatus*); Echinolane from the coneflower plant Echinacea angustifolia (used against *Oncopeltus fasciatus* and *Tenebrio molitor*). **JH mimics** commercially available; Methoprene (trade name- Altosid to control water mosquito, houseflies, hornflies), Kinoprene (trade name- Enstar-5E to control aphids, white flies), hydroprene (trade name: Gencor), Diflubenzuron (trade name-Dimilin), **ecdysone mimic**- PBO, cyasterone.

Juvenile Hormone (JH) Antagonist/ Anti-juvenile Hormone (AJH): The hormone like component which deranged the development of immature stages of insects and induces precocious metamorphosis, shortens life cycle, produces sterile females such as precocene I (7-methoxy-2,2-dimethyl-chromene) and precocene II (6,7-dimethoxy-2,2-dimethyl-chromene) extracted from bedding plant, *Ageratum houstonianum* used against milkweed bug, *Oncopeltus fasciatus.* Some other AJH agents are vertebrate hypocholesterolemic agents compactin, fluoromevalonate; methyl farnesoate, PBO (Piperonyl butoxide), EMB (ethyl E-3-2-terbutylcarboxy-loxy butoxy benzoate).

Juvenile hormone: It is a terpenoid (non sterolic compound) secreted by corpora allata triggers fat body, accessory reproductive glands and follicle cells of the body to control metamorphosis, yolk deposition in the eggs, egg maturation, vitellogenin production, green brown polymorphism in locust and tanning of the cuticle.

K

K- pest: The pests having low fecundity, longer generation time, poor powers of dispersal, low population and have specialized food preference. Example; housefly.

Kairomone: The compound which is released by one organism to provoke a reaction in other individual of different species which is significant for the receiver but not the emitter e.g., repellants.

Katatrepsis: The immersion of the germ band during embryogenesis reverts back bringing the embryo back in position on surface.

Koinobiont Ectoparasitoids: The Koinobiont which develop outside the host body, though they are frequently attached or embedded in the host's tissues

Koinobiont Endoparasitoids: The Koinobiont which develop inside of the prey.

Koinobiont Parasitoids: The parasitoids which allow the host to continue its development and often do not kill or consume the host until the host either pupate or become an adult. They typically live within an active mobile host.

L

Labial Glands: A pair of glands located on each side of the foregut in the thorax region and combine their secretion with salivary glands e.g., grasshoppers, cockroaches.

Labium /Lower Lip: They are paired, sensory, having three segmented labial palps, moves longitudinally. It consists of three regions prementum (glossa, paraglossa and labial palps), mentum and submentum.

Labrum /upper lip: A sclerite that can move longitudinally, closely associated with the clypeus and bounded with many sensory structure.

Lac culture: The culture of red or purple dye called lac which is produced by the lac insect or scale insect *(Laccifer lacca).*

Lac glands: The glands are placed all over the body in the integument of lac insect (*Laccifer lacca*) in large amount in females than in males containing resin, wax, pigments, and inorganic materials.

Lac: It is the resinous material secreted by the glands of scale insect, *Laccifer lacca.* It is used in making shoe polish, artificial fruits, flowers, lithographic ink, electric insulation, sealing wax, shellac varnishes, molding, dental plates and hair dyes.

Lactation period: The period where lipolysis (breakdown of lipids) occurs and nutrient transfer to milk gland e.g., *Glossina spp*.

Larva: When the egg hatches larva emerges out from the egg shell which are voracious feeder.

Larval diapauses: Arrest of development during larval stage e.g., fourth larval instar of *Trogoderma granaria.*

Larval paedogenesis: A kind of paedogenesis in which production of young one or larva produced by larval stages e.g., Dipteran - Cecidomyidae, Coleopteran- *Micromalthus debilis* (a beetle), gall midge, *Heteropeza pygmaea.* A female larva can give rise to more female larva paedogenetically or adult females or both but the male larvae can only develop into adult male.

Larviparous: When larva hatches from egg while they are in the reproductive tract of females e.g., Sarcophagidae, the flesh fly lays only 40-80.

Lateral and Median oviduct: Each ovary leads to the thin walled tube the lateral oviduct which joins to form the median oviduct in female reproductive system. Exceptionally, in Ephemeroptera the lateral oviducts opens independently to outside.

Law of periodic cycle: This law was given by Volterra and Lotka which states that the population density o the predator and prey changes in a systematic way. If, prey population is more; the predator population is less in a particular area or vice versa.

LC 50: It is the lethal concentration at which 50% of the test animals are killed. It is basically the concentration of the poisonous material or chemical in the air or water at a certain period of time.

LD 50: It was discovered by J.W. Trevan in 1927. It is the lethal dose (amount of A.I.) at which 50% test animal died and measured in the mg of insecticide per kg of body weight (mg/kg). It is a method to determine the acute toxicity of a pesticide. The dose can be applied either through dermal (applied through skin) or oral (through mouth). Example, oral LD50 (rat)=42 mg/kg, Dermal LD50 (rat)=57 mg/kg. It is used to compare toxicity or lethal doses of different pesticides.

Leaf defoliators: The insect which feed upon leaves by their biting and chewing mouth parts e.g., grasshoppers, locust, weevils, caterpillars.

Leaf miners: The insects which eats the leaf tissue between the lower and upper epidermis e.g., citrus leaf miner, *Phyllocristis citrella*.

Leaf rollers: The caterpillar stages feeding upon leaf which results in rolling of the a leaf, shrivel and fall later e.g., cotton leaf roller, *Sylepta derogate***.**

Lepidopterist: It as an entomologist who study about butterflies.

Life system: Clark (1967) has given the concept of life system which is defined as a part of an ecosystem which determines the existence, abundance, and evolution of a given population.

Life Table: The table consisting of information about population densities, age, mortality, causative factors at different times of the life cycle.

Light producing organs: Some insects glow at night and look beautiful as they can produce light from bioluminescent organs e.g., (lantern flies) *Fulgora lanternaria, Photinus* (fire flies).

Line Transect Method: It is a method used to determine the absolute estimate of insects by dividing the field in straight line and calculating the number coming in that line. It is applicable for both between different species or between the different areas occupying different habitats.

Lipophorin: It is present in the hemolymph of some insect and is a lipoprotein which plays a vital role in the transportation of fatty acids, cholestrol, carotenoids, xenobiotics, and hydrocarbons.

Liquified gas: Several fumigants which remains liquid at atmospheric pressure and turned into gas after application.

Longitudinal Veins: The veins which are longitudinally humeral (h) connecting costa and subcosta, sectional (s) lies between R2+R3 and R4+R5, radiomedial (rm) lies between a radius and medial, median present between M2 and M3 and Mediocubitus present between a medial and cubitus.

Looper: The polypod larvae having two pairs of prolegs placed on 6^{th} or 10^{th} abdominal segment e.g., cabbage looper.

Low volume spraying: The quantity of the water mixed with insecticide is low e.g 1.2 kg of A.I (1.2% concentration) in 100 litres of water per hectare spread by sprayers (mist blower or atomizer).

LT 50: It is the lethal time taken up by the insecticide to kill 50% of the test animals.

Luminelle: There are many membrane bound vesicles present in light producing specialized cells photocyte.
Lumisomes: The luminelle consists of many tiny vesicles.

M

Macroevolution: The evolution where changes occurs in class, order, or family i.e larger than the microevolution.

Macroparasitism: The parasites which can be seen by our naked eye i.e large in size.

Maggot therapy*:* *Lucilia sericata* larvae were used during the World War II for treating the injured patients as it feeds upon necrotic tissue and inhibit infections. It is also used in the treatment of osteomyelitis and chronic open sores.

Maggots: The larvae of flies/ Dipterans.

Major Pest: The pest which is common and important as it causes greater damage to the crop.

Male Attracting Pheromones: The pheromones secreted by the females to attract the males e.g., honey bee secretes 9-oxodecenoic acid and silk moth secretes bombykol.

Malphigian tubules: These tubules are excretory tubules, white /yellow located at the junction of midgut and hindgut. The name comes after the discoverer, "Marcillo Malpighi".

Mandibles /Jaws: The mandibles are paired, sclerotized structures, meant for chewing. It may be reduced or absent in some species. Some have pointed teeth like structure or in some have serrated margins.

Mandibular Glands: The glands located near the mandible which secretes pheromones the queen substance in honey bees and inhibit other worker to become a queen.

Mandibulate/ Biting and Chewing Mouthparts: These are most primitive and generalized mouth parts taking solid food by grinding and chewing the larger food particles into the smaller ones. Examples: Dragonflies and damselflies, cockroaches, grasshoppers.

Maxillae /Second Jaws: They are paired, sensory, slightly movable, having five segmented maxillary palps that detects and qualitatively analyze the nature of food. They consist of parts cardo, stipes, lacinia, galea and maxillary palps.

Maxillary Glands: In Collembola, Protura, Neuroptera maxillary glands are modified from the salivary gland.

Mechanical Control: It is the strategy used to control the insects by applying simple manual techniques such as hand picking, swatting, sieving, making barriers, crushing etc.

Mechanical Transmission: If the transfer of a pathogen takes place by a vector without involvement of reproduction or any developmental changes in the pathogens. They do not cause any disease or epidemic and non persistent e.g., aphids.

Mechanoreceptors: The receptors which can sense mechanical stimuli like solid surface, air movement, sound waves and gravitational forces.

Megaevolution: The evolution where changes occur in phylum or more large phylogenic patterns.

Meiotic Thelytoky: In this type normal meiotic division occurs and diploid condition is obtained either by the restitution (non disjunction of the chromosomes) or by auto fertilization (fusion of ovum with its own polar body) e.g., aphids.

Meriostic ovariole: This is the type of ovariole in which specialized nutritive cell trophocyte are present and are of two type; telotropic and polytropic.

Mesonotum: The terga/ notum of mesothorax

Mesothorax (meso: middle): This is the second division of the thorax and bears forewings and midlegs.

Metameric Segmentation: The individuals in which each segment is a copy of one another performing all functions. They are divided externally and internally.

Metanotum: The terga/ notum of metathorax.

Metapneustic: It is a kind of oligopneustic respiratory system containing only one post abdominal pair of spiracles e.g., mosquito larvae.

Metathorax (*meta*: last): This is the last segment of thorax and bears hind wings and hind legs.

Microbial Control: It uses the control of pest by micro-organisms protozoa, bacteria, fungi, virus, mycoplasma, nematode, rickettsia which causes diseases in them. Example, *Bacillus popilliae* (Trade name: Doom) used to control Japanese beetle, *Popilliae japonica*.

Microclimate: It is the climate of insects immediate to its cubic centimeters or millimeters of space.

Microevolution: The evolution where changes occurs in a population or species due to the selection pressure.

Microparasitism: The parasites which cannot be seen by our naked eye i.e small in size.

Micropyle: In insect egg there is usually one or rarely more specific opening present at one end of the egg which facilitates the entry of sperm.

Midgut/Ventriculus/Mesenteron: It is located between the foregut and hindgut, endodermal in origin, no cuticular lining but lined by a thin peritropic membrane made of chitin and not differentiated into chambers except chinch bug where divided into 3- 4 chambers (Heteroptera) and Cercopid into 2 chambers anterior midgut filter chamber and posterior midgut (Homoptera). Its function is to digest the food and absorb of water and essential components.

Midlegs: A pair of leg placed on the mesothorax.

Mimesis/ Protective Resemblance: The structure or the part of the body of insect which matches with the leaves, stick, seeds, bark, stone e.g., *Kallima* (dead leaf butterfly), *Phyllium* (leaf butterfly), *Carausius* (stick insect).

Mimicry: When one organism called the mimic resembles in shape, color, or pattern with an other organism or plant part called model to escape predator.

Minor Pest: The pest which is uncommon and important as it causes greater damage to the crop.

Mixed Function Oxidases (MFO) Enzyme: These are the enzymes which are present in the fat body and midgut which converts the man made toxic insecticides into the non toxic or less toxic products.

Monitoring: It is the measurements of various factors like population density, life history, presence of natural enemies, abiotic factors used to predict the pest outbreaks.

Monogenetic parasites: The parasites that can complete their life cycle in one host.

Monogenic resistance: The resistance is controlled by a single gene and it is less persistent e.g., IR-8 rice variety is resistant against leaf hoppers.

Monolectic: the pollinators which visit a single type of plant.

Monophagous Pest: The pest which depend upon a single plant species for its feeding e.g., yucca moth on yucca plant.

Monophyletic origin: In monophyletic origin arthropod develops from single ancestor worm like lobopods i.e common ancestor. Monophyletic origin is supported by head embryology, eye structure, visceral anatomy and sensilla.

Morphology: It is a Greek word Morpho means shape or form and logos means study or research.

Moulting fluid: A fluid secreted by the epidermal cells and contains chitinase and protinase which digests upto 80-90% of the endocuticle before the immature insect moults.

Moulting Hormone Agonist (MHA): These are the mimics of moulting hormone which interferes with the normal moulting, growth and maturation of insects. The MHA are ponastron from Taiwan tree, *Podocarpus makaii*; phytoecdysone from Berken fern, ecdysterone, inkosterone from *Achyranthus fauriei*; ecdysone from *Pteridium aquilinum*; ecdysterone from *Polypodium vulgare*.

Moulting Hormone Antagonist: These compounds are having anti-ecdysone properties and delays the moulting cycle. They are ajugalactone from *Ajuga decumbens*; ajugarins from *A. remota*; plumbagin from roots of *Plumbago capensis*; azadirachtin from neem plant, *Azadirachta indica*.

Mullerian mimicry: The type of mimicry where the mimic and the model both are unpalatable and resemble to each other which increases the chance of their survival and benefitted to every member as predator learn to avoid these species.

Multiparasitism: If same host or individual is attacked by a number of different species of parasites.

Multiporous chemosensilla: The chemosensilla which are thin walled, consist of few to several thousand pores and connected to multineural innervations e.g., antenna of insects in many orders.
Multivoltine Species: The species which have more than two generation per year.

Muscardine disease: It is the disease of the silk worms caused due to fungus, *Beauveria bassiana* and *B. tenella*.
Mutualism: Association between the two different species which is mutually benefits each other e.g., fungus growing with ants, pollination of plants by insects.

Mycetocytes: The cells present in fat body contain microorganisms.

Myiasis: Myasis is a term used to refer to an infection of some Dipterous larvae that can invade and feed on living tissues of human and other animals/livestocks.

Myogenic heart: when initiation of the heart beat occur from the muscle and the frequency of heart beat is controlled by cardiac neurons e.g., vertebrates, molluscs, tunicates.

Myrmecologist: An entomologist who is concerned only with ants.

N

Naiads: The larvae of dragonflies and damselflies inhabit aquatic habitat and different from the adults

Narcotics: The chemical which causes uncounciousness of the insects as it is fat soluble and stored in fatty tissues e.g., compounds of chlorine, bromine, fluorine.

Nassanoff's or Nasonov Glands: The intersegmental membrane between the 6^{th} and 7^{th} abdominal tergite of the worker honey bees secretes pheromones consisting of geraniol, citral, geranic acids to attract other worker bees when the food is located.

Natatorial Leg: The leg modified for swimming having long setae on tarsi and sometimes flattened leg like segments e.g., aquatic beetle.

Natural Enemies: When one organism eats or kills the other organism such as predator, parasite, or parasitoids.

Necrotropic Parasites: They are the parasitoids which eat a part or whole animal till it dies.

Neopterous Endopterygotes: The new world insects in which wing flexion mechanism is present and develops by complete metamorphosis.

Neoteny: The non terminal instars having the reproductive characteristics like the adult such as ability to locate mate, copulate, deposition of the egg e.g., scale insect and Strepsiptera.

Nephrocytes: Specialized cells the nephrocytes are found in large number in the larvae of Diptera.

Nerve plexus or Nerve Net: These cells are proprioreceptor consists of bipolar and multipolar neurons placed below the body wall; detects both the movement and stress in the body.

Nervous System: It consists of a dorsally located brain in the head, and a ventral nerve cord runs through the thorax and abdomen with their associated nerves.

Neuro-endocrine system: The endocrine glands when triggered by stimuli secrete hormones and received by the nervous system to act accordingly.

Neurogenic Heart: In this type the heart beat initiates by external nerves supplied from corpora cardiac and motor fibres of segmental ganglia which control the heart. Cardioaccelerator neuropeptide proctolin acts as myotropins regulating the heart while Indolalkylamine (= adrenaline of higher organisms) that accelerate the heart beat e.g., cockroach.

Neurons: The nervous system is made of a network of specialized cells that generate electrical impulses (action potentials) that travel as waves of depolarization along the cell's membrane. Every neuron has a nerve cell body (where the nucleus is found) and filament-like processes (dendrites, axons, or collaterals) that propagate the action potential.

Neurosecretory cells: The cells present in the pars intercerebralis region of the brain and ganglion.

Neurotransmitter: The nerve impulses when reach to synapses releases a chemical messenger that diffuses across the synapse and triggers a new impulse in the dendrite(s) of one or more connecting neurons e.g., Acetylcholine, 5-hydroxytryptamine, dopamine, noradrenaline.

Niche: It is the interaction of the biotic and physical factors in which the species is living.

Nicotine: It is an alkaloid organic compound acting as stomach poison or contact poison and obtained from tobacco plant, *Nicotiana tobacum.* Nicotine benconite is commercially prepared to control codling moth.

Nitrogaundins: It affects insects and mites by binding to ligand gated channels opens into neurons which results in loss of cell function.

Nits: The eggs of the lice are called nits which are glued to the hairs.

Nomenclature: It is the naming of the organism and group of organisms by following guidelines of 1964 revision of the International Code of Zoological Nomenclature (ICZN).

Non Atriate Spiracles: The kind of spiracles do not have closing valves and tracheoles end to a muscle fiber e.g., cockroach.

Non Inducible Immunity: It is a type of humoral immunity which does not involve the synthesis of RNA and protein e.g., lectins /haemoagglutinin, phenyloxidases.

Non lactation period: It is also named as dry period where the lipid accumulates in the body for the next lactation period e.g., *Glossina sps*.

Nosema disease: It is the disease of the bees caused due to protozoan, *Nosema apis* transmitted by food and water in winter and spring mostly.

Notum: The terga/notum of the thorax region.

Nurse bees: Three to ten days older worker bees which have pharyngeal glands to prepare royal jelly or bee milk.

O

Obligate Parasites: A parasite that is completely dependent upon a host and dies if it gets separated from host e.g., head lice are obligate ectoparasites of man.

Obligatory Diapause: Diapause of univoltine species in which all members show diapause.

Obligatory Parthenogenesis: This type of parthenogenesis based on occurrence which can be induced naturally, constant and compulsory in insect life called obligatory parthenogenesis e.g., stick insect.

Obtect: A type of pupa in which appendages glued down to the body e.g., Lepidoptera, Diptera (Nematocera), Coleoptera.

Occasional Pest: Some insect pest can be seen due to absence of certain plant or rarely seen in a field e.g., caseworm of rice.

Ocellar centre: It is a part of protocerebrum present at the base of ocelli.

Ocelli (singular: ocellus): They are a very small eye, a simple photoreceptor, don't form image but light sensitive positioned on the dorso-frontal part of head innervated from the protocerebrum between the optic lobes containing approximately 500-1000 photosensitive cells below a common lens. There may be one to three but exceptionally eight ocelli in Collembolans e.g., many adult insects and larvae of many exopterygotes.

Oenocytoids: They are the special kind of hemocyte present in some Coleopterans, Dipterans, Lepidopterans, and Hemipterans having large and rounded nucleus which is eccentric in position and not derived from prohaemocytes.

Off Loader Bees: The worker bees between 16 to 20 days old receive the pollen from the returning forager bees.

Oligophagous Pest: The pest which depends upon a few plants, or a single family to complete its life cycle e.g., *Hypsiphyla robusta* on mahogany family.

Oligopod Larvae: The larvae having well developed mouthparts lacking compound eyes e.g., Compodeiform, scarabeform, carabeiform, elateriform, platyform larva.

Ommatidia: Compound eyes are made up of number of small subunits each of which forms a part of image and whole of the image is formed by joining these parts together. Each ommatidium consists of cornea, cornegean cells, retinal cells, cone cells, crystalline cone, rhabdom, primary and secondary iris pigment.

Ommochromes: The pigment present in the compound eye of insect.

One to One Relationship: Association between single plant species and single insect species e.g., yucca moth and yucca plant where yucca plant is dependent wholly upon the yucca moth for cross pollination and moth larvae grows inside the pods of the plant.

Oocytes: When oogenesis is highly active, new oocytes are produced in a regular manner within every ovariole in the bead like arrangement.

Oogenesis: Eggs are produced in female ovaries by the process oogenesis and are released outside through the ovipositor after fertilization.

Oogonia: At the base of distal end of each ovariole group of germ cells are present called as oogonia which divide by normal mitosis and increase in size to form next stage of cell the oocytes.

Ootheca or Pods: Some insect lays their eggs in cases called ootheca e.g., pods of grasshopper, ootheca of cockroach.

Open Circulatory System: In the phylum Arthropods the blood or hemolymph to flows freely in body cavities/ sinuses and the organs are in direct contact with the blood.

Open Tracheal System: The insects mostly terrestrial and some aquatics are having pairs of spiracles which open to the exterior.

Opisthognathous: When the mouth parts are positioned obliquely or pointed backwardly e.g., Homopterans.

Optic Lobe: It is a part of protocerebrum which are the lateral extension of brain lying near eye.

Order (Latin word *ordo*): It used in classification of organism fitted between the class and family. Immediate higher and lower ranks are superorder and suborder.

Organochlorine Compounds: They are the synthetic organic insecticides and derivatives of carbon, hydrogen, chlorine e.g DDT, methoxychlor, BHC, lindane.

Organophosphorous Insecticides: The synthetic organic compounds containing phosphorous esters which block the enzyme cholinesterases causing paralysis and death of insects. They can act as contact or stomach insecticide (dichlorvos/ DDVP, malathion, diazinon, parathion, methyl parathion, fenitrothion) and systemic poison (phosphamidon, monocrotophos, phorate, chlorenvinphos, dimethoate).

Osmeteria: The caterpillar of swallow tail butterfly consists of the lobe like eversible part containing repungatorial gland located on the dorsum of prothorax.

Ostia/ valves : These are the slit like valves or funnel shaped openings found in the heart of insects from which the hemolymph of abdomen flows inward, number may vary from one (dragon flies) to 12 (Cockroach). The valves present in the heart to maintain the unidirectional flow of blood.

Ovaries: The reproductive system consists of a pair of ovaries located dorsolaterally to the gut containing few to many ovarioles.

Ovarioles: They are the subunits of ovary rang from one ovariole as in tse-tse fly, dung beetles to 2,000 in a queen of the termite. Its wall consists of outer epithelial sheath and inner acelluar elastic tunica propria. It is composed of terminal filament, germarium, vitellarium and pedicel.

Oviposition: A process of egg laying in a specific ovipositional site suitable for the nymphs when they hatch.

Ovipositor: It is an egg laying apparatus in female insects developed from 8^{th} and 9^{th} abdominal segments.

Oviscapt: The abdomen performs the function of ovipositor in some insects.

Ovovivparity- It is the simplest type of viviparity where eggs are retained within the female genital tract, but the nourishment takes place through the reserve yolk e.g., family Tachinidae, the eggs are laid just before they are going to hatch.

P

Paedogenesis: In this phenomenon the juveniles exhibit the power of reproduction by developing gonads and give birth to young ones and during development they escape a pupa or larva stage. This term is given by K.M. Bear and N.V. Vagner found in the dipterous insect *Miasto*r belongs to the family cecidomyiidae. In, some cases the daughter larvae feed on the tissue of maternal larvae acting as endoparasite and comes out by rupturing their cuticle.

Paleopterous wing: They are primitive insect type where wing do not fold at rest and placed horizontally e.g., dragonfly and damselfly.

Palpifer: There is a pair of lateral sclerite present on the stipes of the maxilla from where arises the maxillary palp.

Palpiger: There is a pair of lateral sclerite present on the prelabium from where arises the labial palp.

Panoistic Ovariole: This is the primitive type of ovariole in which specialized nutritive cell trophocyte are absent e.g., thysanura, Paleoptera, Siphonaptera.

Parameres: The outer surface of phallic lobes which develops into claspers.

Paranotal Theory: According to Miller, wing arises from the lateral extension of the thoracic terga that enable the insect to fly.

Parapheromone/ Pheromone Mimics: The chemical which mimics the pheromones made up of alcohols, aldehydes, esters, and epoxides.

Parasite: An organism that feeds on another organism without killing the host and may be carrier of most dreaded diseases, including malaria, typhus, and plague.

Parasitoid: The term *parasitoid* give by the German writer O. M. Reuter (1913) to for the parasite lives in or on the body of a single host individual eventually results in killing and the adult parasitoid being free-living.

Parental Solicitude: Some insects simply lays their eggs in suitable sites but many of them take care by watching, shielding them, build brood nests, provide larval food or personally feed them and nurse their young ones. Example; thrips, membracids, Chrysomelids.

Pars intercerebralis: It is a part of protocerebrum located medially above Protocerebral Bridge consisting of neurosecretory cells which secrete neurohormone.

Parthenogenesis: It arises from the Greek word partheno-virgin, genesis-origin. It is the ability of the egg to undergo development without taking part in fertilization under certain conditions and forms parthenotes (progenies formed).

Paurometamorphosis: A type of metamorphosis with gradual development; immature resemble the adult in many respects except wing, gonads and external genitalia sharing a common habitat e.g., exoterygote insects like termites, grasshoppers, cockroaches, most of the bugs.

Pebrine disease: The young larvae of the silkworms are infested by protozoan *Nosema bombycis*.

Pecten/Rastellum: The tibia has a notch containing of row of spines used to clean the antenna with auricle.

Pedicel: It is a basal stalk part of ovariole which is plugged at its end by epithelial tissue that lost during ovulation.

Peleopterous Exopterygotes: The primitive insects in which wing flexion mechanism is absent, and develops by simple metamorphosis.

Penetration Resistance: It is the resistance of the insect against the insecticide by absorbing them in the cuticle therefore, causes barrier.

Pericardial Septum/ Dorsal Diaphragms: A layer of interrupted muscle or membrane present on the dorsal side between the dorsal vessel and alimentary canal.

Pericardial Sinus: Blood sinus surrounding the heart or dorsal aorta.

Perineural Septum/ Ventral Diaphragms: A layer of interrupted muscle or membrane present on the ventral side between the alimentary canal and ventral nerve cord.

Perineural sinus: Blood sinus around the nervous system or ventral nerve cord.

Periplasm: The superficial area of the cytoplasm of the insect egg**.**

Peripneustic: It is a kind of polypneustic respiratory system containing one meso thoracic and eight abdominal pairs of spiracles e.g., some fly larvae.

Perivisceral sinus: Blood sinus surrounding the alimentary canal above which lies pericardial sinus and below lies a perineural sinus.

Pest: The small creatures that causes damage to the growing crops, stored grains, forest, and domestic usables and reduces its quality and quantity.

Pesticidal Interaction: When two substances interact together chemically, and the resultant product has different toxicity to the reactants e.g., synergists, antagonist, potentiation, additive effects, enhancement**.**

Petiole: The first abdominal segment of the Hymenoptera (Suborder: Apocrita) is broadened at the anterior part called **propodeum** fused with the metathorax and constricted posteriorly forming petiole.

Phallobase: A single basal plate where paramere and mesomere is attached.

Phallotreme: It is a circular opening of the endophallus.

Pharate: The newly skinned larvae after apolysis.

Pharynx: It is the part of foregut consisting of strong muscles which pumps the saliva into the buccal cavity and lubricates the food and passes to the esophagous.

Phenetic classification: Phenetic approach assumes that all the characters are equal in weightage and give a family tree **phenogram or dendrogram**.

Phenology: A term applied for the timings of the various stages in the life cycle of the insects.

Pheromone Antagonist/ Anti-pheromones: They are the inhibitory chemicals which prevents the males from approaching the female for mating.

Pheromones by both sexes: The pheromones secreted by both the sexes to aggregate near flower e.g., *Lycus* beetle.

Pheromones: These are the chemicals secreted by an individual to communicate the members of same species. The term was given by Karlson derived from the Greek word 'pherein' means 'to transfer'. There asre some examples, *Danus* butterfly- Danaidone, zootermepsis- caproic acid, silkmoth- bombykol, bumble bee (Bombus *sps*.)- 2,3-dihydro-6-trans farnesol, queen bee- 9-oxy-2- decinoic acid, formicine ants- undecane, *Melipona* bee (stingless bee)- citral, *Coromyrma*- 2-heptanone, honey bee worker- citral and gerniol.

Phoretic relationship: A relation between insects and microbes in which the pathogen uses insects as a mode of transportation while moving (they entangled on the mouthparts, legs, wings, or body) e.g., chewing lice (Order: Mallophaga) attach to the mouth parts of louse fly (Diptera) to move from one host to another.

Photocytes: Insects that produces light consist of photogenic specialized cells containing many membranes bound vesicles called **luminelle**.

Photoreceptor: The organ that can detect light due to the presence of photosensory structures like compound eyes, ocelli and stemmata**.** These structures are absent cave dwelling and nocturnal insects.

Phragma: The terga that invaginates where the longitudinal wing muscles attaches.

Phylacobium: It is the guest symbiotic relationship between the *Camponotus* ants and termites.

Phyoalexins: These are the chemicals secreted by the plants when they are attacked by insects to resist further damage.

Physical Control: It is the simple technique which uses variation in physical factors like temperature, humidity, wind, light to kill or inactivate the insects e.g., most insects becomes inactive at a temperature 4ºC.

Physiological Resistance: It is the resistance of the insect against the insecticide where the insecticides are not broken down but altered by some physiological action ultimately reducing the toxicity e.g., DDT storage in fat body.

Phytophagous Insects: The insects which feed upon plants and dependent for their reproduction and survival.

Piercing-Sucking Mouthparts: They have needle like mandibles and maxilla for piercing and proboscis for sucking the blood or sap e.g. Cicadas, aphids, and other bugs (order Hemiptera).

Piokilothermic: The insect which maintains their body temperature as that of the external environment.

Placiticising factor: *Rhodnius* bug (assasian bug) secretes this factor that changes the pH of cuticle and allows expansion of while taking blood meal.

Planting Date: It is a kind of cultural control where the change of the plating time by creating asynchrony between the susceptible stages of crop and damaging stage of insect causes reduction in the colonization rate of pest. Example, planting of soyabean prevents velvet bean caterpillar.

Plasma: The blood consists about 90% of plasma, carries 5-40% of total body weight, colorless fluid (sometimes it may be green, yellow or brown) containing 85% of water, slightly acidic, consists of almost all amino acids, proteins, sugars (example, glucose in honeybees, trehalose), uric acid, pigments, and other inorganic ions. Variable constituent of plasma; carnivorous insects have high concentration of Mg+ and K+; herbivores have high Na+ concentration; terrestrial insects with high protein, amino acids and uric acids; aquatic insects have high allantion, allantoic acid, NH3, urea content.

Plasmatocytes: They are hemocytes which are variable in shapes having numerous vacuoles, phagocytic and most abundant of all hemocytes.

Plastrons: The rigid, closely spaced hydrophobic hairs (setae) that create an air trapped within a plastron operates like a physical gill (just like air in a bubble) but the difference lies that the airspace do not shrink in volume due to the fortress of setae which prevents encroachment of surrounding water, e.g., *Elmis, Acentropus, Aphelocherirus.*

Platyform/ Oncisciform Larvae: The oligopod larvae having broad and flattened body, short legs e.g., larvae of some Lepidoptera, Diptera, and Coleoptera.

Pleura (singular: pleuron): The paired sclerite present on the lateral side of the body.

Poisonous Baits (B): The formulation of insecticides which are mixed with edible and attractive substances.

Polyembryony: It is a phenomenon in which many embryos form from a single egg and the eggs are small, lacking yolk and dependent upon the host for their nutrition e.g., parasitic Hymenoptera (Playgasteridae, Braconidae and Encyrtidae) and one species of Strepsiptera. *Platygaster* parasite of Hessian fly larvae separates into two embryos, chacid hymenopterans parasitize moth larva after 220-225 may forms up to one thousand embryos.

Polygenic Resistance: The resistance is controlled by many genes and it is more persistent e.g., rice plant is resistance to the striped borer, plant hopper and leaf hopper.
Polylectic: The pollinators which visit plants of various taxa.

Polymorphism: It is a phenomenon concerned with multiple forms of a single organism in the same stage of its life cycle found in some members of the order Orthoptera, Lepidoptera, Isoptera, Hymenoptera.

Polymorula: The eggs are laid onto other egg or larval host which after hatching develops into single embryo which clonally gives many additional embryos that together form a group.

Polyphagous Pest: The pest which depends upon diverse group of plant species to complete their life cycle.

Polyphyletic Origin: In polyphyletic origin the arthropods originate from two ancestors; uniramous terrestrial line and biramous aquatic line and supported by a hemolymph, paired jointed appendages, trachea, malphigian tubes, compound eyes and cuticle.

Polypod /Eruciform larvae: The larvae which posses thoracic and abdominal prolegs e.g., Lepidopterans, Mecopterans and Tenthridinidae (sawfly).

Polytrophic Ovariole: A type of ovariole in which trophocyte are enclosed in each follicle along with an oocyte e.g., Dermaptera, Pscoptera, Lepidoptera, Hymenoptera.

Population Crash: When the chemosterilized individual competes with the non sterilized individuals for food, space, and shelter they ultimately lead to the decrease in the pest population.

Population Density: It is the number of individuals per unit area of the habitat like per shoot, per plant.

Pore canals: Vertical canals that traverse both exo and endocuticle of the insect integument used to transport wax molecules.

Postgenal Bridge: In some insects the lobes of the postgena fuses to form bridge.

Potential pest: The pest which is a minor pest causes less damage but due to change in environmental condition may become destructive e.g., brown plant hopper infesting paddy.

Potentiation: It is the pesticidal interaction in which two toxic components when mixed increases its toxicity than a single component has.

Ppm: parts per million like 1mg in 1 kg.

Predator: Organisms that kill and consume several other organisms for their living.

Prescutum: The anterior part of terga of prothorax**.**

Presternum: Sternum of prothrorax.

Pretarsus: The segment before pretarsus and consists of a pair of claws with arolium at centre.

Primary Pest: The pest which feeds upon whole grain e.g., *Callosobruchus spp*.

Primary Vitellophages: Some of the divided energid do not move towards a periphery behaves as primary vitellophages and requires for the digestion the yolk except in Lepidoptera and Diptera.

Proctodeal feeding: When an individual feeds upon the anus excretion of another individual.

Procuticle: It is the inner layer of cuticle which is 200µm thick, made up of chitin, mixture of protein and further consists of outer **exocuticle** and inner **endocuticle.**

Prognathous: When mouth parts are positioned horizontally or forwarded e.g., beetles.

Prohaemocytes: They are hemocytes which are round, larger nucleus, and rich in RNA homologous to archaeocytes of sponges and able to give rise to all other cells.

Proline: It is an amino acid present in a hemolymph which oxidizes and produces energy during flight e.g., bees.

Pronotum: The terga/notum of prothorax.

Propagative Transmission: It is a kind of biological transmission in which the pathogen do not undergo cyclic changes but multiply in the vector body e.g., fleas (Order: Siphonaptera) containing bacteria, *Yersinia pestis* causing bubonic plague.

Propneustic: It is a kind of oligopneustic respiratory system containing only one meso thoracic pair of spiracles e.g., Dipteran pupae.

Proprioreceptor: The sense receptors sensitive to pressure and can detect change in length, tensions, compression, body posture and position.

Prostaglandins: This term is given by Von Euler and it is the biosynthetic compound of prostate gland which effect to increase in oviposition activity of virgin crickets, *Acheta domesticus* and flying capability of mosquito. Some chemicals' aspirin, indomethacin are inhibitors of prostaglandins.

Prostomium: It is the preoral part of first segment projected like cap called as acron.

Protective Coloration Adaptation: The color body of the insect match with the surrounding to conceal them from enemies.

Protelean Parasitism: When the larval stages of the insects behaves as parasites.

Prothoracic Glands/ Ecdysial Gland: A pair of glands located in the ventro-lateral regions of prothorax, ectodermal in origin, absent in apterygotes and associated with the lateral longitudinal tracheal trunks.

Prothoracicotropic Hormone (PTTH)/ Ecdysone Hormone: Moulting and pupation require the steroid hormone ecdysone secreted by paired prothoracic glands. There are two moulting hormones α-ecdysone and β-ecdysone which is a homo-dimer of two polypeptides consisting of chain of 109 amino acids. Ecdysone was firstly isolated by Butenandt and Karlson (1954) from the pupae of silkworm.

Prothorax (*pro*: first): First division of thorax and bears a pair of foreleg.

Protocerebral Bridge/Pons Cerebralis: It is a part of protocerebrum located dorsally to the central body and connected with axons from many parts of brain except corpora pendunculata.

Protocerebrum: The insect brain contains six fused ganglia of which first pair of ganglia is large, associated with vision that innervate the compound eyes and ocelli. It is the largest complex and is responsible for behavior e.g., Hymneoptera and less developed in bugs. It consists of optic lobe, ocellar centre, central body, pons cerebralis, pars intercerebralis and mushroom body.

Protoplasmic Poison: Some insecticides reacts with the proteins of the midgut causes precipitation and death of the insect e.g., nitrophenols, mineral oil, formaldehyde.

Protopod Larva: The larva showing incompletely segmented body and hatch early in immature stage during development e.g., parasitic Hymneoptera (*Platygaster*).

Proventriculus: The hindermost part of foregut, lies before the ventriculus, having valves that regulates the rate of food passing to the midgut.

Przibram's Rule: Przibram states that the progression ratio x/y as stated in the Dyar's law does not range from 1.2-1.4 but it should be the same for all the parameters and have the value 1.26. This rule is considered as the extension of Dyar's Law and it was observed in the mantid, *Sphrodomantis* where in each instar the mass of the cells and hence, the volume get double as compared to the previous instar. It is applicable only in the isogonic insects.

Pseudocone: It is the type of compound eye where cone is filled with gelatinous fluid since a crystalline cone is lacking e.g., Diptera.

Pseudoplacental Viviparity: It is a type of viviparity where the follicle cell are the main source of nourishment to the developing embryo as they attach themselves to the embryonic membrane and forms a false placenta called pseudoplacenta e.g., aphids, Psocoptera, Dermaptera (yolk is little or absent and lacks chorion).

Pterins: The pigment of compound eye.

Pterothorax: Mesothorax and metathorax combined to form pterothorax as it consists of wings.

Pterygota: It is a subclass of class Insecta that are winged and secondarily wingless insects having various kind of metamorphosis.

Pterygotes: The winged insects.

Ptilinum: An eversible sac is present on the head of the Dipera (Cyclorrhaph) which can be expanded by the pressure of the hemolymph.

Pulsatile organs: The specialized organs located near the base wings or legs in some insect to pump hemolymph into the extremities.

Pulvilli: If a pad is present at the base of each claw**.**

Pupa: One larva converted into other and so on ending in fully mature larva and starts preparing for the next development stage called pupa.

Pupal Paedogenesis: A type of pedogenesis in which embryos are formed in the haemocoel and term as hemipupa (not a perfect pupa) e.g., gall midges, *Miaster sps*.

Puparium: It is the skin of the last larval instar containing pupa which becomes hard, thick, airtight and waterproof.

Pygidial Glands: These glands are located at the terminal part of abdomen near the anus secreting the toxic or pungent or corrosive substances having different components like butyric

acid, esters, ketone, formic acid, phenol, aldehydes in ground beetles and indole, dodecalactone, heptadecane in ants.

Pylorus: It is the first part of hindgut having well developed circular muscle, having pyloric sphincter regulates the movement from mid gut to hindgut, malphigian tubules opens into it.

Pyrethrum: It is an organic compound acting as contact poison and obtained from ground flowers of *Chrysanthemum cinerariaefolium, C. roseum, C. carneum*. The active ingredients are pyrethrin and cinerins used to control mosquito, flies, bedbudg, silverfish, stored grain pest.

Q

Quadrat Method: It is a method used to determine the absolute estimate of insects which are fairly immobile like caterpillars, cutworms, borers. It is measured by counting or collecting randomly the insect number by taking small areas or quadrats from a large area.

Quiescence: It is the inactive individual but differs from diapauses as it is temporary, non adaptive form and induced due to adverse condition suddenly.

R

r- pest: The pests having high fecundity, short generation time, well developed powers of dispersal, high population, little interspecific competition and able to locate new food sources. For example mosquito, locust, aphids.

Random pest: The pests which are observed anytime in the year and have no seasonal requirement.

Rank: Position of a category relative to other categories in a taxonomic hierarchy. Example, Insecta (taxon) is a class (category) ranked between superclass and subclass.

Rapid Induced Resistance (RIR): It refers to the resistance of the plants occured due to the damage caused by insects in the same generation and hence the fecundity of the insect reduces up to 5-10 % in RIR.

Raptorial Leg: The leg modified for grasping or catching prey e.g. Praying mantis.

Rasping and Sucking Mouthparts: Their beak is modified from labrum, labium and maxilla with only left mandible is present i.e they have asymmetric mouth parts e.g. thrips (Thysanoptera).

Rectal Pads: In the rectum there are 6-8 thick walled pads present function to absorb ions, water and small organic material.

Rectum: It is the last part of hindgut, enlarged for storing waste undigested food for elimination, having 6-8 rectal pads.

Regular Pest: The pest which occurs throughout the year and have close association with a particular plant e.g. *Aphis gossypii* on cotton.

Regulatory Control: The control which involves enforcement and enactment of quarantines. Plant quarantine Act 1912 used to protect the agriculture in US.

Repellents: Midly toxic or non toxic chemicals or naturally occurring compounds which prevent the insects by repelling them away from the food source e.g ideal repellent DEET (N-N, diethyl-m-toluamide) repels many insects, citronella oil repels mosquito. They are advantageous as compared to other controlling agents as it is less time consuming, repels variety of insects i.e used in broad spectrum, do not kill the organism, ecofriendly, inoffensive in odor, non irritating. But there are also some disadvantages like last for few hours, required in large doses, can damage some plastics or painted surfaces. Other repellents are oil of Eucalyptus, lemon leaves, cedar oil, wood oil, Deet, MGK-326, MGK-11, naphthalene, Bordeaux mixture, coaltar (creosote).

Repugnatorial glands: These glands are varies in number, location, and form in different from one insect species to other and useful in repelling the predators and potential enemies e.g., meloid beetles secrete catharidines, stink glands in stink bugs.

Resilin: It is a flexible protein and help in movement of body parts; wing bases, legs,antenna.

Retinal Cells: There are eight retinal cells originally but one degenerate and left seven eccentrically arranged themselves around centrally placed receptive area called rhabdom which is the actual light detector.

Retinaldehyde: The photosensitive chromophores consist of aldehyde and vitamin-A known as retinaldehyde.

Retinue Bee: The worker bees which take care of queen and its requirements.

Retinular Cells: These are the primary sense cells of ommatidium which are essential to collect and transduce light energy.

Rhabdom: It contains visual pigment rhodopsin; which are the conjugated proteins resembling the pigment found in vertebrate eye.

Rhyniognatha hirsti: It is the oldest known insect fossil having dicondylic mandibles found in the Devonian period estimated at 396-407 million years old.

Rickettsiae: They are the insect pathogen characterized between the bacteria and viruses. They are slow in their action and have independent metabolism e.g *Rickettsia prowazekii* causing epidemic typhus vectored by body lice and fleas.

Ring gland/ Weisman's ring: In cyclorrhaphous Dipterans corpora allata, corpora cardiac and thoracic glands forms ring.

Root borer: The insect stages such as caterpillar bore into the roots of the plant which results in stunted growth and drying e.g. sugarcane borer.

Rotenone: It is an organic compound acting as contact poison and obtained from roots of the leguminous plants like *Derris elliptica, D. malaccensis.*

Ryania: It is an alkaloid organic compound acting as stomach poison or contact poison and obtained from roots and stems of *Ryania speiosa* used against European corn borer.

S

Sabadilla: It is an organic compound acting as stomach or contact poison and obtained from seeds of *Schoenocaulon officinale* used against human lice and hemipterans.

Saliva: It is a watery liquid secreted by salivary glands that lubricates the food. It has various function; in chewing insects containing various enzymes (amylases) that help in breakdown of the food, in blood suckers contain anticoagulants, in silk moth and other Lepidopterans makes cocoon, in predatory insects (robber flies, assassin bugs) contains toxin.

Salivary Glands: A pair of gland presents near the hypopharynx and secretes saliva in the salivarium through a salivary duct.

Saltatorial Leg: The leg adapted for jumping having long femur and tibia e.g. grasshopper.

Sanitation: It is the removal or destroying crop residue from the field by ploughing, burning, shredding, raking or chopping. Used against the cultural control of Hessian fly, European corn borer, pink bollworm.

Sap Suckers: The insects having piercing and sucking type of mouth parts feeding upon the sap of the plant causes serious injury due to which leaves fall off e.g. mustard aphid, *Lipaphis erysimi***.**

Scansorial Leg: The leg meant for clinging having sharp claw e.g. head louse.

Scarabaeiform Larvae: The oligopod larvae having cylindrical C shaped body, and a well developed head with thoracic legs e.g., Larvae of Scarabaeidae (dung beetles).

Scavengers: The insects that feed upon dead plant and animal tissues and thus contribute in recycling and decomposition of the nutrients e.g. skin beetle (Coleoptera: Dermestidae) eats dried skin and cartilage, flesh fly (Diptera: Sarcophagidae) and blow fly (Diptera: Calliphoridae) eats upon soft tissue, soldier fly larva (Stratiomyidae) scavenge decaying matter of plant, dung beetle (Coleoptera: Scarabidae) feed upon dung.

Sclerites: Each segmentof insect thorax and abdomen bears hard and sclerotized plates.

Sclerotin: The insoluble protein in exocuticle responsible for the hardness and toughness of integument.

Sclerotisation: When the insect emerges from the old cuticle; new cuticle is softer and paler soon becomes harder and darker after an hour.

Sclerotization Disruptors (SD): These are the inhibitors which disrupt the sclerotization process by inhibiting the deposition of phenolic compounds, proteins which participates in stabilization of cuticle. They are DDC 3,4-dihydroxyphenylalanine decarboxylase toxic against blowfly larva; MON 0585 against mosquito; cyromazine against housefly and *Lucilia cuprina*.

Scutellum: It is the extension of mesonotum e.g. bugs have a well developed triangular scutellum.

Scutum: It is the anterior sclerite of the notum**.**

Seasonal Pest: The pest which occurs only in a particular season of the year e.g red hair caterpillar can be seen in April to May.

Second Generation Pesticides: The chemicals of chlorinated hydrocarbons, organophosphates, and carbamates.

Secondary Pest: The pest which feeds upon damaged kernels e.g., *Tribolium spp.*

Secondary Pigment Cells: The cells consisting of ommochromes having granules of brown, red and yellow pigments.

Secondary Vitellophages: Some cleaved energids moves to periphery and then return back to centre and act as supplement of the primary vitellophages. The tertiary vitellophages are also produced in some insects like cyclorrapha (Diptera) and apocrita (Hymenoptera).

Seed Feeders/ Storage Insects: The insect which feeds upon stored seed, grains, pulses and damage them e.g. stored grain pest, *Tribolium castaneum*.

Seed Lac: The lac obtained from stick lac which is washed, dried, bleached in sun, heated in cloth bags and when melted squeezed into thin sheets and then flaked.

Semilooper: The polypod larvae having three or four pairs of prolegs or may be reduced or absent e.g., castor semilooper.

Seminal Vesicles: The vasa deferen swells at the end forming storage chambers where sperms are temporarly stored.

Semiochemicals: The term was given by Law and Regnier (1971) arises from Greek word 'Simeon' means signal refers to the chemicals which can stimulate interspecific and intraspecific communication. Karlson and Luscher later gave the term pheromone.

Sensory Hairs/ Sensilla Trichodea- They are the simplest type of mechanoreceptor distributed all over the body but much distributed on antenna, mouthparts and tarsal segments. It consists of a hair placed in a socket associated with four cells; inner trichogen cell which originate the hair cell, outer tormogen cell which forms membrane of the cell, neurilemma cell which cover cell body and axon of sensory neuron

Sequential Sampling: As the population density varies with distribution pattern few samples are taken from high population and few from low population and hence time and efforts is minimized.

Sericulture: It is a term used for the culture of silkmoth to obtain silk e.g rearing of *Bombyx mori*.

Serosa: It is an extra embryonic membrane layer which covers not only the embryo but also the yolk. In Apocrita (Diptera) extra embryonic membranes is absent as amniotic folds are not formed in Cyclorrypha (Diptera).

Sieve Plate: The spiracles are covered with the porous membrane which prevents water loss and foreign particles to invade.

Silk Glands: These glands are modified labial glands which secretes silk to make a cocoon for the pupae e.g., silk moth, other Lepidopterans and Trichopterans.

Silk: It is the product of silkworm *Bombyx mori* which is secreted by the salivary glands to construct a cocoon. It is made up of two proteins the fibroin and sericin which gets hardens when comes in contact with air.

Siphoning/ Nonstylate Mouthparts: These insects do not posses stylet but have long, coiled siphon like proboscis which sucks liquids e.g. Butterflies, moths and skippers (order Lepidoptera), bees (order Hymenoptera).

Skeletonizers: The pest which eats everything of the leaf except the veins i.e except a skeleton of the leaf e.g., *Promecotheca armingii.*

Slug Caterpillar: The polypod larvae having small retractile head, short sluggish body, possess only thoracic legs and poisonous spines on the whole body.

Socialparasitism: When some species acts as guest in the nest of various social insects and take their advantages.

Sociotomy: Given by Lindauer, 1965 is the separation of parent termite colony into two daughter colonies or separation from parent colony by some immature and secondary reproductive caste into a daughter colony.

Solutions (S): They are the insecticide which is dissolved before the spray application.

Sound Producing Organs: Insects produce sound to communicate the members of the same species either by rubbing one body part with another or other external object.

Space Effect: When the sterile individual (sterile through chemosterilants or radiation) moves outside their area they affect the reproductive potential of the individuals outside the area by competition.

Species: The basic unit of taxonomic classification refers to the real population which can interbreed among themselves.

Spermatheca: Spermatheca is a single pouch like structure connected by median oviduct through spermathecal duct which receives spermatophore during copulation. In higher Diptera, there are three spermatheca present.

Spermathecal Gland: A gland associated with the spermatheca which produces enzymes for the digestion of the protein coat of the spermatophore and nourishes the sperm within the spermatheca.

Spermatids: The spermatocyte in the follicular testis undergoes reductional division resulting into four haploid spermatids which soon transformed into mature **spermatozoa** through the process of spermiogenesis.

Spermatocyte: The cells which are the results of by the mitosis of spermatogonia, increase in size and moves downwards at the basal end of the follicle.

Spermatodesms: The bundles of spermatozoa**.**

Spermatogonia: Group of germ cells at the distal end of each of the follicle forms the spermatocytes.

Spermatophore: The male forms temporary storage pouch consisting of sperms received in the bursa copulatrix of the female while copulation.

Spherules: They are the hemocyte which are spherical, oval or spindle shaped consisting of spherules in their cytoplasm and present in some Dipterans and Lepidopterans.

Spiracles: They are the external apertures sometimes guarded by the valves from which the oxygen in inhaled and carbon dioxide is exhaled to the environment. The number of spiracles may vary from species to species and in generalized insects 2 thoracic and 8 abdominal spiracles are present.

Sporadic Pest: The insect which becomes pest in certain isolated localities of the year e.g. rice stink bug.

Sprayers: This is the equipment used to disperse the insecticidal solutions which breaks the solution into fine droplets so that the insecticide is spread evenly in the field. They are of different types like hand syringe, flit pump, hand compression sprayer, foot or pedal pump sprayer, knapsack sprayer, power sprayer and hydraulic sprayer.

Stable Number Rate: It is equal to the mortality rate which maintains the population in the same size from generation to generation.

Stadium or Instar: During metamorphosis of endopteryoges the stage between different moults which may vary from 3-5 instars in generalized insect and may be 15 or more in exopterygotes.

Stem Borers: The insect stages such as caterpillar bore the stem of the plant which results in stunted growth and drying e.g. rice stem borer.

Stemmata/ Lateral Ocelli (**singular: stemma):** These are second group of simple eye other than ocelli found laterally, innervated by optic lobes, may be 0-7 in number, found in larva of many endopterygotes (saw fly and beetle larvae).

Sterile Male Technique: This technique was originated by E.F. Knipling (1955) under genetic control of insects by capturing and sterilization of the males (achieved by Co-60 radiation, chemostrilants). After then the sterile males are released in the field which then compete with non sterile males for mating and thereby results in the decrease of the population. Example, the screwworm fly, *Cochliomyia hominivorax* a serious pest of cattle in US was controlled by male sterile technique.

Sterna (singular: sternum): The sclerite which is ventrally placed.

Sternellum: Sternum of metathorax.

Sterol Utilization Inhibitor: Normally phytophagous insects obtain beta sitosterol from plants converted later into cholesterol which serves as precursor for the moulting hormone. Hypocholesterolemic agents 22, 25-diazacholesterol and triparanol inhibit the conversion of beta sitosterol into cholesterol.

Stick lac: To harvest of the lac; the twigs covered with lac are removed and grinded.

Stinging Apparatus: The ovipositor of Hymenopterans (bees) is modified into stinging apparatus and accessory or collateral gland into poison gland. In bees first gonapophysisis converted into lancelet and the second gonapophysis developed into stylet.

Stomodaeal Nervous System: The internal organs are largely innervated by a stomodaeal/ stomatogastric nervous system connected by a pair of frontal nerves arising from tritocerebrum link the brain with a frontal ganglion (unpaired) on the anterior wall of the esophagus. This ganglion innervates the pharynx and muscles associated with swallowing.

Stretch Receptors: They are proprioreceptors attached to connective tissue on one end and other end by body wall or intersegmental membrane or muscle. It receives message and convey it to CNS for the conduction of regular mechanism like breathing, gut peristaltic movement and locomotion.

Stridulatory leg: The leg which produces sound e.g. grasshopper.

Sub Species- It is the subdivision of species refers to a group of local population of a species inhabits a geographical subdivision of range of the species e.g. *Kerria* (genus) *lacca* (species) *lacca* (subspecies).

Subesophageal Ganglion: It is located ventrally in the head capsule below the brain and esophagus only innervates the mandibles, maxillae, and labium, hypopharynx, salivary glands, and neck muscles in modern insects.

Subgenual Organ- They are present on tibia consisting of 10-40 sensilla in some members of the order Coleoptera, Diptera and Thysanura.

Subterranean Nest: The termitaria that builds under the ground in a ground in a decaying stump or crown roots.

Superparasitism: Many individuals of same species when attacked by the same host.

Superposition Image/ Scotopic Ommatidium: This type of image is formed when the pigment cells are in contracted state and each rhabdom receives various light rays from many lenses e.g. nocturnal insects such as moths, some flies.
Surfactants: They are the chemical that helps in the modification of the pesticidal properties.

Surveillance: When monitoring is integrated with decision making in Insect Pest Management.

Symphilium: The symbiotic association in which one species produces narcotic compound for their hosts e.g. myrmecophilous and termitophilous sps. for their host.

Synapses: Individual nerve cells connect with one another through special junctions

Synaptic poison: The chemicals which interfere with the enzyme acetylcholinesterase at synaptic junction e.g., organophosphates, carbamates.

Synctium: It is the multinucleate condition in the early stages during cleavage in almost all the insects except entognathous, Collembolans, subphyla Onychophora where total cleavage occurs.

Synergists: The pesticidal interaction in which the toxic insecticide is mixed with non toxic or slightly toxic substances which together increases the toxicity or lethality. They interfere with the detoxification mechanism through their action on Polysubstrate Monoxygenases (PSMOs),

Cytochrome P450 (CYP) Enzymes. For example, Piperonyl Butaoxide (PBO), MGK-264 (n-octyl bicycloheptane dicarboximide) used as synergists with a pyrethrum or parathion.

Synomone: The compound which is released by one organism to provoke a reaction in other individual of different species which benefits both the emitter and the receiver e.g. pollination by insects.

Systematic: It deals with the classification of insects and considered as the senior most branches in the field of study of living things.

Systolic Phase (contraction): When the ostia close the hemolmyph moves farward due to the contraction of heart.

T

Tagmata: It is a plural word (singular term is tagma) which means lobes or regions e.g. Troilobites have tagmata or lobes

Tagmosis: It is the grouping of segments into functional regions.

Tarsomere: They are made up of 2-5 subsegments called tarsomeres**.**

Tarsus: The last segment of the leg.

Taxon (plural - taxa): It is a group of real organisms forming a unit at any level of hierarchy.

Tegmina (singular tegmen): The forewings are leathery, thickened and opaque used to protect the hind wings e.g. Orthopterans.

Telotropic/ Acrotropic Ovariole: A type of meriostic ovariole in which the trophocyte fuse to form synctium at the proximal part of germarium and connect to each oocyte by the trophic cord e.g. Hemiptera, Coleoptera.

Telson: The 12^{th} segment of Proturans is telson which persists in the order Protura.

Temporal Polymorphism: Different forms of an individual developed due to effect of photoperiod e.g Aphids.

Tenent hairs: Very tiny small hairs located on the pulvilli and tarsal pads of leg to stick to to the smooth surface.

Teneral: When the adult emerges it is soft and pale before the sclerotisation and mealnisation completes.

Tentaculum: The abdominal structure present on the venter of abdomen to lock furcula in Collembola.

Tentorium: The cranium is strengthened by a set of sclerotized invaginations of the body wall that supports the head and meant for the attachment of muscles.

T**ergosternal muscles:** These are the bunch of muscles which are extended from teraga to sterna which when stretch pull the notum downward causing the wings to flip upward.

Tergum (singular: terga): The sclerites placed on the dorsal side.

Terminal filament: It is a terminal part of ovariole that attaches the ovaries to the dorsal body wall in place within the abdominal cavity.

Terminal Tracheal Branch: Each tracheal tube is further subdivided into finer and smaller tubes approaching each and every part of the body.

Testicular Follicles: These are the units of male testis and their number may vary from one in certain beetles, two in lice, hundreds (100 in grasshoppers) which are beautifully arranged parallel to one another. In locust and moth the two testis fuses with each other at the tip. It is also distinguished like ovarioles into germarium, zone of growth, zone of maturation and zone of transformation.

Testis: Male reproductive consists of a pair of testis like the females placed ventrally in the abdomen divided into functional units called follicles where the development of sperm takes place.

Thermal Constant/ Heat Budget: A constant representing the product of temperature and time required for the development of insects measured in unit of degree days.

Theytoky: During parthenogenesis when only females are produced, e.g. aphids

Third Generation Pesticides: The hormonal insecticides (Juvenile hormone) which the William isolated from the silkworms.

Tibia: The longest, slender structure with downward-pointing spines that aid in climbing.

Tibiotarsus: In Collembola tarsus fuses with tibia.

Time effect: The chemosterilized individuals having longer life span shows time effect as they will compete for mating up to several generations.

Tolerance: It is the ability of the plant to tolerate insect infestation without any loss of vigour and crop yield reduction e.g. corn rootworm *Diabrotica sps*. (Coleoptera: Chrysomelidae) attacks corn root which shows tolerance.

Trachea: The spiracle carries the air to the longitudinal tracheal trunk consisting of thin cuticle membrane thickened spirally arranged called Taenidia prevent collapsing of the tube.

Tracheal Gill Theory: According to Graber and Woodworth, the wing arises from thoracic tracheal gills.

Tracheal Gills: Trachea when function as gills, e.g. Mayflies and Damselflies larva.

Tracheal system: It is made up of complex network of tubes that supplies oxygen to each and every cell of the body.

Tracheal Tubes: The longitudinal trachea is divided into many branches.

Transient Phase: The transistion of the gregarious to solitary phase or vice versa in locusts and the locust is called as transiens.

Trap cropping: It is the plantation of the small area of crop with the main crop e.g. strips of alfalfa in cotton plantation prevent *Lygus sps.* (bug).

Traumatic Insemination: During the ejaculation when semen directly inseminate inside the body in hemocoel e.g. bedbugs.

Trehalose: A diasaccaride non reducing dimer of glucose present in insect blood considered as major blood sugar. Certain insect may have glucose, fructose or ribose as sugar

Trenching: The trenches are dug about 45cm deep and 30cm wider around the field to ban the hoppers' infestation.

Trend Index: It is the ratio of the eggs laid in new generation to the eggs laid in old generation.

Tribe: It is a category between the subfamily and genus in the hierarchy.

Tritocerebrum: It is a part of brain made by third pair of ganglia innervate the labrum and integrate sensory inputs from proto- and deutocerebrums. They are the link between the brain and ventral nerve cord & stomodaeal nervous system that controls the internal organs.

Tritrophic Relationship: There is a role of three trophic levels or states of organism i.e host, pathogen, and vector which are closely related to each other, and a limitation of one level restricts the other. For example, Den virus (pathogen) inhabiting in Aedes mosquito species (vector) causing dengue (disease) in human beings (host).

Triungulin: It is the first instar of Strepsiptera which is free living and possess legs.

Trochanter: It is a small segment that joins the coxa with femur.

Trochantin: The articular membrane between episternum and coxa.

Trophamnion: In some insects the chorion is very thin permeable which disappears soon and the serosa modifies to form trophamnion which function to absorb the nutrition from the host.

Trophobium: It is the symbiotic relationship when one species offers secretion as a gift to other species e.g. aphids offers honeydew to the ants.

Trophocyte: The cells present in fat body and dispersed having round nucleus, enlarged having vacuoles containing fat, protein and glycogen which are released during metamorphosis in hemolymph.

Tympanal organ: They are located on some body parts of various insects such as foretibia of Tettigonidae, Gryllidae (Order: Orthoptera), abdomen of cicada (Order: Hemiptera) and metathorax in Noctuidae (order: Lepidoptera). They consist of many chordonotal sensilla.

Tympanum: Cicada (Hemiptera: Homoptera) have a special sound producing organ tympanum which consists of tymbal covered with thin sheet called tymbal cover associated with air sacs and tymbal muscles. When the tymbal muscles contracts the tymbal gets pulled produces a click and when tymbal takes back its position and get relaxed produces another click. The sound of ciciada is audible upto a kilometer in dense vegetation.

Tyrosin: It is present in blood function in sclerotization of cuticle.

U

Ultra Low Volume Spraying: The quantity of the water mixed with insecticide is low e.g 1.2 kg of A.I in 20 litres of water per hectare spread by sprayers (mist blower or atomizer).

Underhill: It is the first resistant variety of wheat against Hessian fly, *Mayetiola destructor* (Say) reported in USA, 1782.

Ungue: The pretarsal claw of the leg.

Uniporous Chemosensilla: The chemosensilla which are thick walled, terminate in a single pore, innervated by many neurons e.g. food canal of aphids, hypopharynx of cockroach, labellum of flies.

Universal antidote: It is the antidote prepared by mixing 2 parts of charcoal, 1part tannic acid, 1 part of magnesia used universally for almost all the insecticidal poisoning.

Univoltine Species: The species which have one generation per year.

Urate Cells: The cells present in fat body accumulates uric acid for excretion and abundant in those insects (Collembola, Apocrita) in which malphigian tubules are absent or non functional.

V

Valvulae: The ovipositor of primitive apterygote has 3 pair of valvulae which originates from small pleural slerite. The first pair of valvulae arises from the first valvifer on the 8^{th} segment. The second and third pair of valvulae born from common basal sclerite that is the second valvifer on the 9^{th} segment

Vasa Deferen: From each testis a lateral duct arises which is called vasa deferen.

Vasa Efferentia: Each testicular follicle leads to the fine tube vasa efferentia.

Vector Borne Diseases: The diseases of human being caused due to pathogen which are transferred by the vectors (insects) e.g., *Plasmodium spp*. a protozoan is transferred by *Anopheles spp*. acting as a vector.

Vector: They are the arthropod or any other organism that carries the pathogen and transfer from one host to another and favours the pathogen in completing their life cycle (asexual phase or sexual phase) e.g., mosquito, bedbug, ticks, mites, fleas etc.

Ventral Nerve Cord: It extends from the head to the abdominal region consists of two nerve cords (**connectives**) running longitudinally with a series of node-like **ganglia**.

Vertical Resistance: It is the resistance of a host plant against broad range of genotypes but has low heritability.

Visceral / Sympathetic Nervous System: The System consisting of Stomogastric system, unpaired ventral nerves, and caudal sympathetic system.

Vitellarium: It is part of ovariole where oocyte matures, encloses in one cell thick follicular epithelium and acculmulates yolk.

Vitelline Membrane: The egg has outer chorion secreted by follicle cells and inner vitelline membrane secreted by the oocyte itself.

Viviparity: Insects lay eggs but when the offsprings are retained in female genital tract it is called viviparity. The complete process of embryonic development takes place within the body of female and produces larva or nymphs e.g Diptera order.

Volterra's Formula: Volterra in the year 1927 stated that the population is always flunctuating and gave a mathematical expression; dN/dt= (n-m)N where N=number of individuals, n= natality, m= mortality, t=time.

W

Warning Coloration: Some insects protects themselves from enemies by showing foul smell, acrid taste, poisonous nature e.g. eyespots on wings of some butterflies, wasp sting which dark in color.

Wasmannian Mimicry: Here the insects that lives closer starts resembling each other e.g. different type of ants living together.

Wasp Venom: *Vespa spp., Polistes spp., Vespula spp*., stings causing painful rashes, and the venom consists of phospholipases hyaluronidases and cholinestrases as enzymes (which causes allergy), kinin, histamine, and serotonin that affects neurons of the nervous system.

Wax Glands: The unicellular or multicellular gland cells present in some parts of the integuments of bees (4^{th} to 7^{th} abdominal sterna) and aphids (discharged through plates) used in making honeycombs in bees and protection in aphids.

Wax Layer: It is the lipid layer of the epicuticle present between the cuticulin layers which provide permeability.

Weed Destroyer: Some insects are beneficial in a sense that they feed upon weed e.g. *Cactoblastis cactorium* control opuntia plant.

Wettable Powders (WP): The insecticides in the form of powder which is dissolved in water and sprayed.

Wing Flexion: When the wings folds on the abdomen at rest.

Wing Venation: The veins of the wing that are arranged in a particular manner called wing venation.

Wing: The outgrowth arises from notal projections of exoskeleton that enable insects to fly.

Winter Magetin: It is a resistant variety of apple against woolly apple aphid, *Eriosoma lanigerum* (Hausmann) reported in USA, 1831.

Y

Yolk/Deutoplasm: It is the amount of carbohydrates, proteins, lipids which is collectively found in mature insect egg**.**

Z

Zone of Growth: The middle part of testicular follicle line by a layer of somatic cell forming cyst where cell divides mitotically into 64-256 cells.

Zone of Maturation: The middle part of testicular follicle line by a layer of somatic cell where the spematocytes undergoes two maturation divisions.

Zone of Transformation: The proximal part of testicular follicle where spermatids differentiated into spermatids.

Zoonosis: It is defined as the diseases of the animals that are transmitted accidently to the human beings under natural conditions e.g., Japanese Encephalitis (JE) is a disease of pigs, goats, birds.

Zoophagous Insects: The insects that kill and eat numerous prey individuals in the course of their growth and development e.g praying mantis.

Section II- Some Interesting Facts about Insects

- 90% of the organisms are the insects almost found in every habitat from snowy mountain peaks to scorching desert.
- Largest order Coleoptera of class Insecta comprises of about 3-4 Lakhs species.
- Second largest order is Lepidoptera comprises of butterflies and moths.
- Third largest order is Diptera comprises of flies.
- Insects are rich in lipids and proteins therefore they have a high nutritional value as dietary supplements.
- Gusanos is a dish made up of fried caterpillars, beetle grubs and earthworm imported from Mexico to US.
- Female mosquito bites more in full moon.
- Some dung beetles roll the dung ball towards their nest in a straight path using stars and rolls up to 10 times their body weight.
- Honey bee dances to communicate their members about the location of the food. Round dance used to communicate the shorter distance and waggle dance for longer distance.
- Scorpion fly likes to mate with male if he has a present for her like alive caterpillar, bugs or flies.
- In China, Japan and America the crickets are considered as lucky charms or a symbol of prosperity.
- The wing of the bee beats 190 times/second.
- A single honey bee colony is sufficient for the production of 100 Kg of honey.
- A lady bird beetle eats about 5,000 insects in its whole life time therefore used as biological control agent in IPM.
- Male giraffe weevils are having a very long neck uses it to fight with each other.
- The adult insect which lives only for a day is mayfly.
- The termite queen is having the longest life cycle of about 50 years in some cases.
- Hercules beetle is able to lift about 850 times of its own weight.
- Locust is able to eat the food of their own body weight in a single day.
- Australian tiger beetle is the fastest running insect that can run 9 km/hr while chasing its prey.
- Horse fly is the fastest flying insect that can fly 145Km/hrs.
- A coleopteran Scarab beetle is the religious and cultural importance in Old Egypt and Greece.
- Heaviest larval insect: According to size, bulk and weight *Golianth goliatus* beetle is the heaviest belongs to the Order Coleoptera and Family Scarabaeidae (subfamily: Cetoniinae) found in African tropical forest (at least 115 gms ranged between 80-100 gms in the larval stage and adults are about half the weight as compared to larva).
- Longest beetle is the Hercules beetle, *Dynastes hercules* (Coleoptera: Scarabaeidae, subfamily- dynastinae) attaining length of 16.7 cm due to the presence of long pronotal horn.
- Largest weight of adult insects: giant weta, *Deinacrida heteracantha* belongs to order Orthoptera and family Anostostomatidae found in New Zealand weight about 71 gms.

- Biggest known insect of all time since history: Belongs to the extinct order Meganisoptera (large nerve wings) occurred in Carboniferous period *Meganeura monyi* and in Permian period *Meganeuropsis permiana* weigh about 450 gms and 75 cm of wing span.
- Longest stick insect: *Phyganistria chinensis* (Phasmatodea: Phasmatidae) measuring about 62.4 cm in length.
- Largest thrip: *Phasmothrips* attaining size of 1.3cm.
- Largest flea: *Hystrichopsylla schefferi* attains length of 1.2 cm.
- Largest earwing: The extinct species of earwig was found in Atlantic Ocean Saint Helena earwig, *Labidura herculeana* (Dermaptera: Labiduridae) measures about 8.4 cm in length. In living species Australian giant earwig, *Titanolabis colossea* measures about 5 cm in length.
- Largest moth: giant silkmoth, *Attacus atlas* (Lepidoptera: Saturniidae) measures 25-30 cm in size.
- Largest butterfly: Queen Alexandra's birdwing, *Ornithoptera alexandrae* (Lepidoptera: Papilionidae) 25 cm in size.
- Largest praying mantis: giant shield mantid/ hood mantis/leaf mantis, Rhombodera (Mantodea: Mantidae) 12 cm in size.
- Largest true fly: giant fly, *Gauromydas heros* (Diptera: Mydidae) wing span of 10cm.
- Largest bug: giant water bug, *Lethocerus grandis* and *L. maximus* (Hemiptera: Belostomatidae) length of 12 cm
- Largest bee: *Megachile Pluto* (Hymenoptera: Megachilidae) measuring 3.8 cm long and 6.3 cm in breadth.
- Largest wasp: tarantula hawk, *Pepsis pulszkyi* (Hymenoptera: Pompilidae) of about 6.8cm in length and 11.6 cm in wing span
- Largest ant: *Dorylus helvolus* measuring 5 cm.
- Largest termite: *Macrotermes bellicosus* (Isoptera: Termitidae) queen measure upto 10.6cm in lenghth and 5.5 cm in breadth.
- Largest cockroach: Heaviest cockroach is the giant burrowing cockroach, *Macropanesthia rhinoceros* (Blattodea: Blaberidae) measuring 8.4 cm and 33.5g of weight, largest cockroach *Megaloblatta* measures about 9.7cm length and 20 cm breadth, longest cockroach is *Blaberus giganteus* (Blattodea: Blaberidae) approximately 9 to 10 cm in length.
- World's smallest known insect: fairy flies, *Mymar* (Hymenoptera: Mymaridae) is a parsitoid measures 0.5 to 1mm in size and other researchers found is fairyfly, *Dicopomorpha echmepterygis* measures 0.139 mm.
- Smallest free living insect: featherwing beetle, *Ptenidium pusillum* (coleoptera: Ptiliidae)
- Smallest butterfly: western pygmy blue 12mm in size.
- Smallest dragonfly: scarlet dwarf dragonfly (Odonata: Libelluidae)
- Smallest moth: Midget moth or pygmy moths (leipdoptera: Nepticulidae).
- Smallest fly: *Euryplatea nanaknihali* found in Thailand, 0.4mm in length 5 times smaller than *Drosophila*.
- Smallest praying mantis: Bolbe Pygmaea mantis (Mantodea: Iridopterygidae) 1cm in Australia
- Smallest mosquito: *Uranotaenia lowii* (Diptera: Culicidae) 2.5mm long
- Smallest ant: pharaoh ant found in Europe.

- Ivermectins: It is a natural product of 16 membered macrocyclic lactone isolated from soil microorganism; mycelia of *Streptomycein ivermectins.*
- Nitrogaundins: It affects insects and mites by binding to ligand gated channels opens into neurons which results in loss of cell function.

Section III- Order name and a brief classification

All insect orders are divided into two subclasses: Aperygota and Pterygota
Subclass: Apterygota (It has two groups Entognathous and Ectognathous)
Entognathous

Order Protura (*Prot-ura*, from Greek *protos* = first, *oura* = tail) e.g. *Acerentomon* species.
Order Collembola; Springtails: (*Coll-embola*, from Greek *kolla* = glue, *embolos* = peg e.g Green Springtail, *Sminthurus viridis* (Lucerne flea).
Order Diplura; Two-pronged Bristletails: (*Dipl-ura*, from Greek *diplos* = double, *oura* = tail) e.g. *Campodea* and *Japyx* species.

Ectognathous (It includes rest of all orders)

OrderThysanura; Bristletails thysan- fringe, ura-tail) e.g. Silverfish *Lepisma saccharina*, Firebrat *Thermobia domestica.*
Order Archeognatha (archeo-ancient, gnath- jaw Jumping bristletail) e.g. *Machilis* species.

Subclass: Pterygota (It includes infraclasses: Paleopterous exopterygotes, Neopterous exopterygotes, Neopterous endopterygotes)

Infraclass: Paleopterous exopterygotes
Order Ephemeroptera; Mayflies: (*Ephemero-ptera*, from Greek *ephemeros* = living a day, *pteron* = wing) e.g. *Ephemera* and *Cloeon* species.
Order Odonata; Dragonflies and Damselflies: (*Odonata*, from Greek *odontos* = tooth) e.g. Large Red Damselfly, Southern Hawker Dragonfly, *Anax junius* (dragonfly) and *Lestes vigilax* (damselfly).

Infraclass: Neopterous exopterygotes (It contains 3 groups of orders: Plecopteroids, Orthopteroids and Hemipteroids)

Plecopteroid orders
Order Plecoptera; Stoneflies: (*Pleco-ptera*, from Greek *plekein* = fold, *pteron* = wing) e.g. *Perla burmeisteriana.*
Order Embioptera; Web-spinners: (*Embio-ptera*, from generic name *Embia* and Greek *pteron* = wing) e.g. *Haploembia* species, *Oligotoma saundersii.*
Orthopteroid orders
Order Grylloblattodea; rock crawlers or icebugs: (*Grylloblattodea*, from generic name *Grylloblatta; gryll-cricket and blatta-cockroach*) **e.g.** *Grylloblatta* species.
Order Orthoptera: (*Ortho-ptera*, from Greek *orthos* = straight, *pteron* = wing) e.g. Crickets, Grasshoppers and Locusts.
Order Phasmida; Stick Insects and Leaf Insects: (*Phasmida*, from Greek *phasma* = an apparition) e.g. Walking Stick, Javanese Leaf Insect.
Order Dermaptera; Earwigs (*Derma-ptera*, from Greek *derma* = skin, *pteron* = wing) **e.g.** Common Earwig
Order Dictyoptera; Cockroaches and Mantids: (*Dictyo-ptera*, from Greek *dictyon* = network, *pteron* = wing) **e.g.** American Cockroach, Praying Mantid.

Order Isoptera; Termites or White Ants: (*Iso-ptera*, from Greek *isos* = equal, *pteron* = wing) *Odontotermis sps.*
Order Zoraptera: (*Zor-aptera*, from Greek *zoros* = pure, *apteros* = wingless) e.g. *Zorotypus* species

Hemipteroid orders
Order Psocoptera; Psocids or Booklice: (*Psoco-ptera*, from generic name *Psocus* = rub small and Greek *pteron* = wing) **e.g.**Booklouse or Dust Louse, winged species *Peripsocus californicus* and wingless *Troctes divinatorius*.
Order Mallophaga; Biting Lice: (*Mallo-phaga*, from Greek *mallos* = hair, *phagein* = eat) **e.g.** Chiken body louse, *Menacanthus stramineus* gnaw through skin and feed on blood, *Trichodectus canis* a dog louse is a intermediate host of double pored dog tapeworm *Dipylidium caninum*.
Order Siphunculata (= Anoplura *anopl=unarmed, ura= tail***); Sucking Lice:** (*Siphunculata*, from Latin *siphunculus* = little tube) **e.g.** Human Louse *Pediculus humanus* and *Phithirus pubis* human pubic louse.
Order Hemiptera; True Bugs: (*Hemi-ptera*, from Greek *hemi* = half, *pteron* = wing) e.g. *Cicada sps.* Aphids.
Order Thysanoptera; Thrips: (*Thysano-ptera*, from Greek *thusanos* = fringe, *pteron* = wing) e.g. Pea Thrips.

Infraclass: Neopterous endopterygotes (It consists of 4 groups of orders: Coleopteroids, Neuropteroids, Panorpoids and Hymenopteroids)

Neuropteroid order
Order Neuroptera; Lacewings, Alder Flies & Snake Flies: (*Neuro-ptera*, from Greek *neuron* = nerve, *pteron* = wing) e.g. Ant-lion, Lacewing, and Snake Fly.

Coleopteroids orders
Order Coleoptera – Beetles: (*Coleo-ptera*, from Greek *koleos* = sheath, *pteron* = wing) **e.g.** Colorado Beetle, Diving Beetle, Rove Beetle, Stag Beetle and Tiger Beetle.
Order Strepsiptera; Stylopids (or Stylops): (*Strepsi-ptera*, from Greek *strepsis* = twisted, *pteron* = wing) e.g. *Elenchus* species, *Stylops medionitans*.

Panorpoids orders
Order Mecoptera - Scorpion Flies: (*Meco-ptera*, from Greek *mekos* = length, *pteron* = wing) e.g. Common Scorpion Fly *Panorpa chelata* and hanging Scorpion Fly *Bittacus chlorostigma* resembles crane flies, snow scorpionflies *Boreus californicus* are found on surface of snow
Order Siphonaptera: (*Siphon-aptera*, from Greek *siphon* = tube, *apteros* = wingless) **e.g.** human flea, *Pulex irritans* is important as it carry pathogen *Yersinia pestis* causative agent of plague.
Order Diptera; True Flies: (*Di-ptera*, from Greek *dis* = two, *pteron*= wing) **e.g.** Crane-fly, Hover-fly and Blow-fly or Bluebottle, housefly, mosquitoes.
Order Lepidoptera; Butterflies and Moths: (*Lepido-ptera*, from Greek *lepidos* = scale, *pteron* = wing) **e.g.** Small White Butterfly, Peacock Butterfly and Death's Head Hawk Moth.
Order Trichoptera; Caddis Flies: (*Tricho-ptera*, from Greek *trichos* = hair, *pteron* = wing) **e.g.** Limnephilid Caddis Fly

Hymenopteroid order

Order Hymenoptera; Sawflies, Wasps, Ants & Bees: (*Hymeno-ptera*, from Greek *humen* = membrane, *pteron* = wing) **e.g.** Horntail or Wood Wasp, Pine Sawfly, Common Wasp, Yellow Garden Ant or Mound Ant and Honey Bee or Hive Bee.

A brief Classification of Phylum Arthropoda

Phylum Arthropoda

1. Subphylum Onychophora (claw bearing) e.g. *Peripatus*
2. Subphylum Trilobita/ Trilobitomorpha (3 lobe forms) e.g. *Triarthrus eatoni*
3. Subphylum Chelicerata (claw horn group)
    a) Class-Merostomata/ Xiphuroidea e.g. *Limulus*
    b) Class-Eurpterida/ Gigantostraca e.g. giant water scorpion
    c) Class- Arachnida e.g. ticks, mites, scorpion, spiders
4. Subphylum Mandibulata (bear mandibles)
    a) Class- Crustacea e.g. prawn, shrimps
    b) Class- Insecta/ Hexapoda e.g. butterflies, bees, termites, bugs
    c) Class- Chilopoda (centipede) e.g. *Scolopendra*
    d) Class- Diplopoda (millipede) e.g. *Julus*
    e) Class- Symphyla e.g. *Scutigerella*
    f) Class- Pauropoda e.g. *Pauropus*
5. Subphylum Pentastomida/ Linguatulida e.g. tongue worms
6. Subphylum Tradigrada (slow walkers) e.g. water bears
7. Subphylum Pcynogonida e.g. sea spiders

Section IV- Various Important Diseases

Various Vector Borne Diseases

Class	Order	Family	Vector	Pathogen	Disease
Insecta	Diptera	Culicidae	*Anopheles stephensi, A.culicifacies* (mosquito)	*Plasmodium falciparum, P.vivax, P. ovale, P. malariae* (protozoan)	Malaria
Insecta	Diptera	Culicidae	*Culex quinquefasicatus, Mansonia annulifera* (mosquito)	*Waucheria bancrofti, Brugia malayi* (nematode)	Filariasis, Elephantitis
Insecta	Diptera	Culicidae	*Aedes aegypti, A. albopictus* (mosquito)	Den virus/ *flavivirus* - serotype 1 to 4 (family- Flaviviridae)	Dengue
Insecta	Diptera	Culicidae	*C.tritaenorhynchus, C.vishnui* (mosquito)	*Flavivirus fibricus* (family- Flaviviridae)	Japanese Encephalitis
Insecta	Diptera	Culicidae	*Aedes albopictus*	*Alphavirus* (family- Togaviridae)	Chickunguniya
Insecta	Diptera	Culicidae	*Aedes aegypti*	*Flavivirus fibricus* (family- Flaviviridae)	Yellow fever
Insecta	Diptera	Psychodidae	*Phelobotomus papatasi,* (sand fly)	Chandipura virus (family- Rhabdoviridae)	Chandipur viral encephalitis
Insecta	Diptera	Psychodidae	*Phelobotomus argentipes* (Sandfly)	*Leishmania donovani* (protozoan)	Visceral Leishmaniasis
Insecta	Diptera	Simulidae	*Simulium trifasciatum* (Black flies)	*Onchocera volvulus*	Oncocerosis (river blindness)
Insecta	Diptera	Tabanidae	*Tabanus spp*. (Horse fly), *Chrysops dispar* (deerfly)	*Francisella tularensis* (bacteria) Loa loa worm (filarial worm)	Tularaemia Loa loa or calabar swelling, Surra disease of horses
Insecta	Diptera	Muscidae	*Musca nebula, M. pattoni* (House fly)	Many Protozoan (E. histolytica) and bacteria of dysentery, typhoid, tuberculosis, cholera	Several infections
Insecta	Diptera	Glossinidae	*Glossina palpalis* (Tsetse fly)	*Trypanosoma brucei* (protozoan)	African sleeping sickness
Insecta	Diptera	Ceratopogonidae	*Culicoides anophelini*	*Mansonella ozzardi*	Human filariasis
Insecta	Anoplura/ Phthiraptera	Pediculidae	*Pediculus humanus* (human body lice), *P. capitis* (head louse), *Phthirus pubis* (crab louse)	*Rickettssia prowazekii*	Epidemic Typhus/ Louse borne Typhus (LBT), louse borne relapsing fever (LBRF)
Insecta	Siphonaptera	Pulicidae	*Xenopsylla brasilensis* (Rat fleas), *Pulex irritans*	*Yesernia pestis* (bacillus)	Bubonic Plague, Septicemic plague, Pneumonic plague, flea

			(human flea) *X. chepsis* (Oriental rat flea),	*Rickettsia typhi or R. mooseri*	borne typhus Murine Typhus
Insecta	Hemiptera	Reduviidae	*Triatoma* bug	*Trypanosoma cruzi*	American sleeping sickness/ Trypanosomiasis/ chagas disease
Insecta	hemiptera	Cimicidae	*Cimex rotundus, C. hemipterus, C. lectularis* (Bedbug)	Excreta or may be by unkown pathogens	Bite inflammation called weals or cimicosis
Arachnida	Trombidiformes	Trombiculidae	*Leptotrombidium deliense* mite/chiggers	*Oriental tsutsugamushi*	Scrub Typhus
Arachnida	Acarina	Ixodidae (hard tik)	*Dermacentor spp.* *Dermacentor andersoni* Hard ticks *Haemaphysalis spinigera* forest tick	*Ricketssia ricketssii* Virus *Borrelia burgdorferi*(nematode) Virus	Rocky Mountaain Spotted Fever (RMSF) Colrado Tick Fever (CTF)/ Mountain Tick Fever Lyme disease Kyasanur Forest Disease (KFD)
Arachnida	Acarina	Agarsidae (soft tick)	*Ornithodorus spp.*	*Borrelia recurrentis*	Tick borne relapsing fever
Crustacea	Cyclopoida	Cyclopidae	Cyclops (copepods)	*Dracunculus medinensis* (guinea worm)	Dracunculiasis

Diseases of plants due to insects

Bacterial diseases: Insects which enhances the bacterial diseases in plants

Some casual diseases
apple maggot- bacterial rot of apples
grasshopper- ringrot of potato
whiteflies- bacterial disease of sugarcane
aphids, codling moth, ants- fire blight of orchard tree,
Some ingestive dieaseas
cucumber beetle- bacterial wilt of cucumber family
flea beetle- bacterial wilt of corn
seed corn maggot- potato blacklegs
olive fly- olive knot disease.

Fungal diseases: Insects which enhances the fungal diseases in plants**.**
Flies, thrips, beetles- ergot disease of cereals (rye)

Corn earworm- black mold and yellow mould of corn
Stink bugs- yeast spot of soyabean
Woolly apple aphid- canker disease of apple
European elm bark beetle- Dutch elm disease (fungus name- *Ceratostomella*)

Mycoplasma diseases: Insects which enhances the mycoplasmal diseases in plants
Leaf hoppers-Aster yellow, clover phyllody, corn stunt

Viral diseases: Insects which enhances the viral diseases in plants
Thrips-tomato spotted wilt (tomato)
Mealy bugs: swollen shoot (cacao plant)
Whiteflies- cassava mosaic (cassava plant)
Aphid-tobacco mosaic (tobacco), lettuce necrotic yellow (lettuce), potato leaf roll (potato)
Leafhoppers- tungro disease (rice), beet curly top (sugarbeet), aster yellow (aster), rice stunt (rice)

Section V- Contribution of Scientist

1.Jan Swammerdam: He was the early insect anatomist.
2.Rene Antonine Ferchault de Reaumur: He was the founder of modern entomology.
3.John Ray: He was the botanist to describe life history of insects and metamorphosis.
4.Thomas Say: Father of American Entomology.
5.William Kibry: Father of Entomology.
6.Thaddeus William Harris: Father of American Economic Entomology.
7.Asa Fitch: First State Entomologist in New York.
8.S. Pradhan: Started Integrated Pest Management (IPM) in India.
9.Wigglesworth: Father of Insect Physiology.
10. Leffroy: Father of Entomology.
11. Tuxen and Lindroth: Given historical development of Insect Systematics (Historical Development).
12. Hem singh Pruthi: First Indian Entomologist
13. H.M. Leffroy: First man Entomologist
14. Nice Wille: First Entomologist by the Government of India
15. Wigglesworth: Father of Insect Physiology
16. Ernst Mayer: Father of Insect Systematics
17. E.A. Steinhaus: Father of Insect Pathology
18. Snodgrass; Father of Insect Morphology
19. R.H. Painter: Studied about Insect Resistance and wrote a book "**Insect Resistance in Crop Plant**".
20. Metcalf and Luckman: Wrote a book "**Introduction of IPM**" (Integrated Pest Management, 1972).
21. Rachel Carson: Wrote the book "**Silent Spring**" in 1962.
22. S. Pradhan: Introduced IPM in India.
23. Gier: Given the term "Pest Management".
24. Orthnar Zeidlar: Who invented DDT
25. Karlson: Given the term Pheromone (Pherin means to transfer)
26. Paul Muller: Discovered that DDT insecticidal property
27. Price (1975): Deals with Insect Ecology
28. Andrewartha and Birch (1973): Historical development of Insect Ecology

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About Author

Dr. Neetu Kachhwaha is presently serving as an Assistant Professor at Department of Zoology, University of Rajasthan, Jaipur since 2013. She did her M.Sc. (Zoology with special reference to entomology) in 2003 with second merit and Ph.D in Entomology (2005) from Jai Narain Vyas University, Jodhur. She also cleared SLET (2005) and ARS-NET in Agriculture Entomology (2009) examination. Dr. N. Kachhwaha also worked as an Entomologist (Gazetted) with Office of the Chief Medical & Health Officer, Jodhpur (Medical & Health Services, Rajasthan) for about four years. She has many research papers published in peer reviewed and indexed National and International Journals. She has contributed twelve chapters in Verdhman Open University, Kota published in e-books of Entomology. She has recently completed her research project entilied "Combination of *Trachyspermum ammi*, mustard oil and naphthalene against test insect *Anopheles stephensi*" sanctioned by BSR-UGC Start-Up-Grant, New Delhi. She is also acting as a co-editor of Newsletter, Agrobios, India. She has presented many research papers in National and International Conferences.

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