

M.S. Dhooria

Ane's Encyclopedic Dictionary of General & Applied Entomology



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Dedication

Rajinder (wife)
Ramanjot — Reena
Taranjit — Sweena

Preface

Insects dominate today's biosphere. Because of their number and diversity, they are by far the most important living beings on this earth. Nearly one million insect species have been described to date, and entomologists estimate that more than three million species may be found when the insect fauna in tropics is fully explored.

Insects are chief competitors of man for food and fibre resources throughout the world. Annual crop losses of 10 to 15% are attributed to insects only. Besides causing huge crop losses, insects are also the principal vectors of many human, animal and plant diseases.

There is a huge wealth of information available on different aspects of entomology. However, most of the terminology used in relation to insects and their management is difficult to retrieve being scattered in various disciplines based literature and Internet accessible databases. Glossaries given in entomology books covers only the basic definitions of some entomological terms but nothing in literature was available that provided comprehensive and authoritative descriptions of many terms, concepts, modern approaches and principles embodied in entomology and pest management.

My aim in writing present book, "Encyclopedic Dictionary of General and Applied Entomology", was to bring together at one place the terminology used in subdisciplines of entomology like insect systematics and taxonomy, biology, ecology, morphology, insect toxicology and physiology, economic entomology and pest management. Salient terminology from agriculture, agronomy, horticulture, plant pathology and plant protection related to different studies on insects is also included. Selection of terms was based on entomologist's requirements in different teaching, research and extension education assignments. Some terms pertaining to mites and ticks, which are close relatives of insects, have also been included for better understanding of the subject. My effort is to present the information to the reader in an easy and interesting way.

Appendices given at the end of dictionary provides very useful information about meanings of different prefixes and suffixed used as combining forms in compound words, technical terms based on colours and shapes; singular and plural usage of different terms in relation to insects; and conversion factors from non-metric to metric, and from metric to non-metric systems are included for better understanding of the technical literature. In section on **Further Reading**, some

excellent books available on different aspects of entomology have been listed for knowing more details about different terms.

I am sure that this encyclopedic dictionary will prove as a very useful reference source for students of agricultural colleges and universities where entomology is taught as introductory course or offered as an elective subject at both the graduate and post-graduate levels. This dictionary will also prove as very useful reference for teachers and researchers in entomology, biology, pest control advisors, pesticide industry managers, policy planners for environmental safety, health planners and other persons having interest and concern for the insects.

If this book enhances the level of awareness about insects and their management by providing a small step towards understanding of many new developments, my objective in writing this book will have been achieved.

Being the first edition, there could be some errors or shortcoming for which valuable informative suggestions will be greatly appreciated.

I would like to put on record my appreciation for the sincere and efficient work of Mr. Narinder Bains in neatly typing the manuscript of book.

Finally, I would like to acknowledge the constant support of my wife Rajinder, for helping me in various ways in preparation of the manuscript. Without her patience and understanding this venture would not have been possible.

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Foreword

Plant Protection plays a vital role in saving the crops from the ravages of Insect pests, diseases, weeds, rodents etc., thereby sustaining the crop production. Insect pests are one of the major cause of crop destruction and also carrier of diseases. Besides, all types of insects are not pests, there are beneficial insects which act as a biocontrol agents by feeding on various life stages of insect pests.

Dr. Dhooria who has long experience of working on different aspects of insect pests, has put in concerted efforts in compiling and elucidating the explanations of commonly used terms in the study of Insect biology, their behaviour and management, in a simple way.

This comprehensive dictionary containing an updated glossary of technical terms would prove to be a great help to the Entomologists, Agricultural graduate & postgraduate students, Agricultural extension workers, Pest Control Specialists, in familiarizing them with these technical terms. This encyclopedia would supplement their efforts in faster and accurate identification of Insects by understanding their physiological characteristics.

I convey my full appreciation to the author for bringing out such “Encyclopedic Dictionary of General & Applied Entomology” With lucid explanations.

A handwritten signature in black ink, appearing to read 'P S Chandurkar'. The signature is written in a cursive style with some loops and flourishes.

(P S Chandurkar)
Plant Protection Adviser
to the Government of India

Abaxial Surface: The lower surface of a leaf.

Abbott's Formula: Mathematical formula used to correct for mortality in the untreated check as given below.

$$\text{Corrected mortality (\%)} = \frac{P - P_0}{100 - P_0} \times 100$$

where **P** is the percent mortality of treated insects, **P₀** is the percent mortality of insects in the untreated control. This adjusted value is permissible when the mortality in control does not exceed 20 percent or when mortality is based on a large number of replications. The Abbott's formula is very commonly used and is recommended in certain standardized tests e.g., the WHO and FAO tests for insecticide resistance.

Abdomen: The hind part of the body of an insect consisting of eleven segments; behind the thorax, though several segments are usually concealed. Each abdominal segment is a relatively generalized unit, consisting of a dorsal tergum which may wrap downward to provide some lateral protection, and a relatively flat sternum. The terminal segment may bear a pair of sensory appendages called cerci, which may represent only abdominal limbs that have persisted in a number of insect groups. The same segment may be modified into a dorsal lobe, the epiproct, above the anus, and a pair of lateral lobes, the paraprocts. In some insects the female has paired structures arising from both the 8th and 9th segments that form an egg-laying device, or ovipositor; the male has one pair arising from the ninth segment that forms a copulatory apparatus. Abdomen is usually

without any jointed appendages other than cerci and genitalia.

Abduction: The movement of the coxa towards the body.

Abiotic: Of a non-living nature, such as weather and physical factors. Abiotic factors affect mortality characterized by the absence of life. Abiotic factors include temperature, humidity, pH, and other physical and chemical influences.

Aboral: In a direction away from mouth.

Abrasion: The process of wearing away by rubbing or grinding. Also, a scrape, scratch or sore that breaks the skin.

Abrasive: Something that grinds down or wears away an object. For example, wettable powders are abrasive to pumps and nozzles.

Abscission Layer: The formation of a layer of cells which permits in fruit, leaf or stem drop from plant.

Absorption: 1. Movement of pesticide from the surface into a plant, animal, or the soil. For example in animals absorption may take place through the skin, breathing organs, stomach or intestines; in plants through leaves, stems or roots. Absorption of toxicants is generally a passive process, dependant upon the lipophilicity of the toxicants, but in some cases it involves active or facilitated transport. 2. In digestive system of insects, midgut epithelium and the hindgut are the principal absorptive regions. Little or no absorption takes place in the crop region which is protected by a waxy intima. Monosaccharide sugars, commonly glucose, rapidly pass

through the permeable epithelial membrane without an active transport mechanism. Amino acids are absorbed by passive diffusion processes related to the uptake of digestion into the haemolymph. The absorption of lipids is done in crop and midgut regions in many insects. The rectal pads of the hindgut are specialized for absorption of water and inorganic ions.

Absorptive Clay: A special type of clay powder which can take up chemicals and hold them. It is sometimes used to clean up pesticide spills.

Acanthae: Fine unicellular, cuticular extensions.

Acari: A very large varied subclass of class Arachnida. Representatives are commonly called mites and ticks. However, in some old references, mites and ticks are placed in order Acarina or as order Acari. Their body is a single, compact unit, unsegmented; chelicera and palps form a compact unit. They are usually small, their length ranges from 0.08-16mm (0.003-0.6in) in mites and 2-30 mm (0.08-1.2 in) in ticks, their representatives are predaceous, parasitic, scavengers or phytophagous. In modern classificatory accounts, in subclass Acari 2 orders: Acariformes and Parasitiformes are recognized. Acariformes are without the visible stigmata, while one to four pairs of lateral stigmata are found posterior to the coxae of the second pair of legs in the Parasitiformes. Tactile and chemosensory hairs of the Acariformes contain a layer of optically active material, actinochitin, which exhibits birefringence in polarized light. Actinochitin is lacking in Parasitiformes.

Acaricide: Alternatively known as miticide. A pesticide used to control mites and ticks (e.g., chlorobenzilate, dicofol, avermectin, fenpyroximate), but is relatively non-toxic to insects. The acaricides include a diverse array of chemical structures. A number of insecticides also display acaricidal activity.

Acaridomatum: Dwelling spots for mites, often provided by certain plants which in turn benefit from the presence of mites.

Acariform: Shaped like a mite (Acari).

Acariformes: An order of subclass Acari. Representatives are without visible stigmata, and their tactile and chemosensory hairs contain actinochitin - an optically active material which exhibits birefringence in polarized light. The Acariformes contain three suborders : Acaridida (=Astigmata), the Oribatida (= Cryptostigmata) and the Actinedida (=Prostigmata).

Acarina: Mites and ticks in some systems of classifications are kept as order Acarina.

Acarine Disease: Also known as **Isle of Wight** disease. A disease of adult bees caused by the parasitic mite, *Acarapis woodi*, which enters from the tracheae and feed. When Congo red dye is injected into the haemolymph of mite-infested bees, both adult and larval mites in the tracheae turn red. There are no outward signs of mite infestation in bees, but mite infestation certainly causes some debilities in bees. Mite infestation causes little effect on strong colonies. To control bee mites, the desired control agent must reach the bee tracheae via a volatile compound, be inhaled by the bee and should only be toxic to the parasite mite (e.g., formic acid, amitraz).

Acaroecidium: A gall caused by gall mites (e.g., Eriophyidae).

Acarology: A branch of zoology dealing with the scientific study of mites and ticks.

Acarophily: A symbiotic relationship between plants and mites.

Acarophobia: Abnormal fear of mites.

Acceptable Daily Intake (ADI): The ADI is the level of a residue to which daily exposure over a lifetime will not cause appreciable risk. This level typically has been set at 100 or more times less than the level where no observable effects of the poison can be detected in experimental animals. It is expressed in mg/kg body weight per day. The ADI constitute a useful regulatory benchmark that is employed by international (i.e. FAO/WHO) and national agencies for establishing tolerances for pesticides residues in raw

agricultural and other commodities. ADIs may be unconditional, conditional or temporary.

Accessory Burrows: Blind and false tunnels close beside the true nest burrow. In every case the accessory burrows are left open and the true nest entrance closed off (e.g., ground nesting sphecid wasps).

Accessory Cell: A wing cell usually not present; a closed cell in wings of many Lepidoptera between branches of the radius.

Accessory Hearts: Pulsatory organs consisting of ampullae with valves, sometimes present near the bases of antennae, wings or legs.

Accessory Pulsatile Organs: Valved muscular pumps aiding the circulation of haemolymph to appendages unidirectionally. Accessory pulsatile organs occur at the base of the antennae, wings and sometimes in the legs.

Accessory Sexual Characters: The structures and the organs (except the gonads) of which the genital tract is composed, including accessory glands and external genitalia. The accessory glands arise from genital chamber or vagina but in Acrididae they are simply anterior extensions of lateral oviducts. Often the accessory glands produce an adhesive substance for attaching the eggs to the substratum. They may also secrete frothy secretion which forms egg pods in grasshoppers. Accessory glands may also produce silk and form cocoon-like structures in which eggs are laid. In case of male, accessory glands secrete the fluid with which the sperms are mixed, and sometimes sac-like coverings for packets of sperms are known as spermatophores.

Accessory Vein: A secondary longitudinal vein in an insect wing ; the most posterior vein in the anal area of the front wing of certain Hymenoptera.

Acclimation: Physiological changes to a changed environment (especially temperature) that allow tolerance of more extreme condition than prior to acclimation. Acclimation in which exposure to gradually cooler temperatures

over an extended period produces tolerance to cold extremes.

Accrescent: Generally widening towards apex.

Accumulative Pesticide: A pesticide which tends to build up in the tissues of animals, plants or the environment (e.g., DDT).

Acephalus: A term applied only to larvae. Apparently without a head or having a head that is much reduced and not clearly separated from the thorax (e.g., larvae of a housefly).

Acerous: Without antennae. Only Protura are entirely acerous.

Acetylcholine (ACh) : A kind of neurotransmitter substance released from the presynaptic neuron and which binds to receptors on the postsynaptic neuron of the synapse to perpetuate the action potential across neurons. The **Ach** is hydrolysed to choline and acetate by acetylcholinesterase, that is an important target for a variety of toxic and therapeutic anticholinesterases, such as the nerve agents, carbamate, thiocarbamate and organophosphate insecticides.

Acetylcholinesterase: The enzyme present in the synapse that breaks down acetylcholine to acetate and choline, making the acetylcholine receptors available for the next release of neurotransmitter.

Acid Gland: The principal poison gland of a bee secreting a complex mixture of histamine-liberating enzymes and proteins of low molecular weight collectively known as apitoxin.

Acinar: Resembling a cluster.

Acinus: Resembling a single grape in a cluster.

Acone Eye: A compound eye in which crystalline cones are absent or very poorly developed, as for instance in the crane fly.

Acquisition Access Period: The period of time a vector has a feeding access to a source of inoculum.

Acraein: A protective or distasteful secretion of certain butterflies.

Acron: Anterior, preoral body cap of a

segmented animal. Also called as prostomium. Embryological studies have convincingly demonstrated that the head comprises the acron (which is non segmental and homologous with the annelid prostomium), three preoral segments and the three gnathal segments. Antennae seems to be outgrowths of the acron.

Acrostichal Bristles: One or more longitudinal rows of small bristles along the centre of the mesonotum (Diptera).

Acrotergite: The narrow strip of cuticle anterior to the antecostal sulcus is the acrotergite (when dorsal) or acrosternite (when ventral).

Actin: A protein that makes up muscle myofibrils. Together with myosin, it mediates muscle contraction.

Action Potential: Self-regenerating standard signals that travel through other nerve cells along the length of long cytoplasmic cell projections (axons) through small gaps (synapses), the switch boards of the nervous system, where they are transmitted by the release of chemicals having specific effects upon the neuron or muscle cell across the synapse.

Action Threshold: The population density at which pest control measures are applied to avoid economic loss.

Activated Charcoal: Very finely ground, high quality charcoal that absorbs liquids and gases very easily.

Activation: Metabolic action that converts an inactive compound to another more active compound. But phenomenon of detoxification refers to reactions which lead to the formation of non-toxic compounds.

Activator: A material added to a pesticide to increase, either directly or indirectly its toxicity.

Active Ingredient: The chemical(s) in a product responsible for the desired effects, which are capable in themselves of preventing, destroying, repelling or mitigating insects, fungi, rodents, weeds or other pests.

Actual Dosage: The amount of active ingredient (but not formulated product) which is applied to an area or other target.

Aculea: A sting; a minute spine such as that found on the wings of some butterflies and other insects; a microtrichium.

Aculeata: A division of Hymenoptera which includes the stinging forms, bees, ants and wasps in contrast to the Parasitica which are parasites of other insects.

Acuminate: Tapering to a long point.

Acute Dermal Toxicity: Acute dermal toxicity refers to a single dose received via the skin.

Acute Inhalation Toxicity: Means how poisonous a single dose (or exposure) of a pesticide is when breathed into the lungs.

Acute Oral Toxicity: Acute oral toxicity refers to a single dose of the pesticide received via mouth.

Acute Toxicity: The toxicity of a material determined at the end of 24 hours to cause injury or death from a single dose or exposure. Acute toxicity to organisms occur by a pesticide when it acts at once. It manifests itself in upsetting of the vital activity of the organism with possible lethal outcome. The acute toxicity is obviously of paramount interest to people engaged in manufacturing and preparing formulation of pesticides and those responsible for their application.

Adaptation: The condition of showing fitness for a particular environment, as applied to the characteristics of a structure, function, or entire organism, also the process by which such fitness is acquired.

Adaptive Colour Change: A fairly rapid change of colour in response to a change in the colour characteristics of the environment.

Adaptive Radiation: Evolutionary divergence of members of a single phyletic line into a series of rather different niches or adaptive zones.

Adaxial Surface: The upper surface of a leaf.

Additive: Any material that is added to a

pesticide (not necessarily a wetting agent or surfactant).

Additive Effects: Two or more factors (e.g., pathogens, toxicants) that in concert produce an effect which is precisely the sum of their individual activities.

Adduction: The movement of the coxa away from the body.

Adecticous: A pupa whose mandibles are non-articulated and often reduced and are not used for escaping from the cocoon. Adecticous pupae are found in most Hymenoptera and Coleoptera.

Adelphoparasitism: Self parasitism. That form of parasitism where one sex develops parasitically in the body of the opposite sex.

Adenotrophic Viviparity: A phenomenon in certain insects whereby the larvae are retained in the parents body after hatching, develop by feeding on uterine secretions, moult twice and are finally deposited in a mature state ready for pupation. Found only in the tsetse flies (*Glossina*) and the Diptera Pupipara.

Adephage: One of the four suborders of beetles (Coleoptera) comprising families in which adults and larvae are usually active and predatory. Land forms include the ground beetle, *Carabus* and the tiger beetle, *Cicindela*; aquatic forms include *Dytiscus* and *Gyrinus*.

Adfrontal: Areas or structures adjoining the frons.

Adfrontal Areas : Two narrow regions surrounding the sides of the frons on the head of lepidopterous larvae, they are lacking in similar beetle larvae.

Adherence: The ability of a material added to stick to a particular surface.

Adhesive (Sticker): Material added to increase pesticide retention. Different commercial preparations of methyl cellulose are available for this purpose.

Adjuvant: A chemical or agent added to a pesticide mixture which helps the active ingredient to do a better job. Examples are

wetting agent, spreader, adhesive, emulsifying agent, penetrant etc.

Adoption Substance: A secretion presented by a social parasite that induces the host insects to accept it as a member of their colony.

Adsorbed: Means a pesticide held tightly on the surface.

Adsorption: The process by which materials are held or bound to the surface in such a manner that the chemical is only slowly available. Clay and high organic soils tend to adsorb pesticides in many instances.

Adult: A full grown, sexually mature insect or mite. In winged species it is the stage bearing the functional wings. In adult stage, insects migrate and begin new infestations or colonies. With rare exceptions the adult does not moult again.

Adulterated Pesticide: When strength or purity of a pesticide falls below standard claimed, or if any substance has been added or any part subtracted.

Adulticide: An insecticide which is toxic to the adult stage of insects.

Adultoid Reproductive: In the higher termites, a supplementary reproductive that is a fully developed imago and is thus morphologically indistinguishable from the primary reproductive it replaces.

Aedeagus: The male intromittent organ, essentially a penis, called the aedeagus ; the distal part of phallus. The aedeagi of male insects belonging to certain groups, including the wasps, moths and flies, are often complex in structure. They are furnished with strange arrays of spines, lobes, hooks and hairs. These structures are quite useful in distinguishing and classifying species.

Aerial Application: Pesticide treatment applied with the use of an aeroplane or helicopter. An aircraft may permit aerial spraying when ground application is not possible in situations when large areas are to be treated quickly, or soil is too wet for application through ground equipment, or if flooded fields are to be given pesticide applications, or if large crop plants, fruit trees,

or forest trees are to be sprayed without damaging plants or trees. But aerial application is costlier than ground application, and generally does not give as uniform distribution of pesticide on the target, and there is increased drift.

Aerial Net: An insect net that has an open mesh bag with a reinforced rim of muslin. The net is swung easily, causes the least damage to the insect, and enables the collector to view the specimen through the bag. The netting portion of the bag may be made of nylon or nylon marquisette, scrim, organdy, or fine mesh bolting cloth. The net's rim is generally 0.3 m (30 cm) in diameter and made of number six or eight wire. The wooden or aluminium handle is about 1 m long with two grooves and holes cut to receive the ends of the wire loop. A metal collar, hose clamps, or a wrapping of wire, heavy cord, or friction tape will hold the rim to the handle. Collapsible nets can be devised by using hinges that divide the handle and rim into two folding parts. The frame of a collapsible fish handling net also serves this purpose.

Aerosol: Aerosols are minute particles suspended in air, such as fog or dust. Similarly, insecticides may be suspended in air as minute particles whose diameter range from 0.1 to 50 microns. The dispersion of insecticide into aerosol form may be accomplished by burning, vaporizing with heat, atomizing mechanically or releasing through a small hole and that has been dissolved in a liquefied gas. The released gas volatilizes rapidly and leaves small particles of the insecticides floating in air. Small quantities of pesticides can be applied from aerosols. Aerosol cans are expensive and for safety reasons their size is limited. They are, therefore, used for small scale applications only in the house or garden.

Aerosol Spray: A fine spray produced by pressurized gas that leaves very small droplets of pesticide suspended in the air. Aerosols are used for the knockdown and control of flying insects and cockroaches, but they provide no residual effect. Since aerosols produce droplets well below 10 μ m, which

are readily absorbed by alveolar tissue in the lungs, therefore, caution must be taken when they are used.

Aestivation: A period of inactivity similar to hibernation but occurring in warm seasons or times of drought. Aestivation enables an insect to overcome hot and/or dry summer conditions. This phenomenon is found in alfalfa weevil, *Hypera postica* and locust, *Schistocerca gregaria*.

Aetiology: The science of causation; origin of causes.

Afferent: Bringing towards; nerves carrying impulses to nervous centres.

Affinity: Relationship; sometimes misleadingly employed as synonym for phenetic similarity.

Aflatoxin: Potent mycotoxins that are carcinogenic and are produced by the fungus *Aspergillus flavus* when it is growing on peanuts, corn, and other crops.

Agamospecies: A species without sexual reproduction; an asexual species.

Agar: A medium for bacterial and other cultures prepared from agar-agar, a gelatinous substance yielded by red algae.

Age Distribution: The proportions of individuals in different age groups of a population at a given time.

Age Polyethism: Development of age-related division of labour in social insects. For example in the ant *Myrmica scabrinodis*, worker individuals which have emerged during the present season function as nurses; those which became adults during the previous season are builders, while even older individuals act as foragers. Such age polyethism reaches its greatest development among honeybees.

Aggregation: A group of individuals, comprised of more than just a mated pair or a family that have gathered in the same place but do not construct nests or rear offspring in a cooperative manner.

Aggregation Pheromones: Also sometimes known as arrestants. These are chemicals or

chemical combinations that cause insects to aggregate or congregate. They are often released by one or the other sex and cause the approach of conspecifics of both sexes. The biological roles of aggregation pheromones are usually obscure, although many of them may serve to bring other individuals to a suitable food source that has been located by the pheromone-releasing individual. Aggregation pheromones are best known from bark beetles and cockroaches. Aggregation pheromones can be used to offset the repellency sometimes associated with insecticides and thereby increase insecticide efficacy. Controlling and monitoring of beetle pests are many times based on aggregation pheromones which are often combined with secondary plant substances and cause both sexes to aggregate on the same host.

Aggressive Mimicry: Also known as **Poecklamian mimicry**. This occurs among tropical mantids, some of which resemble flowers and presumably lure flies and bees to their doom. Female *Photurius* fireflies that attract males of other species to eat them are likewise aggressive mimics.

Agitate: To keep a chemical mixed up to keep it from separating/settling in the spray tank.

Agitator: A paddle, air or hydraulic action to keep a pesticide chemical fixed in the spray or loading tank.

Agriculture: Cultivation of soil for purposes of crop production, sometimes distinguished as agriculture (field crops) and horticulture.

Agrochemicals: The term agrochemicals includes plant nutrients like fertilizers as well as other alternate chemicals like plant growth regulators, pheromones, hormones, attractants, repellants, chemosterilants and bioorganisms. Agrochemicals play an important role in ensuring food supply and better health for a growing world population.

Agroecology: The study of ecology in relation to agricultural systems.

Agroecosystem: An agroecosystem is basically the ecosystem of an area as modified by the practice of agriculture, horticulture or

animal rearing. It is composed of cultivated land, the plants contained or grown thereon, and the animals associated with these plants.

Agronomy: Scientific land management concerned with the theory and practice of field crop production and soil management.

Air Blast Sprayer: Spray equipment that uses a fan to create a high speed air stream to transport and deposit pesticide solutions. It is used for orchards, shade trees, vegetables and fly control.

Air Sacs: Thin-walled dilations of the tracheae which by their elasticity increase the efficiency of respiration, particularly in fast-flying insects. Taenidia are absent from, or poorly developed in air sacs. The sacs are collapsible, are important in ventilation and also permit internal organs in the body cavity as for example when the ovaries are enlarged by eggs or the gut is engorged with food. Air sacs serve as reservoirs of oxygen and also serve as bellows in distributing air and cooling the body particularly during flight. They also help in decreasing weight in fast-flying species.

Akinesis: A motionless state of an insect resembling sleep, particularly after loss of or damage to sensory organs such as antennae.

Alae Cordis: Wing-like bands of fibrous tissue suspending the heart from the pericardium in insects and other arthropods.

Alar (Alary): Wing like or pertaining to wings. Alary muscles connect the heart to lateral portions of terga.

Alarm Pheromones: A substance produced by an insect to repel and disperse other insects in the area. It is usually released by an individual when it is attacked. They are produced by insects that live in groups e.g. aphids, bed bugs and social Hymenoptera. In termites it is only soldiers that produce (and respond to) the pheromone. Among Hymenoptera, hornets and honeybees but not bumblebees, produce alarm pheromones as do almost all ants. Typically the alarm pheromones of non-social insects and mites stimulate dispersal (escape behaviour). In case

of ants, alarm pheromones serve as defensive compounds, repelling intruders, or release digging behaviour, or act as trail pheromones. In the honeybee the alarm pheromone may be released to indicate a depleted food source. In case of honeybees the alarm pheromones has also been used to repel the bees from oilseed rape before insecticide applications.

Alary (Aliform) Muscles: A series of triangular muscles inserted on the membrane that separates the perivisceral from the pericardial cavity of an insect. Contractions of these causes blood to flow into the pericardial cavity and thence through small opening or ostia into the long dorsal tubular heart. Alary muscles support the heart within the body cavity.

Alate: Winged; having wings.

Albinism: The absence of pigmentation, particularly of melanins in an animal.

Algorithm: Sequence of rules, stating how to produce specified output information from given input information in finite number of steps. In insect pest management, output consists of a suggested courses of action, while the input consists of information received from several sources.

Alien Species: An organism which has invaded and is growing in a new region.

Aliform: Wing-like.

Alimentary Canal: This organ is a tube passing through the central part of the body. Its anterior opening, the mouth, is situated at the base of the 'preoral cavity' (the space enclosed by mouthparts); its posterior opening, the 'anus', is on the posterior body segment. The alimentary canal is divided into 3 distinct parts : an anterior 'foregut' (stomodeum); a middle 'midgut' (mesenteron); and a posterior 'hindgut' (proctodeum). Usually between the foregut and midgut is the 'stomodaeal' or 'cardiac valve', and between the midgut and the hindgut is the 'proctodaeal' or 'pyloric valve'. The foregut and hindgut result from embryonic infoldings of the 'ectoderm'; the midgut is formed from the 'endoderm'.

Alimentary Castration: Sterility of the worker and soldier castes of some social insects, brought about by a deficiency in their diet.

Alinotum: The notal plate of the mesothorax or metathorax of a pterygote insect.

Aliphatic: Organic chemical compound in which the carbon atoms are linked in open chains rather than rings.

Alitrunk: The two wing-bearing segments of an insect's thorax, i.e. usually the second and third segments. In ants the first abdominal segment propodeum is also involved in wing attachments.

Alkaline Gland: Also called **Dufour's gland**, one of the glands connected with the sting of a bee, producing an oily alkaline secretion whose function is obscure, but may be lubricatory.

Alkaloid: Nitrogenous alkaline compounds found in certain plants. Many alkaloids have toxic properties and are used in preparing the botanically derived insecticides. Alkaloids are among the best known of the toxins that serve as defence against insects. Nicotine (from tobacco) and tomatine (from *Solanum* spp.) are alkaloids and are used in controlling insects.

Alkylating Agents: Highly active compounds that replace hydrogen atoms with alkyl groups in cells undergoing division.

Allatectomy: An act of removal of the corpora allata of last instar or newly emerged females of grasshoppers that may completely prevent the onset of normal sexual receptivity.

Allatostatin: A hormone produced by the brain that inhibits juvenile hormone production by the corpus allatum.

Allatotropin: A hormone produced by the brain that stimulates juvenile hormone production by the corpus allatum.

Allele: Any of the alternative expressions (states) of a gene (locus).

Allelochemical: A substance that is significant to organisms of a species different from its source, for reasons other than food

as such. Allelochemicals include allomones, kairomones, synomones, and apneumones.

Allergy: An allergy is a condition of hypersensitivity to any of a wide number of materials in the environment. Allergic response can occur as a result of almost any form of contact with insect or their parts. Chronic forms of allergy include severe itching, eczema, or the symptoms of hay fever; deaths that occur are usually the result of anaphylaxis. However, a range of reaction is quite variable. For example, everyone finds a bee or wasp sting to be painful, however, different individuals may have different side reactions. Some suffer little more than some temporary itching, some remain swollen around the sting for several days, while others become gravely ill and even die.

Allochronic Species: Species which do not occur at the same time level.

Allometry: The growth of a part of the body at a rate that is greater or less than that of the body as a whole.

Allomone: An allomone is a chemical substance, produced or acquired by an organism, which, when it contacts an individual of another species in the natural context, evokes in the receiver a behavioural or physiological reaction adaptively favourable to the emitter but not to the receiver (e.g. repellents). Most of allomones detected in beetles (*Coleoptera: Lycidae*) are defensive secretions (alkylpyrazines allomones) that convey an important but general chemical message. Others share the allomones but differ in distasteful chemicals, whereas some have the warning chemicals but differ in distasteful chemicals.

Allopatric: Populations or species, occupying mutually exclusive but usually adjacent geographical areas.

Allopatric Hybridization: Hybridization between two allopatric populations (species or subspecies) along a well-defined contact zone.

Allopatric Speciation: Species formation during geographical isolation.

Allosematic Resemblance: Also called **Batesian mimicry**. The resemblance of a harmless insect to a poisonous or distasteful one, giving protection to the former, since predators will tend to avoid both; (e.g., the close resemblance of clearwing moth to a wasp).

Allotype: A paratype of the opposite sex to the holotype.

Alpha Taxonomy: The level of systematics concerned with the characterization and naming of species.

Alternate Host: The other species of plant that is necessary for the completion of the life cycle of the same species.

Alternation of Generations: The phenomenon when parthenogenetic generations alternates with bisexual generations. (e.g., small wasps, *Neuropterus lenticularis*; aphids, *Brevicoryne brassicae*).

Alternations: The population density alternates between high and low values in successive generations if the key factor is density dependant and strongly overcompensates for change in population density.

Alternative Host: A plant or animal which acts as one of several hosts to an insect pest; one of the two or more kinds of plants on which an insect or disease complete its life cycle.

Altruism: Self destructive behaviour performed for the benefit of others.

Altruistic: Existence of self sacrificial behaviour in the insect societies (e.g., most wasps and hornets).

Alula: A part of an insect's wing forming a small separate lobe close to the base of the hind margin (e.g., Diptera).

Alveolate: Having cells, or alveoli ; deeply pitted.

Ambient Vein: A dark stiffening around margin of wing in the cicadas (Homoptera).

Ambrosia Beetle: Ambrosia beetles carry fungi within their bodies. The numerous

species of these wood-boring insects (Scolytidae, Platypodidae and Lyncoxilenidae) can not survive without ambrosia fungi (several genera of Ascomycetes and 'imperfect' fungi). In their external skeleton are small pockets called mycangia (literally 'fungus containers'). These pockets always contain a supply of viable fungus spores. When an ambrosia tunnels into wood, spores are dislodged from the mycangia and soon a mass of velvety fungus lines the interior of the tunnel. On this 'ambrosia', which concentrates in its cells nutrients that have been extracted from the wood, the beetles feed.

American Foul Brood: American foul brood disease of honeybee is caused due to an infection with a bacterium, *Bacillus larvae*. Only the sealed brood is attacked and the larvae usually die at the prepupal stage. The cell cappings are usually sunken, and the larvae in them decay giving a characteristic smell. Larvae changes colour from white to brown, and finally to a very dark brown.

Ametabola: The insects that develop without metamorphosis (e.g., Collembola, Diplura, Protura and Thysanura). Except for size differences and the presence of genitalia and gonads, there are no major changes in morphology between immature and adult forms of these insects.

Ametabolous: Without noticeable metamorphosis.

Amide: A compound derived from carboxylic acids by replacing hydroxyl of the COOH by the amino group NH₂.

Amine: An organic compound containing hydrogen derived from ammonia by replacing one or more hydrogen atoms by as many hydrocarbon radicals.

Amino Acid: Organic compound containing both basic amino (NH₂) and acidic carboxyl (COOH) groups. There are twenty types of amino acids, hundreds of these compounds combine to form a protein.

Ammochaeta: A stiff type of bristle occurring in bunches on the heads of ants, used for cleaning the legs etc.

Ammonia: This is a waste product in insects found in freshwater and in a few terrestrial insects such as blowfly larvae that live in very moist habitats.

Amniotic Fluid: The fluid in which the developing embryo is suspended in the egg.

Amphipneustic: Having only two pairs of functional spiracles i.e. prothoracic and posterior abdominal spiracles. This condition is found in larvae of the housefly.

Amphitoky: Also known as deuterotokous parthenogenesis. Production of both males and females parthenogenetically as in some Thysanoptera.

Amplexiform: In Lepidoptera, the mode of wing coupling in which the humeral region of the hind wing projects beneath the fore wing, but without any specific coupling mechanism.

Ampulla: Blister or wart-like protuberances used as organs of locomotion usually confined to the abdominal segments, ventral or dorsal, rarely lateral in position.

Anabolism: The metabolic production of protein, carbohydrates, and fats from ingested food.

Anaesthetize: Process of immobilizing an insect by exposing it to carbon dioxide.

Anal Area: The posterior part of the wing, supported by the anal veins.

Anal Cell: A cell in the anal region of a wing.

Anal Fold: Also known as 'vannal fold'. A distinctive fold in the anal area of the wing.

Anal Lobe: A lobe or localized expansion along the posterior wing margin near the wing base.

Anal Loop: A series of cells that forms a rounded to elongated or footshaped area in the hind wings of dragonflies.

Anal Margin: The posterior edge of an insect wing.

Anal Papillae: Thin-walled projections from the anus of various aquatic larvae of Diptera, notably mosquito larvae.

Anal Ring: In coccids, an elevated ring-like structure surrounding the anus.

Anal Veins: The most posterior veins of an insect's wing.

Analogue: A compound that is very similar in both structure and formula to another compound.

Analogous: A similar feature in two or more taxa which can not be traced back to the same feature in the common ancestor of these taxa.

Analogy: Similarity in function filling a common need but having a different evolutionary origin.

Analysis of Variance: The analysis of variance is a simple arithmetical process of sorting out the components of variation in a given data. It is a tool by which the total variation may be split into several physically assignable components. In order that the F-test in the ANOVA may hold good, the necessary condition is that the experimental error should be independently and normally distributed with mean zero and variance (δ^2) the population variance. If a transformation is used, the best estimates of the treatment means in the original scale are obtained by transforming back the means of the transformed variate.

Analytic Agent (AR) : Reagents that are pure and are used for quantitative analysis.

Anamorphosis: Post-embryonic development in which abdominal segments are added at the time of moulting (e.g., Protura).

Anaphylaxis: Generalized reaction to foreign proteins to which the body has become sensitized (e.g., common in solitary wasps belonging to Pompilidae, Sphecidae and Eumenidae).

Anatomy: The science of internal morphology as revealed by dissection.

Anautogenous: Requiring a protein meal to develop eggs.

Androconia: Specialized scales and associated sex pheromone producing glands among the wing scales of some male Lepidoptera. They produce a secretion that attract female butterflies.

Anecdysis: A long passive period between two moults of an insect or other arthropod during which there appears to be no preparation for the next moult.

Anellus: A chitinous ring supporting parts of the male genitalia in some insects.

Anemotaxis: A tendency of small insects to fly into a current of air.

Anepimeron: The upper part of the epimeron or posterior sclerite of the subcoxa at the base of an insect's leg.

Anepisternum: The upper part of the episternum or interior sclerite of the subcoxa at the base of an insect's leg.

Aner: A male insect; a term used more especially in relation to ants.

Angstrom ($^{\circ}\text{A}$) : A unit length equal to 1/10 millimicron ($\text{m}\mu$) or nanometre (nm)=1/10,000 micron or micrometre (μm)=10⁻¹⁰ metre to measure wave lengths and dimensions of intracellular structures of microorganism and viruses.

Anholocyclic: In aphids, a life cycle in which the only host plants used as a summer annual, and in which reproduction is solely by parthenogenesis.

Animalia: Animal kingdom, also known as **metazoa**. They are multicellular animals. A monophyletic taxon, containing 34 phyla of ingestive, heterophic, multicellular organisms. About 1.3 million species have been described; estimates of the number of undescribed species range from lows of 10-30 million to highs of 100-200 millions.

Anionic: An ion having a negative charge is an anion. When the surface active portion of a surfactant molecule possesses a negative charge it is termed as anionic surface active agent.

Anionic Surfactant: Salt of an organic acid, the structure of which determines the surface activity.

Anionic Wetting Agent: Anionic wetting agent is a wetting agent that has a negative charge and performs best in cold soft water.

Annual: A plant that grows from a seed,

produces flowers, fruit or seed, and dies in the same season.

Annulate: Formed in ring-like segments.

Annulus: A ring-like marking, or a ring of hard cuticle.

Anoplura: Sucking lice; an order of wingless blood sucking insects mostly parasites of mammals.

Ant: Hymenoptera with elbowed antennae and with a very narrow abdominal constriction or waist, known as the 'petiole' having 1 or 2 nodes. They invariably live in highly organized colonies containing many types or castes. The queen is the only ant capable of laying eggs. The majority of ants in a colony are workers or incomplete females without wings and with large heads. The social activities of ants include such varied occupations as storing food, tending and 'milking' aphids cultivating fungi, enslaving other ants, defending the colony etc. Some types of 'soldier ants' use their extra large jaws for defence, others shoot out formic acid from glands at the hind end of the body.

Antagonism: Decrease in bioactivity of two compounds when mixed than the summation of activity when they are administered individually.

Antarctic: Of or near the South Pole.

Anteapical: Just proximad of the apex.

Anteclypeus: An anterior division of the clypeus.

Antecosta: The internal ridge marking the original intersegmental boundary and on which the longitudinal muscles of secondary segments are inserted.

Antecostal Sclerite: A sclerite of the metasternum, just anterior to the hind coxae.

Antecostal Suture: Also called 'intersegmental groove'. A groove marking the position of the intersegmental fold between the primary segments.

Antenna Comb: A row of bristles forming a comb-like structure at the proximal end of the anterior tarsus in bees, used for removing pollen etc. from the antennae.

Antennae: Elongated sensory appendages on the heads of insects and other arthropods; very varied in structure, often segmented and mobile, and usually bearing olfactory and tactile receptors. Antenna consists of a scape, a pedicel and a flagellum that is frequently subdivided into 'flagellomeres'. Antenna is pivoted on a single marginal point called antennifer, and can move in all the directions. Insects may possess filiform, moniliform, setaceous, clavate, capitate, lamellate, serrate, pectinate, flabellate, plumose, geniculate or aristate type antennae.

Antennal Club: The enlarged distal segments of a clubbed antenna.

Antennal Fossa: A cavity or depression in which the antennae are located.

Antennal Groove: A groove in the head capsule into which the basal segment of the antenna fits.

Antennal Socket: Receptacle or pit in which antenna is placed.

Antennal Sulcus: The groove indicating the internal cuticular ridges bracing the antennae.

Antennation: Touching with the antennae. The movement can serve as a sensory probe or as a tactile signal to another insect.

Antennifer: The articulatory process in the antennal socket.

Antennomere: A subdivision of the antenna.

Antennule: A small antennal or feeler-like process.

Antenodal: Preceding or before the nodus.

Antenodal Cross-veins: One to many cross-veins meeting the anterior (costal) margin of the front wing between the base and the nodus; used in identification of dragonflies and damselflies.

Antepenultimate: The second from the last.

Antepygidial Bristles: Large bristles situated just in front of the sensillum of fleas.

Anterior: Front, or in front of.

Anterior Cross-vein: A cross-vein usually above the discal cell in the wings of Diptera; identical to **r-m** cross-vein.

Anterior Notal Wing Process: The anterior lobe of the lateral margin of the alinotum supporting the neck of first axillary.

Anterior Tentorial Pits: Within the epistomal (frontocylpeal) sulcus lie the anterior tentorial pits, which indicate the internal origin of anterior tentorial arms.

Anterodorsal: In the front and at the top or upper side.

Anteromesal: In the front and along the midline of the body.

Anteroventral: In the front and underneath or on the lower side.

Anthogenesis: The production of males and females parthenogenetically, as in some aphids.

Anthophilous: Attracted by flowers; feeding on flowers. The major anthophilous insects are the beetles, wasps, bees and ants. These insects visit flowers primarily to obtain nectar and/or pollen.

Anthoxanthins: Whitish or yellow pigments common in insects.

Anthraquinones: Red and orange pigments common in scale insects. Cochineal, produced by scale insects which feed on prickly-pear cactus was earlier a highly prized red dye for cloth. Earlier this dye was widely used as a red food colouring agent but has been banned now because of potentially dangerous properties.

Antropogenic: Caused by humans.

Anthropomorphism: Attributing human characteristics to insects. For example the female earwig broods her young because she loves them.

Anthrophilic: Associated with humans.

Antibiosis: All adverse physiological effects of a temporary or permanent nature resulting from the ingestion of a plant by an insect. Antibiosis directly or indirectly affects the pest in terms of death, and lowering of survival rates, growth, development rate and fecundity.

Antibiotic: Chemical substance produced by

a microorganism and that inhibits growth or is toxic to other microorganisms in very small amounts. Gliotoxin (from *Trichoderma viride*) and streptomycin (from *Streptomyces griseus*) are common examples of antibiotics. Modern usage of the term includes synthetic and semisynthetic compounds that exhibit antimicrobial activity.

Antibody: A serum globulin which is produced in blood of an immunized animal in response to the introduction of a foreign antigen.

Anticoagulant: A chemical used in a bait to destroy rodents. It destroys the walls of the small blood vessels, and keeps the blood from clotting. As a result the animal bleeds to death (e.g., warfarin is an important anticoagulant).

Anticoagulin: A substance antagonistic to the coagulation of the blood.

Antidote: A practical immediate treatment, including first aid, used in the treatment of pesticide poisoning or some other poison in the body. Atropine sulphate is used as an antidote to counteract the effects of various organophosphate and carbamate pesticides. Protopam chloride (2-PAM) antidote is given only in case of poisoning by organophosphates. Barbiturates and calcium gluconate are given in case of poisoning by chlorinated hydrocarbons.

Anti-Drift Agent: A chemical used to reduce spray drift during the actual spray operation by various physical factors. Under some situations it is necessary to add thickeners to the spray solution to reduce the number of fine drops created at the nozzle. Fewer fine droplets result in less drift.

Anti-Dusting Agent: Anti-dusting agents are generally liquid substances, which cause extremely fine particles of dry materials to adhere to each other, thus making them less susceptible to drift water soluble materials. Glycerine and petroleum oils may be used as anti-dusting agents.

Anti-Feeding Compound: Also known as antifeedant. A compound which will prevent the feeding of pests on a treated material

without necessarily killing or repelling them. It is not a repellent. Phlorizin-a phenolic compound, function as a stimulant for apple feeding aphid, *Aphis pomi*, but inhibits probing by non-apple feeding aphid, *Myzus persici*. Coumarin found in sweetclover (*Melilotus* sp.) acts as strong feeding deterrent for blister beetles. Similarly triterpenoid-*ameliantril*, causes 100 percent antifeeding activity against desert locusts.

Anti-Foaming Agent: Anti-foaming agents are surfactants which suppresses the tendency to foam insecticide formulation by other surfactants used as emulsifiers or wetting agents, when the formulation is diluted with water (e.g., silicones). Anti-foaming agents may be added to the formulation to reduce foaming of the liquid in the spray tank.

Antigen: A substance capable of inducing the formation of antibodies when introduced into the blood stream of an animal.

Anti-Juvenile Hormones: A high titre of juvenile hormone in the insect maintains its larval characteristic and if this effect can be counteracted in the early stages, then the larvae may metamorphose into miniature pupae or sterile adults. This is known as precocious development and the name, 'precocenes' have been given to a major anti-juvenile hormone compounds. However, none of the compounds developed so far have been sufficiently active for practical pest control.

Antimetabolites: Chemicals that are structurally similar to biologically active metabolites, and that may take their place detrimentally in a biological reaction. When these compounds are ingested with the food, the insect displays the symptoms of a dietary deficiency which may result in death.

Antioxidant: A substance capable of chemically protecting other substances against oxidation or spoilage.

Antixenosis: In plant resistance, antixenosis (non-preference) refers to plant properties which cause avoidance or reduced colonization by pests seeking shelter, food or oviposition

sites. Antixenosis includes the mechanisms that deter colonization of the plant by insects. For example 'hairy stems' in wheat varieties confer resistance to cereal leaf beetle.

Antlia: The tubular proboscis of a butterfly or moth; a dilated part of the post-pharynx in some Diptera.

Antliata: An old name for sucking insects, especially Lepidoptera and Diptera.

Antlion: The larva of a winged insect of Myrmeleontidae (Neuroptera). Wingless, with large jaws and very voracious, it digs a pit in loose sand and lies with its jaws exposed as it waits for ants and other passing insects. It devours a large number of ants and when full-grown pupates and eventually becomes a four-winged insect resembling damselfly.

Anus: The posterior opening of the digestive tract.

Aorta: Anterior subdivision of the dorsal blood vessel, the 'aorta' is a valveless tube that simply conducts the haemolymph to the head, where it is released near the brain.

Aphagia: Inability to digest.

Aphaniptera: An alternative name for the insect order Siphonaptera (e.g., fleas).

Aphidovorous: Feeding on aphids.

Aphins: Red, orange, and yellow pigments found only in aphids.

Aphis: Plant lice belonging to the order Homoptera. They are extremely prolific and do much damage by sucking the sap of leaves and by exuding a sticky or waxy secretion from the abdomen.

Aphis Lion: Also known as 'aphis wolf'. The predatory larva of a lacewing fly (*Chrysopa*, *Hemerobius* etc.) that feeds on aphids and other small insects.

Aphrodisiacs: Substances produced by either sex (usually by the male and often as only part of a complex pattern of courtship behaviour) that facilitate courtship or prepare the opposite sex for copulation after the pair have been brought together (e.g., many butterfly species have virgin females that

produce sex attractants, whereas males have aphrodisiac scent glands).

Apiary: A group of beehives or other containers for keeping and breeding bees.

Apical: At the end, tip, or outermost part.

Apical Cell: A cell near the wing tip.

Apical Margin: The outer edge of an insect wing.

Apical Spur: In Diptera, present as short rather stout bristles on the ventral surface of tibia.

Apiculture: Bee keeping. Involves care and management of honeybees for their honey and other commercial products such as beeswax, venom, royal jelly and queen substance, besides their services as pollinators.

Apidology: Scientific study of bees.

Apimyiasis: Myiasis of the adult honeybee caused by larvae of *Senotia tricuspis* and certain other fly species.

Apitherapy: Apitherapy is the medical use of honeybee products. This include the use of honey, pollen, propolis, royal jelly and bee venom, but most commonly refers to use of bee venom and is commonly known as bee venom therapy (BVT).

Apitoxin: The poison of bee's sting consisting chiefly of histamine producing enzymes and proteins of low molecular weight.

Aplasia: The entire failure of organs or tissues to develop.

Apneumone: A substance emitted by a nonliving material that evokes a behavioural or physiological reaction that is adaptively favourable to a receiving organism but detrimental to an organism of another species that may be found in or on the nonliving material.

Apneustic: A type of respiratory system in some submerged aquatic insects which don't possess any functional spiracles but does have a closed tracheal system. Oxygen enters the body by cutaneous diffusion either over the general body surface or in special

integumental gill. This system is found in immature Ephemeroptera, Odonata, Plecoptera, Trichoptera, and many larval Diptera.

Apocrita: Bees, wasps, ants and ichneumon flies : insects of order Hymenoptera with deep constriction between the thorax and the abdomen. The larvae are grub-like, without legs.

Apod: A larva lacking true legs.

Apodeme: A chitinous ingrowth of the exoskeleton to which muscles are attached; such ingrowths serve as tendons in insects.

Apodous: Without jointed legs.

Apolysis: The separation of the old cuticle from the epidermis during moulting.

Apophysis: Pits on the exoskeleton mark the sites of internal, tubular invaginations of the integument.

Aposematic: Having a warning colouration, either indicating that an insect is dangerous, e.g., a wasp, or in the case of harmless insects giving some degree of protection by mimicking the colours of a more dangerous predator.

Aposematic Colouration: Warning colours or markings which signal to a predator that the organism is harmful, such as the colours of some stinging insects.

Appeasement: A function of courtship in which there is inhibition of the normal predatory instincts of the participants, especially the female. Among mantids, courtship by the male has sometimes been described as a 'sneak attack', often the female devours the male.

Appendage: Any attachment to the body that is hinged to the head, thorax or abdomen by a joint; antennae, legs, wings, and so on.

Appendiculate: Bearing an appendage(s).

Appendix: Any attachment; particularly used of a short, stump-like vein.

Appetitive Flight: Also called 'trivial flight'. Insect flight that involves local movements of varying length and orientation concerned with food and mate finding, escape from

potential enemies, location of suitable oviposition sites, territorial defence and other such 'vegetative' activities.

Application: The placing of a pesticide on a plant, animal, or soil, or its release into the air of water to prevent damage, or destroy pests.

Applicator: A person or piece of equipment which applies pesticides to destroy pests or prevent damage by them.

Apposed: Having surfaces adjacent or against one another.

Apposition Eye: Found in most day-flying insects. Each ommatidia in such eyes has a light gathering apparatus, the 'corneal lens' and 'crystalline cone', and a light sensing apparatus, the 'rhabdom'. Direct bright light is focussed by each lens system onto its own rhabdom, which contains visual pigments, and initiates a discharge of a nerve. Interpretation of these messages by association centres in the brain is made and the insect accomplishes vision.

Aptera: Insects which are wingless.

Apterous: Wingless.

Apterous Neoteinic: In termites, the same as ergatoid reproductive.

Aptery: The condition of lacking wings.

Apterygota: A subclass of class Insecta. These insects are similar in body organization to pterygote (winged) insects, but primarily lack wings. Apterygotes (Archeognatha and Thysanura) have ectognathous mouthparts and intrinsic musculature in only the basal two antennal segments, and they have compound eyes and ocelli. The long, slender cerci and median filament recur in Ephemeroptera (mayflies), and the body form of Apterygota strongly resembles that of Ephemeroptera nymphs. Like the Entognatha, apterygotes have rudimentary abdominal appendages, employ indirect insemination, and moult throughout life.

Aquatic: Living in water. Aquatic insects are a minor fraction of all insects numbering not more than 3 to 5 percent of all species. Aquatic insects like mosquitoes are of extreme importance in public health.

Arable Land: Land cultivated for crops that are replanted after each harvest.

Arachnida: A class of phylum Arthropoda that includes the scorpions, spiders, mites, ticks and several other groups. In general, the body is divided into a cephalothorax with six pair of jointed appendages and an abdomen with no appendages. The head region lacks antennae and compound eyes, although a variable number of simple eyes may be present. Adjacent to the mouth, the first pair of appendages form a pair of 'chelicera'. The second pair of appendages sometimes form long sensory structures called the 'pedipalps' which in scorpions are used for grasping prey. In addition, all adult arachnids have four pairs of rather long walking legs. Some spiders, ticks and scorpions are venomous and inflict painful, even fatal bites or transmit diseases of man. Mites comprise the largest group of parasitic arthropods; plant feeding mites comprise one of the most important groups of pests of trees, crops, and stored products. Spiders and predaceous mites also have some potential in the biological control of arthropod pests.

Arachnophobia: Fear of arachnids (spiders and relatives)

Araneae: Commonly known as spiders. Abdomen unsegmented, separated from cephalothorax by a narrow stalk; chelicerae fang-like; abdominal spinnerets spin silk. They are predaceous, either pursuing or stalking prey or trapping it in nets. Large spiders sometimes bite and a few are poisonous. Majority are mildly beneficial feeding on small insects.

Arboreal: Living in, on, or among trees.

Arbovirus: Viruses which multiply in an invertebrate vector and a vertebrate host are termed arboviruses. Dengue and yellow fever are caused by arboviruses.

Archaeognatha: A subclass of the group Apterygota. This subclass has been recognized based on major differences in the jaw articulation of primitively wingless orders: Protura, Collembola and Diplura.

Archaeognathans are small (up to 15mm) and elongate having ectognathous chewing mouthparts with single point of articulation (monocondylic). Representatives are commonly known as jumping bristletails. The other subclass of Apterygota is Dicondylia which is split into two infraclasses, the Thysanura and the Pterygota. Archeognathans are scavengers, live in litter, soil etc. and have little economic importance. They are fast runners and can jump.

Archetype: A hypothetical ancestral type arrived at by the elimination of specialized character.

Archidictyon: An irregular network of small veins like those of a leaf in the wings of the Palaeodictyoptera, primitive fossil insects of the carboniferous period. Most present day insects show considerable simplification of wing venation by reduction of the number of cross-veins. Mayflies and dragonflies, however, closely resemble the primitive type.

Arcsin Transformation: Used to transform data in proportions with the range of 0 to 30% and 70 to 100%.

Arctic: The extreme northern region above latitude 65°N in the geographical globe. In this region climatic conditions are rigorous with a long, cold, dark winter. There is a short summer period of continuous daylight. The population of aquatic insects is very high.

Arcuate: Bent like a bow.

Arculus: A cross-vein between the radius and cubitus near the base of the wing; used in identification of dragonflies and damselflies.

Arenicolous: Living in sand.

Areole: A cell of the wing in some Lepidoptera, between veins R_3 and R_4 .

Argasid Ticks: Belong to family Argasidae (Ixodida). Commonly known as soft ticks. Dorsal scutum is absent in these ticks. Argasids are tough, leathery ticks. In nymphs and adults the capitulum is not visible from the dorsal view, being located ventrally in a recess, the 'camerostome'. The stigmata are small and placed anterior to the coxa of the

fourth pair of legs. The pad-like pulvillus between the claws is either absent or rudimentary.

Arid: Refers to regions or climates which lack sufficient moisture for crop production without irrigation, precipitation 10" (25.4 cms) or less in cool regions, up to 15" (38.1 cms) or 20" (50.8 cms) in tropical regions.

Arista: A large bristle near the tip of the last antennal segment of certain flies (Diptera).

Armature: Setae, spines or sclerotized processes on the body, head and appendages.

Army Ants: Also called driver ants or legionary ants. Carnivorous ants of tropical countries that live in temporary nests and migrate in long files like an army.

Armyworm: An alternative name for the cutworm, a term used to denote the larvae of various noctuid moths; common pests of agriculture.

Arolium: A pad between the tarsal claws in Orthoptera, or at the base of each tarsal claw in Hemiptera. These pads are either coated with a sticky secretion produced by gland cells in the pad or are covered with a dense mat of special adhesive hairs which help the insects to walk on smooth window panes etc.

Arrestant: A chemical that causes an organism to aggregate in contact with it. An arrestant may slow the linear progression of the organism by reducing actual speed of locomotion, or by increasing the turning rate.

Arrhenotoky: The phenomenon of giving rise to males through unfertilized eggs. This is the sex-determining mechanism in all Hymenoptera, some Thysanoptera and Coleoptera.

Arsenicals: One of the most important groups of early insecticides, comprised principally of arsenates and arsenites. Paris green (a complex between copper acetate and copper arsenite) was used in USA since 1867. It is quite toxic to plants and animals, therefore, its use is limited to insect poison baits. Lead and calcium salts of arsenic have been the commonest arsenicals in use against

beetles, weevils, leaf-rollers and many tree insects. In view of high mammalian toxicity of lead, preparations of calcium arsenate are often preferred as lead is a cumulative poison, and presents a serious problem.

Arthroial Membrane: Soft, stretchable cuticle between segments. Arthroial membrane is evident in gravid ovipositing migratory locust, *Locusta migratoria* (Orthoptera : Acrididae), in which intersegmental membranes may be expanded up to 20-fold for oviposition. Gross abdominal dilation of gravid queen bees, termites and ants is possible through expansion of the unsclerotized cuticle.

Arthropoda: A large phylum of invertebrates including crustaceans, arachnids, insects, millipedes and centipedes. Of these different organisms, the insects form by far the greatest number. Arthropods have externally segmented bodies and with jointed appendages, appendages modified for feeding, an exoskeleton with chitin, a haemocoel instead of coelom, a ventral nerve cord and dorsal brain, and bilateral symmetry.

Arthropodins: A group of water-soluble proteins found in the insect cuticle. Part of arthropodin may later be tanned to form a hard darkened structure called sclerotin which provides hardness to the sclerites.

Articular Sclerites: Separate, small, movable plates that lie between the body and a wing.

Articulated Gill Theory: One of the two theories which attempt to explain the evolution of wings from unwinged ancestors. According to this theory wings evolved from winglets that originated as gills. In this case protowings could have first evolved in aquatic larvae and enlarged to allow improvements in underwater navigation. Once the ancestors left the water, and then became large enough for swimming and finally flight. The reduced muscle power and wing movements used in swimming are sufficient to propel them through the water and explain the initial evolutionary benefits of wings before insects actually left the ground.

Articulation: A joint as between two segments or structures.

Artificial Classification: Classification based on convenient and conspicuous diagnostic characters without attention to characters indicating relationship; often a classification based on a single arbitrarily chosen character instead of an evaluation of the totality of characters.

Artificial Infestation: Infestation of plants with insects by placing them directly on plants by hand or by releasing them into a cage, in contrast to natural infestation when a natural field population is depended on for testing an insecticide.

Artificial Respiration: First aid given to a person who has stopped breathing.

Asexual Reproduction: Not involving the fusion of the nuclei of different gametes.

Aspirator: Also known as a 'pooter'. An aspirator is an equipment that collects or sucks small insects into a glass or plastic vial or tube. The collector sucks on a mouthpiece inserted into the end of a rubber tube. The other end surrounds a glass or metal tube which inserts through a cork or stopper into the vial. The end of the tube in the vial is covered with a piece of fine netting or screening to prevent the inhalation of insects. A bent glass or metal tube protrudes from the vial and is placed against the desired insect. But if pooters are used for long periods, there is a risk that minute particles, microorganisms and fungal spores could be inhaled which might lead to allergies and chest infections.

Associative Learning: The ability to form association between previously meaningless stimuli and reinforcements such as reward or punishment. Bees can associate colours with food sources and learn to seek the right colour rather than following the original olfactory cues. Honeybees can also differentiate between certain forms of depressions and can be trained to associate these with food.

Assymetrical: Organs or body parts not alike on either side of a dividing line or plane.

Asymptote: The point in the growth of a population at which numerical stability is reached.

Asynchronous Muscle: A muscle that contracts many times per nerve impulse, as in many flight muscles and the muscles which control the cicada tymbal.

Atlas: In taxonomy, a method of presenting taxonomic materials primarily by means of comparative illustrations rather than by comparative descriptions.

Atomization: Process of breaking a liquid into a fine spray by passing it through an apparatus under pressure.

Atomizer: Device used to break up a liquid spray into small droplets by passage of air across a narrow orifice through which spray fluid is being delivered.

Atrium: A chamber just within the spiracle into which opening to the external environment is referred to as atrial aperture or orifice.

Atropine: An antidote used by doctors to treat people or animals poisoned by organophosphate and carbamate pesticides in an attempt to save their lives.

Attapulgit: A magnesium silicate clay that is used as a carrier for the pesticide.

Attenuated: Tapering apically.

Attenuation: The process of decreasing the virulence of a microorganism.

Attractant: A chemical that causes an organism to make oriented movements towards its source; chemicals having positive attraction for insects, usually in low concentration and at considerable distances; a substance that lures insects to trap or poison-bait stations. Usually classed as food, oviposition and sex attractants. Odours given by host plant and animals, or by other sources of food are used by insects in location of feeding and breeding sites. In addition insects produce a variety of odoriferous compounds (pheromones) which are used in various kinds of communication including species recognition, aggregation for mating and host colonization, defense, sex attraction and

mating stimulation. Methyl eugenol is an extremely potent attractant for the male oriental fruit fly, and cue-lure has been found as an attractant for melon fruit fly.

Auditory Organs: Organs by which an insect can hear sounds or perceive vibrations. Tympanic organs present in the abdomen of grasshoppers, legs of crickets, and thorax of moths respond to the sounds like the inside of an ear drum.

Augmentation: The supplementation of existing natural enemies by release of additional individuals through periodic releases that do not establish permanently but nevertheless are effective for a while after release. Periodic releases may be made regularly during a season so that the natural enemy population is gradually increased (augmented) to a level at which pest control is effective. Augmentation or periodic release is achieved through inoculation as well as inundation. Releases of mass-reared *Trichogramma* wasps in field or glasshouses is a good example of inundation. Predaceous insects, mites, and nematodes have also been used in this manner for management of pests.

Auricle: A small lobe or ear-like structure; in male dragonflies, a dorsolateral appendage on the second abdominal segment.

Autecology: Branch of ecology which is concerned with the study of an individual organism or individual species with reference to its life history, behaviour and adaptations which it shows in relation to its environment.

Authority Citation: The custom of citing the name of the author of a scientific name or name combination.

Autocidal Control: Death or reduced reproductive capacity of insects as caused by individuals of their own species. This involves release of enough sterile insects of species to effectively reduce the chances of a wild female mating with a fertile male. Under ideal conditions repeated releases of sterile insects can eliminate an invading pest species.

Autocide: Control of pest by sterile male technique.

Autogeny: The ability of insect species, particularly those having a short adult life span, to lay eggs without having ingested any proteinaceous food. Some autogenous insects never eat at all as adults or ingest only water or carbohydrates such as nectar. Most autogenous species lay relatively a few eggs under such conditions.

Automimicry: Intraspecific mimicry, when some members of a species are unpalatable and palatable members of the same species mimic them.

Autotomy: Ability to amputate a limb spontaneously, as in stick insects. These insects have weakened areas at the trochanter that break under extreme stress, such as when its appendage is grasped by a large predator. Reflexes within the removed appendage cause the leg to twitch, which diverts attention from the escaping insect. Specialized membranes prevent bleeding, and regeneration of the leg may be possible should future moults occur.

Auxin: A genetic term for compounds characterized by their ability to induce elongation in shoot cells. They resemble indole-3-acetic acid in physiological action.

Avermectins: Natural control agent from the species *Streptomyces avermitilis* is used for control of mites and leafminers and has been used as a key element for insect management in vegetable and orchard crops. Unlike existing microbial-based products, the toxicology and performance characteristics of this product are very similar to conventional synthetic insecticides.

Avicide: A substance to control pest birds. Generally these compounds are not designed to kill but to repel or to so affect a few individuals that others are frightened away. Strychnine is an important avicide.

Avoidance: Pest control measure that operates by the avoidance of areas of known high risk such as not planting a susceptible crop in a field known to contain a major pest.

Awn: A bristle like extension of varying length originating from the lemma of the rice grass.

Axenic: Without, or deprived of, any commensals, symbionts or parasites; not contaminated.

Axil: The upper angle between a leaf stalk and the stem from which it branches. Buds of new vegetative growth or flowers form in the axils.

Auxillary Area: An area of the wing base bearing the wing articulation.

Auxillary Plates: Two (anterior and posterior) articulating plates that are fused with the veins in an odonate wing; the anterior supports the costal vein, and the posterior support the remaining veins. In Ephemeroptera, there is only a posterior plate.

Auxillary Sclerites: Three or four sclerites, which together with the humeral plate and tegula comprise the articular sclerites of the neopteran wing base.

Auxillary Vein: A supplementary vein. In Symphyta (Hymenoptera), a vein in the anal area of the hind wing. The subcosta is often considered to be auxillary.

Axon: Sometimes called neuritis. A very thin long fibre of a neuron. A branch of an axon is called collateral. At the end of an axon, tiny branching processes called dendrites are found. Axon transmits a nerve impulse away from the cell body.

Azadirachtin: The chemically active principal of the neem tree (*Azadirachta indica*). Neem oil from neem seeds is used for insect control in different formulations. The main neem chemical is a mixture of three or four related compounds. Azadirachtin is the main agent for controlling insects, representing 90% of the effect on most pests. It is a feeding deterrent and growth regulator, repelling and disrupting the growth and reproduction of pests.

Bacteremia: The presence of bacteria in the haemolymph or blood of invertebrates and other animals without production of harmful toxins or other deleterious effects.

Bacteria: Bacterial preparations for insect control are available as powders which typically contain about a thousand resistant parasporal bodies per milligram. The powders are wetted and sprayed and the pest may then ingest vegetative bodies while feeding. Each vegetative body contains two structures, a spore and a protein crystal. Although the spore often releases some toxins, the important pesticidal element is the protein of the crystal. When the parasporal body reaches the high pH of the gut, the protein crystal dissolves which kills pest; the spore itself does not germinate and propagate vegetatively until pH conditions change when the gut ruptures and the insect becomes a corpse. As the cadaver dies out, the bacterium resporulates to form parasporal bodies (e.g., *Bacillus thuringiensis* formulations).

Bacteriophage: A virus whose host is a bacterium.

Bacteriostat: Material used to prevent growth or multiplication of bacteria. Bacteriostats include dyes, weak antisepsics and certain antibiotics.

Baculovirus: Member of the virus family Baculoviridae. These are most common insect viruses, and known exclusively from arthropods. They consist of nuclear polyhedrosis viruses (NPVs), granulosis viruses (GVs), and nonoccluded rod-shaped nuclear viruses (NDVs). All are DNA viruses.

Bait: Foodstuff used for attracting pests. Usually it is mixed with a poison to form a poison bait which is used for the control of insects, slugs, snails and rodents. A major problem with pelleted baits is that domesticated pets can eat them.

Bait Shyness: The tendency for rodents, birds or other pests to avoid a poisoned bait. Prebaiting with unpoisoned basic can help.

Balance of Nature: The developing, evolving and diversified life and state of adjustment (balance) of all organisms have reached in relation to the environment. Nature is in a constant state of change and this constant evolutionary process is nature's way of trying to create a balance which is never reached.

Ballooning: A dispersal method for early instars of lepidopterous larvae, some spiders, and mites. The organism produces a silken thread that is caught by the wind resulting in the organism being transported by air movement.

Band: A transverse line, usually wide, crossing the body. Sometimes term band is confused with 'stripe' which is used to designate a longitudinal line running the length of the body.

Band Application: An application to a continuous restricted area such as in or along a crop row rather than over the entire field area.

Bark: A general term for all the tissues outside of the cambium in stems of trees ; outer part may be dead, inner part is living.

Barrier Application: The use of pesticide

or another agent to stop pests from entering a container, area, field or building.

Basad: Towards the base, and away from the tip or apex.

Basal Cell: One or more cells near the base of the wing.

Basal Treatment: A treatment applied to the stems or trunks of plants at and just above the ground line.

Base: A part of an appendage or structure nearest the body; on the thorax, the part nearest the abdomen; on the abdomen, the part nearest the thorax.

Basement Membrane: Thin, noncellular about 0.5 μm thick membrane forming the inner lining of the hypodermis of the body wall. It separates the body cavity from the integument. Chordotonal organs, tracheoles, and nerves run through it.

Basifemur: Anterior segment of femur in mites.

Basisternum: Part of the sternum anterior to the sternocostal suture.

Basitarsus: The proximal or basal segment of tarsus.

Batesian Mimicry: A form of similarity in the colouration of two or more species, one of which is unpalatable or distasteful species (the model) the others of which are edible species (the mimic). Batesian mimics are avoided by predators familiar with the unpalatable model. This method requires that the population density of the model be much greater than that of the mimic. Examples include neotropical moths and katydids that resemble wasp.

Beak: The narrow, elongated, and often somewhat rigid mouthpart complex of sucking insects (e.g., Hemiptera) or certain insects with chewing mouthparts (e.g., weevils, scorpionflies); proboscis.

Beating: The method of holding the tray beneath bushes or branches or trees, and beating the foliage with a stick so that the insects that fall into the white enamelled tray can be collected or counted. Beating is very

simple and quick technique. Beating of wet foliage is not recommended.

Bee: A furry insect of the order Hymenoptera. There are solitary and social bees. Social bees live in colonies. Each colony has one queen bee, large number of workers, and a few drones. *Apis mellifera* is the highly social bee and is commercially reared. Bumblebees (*Bombus* spp.) have comparatively much smaller colonies.

Bee-Hive: They are wooden boxes having two parts, the upper chamber called 'super' and lower chamber known as 'brood chamber'. In the super, honey is deposited by worker bees, while in brood chamber eggs are laid by the queen bee and immature stages are reared. A 'queen excluder' is kept in between these two chambers which do not allow the queen to enter in the super chamber. However, worker bees can pass through the queen excluder because of their small size. The bee hive is closed from all sides, only a small hole (hive entrance) is kept near the bottom board for entrance of bees. Hive entrance faces either east or south. In each chamber, wooden frames are hanged at a distance of 10 to 12.5 cm. As the population of bees increases additional boxes may be added.

Beeswax: Beeswax is a yellowish white solid waxy material, insoluble in water but soluble in carbon tetrachloride and chloroform. It is secreted as tiny scales or flakes from four pairs of abdominal glands located on the ventral body surface of honeybee. The scales are transferred to the mouth by the legs where they are chewed by mandibles before the wax is incorporated into the comb. Beeswax is mainly used in the preparation of comb foundation, which is affixed to the frames of a commercial beehive. This foundation serves to induce the bees to construct the honey comb in the frames. Bees eat about 3.5-7.0 kg of honey to produce 0.5 kg of wax. Beeswax is used in religious candles, polishes and cosmetics. It is sometimes used in pharmaceuticals, dental wax, wax museum figures etc.

Behaviour: The ways in which an organism adjusts to and interacts with its environment, includes both maintenance and communicatory activities.

Behavioural Resistance: A mechanism in insects of resistance to insecticides which involves a behavioural change whereby contact with the insecticide is avoided.

Belt: A geographical zone characterized by certain climatic or biological features; ecological unit characterized by its vegetation.

Beneficial Insects: Means insects that yield useful products such as bees, lac insects or silk insects; are parasitic or predaceous on harmful insects or other organisms or act as pollinators of useful crops.

Benefit-Cost Ratio: Ratio formed by dividing the benefit in terms of increased crop value when a pesticide is used, by the cost of the insecticide treatment.

Benefit Cost Ratio =

$$\frac{\text{Value of treated crop} - \text{Value of untreated crop}}{\text{Coat of insecticide application to treated crop}}$$

Bentonite: A colloidal native clay (hydrated aluminium silicate) that has the property of forming viscous suspension (gels) with water; used as a carrier in dusts to increase adhesion of the pesticide.

Berlese Funnel: A sampling device that uses heat to drive small insects and mites from a sample of soil, vegetation or litter. The material is placed on a coarse screen platform which has been inserted into a funnel whose tip is dipped into a jar containing 70% alcohol. Over the funnel is lighted a lamp. Since insects evades the light and heat, and as the material dries the insects are driven away from the material in 6-8 hours and are collected in the jar containing alcohol. Originally, Berlese utilized a water jacket surrounding a funnel to heat and dry the soil sample contained inside the funnel.

Beta Taxonomy: The level of taxonomy concerned with the arranging of species into a natural system of lower and higher taxa.

Bibliographical Reference: For nomenclatural purposes the citation of the

name of the author and date of publication for a scientific name; a full bibliographical reference includes, in addition, the citation of the exact place of publication of a scientific name (i.e., title of book or journal, volume, page, etc.).

Biennial: A plant that completes its life cycle in two years. The first year it produces leaves and stores food. The second year, it produces fruit and seeds.

Bifid: Double; divided into two parts or lobes.

Bifurcate: Forked; divided into two, but usually only partly so.

Bilateral Symmetry: Similarity of form of one side with the other.

Binominal Nomenclature: The system of nomenclature adopted by the International Congress of Zoology, by which the scientific name of an animal is designed by both the generic and specific name. Devised by a Swedish naturalist Linnaeus and now almost universally applied to living organisms.

Bioaccumulation: Also known as biomagnification. The accumulation of a chemical by organisms from water directly or through consumption of food containing the chemical. Efficient transfer of chemical from food to consumer, through two or more trophic levels, results in a systematic increase in tissue residue concentration from one trophic level to another.

Bioactivity: Pertains to the property of affecting life.

Bioassay: Also known as biological assay. The qualitative or quantitative determination of a substance by the systematic measurement of the response of living organism as compared to the measurement of the response to a standard or standard series. Through bioassay-potency and relative toxicity of different pesticides can be ascertained, new formulations can be developed, new toxic agents can be screened and insect resistance to insecticides can be studied.

Biochemical Oxygen Demand: The quantity of oxygen used by microorganism in the biochemical oxidation of organic matter

and oxidisable inorganic matter by aerobic biological action.

Biocide: A chemical which has a wide range of toxic properties, usually to members of both the plant and animal kingdoms.

Biocoenosis: Community of organisms inhabiting a given habitat and mutually interacting.

Bioconcentration: The process of a pesticide becoming concentrated in plants or animals; increase in concentration of a chemical at each succeeding link in the food chain.

Biodegradable: A substance which may break down in the biological system.

Biodegradation: The environmental destruction of toxicants as a result of microbial or fungal action. This is an extremely important mechanism for the detoxification of environmental pollutants in soil and water such as pesticides.

Biodiversity: The natural diversity of living organisms; the range of types and species of plants and animals in an area. This also includes diversity within species, between species and of ecosystem. The term encompasses different genes, species, ecosystem and their relative abundance. Habitat destruction and species overexploitation are main causes of biodiversity loss. There is no direct and obvious link between the diversity of ecosystems and their importance in maintaining essential global processes.

Biogas: Gas formed by anaerobic digestion of organic materials, e.g., whey or sewage sludge. Typically of 62% methane, 38% carbon dioxide.

Biogeography: Biogeography is the study of the distributions and the past historical and current ecological explanations for these distributions.

Biological Classification: The arranging of organisms into taxa on the basis of inferences concerning their generic relationship.

Biological Clock: Mechanism in an organism which enable it to 'tell the time' in that it can perform metabolic or behavioural endogenous

rhythms. Also known as 'circadian rhythms' and these rhythms are largely independent of temperature, within normal limits of tolerance.

Biological Control: The action of parasites, predators, or pathogens on a host or prey population which produces a lower generation equilibrium position than would prevail in the absence of these agents. Biological control is advantageous as it is selective and has no side effects, is cheap, and biological control agents are self propagating and perpetuating besides risk of development of resistance to pests are unlikely. But on the other hand biological control limits the subsequent use of pesticides, acts slowly, is not an exterminant, and success rate of this technique is not predictable. Biological control has been more successful against pests of perennial crops especially orchards, than in annual cropping systems and this has been attributed to territorial stability of such habitats, contrasted with the seasonal disruption brought about by ploughing, planting and harvesting. In order to enjoy more wider exploitation, biocontrol must become more reliable, predictable, and compatible especially with selective pesticides.

Biological Control Agent: Any biological agent that adversely affects pest species. Synchrony with the pest, effectiveness at low host/prey density, reproductive capacity greater than the host's, dispersal ability greater than host's, ease of management and climatic similarity are characteristics of an ideal biological control agent.

Biological Diversity: The number of different kinds of organisms per unit area or volume and the richness of species in a given area.

Biological Insecticide: A biological agent such as bacteria *Bacillus thuringiensis*, which kills insects like a chemical insecticide, and then rapidly dissipates in the environment.

Biological Oxygen Demand (BOD) : Measurement of the amount of organic pollution in water, measured as the amount of oxygen taken up from a sample containing

a known amount of oxygen kept at 20°C for 5 days, a low BOD meaning little pollution, and a high BOD meaning much pollution.

Biological Races: Non-interbreeding sympatric populations, which differ in biology but not, or scarcely, in morphology; supposedly prevented from interbreeding by preference for different food plants or other hosts.

Biological Species Concept : A concept of the species category according to which 'Species are groups of actually (or potentially) interbreeding natural populations which are reproductively isolated from other such groups'. As per this concept species form a reproductive community, is an ecological unit, and is also a genetical unit.

Biology: 1. The scientific study of the life and structure of plants and animals. 2. The way in which the body and cells of a living thing behave.

Bioluminescence: Phenomenon of production of light by living organisms. Some insects coopt symbiotic luminescent bacteria or fungi, but self-luminescence is found in a few Collembola, one hemipteran (the Fulgorid lantern bug), a few dipteran fungus gnats and in some families of Coleoptera. Different insects which produce light have been mentioned under common names like fire flies, glow worms and lightning bugs. Members of light producing insects commonly known belong to families Elateridae and Lampyridae. Any single or all stages in the life history of such insects may glow using one to many luminescent organs situated nearly anywhere in the body. But in most beetles, light organs are found on the ventral surface of the abdomen. Majority of bioluminescent insects utilize the fat body for light production. Light emitted may be white, yellow, green or red. The enzyme luciferase oxidizes a substrate, luciferin, in the presence of energy source of adenosine triphosphate (ATP) and oxygen, to produce oxyluciferin, carbon dioxide and light. Variations in ATP release controls the site of flashing. Bioluminescent communication in insects appears directed

toward pair formation, mate identification, and location. Sometimes it may also function in prey capture.

Biomagnification: The increase in concentration of pesticide residue in animals as related to their position in a food chain, usually referring to the persistent organochlorine insecticides and their metabolites.

Biomass: The total dry weight or volume of all organisms per unit area.

Biome: A major community of living organisms usually a climax community such as tundra, grassland and forest. The biome has a particular form of a vegetation and associated animals which have become adapted to the local conditions. In other words, it is a balanced community.

Biometrics: Statistical study of living organisms and their variations.

Bionomics: The study of the habits, breeding and adaptations of living organisms in relation to their environment.

Biorational Control: The utilization of chemicals that affect insect behaviour, growth or reproduction, for suppression of insect populations. Sex pheromones, aggregation pheromones, alarm pheromones are examples in this type of control. Entomopathogens and insect growth regulators are also covered under this type of control. These all are narrow-spectrum compounds and generally affect only insects. Hazards to humans, livestock or wildlife due to accidental exposure are minimal and consequently less disruption of ecosystem functions is likely. Application of biorational insecticides is generally compatible with other agricultural management activities, for most can be applied using the same equipment as for broad-spectrum insecticides, herbicides, or fungicides.

Biorational Pesticides: Biological pesticides such as bacteria, viruses, fungi, rickettsia, nematodes and protozoa; includes pest control agents and chemical analogues of naturally occurring biochemicals (pheromones, insect growth regulators etc.).

Biordinal: The arrangement of crochets in a single series (or row) but of two alternating lengths.

Biosemants: Are chemicals produced by plants and affect the behavioural responses (immediate) resulting from detection. Examples lie among arrestants, attractants, deterrents and suppressants, repellents and stimulants.

Biosphere: The land, water, and atmospheric portions of our planet in which living forms exist.

Biota: Animals and plants of a given habitat.

Biotechnology: Biotechnology means integrated application of biochemical, microbiological and engineering sciences to the technological (industrial) employment of microorganisms, cell cultures or their components. It involves the production, isolation, modification and use of substances derived by means of biosynthesis. Biotechnology has provided new avenues for management of insect pests and it holds great potential to be included in the integrated pest management (IPM) system. However, likelihood of toxicity of transgenic plants to nontarget species and humans, the invasiveness of transgenic plants, potential for horizontal movement of the transgene, concerns surrounding antibiotic marker resistance genes in plants, and development of pest species resistance to transgenic plants, can be disadvantages of using transgenic plants for pest control.

Biotic: Referring to life or living organisms. Biotic elements include the study of organisms and their interactions within and between populations (localized breeding groups).

Biotic Insecticide: Usually microorganisms known as insect pathogens that are applied in the same manner as conventional insecticides to control pest species.

Biotic Potential: Alternatively known as reproductive potential. The maximum possible rate of increase of an organism in the absence of any limiting factors ; a measure of

the innate ability of a population to survive and reproduce.

Biotype: A genetically distinct strain / subgroup of a species distinguished by some behavioural or physiological difference but indistinguishable morphologically. Usually applied to strains of insect species which can overcome resistant plants. Biotype problem has been commonly observed in aphids which are among the fastest breeding pests. Biotypes are a particular problem for host plants that show vertical resistance to pests. Monogenic vertical resistance is highly likely to drive the development of new biotypes, most notably where the primary resistance mechanism is antibiosis. So far, insect biotypes have developed mostly among hemipterous pests like brown plant hopper (BPH) and grape phylloxera. In general problems with biotype development are relatively rare.

Bipectinate: Comb is present on both sides of the segments of antennae (e.g., Australian moth).

Biramous: Having two branches.

Biserial: Refers to crochets when their proximal ends are arranged in two rows, usually concentric.

Bisexual: Having two sexes distinct and separate with males and females.

Bivoltine: Producing two generations in a year.

Bivouac: A few ant species such as the army ant lack nests, the permanent nest is replaced with a temporary structure or bivouac formed by interconnecting legs and bodies. Such bivouacs are found often under a low hanging branch or vine when the solemn procession of army ants, *Eciton* sp., finally settles in a temporary camp.

Blade: A flat, thin structure especially used of mouthparts and antennae.

Blast: Plant disease similar to blight ; the common name for the sudden death of flowers, buds, or young fruit caused by disease.

Blastogenesis: The origin of different caste traits from variation in either the ovarian

environment of the egg or the nongenetic contents of the egg.

Blastokinesis: All the displacements, rotations and revolutions of the embryo in the egg are collectively known as blastokinesis. Such movement is characteristic of the eggs that have much yolk, as is common in insects undergoing incomplete metamorphosis, but eggs that have little yolk have reduced movement or the process is absent.

Blastula: An early embryonic form that usually consists of a hollow sphere composed of a single layer of cells.

Blattodea: An orthopteroid order of insects. In these insects body is oval, dorsoventrally flattened, head directed downwards with biting mouthparts. Head largely concealed by pronotum. Compound eyes well developed. Antennae thread like, multisegmented. Two pairs of wings usually present. Front wings toughened, overlap to cover the larger fan-shaped membranous hind wings. Abdomen with a pair of cerci. Eggs are laid in toughened case (ootheca). They are largely tropical and subtropical omnivorous insects and are recognized as household pests.

Blight: A general term that may include spotting, discolouration, sudden wilting, or death of leaves, fruits, flowers, stem or the entire plant.

Blood Gill: Hollow process of the body wall through which blood circulates but which lacks tracheae; present in endopterygote larvae, probably functioning in maintaining ionic balance. Blood gills permit direct exchange between the blood in the haemocoel and the environmental water. In larval Chironomidae (Diptera), blood gills are involved in obtaining chloride ions from the water.

Blotch Mines: Broad, irregular excavations produced in leaves especially by larvae of Lepidoptera.

Body Wall: The body wall of insects serves as an exoskeleton and is the only counterpart in insects to the internal skeleton of vertebrates. To the exoskeleton are attached the principal muscles which give the body

cohesion. Body wall may have considerable spring or flexibility, but, except for a short time after a moult, it will not stretch. Serving as both protection and a rigid attachment spot for muscles, various parts of the body wall are hardened or sclerotized. Movement is possible because the hardened body areas form a series of plates or 'sclerites' within which the body wall is soft and flexible, or membranous. This arrangement permits the development of hard exterior plates for protection and rigidity and at the same time allows many types of movements. Intersegmental membrane is not sclerotized but is thin and has the property of elasticity, it can be distended or convoluted or retracted inward (telescoping of segments). Only the membranous connections between the segments permit movement.

Bolus: Mass of food prepared in the mouth for swallowing.

Bombykol: Female sex pheromone of the silkworm moth. Male silk worm moths are very sensitive to female scent and the male start wing fluttering flying upwind and exhibit abdominal movements attempting copulation when exposed to female scent.

Book Gill: Breathing apparatus in some arachnids resembling a book lung, but on exterior of body.

Book Lung: A respiratory cavity containing a series of leaf like folds situated on the underside of abdomen in most arachnids including spiders. In arachnid orders Scorpionida, Thelyphonida and Phryneida-book lungs are the respiratory structure. The scorpions have four pairs of book lungs located on the 4th, 5th, 6th and 7th abdominal segments. The Phryneida and the suborder Holopeltidea (Thelyphonida) have two pairs of lungs placed on the 2nd and 3rd abdominal segments. The other suborder of Thelyphonida, the Schizopeltidea have only one pair on 2nd abdominal segment. Book lungs increase the surface area for gaseous exchange and yet minimize water loss by maintaining this expansion internally. But most mites and ticks breathe by means of tracheae.

Boom: Horizontal or vertical light frame carrying several spray nozzles so that a pesticide can be applied over a wider area. The boom is often hollow, serving also as a supply tube for the spray liquid.

Bordeaux Mixture: Bordeaux mixture consists of i) Water (cold): 100 gallons (450 l); (ii) Hydrated lime : 10 lb (4.54 kg), and (iii) pure copper sulphate (bluestone) : 6 lb (2.72 kg). It is mainly used for controlling downy mildew disease. Bordeaux mixture is repellent to flea beetles, leafhoppers and psyllids when sprayed on the leaves. Earlier this mixture was also used to control chewing insects by adding lead arsenate in the mixture. It is to some extent an ovicide with some residual toxic effect on the sap.

Boot Stage: The stage when the seed head of a grass begins to emerge from the sheath.

Borer: A maker of burrows in dead or living tissue.

Bot: The larvae of certain flies that are parasitic in the body of mammals.

Botanical Insecticides: An insecticide produced from a plant or plant product (e.g., pyrethrum, rotenone, ryannia, nicotine etc.). Azadirachtins extracted from seeds of the neem tree, *Azadirachta indica* (family Meliaceae) are believed to deter insect feeding and oviposition, and interfere with growth, development and reproduction. Limonene extracted from citrus peel is used against ectoparasites like fleas, mites and ticks.

Brace Vein: A slanted cross-vein in the wing ; located near the stigma in dragonflies and damselflies.

Brachypronotal: Having the pronotum (and wings) short (clear) whereas some individuals of the same species have them much larger (stippled).

Brachypterous: With short wings that do not cover the abdomen.

Bract: A leaf from the axis of which a flower arises.

Brain: The brain is situated in the head above the oesophagus and for this reason is

frequently referred to as the **supraoesophageal ganglion**. Insect brain has three ganglionic masses : **1. Protocerebrum** : is the largest and most complex region. Laterally, it receives the nerves from the optic lobes of the compound eyes; dorsally, it receives from the ocelli. Internally, protocerebrum has a pair of mushroom-shaped neuropiles, the 'corpora pedunculata', which are the important centres for the integration of behaviour. These bodies are large especially in social Hymenoptera. **2. Deutocerebrum** : has motor and sensory axons to the antennae. **3. Tritocerebrum** : has sensory and motor axons to the labrum and to the frontal ganglion of the stomatogastric system. Concerned with handling the signals that arrive from the body.

Brand: Refers to the name, number, if any, trademark or designation of a pesticide or the device made/manufactured by the manufacturer, distributor, importer etc.

Breaking: The separation of phases from emulsion.

Briquette (BR) : This is a solid block formulation of pesticides, it is made by mixing the active ingredient (a.i.) with low density, inert granules and binding agents. It is convenient for the manual application of pesticides in aquatic environment where spray application is ineffective.

Broadcast Application: Application of fertilizer, pesticide, or seed over an entire area rather than only on rows, or bands.

Broad-Spectrum Insecticide: Non-selective, having an effect on a wide range of insects; to spread pesticide granules by hand or machine randomly over a surface area.

Brood: The individuals which hatch at the same time from the eggs laid by one mother; individuals which hatch at about the same time and normally mature at about the same time, and live together in a defined and limited area. In apiculture, the term brood refers to immature or developing stages of bees, includes eggs, larvae (unsealed brood), and pupae (sealed brood). The term brood is often used interchangeably with generation, which is an incorrect usage.

Brood Care: Females of many nonsocial insects, after thorough choice of oviposition sites, tailor the environment to the needs of their young through various behaviours such as nest construction, feeding and protection. Brood care has evolved in a variety of insects that have developed strategies opting for maximum protection of the offspring as opposed to production of large numbers of offspring that are left to their own devices. Extreme examples are provided by certain cockroaches which retain and nourish their larvae internally in a uterus like structure. In crickets more advanced type of parental care occurs, female prepares a burrow which she seriously guard from predators and intruders. The eggs are laid in a cell at the bottom of the burrow, and when the eggs hatch, young ones are fed by the mother. Dung beetles (*Scarabaeidae*) prepare balls of dung, roll them to a suitable site, and bury them as food for the larvae. Strikingly in giant water bug (*Belostomidae*), male carries the eggs on its back till hatching. In carrion beetles (*Silphidae*), males also assist female in providing food to the young ones. In scarabaeid beetles, adults amass manure provision upon which eggs are laid; and in *Coris* spp. (*Scarabaeidae*), the mother stays with her young ones until they reach adulthood.

Brood Cell: A specially prepared space or structure in the nests of bees and wasps in which food is stored, an egg is laid and the larva completes its development.

Brood Chamber: Section of hive in which brood is reared and food may be stored.

Brood Comb: Wax comb from brood chamber of hive containing brood.

Brood Nest: Area of hive where bees are densely clustered and brood is reared.

Brood Passage: In Strepsiptera, the space between the venter of the female and the puparium through which the triungulins emerge.

Bucca: The mouth in adult Diptera.

Buccal Cavity: Also known as oral cavity. The first part of the stomodaeum lying just within the mouth.

Bucket Pump: The simplest hydraulic sprayer is the bucket pump. It is a plunger pump adapted by a clamp or otherwise for use in an open pail and delivering the liquid through a spray nozzle at the end of a hose.

Buffer: 1. Any chemical that prevents sudden changes in pH. 2. Area of field where no pesticide is applied to prevent worker exposure or contamination of adjacent areas.

Bulla: A blister-like structure; a weak point on a wing vein.

Bumblebees: Bumblebees are relatively large, hairy bees, 20 mm or longer. They are usually coloured black and yellow, build nests in ground depressions, deserted rodent nests, hollow logs, and other such places. Bumblebees are efficient pollinators of crops but their populations are normally too low to pollinate large areas of agricultural crops. Also the number of bees fluctuate greatly from year to year and area to area, and consequently commercial growers find bumblebees undependable general pollinators.

Bursa Copulatrix: A specialized part of the female reproductive system into which sperm is received from the male during copulation as in Lepidoptera; the female genital chamber if functioning as a copulatory pouch.

Bursicon: Neurosecretory hormone that stimulates sclerotization and melanization of the cuticle following ecdysis; also called tanning hormone. Bursicon is synthesized and/or released from a variety of different sites according to species.

Butterfly Farming: Rearing butterflies under confined conditions to sell to the international trade in butterflies.

°C: Centigrade (formerly Celsius); unit of temperature between boiling and freezing points of water at a standard pressure.

Caecum: A sac or tube-like structure open at only one end. Lateral diverticula or gastric caecae may expand outward from the ventriculus to increase the surface area.

Calcar: One of the movable spurs at distal end of tibia.

Calibrate: To measure or figure out how much pesticide will be applied by the equipment to the target in a given amount of time.

Calling: A virgin female moth releasing sex pheromones to attract males for the purpose of mating.

Callow: Alternatively known as teneral. An insect newly emerged from the pupa, having a soft body not fully coloured. The term may be used generally but is particularly applied to worker ants.

Callus: Tissue overgrowth around a wound or canker; a mesonotal swelling in some insects.

Calypter: One of two membranous lobes or flaps near the base of fly (Diptera) wings, covering the haltere.

Calyx: A cup-like expansion, especially of the oviduct into which the ovaries open.

Camera Lucida: A device enabling one to make accurate drawing of objects seen through a microscope ; when it is attached to the eyepiece of a microscope the observer can see the object under the microscope and his drawing paper at the same time.

Camouflage: Camouflage is widely used by insects to blend in with their environments so as to escape detection from predators. The walking sticks (Phasmatodea) resemble the sticks and twigs on which they live, even to the extent that the young are green in the spring and the adults change to brown by autumn. Many moths at rest resemble bark. Grasshoppers resemble lichens, various types of soil, dried leaves or grass, depending on the species and its food.

Campaniform Sensillum: A sense organ consisting of a bell or dome-shaped cuticular area into which the sensory cell process is inserted. It is sensitive to bending. These are often located in groups on the palps, wings, halteres, basal joints of appendages etc.

Campodeiform: A larva shaped like the diplurans. Campodeiform larva have elongate, flattened well-developed legs and antennae, and usually with filaments on end of abdomen, and are usually active. They are found in family Dytiscidae (Coleoptera), Neuroptera and Trichoptera.

Canister: A metal or plastic container filled with absorbent material which filters fumes and vapours from the air before they are breathed in by an applicator.

Canker: A definite, localized, dead, often sunken or cracked area on a stem, twig, limb or trunk, surrounded by living tissues.

Cannibalism: Phenomenon of feeding on other individuals of the same kind. Cannibalism among entomophagous species is common : larvae of the solitary parasitoids,

for example, often kill or suppress the development of other individuals occurring in the same host. Cannibalism has also been reported among stored-grain insects and phytophagous insects under crowded conditions as in flour beetles and in codling moth larvae.

Canopy: Topmost layer of leaves, twigs, flowers, and branches of forest trees and other woody plants.

Canthariasis: Condition arising when beetle larvae live in the body of another animal.

Cantharidin: An irritating chemical constituent of the cuticle of blister beetles (Meloidae). There is a high concentration of cantharidin in the elytra. When taken internally cantharidin acts as a strong urogenital irritant. For this reason it has been used as an aphrodisiac (e.g., in cattle breeding), and for the treatment of certain urogenital diseases. It is a very dangerous substance and is no longer used in humans.

Cantharophily: Plant pollination by beetles. Beetle-pollinated flowers often are white or dull coloured, strong smelling and regularly bowl or dish-shaped. Beetle pollinators belong to family Cantharidae, Cerambycidae, Dermestidae and Scarabaeidae.

Capitate: With a head; a type of antennae terminating in a knob-like process.

Capitulum: A small head; in particular the false head of certain mites and ticks on which the mouthparts are borne.

Carabiform: A larva shaped like the larvae of a caraboid beetle, that is elongate, flattened, legs are shorter and filaments lacking on end of abdomen.

Carapace: A hard dorsal covering on cephalothoracic region consisting of fused dorsal sclerites (Crustacea).

Carbamates: A group of chemicals which are salts or ethers of carbamic acid. Includes insecticides, herbicides and fungicides. These are mainly residual contact insecticides and in 1956 carbamate compound carbaryl was introduced for insect control on crops.

Persistence of carbamates lies between that of the organochlorines and organophosphates. Carbaryl was followed by highly systemic carbamate compounds like aldicarb and carbofuran but these compounds are very toxic to mankind. However, later highly systemic compounds like 'primicarb' was released. Primicarb has very low mammalian toxicity and a biochemical selectivity for aphids, therefore, natural-enemies are not killed. The carbamates are largely contact insecticides, most have rather low mammalian toxicity and are readily degraded in the environment.

Carcinogen: A substance that causes cancer in animal tissue.

Carcinogenic: The term used to describe the cancer producing property of a substance or agent. Carcinogenicity is a specific form of oncogenicity characterized by malignant tumours. A number of chlorinated hydrocarbon pesticides have been reported to induce tumours in mice and rats in laboratory tests.

Card Point: Card points are elongated triangles cut with a point punch or scissors from light, white cardboard such as file cards. The triangles are 3-4 mm wide at the base and 8-10 mm long. A pin is inserted through the base and the triangle moved up to the same height as for a pinned insect. Insects are generally glued with their right side against the tip of the point.

Cardiac Valve: A valve at the junction of the proventriculus and ventriculus.

Carding: Insects sometimes are 'carded', it involves glueing each specimen usually by its venter to a rectangular piece of card through which a macropin passes. Carding is suitable for mounting exuviae, pupal cases, puparia or scale covers but not for adult insects as structures on undersurface are obscured by being glued to the card. Carding is generally done for displays or for hobby purposes.

Cardiopeptide: A neuropeptide hormone that stimulates the dorsal vessel (heart) causing haemolymph movement.

Cardo: Basal segment of the maxilla. The base

of the maxilla is divided into a proximal sclerite or 'cardo', that carries the single condyle with which the maxilla articulates with the head.

Carina: A ridge, or raised keel.

Carnivorous: Preying or feeding on animals.

Carotenoids: Are pigments which are acquired directly from plants and are not synthesized by insects. The most common is β -carotene, which is an orange-yellow pigment that often combines with blue pigments to produce a group known as insectoverdins, which make insects many shades of green.

Carrier: The liquid or solid material added to a chemical compound to facilitate its field application. An inert material which when used with a toxic compound improves the physical dispersion of the toxicant.

Carrying Capacity: The maximum population density a given environment will support for a sustained period. As population increase exponentially the number of individuals that can be supported by the environment and by competition reaches a plateau, the 'carrying capacity'. Carrying capacity of the environment is determined by the availability of food, space and predators, while 'r' is the intrinsic growth rate and is free from environmental constraints. The parameters **r** and **k** are important description of population change and are much used in the discussion of pest populations. This can be inserted to produce the following simplified equation:

$$\frac{dN}{dt} = rN \left(\frac{K - N}{K} \right)$$

The resulting rate of increase per unit time produces a typical sigmoid growth curve. When point 'K' is reached, population growth stops because death and emigration rates equal birth and immigration rates, and either the population crashes or a steady state is established.

Cartridge: The part of a respirator which adsorbs fumes and vapours from the air before the applicator breathes them in.

Case-Making Insects: Many larvae construct tubes or shelters in which they live and from which they feed. All of these species are called case bearers. The insect cases may be attached to the plants or other objects or they may be portable. The typical case bearers are those insects that make portable cases. The larvae of the typical case bearers, such as the bagworms (Psychidae and the Coleophoridae) move about freely during the summer carrying their cases wherever they go. When winter comes, these species migrate to the branches where they fasten their cases.

Castes: Morphologically and functionally different types within a colony of social insects as in some Hymenoptera and Isoptera. Each caste perform particular tasks of colony. Such castes are particularly well-defined in ants, bees, termites and wasps. Among bees the three chief castes are the queen (fertile female), workers (sterile females) and drones (fertile males). Among ants and termites there are often many types varying considerably in size, form and function.

Castration: Any process which inhibits completely or to a considerable extent the production of mature gametes by the organism, whose gonads may be atrophied or well developed but not normally functional. It is of two types: **1. Physiological castration** - this occurs as a normal phenomenon in social insects with one or more sterile castes; **2. Parasitic castration** - development of different parasites in an adult insect may induce sterility which may be accompanied by changes in the secondary sexual characteristics of the host.

Catabolism: The metabolic processes that breakdown ingested organic molecules and release energy, captured by ATP, and waste products.

Catalog: An index to taxonomic literature arranged by taxa so as to provide ready reference to at least the most important taxonomic and nomenclatural references to the taxon involved.

Catalyst: A substance that speeds up the rate of a chemical reaction but is not itself used in the reaction.

Category: A class, the members of which are all taxa placed at a given level in a hierarchic classification.

Caterpillar: A larvae with a cylindrical body, distinct head, thoracic legs and abdominal prolegs. They have chewing mouthparts and up to five pairs of abdominal legs (located on abdominal segments 3 to 6, and 10) provided with hooks or crochets. Many larvae have numerous hairs and are brightly coloured, a few have stinging or urticating hairs. The larvae of butterfly, moth, sawfly, and some scorpionflies are known as caterpillars.

Caterpillar Wilt: A type of typical symptoms the caterpillars develop slowly after ingestion of polyhedra of NPV viruses. After ingesting the polyhedra, caterpillar develop no outward symptoms for 4-days to 3-weeks. At this time the larval skin darkens, and larvae climb to the highest point on their host plant, where they die. Dead, blackened larvae may be found hanging from the tops of plants. Subsequently the integuments of these dead larvae rupture, and millions of polyhedra are released into the environment. Such diseases have been called collectively **caterpillar wilt**.

Catfacing: The injury caused by the feeding of certain plant bugs and stink bugs on developing fruit which results in uneven growth and a deformed mature fruit.

Cationic: An ion having a positive charge is a cation. When the surface active portion of a surfactant molecule possesses a positive charge it is termed a cationic surfactant.

Cationic Surfactant: Material in which surface activity is determined by basic part of the compound.

Cationic Wetting Agent: Cationic wetting agent is a wetting agent that carries positive charge.

Cauda: The pointed end of abdomen in aphids.

Caudal: Pertaining to the anal end of the body.

Caudal Gills: Respiratory organs in the form of thin-walled lamellae or outgrowths from

the hind end of the abdomen in some aquatic insects such as the nymphs of damselflies.

Caudal Sympathetic System: This system arises from the last compound ganglion of the ventral nerve cord and sends nerves to the reproductive system and posterior part of the alimentary canal.

Caudate: Bearing a tail-like extension or process.

Caudate Larvae: In certain Hymenoptera, first instar larva in which the terminal abdominal segment forms a tail-like extension.

Causal Organism: The pathogen that produces a given disease.

Caution: A warning to the user of pesticide chemicals. Used on labels of pesticide containers having slightly low toxicity and low toxicity pesticides in toxicity category III and IV. In category III pesticides having oral LD₅₀ within range of 500 to 5000 mg/kg; but in category IV, pesticides having oral LD₅₀ of more than 5000 mg/kg are included. The figures of LD₅₀ ratings regarding categorization/toxicity of pesticides is as per 'Federal Insecticide, Fungicide and Rodenticide Act of USA.'

Cecidogenous: Insect larvae that make and live in galls on plants.

Cecidology: Study of plant galls, mostly formed by insect action, but some made by fungi.

Cecidozoa: Gall causing organisms (insects, mites and nematodes) are called cecidozoa, and galls induced by cecidozoa are referred to as zooecidia. Representatives of Hemiptera, Diptera and Hymenoptera are the principal cecidozoa. The Diptera contains the highest number of gall-inducing insects. Most cecidogenic flies belong to family Cecidomyiidae (gall midges) and induce simple or complex galls on leaves, stems flowers, buds and even roots. Besides large number of wasps are also gall inducing (Cynipidae).

Cell: 1. A unit mass of protoplasm surrounded by a cell membrane and containing

one or more nuclei or nuclear material. **2.** Cells are areas of the wing delimited by veins and may be 'open' (extending to the wing margin) or 'closed' (surrounded by veins). They are named usually according to the longitudinal veins or vein branches that they lie behind, except that certain cells are known by special names such as the 'discal cell' (in Lepidoptera) and 'triangle' (in Odonata). Numerous identification characteristics can be seen in this region of the wing.

Cell Culture: The growing of cells in vitro, or in an artificial container rather than in an organism.

Cellulase: An enzyme which digests cellulose.

Cellulose: Complex carbohydrate polysaccharide formed by the combination of many glucose molecules to give the fibrous material which is the fundamental constituent of the cell wall in plants.

Cement Layer: A thin layer on the surface of the insect cuticle formed by the hardened secretion of the dermal glands. This layer, outermost when present, determines whether the cuticle will be hydrophobic (water repellent) or hydrophilic (water attractant). Cement layer seals the wax layer, provides protection from physical abrasion and fungus attack. It is completely absent in the cuticle of honeybees. Cement layer protects the underlying wax layer from abrasions and to act as a reservoir of mobile lipids, which leak out to replace lost waxes.

Cenchrus: A papery membranous lobe or area on each side of the metanotum of Symphytan Hymenoptera. It serves to hold the wings in place when they are folded over the body.

Central Nervous System: Central nervous system is the principal division of the nervous system and consists of series of ganglia joined by paired longitudinal nerve cords called 'connectives'. Basically, the central nervous system is formed from a brain and a ventral nerve cord running from the brain through the abdomen along the base of the body cavity.

The central nervous system supervises and coordinates activities of the insect body.

Cephalic: On or attached to the head.

Cephalothorax: A body region consisting of head and thoracic segments as in spiders and crustaceans.

Cerci: A pair of sensory appendages at the posterior of the abdomen. It is generally agreed that the cerci are appendages of the eleventh segment although frequently all traces of the latter have disappeared. Typically, they are multi-segmented structures that function as sense organs. Paired cerci occur in Diplura, Ephemeroptera, the Orthopteroids and Blattoids, and Mecoptera. Cerci vary from a stub to a long filament.

Certification: Means the recognition by a certifying agency that a person is competent and thus authorised to use or supervise the use of restricted-use pesticides.

Certified Applicator: Commercial or private person qualified to apply restricted use pesticides.

Cerumen: A brown mixture of wax, and propolis used for nest construction by social bees.

Cervical Gills: Gills in the neck or cervix region between the head and thorax (e.g., stoneflies).

Cervical Sclerites: Small sclerites in the membrane between the head and thorax.

Cervix: Alternatively known as 'neck'. Cervix is the flexible region between the head and prothorax. Embedded in the cervix are two pairs of cervical sclerites, which serve as points of articulation for the head with the trunk. The two sclerites on each side are hinged with each other to form a single unit, which articulates anteriorly with the occipital condyle on the postocciput of the head and posteriorly with the prothorax. Frequently the cervical sclerites are fused with the pleurae of the prothorax.

Chaeta: An articulated stiff hair, or thin bristle.

Chaetosema: In Lepidoptera, sense organs located on the head between the eyes and ocelli.

Chaetotaxy: Arrangement and nomenclature of more constantly located setae in the exoskeleton of an insect. Chaetotaxy is important in the systematics particularly in Diptera, Thysanoptera, cyclorrhaphan Diptera and larval Lepidoptera. Clothing hairs, scales, glandular setae and sensory setae are main kinds of setae.

Chaff: 1. A dry, thin scale found especially as bracts in flower heads of many composites. **2.** The outer layers of cells of grains removed during threshing.

Chalk Brood: A disease of larval honeybees, caused by the fungus, *Ascosphaera apis*. Disease is generally confined to a few patches of brood. Disease turns the larvae into tough mummified corpses. As they dry up they become loose enough to shake out of the cells. It seldom occurs to a serious extent, but it is advisable to take an opportunity of removing combs in which the complaint has manifested itself.

Character: An attribute or property of an organism, functional or structural, modifiable by environmental conditions within genetically determined limits.

Character Index: A numerical value, compounded of the ratings of several characters, indicating a degree of difference of related taxa; also a rating of an individual particularly a hybrid, in comparison with its most nearly related species.

Check: 1. Units in an experiment that receive either a standard treatment that will result in a predictable response or no treatment. **2.** An earthen barrier that keeps water in a field or orchard.

Checklist: Usually a skeleton classification of a group listed by taxa for quick reference and as an aid in the arrangement of collections.

Check: The lateral part of the head between the compound eye and the mouth.

Cheironym: A manuscript name.

Chela: In mites, distal pincer-like part of chelicera. It is composed of two jaws : the fixed jaw (distal part of the cheliceral body), and the movable jaw (the apotele).

Chelicera: The inner portions of the mouthparts of mites, ticks, scorpions and their relatives; modified as piercing stylets in plant feeding mites. Chelicerae are believed to be appendages of the third body segment usually modified into predatory organs. They are 2-3 segmented and most have an opposable 'thumb' (chelate condition) whereby the prey may be grasped and torn apart, the exceptions are the many parasitic mites, ticks and spiders in which the thumb is lacking (unchelate condition). In phytophagous mites (spider mites) chelicera is styliform.

Chelicerata: A subphylum of Phylum Arthropoda. Their body is divided into cephalothorax and abdomen. Cephalothorax consisting of 5 postoral somites each bearing a pair of appendages and of at least one preoral somite which bears the chelicerae, a pair of appendages with a basically prehensile function; median ocelli present, compound eyes tending to degenerate and simplify. Abdomen consisting of 12 or 13 somites terminating in a telson, but telson and some terminal somites are absent in advanced groups; genital opening on second abdominal segment, covered by an operculum modified from a pair of appendages. Class Merostomata, Arachnida and Pycnogonida are all parts of subphylum Chelicerata.

Chemical Control: The use of chemicals to kill, deter or in any way suppress pest populations. Use of chemical control agents (insecticides) is useful as they act quickly and result in rapid reductions in pest populations, their use can be effective regardless of what control measures are practiced by adjacent users, suitable application equipment is readily available and their use permits development of crops with high cosmetic value. But when we rely too much on pesticides, problems like pollution of water and human dwellings, delays occur

in pest management attempts, and resistance to pesticides occur frequently.

Chemical Name: Name that indicates the chemical composition and/or chemical structure of the compound being discussed; scientific name of the active ingredient(s) found in the formulated product.

Chemigation: Refers to a technique of injection of pesticides into the irrigation water using a positive displacement pump. Irrigation water is applied on the surface as a furrow treatment system. The sprinkler system allows both foliar and soil treatments.

Chemoreception: Sensory perception of chemical substances; includes both taste and smell. Chemoreception is accomplished by modified hairs or sensilla generally present on antennae and palps.

Chemoreceptor: A chemical sense organ perceiving taste or smell. Organs of taste are common on the mouthparts, especially the palps, though they have been identified also on the antennae (Hymenoptera), tarsi (many Lepidoptera and Diptera), ovipositor (parasitic Hymenoptera) and on general body surface. The antennae are primary sites of olfactory organs.

Chemosterilant: Chemical compounds that cause sterilization or prevent effective reproduction. Insect chemosterilants may cause the insects to fail to produce ova and sperm, or cause the death of ova and sperm after they have been produced. They also produce lethal mutations or severely damage the genetic material in the sperm and ova. Thus although the sperm and ova remain alive, the zygotes if formed do not complete development. Chemosterilants are used to sterilize insects reared in large numbers for release in infested areas, and also used to induce sterility in the natural population. Alkylating agents like apholate, aphomide and aphoxide (tepa) are used for inducing sterility in houseflies.

Chemotherapy: Cure or prevention of disease in plants by internal chemical treatments.

Chi-Square Test (χ^2 -Test): The quantity χ^2 gives the magnitude of the discrepancy between the theory and observation. From this test we can determine whether we should believe that the observed data constitute a sample drawn from the hypothesized theoretical distribution. The range of the χ^2 is from 0 to ∞ . If χ^2 is = 0, all the observed and expected frequencies completely coincide. If χ^2 value is large, then the observed and expected frequencies differ greatly. The calculated value of χ^2 is compared with the table value of χ^2 . If observed value of χ^2 exceeds tabulated value, then the difference between observed and theoretical (or expected) frequencies is significant. Otherwise the data are consistent with the hypothesis of no significant difference between theory and practice. This statistic is used to test the goodness of fit of the fitted probit log dosage regression line.

Chigger: The parasitic larvae of a trombiculid mite (Acari: Trombiculidae). They damage by feeding as well as they serve as vectors of scrub typhus disease. In Europe they are known as harvest bugs but in Americas they are referred as chiggers, and in Asia and Australia as scrub itch mites. They are widely distributed throughout the world, and in many countries their feeding has been reported to cause dermatitis or trombidiosis.

Chilopoda: A class of Phylum Arthropoda that comprises the centipedes which are elongated, flattened, multisegmented animals with one pair of jointed legs on each segment. Head bears one pair of antennae, a pair of mandibles, a pair of separate first maxillae, and a pair of united second maxillae. Centipedes have an insect-like excretory system, consisting of a group of long tubules that empty into the hind part of the gut. A tracheal system supplies oxygen directly to the tissues and the blood is pumped through the body cavity by a pair of dorsal arteries. The centipedes although terrestrial inhabit the moist litter and humus rich layer of soil where they feed as predators.

Chitin: A high molecular weight polymer of

N-acetyl-D- glucosamine that resembles cellulose and constitutes one-fourth to one-half of the dry weight of the exocuticle and endocuticle. It is a complex, chemically inert material resistant to the action of some of the strongest chemicals like concentrated alkali, alcohol, organic solvents and dilute acids, and is formed from a semi-fluid secretion produced by a layer of cells underneath. All external appendages are protected by a layer of chitin underneath. It is found in the cuticle, but is also present in the peritrophic membrane of midgut.

Chitin Synthesis Inhibitors: In insects, benzoyl phenyl ureas interfere in chitin synthesis and are available commercially for agricultural use. Number of these compounds have been marketed quite successfully particularly against the Lepidoptera. These compounds interrupt the moulting process. Although the new skin seems to be formed normally, it is the shedding process which is disrupted and affected. Insects either die within their old cuticle or fail to emerge satisfactorily from it. Although these compounds are effective but are rather still expensive compared with traditional pesticides. Chitin synthesis inhibitors are particularly useful where some selectivity of action is required (parasitism is usually not reduced by application) or where the pest has become resistant to insecticides. Buprofezin (Applaud) against some Homoptera; diflubenzuron (Dimilin) against some Lepidoptera, Diptera, Homoptera and Orthoptera; and flufenoxuron (Cascade) against phytophagous mites are important formulations of chitin synthesis inhibitors available commercially.

Chlorinated Hydrocarbon: Also known as organochlorine compounds. A chemical compound containing chlorine, carbon and hydrogen atoms. They may also contain atoms of oxygen and sulphur. DDT group, hexachlorohexane group (Lindane) and cyclodiene group (Dieldrin and Endosulfan) are three main groups of organochlorine insecticides. In insects these compounds act primarily on the central nervous system.

They are also known to slow the rate of photosynthesis in plants.

Chloroplast: The organelles inside plant leaf cells to which the chlorophyll is confined and in which the reactions of photosynthesis are carried out.

Chlorophyll: The green, light sensitive pigments found chiefly in the chloroplasts of leaves and other green parts of higher plants, that absorbs the light energy used in the process called photosynthesis. It is also found in all algae and phytoplanktons.

Chlorosis: In plants, yellowing of normally green tissues because of the partial failure of chlorophyll to develop or to removal of chlorophyll.

Cholinesterase (ChE) : Shortened name for acetylcholinesterase. An enzyme(s) present in body tissues which hydrolyzes or break down acetylcholine. This is formed at nerve connections (synapses) each time a nerve impulse is transmitted. This enzyme is necessary for proper nerve function and it is destroyed or damaged by organophosphates or carbamates taken into the body by any path of entry.

Cholinesterase Inhibitor: Any organophosphate, carbamate or other pesticide chemical that can interrupt the action of enzymes which inactivate the acetylcholine associated with the nervous function.

Chordotonal: Pertaining to organs for the perception of sound.

Chordotonal Organ: An elongated sense organ attached at both ends to the body wall and sensitive to stretching. Such organs occur on the legs, wings, antennae, palps and epidermis. Chordotonal sensilla are composed of bundle of bipolar nerve cells stretched between two surfaces of the integument. These detect pressure on the body wall and movements of the insect. Specialized groups of chordotonal sensillae make up 'Johnstons organ' - a structure on second antennal segment of adult insects that respond to movement of the antennae.

Chorion: The tough protein membrane which forms the shell of the insect egg as laid down by the mother.

Chromatography: A technique used for segregating and identifying the components from mixtures of molecules having similar chemical and physical properties. The proportion of different molecules is dissolved in an organic solvent miscible in water, and the solution is allowed to migrate through a 'stationary phase'. Since the molecules migrate at slightly different rates they are eventually separated. In **paper chromatography**, filter paper serves as the stationary phase. In **column chromatography** the stationary phase is packed into a cylinder. In **thin layer chromatography** the stationary phase is a thin layer of absorbent silica gel or alumina spread on a flat glass plate. In **gas chromatography** an inert gas is used to sweep through a column of the vapours of the materials to be separated.

Chromosomes: The small rod-like elements in the nucleus of a cell responsible for transmission of genetic material.

Chronic Effect: A slow and long continual effect.

Chronic Poisoning: Resulting from long periods of exposure to low levels of a toxicant.

Chronic Toxicity: The toxicity of a pesticide (to higher animals) when administered in small sublethal doses over a long period of time. The toxicity of pesticide varies depending on their amount, their ways of penetration, the duration of action, the state of organism, environment etc. In true chronic toxicity tests, the purpose is to find any undesirable delayed harmful effects of the chemical. The doses given are generally high, and clinical signs of illness and gross physiological and pathological changes are carefully watched for and recorded. Chronic toxicity may lead to secondary harmful effects such as carcinogenicity, mutagenicity and teratogenicity.

Chronology: The study of the geographical

distribution of organisms, considering arrangement of events with dates.

Chrysalis: The obctect pupa of a butterfly. The chrysalis appears to be in an inactive stage and does not feed, but in fact during this apparent resting stage there is considerable internal physiological activity involving the breakdown of larval organs and their replacement by those of the adult itself.

Cibarium: The portion of the preoral cavity between the hypopharynx and the labrum in the head region of insects possessing piercing and sucking mouthparts (Hemiptera). The food remains here before it enters the mouth and the true digestive tract.

Circadian Rhythms: Behavioural or physiological events that occur at approximately 24 hour intervals, and such rhythms are called circadian or diel rhythms. During the 24 hour cycle of day and night there is a daily rhythm of temperature and humidity characteristic of each area. Except during diapause, activities of most insects are definitely related to this rhythm. During hot summer days when the humidity is depressed, many insects will be relatively inactive, locating cooler and moister niches. Toward dusk as the temperature drops there is a rapid increase in humidity and during this period a great number of insects will emerge from daytime hiding and swarm over the ground and foliage, and in the air.

Circulative Viruses: Also known as persistent viruses. A virus that circulates through and possess some part of its life cycle within its vector. This group is sometimes divided into 'propagative' and 'non-propagative' depending on whether or not they multiply in the vectors.

Circulatory System: In insects circulatory system consists of blood, the vessels through which the blood passes, and a pumping organ that causes the blood to flow. In insects there are no arteries, veins, or capillaries arranged as a closed system instead the space between the organs forms a blood cavity or haemocoel. There is a single dorsal circulatory vessel that extends the full length of the body. This vessel

is divided into a posterior heart and an anterior aorta. Generally the heart portion is swollen in each of the first nine abdominal segments to form a series of nine chambers, each with a pair of lateral openings called ostia. A pair of fan-like alary muscles is attached to the ventral side of each chamber. The contraction and relaxation of these muscles change the shape of the chambers in a pulsating rhythm that draws blood in through the ostia and forces it forward into the aorta. The aorta is a simple tube that carries the blood anteriorly to the head, where it empties back into the haemocoel. Thus, the blood flows backward through the body, irrigating the tissues as it goes, and then it is returned forward by the heart and the aorta. The circulation of blood is further aided by the normal movement of the body and sometimes by special accessory pumping organs.

Circulus: In coccids, a lip on the ventral side of the abdomen between the second and third segment.

Circumoesophageal Connectives: Nervous connections between the brain and the ventral nerve cord.

Circumversion: In male Diptera, the 360° rotation of the genitalia about their longitudinal axis.

Clade: A group of organisms proposed to be monophyletic, i.e. all descendants of one common ancestor.

Cladistics: A school of systematic thought grounded in the belief that classification can and should reflect phylogeny.

Cladogram: A diagram based on cladistic analysis of a group of organisms.

Claspers: A pair of processes at the end of the abdomen of male insects which serve to clasp the female during copulation.

Clasping Legs: The forelegs of certain aquatic beetles are modified for holding the female during copulation. Several tarsomeres are usually enlarged with suckers and large claws to produce effective holdfast organs.

Class: A division of the animal kingdom lower

than a phylum and higher than an order; for example the class Insecta.

Classification: The delimitation, ordering, and ranking of taxa is covered under classification. Classification is a means of reducing the bewildering diversity of species to a limited and manageable number of categories. The main object of classification for a real taxonomist is to furnish the information to his fellow scientists in behavioural, ecological and physiological studies regarding the identification and phylogeny of the organism concerned. A knowledge of the classification system is important, for it is vital to data interpretation, storage and retrieval. A classification may be either artificial or natural. Artificial classifications are usually designed so that organisms belonging to different taxa within the system can be separated on the basis of single characters. Such schemes have extremely restricted value and can be used only for the purpose for which they were initially designed. Artificial classifications provide no indication of the 'true' or natural relationships of the constituent species. On the other hand natural classifications are based on genealogy (i.e. relationships by descent). In other words, they show evolutionary relationships among taxa. Thus, the key step in any natural classification is the determination of homology.

Classification of Pesticides: The World Health Organization (WHO) has classified the commercially available pesticides according to the LD₅₀ data for solid and liquid formulations. Granular formulations are generally regarded as less hazardous to apply than sprays of the same chemical. When selecting a pesticide, preference should be given to the least hazardous pesticide which is effective and, if possible, to the least persistent. Preference is given to water dispersible formulation, if available, rather than liquid formulation such as the emulsifiable concentrate. WHO classification of pesticides based on their LD₅₀ values is as given below :

Class	Hazard Level	Oral Toxicity		Dermal Toxicity	
		Solids	Liquids	Solids	Liquids
Ia	Extremely hazardous	<5	<20	<10	<40
Ib	Highly hazardous	5-50	20-200	10-100	40-400
II	Moderately hazardous	50-500	200-2000	100-1000	400-4000
III	Slightly hazardous	>500	>2000	>1000	>4000

Claval Furrow: A flexion line on the wing that separates the ‘clavus’ from the ‘remigium’.

Clavate: Gradually thickening toward the apex to form a club (e.g., antennae of butterflies).

Clavus: The elongated anal (posterior) area of the front wing or hemelytron in bugs (Heteroptera) that lies next to the scutellum when the wing is folded.

Claw: A hooked structure on the distal end of the pretarsus, usually paired. Claws serve as holdfast organs and enables insects to move on rough surfaces. In case of lice (Phthiraptera), the legs are well developed and stout with strong claw(s) which are used for grasping host or fur. In case of mites-ungues and apotele, regarded as a unity.

Cleavage: A series of mitotic divisions that transform the zygote into an embryo.

Cleptobiosis: The relation in which one species robs the food stores or scavenges in the refuse piles of another species, but does not nest in close association with it.

Cleptoparasite: Also sometimes called as kleptoparasite. A species which uses the nest and provisions of another species, as in cleptoparasitic bees.

Cleptoparasitism: The parasitic relation in which a female seeks out the prey or stored food of another female, usually belonging to a different species, and appropriates it for the rearing of her own offspring. Spider wasps (Pompilidae) are cleptoparasites of other pompilids; they detect the provisioned nest, dig down to it, consume the original wasp egg and lay their own in its place.

Climate: Refers to average or mean conditions of temperature, humidity, rainfall etc. of an area over a long period of time, and affects insect populations and species. Macroclimate means climate over a large area ; mesoclimate refers to climate within a limited area often clearly defined such as a valley, and microclimate refers to conditions within a small or very small area (microhabitat) generally with little fluctuation in relation to the microclimate (e.g., compost heap, a rotting log).

Climatograph: A polygonal diagram resulting from plotting temperature means against relative humidity.

Climax: The mature or stabilized stage in a series of communities when dominant species are completely adopted to environmental conditions.

Cline: A gradual and nearly continuous change of a character in a series of contiguous populations; a character gradient.

Cloaca: A common chamber into which the anus and gonopore open.

Clod: A mass or lump of aggregated soil usually clay soil.

Clone: All the offspring derived by asexual reproduction from a single sexually produced individual.

Closed Cell: A cell enclosed by the veins on all sides and does not reach the wing margin.

Closed Tracheal System: A gas exchange system comprising tracheae and tracheoles but lacking spiracles and, therefore, closed to direct contact with the atmosphere.

Clubbed Antennae: Enlarged toward the tip, enlargement ranges from gradual (clavate) to abrupt (capitate; lamellate).

Clumped Distribution: A distribution of organism in which there is some aggregation of individuals that exceeds the clumping that would occur randomly. This is the most common distribution displayed by insects.

Clypeolabral Sulcus: Line of articulation between the labrum and clypeus.

Clypeus: Epistomal sulcus, when present, divides frontoclypeal area (facial area) of head into the dorsal 'frons' and the ventral 'clypeus'. The clypeal area is often divided into a 'postclypeus' and 'anteclypeus'.

Coalescent: Running together, merging ; as of wing veins.

Coarctate Larva: A larva somewhat similar to a dipterous puparium, in which the skin of the preceding instar is not completely shed but remains attached to the caudal end of the body; the sixth instar of a blister beetle, also called a pseudopupa.

Coarctate Pupa: A pupa enclosed in a hardened case formed from the next to the last larval skin, found among higher Diptera.

Coccids: Scale insects or soft scales (Coccidae). Their body is covered with soft wax not easily removable. Adult female insects are wingless and usually lack legs. They remain stationary through most of their lives. Males have legs and usually one pair of wings on the mesothorax. Newly emerged immatures are known as crawlers, they have their legs and antennae and are active. They are important pests of crops and fruit trees.

Cochineal: A red dye produced from the dried and powdered body of cactus mealybugs (*Dactylopius coccus*) commonly known as cochineal insect. This insect is native to Mexico and Peru. By using different treatment methods, bright red to orange dye can be obtained from dried insect bodies. Cochineal is used in cosmetics, homeopathic medicines and in foodstuff colouration, as it is a natural product with minimal side effects to its usage.

Cocoon: A protective sac, spun by the larvae of many insects, in which they pass the pupal stage. It consists of silk or viscid material which hardens upon exposure to air. For making cocoon, larvae in addition to silk also utilizes particles of mud, tiny wood pieces, hairs, etc. as in Trichoptera. In Siphonaptera, pupation is also there in silken cocoons. Most

butterflies lack this structure and have normal obtect pupa. Full grown larvae of bumblebees also spin cocoons and pupate in them.

Cocoonase: An enzyme that digests the silken cocoon in saturniid and bombyliid moths.

Code: Also known as 'International Code of Zoological Nomenclature' (ICZN). The formation and use of scientific names of animals are governed by this Code, fourth edition of which was published in 1999. In the Code, set rules regarding uni-, bi-, and trinomialism; name changes and instability in nomenclature; use of parentheses, square brackets and punctuation marks are clearly written. Rules regarding priority of names, kinds of names, synonymy, typification etc. are also given in the Code.

Code of Ethics: A set of recommendations on the propriety of taxonomic actions, to guide the taxonomist.

Coded Insecticide: Unnamed insecticide but having a Code which identifies it with the manufacturer.

Codlure: A synthetic sex pheromone of the codling moth; (E, E) - 8, 10-dodecadien-1-01; female scent attractive to male codling moth; used in traps to determine moth flight activity.

Coefficient of Difference (CD): Difference of means divided by sum of standard deviations.

$$CD = \frac{Mb - Ma}{SDa + SDb}$$

Coefficient of Variability (CV): The standard deviation as percentage of the mean.

$$CV = \frac{Sd \times 100}{M}$$

Coelom: The main body cavity surrounding the gut in animals such as annelid worms, starfish and vertebrates. In arthropods and molluscs the coelom is much reduced and the main body cavity is a haemocoel.

Coevolution: When two or more populations interact so closely that each acts as a strong selective force on the evolution of the other,

reciprocal stepwise adjustments occur that results in co-adaptation.

Cole Crops: Crops of the family Cruciferae, such as cabbage, broccoli and collard. Cole crops are also called crucifers.

Coleoptera: An endopterygote insect order. Representatives are commonly known as beetles, they have biting type mouthparts. Prothorax usually large and distinct, front wings toughened as wing cases or elytra covering all or part of the abdomen. Elytra meet in body midline. Hind wings larger, membranous. Complete metamorphosis, distribution is worldwide. This is the largest order of class Insecta. Many species are plant pests.

Coleoptile: Appearing at seed germination, the cylinder like protective covering that encloses the young plumule.

Collateral: Side by side.

Collective Group: An aggregate of related species of which the generic position is uncertain, used principally in paleontology and parasitology.

Colleterial Glands: Accessory glands of the female internal genitalia that secrete adhesive material which may prove useful for attaching the eggs to the substratum. They are modified dermal glands and produce cement that helps attaching or glueing the eggs to the substrate. In insects that retain their eggs after they hatch such as tsetse flies, *Glossina* sp., accessory glands produce a nutritive secretion that nourishes the larvae during their entire larval period. In cockroaches and mantids, the colleterial glands produce the hardened egg cases, or oothecae.

Colloidal Formulation: Solution in which the particle size is less than 6 μm in diameter, and the particles stay indefinitely dispersed.

Collophore: A tube-like structure located on the ventral side of the first abdominal segment of springtails (Collembola). Collophore literally means 'that which bears glue'.

Colon: The large intestine; the part of the hindgut between the ileum and rectum.

Colonisation: The controlled release of a quantity of biological control agents in a favourable environment for the purpose of permanent or temporary establishment.

Colonisation Flight: The flight undertaken by winged termites when they swarm from the nest or termitarium.

Colony: A group of individuals, other than a single mated pair, which constructs nests or rears offspring in a cooperative manner. Hymenopteran colonies may be initiated by a single fertile female ('haplometrosis'), by multiple queens ('pleometrosis') or by colony division ('swarming'). The size of an established colony can vary from several dozens in certain primitive ants to over 22 million in the army ant (*Dorylus* sp.).

Colony Fission: The multiplication of colonies by the departure of one or more reproductive forms, accompanied by groups of workers, from the parental nest, leaving behind comparable units to perpetuate the parental colony. This mode is referred to occasionally as 'hesmosis' in ant literature and 'sociotomy' in termite literature. Swarming in honeybees can be regarded as a special form of colony fission.

Colorimetric Analysis: Determination of the amounts of substances by comparing the intensity of colour produced by them with specific reagents in comparison to the intensity of colour produced by a standard solution with the same reagents. It is based on the fact that the colour intensity of a solution is proportional to the concentration of the solute.

Coloured Traps and Panels: Shallow, coloured trays filled with water and a little detergent meant for attracting aphids and other insects. Bright yellow traps are especially attractive. Coloured panels smeared with a very thin layer of sticky adhesive or petroleum jelly also are used.

Comb: A layer of brood cells or cocoons crowded together in a regular arrangement. Combs are a characteristic feature of the nests of many species of social wasps and bees;

rows of hairs, the 'comb' on the inner side of the first tarsomere of hind legs in bees. Comb scrapes the pollen off the abdomen.

Combination Aerial Sweeping Net: These are net bags consisting of muslin except for the bottom third which is netting. The bag can be used for sweeping with minimal damage from tearing and the insects at the bottom can be seen. This type of net is good for all purpose collection.

Commensalism: A living together of two or more species, none of which is injured, thereby, and at least one of which is benefitted.

Commercial Insecticide: Formulated insecticide sold in the market.

Commission: The International Commission on Zoological Nomenclature.

Commissure: The nerve cord connecting two ganglia.

Commodity Product: An expression used in the trade to distinguish a patent free substance from one over which a company exercises exclusive rights.

Common Name: Insects that are particularly common in a given locality may be given vernacular names. For example, dragonflies are variously referred to in literature as 'mosquito hooks' and 'snake feeders'. Such names have little value other than in the context of local relevance. However, certain common names are useful when applied to agricultural or medical pests as they facilitate communication between the professional and laymen.

Common Oviduct: Also called median oviduct. In female insects, the tubes leading from the fused lateral oviducts to the 'vagina'. It is ectodermal in origin and is lined with cuticle.

Common Pesticide Name: A common name given to a pesticide by a recognized committee on pesticide nomenclature. Many pesticides are known by a number of trade or brand names but have only one recognized common name. For example, the common name for sevin insecticide is carbaryl.

Communal: Applied to the condition or to the group showing it in which members of the same generation cooperate in nest building but not in brood care.

Communication: The influence of signals from one organism on the behaviour or physiology of another organism.

Community: The collection of different species and types of plants and animals in their respective niches within the common habitat, e.g., a lake community, mangrove community or ravine community. The basic plan for all communities is the same, i.e. they are composed of saprophytes, autotrophic plants, herbivores, carnivores etc.

Compatibility: Compatibility means the ability of two or more pesticide chemicals to be mixed and applied together without undesirably altering their individual effects.

Compatible: Two compounds are said to be compatible when they can be mixed without affecting each others' properties.

Competition: Refers to the condition when two or more individuals or species are sharing a limited resource-the resource may be food, nesting site, or just space. There are two different types of competition, i) intraspecific competition occurring between individuals of the same species; and ii) interspecific competition occurring between different species.

Competition Curve: The relationship between percent parasitism and the area transversed by a parasite population. The curve rises asymptotically towards 100% as parasite density increases.

Competitive Displacement: The replacement of an indigenous species by a recent arrival with similar ecological requirements.

Competitive Exclusion: The principle that no two species can coexist at the same locality if they have identical ecological requirements.

Complete Metamorphosis: Same as complex metamorphosis or holometabolous development.

Completely Randomized Design (CRD):

Experimental design in which the whole experimental material is divided into a number of experimental units depending upon the number of treatments and the number of replications for each. Treatments are allotted to the units entirely by chance. In field trials, the whole field is divided into a required number of equal plots and then the treatments are randomized in these plots. In CRD any number of replicates and treatments may be used, even the number of replicates can also be varied at will. Sensitivity of the experiment increases with the increase in number of error degrees of freedom. CRD is frequently used in laboratory experiments but is not suitable for field experiments because of variable fertility gradient in the field.

Complex Metamorphosis: Metamorphosis in which the insect develops by four distinct stages namely egg, larva, pupa, and adult; the wings (when present) develop internally during the larval stage.

Compost: A pile of decomposing organic matter of plant or animal origin in which soil or other amendments such as lime, nitrogen, and phosphorous may be mixed.

Compound Eye: An eye consisting of many individual elements or ommatidia each of which is represented externally by a facet. The facet is comparable to a cornea or lens. To the rear of the cornea is a light gathering device, the crystalline cone. This cone rests upon a group of sensory neurones, the retina, which forms an internal photoreceptor unit, the rhabdom. Insects in general are near-sighted with a fixed focal length. They can not focus their eyes or close their eyes. Perception of colour varies with insects. Some are capable of greater perception than man and are able to see ultraviolet light while others are colour blind especially to red.

Compound Nest: A nest containing colonies of two or more species of social insects, up to the point where the galleries of the nests anastomose and the adult sometimes intermingle but where the broods of the species are still kept separate.

Compressed Air Sprayer: Sprayer usually 5 to 15 litres capacity with extension rod, equipped with air-pump to develop pressure, often with shoulder strap for carrying. Not suitable for spraying at heights over 2 to 3 metres. They can be used to control insects in the home and are used by public health workers for applying residual deposits of insecticides in homes and other buildings to control mosquitoes and other insects of medical importance, can also be used for spraying fruit plants and vegetables.

Concentrate: Opposite of dilute. A liquid or dry formulation containing a high percentage of toxicant to save shipping and storage charges and yet be of convenient strength and composition for dilution.

Concentrate Spraying: Direct application of the pesticide concentrate without dilution.

Concentrated Solution: Commercial pesticide preparation before dilution for use.

Concentration: Proportion of active ingredient (a.i.) in the pesticide preparation, before or after dilution.

Conditioned Reflex: A 'reflex' modified by experience; notably a response given to a particular 'stimulus' because the animal has learned to associate that stimulus with some particular experience, e.g. the sound of a bell with the presence of food.

Condyle: A rounded structure adapted to fit into a socket.

Confluent: Running together, merging.

Conformulent: Any substance other than an active substance which is used or intended to be used in a plant protection product or in an adjuvant such as solvents or surfactants.

Congeneric: A term applied to species of the same genus.

Connective: A longitudinal cord of nerve fibres connecting successive ganglia of the central nervous system.

Conservation: In biological control, conservation deals with concepts for habitat modification to improve the impact of natural

enemies. Changing the microclimate and crop background, providing alternative and alternate prey to natural enemies and provision of flowers as food for adults of natural enemies, are mainly the approaches considered for conservation of natural enemies.

Conspecific: A term applied to individuals or populations of the same species.

Consumer: A heterotrophic organism or population, usually animal, fungus, or virus which utilizes dead or living organic matter as food.

Contact Poision: Material killing pests by contact action presumably by absorption through the cuticle. Contact poisons are the major group of modern insecticides, they usually enter the body when the insect walks or crawls over a treated surface like a leaf. These poisons also enter digestive tract and are thus absorbed through it.

Contagious Distribution: Condition where in a given habitat the individuals of the same species tend to occur close together in groups, separated by areas where they are absent.

Contaminate: To alter or render a material unfit for a specified use, by the introduction of a foreign substance.

Contamination: Presence of unwanted pesticide or other material in or on a plant, animal or their byproducts.

Contest Competition: A type of competition where each successful competitor gets all it requires for survival or reproduction, the remainder get none or insufficient.

Contiguous: Touching each other.

Continuity: In nomenclature the principle that continuity of usage should take precedence over priority of publication in determining which of two or more competing scientific names should be adopted for a particular taxon.

Continuous Variation: Variation in which individuals differ from each other by infinitely small steps, as variation in quality of expression of a character or group of characters.

Control: To prevent from doing damage; to reduce or keep down the number of pests so that little disease, damage or injury occurs to a crop or property; any action which has, as its objective, the amelioration of the harm caused by pests and in which man plays some deliberate role; untreated subjects used for comparison with those given a particular crop protection treatment is also referred as control. There are two categories of control - preventive control and curative control. In preventive control the aim is to prevent the initiation of an attack, and the pest may or may not be killed. In curative control the aim is to destroy the organism either by killing it or preventing its reproduction after its attack has started.

Control Schedule: Time table for the application of control measures irrespective of the presence or absence of the pests.

Controlled Droplet Application (CDA) : In contrast to the relatively wide range of droplet sizes produced by hydraulic nozzles, controlled droplet application emphasizes the application of a narrow spectrum choosing the appropriate droplet size to optimize deposition on the intended spray target. While sprays with droplets having a diameter of 50-100 μm are suitable for ULV application, larger droplets (100-150 μm) are needed for applying insecticides at very low volumes. CDA have been widely adopted in semi-arid areas where water supplies are poor which prevent widespread adoption of more traditional spraying techniques.

Controlled Release Formulations: Technique or method in which the active ingredient is made available to a specified target at concentration and duration designed to accomplish an intended effect. These formulations are advantageous over conventional formulations because they provide satisfactory effect for a longer time, small dosage is required, longer application interval, decrease in phytotoxicity and environmental pollution.

Conventional Spraying: Conventional

spraying refers to spraying (56-224 l/ha) with a knapsack sprayer fitted with a tailboom.

Convergence: Morphological similarity in but distantly related forms.

Convex Veins: Longitudinal veins located on crests resulting from wings folded in a pleated fashion.

Cootie: A name used in the United States of America, for the human louse (*Pediculus humanus*). There are two forms of this species : the head louse which occurs chiefly on the head and glues its eggs to the head hairs, and the body louse which lays eggs on clothes and reaches to adjacent body areas to feed. Under conditions of regular head washing and clothes change, cootie are seldom a nuisance.

Cope's Rule: The generalization that there is a steady increase in size in phyletic series.

Coprophagous: Insects that feed on dung (e.g., subfamily Scarabaeinae and Aphodiinae of family Scarabaeidae).

Copularium: The first chamber built by a colony-founding couple of termites.

Copulation: Sometimes also known as mating. Copulation involves the linking of the male and female genitalia to form a firm connection between the two insects; sexual union. The opposite sex is located by responding to at least a variety of stimuli including vision, hearing, smell, or touch. Swarming also plays a major role in locating mates in mayflies and caddisflies. Swarms consist primarily of males which orient toward conspicuous landmarks such as trees or roads. Females are attracted to and fly into these swarms where a male immediately copulates with her. Once coupled the pair may remain in copula for less than a minute or up to several weeks. Silkworm moths have been reported to remain 'in copula' for over three days.

Corbicula: Also known as pollen baskets. They are created by a circle of stiff hairs on the outer surface of hind tibiae of honeybees and bumblebees.

Coremata: Eversible, thin walled abdominal

organs of male moths used for dissemination of sex pheromone.

Coriaceous: Thick, tough and leathery.

Corium: The elongate, usually thickened basal part of the front wing of Hemiptera.

Cornea: The transparent lens-like thickening of the cuticle overlying a simple eye or a single facet of the compound eye.

Corneagen Cell: Modified epidermal cells that produce the cornea of the compound eye.

Corniculi: Also known as 'siphunculi'. A pair of dorsal tubes on the posterior region of the abdomen of aphid which secrete a waxy substance. The cornicles produce the protective wax which is conspicuous in the wooly aphids. Lipid secretions from the cornicles of aphids may gum up predator mouthparts or small parasitic wasps.

Corpora Allata: A pair of small ductless glands associated with the brain of insects and their larvae which secrete juvenile hormone that maintains the insects in the larval stage at each moult. When this hormone ceases to be produced, metamorphosis takes place. Typically the corpora allata are seen as a pair of spherical bodies lying one on each side of the gut behind the brain. They produce both juvenile hormone and gonadotropic hormone.

Corpora Cardiac: Small organ of nervous origin behind the brain. believed to discharge into the blood the hormone from the neurosecretory cells of the brain. They arise as invaginations of the foregut during embryogenesis at the same time as the stomatogastric nervous system and are, in fact, modified nerve ganglia. In older publications they have been referred to as postcerebral or pharyngeal ganglia.

Corpora Pedunculata: The mushroom bodies of the protocerebral lobes of the brain. They contain abundant nerve cell 'perikarya' and 'interneurons', its size is correlated with behavioural complexity and is most highly developed in social Hymenoptera that display complex behaviours.

Correlation Coefficient (r): A quantitative

assessment of the direction and magnitude of the relationship between two variables. Degree of correlation ranges from +1 or -1. The correlation coefficient of zero means that the two variables are not interrelated. A 'r' value of +1 or -1 indicates complete association. A positive (+) correlation means that higher values of one variable are associated with higher values of the other. A negative (-) correlation means that as one variable increases the other tends to decrease.

Corrosive: Having the power to eat away slowly. Some pesticides eat or wear away the rubber hoses, nozzles and other parts of spray machinery.

Cosmopolitan: A species occurring very widely throughout the major regions of the world.

Costa: The vein nearest the fore-margin (leading edge) of the wing, in most insects forming the margin itself; sometimes continued all round the margin of the wing. The costa is a stout vein.

Costal Cell: The wing area between the costa and the subcosta.

Costal Fracture: A break or weakness in the costal margin in Heteroptera that divides the 'corium' separating the 'cuneus' from the embolium.

Costal Margin: Anterior edge of the wing.

Cotyledonary Leaves: The first leaf, or pair of leaves of the embryo of seed plants.

Cotype: Syntype.

Countershading: A form of colouration that tends to reduce the 3-dimensional appearance of an insect by suppressing highlights.

Coupling Agent: A solvent that has the ability to stabilize or to increase the amount of solubility of one material in another is referred to as coupling agent.

Courtship Feeding: A mechanism in insects where the male provides a food 'gift' to his 'bride', has evolved independently in diverse predatory groups like empidid flies and mecopterans and appears to be another mechanism for appeasement.

Cover: **1.** Proportion of the surface area of the target plant on which the pesticide has been deposited. **2.** Non-crop plantings used to protect soil during a fallow period, to add organic matter to soil when ploughed under, and in some cases to reduce pest and pathogen numbers.

Coverage: The degree to which pesticide applied reaches the area intended.

Coxa: The proximal (basal) segment of insect legs by which they are attached to the thorax. Coxa fits into the body like a ball and socket arrangement and permits movement of the leg in every direction.

Coxite: The base of a reduced appendage, especially one of those on the last two or three segments of the abdomen.

Coxopodite: The basal segment of a genital appendage.

Cranium: The cranium is a hardened capsule with an opening leading to the mouth and thorax. Cranium is attached to the thorax by a short neck, or 'cervix'. The orientation of the cranium varies among different insects, positioned vertically (hypognathous), horizontally (prognathous), or obliquely (opisthognathous). Ground beetles and grasshoppers have heavy cranium, adapted for muscles involved in capturing prey/biting off leaf tissue. Leafhoppers and mosquitoes which pierce and suck liquid food, often have much more delicate crania.

Crawler: The first instar nymph of scale insects which possesses legs, and thus enables dispersal to take place. In pest management strategies, the crawler stage is often one that is targeted for control because crawlers are small and have a relatively thin wax coating that makes them easier to kill with pesticides.

Cremaster: Terminal spines of the abdomen; the anal hooks by which many pupae suspend themselves (Lepidoptera).

Crepitation: Production of sound in some acridid grasshoppers and a few cicada species by snapping their wings against one another.

Crepuscular: Insects that are active in the twilight, predawn and at dusk in the evenings.

Crickets: Crickets belong to family Gryllidae (Orthoptera). Characterized by long antennae, a lance-shaped ovipositor and three segmented tarsi. They produce a chirping sound.

Crista Acoustica: The main chordotonal organ of the tibial tympanal organ of the katydids (Orthoptera : Tettigoniidae).

Crochets: Curved hooks, spines or spinules on the tips of prolegs of lepidopterous larvae. Hooked spines may be in rows or circles. Crochets may be biordinal (Saturniidae), triordinal (Nymphalidae), or ellipse (Pyralidae). Crochets permit tenacious gripping on rough substrates. When smooth surfaces are encountered, the region with hooks is rotated dorsally to expose a sucker-like area for increased efficiency in locomotion.

Crook Stage: That stage of plant growth as it emerges from the soil, i.e. bean seedlings which have broken through the soil but before the stem becomes erect.

Crop: 1. The dilated section of the foregut just behind the oesophagus, where food is stored. In Diptera and Lepidoptera, however, the crop is actually a diverticulum that is separated from the rest of the oesophagus by a short duct fitted with a valve. Sugar meals are stored in the diverticulum and passed slowly to the midgut while protein is sent directly to the midgut. The cuticular lining of the crop limits its absorptive capacity and it, therefore, functions mainly as a food reservoir but it is permeable to some ingested fats. During storage the food may undergo some digestion in insects where saliva contains enzymes that regurgitate digestive fluid from the midgut. In some species intima or crop forms spines or ridges which probably aid in breaking up solid food into smaller particles and its mixing in the digestive fluid. **2.** A plant growing where it is desired.

Crop Residue: A portion of the crop that is not harvested, and usually is returned to the land by tillage or as mulch.

Crop Rotation: A technique of pest control which involves the deliberate planting of

specific crop sequences to make the year-to-year survival of soil-dwelling pests difficult or impossible. Crop rotation can provide good control for certain fairly host-specific soil-borne plant pathogens and nematodes, and can also contribute to weed management. Only a few insect pests can be controlled successfully through this method.

Crop Tolerance: The degree or the ability of the crop to be treated with a chemical but not injured.

Cross Pollination: Transfer of pollen from the anther of one plant to the stigma of another plant having a different genetic make-up, and it always involves an external agent usually wind or insects.

Cross Resistant: When a pest population which has become resistant to one pesticide also becomes resistant to other chemically related pesticides. For example insects that have become resistant to DDT have also become resistant to methoxychlor. Cross resistance results from a common detoxification system or from target site insensitivity.

Cross-Vein: A wing vein that connects adjacent longitudinal veins. These veins support structures in the wing.

Crown: The point where stem and root join in a seed plant. This term is also used to describe the foliage and branches of trees.

Crucifers: The plants that belong to the mustard family including mustard, cabbage, radish, turnips etc.

Crural: Femoral

Crustacea: A class of arthropods that includes a variety of marine and fresh-water arthropods. In most crustaceans the body is divided into a head, thorax and abdomen, although the head and thorax are closely joined and sometimes protected from above by a single carapace. Head is composed of six segments, first segment bears a pair of stalked eyes. The next five segments bear serially homologous appendages represented by the uniramous first antenna, the biramous second

antenna, the jaws (mandibles), and two pairs of food handling structures, the first and second maxillae. The thorax may vary from 4 to 20 segments each with a pair of limbs. In the lobster there are 8 segments, which support three pairs of food handling and sensory maxillipedes, one pair of large pincer bearing limbs, and four pairs of walking legs. The abdomen has a pair of appendages on every segment except the last, which is flattened to form the middle of the three-lobed tail (telson). The abdominal appendages are mainly used for slowly swimming forward and also serve reproductive functions.

Crypsis: Often called as **camouflage** or **protective colouration**. Combination of form, colour and pattern that facilitates 'hiding' from predators and/or parasites. Crypsis interferes with other life activities such as feeding and mating. It is especially prevalent during diurnal resting period of insects that are mainly active at night.

Cryptic Colouration: This is simply camouflage and can result from either blending into a featureless background or looking like a particular object that forms a common component of the environment; colour and pattern which stimulate the background on which the insect rests.

Cryptobiosis: The state of a living organism during which there are no signs of life and metabolism virtually ceases.

Cryptonephry: A condition of the excretory system in which there is a close association of the malpighian tubules with the hindgut-an adaptation to increase water retention. This condition is called cryptonephridial. It occurs in larvae and adults of many Coleoptera, in some hymenopterous larvae, Neuroptera, and larvae of Lepidoptera.

Crystalline Cone: The clear conical-shaped structure lying immediately beneath the cornea in each unit (ommatidium) of insect compound eyes.

Ctenidia: Rows of stiff spines on head and thorax of fleas. It is a useful character in identification of fleas (Siphonaptera).

Cube: The root of a tropical plant (*Lonchocarpus* spp.) valued as a source of rotenone. Obtained commercially mostly from Peru.

Cube Mounts: Some very small and delicate insects that are difficult to pin (e.g. mosquitoes) are pinned to cube mounts; a cube of pith is mounted on a macropin and a macropin is inserted horizontally through the pith so that most of its length protrudes and the insect then is impaled ventrally or laterally. This technique of mounting insects is also known as 'staging' or 'double mounting'.

Cubitoanal Cross-Vein: A cross-vein connecting the cubitus and an anal vein.

Cubitus: A longitudinal vein of an insect wing behind the media, usually two-branched.

Cuckoo: A term used for an insect that uses the food stored by another to rear their own young.

Cuckoo Spit: A frothy secretion produced by the nymphs of certain soft-bodied plant bugs in which they live and frothy secretion protects them from desiccation.

Cucujiform: Larvae having the body extremely flat, with the legs directed laterally.

Cucurbit: Plants which belong to the gourd family including the pumpkins, cucumbers, squash etc.

Cucurbitacin: Cucurbitacins are a group of tetracyclic terpenoids isolated from the plants of family Cucurbitaceae. These are extremely bitter compounds and are found in the roots, stems, cotyledons, leaves and fruits of cucurbitaceous plants. **Cucurbitacin B** is the predominant compound. Cucurbitacins are feeding deterrents for cucumber leaf beetles. *Phyllotreta* spp; and red spider mites. But spotted cucumber beetle, *Diabrotica undecimpunctata* are immune to the toxic effects of cucurbitacins.

Culm: The jointed stem of a grass which is usually hollow except at the nodes or joints.

Cultivar (cv.): An accepted term for a variety of a man made selection of a particular plant. A cultivated variety : assemblage of closely

related plants of common origin within a species that differs from other cultivars in certain minor details (e.g., form, colour, flower or fruit) which when reproduced sexually or asexually retain their distinguishing features.

Cultural Control: Manipulation of cultural practices to provide control of a pest. Manipulation of cultural practices like sanitation, manuring, soil cultivation, water and humidity management, strip farming, intercropping, crop rotation and isolation, cultivation of trap crops, and keeping variations in sowing dates helps in disrupting the life cycle of pests thus achieving their maximum control.

Cumulative Pesticides: Those chemicals which tend to accumulate or build-up in the tissues of animals or in the environment (soil, water).

Cuneus: In heteropteran wing, a more or less triangular apical piece of the corium, set off from the rest of the corium by a suture.

Curative Pesticide: A pesticide that can inhibit or eradicate a disease-causing organism after it has become established in the plant or animal.

Curly Top: A virus disease of sugarbeets, beans, tomatoes, and other plants transmitted by the beet leafhopper.

Cursorial: Adapted to running habits. Insects which run have elongate and slim legs. Increased length permits greater distances to be covered with the same muscular effort, and the slimness reduces environmental friction. Tiger beetles and cockroaches have cursorial type of legs.

Cutaneous Respiration: The ability to take up oxygen through the integument. It occurs in some aquatic insects and endoparasites. A thin cuticle in chironomid larvae allows oxygen to be taken up from the water. Oxygen take up is also supplemented by respiratory pigment haemoglobin which is present in the haemolymph.

Cutaneous Toxicity: Same as dermal toxicity.

Cuticle: The outer non-cellular layers of the

insect integument secreted by the epidermis. It forms a protective envelope that resists evaporation from the watery tissues within. The seal is further improved by the addition of a waxy outermost layer, the epicuticle. Chitin, proteins, lipids, phenols, inorganic compounds like magnesium, potassium, sodium etc. are the main constituents of insect cuticle. Certain enzymes and pigments are also found in cuticle. The strength and hardness of the cuticle enable this layer to serve both as an exoskeleton and in the protection of the insect against physical damage and entry of pathogens. The wax layer is important in reducing water loss/entry of water in terrestrial/fresh water insects, is a barrier to insecticides, and for some insects contains pheromones. Colour is also a function of the integument.

Cuticulin: The outer epicuticle, is also referred to as the cuticulin layer which is the third region of the epicuticle. It is also synthesized by epidermal cells and is the only epicuticular layer found in the tracheoles.

CV. : Varieties released for cultivation.

Cutworm: Any of a member of caterpillars in the family Noctuidae that hide in the soil, feeding there or emerging at night to feed on foliage or seedlings.

Cyanide Jar: The insect killing jar, also known as cyanide jar, is made by placing a layer about 5-10 mm thick of the finely granular or powdered cyanide compound on the bottom of a clean and dry jar. The cyanide is covered with a slightly thicker layer of dry 'Plaster of Paris' (or fine sawdust) followed by a wet 'Plaster of Paris' layer of similar thickness. After the plaster has set and dried, the jar is capped or corked and is ready to use in about two days. Cyanide is preferred by many collectors because it lasts for months to a year or more and kills insects quickly. 'Poison' label should be pasted on it. Potassium and sodium cyanide are the least dangerous to work with and last the longest.

Cyclical Parthenogenesis: Parthenogenetic reproduction which recurs every other generation as in Cynipidae (Hymenoptera).

Cyclodevelopmental Pathogens: The pathogens that not only multiply but also transform within the arthropod.

Cyclodienes: A class of organochlorine insecticidal compounds with a ring structure such as that of aldrin, chlordane, dieldrin and heptachlor.

Cyclomorphosis: Seasonal change of body form as in Aphididae, Cynipidae, and other insects.

Cyclopropagative Pathogens: Same as cyclodevelopmental pathogens.

Cyclorrhaphous: The group of flies that emerge from the puparium through a circular opening at one end of the puparium. These flies belong to the suborder Cyclorrhapha (Diptera).

Cyst: A sac, normal or abnormal, especially one containing a liquid or semisolid. The term is used here for a group of eggs contained within a tough protective envelope; the dormant stage of some species of nematodes

or eelworms. This cyst is actually a dead swollen female.

Cytogenetics: The comparative study of chromosomal mechanism and behaviour in populations and taxa, and their effect on inheritance and evolution.

Cytology: The study of the structure and physiology of the cell and its parts.

Cytoplasm: The fluid or gelatinous content of living cells as distinct from reproductive nucleus.

Cytoplasmic Polyhedrosis Viruses: Insect viruses that are occluded in a polyhedral protein crystal and multiply in the cell cytoplasm; virus particles are nearly spherical. Cytoplasmic polyhedroses cause diseases of caterpillars and the larvae of a few lacewings (Neuroptera). They mainly invade the cells of the alimentary canal, and infected larvae often become white and swollen. The virus is spread when polyhedral bodies are regurgitated or passed out with the faeces.

D

Damage: Destruction, injury or loss in value caused by the feeding activity of insects and rats or by disease infection or by weed infestation. In exploiting their victims for their own needs pests may damage them directly or indirectly. If the part of the victim which is damaged is the part in which man is interested then the damage is said to be direct, whereas if some other part of the victim is damaged and not the useful part, except indirectly, the damage is indirect. Direct damage usually results from the pest's use of the victim as a source of nourishment. Insects chew the tissue or suck the sap or blood of living organisms. Direct damage may be caused in other ways, for pests may exploit their victims as sites for egg laying or shelter. Cicadas, when laying their eggs in young twigs, frequently damage them so severely that die-back follows. Indirect damage caused by pests displays a much wider range of forms. Possibly the most important type is when the pest is a vector or alternative host of some economically important parasite or disease. Plant viruses of many kinds, and of great destructive power, are transmitted by sap-sucking aphids, leafhoppers and nematodes. In general about 14% of actual product is lost by insect pests. Further heavy losses follow during the storage and transport of products and from depredations of such organisms as rodents, and fungi.

Damage Threshold: The lowest pest population density above which crop loss occurs.

Damping Off: Infection of newly formed

roots and stems of young seedlings by fungi or bacteria, typically at soil level, resulting in decay or seedling death.

Dance of Bees: A behaviour pattern of honeybees through which incoming worker bees are able to communicate information regarding direction and distance of food supplies. There are two types of bee dance **1.Round dance**—performed when food is close, and **2.Wagtail dance**—when food is away. In the wagtail dance the movement resembles a figure of eight in which the two loops are separated by a straight run. The orientation and frequency of this movement are said to give other bees the required information. A strong vigorous dance creates excitement because the food source is near and abundant, a weak dance elicits little response and hive energy is therefore conserved. This communication by dances is unusual and is not found in most bees, although some stingless bees may leave a scent trail to assist others in locating food.

Danger: A signal word used on pesticide labels to inform the user that the pesticide is highly toxic. The word poison, and the skull and crossbones symbol always accompany the signal word danger.

Data: Records of observations and measurements of physical facts, occurrences, and the conditions reduced to written, graphical or tabular form.

Days-to-Harvest: The least number of days between the last pesticide application and the harvest date as set by law. Also called harvest intervals.

Dead Heart: Dead rice or sugarcane tiller caused by a stem borer which girdles its base.

Dealation: The removal of the wings by the queens (and also males in the termites) during or immediately following the nuptial flight and prior to colony foundation.

Death: Complete and permanent cessation of vital functions in an organism.

Death Feigning: Many species of stick insects, beetles and caterpillars apparently feign death, if disturbed. Some of them drop from a twig/leaf and lie completely stiff on the ground. Stick insects bring their legs closer to their body and this motionless behaviour makes them look even more like a stick, and this appearance gives them a high degree of camouflage by protective resemblance to the plant to which they are attached.

Debris: Trash or unwanted plant parts or remains.

Deciduous Plant: A plant species having a part or parts that may fall off or be shed.

Decomposer: A heterotrophic organism which utilizes dead organic matter as food, decomposing it into more simple substances.

Decontaminate: The removal or breakdown of any pesticide chemical from any surface or piece of equipment.

Dectious: Having the ability to move the mandibles applied to the exarate pupae.

Deet: N, N-diethyl-m-toluamide. Commonly used as a repellent for biting flies and mosquitoes.

Defence Secretions: Many species of insects produce caustic, irritant or bad smelling fluids for their own defence. These fluids may be applied to their victims through a sting as in bees and wasps or through irritant secretions from hairs as in many caterpillars, or through blistering chemicals as in blister beetles, or in the form of a poisonous vapours as in bombardier beetles.

Deflocculating Agent: Material added to a spray preparation to prevent aggregation or sedimentation of the solid particles in the liquid in the spray tank.

Defoliant: A preparation intended for causing leaves to drop from crop plants usually to facilitate harvest.

Defoliation: 1.Reduction in the amount of foliage possible due to insects, fungi or other agents as distinguished from natural leaf-fall. 2.Removal of leaves by application of a defoliant.

Degradability: The ability of a chemical to decompose or breakdown into less complex compounds or elements.

Degradation: Breakdown of a complex chemical by the action of microbes, water, air, sunlight, or other agents.

Degree Hours or Degree Days: Degree days are also known as day degrees. An accumulation of heat units above some threshold temperature for a 24 hour period. The units are used to estimate the total heat required to complete one generation of an insect. Each such unit is the difference between the established developmental zero and the actual temperature multiplied by time. It is expressed as $k=y(x-a)$, where k =thermal constant expressed in degree days ; y =time required to complete development; x =maximum temperature + minimum temperature ; and a = threshold temperature. The most accurate method of establishing thermal constants is to conduct rearing experiments under controlled laboratory conditions using constant temperatures. However, it is possible to generate degree days by monitoring maximum and minimum field temperatures and accumulating degrees above threshold for each day until the insect complete its development. After knowing degree days requirement, it is easier to predict in a general way how many generations are likely to occur during the season (i.e., between dormant periods, if they exist).

Degrees of Freedom: In statistical analysis of data, numbers of degrees of freedom is the number of independent comparison that can be made within the body of data. The number of degrees of freedom is one less than the number of variates in the sample concerned. Here, it will be $(n-1)$. If the number of

treatments is **t**, degrees of freedom for any number of group means is one less than the number of groups concerned. Number of degrees of freedom (**n-1**) forms the correct denominator in the expression for an unbiased estimate of standard deviation.

Delayed Density Dependant: A parasite will act as a delayed density dependant mortality factor on the host if its rate of increase is strongly correlated with host density in successive generations.

Delayed Dormant Spray: An orchard spray applied during the period from swollen bud to late green tip of bud development; often called swollen bud in stone-fruit work.

Delayed Parasitism: Parasitoidism in which the parasitoid egg remains dormant in an early stage of development until the host is near maturity, then develops rapidly.

Dello's Rule: The principle that evolution is irreversible to the extent that structures or functions once lost can not be regained.

Delusory Parasitosis: Also known as **entomophobia**. A psychotic illness in which parasitic infection is imagined.

Deme: A local population of a species ; the community of potentially interbreeding individuals at a given locality. In other words demes are open genetic systems that are affected by gene flow from adjacent populations i.e., they are only partially isolated organisms.

Demographic Equations: Change in numbers from one time to the next and from one place to the next is one of the most prevalent properties of any population. A widely used expression with the primarily factors of this change is, $N_t = N_{0e} (b-d)^t - E_t + I_t$, where :

- t** = is a very short interval of time
- N_t** = the number at the end of a short time period (t)
- N₀** = the number at the beginning of the time period
- B** = the birth rate
- d** = the death rate

- e** = base of natural logarithms = 2.7183
- E** = emigration (movement out of an area)
- I** = Immigration (movement into an area)

The expression is a general model of change in any population and shows the mathematical relationship among the primary factors of this change : births, deaths, and movements. In attempting to explain population numbers, we must account quantitatively for these primary factors. To attempt prediction of change, however, we must understand how environment modifies these primary factors.

Demography: The study of number of organisms in a population and their variation with time.

Dendrites: Tiny branching processes associated with or near the cell body of a neuron. Nervous impulses are transmitted from the 'presynaptic' axon across the gap to the 'postsynaptic' axon by a chemical transmitter substance. The postsynaptic or receptive axon is also called the 'dendrite'.

Dendrogram: A diagrammatic drawing in the form of a tree designed to indicate degrees of relationship.

Dengue: Also known as break-bone fever. A virus disease of man marked by severe pains in head, eyes, muscles and joints, and transmitted by mosquitoes (*Aedes aegypti*).

Density: The density of a population denotes the number of individuals per unit area or space. The number of individuals per unit of total space is known as **crude density**. Number of individuals per unit of habitat space, i.e. the space actually occupied by the population, is known as **ecological density**.

Density Dependant Factor: An environmental factor that causes a level of mortality that varies with the number of individuals, in the population. Food, predators and parasites are all density dependant factors.

Density Independent Factor: A factor regulating populations of living organisms, whose influence is independent of the population density of the organism concerned.

The primary example of this kind of factor is weather which includes rainfall, temperature, and humidity, may have a strong effect on insect survival.

Dentes: Prongs of the furcula borne on manubrium as in Collembola.

Denticles: A small tooth or tooth-shaped structure.

Deodorants: Deodorants are materials added to insecticides to mask unpleasant odours. Cedar oil, pine oil, or flower scents are added to insecticide concentrates to disguise their odour.

Deposit (Dried): Amount and pattern of active ingredient deposited per unit area of plant surface.

Deposit (Spray): Amount and pattern of spray or dust per unit area of plant surface remaining immediately following application.

Deposition Velocity: Velocity at which the spray impinges on the target.

Derived Character: A character that differs materially from the ancestral condition.

Dermal Glands: Modified epidermal cells on the outer surface of the insect body that produces cement layer, and secrete irritants, poisons, wax, scents, silk etc. Wax secreting glands are particularly well developed in scale insects and mealybugs.

Dermal Toxicity: Dermal toxicity is the passage of pesticides into the body through the unbroken skin. Dermal exposure results from spillage onto skin and clothing, from drift, or from damaged or improperly maintained equipment.

Dermaptera: An orthopteroid order of insects. Commonly known as earwigs. They are elongate but slightly flattened. Eyes present or absent. Mouthparts biting, forward facing. Antennae long, multi-segmented. Two pairs of wings, front wings short. Hind wings large, semicircular (folded under front wings). Abdomen usually with distinctive toughened abdominal forceps. Incomplete metamorphosis (egg, nymph and adult). Worldwide in distribution, predominantly found in tropical regions. Earwigs prefer

confined, humid microhabitats such as soil, litter, or live under bark.

Dermatitis: Inflammation of the skin.

Derris Powder: The finely ground roots of the leguminous shrub, the *Derris elliptica*, which contains rotenone-an insecticidal substance. *Derris* species are grown in Malaysia and the East Indies. Oral LD₅₀ of derris is 1500 mg/kg.

Description: In taxonomy, a more or less complete formal statement of the characters of a taxon without special emphasis on those characters which set limits to the taxon or, distinguish it from coordinate taxa.

Desiccant: A compound that promotes drying or removal of moisture from plant tissues. They are used for preharvest drying of actively growing plant tissues when seed or other plant parts are developed but only partially mature. Sodium and magnesium chlorates, calcium cyanamide, and other compounds are employed as desiccants.

Designated Priority: In cases of simultaneous publication of several names, the priority established by the first reviser.

Desmergate: An ant intermediate between a soldier and a worker.

Detection: Also called detection surveys. The procedures and protocols used to discover the presence of pests to monitor outbreaks or introductions.

Detergent: A chemical (not soap) having the ability to remove soil and grime. Detergents can be used as surfactants in some pesticide sprays.

Determinates: Describing growth or development in which there is a distinctive final adult instar.

Deterrent: A chemical that inhibits feeding, mating or oviposition when in a place an organism in its absence feed, mate or oviposit. Deterrents are usually thought of as natural plant constituents that are most important in host plant resistance. Many chemicals including some pesticides like pyrethroids have deterrent or irritant property.

Detoxify: To make an active ingredient in a pesticide or other poisonous chemical harmless and incapable of being toxic to plants and animals.

Detritivores: Insects that feed on small bits of animal or vegetable trash (e.g., dung, carrion, leaf litter etc.). Detritivores includes representatives from Collembola, Thysanura, Diplura, some Coleoptera (Staphylinidae; Scarabaeini, Silphidae), some larval Diptera (Calliphoridae, most Phoridae), some Psocoptera, Blattodea, immature Plecoptera and Ephemeroptera, some Hemiptera (Corixidae) and larval Siphonaptera.

Detritus: Organic material produced by the disintegration of plant and animal bodies after death and decomposition; also used geologically.

Detritus Food Chain: The passage of nutrients and energy through an unstructured assemblage of decomposer organisms.

Deuterotoky: A pattern or mode of parthenogenetic reproduction where progeny of both sexes are produced by unmated females.

Deutocerebrum: The middle portion including the antennary lobes in the brain of an insect.

Deutonymph: Second nymphal stage in development of mites and ticks. Deutonymphs in astigmatid mites may be completely unlike the preceding and succeeding stages both in morphology and behaviour. Such a heteromorphic nymph is known as **hypopus**.

Deutosternum: Sternite of segment bearing pedipalpi in subclass Acari of class Arachnida.

Deutovum: A stage in the metamorphosis of certain mites; a secondary or deutovarial membrane surrounding the embryo until the larval stage.

Development: The changes undergone by an organism from its beginning to maturity. Embryonic development begins with the first mitotic division of the zygote nucleus and

terminates at hatching. In view of their diversity of form, function and life history-insects exhibit a variety of embryonic developmental patterns. In general the eggs of endopterygotes are smaller in relation to the body size of laying insect and develop more rapidly than that of exopterygotes. Compared with that of exopterygotes, development of endopterygotes is streamlined and simplified. Parthenogenesis, polyembryony, viviparity and paedogenesis type of development of embryonic development occurs in different insects. During their postembryonic growth period insects pass through a series of stages (instars) until they become adult, the time interval (stadium) occupied by each instar being terminated by a moult. Apterogotes continue to grow and moult as adults, periods of growth alternating with periods of reproductive activity. In these insects structural differences between juvenile and adult instars are slight and their development is known as ametabolous. Among the Pterygota which do not moult in adult stages, two forms of development is found. In exopterygotes, the later juvenile instars broadly resemble the adult, except for their lack of wings and incompletely formed genitalia, are said to have partial (incomplete) metamorphosis and their development is described as hemimetabolous. Endopterygotes have larvae whose form and habits, by and large, are very different from those of the adults.

Developmental Cycle: The period from the birth of the egg to the eclosion of the adult insect.

Developmental Threshold: Also called growth threshold. The temperature below which no development takes place; the minimum temperature (cardinal temperature) required for development to proceed.

Dew: The very small drops of water that form on the ground etc. during the night. Dew is a common form of precipitation that occurs when air comes in contact with a cold surface and is cooled beyond its saturation point (dew point). Length of time dew forms on plants is

called **dew period**, and dew period is important in defining opportunities for infection by plant pathogens that require free water to infect.

Diagnosis: 1. In taxonomy, a formal statement of the characters which distinguish a taxon from other similar or closely related coordinate taxa. **2.** To distinguish one disease from another, the determination of a disease from its signs, symptoms, etiology, pathogenesis, physiopathology, morphopathology; also the decision reached.

Diagnostic: A distinguishing characteristic important for identification of disease or other condition.

Diapause: A state of suspended activity and metabolism which may occur at any stage in the life cycle of an insect as a means of surviving unfavourable conditions. During diapause—growth, differentiation and metamorphosis cease. Diapause is normally brought about by a change in environmental conditions (especially reduced daylength) and requires a particular stimulus for its termination. Once the state of diapause comes to an end, normal growth and development are resumed.

Diaphragm: A horizontal membranous partition of the body cavity.

Diastasis: A period of rest between successive heartbeats.

Diastole: Relaxation phase of the heartbeat cycle.

Diatomaceous Earth: A very abrasive, white powder prepared from naturally occurring deposits formed by the silicified skeletons of diatoms; used as a diluent in dust formulations.

Dichotomous: Divided or dividing into two parts.

Dicondylic: In the Insecta mandibles are primitively dicondylic, articulated with the head capsule at two points. These mandibles move transversely and are adapted for biting off and grinding food particles. Insecta used to be simply divided into two groups,

wingless and winged insects (the Apterygota and Pterygota respectively). But major differences in the jaw articulation of the primitively wingless order led to the division of Apterygota into two subclasses Archeognatha and the Dicondylia. The Dicondylia is split into two infraclasses, the Thysanura and the Pterygota.

Die-Back: Progressive death of twigs, branches or stems from the tip back toward the main stem of the plant.

Diel: During or pertaining to 24 hours; at 24 hours interval.

Digestion: The process by which the food is rendered absorbable through the gut wall by breaking the food material down into simple molecular components through the action of enzymes is called digestion. Digestion mostly occurs in the lumen of the midgut, though regurgitation of digestive fluid into the crop is important in some species. In wood-eating forms, digestion is carried out by microorganisms in the hindgut.

Digestive System: In insects, digestive system consists of a conspicuous tubular alimentary tract and a series of less conspicuous glands. The generalized alimentary canal extends from the mouth at one end to the anus at the other. The alimentary canal is divided into three distinct regions : the anterior stomodeum and posterior proctodeum, the linings of which are formed by the invagination of ectodermal cells capable of secreting cuticle; and a middle region mesenteron which is lined by endoderm. The foregut is usually divided into an anterior tubular oesophagus, an enlarged food storage chamber called the crop, and a valve like proventriculus. Where the proventriculus joins with the mesenteron, there is a flap-like stomodeal valve to prevent the return flow of partially digested food. The midgut is often less differentiated and consists of a large stomach or ventriculus with several anterior finger-like projections, the gastric caecae. The hindgut is highly variable, but is generally subdivided into a tubular intestine and a short expanded rectum that is connected

to the anus. Pyloric valve is situated at the junction of ventriculus and intestine. Almost all insects possess a variable number of long slender tubules, which coil throughout the haemocoel and joins with the digestive tract just posterior to the pyloric valve. These structures are named malpighian tubules.

Digit: Distal part of chelae and chelicerae.

Digitate: Finger-like.

Dilator: Any muscle that expands or dilates an organism.

Diluent: Component of spray or dust that reduces the concentration of the active ingredient, and may aid in mechanical application but does not directly affect toxicity. Use of diluents is necessary to obtain proper coverage of treated surfaces. Water or refined oils are the liquid diluents, when water is used it is necessary to add dispersing and wetting agents for proper suspension of the insecticide. But where oil solutions are used with water, emulsifying agents are required. For formulation of insecticide dusts or granules—soybean flour, bentonite clay, talc, volcanic ash etc. are used as solid diluents. Coarse to finely ground particles of the diluent serve as a carrier of the insecticide.

Dilution Rate: The amount of diluent that must be added to a unit of a pesticide to obtain the desired dosage.

Dilutions (Serial): Successive dilution of a toxicant solution, e.g., one containing toxicant. A 1:10 dilution equals 1ml of toxicant plus 9 ml of diluent (e.g., water); 1:100 dilution equals 1 ml of a 1:10 dilution plus 9 ml of diluent, etc.

Dimorphic: Occurring in two different forms.

Dimorphism: A difference in size, form, or colour, between individuals of the same species, characterizing two distinct types.

Dinergate: A soldier ant; a particular caste having the head and jaws greatly enlarged.

Dintrophenol: A synthetic organic insecticide characterized by nitro groups (NO_2) attached to a phenol ($\text{C}_6\text{H}_5\text{OH}$) ring (e.g., Dinoseb).

Dioecious: Having the male and female sex organs in different individuals, any one individual being either male or female.

Dip Treatment: The application of a liquid chemical to a plant by momentarily immersing it, wholly or partially under the surface of the liquid so as to coat the plant with the chemical. Under laboratory conditions dipping method is employed when topical application or infection are impractical, for example with small plant feeding insects, stored-product insects, housefly larvae, insect eggs, spider mites etc. The insects are dipped in aqueous solutions, emulsions, or suspensions of the pesticide for short periods of time. In such cases LC_{50} is used to express the results.

Diploid: Having a double set of chromosomes; normal chromosome number of the cells (except for natural germ cells) of a particular organism derived from a fertilized egg.

Diplopoda: They are similar to chilopods except that the body segments have fused in pairs giving the appearance of two pair of legs per segment. The head consists of six segments, but the mouthparts lack the separate first pair of maxillae in the adult. The millipedes although terrestrial, inhabit the moist litter and humus-rich layer of soil where they feed as scavengers. When their population is very high they may cause extensive damage to roots, tubers and seeds of cultivated plants. They brood mainly in spring and early summer.

Diptera: An endopterygote insect order. Diptera is the fourth largest order of class Insecta. Commonly known as flies. They have mobile head, large compound eyes with three ocelli. Possess one pair of membranous front wings. Hind wings are reduced to form a pair of small balancing organs known as halteres. Middle segment of thorax enlarged. They have complete metamorphosis and are worldwide in distribution. Some species are important as obligate vectors of major human pathogens. Many species are highly beneficial, whereas others are serious pests of crops.

Direct Flight Muscles: Flight muscles that are attached directly to the wing.

Direct Pest: A pest insect that attacks a part of a plant that is harvested, as contrasted to an indirect pest.

Directed Application: An application to a restricted area such as a row, bed, or at the base of the plants.

Direction Finding: Social insects have a very good sense of direction and are able to find their way either by keeping a constant angle to the sun or to the polarized light of the sky as in ants. Returning bees communicate information about the distance and direction of food supplies to the other bees of the colony by means of their typical dances. Some male butterflies are guided chiefly by scents given out by females.

Disc: The centre of any sclerite, away from its edges.

Discal: On the disc or main surface of any part of the body as opposed to 'marginal', near its edges.

Discoïdal Area: The middle of an area or a field such as in the wing of an insect.

Discoïdal Cell: A cell near the middle of the front wing (Hymenoptera).

Discoïdal Vein: First and principal branch of humeral vein; provides framework for much of outer part of tegmen.

Disease: Any disturbance which interferes with normal structures, function or economic value of the host is known as disease.

Disease Complex: A plant disease caused by the interaction of two or more pathogens, often manifested by a greater than normal array of symptoms.

Disease Transmission: Many insect species spread diseases to humans, other animals and to plants by carrying bacteria, viruses, fungal spores, etc. on their legs and mouthparts. For example houseflies spread diarrhoea in this way. Blood-sucking insects like mosquitoes transmit disease organisms from one organism to the other by their saliva which they inject

into the skin of their victims. Lice can spread typhus and tsetse flies transmit sleeping sickness disease. Many species of aphids and leafhoppers spread several viral diseases in many economic plants.

Disinfect: To free from infection by destruction of the pest or pathogen established in or on plants or plant parts; to kill or inactivate pests or pathogens present upon the surface of plants or plant parts, or in the immediate vicinity.

Disinfectant: A chemical or other agent that kills or inactivates disease producing microorganisms in animals, seeds or other plant parts.

Disinfest: To kill or inactivate pests present upon the surface of plants or animals in their immediate vicinity (e.g., in soil).

Disparlure: Synthetic gypsy moth sex pheromone; cis-7, 8-epoxy-2-methyloctadecane; female scent attractive to male gypsy moth used in scouting for infestations.

Dispersal: Movement of individuals away from a favourable area to other locations, which may or may not be favourable to survival. Dispersal reduces competition for local resources and sometimes leads to establishment of a portion of the population in a new favourable area that is relatively free from competition. The cost of dispersal to a population is the loss of many propagules (dispersing insects) that do not locate, or happen to land in favourable locations. Dispersal is nevertheless vital to long term survival of a species because all local environments in the long run are likely to change. Dispersal is especially vital to insects that inhabit ephemeral resources: carrion, dung, temporary pools, etc. Dispersal tendency may be genetically controlled.

Dispersing Agent: A material that reduces the cohesive attraction between like particles. Dispersing and suspending agents are added during the preparation of wetttable powders to facilitate wetting and suspension of the active ingredient.

Dispersion: In population density studies,

dispersion (not dispersal) is the pattern or arrangement of insects in space, or how they are spread out in an area. An understanding of dispersion is important because it gives us information about population dynamics and may influence the way we sample the population in an area. Dispersion of insects in environment may be **random** and **clumped**. Random dispersions in insects probably occur most often in relatively uniform environments, but clumped (contagious) dispersions probably are the most common type in insect populations. Clumping of individuals in a population means that if one insect of the species is found, chances are good that others are in the same vicinity.

Disruptive: Treatment that interferes with the ability of beneficial species to control pest populations.

Disruptive Colouration: A colour pattern that breaks up the outline of the body such that it does not stand out against a variable background.

Dissemination: The transport of inoculum or pest from a diseased to a healthy plant.

Distal: Near or toward the free end of an appendage ; part of a segment or appendage farthest from the body.

Distribution: Range of an organism/group in biogeographical divisions of globe. No insect species occur naturally throughout the world. The few that do now occur almost everywhere bear a close association with the human species or human artifacts as do body lice, granary weevils, and some species of cockroaches. In nature all species have certain limitations to their distribution. Lack of opportunity to disperse, lack of suitable habitat or host plant or animal, temperature and moisture are among the main limitations to their distribution. Distribution of insects in two dimensional space assume patterns that correspond broadly to one of three types. In a regular distribution, individuals are spaced evenly at (more or less) regular intervals. In a random pattern the occurrence of each individual is independent of the occurrence of any other; they are scattered literally at

random. Observed randomness may be an artifact of sampling rather than a function of the insect's biology. Clumped (contagious) pattern of distribution is most typical of insect populations, here there is a tendency for observations to occur in small clusters. More formally in a contagious pattern the presence of any individual increases the likelihood of others being found nearby.

Ditrysiian: In Lepidoptera, referring to the presence of separate genital openings for copulation and oviposition (e.g., Pyralidae, Papilionidae, Sphingidae).

Diurnal: Insects that are active during some period of the day are called diurnal.

Diversity: Differences in appearance, habits etc. in a group of animals or plants; also species richness.

Diverticulum: An invagination of the alimentary canal that produces a blind sac for the storage of ingested food.

Dockage: Foreign material in harvested grain, such as weed seeds, chaff and dusts; value depreciation of a product owing to the presence of insects or other foreign matter.

Domatia: Plant chambers produced specifically to house certain arthropods, especially ants. Domatia may be hollow stems, tubers, swollen petioles or thorns, which are used by ants either for feeding or as nest sites, or both. True domatia are cavities that form independantly of ants such as in plants grown in glasshouses from which ants are excluded.

Dominant: An allele which determines the phenotype of a heterozygote.

Dormancy: A state of quiescence/inactivity, which is associated directly with changes in the abiotic environment. There are two extremes of dormancy : at one extreme an insect responds to adverse environmental conditions by a slowdown in metabolism and development, this type of dormancy is referred to as **quiescence**. At the other extreme, an insect enters into a state of metabolic and developmental arrest in response to certain environmental conditions.

These conditions may or may not be adverse, but serve as indicators of the imminent onset of adverse conditions. Development does not necessarily resume immediately with the return of favourable conditions. This type of dormancy is called **diapause**.

Dormant: Alive but not growing ; buds with an unbroken cover of scales : quiescent; inactive; a resting stage.

Dormant Spray: Chemical applied in winter or very early spring before treated plants have started active growth. They are applied to fruit trees during periods of mild weather in late winter when bud-swell occurs. They are applied mostly to kill partially grown scale insects and eggs of aphids and mites that are overwintering in branches and twigs.

Dorsal: Refers to the back, or upper sides of an object.

Dorsal Ocelli: Simple eyes usually accompanying compound eyes and found dorsally on the insect head.

Dorsal Shield: The scutum or sclerotized plate covering all or most of the dorsal surface in males and the anterior portion in females, nymphs and larvae of hard ticks (Ixodidae).

Dorsolateral: Between the top and side.

Dorsoventral: From top to bottom, or from the dorsal to the ventral lower surface.

Dose (Dosage): Quantity of an insecticide applied per individual or per unit area, or per unit volume or per unit weight.

Downwind: Direction toward which the wind is blowing.

Drench: Saturation (thorough soaking) of the soil with a pesticide, or an oral treatment of an animal.

Drench Treatment: The application of a liquid chemical to an area until the area is completely soaked.

Drift: Movement of spray or drift material by wind or air-currents outside the intended area, usually as fine droplets, during or shortly after application. Accidental movement of toxic compound from the site of application

into susceptible plant, wild life, domestic livestock, or bees, or into water supplies intended for fisheries or for human consumption is of grave concern. The addition of drift control adjuvants like Sta-Pul® (a polyvinyl polymer adjustment) and Paratac® (an oil soluble polyisobutylene polymer) increase the droplet size with two diluents—water and a paraffinic oil (Orchex 796), and decrease the percentage of smaller droplets.

Drizzle: A light rain falling in small drops.

Drone: Drones are male bees, they are larger and stouter than queens or workers, have no pollen basket, stinger, or wax glands. Their proboscis is shorter than that found on workers, and their eyes are much larger. When inside the colony, they stay near the brood area where workers feed them regurgitated nectar from their crop. Mating flights occur after they are 12 days old. Prior to these flights they engorge on honey and thoroughly clean their antennae and eyes. Drones can be distinguished from queens in that the abdomen of a queen tapers to a point, whereas in the drones it is blunt or rounded. The number of drones in the colony may be in the hundreds. The drone larvae hatch from unfertilized eggs. Mated queen lays unfertilized eggs in the hexagonal wax cells similar to but larger than worker cells. On the fourth day, drone larvae are fed a diet of **drone jelly**, which is similar to worker jelly but contains more pollen and honey. After six and a half days of feeding, the cells of drone larvae are capped with wax. The capped drone cell is dome-shaped, like a bullet's head, and is readily distinguished from the slightly convex shape of the capped worker cell. Newly emerged adult drone begs food from a worker bee, but later he feeds himself from the honey stores. Drones never collect food, secrete wax, or feed the young. Drones are produced throughout the life of the honeybee colony, either by the queen or perhaps by the workers with developed ovaries. Males contribute little to the colony, living only to mate, their genitalia are ripped out after successful mating and they bleed to death.

Drop Spectrum: Distribution by number or volume of drops of spray into different droplet sizes.

Droplet: Spherical body of fluid that is produced by a spray nozzle or spinner.

Droplet Density: Number of droplets required per unit area (generally per 1cm^2) for effective coverage of target in a spray operation.

Droplet Size: A spray cloud never consists of identical-sized drops as the spray equipment relies on forcing liquid through a hole under pressure to produce the spray and this process produces particularly variable drop sizes. The sprays are classified according to their droplet size. Sprays having up to $100\ \mu\text{m}$ droplet size are designated as **very fine spray**, sprays with $101\text{-}200\ \mu\text{m}$ droplet size are called **fine sprays**; while sprays of size $201\text{-}300\ \mu\text{m}$ are known as **medium sprays**. But if droplet size is more than $300\ \mu\text{m}$ the sprays are referred as **coarse sprays**. The larger drops contain most of the pesticide but cover very little of the crop surface if they are retained on the foliage at all. These large drops often bounce off the leaf they contact particularly if the leaf is hairy or very waxy. The spray reflection may occur with drops about $250\ \mu\text{m}$ or larger. Moreover larger drops are likely to spread into each other and coalesce and in this way the liquid on the leaf collapses into a very thin film and much runs off onto the ground. Smaller drops which are vast in number and account for little of the volume applied provide the desired coverage on the foliage for pest control. But in warm and dry weather, smaller drops which have enormous surface to volume ratio will rapidly evaporate and get even smaller as soon as they leave the nozzle. Moreover the problem with smaller drops is that they have very little movement and lose speed very rapidly. Drops in the range of $30\text{-}50\ \mu\text{m}$ diameter may be right for contacting insects resting on foliage, whereas $50\text{-}100\ \mu\text{m}$ drops are more likely to deposit on and be retained by the foliage itself.

Dryland: Also known as upland. Level area without levees and sloping areas which are

not terraced where rice or other crop is grown during the rainy season without retaining water to the field.

Duct: Any tube which conveys fluid or other substances.

Ductless Glands: Glands which do not communicate with any organ directly by means of a duct such as endocrine glands.

Ductus Seminilis: In female Lepidoptera, the tube connecting bursa copulatrix and the common oviduct.

Dufour's Gland: Also called alkaline gland. An exocrine gland on the ventral posterior part of the abdomen of female Hymenoptera. The secretion of Dufour's gland has a variety of functions including lubrication of the ovipositor and release of alarm and trail-marking pheromones.

Dulosis: The relation in which workers of a parasitic (dulotic) ant species raid the nests of another species, capture brood (usually in the form of a pupae), and rear them as enslaved nestmates.

Dun: Alternatively known as subimago. Duns are winged but sexually immature mayfly adults which has to undergo another moult.

Duncan's Multiple Range Test: In statistics, a mathematical calculation used to make comparisons among all possible pairs of treatments regardless of the number of treatments involved. This test is applicable in case treatment under investigations are equi-replicated. This test is better than other tests as lesser amount of errors creeps in during its application.

Dunnage: Materials such as wooden planks, loose wood of any kind and wheat straw, which insulate the stored material against the seepage of moisture from the floor and sides of walls.

Duplex: Double ; consisting of two distinct structures (e.g., duplex setae on legs in some spider mites).

Dust: A dry mixture consisting of the pesticide and some inert carrier such as clays, talc, attapulgit, walnut shell, calcium

carbonate and others as carriers or diluents to facilitate application. Fine dry dust particles are usually less than 30 µm in diameter. Most dust formulations contain between 0.5 and 10 percent of active ingredient. Most dusts are used to treat seeds, to protect horticultural crops grown in long narrow polythene tunnels. But most dust is removed from foliage by rain, although the very small particles adhere very effectively to plant surfaces. Dusts with a low content of active ingredient (0.5% a.i.), with a short persistence such as malathion and primiphos methyl have been commonly mixed with grain for insect control.

Dust Driftless (DI-Dust): This pesticide formulation overcomes the dust problems associated with the common dusts. It has mean particle diameter of 20-30 µm which differentiates it from the conventional dusts having mean diameter of only 10-12 µm. This dust formulation has good floatability which enables the coverage of lower side of leaf also. It is environmentally safe, floats less during application and has good coverage of the target. Many organophosphates and carbamate insecticides are recently being formulated as DL-dust for use.

Duster: Equipment for applying pesticide dusts to a crop.

Dyar's Rule: An empirical rule based on the observation that the width of the head capsule increased in a regular linear progression in successive instars of caterpillars (Lepidoptera) by a ratio (range 1.3-1.7) that was constant for a given species. Dyar's rule states that :

$$\frac{\text{Post-moult size}}{\text{Pre-moult size}} = \text{Constant}$$

Thus if the logarithm of the size of the head is plotted against the number of instar, the resulting graph will be a straight line. Any deviation from a straight line indicates a missing instar. Dyar's rule is useful in determining the total number of instars in a life cycle. In practice, however, there are many departures from Dyar's rule, as the progression factor is not always constant especially in field populations subject to variable conditions of food and temperature during growth.

Dynamic: Producing or manifesting activity.

EC₅₀: The median effective concentration (ppm or ppb) of the toxicant in the environment (usually water) that produces a designated effect in 50 percent of the test organisms exposed.

Ecdysial Cleavage Line: Preformed lines of weakness along which the shed cuticle of the cranium splits during ecdysis, cuticle in the region of these lines lacks the exocuticle.

Ecdysial Fluid: Moulting fluid; a liquid secreted by glands in the epidermis of an insect, having the function of dissolving away the endocuticle by enzyme action. In this way the exocuticle and the epicuticle, which together form the hard outer part of the exoskeleton are loosened prior to being shed when the insect moults.

Ecdysis: Also known as moulting. The process of shedding the skin (exoskeleton) undertaken periodically by insects. Generally this takes place a definite number of times during the larval stage and, in holometabolous insects, once more when the adult emerges from the pupa. Ecdysis enables the insect to grow rapidly after each moult before the new cuticle hardens. The stages between each moult and the next are known as **instars**.

Ecdysone: Hormone secreted by insects essential to the process of moulting from one stage to the next. Also termed as moulting hormone. It is secreted by the prothoracic (=thoracic or ecdysial) glands which are inconspicuous tissues often associated with the first pair of thoracic spiracles. Although small, their effect is monumental, for they

produce a group of hormones, the **ecdysones** (=growth and differentiation or moulting) that activate the epidermal cells to produce both a new exoskeleton and moulting fluid. When juvenile hormone is absent or is in low concentrations, ecdysones may induce metamorphosis of the immature to an adult.

Ecdysteroids: The general term for steroids that induce moulting. The primary site of ecdysteroid synthesis is the prothoracic gland, which develops during embryogenesis from ectodermal cells in the head, and in some insects remains there to be known as ventral glands. In cyclorrhaphan Diptera, the prothoracic gland has been incorporated into a ring gland that also consists of the corpus allatum and corpus cardiacum. In other insects, the glands are found in the thorax where they form loose chains of cells, with a close association with the trachea that has led to their often being called **peritracheal glands**. Since pterygote insects no longer moult, prothoracic gland degenerates in most adult pterygote insects, but in apterygote insects which continue to moult as adults- they retain their active prothoracic glands. In many female adults- ecdysteroids synthesis is shifted to the ovaries.

Eclosion: The emergence of an insect from its pupa is known as **eclosion**. The phenomenon is sometimes improperly called **hatching**, a term commonly used for the emergence of the immature insect from the egg. Chewing insects may employ their jaws to gnaw their way to freedom. Some sucking insects secrete a liquid which softens the silk

at one end of the cocoon. Some Lepidoptera possess a series of spines which are used to slit the cocoon.

Eclosion Hormone: A hormone, synthesized by the median neurosecretory cells, stored in and released from the corpora cardiaca, and controlled by a circadian clock, that influences behaviour associated with pupal adult ecdysis.

Ecoclimate: Climate within the plant (crop) community.

Ecological Control: The manipulation of existing environmental factors either to harm the pest directly, or benefit natural enemies of the pest. Ecological control procedures involve the removal, destruction, modification or isolation of materials that might favour the survival of an insect pest by affording food or making a site suitable for breeding and/or dormancy.

Ecological Efficiency: The efficiency of a trophic level is expressed as ecological efficiency. It is calculated as follows :

$$\text{Ecological Efficiency (EE)} = \frac{\text{Calories ingested by carnivore}}{\text{Calories ingested by prey}} \times 100$$

Ecological Homologues: Species that have the same fundamental ecological requirements and, therefore, can not occupy the same area indefinitely without one species displacing the other.

Ecological Isolation: A condition in which interbreeding between two or more otherwise sympatric populations is believed to be prevented by mating in different ecological niches.

Ecological Niche: The place an organism occupies in its biotic relationships and physical environment as determined by its particular structural adaptations, physiological adjustment, and developed behavioural patterns.

Ecological Race: A local race that owes its most conspicuous attributes to the selective effect of a specific environment.

Ecology: The study of the interactions between organisms and their environment.

Ecomone: Chemical substances originated either from organisms or the abiotic environment and provide communicative signals.

Economic Control: Control of a pest such that expenditure on control measures is more than compensated by increased value of yield.

Economic Damage: The amount of pest-induced injury to a crop which will justify the cost of applying pest control measures.

Economic Injury Level (EIL): The lowest density of pest population that does economically significant damage. Upon establishment in a favourable environment, any population increases in density of an insect pest to an upper limit which does not exceed due to predation, competition, or other environmental factors. Density to an upper limit is also called as **carrying capacity** or **environmental resistance** and is designated as **k**. Economic injury level (EIL) is an arbitrary density lower than **k**; at densities higher than EIL the insect is considered to be a pest. EIL's are not constant, but vary with market conditions, agronomic practices (variety, fertilizer, irrigation etc.), geographic location and time. Cost of control and consumer preferences are factors in the determination of EIL. The concept of EIL has marginal utility to pests of public health importance wherein the most critical factor is the presence, or even the potential of a pathogen within the vector or host population. The population density at which a pathogen is maintained by the vector can be considered to be the EIL. An economic threshold should be established well below this for humanitarian reasons as well as because of the potential for societal disruption due to outbreak of a disease epidemic.

Economic Level: The insect pest level at which additional management practices must be employed to prevent economic losses.

Economic Pest: A pest causing a crop loss of about 5-10%, as per definition.

Economic Poison: Any substance or mixture of substances intended for preventing, destroying, repelling or mitigating insects, rodents, nematodes, fungi or weeds or any other form of life declared to be a pest and any substance or mixture of substances intended for use as a plant regulator, defoliant or desiccant.

Economic Threshold (ET): The pest density at which control measures should be applied to prevent an increasing pest population from reaching the economic injury level. It is sometimes also known as action threshold. Although the ET is defined in terms of population density, it actually represents the time for instigation of control measures.

Ecophenotypic Variation: Also called habitat variation. A nongenetic modification of the phenotype by specific ecological conditions, particularly those of a habitat.

Ecospecies: A group of populations so related that they are able to exchange genes freely without loss of fertility or vigour in the offspring.

Ecosystem: The interacting system of all the living organisms of an area and their nonliving environment. Producers, consumers, decomposers and abiotic substances or components are the structural components of an ecosystem. No size limits are placed on ecosystem—the largest one, of course, is the world's biosphere, but smaller sizes such as a square kilometre of forest, a square metre of grassland or a pond, or even a pile of dung, are more practical for individual study. Ecosystems vary greatly in geographical extent and in internal size and complexity. Boundaries between adjacent ecosystems overlap and merge, such as the edge of a pond or a river floodplain. Autotrophs, heterotrophs and decomposers are biological components of ecosystem, while climate (temperature, rainfall, seasons etc.), inorganic substances and organic compounds are different types of physical components of an ecosystem.

Ecosystem Balance: Also known as **cybernetics**. This is an integral part of natural

ecosystems and is built into the interactions between processes and components. Usually these are feedback mechanisms which are commonly visualized as mathematical models that form the science of **systems ecology**. Prey-predator interactions are the simple examples of this system. As the prey population density increases, there is a lag in the predator population density increase. As the prey population expands, the predators are able to find the prey more readily and this allows the predators population to gradually build up also. A point is reached where the population density of the predator is sufficient to search out and devour a high proportion of prey.

Ecotype: A descriptive term applied to plant races of varying degrees of distinctness which owe their most conspicuous characters to the selective effects of local environments.

Ectadenia: Accessory glands arising from the ectoderm of the male's ejaculatory duct in some insects.

Ectoderm: The outer embryological layer that produces the nervous system, the integument, and several other parts of an insect.

Ectognathous: The mouthparts project freely from the head capsule (e.g., Thysanura, Pterygota). The mandibles and maxillae are visible or secondarily recessed, but lateral folds of the head are absent.

Ectohormone: A substance secreted by an animal to the outside causing a specific reaction, such as determination of physiological development in a receiving individual of the same species.

Ectoparasite: A parasite which lives externally on the body of its host. The large majority of parasitic insects feed through the outer surface of the host. Ectoparasites with chewing mouthparts usually ingest cells or blood seepage, whereas others with piercing-sucking mouthparts either penetrate and take blood directly from blood vessels or lacerate blood vessels and feed from the resulting blood pool. Some feed only as adults (fleas,

mosquitoes), others only as larvae (some Hymenoptera), and certain species normally those with incomplete metamorphosis, are parasites both as adults and as immatures. Several adaptations often include the absence of wings in most of the obligatory forms.

Ectosymbiont: A symbiont that associates with the host colonies during at least part of its life cycle in some relationship other than internal parasitism.

Ectothermy: The ability to regulate the body temperature relative to the surrounding environment. They derive heat from outside the body, and are cold-blooded or poekilotherms. These insects depend on radiation to maintain body temperature for normal metabolism. They also raise their temperature by exposing themselves to direct sunlight, by activating or by seeking warm sites. Conversely they may lower their body temperatures and water loss by resting in shade and cool substrates. Heat gain or heat loss is rapid because of their small size.

ED₅₀: The median effective dose, expressed as mg/kg of body weight, which produces a designated effect in 50 percent of the test organisms exposed.

Edaphic Factor: The influence of soil properties on organisms.

Eelworms: The common name for nematodes especially those living in the soil or as plant parasites.

Effective Environment: All environmental factors that directly influence the fate of a population.

Efficacy: A measure or appraisal of the effectiveness of a control tactic with respect to the extent that the tactic controls the target pest.

Egestion: The process of ridding the body of any waste material as by defecation and excretion.

Egg (Ovum): Insect eggs are of many shapes, many of them are simple smooth ellipses; others may be ribbed or sculptured in various ways; some are provided with processes of

different kinds, such as the lateral floats of *Anopheles* eggs, which keep them afloat in water. Insect eggs differ greatly in size, collembolan eggs are smallest while eggs of *Polyphemus* moth is 3mm in diameter. A typical egg is a cell encased in two coverings. The outer covering is a tough shell, the **chorion**, which has one to several minute pores, or **micropyles**, through which the spermatozoa enter the egg. Within this chorion is a delicate enveloping membrane, the **vitelline membrane** surrounding the large nucleus and the mass of cytoplasm. The cytoplasm consists of a large central area of yolk (essentially a food store) and a peripheral or cortical layer which is denser than the central part and relatively free from yolk.

Egg Burster: A set of hard spines or ridges on the head of an embryo of insect, used for breaking open the egg shell when hatching. The Colorado beetle larvae, for instance, has three pairs of spines; the embryo flea has a knife-like projection.

Egg Mass: A group of eggs deposited by the female insect which are adjacent to each other as in the rice bug or overlapping such as in the yellow stem borer as opposed to eggs laid singly.

Egg Pod: A capsule that encloses the egg mass of grasshoppers and is formed through the cementing of soil particles together by secretions of the ovipositing female.

Ejaculation: The release of sperm by the male.

Ejaculatory Duct: A duct formed by the joining of vas deferens from each testis and involved in the propulsion of semen. It is ectodermal in origin and is lined with cuticle whose walls are heavily muscularized. Posteriorly the ejaculatory duct may run through an evagination of the body wall, which thus forms an intromittent organ. In Ephemeroptera, no ejaculatory duct is present, and each vas deferens opens directly to the exterior.

Elateriform Larva: A larva with the form of a wireworm : that is long, slender, heavily

sclerotized, with short thoracic legs, and with few body hairs.

Elbowed Antenna: An antenna with a long first segment and the remaining segments attached to the first at a distinct angle. Also known as geniculate type of antenna (e.g., Apidae).

Electroantennogram: An instrument to study the whole antennal responses. It gives a measurement of the summed receptor potentials of a number of olfactory receptors responding to a stimulus.

Electron Microscope: A microscope which works on electronic beam penetrating the thin film of the material (object) producing a much highly magnified image on a fluorescent screen which is recorded by a camera. The resolving power of an electron microscope is much greater than an ordinary microscope. Electron microscope helps in : **1.** Visual examination of structures too fine to be resolved with ordinary or light microscopes, and **2.** The study of surfaces that emit electrons. The first function made transmission electron microscopes essential research tools in biology. The scanning electron microscope came to play an increasingly important role in the study of the surfaces of solid objects at more moderate modifications. Various emission electron microscopes serve more specialized research purposes.

Electronic Data Processing (EDP): The sorting and storage of data with the help of computers.

Electrophoresis: A process of separating different molecules, particularly polypeptides, owing to their differential rates of migration in an electric field.

ELISA: Enzyme-linked immunosorbent spray. ELISA is now becoming a rapid and reliable analytical method for the estimation of pesticide residues in numerous environmental samples. This is possible because the sample requires less clean-up than for GLC and is also economical than the classical methods usually employed. Another advantage of ELISA is that it can be

conveniently used for many modern pesticides which show instability to chromatographic technique and degrade during analysis by classical methods. ELISA is used for detecting and identifying pest organisms using the affinity of antibodies for antigens that are specific to particular organisms.

Elytron: The hard horny fore wings of beetles and earwigs which act as protective cases for the membranous hind wings.

Emarginate: Notched or indented.

Embioptera: A pterygote order of insects. Representatives are called web spinners. They are narrow-bodied elongate, cylindrical or slightly flattened. Compound eyes small, kidney-shaped. Thread-like antennae. Mouthparts biting, forward facing. Front legs with swollen basal tarsal segments, containing silk glands. Possess incomplete metamorphosis. Mainly distributed in tropical areas. Only the adult females and the nymphs (which closely resemble females) feed. Males do not feed as adult.

Embolium: A narrow strip of the corium, separated by a suture, along the anterior margin of the front wing of some Heteroptera.

Embryo: A young organism in early stage of development.

Embryogenesis: Developmental events that occur between the formation of the zygote and the exit of the fully developed individual from the egg (eclosion).

Embryology: The part of biology dealing with formation and development of the embryo.

Embryonic Cuticle: A thin cuticle formed by the larva in the late stages of development within the egg and cast off at the time of hatching.

Emendation: In nomenclature, an intentional modification of the spelling of a previously published scientific name.

Emergence: The act of the adult insect leaving the pupal case or the last nymphal skin; germination of a seed and the appearance of the shoot.

Emergence Traps: These are passive trapping techniques in water. They are generally large inverted cones, into which adult insects fly on emergence. Such traps can also be used in terrestrial situations such as over dung or detritus etc.

Emetic: A substance used to make humans or animals vomit.

Emigration: The movement of individuals out of a population.

Empodium: A single, pad-like or bristle-like structure often present between the tarsal claws of insects, either between paired pulvilli or alone especially in Diptera.

Emulsifiable Concentrate (EC): An insecticide formulation in which the active ingredient is dissolved in a non-aqueous solvent to which emulsifiers are added. Emulsifiers are partly hydrophilic and partly lipophilic in nature. A pesticide dissolved in a suitable organic solvent such as xylene can not be mixed with water, because the two liquids form separate layers. The addition of an emulsifier enables the formation of a homogenous and stable dispersion of small globules, usually less than 10 μm in size of the solvent in water. The small globules of suspended liquid are referred to as the **disperse phase**, and the liquid in which they are suspended is the **continuous phase**. The concentration of most emulsifiable concentrate formulations is usually 25% w/v active ingredient. An unstable emulsion 'breaks' if the 'disperse phase' separates and forms a 'cream' on the surface, or the globules coalesce to form a separate layer. Creaming is due to differences in specific gravity between the two phases, and can cause uneven application. Agitation of the spray mix normally prevents creaming.

Emulsifiable Liquid: A liquid that will form an emulsion when it is mixed with water.

Emulsifier: Spray additive which permits formation of a stable suspension of oil droplets in aqueous solution, or of aqueous solution in oil.

Emulsify: To make into an emulsion. When

small drops of one liquid are finely dispersed (distributed) in another liquid, an emulsion is formed. The drops are held in suspension by an emulsifying agent, which surrounds each drop and makes a coating around it.

Emulsifying Agent: A material which facilitates the suspending of one liquid in another; for example, oil dispersed in water.

Emulsion: A stable dispersion of oil droplets in aqueous solution or vice versa. There are two types of emulsions. **1. Oil in water (OW type)**—in which water is external or continuous phase and oil is the internal or dispersed phase; and, **2. Water in oil (WO type)** - in which oil is external and water is internal. Generally OW emulsions are required for spray purposes in agriculture.

Emulsions in Water (EW): These are stabilized emulsions in water. For the formulation of hydrolytically stable liquid compounds, they are an attractive alternative to emulsifiable concentrate (EC). Such combinations represent special challenges particularly in terms of long term physical stability, and are also known as **suspoemulsions**.

Enation: Literally means 'small leaf'. A small abnormal growth of host tissue or eruption from a plant surface, often from veins (mostly from leaves, petioles and flowers); usually induced by certain virus infections.

Encapsulated Pesticides: Encapsulation is a method of formulating pesticides in which the active ingredient is encased in a material (often polyvinyl) resulting in sustained pesticidal release and decreased hazard. Also, a method of disposal of pesticides and pesticide containers by sealing them in sturdy, water proof, chemical proof containers which are then sealed in thick plastic or steel packing to resist damage of breakage so that contents can not get out. This formulation ensures more safety for the user as it shows a remarkable reduction in oral and dermal mammalian toxicity as compared to the emulsifiable concentrates. Encapsulation of the active ingredient which are volatile may also offer an advantage. Microencapsulated

formulations have been developed for volatile chemicals, e.g. pheromones. An encapsulated insecticide can be targeted at foliar feeding Lepidoptera and the capsule wall is ruptured only when it reaches the alkaline gut. Specificity can be increased especially if a suitable attractant is used with a stomach poison, for example in leaf-cutting ant control. In practice slow-release characteristics of microcapsules are particularly useful for application of chemicals which affect the behaviour of insect.

Encapsulation: A protective mechanism in which large numbers of haemocytes become layered around a foreign entity, such as a parasitic worm, that has invaded the haemocoel.

Encephalitis: Inflammation of the brain in human beings. This is caused by a virus which is transmitted by mosquitoes. The disease is sporadic in tropical and temperate parts of the world.

Endangered Species: A species of animal or plant threatened with extinction.

Endemic: A disease that is regularly present in a given area or areas but does not necessarily cause significant losses. Such a disease may become epidemic. Such diseases are restricted to or native to a particular locality.

Endite: A lobe of a leg segment that is directed inwards towards the midline of the body.

Endite-Exite Theory: A theory of wing development which suggests that protowings developed from the fusion of inner and outer appendages (endites and exites respectively) of basal leg segments which were already articulated and might have been under some sort of muscular control.

Endochorion: The inner layer of the chorion or shell of an insect's egg.

Endocrine Glands: Ductless glands whose products are released directly into the insect haemolymph. Released products have an important role in metabolism. The endocrine glands of insects controls such functions as

moulting and metamorphosis by the elaboration of hormones.

Endocrinology: The study of endocrine glands and secretions, and of hormones and their effects.

Endocuticle: The innermost layer of the cuticle secreted by epidermal cells. It is unsclerotized, may or may not be pigmented and is digested during moulting.

Endoderm: The inner germ layer in a gastrula, which lines the archenteron; any tissue derived from this layer such as the epithelium of digestive and respiratory organs, and of glands associated with digestive system.

Endogenous Rhythms: Clock-like or calender-like activity patterns, commonly **circadian**, unaffected by external conditions.

Endoparasite: A parasite that lives internally at the expense of another organism, which it does not kill.

Endopleurites: Y-shaped ingrowths of cuticle from the sides of the thorax forming pleural ridge in the wing-bearing segments of insects. These support the wing above and articulates with the coxa of leg below.

Endopterygota: Alternatively known as Holometabola - subdivision of subclass Pterygota, the representatives of which undergo complete metamorphosis. The young stages are called larvae and look very different from the adults they will develop into. Their wings develop internally. The total transformation from larva to adult takes place during a pupal stage. The endopterygote insect orders are recognized under **3** superorders, **1. Neuropteroidea** (includes Megaloptera and Raphidioptera); **2. Mecopteroidea** (includes Lepidoptera and Trichoptera); and **3. Hymenopteroidea** (includes Hymenoptera).

Endoskeleton: A skeleton or supporting structure on the inside of the body. Rigid finger-like ingrowths of the integument associated with muscle attachments are commonly called **apodemes** or if larger and

arm-like, **apophyses**. Large apophyses in the head and thorax buttress the exoskeleton and provide areas for muscle attachment. These apophyses serve as the endoskeleton. The integument may also be infolded linearly to produce internal ridges for strengthening the body wall or for muscle attachment.

Endosternites: Apodemes or ingrowths from the ventral cuticular plates of an insect. They form part of the endophragmal endoskeleton to which important muscles are attached.

Endotergite: An infolding from tergite for muscle attachment.

Endothermy: The ability to increase body temperature beyond that of the environment through basal metabolism. Endothermy is restricted to the periodic activity periods, while the insect becomes ectothermic during non active periods.

Endotoxin: Any of a group of toxic substances found in certain disease producing bacteria and liberated by the disintegration of the bacterial cell. They are released after autolysis.

Energetics: Energy flow and utilization through the ecosystem.

Energy Flow: This originates from solar radiation of which only a fraction (up to 5%) is used to fix carbon in organic compounds by autotrophs. Most solar radiation (90-95%) is used up in evaporation and maintenance of climatic zonation. Primary consumers such as leaf-eating caterpillar, are able to transfer to their bodies only about 10-20% of the biochemical energy stores by the leaves (autotrophs). Each level of secondary consumption has about the same efficiency (10-20%).

Enphytotic: The sudden and destructive development of a plant disease, usually over large areas.

Entad: Inward relative to the midline of the body.

Enteric: Pertaining to alimentary canal.

Enteromyiasis: Infection of intestines by the maggots of flies. Nearly all the internal

parasites of vertebrates belong to the order Diptera. Infestation with the maggots of flies is termed **myiasis**.

Entognathous: Based on jaw articulation, the hexapods are placed in subclass Archaeognatha. The mouthparts are enclosed within a cavity formed by the ventrolateral extension of the genae which fuse in the midline (e.g., Protura, Collembola, Diplura). These small arthropods form an important group from an evolutionary as well as ecological point of view. They are elongate; antennae are long and multi-segmented, compound eyes large and contiguous. They have three ocelli, 7-segmented maxillary palp. Thorax humped, abdominal segments with small appendages called styles. Abdomen with a pair of multi-segmented cerci and a much longer central filament.

Entoleter: A centrifugal force machine to kill insects infesting grain.

Entomogenous: Microorganisms growing in or on the bodies of insects; used of fungi causing disease in insects.

Entomologist: One who studies insects scientifically. Entomologists observe, collect, rear and experiment with insects. Research undertaken by entomologists covers the total range of biological disciplines including evolution, ecology, behaviour, anatomy, physiology, biochemistry and genetics.

Entomology: Science that deals with insects or the Hexapoda. The term is derived from the Greek word 'entomon' meaning an insect.

Entomopathogen: A pathogen (disease-causing organism) that attacks insects particularly.

Entomophagous: Insects that kill other insects are termed as entomophagous. Parasites and predators are termed as entomophagous insects.

Entomophagous Plants: Entomophagous plants trap insects using one or a combination of different mechanisms. Some such plants are covered with a normal sticky exudate (fly catcher plant, *Drosophyllum* sp.) ; some plants have developed structural

modifications that entrap insects, but the plants do not move (pitcher plants *Sarracenia* sp., *Darlingtonia* sp.) ; and a group of plants has developed mechanisms that move modified leaves to entrap insects. More than 500 plant species make use of organic compounds from insects that they trap and digest.

Entomophagy: The consumption of insects by other animals (e.g., spiny anteaters).

Entomophilous: The plant species that are pollinated by insects.

Entomophily: Pollination of flowers by insects.

Entomophobia: Also known as **delusory parasitosis**. In some individuals, continued annoyance by insects and arthropods can cause psychotic behaviour termed **entomophobia** or **delusory parasitosis**. Victims of entomophobia imagine that insects are jumping at them, are feeding on them, are making loud noises while they are walking around at night, are ruining their food, are crawling on their skin, and so forth.

Entomophthoraceus: Insect-devourers fungi belonging to the family Entomophthoraceae, best known are in the genus *Entomophthora*.

Entomopox Viruses (EPVs): Insect viruses that resemble vertebrate pox viruses in having a beaded lipoprotein envelope, a plate-like core, and either one or two lateral bodies; they differ in being occluded in large proteinaceous bodies. These are occluded DNA viruses that cause diseases, varying from being chronic to acute. After ingestion, the occlusion bodies release virions in the midgut where the virions invade via the midgut microvilli. These viruses replicate extensively throughout the tissue. EPVs have been found in Coleoptera, Lepidoptera and Diptera.

Entotrophi: Synonym of Diplura. Also known as entognatha.

Envelope: A sheath of carton or wax surrounding the nest of a social insect, especially that of a social wasp.

Envenomation: The poisonous effects caused by the bites, stings, or secretions of insects and other arthropods.

Environment: The totality of physical, chemical, and biotic conditions surrounding an organism. It may be as small as a thin layer of air around an individual or as large as a continent or the entire world.

Environmental Manipulation: Alteration of environment, particularly to enhance natural populations of insect predators and parasitoids.

Environmental Protection Agency(EPA): In U.S.A., the federal agency responsible for pesticide rules and regulations, and all pesticide registrations.

Environmental Stability: This has an important effect on insects and their adaptation. In general insects inhabiting environments that have short-term stability (such as strongly contrasting seasons or unpredictable weather) are usually small, very mobile, and have high reproduction potential and short generation time; these are called **r**-strategists. But insects in highly stable environments tend to be longer, more territorial, have lower reproduction potential, and have longer generation time. These insects are called as **k**-strategists. The **r**- and **k**-strategists form the ends of a spectrum that is referred to as the **r-k** continuum. It is possible to compare population density of various types of population in the **r-k** continuum and their interaction in the predator-prey population. The desert locusts and houseflies are r-selected strategists as their physical environments are highly unstable and they have few natural enemies and predators, and disperse rapidly and widely. Codling moth, usually lives in stable environment, has low reproductive capacity and little fluctuation in population density and is a k-selected strategist. Most insects lie between these extremes of r- and k-selected strategists. Those nearest the r-end of the continuum such as aphids are ones most likely to escape control by natural enemies and become epidemic pests.

Enzootic: This term is usually used to suggest long term presence of disease in an animal population but also suggest disease at a low level of incidence.

Enzyme: A natural substance which regulates the rate of a reaction but which itself remains chemically unchanged.

Eperythrozoonosis: A disease in swine caused by the protozoan, *Eperythrozoo suis*; symptoms are fever and anemia, may be fatal; transmitted by hog louse.

Ephemeral: Short-lived plant or animal species; completing life cycle within a brief period.

Ephemeroptera: An order of winged insects. They are soft-bodied, antennae short, compound eyes large. They have reduced non-functional mouthparts. Possess two pairs of wings, hind wings are absent in some species. Abdomen has a pair of elongate cerci. Adults are short-lived and non-feeding. Nymphal stages are aquatic. Incomplete metamorphosis. Worldwide in distribution but mostly found in temperate regions. Mating swarms often observed over water. They are essential component of freshwater food chains. Commonly known as mayflies.

Epicranial Suture: A line of weakness on the head, above the antennae, and in many insects it is shaped like an inverted 'Y'. Not a true suture, and without reference to segmentation, often mis-called the **frontal suture**. Also known as **ecdysial line** for it is along this groove that the cuticle splits during ecdysis.

Epicuticle: The insect cuticle consists of a number of layers. There are two major layers : the very thin and outer epicuticle (0.05 - 4.0 μm thick), and much thicker inner procuticle (up to 200 μm thick). The epicuticle despite its thinness possesses characteristics that make it an important layer of cuticle. Epicuticle consists of four layers namely the outer cement layer, the wax layer, the cuticulin layer and the inner epicuticle. These four layers may be of varying thickness depending on the species and life stage. Epicuticle covers

the entire external surface of an insect, except same chemoreceptive sensillae, midgut and ends of gland cells. The main function of epicuticle is to prevent water loss from the insect body. It can maintain the water content in the body by uptake of water in terrestrial as well as aquatic insects, and also dictates the extent of expansion of a newly ecdysed cuticle or distension of cuticle during the feeding activity of sap-sucking or blood-sucking insects.

Epidemic: A widespread and rapidly developing outbreak of an infectious disease of humans in a community; used loosely for plants and animals.

Epidermis: The cellular layer of the integument that secretes or deposits a comparatively thick cuticle on its outer surface. The epidermis is closely associated with moulting - the events and processes leading up to and including ecdysis. Epidermis lies just above the basement membrane and is the only living portion of the integument. It is ectodermal in origin. Modifications of the epidermal cells produce structural features such as dermal glands, sensory receptors, and oenocytes.

Epigaecic: Living, or at least foraging primarily above ground.

Epimeron: The posterior sclerite of a thoracic pleuron.

Epimorphic: Describing development in which the segment number is fixed in the embryo before hatching.

Epinasty: Increased growth on upper surface of a plant organ or part (especially of leaves) causing it to bend downward.

Epiopticon: The middle section of the optic lobe of an insect's brain, also called the external medullary lobe.

Epipharynx: A mouthpart structure on the inner surface of the labrum or clypeus.

Epiphysis: A movable pad or lobe-like process on the inner surface of the front tibia (Lepidoptera).

Epiphyte: A plant that grows upon another

plant which it uses as the chemical support but not as a food source.

Epiphytotic: The sudden, widespread, and destructive development of a disease on many plants, usually over large areas (corresponds to an epidemic of a human disease).

Epipleurite: A small lateral cuticular plate sometimes present on the thorax of an insect, when a pleurite is divided horizontally into two parts.

Epipleuron: The turned-down outer edge of the elytron of a beetle.

Epiproct: A process or appendage situated above the anus and is a representative of eleventh abdominal segment.

Episternum: The area of a thoracic pleuron anterior to the pleural suture.

Epistomal Suture: The suture between the frons and the clypeus.

Epistome: The part of the face just above the mouth; the oral margin (Diptera).

Epithelium: The layer of cells that covers a surface or lines a cavity.

Epizootic: Disease affecting a large number of insects simultaneously, corresponding to epidemic in man. Essentially there are four primary components in the development of an epizootic : the pathogen population, the host population, an efficient means of pathogen transmission, and the environment, all of which are closely interrelated.

Equal Weighting: The method which treats all taxonomic characters as equally important, a key assumption of phenetics.

Eradicant: A chemical used to eliminate a pest from a plant or a place in the environment.

Eradication: A complete elimination of either weed, insects, disease organisms or other pests from an area.

Ergataner: A male ant resembling a worker, because it has lost its wings.

Ergatandromorph: An ant which combines some of the characteristics of both male and worker.

Ergate: A worker ant.

Ergatogyne: A female ant without wings and looking like a worker.

Ergatoid Reproductive: Supplementary reproductive termite without a trace of wing buds. They are usually larval in external form, and with a distinctively rounded head. Also known as third form reproductive, tertiary reproductive and apterous neoteinic.

Ergatomorphic Male: An individual with normal male genitalia and a worker-like body.

Ergot: Rye smut disease caused by various fungi of the genus *Claviceps*.

Erineum: Also known as erinose. A growth of hairs in dense patches on plant leaves resulting from the attack of certain eriophyid mites.

Error: In nomenclature, an unintentional misspelling of a scientific name, as a typographical error or an error of transcription.

Eruca: A caterpillar; an insect larvae having the shape of a caterpillar.

Eruciform Larva: A caterpillar; a larva with cylindrical body, well-developed head, short thoracic legs and abdominal prolegs, and reduced or no caudal appendages. Examples are caterpillars of Lepidoptera and larvae of Mecoptera.

Erythrocyte: A red blood cell.

Escape: A plant in a treated area that either missed treatment or failed to respond to treatment in the same manner as other treated plants.

Ester: A compound formed by the union of an organic acid and an organic base (an alcohol). An example is 2, 4-D and isoctyl ester of 2, 4-D.

Ethology: The study of the behaviour of insects in their natural habitat.

Etiolation: Excessive spindliness in plants, owing to lack of sufficient light or disease.

Etiology: The science of the causes or origins of disease; the study of the nature of the causal factor and its relations with the host.

Eucephalic: In Diptera, refers to the presence of a distinct head capsule.

Euplantula: Euplantula is a pad-like structure on the ventral surface of some 'tarsomeres' of the leg.

Eurygamy: Being unable to mate in a confined space; a phenomenon characteristic of many gnats and mosquitoes.

Euryhygric: Organisms adaptable to a wide range of atmospheric humidity.

Eurythermic: Organisms adaptable to a wide range of temperatures.

Eurytopic: Having a wide geographical distribution and tolerant of a wide range of ecological habitats.

Eusocial: Applied to the condition or to the group possessing it in which individuals display all of the following three traits-cooperation in caring for the young, reproductive division of labour with more or less sterile individuals working on behalf of individuals engaged in reproduction, and overlap at least two generations of life stages capable of contributing to colony labour. This is the formal equivalent of the expressions 'truly social' or 'higher social' which are commonly used with less exact meaning.

Evagination: An outpocketing, or sac-like structure on the outside.

Evergreen: Plants that retain their functional leaves throughout the year.

Evolution: The process through which complex or specialized organisms gradually develop from simpler or primitive ones.

Exarate: A pupa in which the appendages are free and not glued to the insect body as in pupa of beetles, bees and wasps.

Exclusion: Control of disease by preventing its introduction (e.g., by quarantines) into disease free areas.

Excreta: Waste material eliminated from body or any tissue thereof.

Excretion: The elimination of waste products of metabolism is called excretion.

Haemolymph carries excess nitrogen until it is absorbed by the malpighian tubules, found at the junction of midgut and hindgut. In Collembola, labial glands excrete nitrogen.

Excretory System: In insects, excretory processes expel or render harmless those metabolic wastes and other substances that are harmful, and at the same time maintain water balance. Excretion plays key role in physiological homeostasis such as the maintenance of a constant internal environment by regulating body chemistry. In contrast to defecation (e.g., physical elimination of food not digested or absorbed), excretion involves the movement of waste molecules. The principal wastes are nitrogenous compounds resulting from protein metabolism and the breakdown of nucleic acids. Excessive amounts of other substances such as water or salts are included as wastes. Most of the excretory products in insects are regulated by the malpighian tubules and the rectum acting in concert.

Exite: A lobe of a leg segment that is directed outwards away from the midline of the body.

Exochorion: The thick proteinaceous outermost layer of the shell or chorion of an insect's egg, variously shaped and sculptured and having a small hole or micropyle at one end through which fertilization takes place.

Exocone Eye: A compound eye in which the cones are not true crystalline cones but are formed by invagination of the cornea. Such eyes occur in lampyrid beetles.

Exocrine Glands: Glands that discharge their products through apertures or ducts into the external world or into lumens of various viscera. The normal epidermal cells, the secretory cells of the malpighian tubules, all forms glandular epithelia.

Exocuticle: The hard and usually darkened layer of the cuticle lying between endocuticle and epicuticle. It is resistant to moulting fluids and is often pigmented and is not broken down during the moulting cycle. The portion which is shed during moulting is mostly exocuticle. Exocuticle is absent from areas of

body where flexibility is required (e.g. at joints and intersegmental membranes). It is very thin in soft bodied larvae.

Exogenous Rhythms: Activity patterns governed by variations in the external environment (e.g., light, temperature etc.).

Exopterygota: Also called Hemimetabola. The subdivision of pterygote insects that undergo incomplete metamorphosis. The exopterygota have diverged as two major lineages, designated as two superorders, **1. Orthopteroidea:** The orthopteroid orders are characterized by chewing mouthparts, long multiarticulate antennae, hind wings with a large anal lobe, multiarticulate cerci, and malpighian tubules, as well as other primitive features; and **2. Hemipteroidea:** The most important feature in interrelating the hemipteroid orders is the configuration of the mouthparts.

Exoskeleton: The external body wall of insects, usually involves hardened plates over at least some of its area. Spurs, scales, spines and hairs are the external processes of the body wall. They are extremely important in function such as sound production and sensing various types of stimuli. Apodemes are the internal processes formed by the invagination of the body wall. The point or line of invagination is always indicated by an external pit or groove. The apodemes provide internal areas for muscle attachment. Insects are able to move, often with amazing agility because their exoskeleton is divided into segments that are joined by more flexible intersegmental membranes serving as hinges. The chitin makes up the exoskeleton, it has remarkable chemical and mechanical properties of its own. Chitin is a polysaccharide of high molecular weight, and is infiltrated with a special protein called **arthropodin**. This substance can be hardened and simultaneously darkened to variable degrees by tanning. It is quite common for the outer portion of the cuticle, the so-called exocuticle, to be hardened and tanned. Resilin, another more flexible protein, is found most frequently in hinges of the body where elasticity is a requirement.

Exotic Species: An organism which evolved in one part of the world and which now occurs either accidentally or intentionally (by man) in a new region.

Experiment: An experiment is defined as a systematic procedure of making observations.

Experimental Design: Includes the plan and the actual procedure of laying out the experiment to have a valid analysis of results and efficient estimation of treatment effects. Depending upon the nature of his problem and available experimental material, scientist should select a design which should be capable of providing maximum information relevant to the problem under investigation subject to the limited available resources such as time, money, personnel and experimental material. Randomization, replication and local control are the basic principles in designing an experiment. These principles help in reducing the experimental error and thus make the experiment more efficient.

Experimental Unit: The different objects of study to which treatments are applied to make observations are called experimental units.

Exploitation: The simple utilization of resources without any adverse chemical or physical activity on the other.

Exploratory Trail: An odour trail laid more or less continuously by the advance workers of a foraging group. This kind of communication is used regularly by army ants.

Exponential Growth: Growth of an organism or population where increase in size is directly related to time; maximum growth rate.

Exposure: When contact occurs with a pesticide through skin (dermal), mouth (oral), lungs (inhalation/respiratory), or eyes.

Exposure Period: The length of time something has been under attack by a pest; the length of time a pest is in contact with a pesticide chemical.

Extant: Presently existing form.

Extension: Out of school education of farmers, conveying the results of research and other methods of better farming through demonstration and other media and assisting them in the adoption of better practices.

Extensor: A muscle that straightens out part of the body.

Extent of Insect Injury: Little that man grows, manufactures, or borrows from nature is free from the ravages of insects. They invade the members of both animal and the plant kingdom. Insects attack leaves, stems, buds, flowers, seeds, fruits, bark, wood and roots; in fact few parts of plants are free from their feeding. Fruits and vegetables, grains and stored products, flowers and shade trees also suffer. In the home-cereals, dried fruits, meats, clothing, stuffed furniture, woodwork, and many other products may be attacked. Many other products derived from plant and animal sources, such as wool, feathers, cigars etc. are also attacked by insects.

Exterminate: Refers to complete extinction of a species over a large continuous area such as an island or a continent.

Extra-Oral Digestion: Any digestion that takes place outside the organism by secretion of the salivary enzymes onto/into the food, with soluble digestive products being sucked up.

Extrinsic: Acting from the outside.

Extrorse: Turned away from the axis.

Exudate: Liquid discharge from diseased or injured tissues.

Exudathoria: Finger-like appendages found on the larvae of certain ant species and on a variety of termitophiles. According to one hypothesis, the exudathoria produce secretions attractive to the ant or termite workers.

Exudations: Secretions or modified excretory products from epidermal glands including such substances as oil (from oil beetles), wax (from bees), silk (from caterpillars), nutrient or sugary secretions (from termites and aphids), scents to attract other insects (from butterflies), unpleasant scents and irritant fluids for self defence (from earwigs, stinkbugs, bedbugs, caterpillars etc.).

Exuviae: The undigested exocuticle and epicuticle of nymphs and larvae shed during ecdysis.

Exuvial Membrane: A thin, homogeneous membrane that may appear in the exuvial space during moulting.

Eye Spots: Dark spots commonly found on the wings of Lepidoptera.

Eyepiece Micrometre: A linear scale in the field of vision of the eyepiece (or one of a pair of eyepieces) of a microscope for use as a measuring device.

F

°F : Fahrenheit; a unit of temperature. A thermometer scale in which the freezing point of water is set at 32° and the boiling point at 212°. To convert from Fahrenheit to Celsius : subtract 32 from the Fahrenheit reading, multiply by 5, and divide the product by 9.

FABRICIAN : Applied to a classification of the Arthropoda that is based on the anatomy of the mouthparts.

Face Shield: Refers to a transparent piece of protective equipment used by a pesticide applicator to protect his face from exposure to pesticides.

Facet: The external surface of an individual unit (ommatidium) of the compound eye. These are formed from the cuticular lenses covering the crystalline cones. Their number varies considerably - worker ants usually have less than a dozen, the housefly have got near 4000 while some dragonflies have 20,000 or even more. Parasitic and cave living insects have very few facets, some have even one. Facets are circular in shape but become hexagonal when tightly packed together.

Factorial Experiments: Experiments characterized by treatments that are composed of all possible combinations of levels in each of two or more factors, e.g., in insecticide studies where two insecticides are applied at three rates. Application of this design helps to save time, money and energy. Factorial experiment also help to estimate interaction effect of different factors which is not possible in single factor experiment.

Facultative: Incidental, not necessarily compelled under one type of environment.

Facultative Diapause: In some insect species, several generations may pass before conditions occur that induce diapause. Such type of diapause is usually induced by a pronounced change in an environmental variable such as a drop in temperature or the temporary drought.

Facultative Parasite: Parasite that can complete its life cycle without invading a host, but can also take advantage of a host if one is available.

Faeces: Indigestible wastes discharged from the digestive tract.

Fallow: The agricultural practice of leaving land uncropped for a time. Fallowing practices have been used in dry regions to allow increases of soil moisture, and fertility for growing crops. Ecologically, fallowing creates a hiatus in the supply of requisites for pests.

False Legs: Also known as prolegs. These are fleshy pad-like outgrowths from the abdomen and are used for gripping the surfaces, whereas true jointed legs which are borne on the thorax are used for walking purposes. Caterpillars of butterflies and moths have 5 pairs, while sawflies have 7 pairs. In butterflies and moths, prolegs bear rows of tiny hooks (crochets) whereas sawfly larva lack these hooks.

Family: A subdivision of an order, suborder, or superfamily, and containing a group of

related genera, tribes or subfamilies. Insect family names always end in **-idae**.

Fanning: Fanning is an activity of bee workers of creating air currents to evaporate moisture from open cells. On warm days when nectar is rapidly coming in, honeybee workers will arrange themselves in front of 25 to 50 per cent of the entrance to the hive. They face inward, spaced so that their wings do not touch when extended sideways, and then rapidly move them (180 to 195 times per minute) to push air outward. This sets up an air flow that ranges between 57 to 90 metres per minute. In extreme conditions, other bees will take a similar position on the opposite side of the entrance. They face outward, forcing air in. This not only evaporates moisture from the honey, but cools the hive.

Farina: A substance having the consistency of flour or meal; the fine mealy-like powder found on some insects.

Fascicle: A small bundle; the bundle of piercing stylets of insects with piercing-sucking mouthparts.

Fastigium: Front portion of head (vertex) between and above compound eyes, often with angular facets, sculptured or produced as a ridge, point, tubercle, or cone, useful in classification of many jumping arthropods.

Fat Body: The principal food storage organ within the insect body, usually of diffuse and variable form providing packing around many internal organs. It serves as store for fat, glycogen and protein, and plays an active part in metabolism. Up to 33 percent of the dry weight of a mature honeybee larva may be fat body. In fireflies light is produced in the fat body. The fat body of many insects contain enzymes that detoxify synthetic insecticides and natural plant poisons.

Fats: Glycerides having a greater proportion of saturated acids, and solid at 20°C, hydrolysed by lipase to fatty acids and glycerol, and forming a food store in animals.

Fatty Acids: A group of saturated and unsaturated monobasic aliphatic carboxylic acids

which forms esters with glycerol and other alcohols to make fats, oils and waxes.

Fauna: The animal life of a region. Faunas are assemblages of coexisting species, these species are either **autochthonous**—of local origin or **allochthonous** having migrated from elsewhere. Either kind may be **endemic**—confined to the geographical limit under study, or **apodemic**—occurring in other units also. If apodemic it may be **native** and have dispersed naturally between the units or it may be **introduced** accidentally or intentionally by human agency. Same classification applies to higher taxa also. An endemic species that has a much wider range is called a **relict**; an area with many relict species or taxa is a **refugium**. The size and composition of a fauna depends on interplay of immigration, speciation and extinction of fauna. If immigration and speciation together outweigh extinction, the fauna grows.

Faunal Areas: Division of the surface of the earth into several areas or realms each with characteristic fauna and flora. Following six faunal areas have been designated.

1. Palaeartic region : Europe, Asia and North Africa, down to the desert belt that includes the Sahara, the Arabian and Persian Deserts, and those of Central China. **2. Nearctic region** : The American Continent down to the deserts of the United States / Mexico borders. **3. Neotropical region** : The whole of South America. **4. Ethiopian region** : All Africa south of the Sahara, plus Madagascar, Southern Arabia, and the islands connecting the two. **5. Oriental region:** A region centred on India, the Malayan Peninsula, Indo-China and Indonesia, but with rather illdefined boundaries in all directions, and overlapping considerably with the next, and **6. Australian region** : Australia and New Zealand, and the island group of the South Pacific.

Faunal Worm: A publication in which taxa are included on the basis of their occurrence in a specified area rather than on the basis of relationship.

Fecifork: A 'dung-fork'; a flattened fork-like

appendage, also called an 'anal comb', attached to the hind end of the abdomen on the larvae of certain beetles and moths. It can be elevated and is used for shovelling up dung which is then deposited on the back of the larvae to serve as camouflage and for protection from the sun.

Fecundate: To impregnate ; to fertilize.

Fecundity: The potential number of offspring that an insect is capable of producing is determined by the number of ovarioles in ovary. Fecundity is important in determining how rapidly insects may reach pest status, or alternatively how rapidly an agent of biological control may bring its host under control.

Feeding Deterrent: A chemical that prevents feeding of pests on treated material.

Femur: The third segment of an insect leg, between the trochanter and the tibia. It is usually broad, sometimes long and stout segment of the leg. In the Orthoptera and a few Coleoptera (e.g., flea beetles), the femur on the hind leg is greatly enlarged to accommodate the extensor muscles of the tibia used in jumping.

Fenestrae: Openings in the dorsal diaphragm through which haemolymph can pass.

Feral: Wild, an animal which has escaped from domestication and reverted to the wild state.

Fertility: The actual number of viable offspring produced which is dependant on a number of factors. Nutrition is most important. Most blood sucking insects (e.g., mosquitoes, bed bugs) need a blood meal to produce each batch of eggs. Starving insects generally reabsorb eggs. The proportion of eggs fertilized depends on the proportion of male insects in the population. With the exception of parthenogenetic forms, in most insects sex ratio is near 1:1 (females: males) at eclosion, though male longevity is often less than that of females. If males are artificially sterilized and then released, population fertility declines sharply. Fertility also depends upon the average longevity of

breeding females. Underpopulation may reduce fertility when population density is so low that a significant proportion of males and females can not locate one another to reproduce and continue the population.

Fertilization: The penetration of an egg (ovum) by sperm and union of their nuclei.

Festoon: The margin, with rectangular divisions of integument in hard ticks (Ixodidae).

Fetotoxin: A substance that can poison an unborn foetus.

Fidelity: The degree of limitation of a species to a particular habitat. Fidelity is the accuracy with which the estimates follow actual numbers in the insect population. Fidelity is usually determined by comparing a program of unknown fidelity with one known to be accurate; numbers known through releases in an area, or habitat removal sampling are examples.

Fiducial Limits: The lower and the upper values for the estimate of LD_{50} or LD_{90} compared from probit regression equation at a given reliability coefficient say, 95% or 99%.

Filament: Very slender and long; thread-like.

Filariasis: Debilitating diseases (e.g., elephantiasis and onchocerciasis) are caused by nematodes namely filarial worms (*Wuchereria bancrofti*) transmitted by insects (*Culex quinquefasciatus*, and *Simulium ornatum*).

File: A minute rough ridge near the base of the front wing (ventral side) of crickets and katydids; used for sound production.

Filiform: Thread-like or hair-like ; that type of antennae with the segments quite uniform in size (e.g., cockroach).

Filler: Inert component of pesticide or granule formulation.

Filter Chamber: A bladder-like structure in which hindgut loops back on the midgut in some homopterans. Filter chamber allows excess water and soluble carbohydrates of the food to be eliminated by diffusing directly

from the anterior of the midgut into the anterior part of the hindgut retaining proteins and fatty materials in the midgut for proper digestion and absorption.

Finn Pipette: A micro -, and semi - micropipette with disposable plastic tips, adjustable to deliver particularly a range of very small volumes. Other brands of this type of pipette are also available.

First Aid: Refers to the first effort to help a victim while medical help is on the way.

First Reviser: The first author to publish a definite choice of one among two or more conflicting names or zoological interpretations which are equally available under the Code. In order to qualify as first reviser, an author must give evidence of a choice between available alternatives.

Fixative: Chemical substance used to stabilize proteins etc. before staining and in other stages of preparation for microscopic examinations. All fixatives contain ethanol and glacial acetic acid, in various concentrations, combined with other liquid. Fixatives containing formalin (40% formaldehyde in water) should never be used for specimens meant for slide mounting (as internal tissues harden and will not macerate), but are ideal for specimens intended for histological studies. KAA (2 parts glacial acetic acid, 10 parts 95% ethanol and 1 part dye-free kerosene), and AGA (1 part glacial acetic acid, 6 parts 95% ethanol, 4 parts water and 1 part glycerol) are commonly used fixatives.

Flabellate: With broad fan-like processes or projections; flabellate antenna (e.g., Rhipiphoridae, Tenthredinidae).

Flabellum: The small spoon-shaped tip of the 'tongue' (glossae) of bees.

Flacherie: A term used to describe the flaccid condition seen in silkworm larvae suffering from dysentery. Also known as rot or wilt disease. Flacherie is caused by several bacteria which occur commonly on mulberry leaves. Worms affected by flacherie become sluggish and soft, vomit clear brownish fluid and pass softer faeces. Finally, the trunk turns black

and worms hang by anal claspers with head downwards, body putrefies and falls down in a semiliquid condition having foul odour.

Flag Stage: Stage of growth in cereals and other grasses at which the sheath and leaf have been produced from which the head will emerge.

Flagellomere: One of the subdivision of a multi-annulated antennal flagellum.

Flagellum: The apical part of the antenna, attached to the pedicel. Flagellum does not have direct musculature, maintains its position by blood pressure and normal rigidity, and move only when environmental factors contact and move them physically.

Flame Thrower: Compressed air type of sprayer filled with kerosene oil for producing flame. Lance modified to carry burner which is heated before allowing oil to flow through. It is commonly used for burning settled swarms of locusts.

Flash Colouration: The sudden exposure of previously hidden colours and/or patterns when threatened (e.g., eye-spots in wings of many Lepidoptera). The sudden bright display of eye-like markings by a previously cryptic individual is often combined with other behaviour that heighten the startle effect.

Flavines: Greenish-yellow pigments found in insects.

Fleas: Belong to order Siphonaptera. Fleas are flattened laterally and lack wings for ease in moving between hairs, have piercing-sucking mouthparts, possess strong bristles and often enlarged spines or ctenidia, have enlarged legs for jumping and contacting their hosts.

Fleck: A minute spot.

Flexion Line: A line along which a wing flexes (bends) when in flight.

Flexor: A muscle that bends a part of the body.

Flight: The movement of an insect's wing during flight is brought about by vertical and

longitudinal muscles located in the thoracic region. The vertical muscles pull the roof of the thorax down and force the wings up but the longitudinal muscles arch the thorax and force the wings down. These muscles work automatically in turn by means of a special type of muscle fibres. In addition to these muscles, there are other muscles attached to the wing bases, giving a turning movement to the wings at each up and down stroke. These are under direct control of nervous system and enable the insect to move in any direction. In Diptera, only the fore wings are functional, and the hind wings are reduced and serve as balancers. But in beetles and locusts, hind wings are functional and the fore wings are modified into elytron/tegmen and serve to protect the hind wings. In bees and in some moths, the fore wings and the hind wings interlock and act as one pair during flight. Velocity of flight is high in hawk moths (15 metres/second) and dragonflies (8 metres/second). Lacewings have less velocity of flight (0.6 metres/second).

Flocculate: To aggregate (clump together) into a loose fluffy mass.

Flora: The plant life of a region.

Flowability: Property of flowing possessed by dusts, colloids, liquids and some pastes.

Flowable: A pesticide formulation in which finely divided particles are suspended in a water (water-based flowables), or in oil (oil-based flowables). The particles are ground to about 4 μm in either water or oil, then a suspending agent is added, and in the case of the water-based material, an anti-freeze agent is added. The final product has the consistency and drying properties of a latex paint. Insecticides formulated in this manner, tend to provide better, residual activity than other spray formulations.

Flowable Pesticide (FL) : Very finely ground solid material which is suspended in a liquid and usually contains a higher concentration or large amount of the active ingredient and must be mixed with water when applied, but needs frequent agitation. This formulation is

a thick creamy pudding-like mixture and contains a suspending agent, a thickener and an anti-freeze compound. This formulation is prepared in case of pesticides which are soluble in neither oil nor water.

Fluorescent Tracer: Fluorescent material added to a spray to aid the assessment of spray deposits on plants.

Flush: A fresh growth of foliage or blossom, particularly when rather sudden.

Foaming Agent: A chemical that causes a pesticide preparation to produce a thick foam, this aids in reducing drift.

Fog: Particles between 0.1 to 50 μm in diameter which make a fine mist. For such applications, fog formulations containing an oil solution of insecticide is normally used with thermal fogging machines. Kerosene or diesel oil is a suitable solvent, provided the solution is clear and no sludge is formed.

Fog Treatment: The application of a pesticide as a fine mist for the control of pests.

Fogger: Machine which disperses spray material in extremely fine droplets (1-10 μm) which remain air-borne for longer time. It is successfully used on dense foliage or on open drains for mosquito control. There are two types of fogging machines : **1. Thermal fogging machines :** which utilize flash heating of the oil solvent to produce vapour or fog; and **2. Ambient fogger-type machines :** which atomize a small jet of liquid into a ventury machine, through which passes an ultra-high velocity air stream. Thermal foggers utilize oil only, usually deodorized kerosene. Ambient foggers use emulsions, water-base or oil-base formulations. These machines have found widespread use for pesticide application in enclosed environments like greenhouses, food storage facilities and buildings. They have also been success in plantation crops with very dense canopies.

Foliar Sprays: Droplets of a pesticide applied to leaves, needles and blades of the plants.

Fontannelle: A small, round depression on top of the head between or behind the compound eye of termites.

Food Canal: A canal anterior to the cibarium through which fluid food is ingested.

Food Chain: Sequence of species within a community, each member of which serves as food for the species next higher in the chain. There are two types of food chain, **1.** Simple, and **2.** Complex. The simple food chain involves essentially two links consisting of photosynthetic plants and microbes that obtain their nutrients from these plants degrading or decaying them after death. Complex chains consist of many links. Food chains are the basis for establishing trophic levels in an ecosystem and insects are primary and secondary consumers and decomposers. Insect food chains are characterized also by changes in food sources as the insect develops and matures. In many insects the larval stages and adult stage have different food sources. Some insects have specific food needs in order to survive. Adult mosquitoes and many flies need to feed on the blood of vertebrates in order to complete their life cycle.

Food Habits: Food is essential to the growth of any organism and, therefore, is an important consideration in the life cycle of an insect. A wide range of organic substances, living and dead, are used by insects as food. According to the type of food utilized, insects may be grouped as, **1.Saprophagous** - feeding on dead organic matter, and may be : a) General scavengers : Dictyoptera (cockroaches); b) Humus feeders - Collembola (springtails); c) Dung feeders, Coprophagous - some Scarabaeidae (dung beetles); d) Restricted to dead plant tissue - Isoptera (termites); and e) Carrion feeders - Calliphoridae (flesh flies); **2.Phytophagous** - feeding on living plants, and may be : a) Leaf feeders - Saltatoria (grasshoppers); b. Leaf-miners-Agromyzidae (flies); c) Stem and root borers - Cerambycidae (beetles, round-headed borers); d) Root feeders - some Scarabaeidae (beetles, white grubs); e) Gall makers-Cynipidae (gall wasps); f) Juice suckers - leafhoppers, aphids

and mites, and g) Mycetophagous (fungus feeders)-Mycetophagidae (fungus beetle).

3.Zoophagous : Feeding on living animals. They may feed as parasites, predators and blood-feeders.

Food Web: The interlocking pattern of energy flow from plants through a series of organisms eating and in turn being eaten.

Foot: An organ of locomotion, e.g., tarsus of insects.

Forage: To seek and gather food. A honeybee worker begins foraging for pollen, nectar, and water when it is three weeks old. Foragers seldom venture out when temperature is lower than 8°C.

Foraging Ants: A name for a number of genera of tropical ants that have no permanent nests but march in large numbers in search of food. Generally they travel in dense columns foraging on either side and driving out or killing all animal life. They drag or carry the queen, the eggs, larvae and pupae as they go.

Foraging Pattern: In bees, the pattern of food-gathering behaviour which is determined by the local abundance and structure of flowers.

Foramen Magnum: Posterior opening of the head capsule through which internal structures (alimentary canal, dorsal nerve cord, and so on) pass to the thorax.

Forcipate: Bearing forcep-like structure. The claspers at the abdomen of insects are forcep-like; most evident as the male cerci in earwigs (Dermaptera).

Fore Wings: The first pair of wings of an insect, growing from the middle segment of the thorax. In Diptera these two are the functional wings. In beetles, and cockroaches the fore wings are thickened and horny and are known as **elytra**; in grasshoppers and locusts they are called the **tegmina**. In such insects they form covers to protect the more delicate membranous hind wings.

Foregut: Also sometimes called 'stomodeum'. The foregut, formed during embryogenesis by invagination of the

integument, is lined by ectoderm which is shed at each moult. The foregut is generally differentiated into pharynx, oesophagus, crop, and proventriculus. Attached to the pharyngeal intima are dilator muscles which are well developed in sucking insects forming the pharyngeal pump. The oesophagus is usually narrow but may be dilated posteriorly to form the crop where the food is stored. During storage the food may undergo some digestion in insects whose saliva contains enzymes. The hindmost region of the foregut is the proventriculus, which may serve as a valve regulating the rate at which food enters the midgut. Posteriorly the foregut is invaginated slightly into the midgut to form the oesophageal (=stomodeal) invagination. Its function is to ensure that food enters the midgut within the peritrophic membrane. A large foregut is often characteristic of insect predators that may find it more difficult to locate their prey and gorge themselves on infrequent large meals, storing the meal for digestion away from the host.

Forensic Entomology: Use of entomological information in criminal investigation. Knowledge of the behaviour and development rates of carrion fly maggots inhabiting corpses allows estimates of egg-laying time and, therefore, the time of death of the victim. Police sometimes utilize such information to investigate cases of homicides.

Form: The neutral term for a single individual, phenon or taxon. An individual which differs from typical specimens in colour, pattern, shape or size (such as seasonal variation).

Formamidines: These are insecticides of new chemistry. These compounds are locomotor stimulants, anorexients, and eclosion inhibitors in insects. Chlordimeform and amitraz are comounds of this group. They are effective against whiteflies, mites and ticks.

Formicary: Also known as formicarium. A nest of ants. The term is also commonly applied to an ant mound or an artificial nest used in the laboratory to house ants.

Formulation: Formulation is a process that involves adding a number of other chemicals or substances to the active ingredient. The chemicals that are added to the active ingredient include solvents, diluents, synergists, surfactants, stickers, penetrants, dispersion aids, safeners, deodorants, anti-foaming agents, buffers and thickeners. Aim of the formulation process is to achieve the adequate shelf-life and to make the active ingredient easy to use and to ensure that it is stable during transport and storage. It is also important that a formulation is safe to use and is simple to apply. Emulsifiable concentrates, suspension concentrates (flowables), solutions, liquid concentrates and micro-encapsulated pesticides are wet formulations; dusts, granules, wettable powders, soluble powders and baits are dry formulations.

Fossa: A pit or trench-like depression.

Fossil Insects: Fossil insects have been found as impressions in limestones and as preserved specimens in amber, resin etc. Earliest fossils that can with certainty be called insects occurs in the carboniferous period. Since wings are far more often preserved than the rest of the body, the major evidence provided by fossils relates to wing venation. The earliest known winged insects were the Palaeodictyoptera whose primitive wing venation closely resembled that of dragonflies and mayflies.

Fossorial: Fitted for or with the habit of digging. Forelegs of the mole cricket and cicada nymph are shortened and heavily sclerotized. Large toothed projections from the femur or tibia are used to rake through the soil to dislodge soil particles. Tarsi are reduced and usually fold back out of the way during excavation activity.

Foulbrood: A bacterial disease of honeybee larvae and pupae. Non-spore forming bacteria *Streptococcus pluton*, is causative agent of European foulbrood, while a spore-forming non-crystalliferous bacteria, *Bacillus larvae* is the cause of American foul brood in bee larvae.

Foundation Seed: Seed stocks increased

from breeder seed, and handled to closely maintain the genetic identity and purity of a cultivar.

Fovea: A group of ommatidia in the centre region of compound eyes that are capable of higher spatial resolution.

Foveolae: Small depressions or pits in grasshoppers located at sites of fastigium.

Frass: The wet or dry sawdust-like excrement of borers usually evident at their exit holes in infested and other plant parts.

Frenate: Bearing a well developed frenulum on the humeral lobe of hind wing and for wing coupling this comes in contact with retinaculum on the underside of the fore wing. In this way the wings are firmly coupled. This type of wing coupling is commonly found in Lepidoptera.

Frenulum: A bristle or a group of bristles arising from the humeral angle of the hind wing in many Lepidoptera and extending underneath the front wing to unite the wings in flight.

Frons: A triangular plate on the face of insects just above the clypeus. No definite boundary exists between the frons and vertex. Frontoclypeal area is the facial part of the head. The frontal ridge is marked externally by a suture that separates the clypeus from rest of the head.

Frontal Bristles: Bristles above the antennae, away from the edge of the compound eye.

Frontal Carina: A longitudinal ridge on the face, mesad of antennae.

Frontal Ganglion: A median ganglion in the head of an insect just in front of the brain and connected to the ventricular ganglion on the hind part of the oesophagus. It forms part of the visceral or sympathetic system.

Frontal Gland: A gland in the front of the head from which poison is discharged in certain insects, e.g. termites.

Frontal Pore: The pore of the frontal gland of the termite or other insects.

Frontal Sac: The 'ptilinum', a sac or vesicle

on the head of a fly by which the insect pushes open the puparium as it emerges. Afterwards the sac is withdrawn into head leaving a U-shaped line, the 'ptilinal suture', enclosing a crescentic structure, the 'lunule'.

Frontal Suture: In Diptera, a groove shaped like an upside down 'U' with the arms extending downward on each side of the face.

Frontoclypeal Suture: A transverse groove that runs across the insect's face, often separating the frons from the clypeus; also known as the epistomal suture.

Frontogenal Suture: A groove separating the frons and gena.

Fronto-Orbital Bristles: In Diptera, the bristles extending along the front margin of a compound eye.

Froth Glands: Glands of the frog hopper that produce 'cuckoo-spit' in insects in which their larvae live (Cercopidae and Aphrophoridae). The insects producing froth are known as cuckoo spit insects or spittle bugs. The function of froth which is affixed to plant stems, is to provide protection from predators and to prevent desiccation. Adults are active hopping insects that in many cases bear a crude resemblance to a frog, hence the common name of frog hopper.

Fructivore: A fruit-eater.

Fruiting Body: A fungus structure that contains or bears spores.

Full Bibliographical Synonymy: A reasonably complete list of references to a given taxon arranged so as simultaneously to serve the needs of nomenclature (chronology of names) and zoology (pertinent taxonomic and biological sources).

Full Coverage Spray: This term on a label signifies that the total volume of spray to be applied thoroughly cover the crop being treated to the point of run off or drip.

Fuller's Earth: A silicate used as an adsorbent base or dust diluents. It is flowable and possesses excellent grindability.

Fumigant: A substance or mixture of substances which produces gas, vapour, fume

or smoke intended to destroy insects, bacteria or rodents. Fumigants may be volatile liquids and solids as well as substances already gaseous. They may be used to disinfect the interiors of buildings; objects and materials that can be enclosed so as to retain the fumigant ; and the soil where crops are valuable enough to warrant the treatment. Fumigants have been used particularly to treat plants and soil in plant quarantine work. Fumigation is greatly useful when insect and other pests have to be controlled inside stored- grains in silos, warehouses, ships and other enclosed area. Since fumigants are hazardous for human beings, so only persons with proper training and equipment must always carry out fumigation. Hydrogen cyanide, phosphine (from aluminium phosphide), ethylene dibromide, and chloropicrin are common fumigants.

Fundatrigeniae: Wingless parthenogenetic female aphids that later give rise to winged sexual forms.

Fundatrix: An apterous viviparous parthenogenetic female aphid that develops from the overwintering egg.

Fungicide: Chemical used to kill or control fungi which cause plant diseases are called fungicides (e.g., captan, vitavax).

Fungus Gardens: In subfamily Macrotermitinae (Isoptera : Termitidae), members culture a basidiomycete fungus of the genus *Termitomyces* in special 'fungus gardens'. In a typical fungus garden the fungus grows on sheets of reddish-brown 'comb' (decaying vegetative material) and is

visible as a whitish mycelium containing conidia and conidiophores. The comb forms the food of the termites. Fungus also provides a source of vitamins.

Fungus Growing Beetle: Any beetle that utilizes symbiotic fungi for food. Ambrosia beetles (Scolytidae) and some other beetles (Anobiidae, Curculionidae) that are associated with symbiotic fungi are fungus growing beetles.

Funicle: The central and major part of geniculate antennae between pedicel and the club.

Furca: Forked endosternal 'V' or 'Y' shaped process in the thorax of higher insects ; in hymenopteran sting, the lever with the fulcral arm.

Furcal Pits: External manifestation of the sternal apophyses.

Furcula: 1. Forked, springing structure in most springtails (Collembola) located ventrally on the fourth abdominal segment. In springtails, the furcula is normally bent forwards and is retained beneath the abdomen by a 'catch' or 'retinaculum' known as 'hamula'. Whenever the catch is released the furcula springs back propelling the insect forwards. **2.** Any fork-like structure, used of various parts of body of an insect, (e.g., caudal furca, labellar furca).

Furrow Application: Placement of pesticides with seed in the furrow at the time of sowing.

Fusiform: Spindle-shaped, tapering at both ends.

Gaba: Gamma-aminobutyric acid. Typically an inhibitory transmitter of neuromuscular junctions. GABA is released from presynaptic endings of stimulated inhibitory neurons and diffuses across the synaptic cleft to bind at postsynaptic sites on the GABA receptor complex, which increases chloride permeability. This results in hyperpolarization thereby deactivating the postsynaptic cell. Therefore, activation of GABA receptors produces inhibition at a variety of sites within the vertebrate and invertebrate central nervous system as well as invertebrate neuromuscular junctions, while the inhibition of GABA-induced chloride ion permeability causes excessive release of acetylcholine at presynaptic sites or stimulates glutamate action, which may account for the stimulant and convulsant effects of the inhibitors.

Galea: The outer lobe of the maxillae, attached to the stipes in case of chewing mouthparts. Galea are equipped with a variety of mechano- and chemosensilla. In siphoning type of mouthparts as found in adult moths and butterflies, the coiled proboscis is highly specialized consisting of only the greatly elongated galea of the maxillae held together medially by interlocking spines and hooks. Traversing this tube is the food canal and salivary duct. In such type of mouthparts, mandibles are reduced or lost and have no role in food digestion. When a butterfly or moth land upon a flower, it uncoils and extends its proboscis. If nectar is present, this fluid is sucked into the body. The proboscis then coils up because of its natural elasticity, and the next flower is visited.

Gall: Abnormal growths on the buds, leaves, stems or roots of plants caused by mites, insects, bacteria, nematodes, viruses, fungi or chemicals. Insects and mites are the chief causative agents of plant galls and they produce a particular type of gall and always on the same region of plant. The simplest galls are mere swellings that involve no major distortion or discolouration, these are known as **indeterminate galls**. In some cases these are expanded to form **pouch galls**, which are often open to the outside and are especially characteristic of aphids and related Homoptera. The majority of gall midges and wasps make **determinate galls**, which have a form and colour quite different from that of the host plant (e.g., oak apple gall and willow cone gall). Galls may continue to grow as long as the stimulation persists even though normal leaf or stem growth may have ceased for that season. **Closed galls** are made by the larvae of mandibulate insects (Coleoptera, Lepidoptera, Diptera and Hymenoptera), none produces young in the galls. The majority of the galls are simple (monothalamous), i.e. they contain but a single larva. A few are compound galls (polythalamous), i.e. each gall contains several larvae in separate cells or chambers. The larvae and nymphs of gall making insects show a reduction of antennae and legs.

Gallicolae: Name given to the gall dwelling stages in certain aphids (including Phylloxeridae) that induces aerial galls on the host plant.

Gallonage: Number of gallons of finished

spray mix applied per acre, tree, hectare, square or other unit.

Gamete: A sexual reproductive cell that must usually fuse with another before development occurs; an egg or sperm.

Gamma Irradiation: The use of rays from a radioactive source. Research with radioisotopes has added knowledge to the understanding of insect behaviour and physiology, and this knowledge has been employed in developing better control techniques.

Gamma Taxonomy: The level of taxonomy dealing with various biological aspects of taxa, ranging from the study of intraspecific populations to studies of speciation and of evolutionary rates and trends.

Ganglion: Neurons are aggregated into nerves and ganglia. Nerves include only the axonal component of neurons whereas ganglia includes axons, perikarya and dendrites. Ganglia is a knot-like enlargement of nerves and supplies nerves to that part of the body where located. Most ganglia are located below the digestive system. Some of the cells in ganglia secrete hormones and are called neurosecretory. The anterior three pairs of ganglia fuse to form the brain or supraoesophageal ganglia (located dorsal to the oesophagus), and the 4th to 6th pairs unite into the suboesophageal ganglion. The remainder of the central nervous system is termed the ventral nerve cord, and these ganglia also tend to fuse, especially each segmental pair and the last three-to-four pairs in the abdomen. In some specialized insects, all ganglia fuse to form a single ganglionic mass in the head and prothorax.

Gas Mask: A device which filters out chemicals in the spray, dust or gas from air breathed by the wearer. A full-face gas mask must be worn to protect from gases; it should be equipped with adequate canisters of absorbent materials (or with oxygen supply). Simple respirators protect from spray and dust without covering the eyes, but not from poisonous gases.

Gaster: That part of the abdomen of ants behind the petiole; collective term for the hymenopteran abdominal segments posterior to the petiole.

Gastric Caeca: The sac-like lateral diverticula at the anterior region of the midgut that are involved with water absorption and the creation of a flow within the midgut.

Gastric Mill: A grinding structure within the foregut of some orthopteroid insects.

Gastrotheca: The part of an insect's pupal case covering the abdomen.

Gastrulation: A process by which the mesoderm and endoderm are invaginated within the ectoderm.

Gattine: Also known as clear head disease in sericulture. It is a mixed infection of bacterium, *Streptococcus bombycis*, and a virus. Head of infected silkworm appears swollen and transparent. In the advanced stages of infection, whole body becomes semi-transparent due to absence of mulberry leaves in the gut, and later turns dark brown. Infected larvae gradually die and decompose.

Gause's Rule: The theory that no two species with identical ecological requirements can coexist in the same place.

Gels (GL): Gel formulation of pesticides are thickened emulsifiable concentrates packed in water soluble bags. Thus viscosity is increased with thickeners, the final gels viscosity being a compromise between the transport stability in the water soluble bag and the dispersibility in water. The premeasured doses in water soluble bags offer advantages in easy handling and increased user safety, and the outer packaging is not contaminated with product and can be easily disposed of.

Gena: The part of the head below the compound eye and to the side of the frons; the cheek. Gena may be separated anteriorly from the frons by a frontogenal suture or a subocular sulcus. It is separated from the clypeus by a 'clypeogenal suture.' Ventrally a subgenal sulci may extend between the

anterior and posterior tentorial pits, separating off a marginal area, the 'subgena'. Posteriorly, the gena may be delimited by the 'occipital suture'.

Genal Comb: A series of strong spines borne on the anteroventral border of the head (e.g., Siphonaptera).

Gene: A hereditary determiner; the unit of inheritance, carried in a chromosome, transmitted from generation to generation by the gametes, and controlling the development of the individual.

Gene Flow: The exchange of genetic factors between populations owing to dispersal of zygotes or gametes, e.g., pollen.

Gene Frequency: The percentage of a given gene in a population.

Gene Pool: The totality of the genes of a given population existing at a given time.

General Equilibrium Position: The average density of a population over a period of time (usually lengthy) in the absence of permanent environmental change.

General Use Pesticide: A pesticide that can be purchased and used by the general public without undue hazard to the applicator and environment as long as the instructions on the label are followed carefully.

Generation: The period from any given stage in the life cycle (usually adult) to the same stage in the offspring.

Generation Curve: The population density of a given developmental stage plotted against generation number for a sequence of generations.

Genetic Control: Genetic control methods fall into two categories: **1.** In which pests are rendered less capable of reproduction, and **2.** In which resistance is increased in the organism attacked by the pest. Genetically engineered introduction of microbial toxin genes into plants is included in this category. Sterile insect release method (SIRM) has been used on full scale. Successive releases of sterile insects over a number of generations lead

cumulatively to eradication of the pest as in case of screwworm (*Cochliomyia hominivorax*) in parts of Southern United States of America and Puerto Rico. Irradiation and chemosterilants are both used in this technique.

Genetic Drift: Genetic changes in the populations caused by random phenomenon rather than by selection.

Genetic Engineering: The changing of the genetic structure of an organism and genotype by gene splicing, translocation etc. To develop resistant plants, recombinant DNA technology (rDNA) has mostly been involved in inserting the gene responsible for producing delta endotoxin from the insect pathogen *Bacillus thuringiensis* (Bt) into plant genomes. With this approach the transformed or transgenic plant has the power to produce the toxic protein in its tissues, consequently killing feeding insects and protecting the plant.

Genetically Modified Organism (GMO): Used to inaccurately describe genetically engineered organisms including transgenic crops. Technically, any domesticated organism derived from a wild species by artificial selection is a genetically modified organism.

Geniculate: Elbow-shaped antennae, body of antennae makes a sharp curve or angle with scape (e.g., ants, honeybees).

Genital Chamber: A cavity of the female body wall that contains the gonopore. Also known as 'bursa copulatrix' if functioning as a copulatory pouch.

Genital Claspers: Organs of the male genitalia which serve to hold the female during copulation.

Genital Segments: The genital ducts open ventrally on segment 8 or 9 of the abdomen, and these segments usually bear external organs that assist in reproduction. Some female insects, like mayflies and stoneflies, lack any special apparatus to assist in egg deposition; most females have an 'ovipositor' to manipulate eggs and often to place them in

a protected location. In bristletails, grasshoppers, dragonflies, cicadas, bees, wasps and their relatives, the ovipositor is formed from appendages of 8th and 9th abdominal segments.

Genitalia: The external structures which enable the sexes to copulate and the females to deposit eggs, strictly these are the external genitalia. In case of male these are located on the 9th abdominal segment and consist of : a) A pair of claspers or 'gonopods' for grasping the female during mating; b) A pair of processes called 'parameres'; c) The penis or intromittent organ from which the gonopore opens. In case of females of many insects, there is a conspicuous ovipositor, consisting of three pairs of long narrow 'valves' or outgrowths from the 8th and 9th abdominal segments. These may interlock or may be permanently united to form a tubular egg-laying device. In worker bees and wasps, the ovipositor is modified to form a sting.

Genome: The genetic material, especially the genes, contained in an organism.

Genotype: The particular combination of genes present in the cells of an individual, as distinguished from its physical appearance.

Genu: Knee; segment between femur and tibia in some acarines, its articulations with femur and tibia are constituted by hinge points. The size of the genu is often relatively small in comparison with femur, tibia and tarsus. Microsensory setae known as 'famulus' are normally found on genu.

Genus: A group of closely related species; the first name in a binomial or trinomial scientific names. A category for a taxon including one species or a group of species, presumably of common phylogenetic origin, which is separated from related similar units (genera) by a decided gap. The size of the gap being in inverse ratio to the size of the unit (genus). Genus names are latinized, capitalized, and when printed are italicized.

Geographic Isolation: The separation of a gene pool by geographic barriers, the

prevention of gene exchange between a population and others by geographic barriers.

Geographical Race: An interbreeding fertile population with morphological characters identical or only varying over a narrow range, and isolated from other populations of the same species by geographical barriers.

Geotaxis: A tendency to move or crawl towards or into the earth (positive geotaxis) or away from the earth (negative geotaxis).

Geotropism: A response in relation to the direction of gravity, either towards the ground (positive geotropism) or away from the ground (negative geotropism).

Germarium: The part of an ovary or testis that contains the primary germinal cells, 'oogonia' and 'spermatogonia' respectively.

Germinal Layers: Primary layers of cells in a developing embryo being epiblast (ectoderm), hypoblast (endoderm), and later mesoblast (mesoderm).

Germination: Process of germinating or beginning of vegetative growth. Often refers to the beginning of growth from a seed.

Gill: Tracheal gills are evaginations of the exoskeleton with extensive tracheole networks. Some aquatic insects have increased the surface area in the form of tracheal gills. Gills vary from finger-like outgrowths on the abdomen (caddisfly larvae) or thorax (stonefly nymphs) to modified appendages in mayfly nymphs. An example of internal gills is the rectal gills of dragonfly nymphs. In these gills oxygen-rich water is pumped in, and gas exchange takes place, then the oxygen-depleted water is pumped out.

Gill Origin of Wings: This theory proposes that flight originated in an insect with an aquatic, gill-bearing nymph. The lateral abdominal gills of certain Ephemeroptera bear some resemblance to wings, being moveable, thin, and membranous and having a ramifying pattern of tracheae. The similarity is quite striking in nymphs of Permian mayflies. These fossils have wings on the mesothorax and metathorax that are too small for flight,

but are curiously held outstretched and curved obliquely backward from the body. The winglets have fairly distinct venation and what appears to be a movable basal articulation.

Girdling: Practice of completely removing a band of bark all the way around a woody stem.

Gizzard: The portion of the gut of insects immediately behind the crop. often thick-walled and muscular. It is poorly developed in sucking insects, however, in insects having chewing type mouthparts gizzard is equipped with powerful muscles and teeth-like structures with which the harder food particles can be crushed.

Glabrous: Smooth, devoid of hairs.

Gland: A distinct tissue or group of tissues which secretes a specific substance (e.g., scent or hormones).

Glial Cell: An accessory cell that surrounds neurons and provides them with nourishment and insulation.

Glossa: One of two lobes at the tip of the labium and between the paraglossae. In bees they become enlarged to form the tongue. The glossae and paraglossae respond respectively to the maxillary laciniae and galea. When the glossae and paraglossae are fused they form a small structure termed as ligula.

Gluttony Principle: Phenomenon of prey escaping predation through group living. It is better to live in an area where predators have full stomachs rather than where their stomachs are empty. Since predators of a given species tend to space themselves out (assuming little or no migration in response to the prey), highly clumped prey are probably at an advantage.

Glycogen: A 'polysaccharide' similar to starch; carbohydrate is stored mainly in this form.

Gnathal Segments: The posterior three segments of the developing insect head that give rise to the mouthparts.

Gnathosoma: The anterior part of the body of mites and ticks which bears the mouth and mouthparts. Gnathosoma is also referred to as capitulum and may be separated from idiosoma by a circumcapitular suture. The gnathosoma resembles the head of a generalized arthropod only in that the mouthparts are appended to it. But the brain lies in the idiosoma (region behind gnathosoma). The gnathosoma bears laterally the palps and more medially the chelicerae.

Gonad: The ovary or testis, or embryonic rudiment of either.

Gonapophysis: A mesal posterior process of a gonopod, in the female forming the ovipositor.

Gonopod: An appendage of the genital segment modified for copulation, insemination or oviposition.

Gonopore: The external opening of the reproductive organs. In majority of Pterygota, gonopore is located on or behind the 8th or 9th sternum in the female and behind the 9th sternum in the male. In Ephemeroptera and most male Dermaptera paired gonopores occur.

Gonostyle: The style (rudimentary appendage) of the 9th segment, often functioning as a male clasper.

Gram-Negative: Not capable of being stained by the standard Gram Stain.

Gram-Positive: Capable of being stained by the standard Gram Stain.

Granary: A storage area for threshed grain.

Grandlure: It is a mixture of two synthetic compounds that copy the natural pheromone produced by the male boll weevil (*Curculionidae*), acts as a sex attractant for the female and as an assembly attractant for both males and females of the species.

Granular Pesticide: A pesticide chemical mixed with or coating small pellets or a sand like material. They are applied with seeders, spreaders, or special equipment. Granular pesticides are usually applied to control soil pests.

Granule: An insecticidal formulation in which the active ingredient is mixed with, adsorbed, absorbed, or pressed on an inert carrier (e.g., clay or rice husk) forming a small pellet. Size of granules is expressed in terms of the number of openings per linear inch of two limiting screens. Four common mesh sizes are 8/15, 15/30, 24/48 and 30/60. The particles range in diameter from about 0.5mm to 1.5 mm. These are used mainly for soil application but sometimes also used for foliar application. Pesticides which are too hazardous to apply as sprays, such as aldicarb, disulfoton etc. are formulated as granules as they are less subject to drift than sprays or dusts. Like dusts, the concentration of active ingredient is usually less than 15%, so transport costs per unit of active ingredient are high. The rate of release of a pesticide from the granules depends on the properties of the pesticide, solvent and carrier, but the period of effectiveness is generally longer than period of effectiveness obtained with a single spray application. When an infestation can be predicted a prophylactic application of granules may be more effective than a spray, especially if weather conditions prevent sprays being applied at the most appropriate time. Uptake of a pesticide by a plant may be negligible if the soil is dry and movement of chemical to the roots is limited, so granules of certain pesticides are more suitable on irrigated land where soil moisture is guaranteed. However, there may be phytotoxicity under very wet conditions. Granules are extensively used as broadcast in rice fields for pest control, and by dropping down a pinch of granules in maize 'funnel' for borer control.

Granule Applicator: Machine designed to apply measured quantities of granules under field conditions for pest control on crops.

Granulosis: Virus diseases of insects characterized by the presence of granular inclusions.

Granulosis Inclusion Viruses: The viruses in which the virus particles or 'virions' are enclosed in proteinaceous capsules or

membranes. Granulosis viruses are restricted to the larvae and pupae of Lepidoptera, and fat body is the main tissue attacked. The virions first multiply in the nuclei but later continue to multiply in the cytoplasm. The disease eventually kills the insect, leaving it hanging as a fragile sack of virus similar to that which results from nuclear polyhedrosis infection.

Grass: Monocotyledonous plant belonging to the family Gramineae.

Grasserie: Nucleopolyhedrosis of the silkworm, *Bombyx mori*.

Grassy Stunt: Virus disease transmitted by brown planthopper (BPH).

Gravid: An insect containing fertilized eggs.

Grease Band: Adhesive material (e.g., resin in castor oil, or 'sticktite') applied as a band around a tree to trap ascending wingless female moths, ants or mealybugs.

Green Manure Crop: Plants grown and then incorporated into the soil to provide nutrients, organic matter, and to improve soil structure. Often legumes are grown as green manure crops.

Green Muscardine: A mycosis of various larval, pupal and adult insects, caused by the fungus *Metarrhizium anisoplaea*.

Gregaria: Also known as gregarious phase. A name given to the stage in the life of locust when millions of them swarm together and migrate. This may only occur after several generations of the solitary phase during which they behave like ordinary grasshoppers.

Gregarious: Living in groups. Migratory locust, *Schistocerca gregaria*, exists essentially as two different forms or phases i.e. the **solitary phase** and **gregarious phase**. 'Gregarious phase' is a morph with much pigmentation, smaller size, elongated wings, a higher metabolic rate, ability to store a high amount of fat, and migrate in daylight hours both as a nymph and an adult.

Gressorial: Walking, or adapted for walking.

Grooming: The licking of the body surfaces

of nestmates. Self grooming also occurs, in which individual clean their own bodies both by licking and stroking with the legs.

Growth Rate: Growth of a population is the number of individuals added minus the number lost during a unit of time and can result from the interaction of an increase in number of births (natality), an increase due to immigrations into the area, an increase in the number of generations during the season, a decrease in time of reproductive age, a decrease in deaths (mortality), and a decrease because of emigrations. The rate of growth of a population at a given instant is calculated as follows :

$$\text{Growth rate} = \frac{dN}{dt} = rN$$

r = instantaneous rate of increase

N = number of individuals

t = time

Growth Regulator: Organic substance effective in minute amounts for controlling or modifying (plant or insect) growth processes; organic compounds other than nutrients which in small amounts promote, inhibit or otherwise modify any physiological process in plants.

Ground Application: Pesticides are usually applied using ground equipment like manual sprayers or tractor-mounted sprayers. But ground application of pesticides has its limitations, i) large areas can not be covered sufficiently and quickly, ii) if the soil is too wet, iii) difficult to get equipments into a flooded paddy fields, and iv) when tall crops and trees may interfere with equipment, or the equipment may damage the crop. Under such conditions ground application is not possible and aerial application of pesticides may be considered.

Group: A neutral term for a number of related taxa especially an assemblage of closely related species within a genus.

Group Predation: The hunting and retrieving of living prey by groups of cooperating animals. A behaviour pattern best developed in army ants.

Grub: A stout, usually sluggish larva with a distinct head and thoracic legs, without abdominal prolegs. Also known as a scarabaeiform larva (e.g., Cerambycidae, Tenebrionidae, and Scarabaeidae).

Grylloblattodea: An orthopteroid order. Representatives are commonly known as rock crawlers or ice crawlers. Elongate insects, compound eyes small or absent. Antennae slender, thread-like, mouthparts biting, forward facing. Ocelli absent, wings absent, prothorax squarish. Abdomen with a pair of slender, multi-segmented cerci. They are found rarely in the cooler regions of northern hemisphere.

Gula: The midventral area of the head between the tentorial pits is secondarily sclerotized to form the 'gula'. The gula is continuous with the postocciput and sometimes also the labial base. The parts of postoccipital suture that delimit the gula laterally are named as gular sutures (as in Coleoptera, Neuroptera).

Gummosis: Phenomenon of protection of plants themselves against wounding by exuding gums, latexes and resins. In conifers, differences in resin flow have been implicated in the resistance of some pine species to attack by pine shoot moth. Some legume varieties also produce gum from the pods when damaged and this seems to drown young bruchid beetle larvae attempting to penetrate pods.

Gustation: The act of sensation of tasting. The sensilla concerned with the response to liquids or solids generally occur on the epipharynx, hypopharynx and palps. These sensilla are also found on antennae (e.g., bees and ants), on tarsi (e.g., butterflies) and on the ovipositor (e.g., parasitic Hymenoptera).

Gut: Also called alimentary canal. The gut includes three primary subdivisions-foregut, midgut and hindgut, and these are typically differentiated into regions of differing function. The foregut is concerned with storage and trituration of food, the midgut with digestion and absorption of small organic molecules,

and the hindgut with absorption of water and ions. Some absorption of small organic molecules may occur across the hindgut wall especially in insects with symbiotic microorganisms in their hindgut.

Gutting: Also called evisceration. For dry preservation, it is important to eviscerate (remove the gut and other internal organs) of large insects or gravid females (especially cockroaches, grasshoppers, katydids and very large moths), otherwise their abdomens may rot and the surface of the specimens go greasy. Gutting is best carried out by making a slit along the side of the abdomen (in the membrane between the terga and sterna) using fine, sharp scissors and removing the body contents with a pair of fine forceps. A mixture of 3 parts talcum powder and 1 part boric acid can be dusted into the body cavity, which in larger insects may be stuffed carefully with cotton wool.

Gynandromorphs: Also known as sex mosaics. They are teratological forms in which some parts of the body show female characteristics while the remaining parts are male. They, therefore, have a striking appearance when secondary sexual differences in colour pattern or structure occur as in some Lepidoptera. In *Drosophylla*, gynandromorphs can arise through the loss of a sex-chromosome in one of the early cleavage nuclei of the embryo, so that different cells form male tissues while those with a full complement of sex-chromosomes yield female tissues. Parasitic Hymenoptera which normally reproduce through thelytokous parthenogenesis, yield many gynandromorphs at usually high temperatures.

Gyne: A reproductive female hymenopteran, a queen.

Gynergate: A female containing patches of tissue of both the queen and worker castes.

Habitat: The place where a plant or animal normally lives. The habitat of some species may be very general such as foliage matrix of a forest, but for others it can be specific. A species habitat is an important environmental component because it influences the impact of other components such as weather and natural enemies on its chance to survive and reproduce. Many microhabitats exploited by insects are characterized by microclimates much less severe than the regional climate. Consequently, each species is adapted to the conditions of its particular habitat and tends to be found occupying the same kind of living place throughout its range.

Habitat Modification: Alteration of the environment where any organism occur e.g., cultivating land for agriculture.

Habituation: A form of learning in insects in which there is gradual lessening of responsiveness to a stimulus as experience finds it to be harmless or at least unavoidable.

Haematophage: An eater of blood or blood-like fluid.

Haematophagous: Feeding or subsisting on blood.

Haemocoel: The body cavity of insects filled with blood (haemolymph) within which the internal organs lie. Blood from the dorsal tubular heart is pumped forwards, it does not go into capillaries but goes directly into the haemocoel, so that every organ is bathed in it. Finally the blood reaches the pericardial sinus from where it reenters the heart through small openings known as 'ostia'.

Haemocoelous Viviparity: A phenomenon that occurs in certain insects which have no oviducts, e.g., in Strepsiptera and in some larval Cecidomyiidae, which develop parthenogenetically. Eggs escape into the haemocoel, develop into larvae and finally through the secondary openings in the body wall.

Haemocytes: A general name for blood corpuscles. In case of insects haemocytes are colourless and are of various kinds. The more important kinds of haemocytes being: Prohaemocytes (=Proleucocytes) - young cells; Plasmotocytes (=Phagocytes) - amoeboid cells that digest bacteria etc.; Granular haemocytes (also phagocytic); Oenocytoids - rounded acidophil cells whose function is obscure; Cystocytes - specialized granular haemocytes; Sphaerule cells-containing large round inclusions; and Adipohaemocytes, containing fat globules.

Haemocytometer: A counting chamber in which, the density of blood cells in a sample can be estimated with the help of optical microscope.

Haemoglobin: The red oxygen carrying pigment that occurs in the red blood cells of vertebrates; found very rarely in insects. Amongst the aquatic insects, some larval chironomids (blood worms) and a few notonectid bugs possess haemoglobin. Vertebrate haemoglobin have a low affinity for oxygen, but haemoglobins of chironomids have a high affinity for oxygen.

Haemolymph: The blood plasma or liquid part of the blood; the term is generally

synonymous for blood of insects. It fills all the body cavities, where it bathes various internal organs and also enters the appendages and the tubular cavities of the wing veins, and combines the functions of blood and lymph. Insect haemolymph is usually clear or straw-coloured or variously pigmented yellow, blue, green or rarely red with haemoglobin. Haemolymph plays an important role in insect immunity to disease. In insects innate immunity appears to be principally a cellular phenomenon, though in some species agglutinating and lytic substances occurs in the plasma. In keeping with their generally short life history and high fecundity, for most insect species acquired immunity is short lived and nonspecific.

Hair: Insect's hairs originate from the epidermis and cuticle and may be any of the following types **1.Microtrichia** : Minute non-movable hairs formed from the cuticle; **2.Spines:** Similar but thicker and stronger; **3.Macrotrichia:** Single or branched hairs, sometimes called **setae**. These are hollow, longer than microtrichia, and arise from a pit or socket, they may be fine or thickened; **4.Glandular hairs** such as those of some caterpillars that secrete an irritant fluid; **5.Sensory setae** acting as tactile, auditory or sometimes chemical receptor, with nerve cells leading from their basis; and, **6.Scales** such as those of butterflies and some other insects (e.g., mosquitoes). They are flattened and coloured but otherwise eventually similar to setae in their structure.

Half-Life: Time required for half of the residue to react or otherwise dissipate. Residual life or RL_{50} is also the same as half-life.

Haltere: A small, flattened structure enlarged on the end and located on each side of the metathorax in flies (Diptera), representing the hind wings. They vibrate and act as gyroscopic stabilizers, a vital role for an insect with a stout body and narrow wings. The halteres oscillate at the same frequency as the wings but out of phase with them. Deviations in flight course are detected as the halteres twist due to inertia.

Hamate: Wing coupling by **hamuli**. In this

type of wing coupling, a row of curved small hooks called hamuli present along the costal margin of the hind wing interlock with thickened hind margin of the fore wing. This type of coupling is found in Hymenoptera.

Hamula: A hook-like structure also called the **retinaculum** which, together with the furcula, enables springtails (Collembola) to leap forwards into the air. The hamula is formed from a pair of appendages on the central side of the abdomen. Before leaping, the caudal furcula is bent forwards and locked to the hamula. When the catch is released the furcula springs back propelling the insect violently forwards.

Hamuli: Minute hooks on the anterior margin of the hind wings of Hymenoptera, with the help of which the front and hind wings are held together during flight.

Hamus: Hooked part of uncus in male Lepidoptera.

Handbooks: In taxonomy, a publication designed primarily as an aid to field and laboratory identification rather than the presentation of new taxonomic conclusions.

Hand Duster: In a hand duster a plunger expels a blast of dust-laden air. The dust chamber may be at the end of the plunger tube or it may be located below the plunger tube.

Hand Sprayer: Small portable pesticide sprayers that can be carried and operated by a man.

Haplodiploidy: The mode of sex determination in which males are derived from haploid eggs and females from diploid eggs.

Haploid: Having only a single set of chromosomes; gametes are usually haploid.

Haplometrosis: Phenomenon of initiation of hymenopteran colonies by a single fertile female.

Hard Water: Water with minerals such as calcium, iron and magnesium dissolved in it. Some pesticides added to hard water will curdle or settle out. The main cause of hard water is dissolved calcium hydrogencarbonate,

which is formed in limestone or chalk region by the action of dissolved carbon dioxide on calcium carbonate. This type is known as 'temporary hardness' because it is removed by boiling. In some areas, hardness also results from dissolved calcium sulphate, which can not be removed by boiling (permanent hardness). Temporary hardness can be removed by adding lime (calcium hydroxide) which precipitates calcium carbonate. But it does not remove permanent hardness.

Harmonic Growth: A growth pattern in which all parts of the insect body, and the body as a whole, increased by the same ratio during each moult; also called isogenic growth.

Harpago: A claspettee; one of a pair of small claspers on the hind end of certain insects, e.g., mosquitoes. They do not form the principal tail forceps but are smaller and nearer to the median line. The term is sometimes used for other clasping organs including the 'harpes' of male Lepidoptera.

Harpes: Claspers formed from modified stylets at the hind end of the abdomen of male butterflies, moths etc.

Harvest Intervals: Period between last application of a pesticide to a crop and the harvest as permitted by law.

Harvesting Ants: Ant species that store food in their nests. Many taxonomic groups have developed this habit independently in evolution.

Hatching: Also called eclosion. To escape from the egg, a larva must break through the various membranes that surround it. These include the chorion, vitelline membrane, and in eggs of some species, serosal cuticle. Further in many exopterygotes and some endopterygotes a newly hatched larva is surrounded by embryonic cuticle which also must be shed before the insect is truly free. At hatching, haemolymph is forced into the head and thorax as a result of abdominal muscle contraction. As the anterior end of the embryo increases in volume the chorion is split. Hatching may be facilitated by lines of weakness in the chorion, by egg bursters or eversible bladders on the head or thorax, or

secretion of pleuropodial enzymes that dissolve the serosal cuticle.

Hatching Spine: Also known as egg burster. A spine or series of spines on the head of an embryo used for breaking open the egg shell when hatching.

Haustellate: Having mouthparts adapted for sucking activities. They are found in insects that feed on liquids. In these mouthparts—labrum, mandibles, maxillae and/or labium have become specialized beak-like or tongue-like structures. These are found in Hemiptera, Homoptera, adult Lepidoptera and Diptera. Several types of sucking mouthparts exist. In piercing-sucking mouthparts such as those found in female mosquitoes, the mandibles and maxillae (except the palpi) form sharp stylets that rest up and down, rather like tiny chisels, to cut a hole in which the hypopharynx and labrum are also inserted. The hypopharynx contain a tube through which is injected saliva containing anticoagulant (to keep the blood flowing) and anaesthetic (to keep the victim unaware of the bite). With the saliva, disease causing pathogens may also be introduced. The labrum likewise forms a tube through which blood is sucked. The labium forms a sheath which serves as a tool box for the mouthparts when not in use.

Haustellum: A part of the beak. It denotes the large distal portion of the proboscis of a blowfly or related insect, bearing at its extremity the large oral lobes or 'labella' containing numerous tubes or 'pseudotracheae' through which food is sucked.

Hazard: The chance that harm will come to beneficial forms of life from the use of a pesticide. The word hazard also refers to the risk or danger of poisoning when the chemical is used or applied. Hazard depends on toxicity of pesticide and chance of exposure to toxic amounts of the pesticide.

Head: The anterior body region. The head bears a pair of large compound eyes and as many as three simple eyes or ocelli, a pair of sensory antennae, and the feeding appendages

or mouthparts surrounding the mouth. Brain is contained in the head region. Head leads the way when the insect moves forward, it is in a position to detect the changing physical and chemical properties of the environment. Sensations of images in colour, moisture and the position relative to the body is with the mouthparts directed downwards, immediately ventral to the head capsule. This is the 'hypognathous' position of grasshoppers and cockroaches. In the 'prognathous' position, mouthparts are directed forward and project anterior to the eyes, as in beetles. When the proboscis is directed toward the rear, it is 'opisthognathous' as in bugs.

Head Capsule: The cuticular covering of the head of an insect, consisting of a number of plates or sclerites fused together or sometimes showing lines of suture but showing little about original embryonic segmentation. Dorsal plate or epicranium, frontal plate or frons; clypeus; genae and a median ventral plate or gula are the principal parts of a generalized head capsule.

Hearing Organs: Some insects possess well-developed auditory organs and it has been shown in a few cases that these are sensitive to frequency modulation, although it is doubtful whether this is generally the case. There may be a built-in sensitivity to one particular frequency which excites reflex behaviour. These organs are formed from modified mechanoreceptors grouped together and attached to a vibratory cuticular membrane or **tympaanum**. They may be on many different parts of the body but are most often on the sides of the abdomen or the thorax (e.g., in many moths) or on the legs (e.g., grasshoppers and cicadas). Some insects can also perceive sounds by means of their antennae.

Heart: The hind part of the dorsal blood vessel of insects. The heart is muscular, contains segmentally arranged valves called ostia which aspirate haemolymph from the abdomen.

Heartwood: The darker, harder, central wood of trees containing no living cells.

Hectare (ha) : A land area in the metric system= $2.471 \text{ acres}=10,000\text{m}^2 = 0.01\text{km}^2$.

Heliotropism: A term sometimes used to denote the attraction of insects to the sun; a misuse of the word which more strictly signifies a turning or orientation to the sun (positive) or away from it (negative). A special case of 'phototropism'.

Helminth: A member of the large group of primitive worms including nematodes and the worms parasitic in animal gut and tissues.

Hemelytron: The fore wing of Hemiptera in which the basal portion is thickened and the distal portion membranous. Literally they are half an elytron (e.g., Heteroptera).

Hemicellulose: A group of carbohydrates related to 'cellulose' but more easily digested; may serve as a food reserve in the seeds of plants.

Hemicephalous: A term used to denote insect larvae in which the head is incomplete posteriorly and is partly embedded in the prothorax (Diptera).

Hemimetabola: Insect orders with incomplete metamorphosis.

Hemimetabolous: One of two major types of development where the immatures (nymphs) usually resemble the adults; incomplete metamorphosis, sometimes restricted only to Ephemeroptera, Odonata and Plecoptera in which the nymphs are aquatic in habit and are better known as 'naids'. Exopterygotes usually moult a fixed number of times, but with the exception of Ephemeroptera, which pass through a winged subimago stage, never as adults. The number of moults is typically 4 or 5, though in some Odonata and Ephemeroptera whose larval life may last 2 or 3 years a much greater and more variable number of moults occur (e.g., 10-15 in species of Odonata, 40-45 in Ephemeroptera). In almost all exopterygotes, the later juvenile instars broadly resemble the adult, except that their wings and external genitalia are not well developed.

Hemipneustic: A term used to denote insects in which one or more pairs of spiracles are

non-functional. This is characteristic of larval Neuropteroidea. The hemipneustic system is subdivided into, (i) **Peripneustic**-arrangement in which metathoracic spiracles are non-functional as in terrestrial larvae; (ii) **Oligopneustic**-when prothoracic plus posterior abdominal spiracles are functional (amphipneustic); when only the last pair of abdominal spiracles is functional (metapneustic). Found in Diptera which are specialized for life in water or liquid media.

Hemiptera: An insect order which have representatives like bugs, aphids, leafhoppers, scales, psyllids, whiteflies etc. Mouthparts are elongated and form needle-like rostrum for piercing and sucking for liquid feeding. Two pairs of wings are usually present. Front wings thickened with membranous rear portion or entirely membranous. Wing reduction or absence is common. Immature stages (nymphs) usually resemble small adults. Incomplete metamorphosis. Distribution is worldwide. This is the fifth largest insect order. Many species are significant plant pests and some transmit human and animal diseases.

Hemipteroid Insects: A group name which includes Hemiptera, Psocoptera, Mallophaga, Anoplura and Thysanoptera. Members of these orders share certain features, including : (i) specialized mandibulate or haustellate mouthparts (lacinia slender, often stylets; labial palps absent or with no more than 2 segments); (ii) enlarged clypeus; (iii) hind wings (if present) lacking a large anal lobe ; (iv) cerci lacking ; and (v) hemimetabolous development.

Herbaceous: Referring to plants with soft stems, such as annuals, biennials, and perennials that normally 'die-back' to the ground in the winter.

Herbarium: A classified collection of dried or preserved plants, or of their parts; the place where they are kept.

Herbicide : A chemical used to kill unwanted plants; a weed killer (e.g., Machete).

Herbivore: Insects which feed on living plants.

Hermaphrodite: Individual insects are sometimes found to have both male and female characteristics. **Gynandromorphs** are genetic mosaics of male and female tissues, derived from a zygote plus other genetically different nuclei. Tissues of **intersexes** have the same but unstable genetic composition, resulting in the differentiation of male and female features. Gynandromorphs and intersexes are not normal in any insect species. In the cottony-cshion scale, *Icerya purchasi* (Coccoidea) and related species, a functional hermaphroditism does occur normally. Both male and female gonads develop in the female scale, and the eggs are self-fertilized. Haploid male scales are rarely produced, and no pure females are known.

Heterodynamic: Heterodynamic species are those in which one of the generations during the year goes into diapause as in case of European corn borer.

Heteroecious: Requiring two or more unrelated hosts for completing the life cycle.

Heterogamy: Alternation of bisexual reproduction with parthenogenetic reproduction.

Heterogenesis: Alternation of generations; spontaneous generation.

Hetrogonic Growth: Growth patterns characterized by some parts of the insects' body developing at different rates than others; also called allometric growth.

Heterometabola: Insects with simple metamorphosis, including the paurometabola and Hemimetabola.

Heteromorphosis: In most endopterygotes the larval instars are more or less alike. However, in some species of Neuroptera, Coleoptera, Diptera and Hymenoptera, a larva undergoes characteristic changes in habit and morphology as it grows-a phenomenon known as heteromorphosis (hypermetamorphosis). In such species several of the larval types may develop successively. For example, blister beetles hatch as free living campodeiform larvae (e.g., planidia, triangulins) which later change to eruciform or may become scarabaeiform.

Heteroneurous: Having the fore wings and hind wings different in venation.

Heterosis: Hybrid vigour, resulting from cross breeding.

Heterotrophic: Feeding on organic materials.

Hexalure: Synthetic pink bollworm moth attractant; cis-7-hexadecen-1-01-acetate; synthetic scent attractive to male moths of pink bollworm; used in traps to survey extent of infestations.

Hexapoda: Arthropods with three pairs of walking legs, are placed in the superclass Hexapoda (meaning six-legged organisms). Two classes of Hexapoda are recognized : **1.Entognatha** for small six-legged soil dwelling arthropods that have their mouthparts retracted in a cavity in the head (hence the name Entognatha); and **2.Insecta** for the insects in the strict sense. Insects do not have their mouthparts retracted in the head.

Hibernaculum: Silken shelter in which larvae of some Lepidoptera hibernate.

Hibernating Aggregation: A phenomenon of insect life by which sometimes many thousands of insects congregate together before hibernating in a suitably sheltered place. This gives them a greater degree of protection from extreme winter conditions.

Hibernation: State of dormancy or arrested development during the winter. It occurs mostly in advanced larval and pupal stages. Many insects go underground, some go under logs or stones in an attempt to hibernate.

Hidden Costs: Undetected costs resulting from pesticide application which can not always be immediately calculated, e.g., resurgence of primary and secondary pests, insecticide resistance, environmental pollution, and poisoning cases.

Hierarchy: A systematic framework for zoological classification with a sequence of classes (or sets) at different levels in which each class except the lowest includes one or more subordinate classes.

High Volume Spraying (HV): The

application of pesticides in dilute form to thoroughly wet the object being sprayed; usually involves the application of more than 600 litres per hectare for field crops, and more than 1000 litres for trees and bushes. In between ultra-low volume and high volume spraying medium volume (200-600 litres/ha), low volume (50-200 litres/ha), and very low volume (5-50 litres/ha) sprays are also used on field crops. Generally speaking the higher the volume of water used, and the lower the pressure, the coarser is the spray. A coarse spray is easier to control and direct than a fine one.

Higher Category: A taxonomic category or rank higher than the species (i.e. from subgenus to kingdom).

Highly Toxic: 1. Substances are considered highly toxic by law if the LD₅₀ of a single oral dose is 50 milligrams or less per kilogram of body weight. **2.**If LC₅₀ through inhalation is 2,000 mcg or less of dust or mist per litre of air or 200 ppm or less by volume of a gas or vapour when administered by continuous inhalation for one hour to both male and female sets or to other rodent or non-rodent species if it is reasonably foreseeable that such concentrations will be encountered by man, or, **3.**If LD₅₀ through skin absorption is 200 milligrams or less per kilogram of body weight when administered by continuous contact for 24 hours with the bare skin of rabbits or other rodents or non-rodent species is specified.

Highly Volatile: A liquid that quickly forms a gas or vapour (evaporates) at room temperature.

Hill: A group of plants (e.g., rice) directly adjacent to each other because the seeds or seedlings were planted together. A hill may also consist of only one plant.

Hill-Topping: A term used to describe the behaviour of butterflies of either sex when they aggregate at tops of ridges, mountains or hills, in order to find mates.

Hind: At or towards the posterior.

Hindgut: The posterior portion of the alimentary tract, between the midgut and anus.

Hindgut is ectodermal in origin and as such, is lined with cuticle which is thinner than that in foregut—a feature related to the absorptive function of this region. Muscles are only weakly developed in this tract. In the hindgut, following regions usually can be distinguished: pylorus; ileum and rectum. The pylorus may have a well-developed circular muscular layer (pyloric sphincter) and regulate the movement of material from midgut to hindgut. Also the malpighian tubules characteristically enter the gut in this region. The ileum is generally a narrow tube that serves to conduct undigested food to the rectum for final processing. The most posterior part of the gut, the rectum, is frequently dilated. Rectum possess six to eight thick-walled rectal pads.

Hind Wings: The hind wings of an insect, when present, are on the third thoracic segment. They may be similar to, or different from the fore wings which are on the second segment. In most cases both pair of wings are functional or flying but in Coleoptera, Orthoptera and Dictyoptera the delicate membranous hind wings are used; when at rest they are folded and protected by the thicker fore wings or elytra. In male Strepsiptera (stylopids) the fore wings are club-like and ineffective in flight. In Diptera and male coccids, on the other hand, the fore wings are used for flying and the hind wings are reduced to form small balancers or ‘halteres’.

Histopathology: A study of abnormal changes especially at the cell and tissue level.

Hollow-Cone: Spray jet with a core of air breaking to give drops in an annular patterns.

Holocephalous: A term used to denote insect larvae in which the head is fully developed.

Holocyclic: A type of life cycle in aphids in which reproduction is solely sexual and in which winter survival is on a (often scarce) host plant with no migration to a summer host plant.

Holometabola: Also known as Endopterygota. Insect orders with complete metamorphosis. Orders Neuroptera, Mecoptera, Lepidoptera, Trichoptera,

Diptera, Hymenoptera, Coleoptera and Strepsiptera are all holometabolous.

Holometabolous: One of two major types of development where the immatures (larvae) do not resemble the adults and a pupal stage occurs; complete metamorphosis. This condition is found in endopterygotes and a few exopterygotes e.g., whiteflies (Hemiptera: Aleuroididae), thrips (Thysanoptera), and male scale insects (Hemiptera: Coccidae). The most obvious structural differences between the larval and adult stages of endopterygotes is the absence of any external sign of wing development in the larval stages. The pupa is probably a highly modified final juvenile instar which, through evolution, became less concerned with feeding and building up reserves (this function being left to earlier instars) and more specialized for the breakdown of larval structures and construction of adult features. Pupa is a non-feeding stage; it is generally immobile as a result of histolysis of larval muscles, it broadly resembles the adult and thereby serves as a mould for the formation of adult tissues, especially muscles.

Holopenustic: Pertaining to open ventilatory system that consists of two lateral rows of 10 spiracles each - a pair of spiracles on each of the mesothorax, metathorax and first eight abdominal segments. Longitudinal trunks and transverse segmental commissures are also present. This type of respiratory system is found in immature stages and adults of many terrestrial Orthopteroidea, Hemipteroidea and some Hymenoptera.

Holotype: The single specimen designated or indicated as ‘the type’ by the original author at the time of the publication of the original description.

Homeostasis: The maintenance of a steady state, especially a physiological or social steady state, by means of self regulation through internal feedback responses.

Homeothermy: The maintenance of an even body temperature despite variation in the ambient temperature.

Homochromism: Similarity of insects to the colour of inanimate objects.

Homodynamic: Are those insect species that can carry on generations throughout the year without interruption if environmental conditions are favourable. This group includes many of the stored-grain and household insects.

Homoeosis: The replacement of a damaged appendage by a different one. If for instance, the antennae is removed from the stick insect (*Dixippus* sp.), the regeneration that follows may not produce another antennae but sometimes gives rise to an extra leg in place of it.

Homologous: Organs or structures that are similar in their position and developmental origin, but not necessarily similar in appearance or function.

Homologues: A series of organic compounds with similar properties but differing from each other by some radical.

Homology: Similarity in structure resulting from having had a common evolutionary origin.

Homomorphism: Similarity of insects to the shape of inanimate objects.

Homoneurous: Having the fore wings and hind wings similar in venation.

Homonym: In nomenclature, one of two or more identical but independently proposed names for the same or different taxa. The earliest of such names is senior homonym; later ones are junior homonyms.

Homopteran: A member of or pertaining to the insect order Homoptera, which includes the aphids, jumping plant lice, treehoppers, spittlebugs, whiteflies, and related groups.

Homotypism: Similarity of insects to form and colour of inanimate objects.

Honey: Chemically, honey is a viscous watery solution of sugars containing 13-20% water, 40-50% fructose, 32-37% glucose, 2% sucrose, traces of maltose, 1-12% dextrins and gums, and traces of minerals, free organic acids, vitamins, enzymes, plant pigments and suspended solids such as pollen grains and

beeswax. Honey is truly an insect product and is prepared by honeybees from the nectar they suck from flowers. The nectar obtained from flowers, after being mixed with saliva and swallowed, is carried in the honey sac (crop), until the bee reaches the hive. At the hive, the collected nectar is masticated thoroughly with saliva containing the enzymes invertase and amylase, and the sucrose is hydrolysed into glucose and fructose. A large portion of water content is removed by the air currents produced over the cells by the rapid beating of the wings of the worker bees. Honey is extensively used as a natural sweet, as a spread, and in making candies, cakes and bread, and is a rich nutritious food.

Honeybee: A member of the genus *Apis*. Unless qualified otherwise, a honeybee is more particularly a member of the domestic species *Apis mellifera* and the term is usually applied to the worker caste. Honeybees are probably the most important pollinators of commercial crops. They produce and store honey in large quantities. During the summer a honeybee colony normally consists of 15,000 to 100,000 sterile female workers, a single fertile female queen, and a few hundred males or drones. Honeybees are especially valuable because the entire colony, except for the females, survives the winter and thus high populations are available in early spring when population requirements are high.

Honeycomb: Wax cells made by the honeybee for storing honey and as brood cells. They are made from wax secreted by four pairs of glands situated in the membrane below the 3rd, 4th, 5th and 6th abdominal segments. This wax is produced as small white scales which the bee manipulates with its feet and mandibles to make regular hexagonal prisms of uniform size. The geometrically perfect shape ensures the most economical use of the wax, because every wall forms part of two cells, moreover this shape packs the maximum number of cells into a given area.

Honeydew: Excess sugary plant sap excreted from the hind end of the gut by phloem feeding Homoptera (e.g., aphids, treehoppers, soft scales, mealybugs and whiteflies). The

homopterans living today are wasteful feeders ejecting the phloem sap largely unaltered and in quantity. Honeydew is rich in sugars and in free amino acids and forms an inexhaustible source of nutrients throughout the time when the producing insects are actively feeding. Natural enemies of phytophagous insects such as ants, predatory wasps, and lacewings, as well as bees and moths are attracted to honeydew. In some cases this is a regular or major part of their diet.

Honey Pot: A container made by stingless bees or bumblebees from soft cerumen and used to store honey.

Honey Stomach: The crop of a honeybee in which nectar is mixed with enzymes from the salivary glands and converted to honey before being disgorged.

Honey Stopper: A valve at the posterior end of a bee's crop specialized for preventing the passage of nectar into the stomach.

Hopperburn: Marginal yellowing, scorching and curling of leaves (e.g., alfalfa, dahlia, potato) due to the feeding of certain leafhopper species.

Hoppers: 1. Leafhoppers (Cicadellidae), Treehoppers (Membracidae) and Froghoppers (Cercopidae): small plant bugs of the group Homoptera, closely related to the aphids, very varied but all having powerful hind legs for jumping 2. Nymphs of locusts (Acrididae) which march in bands.

Horizontal Classification: Classification which stresses grouping together species in a similar stage of evolution rather than location on the same phyletic line.

Horizontal Resistance: Plant resistance that operates generally against all races of a pest. Improvement in crops with horizontal resistance is a building process based on stepwise accumulation of genes with favourable additive effects. It is relative or quantitative. Horizontal resistance has the advantage of stability, it does not wither under the pressure of attack by different strains of the pest species in different localities and over time.

Horizontal Storages: Any storage where the height is less than the diameter or width. These storages are also referred to as deep bin, tank, silos or cell.

Hormesis: Growth stimulation by exposure to low doses of a toxicant.

Hormoligosis: Refers to the situation when sublethal quantities of any stressing agent will be stimulatory to an organism by providing it with increased sensitivity to respond to changes in the environment. This concept has been well proven in many insecticide-insect reactions when exposure of insects to sublethal doses of insecticides is involved. Sublethal doses might positively stimulate neural activity to bring about a favourable neurohormonal influence on insect reproduction.

Hormone: A substance produced in small quantity in one part of the body (usually in a gland of internal secretion) and transported to other parts where it exerts its action. The post-embryonic development and sexual maturation of insects are regulated by hormones. The organs that secrete the developmental hormones are associated with and are under the control of the nervous system.

Hornet: A large wasp of the family Vespinae, particularly a member of the genus *Vespa*. They form annual colonies. Their nests may be suspended from branches, or other aerial structures, may be concealed beneath stones or in hollow logs, or may be constructed in cavities which the wasps excavate in the ground. Stinging is largely used to deter mammalian predators, which are very sensitive to the pain producing substances injected through the sting.

Hornworm: A caterpillar with a dorsal spine or horn on the last abdominal segment (e.g., larvae of Sphingidae).

Host: The term 'host' means any plant or animal on or in which another lives for nourishment, development or protection.

Host Discrimination: Condition when most parasitoids can recognize, and generally reject

hosts that are parasitized already either by themselves, their conspecifics or another species. Distinguishing unparasitized from parasitized hosts generally involves a marking pheromone placed inside or externally on the host at the time of oviposition.

Host Evasion: A type of apparent host-plant resistance in which the plant passes through a susceptible stage quickly or at a time such that its exposure to potentially injurious pests is reduced.

Host Finding: For host finding, vision is of great importance in blood-sucking Diptera but it is of much less importance in blood-sucking bugs, fleas, lice, mites and ticks. Thermal stimuli is important in attracting bugs, ticks, lice, mosquitoes and tsetse flies to their hosts.

Host Indexing: A procedure to determine if a plant is a carrier of a virus, mycoplasma, or spiroplasma.

Host Races: Different genetic races of the same species in oligophagous food specialists or parasites occurring on different hosts.

Host Range: The complete range of plant species susceptible to an insect.

Host Specific: An organism that is monophagous, feeding only on a certain host.

Host Specificity: The degree of specificity of an animal preying on hosts. Levels of host specificity include monophagous, stenophagous or oligophagous and polyphagous.

Hot Spot: Site where the natural infestation of a particular insect is high, providing sufficient pressure for reliable results in insecticide evaluation tests.

Hoyer's Solution: Also known as modified Berlese's solution. This is a common, water-based medium. It bleaches the specimens slightly. Living insects or dead specimens in alcohol are first dipped into water for about 30 seconds and then placed directly into the drop of Hoyer's solution on the slide. Its formula is: Distilled water - 50g; gum arabic (clear crystals) - 30g; chloral hydrate - 200 g; and Glycerine - 20g. The above ingredients

should be mixed at room temperature in the sequence given above. In the more humid areas, slides mounted in Hoyer's medium should be ringed with the nailpolish, or some other ringing medium. It is an excellent medium for mounting particularly spider mites (Tetranychidae) which are one of the more difficult groups to mount.

Humectant: Material added to a spray to delay evaporation of the water carrier.

Humeral: Near the base of wing on the anterior margin.

Humeral Angle: The basal anterior angle or portion of the wing.

Humeral Bristles: Bristles on the humeral callus (Diptera).

Humeral Callus: One of the anterior lateral angles of the thoracic notum, usually more or less rounded (Diptera).

Humeral Cross-Vein: A cross-vein in the humeral portion of the wing between the costa and the subcosta.

Humeral Plate: A plate in the humeral region of the wing.

Humeral Region: The anterior base of the wing.

Humeral Suture: In termites, the line of weakness along which the wings break after the nuptial flight.

Humeral Vein: A branch of the subcosta that serves to strengthen the humeral angle of the wing (Neuroptera).

Humus: Organic soil, well-decomposed organic matter in soil, which makes the soil dark and binds it together.

Hyaline: Clear and transparent like glass.

Hybrid: A cross between two species, or a cross between two genetic types.

Hybrid Belt: A zone of interbreeding between two species, subspecies or other unlike populations.

Hybridization: The crossing of individuals belonging to two unlike natural populations, principally species.

Hydraulic Agitator: A device which keeps the tank mix from settling out by means of water flow under pressure.

Hydraulic Sprayer: A machine which applies pesticides by using water at high pressure and volume to deliver the pesticide to the target. Same as high pressure sprays.

Hydrocarbon: A chemical whose molecules contain only carbon and hydrogen atoms. The simplest hydrocarbon is methane. Crude oil is a mixture of hydrocarbons.

Hydrofuge: Having a waxy surface that repels water and is not wetted, e.g., the cuticle and the cuticle hairs of most insects. This property enables many aquatic insects to breathe under water by taking down a bubble of air trapped by the hairs under their bodies.

Hydrolysis: Chemical process of (in this case) pesticide breakdown or decomposition involving a splitting of the molecule and addition of a water molecule.

Hydropyle: A special region on the surface of the egg concerned in the regulated absorption of water.

Hydrostatic: Concerned with mechanical balance or equilibrium in water.

Hydrostatic Balance: Maintenance of body position in the water by aquatic insects.

Hygoreception: The ability of insects to perceive moisture in the air. It is a form of chemoreception in the sense that water is a chemical compound.

Hymenoptera: An endopterygote insect order. This is second largest order of class Insecta. Commonly known as sawflies, wasps, bees and ants. They have multisegmented, often long and forwardly held antennae. Compound eyes well developed. Three ocelli, mouthparts are biting type and in many species for taking liquid. Usually with two pairs of membranous wings. Wings are joined in flight by hook-like structures called hamuli. Distinctive 'waisted' appearance except in sawflies. Females are often provided with ovipositor, conspicuously saw-like or needle-like or sting.

Hypandrium: The ventral part of the 'andrium' or male external genitalia- a plate formed from the 9th abdominal sternum. It may bear two short stylets, as for example in the cockroach. This and its complimentary term 'epandrium' are more often used by taxonomists than by morphologists.

Hypermetamorphosis: A modification of holometabolous development (complete metamorphosis) where certain larval instars assume quite different forms and behaviour. Some blister beetles (Meloidae) pass through at least four larval stages including triungulins, caraboids, scarabaeoids and coarctate larvae.

Hyperparasitoid: Parasitoids that attack other parasitoids are called hyperparasitoids or secondary parasitoids. Some insects are obligate hyperparasitoids, developing only within primary parasitoids, while others are facultative and may develop also as primary parasitoids. Development may be external or internal to primary parasitoid host. External feeding is frequent and predominantly restricted to the host larval stage.

Hyperplasia: Abnormal increase in the number of cells of a tissue, excluding tumour formation, whereby the bulk of the organ is increased in response to increased functional demands (e.g., gall, enation, tumour, witch's broom).

Hyperplastic: Refers to type of symptom characterized by the abnormal multiplication of cells.

Hyperpneustic: Possessing more than the usual number of spiracles as in some Thysanura.

Hypertrophy: Abnormal increase in the size of cells of a tissue, without an increase in the number of structural units upon which their functions depend. Hypertrophy is usually stimulated by increased functional demands.

Hypodermis: The cellular layer of the body wall which secretes the cuticula. It is a more or less continuous sheet of tissue, one cell thick, responsible for secreting the bulk of the cuticle. During periods of inactivity its cells are flattened and intercellular boundaries

are indistinct. When active the cells are more or less cuboidal, and their plasma membranes are readily apparent; one to several nucleoli, extensive rough endoplasmic reticulum and many golgi complexes are evident.

Hypodigm: The entire material of a species that is available to a taxonomist.

Hypogaic: Living primarily underground (subterranean) or at least beneath cover such as leaf litter, stone, and dead bark (cryptobiotic).

Hypoglottis: A sclerite or cuticular element sometimes present between the mentum and the labium of an insect, i.e. at the base of the 'tongue' in some Coleoptera.

Hypognathous: Position of head in which the mouthparts are directed downwards, immediately ventral to the head capsule (e.g., grasshoppers and cockroaches).

Hypopharynx: In piercing and sucking insects, it is a tongue-like structure surrounded by maxillae and labium., it may be stylet-shaped and contain the salivary channel. In generalized insects, the hypopharynx is so closely associated with the base of the labium as to be considered a part of it. Unlike the other mouthparts, the hypopharynx is not an appendage but an unsegmented outgrowth of the body wall. The hypopharynx divides the preoral cavity into anterior and posterior spaces, the upper parts of which are 'cibarium' leading to the mouth and salivarium into which the salivary duct opens respectively. At its base, ducts open from the salivary glands which secrete liquid containing enzymes chiefly amylase and invertase, to moisten food and begin digestion of starches and sugars in lepidopterous larvae. The salivary glands secrete silk which is manipulated by the spinneret-a specialized structure fused from the maxillae, hypopharynx and labium. The silk is used for webbing or for a cocoon in which to pupate.

Hypoplastic: Refers to type of symptom characterized by the underdevelopment

(malformation) of plant cells, tissues, or organs.

Hypopleural Bristles: A nearly vertical row of bristles usually located just above the hind coxae of flies (Diptera).

Hypopleuron: In flies (Diptera), a sclerite found just above the hind coxae.

Hypopneustic: Also called 'oligopneustic' having a reduced number of functional spiracles, as for instance in the Coccidae and the Thysanoptera.

Hypopus: A deutonymphal stage in the development of astigmatid mites in which it developed suckers or claspers for grasping insects and thereby effecting dispersal. Hypopus may be completely unlike the preceding and succeeding stages in morphology and behaviour. In this stage mites are highly resistant to environmental stresses, they may be inactive and nonfeeding.

Hypopygium: The terminal segments of the abdomen of an insect, often modified for copulation; a term chiefly applied to male Diptera.

Hypostoma: In many of the more primitive orthorrhaphous flies, head of the larva is retracted into the thorax and enclosed within a sheath formed from the neck surface. In them labium is rudimentary and often confused with the 'hypostoma' - a toothed, triangular sclerite on the neck membrane.

Hypostomal Bridge: Sometimes a sclerotized area develops between labium and neck, and the sclerotized area 'hypostomal bridge' represents the extension of the hypostomal area.

Hypostome: A structure with recurved teeth located in a median position and arising from the basis capituli in Ixodid ticks. The hypostome is armed with rows of backwardly-directed teeth which securely attach the tick to its host. An anteroventral region of insect head is also sometimes called as hypostome.

Hythergraph: A polygonal diagram resulting from plotting temperature means against rainfall.

Identification: The determination of the taxonomic identity of an individual. The purpose of identification is to determine what kind of organism a given specimen is. The meaning of 'kind' depends largely upon one's objectives. All methods used to identify are based on comparison, and use of a key (mostly dichotomous) is the most common method employed. Insects can be identified by sending to an expert, or by comparing with the specimens on a labelled collection, or may be compared with pictures or descriptions, or it may be identified by the use of keys. Pictorial keys which are especially useful to nonspecialists, include printed material as well as user-friendly computer-based interactive systems. A tentative identification from a key should be confirmed by comparing the specimen's characters with the diagnosis or description for the species.

Idiobiont: A parasitoid that kills or paralyzes its host when laying an egg, and thus preventing the host from developing any further.

Idiosoma: Entire body of mites and ticks excepting gnathosoma. Idiosoma and gnathosoma may be separated by a circumcapitular suture. Unlike insects, brain lies in the idiosoma. The idiosoma can be subdivided into the area of the legs-**podosoma** (area of body between the legs), and **opisthosoma** (the area behind the fourth pair of legs). In the Acariformes four pairs of legs are usually arranged in anterior and posterior pairs, and the areas associated with them is referred to respectively as the propodosoma

and metapodosoma. Region of gnathosoma and podosoma combined is known as prosoma. The region of gnathosoma and propodosoma are jointly known as proterosoma, while the region of metapodosoma plus opisthosoma is referred to as the hysterosoma.

Ileum: Anterior part of the hindgut between the ventriculus and the colon. The ileum is a narrow tube that serves to conduct undigested food to the rectum for final processing. In some insects, however, some absorption of ions and or water may occur in this region. In a few species production and excretion of nitrogenous wastes occur in the ileum. In many wood-eating insects (e.g., species of termites and beetles) the ileum is dilated to form a 'fermentation pouch' housing bacteria or protozoa that digest wood particles. The products of digestion, when liberated by the microorganisms, are absorbed across the wall of the ileum.

Illegal Residues: Means residues higher than the tolerance level. The tolerance level is the legally permitted concentration in parts per million (ppm) of a residue of a hazardous material in or on a food.

Imaginal Discs: A relatively undifferentiated tissue mass occurring in the body of a larva which is destined to develop later into an adult organ.

Imago: The imago or adult, is the stage being fully developed and with functional reproductive organs and associated mating or egg laying structures. In winged species it is

the stage bearing functional wings. The only known exception to this latter is the mayfly order (Ephemeroptera) in which the stage before the winged reproductive also has wings and uses them, and this curious flying pre-adult instar is called a subimago.

Immature: The feeding stage of insects after birth but before adulthood, including both larvae and nymphs.

Immigration: The movement of individuals into a population.

Immune: A state of not being affected by disease or poison; exempt from or protected against. Ability of an insect to resist the pathogenic effects of microorganisms that have gained entry into the body cavity is termed immunity. Immunity may be innate (natural) and acquired (induced).

Impermeable: Not capable of being penetrated, semi-permeable means permeable to some substances but not to others.

Impregnated Dust: Impregnated dust refers to a dust in which each pesticide particle carries the pesticide.

Impregnating Materials: Chemicals that are used in the treatment of woollens for moth-proofing and timber against wood-destroying organisms.

Impulse: The electrical disturbance, or 'message' that is carried along the nerve fibre or 'axon'. Impulses in motor or association neuron which lack dendrites, travels only along the axon originating on a collateral branch and normally do not pass through the cell body. In sensory neurons the impulse is passed along the dendrite to the cell body before reaching the axon.

Inactive: Not involved in the pesticide action; not reaching chemically with anything.

Incidence: Number of plants affected within a population; pest incidence should be distinguished from pest severity.

Incisor: Adapted for cutting (e.g., mandibles of grasshoppers).

Inclusion Body: The proteinaceous or

crystal like structure produced in insect cells infected with certain viral pathogens, it occurs in various shapes and sizes, and usually encloses a number of replicated virions.

Inclusion Viruses: The majority of insect pathogenic viruses are different from most viruses in that the virus particles or 'virions' are enclosed in proteinaceous capsules or membranes. Such viruses are called inclusion viruses. There are two main types of inclusion viruses : the **polyhedrosis** and the **granulosis**. The polyhedrosis are divided into nuclear and cytoplasmic forms, based on the site of virion multiplication within the cells of the host.

Incompatible: Not capable of being mixed or used together in the case of pesticides, the effectiveness of one or more is reduced, or they may cause injury to plants.

Incomplete Metamorphosis: Also known as partial metamorphosis and gradual metamorphosis. A type of metamorphosis in which there is a gradual and often not very marked transformation from immature to adult stage. There is no pupal stage and immature stages are referred to as nymphs.

Incubation: The hatching of eggs by means of heat, natural or artificial.

Incubation Period: The period in which the embryo develops within the egg before hatching (eclosion). In epidemiology, however, it refers to the period between infection of organisms with a disease, and the appearance of the disease.

Indeterminate: Describing growth or development in which there is no distinctive final adult instar, with no definitive terminal moult.

Indexing: Testing of plants for presence of certain viruses.

Indication: In nomenclature the publication of certain types of evidence or cross references which establish the typification of a name and thus make it available.

Indicator Plant: A plant that responds specifically to certain viruses, other

pathogens, or different environmental factors with specific characteristic symptoms; used for identification of the specific pathogen(s) or environmental factor(s), also used in diagnosis of pathogens.

Indigenous: Occurring naturally in a country or area.

Indirect Fertilization: In Collembola, Diplura, Archeognatha and Thysanura, the transfer of spermatozoa by means of a spermatophore which is deposited onto the substrate and picked up by the female.

Indirect Loss: Also known as indirect damage. Decline in quantity or quality of a marketable commodity (e.g., seeds) owing to the feeding of insects on the nonmarketable portions (sometimes roots, stems, leaves) of the plant; damage resulting from injury to non-yield forming organs.

Indirect Metamorphosis: Complete metamorphosis in which there are four stages: egg, larva, pupa and adult.

Industrial Melanism: The evolution of darkened population owing to selection in the sooty surroundings of an industrial area (e.g., peppered moth, *Biston betularia*).

Inert Ingredient: A material having no biological action (e.g., diatomaceous earth, magnesium oxide and activated charcoal); an ingredient in a formulation which has no pesticidal action.

Infect: To enter and establish a pathogenic relationship with a plant (host); to enter and persist in a carrier.

Infection: The development and establishment of a pathogen (e.g., a bacterium) in its host which will produce a disease.

Infest: To occupy and cause injury to either a plant or to soil or stored product (e.g., insects, mites, nematodes, bacteria, fungi etc.).

Inflorescence: Collective term for a terminal cluster of flowers.

Infochemicals: The chemicals which act as a feeding deterrent and growth inhibitor in insect pests but influence the host searching

efficiency of predators and parasitoids (e.g., Caryophyllene).

Infraorder: An optional category below the suborder.

Infraspecific: Within the species; usually applied to categories (subspecies) and phenotypes (varieties).

Infrasubspecific: Individuals and seasonal variants in a single interbreeding population.

Ingest: To eat or swallow.

Ingestion: The swallowing or taking in of food material to the gut or food cavity. Insects take their food into the alimentary canal by way of the mouth. In insects with chewing mouthparts, the mandibles and maxillae cut off and shred the food. The closing together of these opposing structures presses the food to the back of the mouth or cibarium, at the base of hypopharynx. The hypopharynx is then pulled upward and forward, forcing the food into the pharynx from where the food is moved along the digestive tract by peristaltic action.

Inguvial: Pertaining to the crop, the distensible middle portion of the foregut in which liquid food is stored in many species.

Ingredient Statement: The portion of the label on a pesticide container that gives the name and amount of each active ingredient and the total amount of inert ingredients in the formulation.

Inhalation: Exposure of test insects either to vapour or dust for a predetermined time; to take air into the lungs.

Inhalation Toxicity: Toxicity of a material to man or animals when breathed into the lungs.

Inject: To force a pesticide chemical into a plant, animal, building or other enclosure, or in the soil.

Injector: A device for injecting a pesticide below the soil surface, or into the transport system of a tree.

Injury: Momentary (transitory) damage by a causal agent, e.g., insect feeding, action of a

chemical, physical agent, or an adverse environmental factor.

Innate: Inherited behaviour which is often referred to as instinct, consists largely of more or less predictable responses or sequences of responses to the different types of stimuli.

Innate Capacity for Increase: A measure of the rate of increase of a population under controlled conditions. The maximal rate of increase under essentially ideal conditions without the effects of naturally occurring mortality due to disease, predation, etc.

Innervation: The nerve supply to an organ or part.

Inoculation: Also called 'introduction' as applied to biological control. The introduction of new species of parasites, predators or disease organisms for biological control purposes. Inoculation proves useful especially in perennials, sedentary pests and in 'ecological islands' Inoculation is particularly applicable where the pest problem is widespread and crop needs little pesticide against other pests. Inoculation has been successfully employed in the glasshouses to control spider mites by predaceous mite, *Phytoseiulus persimilis*.

Inoculum: The pathogen or its parts (e.g., bacterial cells, fungus spores, mycelium, nematodes, virus particles etc.) used for inoculating to produce the disease.

Inorganic Compounds: Inorganic pesticides like i) lead arsenate which is effective against chewing insects, ii) sodium fluosilicate used as a bait for ants, cockroaches, and grasshoppers, and iii) finely ground sulfur dust used to control mites and some fungi.

Inornate: In ticks this refers to the absence of a colour pattern on the scutum.

Inquilinism: The relation in which a socially parasitic species spends the entire life cycle in the nests of its host species. Workers are either lacking or, if present, are usually scarce and degenerate in behaviour. This condition is sometimes referred to as 'permanent parasitism'. Some cases of such extreme social

parasitism are found in gall wasps. Small gall wasps live in the nests made by large gall wasps.

Insect: The word insect comes from the Latin, **insect-us**, past participle of **insecare** which means to cut into, and refers to the major divisions of an insect's body. On land two groups of organisms dominate: the plants and the insects. More than 56% of all described species of different organisms, and about three-quarters of all animals are insects and there are many more species awaiting discovery and description. Insects are covered under class Insecta of Phylum Arthropoda. More than one million species of insects have been described. They range in size from minute parasitic wasps at around 0.2 mm to stick insects measuring 30 cm in length. The insects have evolved very diverse life styles. The head bears external mouthparts, antennae and compound eyes. The thorax has three pairs of legs and typically two pairs of wings. Insects have a well-developed tracheal system.

Insect Abundance: The Hexapoda, or insects, comprise the largest number of species of the animal world. There are about six times as many species of insects as of all other animals combined. Insects are too numerous to be listed conveniently. There are approximately one million described species of insects. Coleoptera (>350,000 species), Lepidoptera (>140,000 species), Hymenoptera (>130,000 species), and Diptera (>120,000 species) are the biggest insect orders as regards number of species known.

Insect Collection (Care) : Since many insects and mite invaders are commonly seen in insect collections in the museums and laboratories, so to prevent their entry in the collection boxes use naphthalene balls (or in flakes form) or paradichlorobenzene. If mould attack is found on insects, then remove moulds from wings with fine brush or dip the brush in carbolic acid. Moulds can be prevented by using beachwood creosote-clear oily fluid, which smells like ordinary creosote.

Only a few drops of creosote are needed per box as it is oily and may stain the floor of the box or cabinet.

Insect Distribution: Few habitats exclude insects. Insects are unparalleled by any other organism in withstanding harsh environments. Some insects live in the arid weather, some in hot springs up to 80°C, others in mountain peaks as high as 6096 metres, some in tropical rain forests, and there are insects that live in arctic temperatures that reach below -20°C.

Insect-Growth Regulator (IGR): A synthetic, organic pesticide which mimics insect's hormonal action so that the exposed insect complete its normal development cycle, and dies without becoming an adult; chemical substance that disrupts the action of insect hormones controlling moulting, maturity from pupal stage to adult, and others. The group includes insect hormones, growth regulators, developmental inhibitors, and synthetic hormone mimics. A number of juvenile hormone analogues have been developed that are successfully used for control of a range of pests, particularly public health and stored product pests. Methoprene (Altosid) has been introduced for use against second to fourth larval stages of flood water mosquitoes to prevent adult emergence. Larvae exposed to methoprene continue their development to the pupal stage when they die. Methoprene has no effect when applied to pupae or adult mosquitoes. Kinoprene is another IGR developed for the control of aphids, whiteflies, mealybugs and scale insects. It acts by inhibiting development, reducing egg laying, and sterilizing adult females.

Insect Larvae: A larva may be defined as a free-living, immature stage differing in structure and habits from the adults. The larvae of insects are very variable but may be roughly classified into the following types :
1. Protopod larvae : Primitive parasitic larvae with barely incipient limb buds and with no segmentation of the abdomen. They are found in some parasitic Hymenoptera. **2. Polypod or eruciform larvae :** Typical caterpillars with six legs on the thorax and a number of

'cushion feet' or prolegs on the abdomen. Typical of Lepidoptera and sawflies.

3. Oligopod or campodeiform larvae : These are usually predatory and have efficient sense organs and long legs but no 'cushion feet'. They are common among beetles. **4. Apodous or legless larvae :** The body is segmented and has a minute head with few sense organs and no legs or limbs of any kind. The absence of these is probably a secondary feature arising from the fact that they are either fed by other members of the colony, as in bees, or the eggs are laid in suitable food such as meat or dung, as in houseflies etc.

Insect Nets: An insect collection net consist of a cloth bag or nylon net bag, a handle and a metal ring which holds the mouth of the open bag. A ring of about 40 cm diameter made of 0.3-0.4 mm thick wire is used. The ends of the ring are fitted into a groove at end of the handle, detachable ring can allow the change of the net if it is dirty or torn. The depth of the bag is about 75 cms or about twice the diameter of the ring. The handle should be light and sturdy and of about 50 cm length.

Insect Pest Management: A management system that uses all suitable techniques and methods in as compatible a manner as possible to maintain pest population at levels below those causing economic injury.

Insect Pinning Stage: It consists of a block of wood or wood covered in metal in the form of a low flight of steps. There are pin holes in each step which go right down to the base, where there is a metal stop. The card point is placed on the top step, the first data label on the second, and so on. The first label is usually a catalogue or registration number, or a determination label, giving the name of the species and the name of the person making the determination. This gives the whole collection a uniform appearance. In the improved type of pinning stage, there is a flat top but the depths of the holes vary. There is also a row of holes through the side which serves to show the depth of downward hole and to clear away fine paper fragments which might in time clog the base of the hole. This

kind of pinning stage enables a large card to be used as well as small points.

Insect Pins: Entomological pins are made from brass plated with nickel which leaves them 'white' or 'black' enamelled. Better pins are made from stainless steel rather bluish in colour and these are headless. Insect pins are sold in sizes from 00 (extremely slender) to 8 (large diameter). Sizes 1 to 3 are the best for general use. Size '0' may be used to pin very slender insects but the pin tends to bend easily. Micropins are very fine, headless, made of stainless steel, and are from 10-15 mm long. The micropins are inserted through the insect's body in the same position as used in macropinning. After this pins are inserted into insect pinning stage.

Insect Pollination: Many plants are insect pollinated. Strawberry, apple and cherry are dependant on insect pollination as are also the melons and squashes. For seed production, carrot family (Umbelliferae) and the cabbage family (Cruciferae) depend on insect pollination. Flies, butterflies, beetles and other plant dwelling insects pollinate many of these plants particularly those lacking showy flowers. The bulk of the pollination with showy flowers is done by honeybees. Many wild bees are also excellent predators if present in large numbers.

Insect Society: In the strict sense, a colony of eusocial insects (ants, termites, eusocial wasps, or bees). In the broad sense, any group of presocial or eusocial insects.

Insect Sociobiology: The study of social behaviour and population characteristics related to social insects.

Insect Vector: An insect that transmits a disease inducing organism or agent. Plant viruses are transmitted by insects in three ways: **1.** Mechanically or stylet-borne (also termed non-persistent or non-propagative); **2.** Semi-persistent or circulative indicating an ability to transmit over longer periods of time, but the virus does not replicate in insect; and **3.** Persistent or propagative for viruses that replicate in the vector as well as in the host plant.

Insect Viruses: More than 700 species of insects are known to be susceptible to viral diseases-of these 80% are Lepidoptera, 10% Diptera, and 5% Hymenoptera. Many of these species are economically important. Viruses can be arranged in two categories based on whether their nucleic acid is DNA or RNA. The DNA viruses (baculoviruses) include nuclear polyhedrosis viruses (NPVs), granulosis viruses (GVs), and iridescent viruses (IVs). Cytoplasmic polyhedrosis viruses (CVs) contain RNA.

Insectary: A laboratory where insects used for experimental purpose are reared in large numbers.

Insecticide: A substance or mixture of substances intended to prevent or destroy insects and related arthropods which may be present in any environment. Insecticides are broadly classified as, **1.** Organometal compounds (e.g., Paris green); **2.** Phenolic compounds (e.g., binapacryl, DNOC,); **3.** Organochlorine compounds (e.g., aldrin, DDT, endosulfan); **4.** Organophosphorous compounds (e.g., malathian, dimethoate and oxydemeton methyl); **5.** Carbamate compounds (e.g., aldicarb, carbaryl, carbofuran); **6.** Pyrethroids (e.g., cypermethrin, deltamethrin, permethrin), and **7.** Compounds derived from plants or botanicals (e.g., nicotine, pyrethrum, rotenone etc.).

Insecticide Nomenclature: Insecticide nomenclature is the formal process by which insecticides are named. Insecticides are designated by three names : the approved common name, the trade name, and the chemical name.

Insectivorous: Feeding on insects (e.g., many birds).

Insectorubin: A brown pigment, usually incorporated with melanin, in the epidermis and cuticle of insects. Formerly considered to be a mixture of a group of pigments called 'ommochromes'.

Insectoverdins: Green pigments found in insects.

Insemination: The introduction of sperm into the female reproductive system : bursa copulatrix, vagina or rarely the spermatheca. Seminal transfer may involve the passage of either free semen or in many insects, one or more spermatophores from the male to the female. However, in the apterygotes (e.g., Thysanura, Diplura and Collembola) the male deposits a spermatophore on the substrate and the female picks it up and deposits it with herself.

Instar: The insect (larvae or nymph) between moults. Instars are referred to by number, the first instar is the stage between after hatching and before the first moult, the second instar occurs after the first larval (nymphal) moult but before the second, etc.

Instinct: Behaviour observable in all individuals of a species regardless of differences in habitat. Examples include cocoon spinning, feeding, migration, mating, oviposition and nest building. Physiological and developmental state of the insect, especially the hormonal milieu, is important in determining whether a stimulus will trigger, or release a given programme of behaviour.

Instinctive Behaviour: Unlearned stereotyped behaviour, in which the nerve pathways involved are hereditary.

Integrated Control: Control of pests which combines and integrates chemical methods with natural and biological control. Chemical control is applied as necessary and in whatever manner is least disruptive to natural and biological control.

Integrated Pest Management (IPM): A management system that uses all suitable techniques and methods in as compatible a manner as possible to maintain pest populations at levels below those causing economic injury. IPM programme mainly aims to educate and encourage agricultural producers to grow crops using pest management methods which encourage reduction of the use of synthetic organic pesticides, are environmentally sound, pose minimal risk to human health, enables growers to obtain a

reasonable return on investment, and ensures a supply of high quality, safe and economical foods and other agriculturally related products. Cultural methods, pest resistant varieties, crop rotation, crop residue refuse destruction, tillage of soil, time of sowing or planting or harvesting, pruning, thinning, fertilization, planting of trap crops, sanitation, water management, flooding and draining, mechanical and physical methods, and chemical methods, are the major components (tools) of IPM.

Integument: The outer covering of the body including the epithelium and the cuticle. Most functions of the integument relate to the physical structure of the cuticle though the latter may serve as a source of metabolites during periods of starvation. Integument imparts strength and hardness, permeability and colouration of body. The cuticular waxes may have important roles in preventing the entry of microorganisms and in chemical communication (e.g., they serve as pheromones or kairomones).

Interaction: In ecology, interaction among organisms is the mutual or reciprocal action of influence they have on each other.

Interantennal Suture: A suture extending between the bases of the two antennae (e.g., Siphonaptera).

Intercalary Vein: An extra longitudinal vein that develops from a thickened fold in the wing, more or less midway between two pre-existing veins as in Ephemeroptera.

Intercastes: Types that are intermediate between the recognized castes, especially in social insects such as bees, ants and termites. Such variations may be due to variations in diet or to invasion by parasites. Either of these factors may have an effect on the relative dominance of certain genes or may cause arrested allometric development.

Intercropping: Mixed planting of agricultural crops. Intercropping is a traditional method of crop production, particularly in the tropics, which in addition can be used as a cultural control method. Intercrops may help build

up of predatory species or they may also target pest species directly. Intercropping has been successfully demonstrated in some cases to suppress a range of pests including nematodes, pathogens, insects for low input farming but not likely to find a place in modern agriculture.

Interference: 1. Any activity which directly or indirectly limits a competitor's access to a resource. **2.** In colours, iridescent colour produced by variable reflection of light by narrowly separated surfaces as the scales of Lepidoptera.

Interference Methods: The use of semiochemicals, the sterile insect technique and use of insect growth regulators are sometimes grouped together under the common theme of 'interference methods'. All of these techniques interfere with normal physiological function or behaviour of insect pests. Semiochemicals are used to affect insect mating or aggregative behaviour. Insect growth regulators affect the normal growth and metamorphosis of insects, while the sterile insect technique interferes with reproduction.

Intergradation: Merging gradually through a continuous series of intermediate forms or populations.

Intermediate Host: Host intervening between two others in the life cycle of various parasites.

International Code of Zoological Nomenclature: The official set of regulations dealing with zoological nomenclature as authorised by the International Congress of Zoology. The object of the Code is to promote stability and universality in the scientific names of animals and to ensure that each name is unique and distinct. The Code consists of three parts - the code proper, appendices and glossary. The Code proper include 'Preamble' followed by 90 consecutively numbered 'Articles' grouped in 18 chapters. Each article is composed of one or more mandatory provisions which are sometime accompanied by Recommendations or illustrative examples.

The official languages of the Code are English and French.

Interneuron: Neuron that serves as a connection between sensory and motor neurons.

Intersegmental Folds: Invaginations of the integument to which longitudinal muscles are attached. Such folds are particularly found in many larval insects to separate the body segments as almost entire cuticle of larvae is thin and flexible. But in majority of insects, however, there is heavy sclerotization of cuticle to form a series of dorsal and ventral plates, the 'terga' and 'sterna' respectively. The primitive intersegmental fold becomes an internal ridge of cuticle the 'antecosta', seen externally as a groove, the 'antecostal sulcus'.

Intersex: An insect which is genetically of one sex throughout, but in which parts of the body have developed the characteristics of the opposite sex.

Intertidal: Occuring on the beach between high water and low water levels.

Intima: Chitinous lining of the foregut, hindgut and tracheae which is continuous with the cuticle of the integument. Intima may be folded to enable the gut to stretch when filled. In some species intima of the crop forms spines or ridges which probably aid in breaking up solid food into smaller particles and mixing in the digestive fluid. Shape of intima of the proventriculus varies according to the function it performs. In species where proventriculus acts as a valve, the intima may form longitudinal folds and the circular muscle layer is thickened to form a sphincter. When it acts as a filter, intima is modified into spines which hold back the solid material permitting only liquids to move posteriorly; but where proventriculus acts as a gizzard and grinds up food, in them the intima is formed into strong, rapidly arranged teeth, and a thick layer of circular muscle covers the entire structure.

Intrinsic: Factors or influences produced within an organism (usually of genetic origin).

Intrinsic Rate of Increase: This is represented by 'r' under natural conditions, 'r' does not remain constant being subject to strong environmental influence. For example, 'r' may well decrease with increasing population density, competition for food and shelter.

Intromittent: Adapted for mating, as applicable to male copulatory organs.

Inundation: This is the use of biological control as a biological pesticide. Large numbers of natural enemies are reared in the laboratory and liberated onto the crop. The aim is to create an outrageously high ratio of biological control agents to pests so that the pest is exterminated, the biological control agent itself dies out, and pesticides can then safely be used. This technique has special use where a pest population has become resistant to the available insecticides.

Invasion: The penetration by a microorganism of the integument and other epithelial barriers of the body of a host organism

Inverse Density Dependence: A proportionate decrease in mortality (or increase in fecundity) as population density increases.

Invert Emulsion: One in which oil is the continuous phase and water is suspended in it.

Invertebrates: Animals without a spinal column or backbone. Protozoa (Amoeba), Porifera (sponges), Coelenterata (jellyfishes and corals), Platyhelminthes (flukes and tapeworms), Aschelminthes (roundworms and leaches), and Arthropoda (insects, mites, ticks and spiders) are most important invertebrate phyla. Arthropoda contain the largest group of animals and are of great agricultural importance.

In Vitro: As applied to biological processes occurring experimentally in isolation from an organism.

In Vivo: As applicable to biological processes occurring within the living organism.

Involucrum: A sheath of soft cerumen surrounding the brood chamber in a nest of stingless bees (Meliponini).

Ionic Surfactant: One that ionizes or dissociates in water.

Iridescence: The production of brilliant colours by optical interference, as for instance in the bodies of dragonflies, the wings of some butterflies and elytra of some beetles. The effect is caused by the presence in the cuticle of numerous thin transparent lamellae separated by material with a different refractive index.

Iridoviruses: Commonly referred to as iridescent viruses, are nonoccluded double stranded DNA viruses that have a very broad distribution among the orders of insects, but also found in other arthropods and invertebrates such as isopods and nematodes. The virions of iridoviruses are icosahedral and fall into two size classes, about 125 and 200 nm in diameter. These viruses replicate in the cytoplasm of a wide range of tissues in infected hosts, causing a disease that is always fatal if acquired during the early instars. The virions form paracrystalline arrays in the cytoplasm of many cells, imparting an iridescent hue to infected hosts, from which the name of virus group is derived. These viruses are observed only rarely in natural populations of host insects and have not been reported to cause epizootics.

Iris Cells: Pigmented cells surrounding each ommatidium or optical unit of a compound eye. In bright light they spread round each crystalline cone; isolating it from its neighbours so that vision is 'mosaic'; in dim light they may retract so that the light entering each ommatidium merges with that of its neighbours causing continuous but rather ill-defined vision.

Iris Tapetum: A network of fine trachea surrounding the ommatidia or optical units in some compound eyes. They are particularly well developed in nocturnal insects such as the noctuid moths and serve to reflect light, so giving the sensitive retinal cells an increased stimulation.

Irrigation Management: Involves techniques which can increase or decrease the damage brought on by insects, mites or other plant pathogens, and affect weed competitiveness. Response varies with pest and crop. Proper consideration of altered irrigation practices from a crop-pest ecosystem 'perspective' and better understanding of the broad effects of changes in water application : flood, furrow, sprinkler or drip irrigation may help in management of the pests.

Isle of Wight Disease: A common acarine disease of honeybees caused by the minute parasitic mite, *Acarapis woodi*, which infests and blocks their tracheal tubes. There are no outward signs of mite infestation but their presence can be ascertained by staining and noting deeply stained tracheae which contain mites.

Isopneustic: A term used to denote a primitive arrangement of the spiracles, two thoracic and eight abdominal pairs, all situated in the intersegmental membranes. Most present day insects have some degree of

specialization or reduction of spiracles as well as migration onto one of the adjacent segments. The isopneustic arrangement persists only in some embryos.

Isoptera: An orthopteroid order, commonly known as termites . They are generally pale, soft-bodied and wingless. But alates (e.g., kings and queens) have two pair of wings, similar in form and usually longer than the body, which are shed after their colony-founding flight. The non-reproductives (e.g., workers, soldiers and immatures) are wingless and vary morphologically depending on their role in the colony, they have incomplete metamorphosis. Abdomen provided with a pair of short cerci. They are worldwide in distribution but mainly found as pests of wood and plant material in tropical and subtropical regions.

Ixodid Ticks: Ticks belonging to the family Ixodidae or hard ticks as differentiated from the ticks belonging to the family Argasidae or soft ticks. These are large, leathery parasites of vertebrates; hypostome with recurved teeth. Scutum (dorsal shield) is present in Ixodidae, but is absent in Argasidae.

J

Jaws: In insects there are two horizontally moving jaws, namely the 'mandibles' or the upper lips, and the 'maxillae' or the lower lips. In biting insects (e.g., cockroaches and beetles), the mandibles are highly sclerotized and toothed. Each maxillae bear a palp, two movable lobes, i.e. an inner 'lacinia' and an outer sheath-like 'galea'. In predators such as Dytiscidae the mandibles may be very sharp and sickle like and have openings at their tip through which the juices of their preys are sucked. Mandibles, maxillae and labium bear teeth in case of dragonflies. In nectar sucking insects such as butterflies, mandibles are reduced or absent but the galea of maxillae are greatly enlarged to form a tubular proboscis. But in Hemiptera both the mandibles and maxillae are extended to form long, piercing stylets which when not in use are bent back under the head and thorax. In female mosquitoes and related Diptera the arrangement is somewhat similar but the stylets are very thin, sharp and sometimes toothed for piercing the skin of their prey.

Jet: Liquid emitted from a nozzle orifice.

Jet Agitator: A device that keeps a tank mix from settling out of suspension by means of water flowing under pressure.

Johnston's Organ: A sense organ similar to the chordotonal organ. It is located in the second antennal segment of many insects and particularly well- developed in male mosquitoes and certain other Diptera. In insects these organs seem to perceive movements of their antennae and thus to

become aware of air vibrations either as sounds or as air currents.

Joint: An articulation of two successive segments or parts. Exocuticle is not found in the joint areas, and the cuticle, therefore, remains membranous and flexible. Presence of these cuticular membranes facilitates movement between adjacent hard parts (sclerites). The degree of movement at a joint depends on the extent of the cuticular membrane. In the case of intersegmental membranes there is complete separation of adjacent sclerites and, therefore, movement is unrestricted. Joint operates like a hinge. Joint may be 'monocondylic' which has only one articular surface, (e.g., the articulation of antennae with the head) or 'dicondylic' in which there are two articulations and the joint operates like a hinge (e.g., most leg joints).

Jugal Area: The posterobasal area of the wings, delimited by the jugal fold and wing margin.

Jugal Fold: The posterior basal fold between the jugal and anal regions of the wing. The jugal lobe of the fore wing overlies the humeral region of the hind wing in Megaloptera (Corydalidae).

Jugal Lobe: A lobe present at the base of the wing, on the posterior side, proximal of the vannal lobe (Hymenoptera).

Jugate: This is a type of wing coupling as found in some Lepidoptera and Trichoptera, in which the jugal lobe is finger like in certain moths and clasps the hind wing.

Jugum: In certain Lepidoptera and Trichoptera, a basal lobe of the fore wing which overlaps the hind wing thereby coupling the wings during flight.

Jumping: This is the principal means of locomotion in some insects. They may use it only for sudden escape movements when disturbed. Femur and tibia of hind legs in these insects are usually strong and enlarged (e.g., grasshoppers, fleas, flea-beetles, leafhoppers, etc). Fleas have been reported to jump about 30 cm or nearly 100 times their own length. Collembolans use the furcula and the reticulum for jumping, while click beetles jump by the sudden movement of a projection beneath the thorax. Hind legs are greatly developed as a jumping device in Orthoptera, many Homoptera, fleas (Siphonaptera) and flea beetles (Alticinae, Chrysomelidae). The middle legs of Encyrtidae (Hymenoptera) are modified for jumping.

Junior Homonym: More recently published of two or more identical names for the same or different taxa.

Junior Synonym: The more recently published of two or more available synonyms for the same taxon.

Juvabione: A substance isolated from the wood of balsam fir trees of the genus *Abies balsamea* and found to have juvenile hormone characteristics. Such compounds are

sometimes also called 'hormone mimics'. Some plants, such as ferns, which have a high concentration of these compounds are almost devoid of insect herbivores. Such compounds may be present in a variety of plants and these compounds may function in part as defensive mechanisms against insect herbivores.

Juvenile Hormone (JH): The hormone secreted by the corpora allata that maintains the expression of juvenile characteristics and suppresses adult characteristics. Synthetic chemical analogues have been developed as insecticides.

Juvenile Hormone Analogues: These function in the same way as the juvenile hormones in the regulation of metamorphosis, and may or may not be similar in chemical structure to the natural hormone. Methoprene and kinoprene are two such analogues. The effects of these compounds are usually seen during larval to pupal metamorphosis and various degrees of incomplete metamorphosis become apparent. Larval-pupal mosaics may be produced, or strange deformations may appear on the pupal structure. Other uses of juvenile hormone analogues are in disrupting embryogenesis in the eggs and preventing adult diapause. They have been extensively tested in public health and stored products work because of their relative safety to human beings.

K

K-strategists: Insect species which are less likely to be pests, occur in more stable habitats, tends to have lower reproductive rates, are less dispersible and are larger (as compared to **r**-strategists) are known as **k**-strategists and such insect species rarely become abundant to destroy their food supply. Populations of **k**-strategists do not undergo violent fluctuations and usually are regulated by density dependant mortality factors. In short, they tend to be stable species occurring in stable environments. Tsetse fly and codling moth are examples of **k**-strategists. Many insects that are **k**-strategists are never numerous enough to become pests. **K**-strategists can often be managed through modification of the environment (changes in agronomic practices, destruction of alternative hosts) or disruption of reproduction (e.g., sterile male technique) or through precisely targeted spray applications used in monitoring since they do not adapt quickly to change.

Kairomone: A substance produced or acquired by an organism that, when it contacts an individual of another species in the natural context, evokes in receiver a behavioural or physiological reaction that is adaptively favourable to the receiver but not to the emitter. Kairomones are quite significant releasers of behaviour in several beetle species.

Kalaazar: A generalized form of leishmaniasis occurring in the tropics. There is anaemia, fever, splenomegaly and wasting. It is caused by the parasite *Leishmania donovani* and is spread by sandflies of genus *Phlebotomus*. Kalaazar is a visceral

manifestation of disease.

Kaolin: A white clay or crushed rock derived from feldspar, reduces insect feeding when applied to foliage.

Karyological Character: A character that involves chromosome structure or number.

Katepimeron: The lower part of the epimeron of an insect in which it is divided by a transverse suture.

Katepisternum: The lower part of the episternum or anterior sclerite of the subcoxa at the base of an insect's leg.

Keel: A sharply elevated ridge.

Keratin: The tough fibrous protein, containing sulphur which occurs in the skin, hair, horn, claws, and feathers of vertebrates. It is a stable protein and can not be digested with common proteinases but is digested by keratinase.

Key: A tabular arrangement of species, genera, orders or other classification categories according to characters and traits that serve to identify them. These are pictorial keys, indented keys and bracket keys. All the keys are dichotomous and based on series of choices. Pictorial keys are designed for field identifications by non-scientists. Indented keys are based on the relationship of various divisions but it is a long key. Bracket keys are most commonly used.

Key Character: In taxonomy a character of special utility in a key.

Key Factor: In population dynamic studies,

a factor which is dominant in regulating the numbers of an organism is called a 'key factor'. It is necessary to identify all of the mortality factors operative throughout the life cycle and to determine which one factor has the most impact on the population in the next generation. The identification of key factors is handled by various kinds of data manipulation and analysis. The importance of the approach lies in the fact that once a key factor has been identified, it is possible to concentrate the investigative effort at critical periods when the factor or factors that will determine the population trend are both operative and measurable.

Key Pests: The serious and persistent pests which attack a crop and causes major damage every season unless controlled is regarded as a key pest.

Kg: Kilogram=1000g=2.20462 lb.

Killing Jars: Wide-mouthed bottles or jars (0.5-1 kg capacity) having air tight lids are used for killing insects. A large test tube, or slender bottle with a cork or rubber stopper is also a handy supplemental container that fits easily into a pocket for carrying. For preparing a killing jar, first of all make a thick mixture of Plaster of Paris and water, and pour the mixture into a clean jar to a height of 20-30 mm and allow it to dry at room temperature or under low heat. When jar is completely dry, add enough ethyl acetate to saturate the 'Plaster of Paris'. Pour back any excess of ethyl acetate and replace the lid or stopper of jar. Ethyl acetate acts as a fumigant, it is safer to use than cyanide or carbon tetrachloride. A label with 'poison' written on it should be pasted on the jar. With frequent use, particularly in hot weather the jar will need to be recharged by adding more ethyl acetate. Killing jars should be kept clean and dry and insects should be removed as soon as they die to avoid colour loss. Moths and butterflies should be killed separately to avoid contamination of other insects with their scales. Sometimes dead insects exhibit stiffening which makes their appendages difficult to handle and it is usually better to

keep them in the killing bottle in a hydrated atmosphere for 8 to 24 hours until they have relaxed. It is important to remove the gut and other internal organs in case of large insects (e.g., cockroaches, grasshoppers etc.) otherwise the abdomen may rot and the surface of the specimens may go greasy. Gutting or evisceration is best carried out by making a slit along the side of the abdomen using fine sharp scissors and removing the body contents with a pair of forceps.

Kin Groups: In social behaviour, a set of individuals whose members are genetically more closely related than random many have the same parents.

Kineses: Random or undirected locomotor reactions initiated by a stimulus the intensity of which governs the rate of movement. Increased movement that is related to light (photokinesis) is common in many insects. For example many butterflies fly only when the light intensity is above a certain threshold ; the speed at which the locusts walk is increased as the light intensity rises. Hygrokinetic response is shown by locusts whose activity is increased in moist air compared with dry. A response with respect to contact with surfaces (stereokinesis) and to a chemical gradient (chemikinesis) is also found in insects.

Kinetopause: An arrestation of activity without necessarily an arrestation of development. It is, therefore, not the same as a diapause but may accompany it. Rest, sleep, and death-feigning are examples. Many insects show long periods of motionless inactivity interrupted occasionally by bursts of energy.

King: In social Hymenoptera or Isoptera, king is a male reproductive individual. In termites king permanently attend the gyne and inseminate it. King and queen both have dark, sclerotized (at least compared to other castes) bodies with completely developed wings and compound eyes.

Kingdom: The largest taxonomic group, such as the animal kingdom.

Kleptobiosis: Thievery by ants.

Klinokinesis: Complex undirected responses which result in a behaviour pattern comprised of a change in the frequency of random turns in the presence of unfavourable conditions.

Klinotaxis: A movement of an insect in a definite direction in relation to a stimulus, e.g., towards or away from light.

Knapsack Duster: A duster carried on the back. These are operated by bellows on top of a cylindrical dust container, the bellow being actuated by a hand lever on the side of the operator.

Knapsack Sprayer: A sprayer that can be strapped on the back and is used to apply liquid pesticide chemicals. The attached hose has a nozzle at the tip that can be aimed at the spot to be treated. They have tanks with a capacity of 4 to 6 gallons (18.184 to 27.276 litres) and develop maximum pressures of 80 to 180 pounds per square inch (5.6-12.6 kg/cm²). The handle of the pumps extends over the shoulder or at hip height and must be operated by hand while spraying.

Knee: Genu

Knock-Down: Immediate incapacitation or paralysis of an insect through quick acting insecticide such as pyrethrum, allethrin, or tetramethrin. The test insect is unable to maintain its normal position in relation to the environment. Sometimes test insects recover from knock-down effects, although ordinary mortality ensues.

Koch's Postulates: Koch proposed certain criterias that are commonly used for establishing the pathogenecity of a microorganism: the microorganism must be consistently associated with the disease, the microorganism can be isolated and grown in culture; and when the microorganism is injected into a healthy host, disease is expressed.

Konobiont: A parasitoid that lays its eggs in a young host, which continues to grow and provides an increasing food resource. Parasitoid development can be delayed until the host has attained a sufficient size to sustain it.

Kynurenine: Oxidation product of the amino acid tryptophane that gives rise to some of the red and brown pigments in insects.

L

L (Litre): 2.1134 pt=0.24178 gal.(U.S.)=1000 ml.

Label: All written, printed or graphic matter on, or attached to the economic poison, or the immediate container thereof, and the outside container or wrapper to the retail package of the economic poison. Each pesticide label carries information regarding brand/trademark type of pesticide, chemical name of active ingredients, common chemical name, type of formulation, total contents in container, a name and address of manufacturer, use classification (general or restricted use), signal words (danger, warning, caution etc.), precautionary statements (regarding how to use the pesticide safely), list of crops and organisms for which pesticide can be sprayed. Information regarding storage and disposal is also printed on the label.

Labial: Of or pertaining to the labium.

Labial Glands: Are commonly known as salivary glands. These glands are associated with the labium and lie below the midgut, commonly having sensory functions. They generally produce salivary enzymes. In few insects the labial glands may function as excretory organs. In apterygote insects which lack malpighian tubules the glands can accumulate and eliminate dyes such as ammonia carmine and indigo carmine from the haemolymph. In most insects, labial glands secrete saliva as in cockroaches; these glands in lepidopterous and hymenopterous larvae secrete silk which is used in making larval nests and pupal cells. In blood-sucking insects

the labial glands secrete an anticoagulant that keeps ingested blood in liquid form.

Labial Hooks: Hooks or spines present on the labial palps of the nymphs of dragonflies (Odonata). In these insects the whole labium forms an enlarged prehensile organ known as 'mask' which is capable of being shot out rapidly to catch tadpoles or other creatures.

Labial Kidneys: Excretory glands in the head with tubules opening near the base of the labium; present in some Collembola and Thysanura.

Labial Palpus: One of a pair of small feeler-like structures arising from the labium. Labial palps are absent in Collembola, reduced in Diplura but they are present in Protura. Labial palps are primarily well-developed in true insects.

Labial Suture: The suture on the labium between the postmentum and the prementum.

Labium: Also called the lower lip. Labium forms the hind or lower lip of an insect's mouthparts and is located just below mandibles and maxillae. The labium is usually articulated directly with the neck membrane, but in some of the insects a sclerotized region separates the two. It appears to be a single unit but really consists of a second pair of maxillae which have fused on the meson to form a single functional structure. The labium closes the preoral cavity to the rear. There are two main parts of the labium : the proximal 'postmentum' attached closely to the posteroventral surface of the head and

sometimes subdivided into a 'submentum' and 'mentum' and the free distal prementum, typically bearing a pair of 'labial palps' lateral to two pairs of lobes, the mesal glossae and the more lateral 'paraglossae'. The glossae and paraglossae, including sometimes the distal part of the prementum to which they attach, are known collectively as the ligula'. Labium is complexly muscled such that the ligular lobes, the palps and their segments, and the prementum are individually movable.

Labroclypeal Suture: A line of articulation between the labrum and clypeus.

Labrum: The labrum forms the roof of the preoral cavity and mouth and covers the base of the mandibles. It is a broad lobe-like structure suspended from the clypeus in front of the mouth and forming the front or upper lip in the insects having chewing-type mouthparts. Anterior surface is usually smooth, whereas the inner (posterior) surface is fleshy and richly endowed with sensory structures. It functions as a hinged upper lip, holding in food and covering the paired mandibles. Its ventral surface is membranous and forms the lobe-like epipharynx, which bears mechano- and chemoreceptor sensilla.

Labrum Epipharynx: A mouthpart representing the labrum. Posterior or inner surface of labrum is fleshy and richly endowed with sensory structures. This fleshy surface is sometimes greatly expanded into a lobe called 'labrum epipharynx'.

Lac: A natural body secretion of the scale insect, *Laccifer lacca* (Homoptera, Coccoidea), that is used to make shellac, shoe polish, paint, adhesives and many other products. The lac is a product of gland cells distributed in the integument. The lac insect is closely related to a pest, the San Jose Scale. Lac insect is a native of India and Burma where it infests native plants related to the fig (*Ficus* sp.). They heavily infest their host plants because they are sedentary for most of their lives, several generations often live side by side. The soft bodies of lac scales are protected by the secretions of a resinous material that hardens into a shield over their

backs. Whenever the density of scales is very high, the entire branch to which they are attached becomes coated with the resinous substances. Such branches are gathered as 'stick lac' which is processed and refined to produce it into small, thinned flakes which are then sold to manufacturers for final processing. It requires approximately 150,000 lac insects to produce about 500 gm of lac.

Lacinia: The inner lobe of the maxilla arising from the stipes sheathed by the hood-like lobe or 'galea'. The laciniae are highly sclerotized and pointed, and assist in holding and masticating the food.

Lacquer: Pesticide incorporated into a lacquer or varnish to achieve slow release over a long period of time.

Lamarckism: The evolutionary theory of Lamarck, which states that the acquired characters are inherited.

Lamella: Plate-like or sheet-like; composed or covered with thin sheets (e.g., antennae of Scarabaeidae).

Lammert's Cycle: A daily cycle of temperature changes is observed in beehives during winter. The temperature falls to a minimum of 13°C. This stimulates the bees to greater muscular activity and the temperature rises rapidly to about 25°C. At this temperature the bees cease their activity and the temperature again falls gradually to 13°C. In an average hive about 20 gms of sugars are consumed during this cycle.

Lanceolate: Spear-shaped ; tapering at each end.

Lanceolate Cell: A cell in the anal area of the wing (Hymenoptera).

Lancets: One of the paired parts, ventral to the stylet, of sting in the Hymenoptera. The poison is caused to flow along the groove by back and forth movements of the lancets.

Lapping Mouthparts: Honeybee has lapping type of mouthparts, formed from maxillae and labium, that enable it to reach into flowers to obtain nectar. Honeybees also possess recognizable mandibles for chewing pollen and

for comb construction and cleaning around the hive.

Larva: In case of insects with complex metamorphosis (Holometabola), the postembryonic form is a 'larva', which feeds actively and may have locomotory appendages developed to varying degrees. Fly larvae (maggots), for example are completely legless, whereas many beetle larvae have well-developed legs. Endopterygote larvae can be arranged in a number of basic types. The most primitive larval form is the 'oligopod', having three pairs of thoracic legs and a strongly developed head with chewing mouthparts and simple eyes. Oligopod larvae may be, **1. Scarabaeiform type:** round-bodied with short legs; and of **2. Campodeiform type:** which are active, predaceous surface-dwellers with a dorsoventrally flattened body and long legs. Polyopod (eruciform) larvae have in addition to thoracic legs a variable number of abdominal legs. The larvae are generally phytophagous and relatively inactive, remaining close to or on their food source. Eruciform larvae are typical of Lepidoptera, Mecoptera, and some Hymenoptera (sawflies). Apodous larvae, which lack all trunk appendages, occur in various forms in many endopterygote orders and these larvae are adapted for mining in soil animals or plant tissues. Variability of form concerns the extent to which a distinct head capsule is developed. In 'eucephalous' larvae of some Coleoptera (Buprestidae and Cerambycidae), Siphonaptera, aculeate Hymenoptera and more primitive Diptera (Suborder Nematocera), the head is well sclerotized and bears normal appendages. In 'hemicephalous' larvae of fly (Tipulidae : Nematocera) and in the larvae of orthorrhaphous Diptera, head and appendages are reduced and partially retraced into the thorax.

Larval Equivalent: The quantity (virus) of inoculum present in one insect (usually a larva) at death/harvesting and, unless otherwise stated, usually implying a larva dying at the maximum size.

Larvapods: In some insects, retention and

development of abdominal appendages in immatures may occur. For convenience, these appendages are collectively termed 'larvapods'. These adaptations are lost when metamorphosis occurs, but their importance in the life cycle should never be minimized. In mayfly nymphs, larvapods are modified into tracheal gills and are present on the most abdominal segments. Aquatic organisms such as the caddisfly and dobsonfly larvae, have hooked holdfasts at the posterior end of their bodies that enable them to retain their position on rocks or to hang onto a portable 'house' or case. These appendages are most often noted in species found in moving water. Lobe-like prolegs that assist the caterpillars in locomotion are found in lepidopteran species, are provided with little hooks or crochets. Some larvae possess appendages 'urogomphi' on the ninth segment. The development of these varies from cerci-like to fixed horny outgrowths.

Larvarium: A nest or shelter made by insect larvae, sometimes a silken tube but often made from pieces of leaf, pine needles, soil particles etc. woven together.

Larvicide: Toxicant (poison) effective against insect larvae.

Larviform: Resembling the larva.

Larviparity: A form of viviparity in which the female gives 'birth' to larvae instead of depositing eggs. Such viviparity is found in fly, *Hippobosca* sp; the sheep ked, *Melophagus*, or the tsetse fly, *Glossina*.

Larviposition: The deposition of larvae by the adult female of some of Diptera.

Latency: Dormancy. The period within a host during which no symptoms of infection are evident even though a pathogen is present.

Latent Infection: Infection in which the pathogen is not multiplying at a rate that will not produce overt disease or pathology until the implied balance between the host and pathogen is disturbed.

Latent Learning: Also called exploratory learning. A type of insect learning in which

the bees and wasps learn the location of their nests through landmarks recognized and remembered from a previous orientation; differs from associative learning in that it occurs without apparent reinforcement.

Latent Period: The period after a vector acquires a virus before it can transmit, as in persistent or propagative transmission.

Lateral: On or pertaining to the side.

Lateral Movement: The horizontal movement of a pesticide from the application site.

Lateral Ocellus: The lateral ocelli are the only eyes present in holometabolous larvae. Also called stemma. They are located on the sides of the head where they occupy positions corresponding with those of the imagines. The number of lateral ocelli is variable and not always constant in the same species. They differ from the dorsal ocelli in being innervated from the optic lobes of the brain.

Lateral Oviduct: In insects one of paired lateral ducts of the female genital system connected with the ovary. Lateral oviduct unite to form the common (or median) oviducts which opens into a gonopore (opening) which is usually concealed in an inflection of the body wall typically forming a cavity the genital chamber.

Latin Square Design (LSD) : LSD is defined as the experimental design in which the given piece of land is divided into horizontal blocks and vertical blocks defined as rows and columns are equal to the number of treatments. The treatments are randomized such that each treatment comes only once in each row and column. Application of LSD minimizes the experimental error when the fertility gradient runs in the orthogonal directions.

Law of Priority: The valid name of a taxon is the oldest available name applied to it provided that the name is not invalidated by any provision of the Code or has not been suppressed by the commission. It is covered under the Article 23. In this article the

limitation is that if a name has remained unused as a senior synonym in the primary zoological literature for more than 50 years then it is to be considered a forgotten name (nomen oblitum).

LC₅₀ : Also called median lethal concentration. A means of expressing the toxicity of a compound present in air as a dust, mist, gas or vapour. It is generally expressed as micrograms per litre as a dust or mist but in the case of a gas or vapour as ppm or µg/L. The LC₅₀ is the statistical estimate of the dosage necessary to kill 50 percent of a very large population of a test species, through toxicity on inhalation under stated condition or by law, the concentration which is expected to cause death in 50 percent of the test animal so treated.

Layby Application: Applications of an agricultural chemical at the last time in the growing season when it is possible to drive tractor through the crop.

LD₅₀ : Also called median lethal dose. Lethal dose of a toxicant that will kill orally or dermally 50 percent of the test organisms. Usually expressed in terms of milligrams (mg) of toxicant per kilogram (kg) of body weight of the test organism (mg/kg). This value often varies according to the route of entry (oral or dermal) and sex. If a compound has an LD₅₀ of 20 mg/kg, it is more toxic than one with an LD₅₀ of 200 mg/kg. Insecticides are also classified on the basis of their LD₅₀ values. Insecticides are designated as : **1.Extremely toxic :** LD₅₀ less than 1; **2.Highly toxic :** LD₅₀ ranges from 1 to 50; **3.Moderately toxic :** LD₅₀ from 50 to 500; **4.Slightly toxic:** LD₅₀ from 500 to 5000; **5.Practically non-toxic :** LD₅₀ from 5000-15000; and **6.Relatively harmless :** LD₅₀ is more than 15000.

Leaching: The movement of a pesticide chemical or other substance downward through soil as a result of water movement.

Leaf-Area Index: Ratio of leaf surface to soil surface area in relation to utilization of solar energy for photosynthesis.

Leaf Crumplers: Leaf-crumplers differ little from leaf-tiers. In leaf-crumpling species larvae live in silken tubes which are conical in shape, much curved and twisted, and densely covered with fecal matter. These tubes are conspicuously small at one end and considerably larger at the open end. From them the larvae feed drawing the leaves in and tying them together in more or less compact masses. They hibernate in these cases and resume feeding in the spring. Leaf-crumplers are found in family Pyralididae (Lepidoptera).

Leaf-Folders: Leaf-folders, in contrast to leaf-rollers, fold the edges of the leaves instead of twisting them into rolls. They are sometimes also called leaf-sewers. Numerous species of the family Tortricidae, Gelechiidae Pyralidae and Oecophoridae have this habit.

Leafhopper: Active insects of family Cicadellidae (Homoptera) having sucking mouthparts, are vector of pathogens, especially persistent viruses; may cause direct plant injury during feeding, even in the absence of virus.

Leaf Insect: The common name for many members of order Phasmida. The most members of this order are remarkable for their close resemblance to the plants on which they are normally found. In the leaf insects, body may be dorsoventrally flattened and sculptured so as to resemble a leaf or a group of leaves. In leaf like species, the venation is much modified to mimic the veins of a leaf. The legs are all similar with broadly flattened tibia and femora.

Leaflet: A small leaf ; individual unit of a compound leaf.

Leaf Litter: Accumulated fallen leaves under trees and bushes. Leaf litter is especially well developed in forests.

Leaf-Miner: A leaf-miner is a species, the larvae of which lives and feeds, for a part or all of its existence between the two epidermal layers of a leaf. Leaf-mining insects are found in Lepidoptera (Gracillariidae), Coleoptera (Hispididae), Diptera (Agromyzidae) and some Hymenoptera. The habit occurs only in insect

orders with complete metamorphosis. The adults are winged, active and able to select the proper food plants; the larvae are adaptable to the unusual manner of feeding. The larvae and pupae may occupy the interior of leaves. Their larvae are pale, with prognathous head, and are more or less legless. The eggs of the leaf-miners are laid generally upon or within the leaf. Chrysomelidae lay their eggs upon the surface of leaves but Curculionidae lay their eggs singly within leaves.

Leaf-Rollers: Insects distort leaves in various ways. A leaf roll in the true sense is produced by a larva that spins silk which is used to twist or distort the leaf. Leaf-rolling habit is most conspicuous in the Lepidoptera (Tortricidae, Gelechiidae, and the Gracillariidae) and in a few Coleoptera (Attalabinae) where silk spinning is paramount and useful for the leaf-rolling.

Leaf-Sheath: The lower part of the leaf that encloses the stem.

Leaf-Tiers: Leaf-tiers differ from leaf-rollers and leaf-folders in that more than one leaf is involved. The habit varies from species that sew the leaves together to those that draw in large number of leaves and even incorporate flowers, fruits and other parts of the plants. They include the webbing insects and those that make ugly nests (Lepidoptera : Pyralididae).

Leaf-Webbers: Habit of webbing and tying leaves together is common in many of the Lepidoptera (Tortricidae, Geometridae, Notodontidae, Arctiidae, Pyralididae and Oecophoridae). They may roll individual leaves at first but as the larvae develop, this habit changes to the leaf-tying habit. Pupation takes place in these nests.

Lectotype: One of a series of syntypes which, subsequent to the publication of the original description, is selected and designated through publication to serve as 'the type'.

Leg: The true legs are always found in thoracic region, and an insect adult has three pairs of thoracic legs. However, in mites and ticks

both the nymphs and adults possess four pairs of legs but their larvae have three pairs of legs. The typical thoracic leg of insects consists of six parts - the coxa, trochanter, femur, tibia, tarsus, and pretarsus. The femur and tibia are longer than the other segments and have a conspicuous 'knee' between them that permits the insect to be slung low to the ground for stability. Although the tarsus appears to have segments, these segments are actually pseudosegments or 'tarsomeres' since each lack independent musculature. The pretarsus consist of only the claws or 'ungues' and either a single lobe-like 'arolium' or the two lobed 'pulvilli'. Claws enable insects to move on rough surfaces. The arolium and pulvilli or other types of adhesive pads and hairs on the tarsi assist in movement across smooth surfaces. The entire leg is moved by muscles originating on the tergum/ sternum and inserted on the coxa. In addition, movement of different individual segments is accomplished by muscles within the leg segments. The legs of the insects are modified for digging, rasping, jumping, swimming and pollen collection. Apodous larvae are found in many Hymenoptera and Strepsiptera.

Legal Control: Control of pests through the enactment of legislation that enforces control measures or imposes regulations, such as quarantines to prevent the introduction or spread of pests.

Legal Residue: Pesticide residue that is within the safe levels according to the regulations.

Legionary Ants: Also known as army ants and driver ants. These ants are carnivorous in habit, live in temporary nests, and migrate in long lines like an army, sometimes as many as 100,000 marching together.

Leks: In certain dragonflies, specific sites where males gather and display and compete for the attention of females.

Length of Life: The length of life of insects varies from a few hours to many years, usually depending on availability of food and degree of activity of the insect. Often the greater

part of their lives is spent in the larval stage, as for instance in some cicadas which take many years to develop. The aquatic nymph of the mayfly lives for two years or more but the adult, which can not feed, dies after a few hours. A worker bee, for instance, lives on an average for about six weeks but a queen bee lives for 4 to 5 years. A queen ant may live for 15 years.

Lentic Habitat: Pond or lake; swamp; a region of standing water.

Lepidoptera: An insect order belonging to subdivision Endopterygota. Commonly known as butterflies and moths. This is the third largest insect order. Their body and both sides of wings are covered with minute overlapping scales or hairs. They have large compound eyes. Mouthparts are typically in the form of a coiled proboscis. Metamorphosis is complete. They are abundant, ubiquitous and worldwide in distribution. Some species are significant plant pests.

Lesion: Any break in the epidermis of a plant; a localized diseased area. It can be a spot, scab, canker or blister, often caused by fungi, bacteria, viruses or nematodes.

Lethal: Deadly.

Leucopterin: A white pigment in the scales of the cabbage and other pierid butterflies ; a derivative of uric acid.

Liability: Legal responsibility for actions performed.

Life Cycle: Habits and changes undergone by an organism from the egg stage to its death as an adult ; the sequence of events in the life time of an organism.

Life History: An organism's life time pattern of growth, behaviour and ecology.

Life System: A life system refers to a subject species and its effective environment. The effective environment is composed of those elements in an ecosystem that may have a direct influence on reproduction, survival, and the movements of subject species.

Life Table: A description of the age-specific survival of cohorts of individuals in relation to their age or stage of development. Life tables provide age specific data which are ideal for use in population management. The most successful application of life table studies is in those insects which have only one generation per year with relatively little overlapping of developmental stages.

Life Zone: Biogeographical zone; geographical subdivision mapped out on the basis of such factors as temperature, moisture and types of plants and animals found there.

Light Compass Reaction: In light compass reaction, an insect moves in a straight line by fixing the position of the sun in the sky (or another light source) and then walking or flying at a constant angle to the light source. The phenomenon is commonly noted in social insects like ants and bees. Insect's ability to perceive the plane of light polarization may also be involved in light compass orientation. Apparently night flying insects are attracted to light because of the light compass reaction, by flying at a constant angle to a fixed light source, a moth spirals inward to a light.

Light Traps: The simplest light trap consists of an incandescent or black light bulb suspended over a funnel. The funnel sits on the rim of a large can that contains an open killing jar. The space between the rim and the funnel should be made nearly airtight by using weatherstripping, etc. Another design uses a vertical black light with three or four baffles placed parallel to the lamp. Light traps are most useful to show the presence and perhaps relative abundance of particular species. With the light traps, rough comparison of different areas or an idea of how the populations of some species fluctuate over time can be made. Material that comes towards light can be collected by hand or by pooter (aspirator) and killed or preserved in a manner appropriate to the taxon in question. Most non-lepidopterans can be put into an ethyl acetate or cyanide killing jar before being decanted into paper envelopes and stored dried or fresh in a sealed plastic tub with chlorocresol.

Lignified: Woody; plant tissues impregnated with lignin.

Lignin: A complex compound which is added to the cellulose by woody plants to give hardness; it forms about 30 percent of the wood.

Ligula: When the glossae and paraglossae are fused they form a single structure termed ligula. Ligula consists of an inner pair of lobes, the 'glossae' and a lateral pair, the 'paraglossae'. The ligula is muscled and the ligular lobes are individually movable. Ligula is attached to the prementum portion of the labium. In Hymenoptera, the glossae are fused to form an 'alaglossa'. In other cases the glossae and paraglossae may be fused together into a single solid lobe known as 'totoglossa'.

Limiting Factor: Any environment factor that imposes a restriction on an organism and its development.

Lingua: The floor of mouth in mites; hypopharynx of insects-a tongue like structure.

Linnean Hierarchy: A structure of categorical ranks for taxa where each category except the lowest includes one or more subordinate categories.

Lint: The fibre surrounding the seed of unginned cotton.

Lipid: Any of a variety of compounds such as fats, oils, waxes, and steroids that are insoluble in water but soluble in alcohol and ethers. Bulk of the lipids that are present in the cuticle are localized in the wax layer of the epicuticle, where they function to prevent desiccation and provide chemical cues for species recognition. They act as primary barriers to the penetration of environmental chemicals, so the nature of lipid must be understood in the design of effective contact insecticides that are able to cross this barrier. Some insects secrete prodigious quantities of wax in addition to the lipid deposited at the cuticle. For example, scale insects use in wax

for protection from predators and from desiccation.

Lipophilic: Fat loving. This term is used to describe a molecule or group of atoms tending to promote oil rather than water solubility.

Lipophobic: Used as opposite of lipophilic.

Lipophorins: Are lipoproteins found in the haemolymph that serve as a vehicle for the transport of lipids that are otherwise not soluble in the aqueous blood. They are found in all life stages in almost all insect species. They are loaded with the dietary lipid that is absorbed through the midgut wall and carry it to developing tissues or to the fat body where it may be stored. Juvenile hormones may also be transported by lipophorins.

Liquid Formulations: Pertains to pesticides which are packed for sale in liquid form. Liquid formulations are preferred by the farmers for preparing spray solutions for several reasons. They can be measured volumetrically, are easy to handle, can spontaneously form stable emulsions or dispersions, and given appropriate container design most formulations are easy to rinse out of the package. Liquid products are easy to handle in bulk handling systems and generally don't cause application problems. Emulsifiable concentrate (EC) and suspension concentrate (SC) are common liquid formulations.

Litter Floor: The floor of a poultry house which is composed of straw or droppings, and other waste materials that builds up during one laying year.

Littoral: Shore-dwelling, either the seashore or the edge of fresh water.

Lobopodia (Onycophora): Onycophorans are soft-bodied, worm-like creatures that have an array of arthropod and annelid-like characters. Their bodies have several bilateral pairs of lobe-like legs. Lobopodes are confined to tropical soil and litter and are probably most closely related to tardigrades.

Local: Tending to occur in very limited areas.

Local Population: The individuals of a given

locality which potentially form a single interbreeding community.

Localized: Limited to a given area or part; something that occurs in a small area or on a certain part of a plant or animal.

Locustol: A primer pheromone of the desert locust that triggers development from the solitary to the gregarious form.

Locusts: Grasshoppers that regularly migrate in large numbers are called locusts. They belong to family Acrididae (Orthoptera). Locusts are found in warmer parts of the world. They are exclusively phytophagous, diurnally active insects, and are strong fliers. *Schistocerca gregaria gregaria* (the desert locust), *S. americana* (South American locust), *Nomadacris septemfasciata* (the red locust), and *Locusta migratoria* (Migratory locust) are important species.

Lodged: Flattened or bent over and tangled. Refers to hay, gram, corn and other plants that fall over if a disease, insects, or a storm damages them.

Lodging: To fall down. Characteristic of the cultivars with weak stems to fall over when under the influence of strong winds. Lodging is most common near harvest when the upper portion of the plant is heavy because of the weight of the grain. High nitrogen, high plant populations, and weed competition contribute to lodging.

Logarithm: The ten base logarithm of a number is the power to which ten must be raised to give that number.

Logarithmic Reproduction Curve: A reproduction curve with logarithmic axes.

Logistic Curve: Sigmoid-shaped growth curve applicable to both the individuals and their populations/organisms, plotted graphically. The logistic theory asserted that populations have a slow initial growth rate, which increases exponentially until it reaches a maximum, and then become progressively less as the population reaches an upper limit of the growth. The upper limit is approached gradually and in an orderly predictable

manner. The resulting curve is the familiar S-shaped curve of population growth :

$$\frac{dN}{dt} = rN \left(\frac{K - N}{K} \right)$$

where **K** equals the asymptote or upper population level. As the population **N** approaches **K**, $[(K-N)/K]$ becomes progressively smaller and gradually reduces the growth, **rN**. **K** is sometimes referred to as the 'carrying capacity' of the environment, and the increasing pressure against further population growth, $[(K-N)/K]$, is often called 'environmental resistance'.

Logistic Equation (= Verhulst. Pearl equation): Increase in population growth and changes in instantaneous rate of increase are found through this equation.

$$\frac{dN}{dt} = rN \frac{(K - N)}{K}$$

In this equation, $\frac{dN}{dt}$ = instantaneous rate of increase; **N** = population; **t** = time; **r** is the intrinsic rate of a population and is represented as **r=(b-d)**, where **b** and **d** refers respectively to average birth (natality) and death rates per individual per unit. '**K**' refers to the carrying capacity of the environment.

Longevity: The length of life of an individual or a population.

Longitudinal: Running lengthwise to the body or an appendage.

Longitudinal Veins: The principal wing veins which normally extend lengthwise through the wings.

Looper: A caterpillar of the family Geometridae, they have only one pair of abdominal prolegs (in addition to the terminal claspers) and move by looping its body. Also known as 'inch-worms' in USA.

Looplure: Synthetic sex pheromone of the female cabbage looper moth; (Z)-7-dodecenyl acetate; attractive to male moths of the cabbage looper.

Lorum: A basal sclerite present in the mouthparts of insects, and is well-developed in bees.

Low Concentrate Solution: A solution which contains a low concentration or a small amount of active ingredient in a highly refined oil. The solutions are usually purchased as stock sprays meant for use in aerosol generators.

Low Pressure Boom Sprayer: A machine which can deliver low to moderate volumes of pesticide at pressures of 30-60 pounds per square inch (2.1 - 4.2 kg/cm²). The sprayers are most often used for field and forage crops, pastures etc.

Low Volume Spray: Concentrate spray, applied to uniformly cover the crop, but not as a full coverage to the point of run-off.

Lower Sonoran: Extreme desert life zone.

LT₅₀: The time required for a toxic substance to kill 50 percent of a test population.

Luciferase: An enzyme in the cells of fireflies, which reacts with luciferin to produce luminosity.

Luciferin: The substance on which 'luciferase' acts to produce light.

Lumper: A taxonomist who emphasizes the demonstration of relationship in the delimitation of taxa and who tends to recognize large taxa.

Lunule: Any moon-shaped structure but particularly the frontal lunule of many Diptera; crescent-shaped scar between the eyes and above the bases of the antennae.

Lyochromes: Yellow and red pigments of insects; flavine derivatives possibly originating from the anthocyanin pigments of plants.

Lysolecithin: One of the substances in the venom of bees and wasps, a very toxic substance which breakdown the cells of its victim and sets free histamine.

Macerate: To soften and wear away by digestion or other means.

Macergate: An unusually large worker ant.

Macraner: An unusually large male ant.

Macrocephalic Female: In the social halictine bees, a larger female possessing a disproportionately large head. Such individuals are usually the egg layers of the colony.

Macrofauna: The larger members of a particular fauna.

Macroperous: Large-winged : a term used with particular reference to the various castes of insects such as ants and termites.

Macrotaxonomy: The classification of higher taxa.

Macrotrichia: A trichoid sensilla, also called a seta or hair. Hair of two types occur on the wings. Larger hairs known as macrotrichia are socketed and may be restricted to veins. The scales of Lepidoptera and Trichoptera are highly modified macrotrichia.

Maculate: Spotted; usually refers to insect wings.

Maggot: A vermiform larva, legless, and without a distinct head capsule (Diptera).

Major Pest: An insect species is designated as a major pest in which case general equilibrium position (GEP) is close to the economic injury level (EIL) and in some cases both may essentially be at the same level. Population crosses EIL quite frequently, thus repeated control measures are necessary and

economic damage is avoided by timely interventions.

Major Worker: A member of the largest worker subcaste, especially in ants, and this subcaste is usually specialized for defence. Adult belonging to it is often also referred to as a soldier.

Mala: The single maxillary lobe of some endopterygote larvae.

Malaise Traps: These are tent-like, square or rectangular traps and consist of panels or baffles of fine netting supported vertically by one or more stakes and guy ropes. The trap may be two metres or more in height and several metres long depending on the modification. The trap takes advantage of the tendency of many flying insects to crawl or fly upward when hitting an obstacle. By doing so the insects become trapped at the highest point inside the netting and move into a killing jar or jar containing alcohol. Fast flying wasps, flies, and other insects not often easily collected, are trapped through this technique.

Malaria: An infectious febrile disease of man caused by four species of parasitic protozoa of the genus *Plasmodium* which invade in man the red blood corpuscles, and are transmitted by bites from infected mosquitoes of the genus *Anopheles*. Parasite has an incubation period of some 9 to 21 days after infection is there. Periods of fever followed by severe sweating, recur cyclically and follow several hours after synchronous rupture of infected erythrocytes. The spleen is characteristically enlarged. Each of the malarial parasites provoke rather different symptoms.

Malaxation: Softening by chewing with the mandibles as for instance by a wasp.

Male Confusion Technique: Also referred to as mating disruption technique. Method of disrupting mating in insects by artificial release of excess amounts of sex attractant chemical.

Malpighian Glands: Glands lining the malpighian tubules of an insect, normally functioning as excretory organs but in the larvae of some Coleoptera and Neuroptera they are able to spin silk threads. The malpighian tubules are the main excretory organs, which by their special design remove nitrogenous wastes from the blood while at the same time conserving vital salts.

Malpighian Tubes: Thread-like organs opening into the beginning of the hindgut. They are chief excretory organs of insects and sometimes branched and open in large numbers into the alimentary canal near the commencement of the hindgut. Waste products from the insect's blood are excreted by the glandular lining of these tubes and passed into the rectum where they mix with the faecal matter. They are almost universally present in most insects excepting Collembola, some Thysanura and aphids. The number of malpighian tubules varies from insect to insect. The primitive number is 6 but fewer or more may be present. Some Odonata and Orthoptera may have 200 tubules. When a few tubules are present, these are generally long, size of tubules is generally short when a great many of these are present. The malpighian tubules of some insects synthesize silk. In larvae of lacewing, *Chrysopa*, some of the tubule cells become thickened and produce the silk used to construct the pupal cocoon. The tubules of larval antlions also produce silk that is stored in a rectal sac and used during pupation. Nymphal spittle-bugs (Cercopidae : Homoptera) produce the spittle from their malpighian tubules to live in them.

Mandibles: The mandible is a heavily sclerotized, rather compact structure having almost always a dicondylic articulation. They are appendages of the second postoral

segment. Typically they are hard and sclerotized and have various sets of teeth and brushes. They articulate with the head at the base of the lateral and mesal margins and function as both jaws and teeth. The median edge of each mandible is differentiated into an apical incisor area which bears teeth for cutting and a proximal ridged molar area for grinding. Mandibular form varies according to diet. Mandibles of predators such as tiger beetles and dragonflies have well-developed cutting edges, while those of leaf-feeding insects have more of a grinding edge. In honeybee workers, the mandibles are flattened and are used mostly for packing wax and pollen. They are stout and tooth-like in chewing insects, needle or sword-shaped in piercing and sucking insects. Predaceous insects usually have long, pointed and very sharp mandibles. Those herbivores that feed on grasses or seeds have greater grinding surfaces on the mandibles than do those that chew soft succulent leaves.

Mandibular Glands: Small glands which open near the base of the mandibles in Apterygota, Isoptera, Dictyoptera, Coleoptera and Hymenoptera. In Apoidea, they secrete attractant or alarm pheromones in some species and produce a queen substance in *Apis mellifera*. In honeybee queen the mandibular glands produce pheromones, which control colony. In some insects they act as salivary glands.

Mandibulata: A subphylum name under phylum Arthropoda. A name given to all those arthropods that have maxillae, mandibles and antennae, i.e. insects, crustaceans, millipedes and centipedes, but not spiders and other Arachnida which are grouped under subphylum Chelicerata. In insects with mandibulate or biting type of mouthparts, the feeding appendages are more or less complete, freely movable and not united in a beak. Mandibulate mouthparts are generally adapted to chewing activities, the mandibles acting as cutting and grinding structures.

Mandibulate Soldier: A soldier which has large mandibles use them in colony defence.

Mange: A group of contagious skin diseases

in livestock caused by parasitic mites, *Sarcoptes scabiei*. Mange-infested hogs scratch and rub vigorously their skin. Skin around eyes, ears and top of neck and back is inflamed. Spraying or dipping mite-infested animals with lime-sulphur or other pesticides proves useful.

Mantodea: An orthopteroid order of insects. Possess distinctive triangular mobile head. Compound eyes large and prothorax elongate. Compound eyes large and prothorax elongate. Front legs raptorial. Two pairs of wings, front wings are narrow and toughened. Hind wings are much larger, membranous with net-like arrangement of veins. Incomplete metamorphosis. Eggs are laid in papery foam-like egg cases (ootheca). They are predominantly found in tropical and warmer regions. Mantids are predaceous in habit.

Manuscript Name: In nomenclature, an unpublished scientific name.

Marginal Cell: In Diptera and Hymenoptera, a cell bordering the distal anterior wing margin, beyond the pterostigma.

Marginal Vein: In Hymenoptera, the vein delimiting the marginal cell posteriorly; any vein near the wing margin.

Market Value: The amount of money that a seller can expect to obtain for a commodity.

Mask: In dragonfly nymphs, the elongate labium which can thrust forward to seize prey.

Masquerade: A form of 'crypsis' in which an organism resembles a feature of its environment that is of no interest to a predator.

Mass Communication: The transfer of information among groups of individuals of a kind that can not be transmitted from one individual to another. Examples include the spatial organization of army ant raids, the regulation of numbers of worker ants on odour trails, and certain aspects of the thermoregulation of nests.

Mass Culture: The propagation in an insectary of very large numbers of a biological control agent, often on a continuous basis over a period of months or years.

Mass Provisioning: In solitary bees and wasps, the act of storage of sufficient food for larval development before oviposition. Mass provisioning species accumulate total number of prey required before oviposition. Normally only a single larval cell is tended at one time.

Mass Trapping: A technique of trapping insects in large scale through pheromone traps. Large scale trapping would be effective only against low level insect populations. In this approach, insects can be suppressed to low levels by using an insecticide trapping the adults that emerge to survive. This technique can also be used for monitoring purposes.

Material: In taxonomy, sample available for taxonomic study; this term is often used to mean a pesticide, active ingredient or additive ingredient.

Mating Disruption: A form of insect control in which synthetic sex 'pheromones' (usually of the female) are maintained artificially at the higher level than the background, interfering with mate disruption. With the attractant found everywhere, the insect becomes confused because it can not distinguish between pheromone from the lure-emitting particles and that from a potential sex partner. Thus, it finds difficulty in locating a mating partner. Mating disruption is one of the most promising methods of controlling insects with sex attractions but it works best with low level populations. This technique has been most widely used for controlling lepidopterous pests. Pink bollworms on cotton have in some cases been successfully controlled by mating disruption technique.

Mating Flight: Flight of a large swarm of males following one or more females prior to copulation (e.g., bees and ants). The instinct of the female to fly out on this 'nuptial flight' may be stimulated by the production of particular hormones but the actual departure may be triggered off by suitable atmospheric conditions such as temperature and humidity. There is usually a great deal of excitement prior to leaving; the insects become very active and noisy and in some cases there is a

sexual 'display' or colour change. Many insects fly very high before the actual copulation takes place, the males being attracted to the females by the scent or sound. In the case of a queen ant, once fertilized she descends to the ground and immediately rubs or pulls off her wings so that she never flies again.

Matrifilial: Describing eusocial hymenopterans whose colonies consist of mothers and their daughters.

Maxillae: A pair of maxillae lie behind the mandibles and are the appendages of the third postoral segment. They form the sides of the preoral cavity. They are usually complex in structure and bear a sensory palp in biting / chewing insects but needle-like in piercing / sucking insects. They manipulate and taste food, keeping it pressed against the mandibular cutting edges. Maxillae may also bear a cutting edge on the 'lacinia' and usually bear 'palpi', finger like projections having many chemical and tactile receptors. Maxillae are often used to clean antennae and legs. The lacinia assist in holding and masticating the food, while the galea and palps are equipped with a variety of mechano-and chemosensilla.

Maxillary Glands: Glands present in some insects opening mesally at the bases of the maxillae. These are concerned with lubrication of mouthparts. In carnivorous Heteroptera they produce toxins which kill or paralyse the prey.

Maximum Residue Limit (MRL): Also known as tolerance. The maximum concentration of pesticide residues which is legally permitted to be present in a food commodity. This is expressed as milligrams of pesticide per kilogram (mg/kg) of food commodity.

Mealybugs: They are small oval insects (Homoptera : Pseudococcidae) with sucking mouthparts and a cottony, scale-like covering. Unlike the scale insects, mealybugs possess functional legs and reproduce by producing eggs or living young. Mealybugs transmit a number of plant-infecting viruses.

Mean: Arithmetic average of the simple

numbers. For a set of N sampling units, where the individual sample numbers are represented by $X_1, X_2, X_3, \dots, \dots, X_N$, the sample mean \bar{X} is calculated as :

$$\bar{X} = \frac{X_1 + X_2 + X_3 + \dots + X_N}{N}$$

Although the mean gives us one of the most important characteristics of an insect population, but it does not tell anything about variations in the sample.

Mechanical Agitation: The stirring, paddling or swirling action of a device which keeps a pesticide and any additives thoroughly mixed in spray tank.

Mechanical Control: Reduction of insect population by means of devices that affect them directly or alter their physical environment radically. They tend to require considerable time and labour and often are not practical on a large scale. Hand picking and trapping are common examples of mechanical control. Screens, barriers, sticky bands, and shading devices are some other mechanical methods of insect control.

Mechanical Transmission: Transmission of an arthropod transmitted disease wherein the causal organism is transmitted more or less incidentally. The disease causing organism is not well adapted to the vector, and usually is not consumed. Flies and cockroaches are often implicated in this process.

Mechanoreceptors: Sensory receptors which perceive sound, pressure, tension, movement etc. They may occur anywhere on an insect's body but particularly on the antennae and cerci, and at the bases of the halteres of flies. The mechanoreceptors found in insects are trichoid sensilla, campaniform sensilla, chordotonal organs (scoloparia) etc.

Meconium: The accumulated solid wastes of the larval stages of some insects, which are expelled when adult stage is reached. In case of legless or apodous larva, no connection exists between the oviduct and hindgut, so wastes build up into a meconium until after pupation when the connection is established. At the pupal-imaginal ecdysis, the body

usually contracts in volume as the wings are inflated by blood pressure. Following ecdysis, a fluid substance called the 'meconium', is sometimes excreted.

Mecoptera: Insect order belonging to subclass Endopterygota. Members are commonly known as scorpionflies. They are elongate, with head extended downwards to form a beak. Compound eyes are large, chewing mouthparts extended ventrally into snout-like structures. Antennae thread-like. They have two pairs of rather slender membranous wings with complex venation, but in few species wings are short and aborted. Complete metamorphosis, and have worldwide distribution. Adults found among dense vegetation where they feed on small insects, pollen, nectar and tender vegetation.

Media: A longitudinal wing vein between the radius and cubitus. It has four branches (M_1 - M_4).

Media Worker: In polymorphic ant series which involve three or more worker subcastes, an individual belonging to the medium sized subcaste (s).

Medial: Towards the middle.

Median Oviduct: Also known as common oviduct. It is formed by the merging of the paired lateral oviducts: Median oviduct opens posteriorly into a genital chamber or vagina. In almost all the insects, lateral oviducts join the common oviduct medially beneath the gut, but in Ephemeroptera the lateral oviducts remain separate and open to the exterior independently. Median oviduct is lined with the cuticle and is usually more muscular than the lateral oviduct. Posteriorly, the common oviduct is confluent with the vagina and may evaginate to form the bursa copulatrix. In some species the bursa copulatrix forms a diverticulum off the oviduct. In nearly all Lepidoptera the bursa copulatrix is physically distinct from the oviduct and opens to the outside via vulva.

Median Plates: Two plates of the wing base near the media and cubitus veins.

Medlure: A synthetic attractant for baiting

the Mediterranean fruit fly; sec-butyl 4 (or 5)-chloro-2-methylcyclohexanecarboxylate.

Megacephalic: Having the head (and often the prothorax as well) unusually large.

Megaloptera: An insect order of subdivision Endopterygota. They have conspicuous compound eyes with long and thread like antennae. Strong jaws hugely enlarged in some males. Possess two pairs of subequal membranous wings with numerous cross-veins. Hind wings with large anal lobes. Wings held roof-like over the body. Larvae are aquatic in habit. Representatives are commonly known as alderflies and dobsonflies. Metamorphosis is complete. Distribution is widespread but mainly found in temperate regions.

Meiosis: Nuclear divisions in which the number of chromosomes is reduced by half.

Melanin: The brown and black colour so characteristic of many insects is the result of the pigment, melanin, which is the same or similar to the dark pigment in our own skin and hair. In most of the animals, melanin occurs in the cells in a granular form, but in most insects, it is incorporated directly into the endocuticle through a chemical reaction with cuticular proteins.

Melanism: An unusual darkening of colour owing to increased amounts of black pigment; sometimes a social character, sometimes as in cases of polymorphism, restricted to a certain percentage of individuals within a population. Melanins are formed by the oxidation of the amino acid tryosine in the presence of specific melanogenic enzymes.

Melanosis: A disease of queen honeybees, characterized by discolouration of the egg cells and trophocytes, which turn from yellowish-brown to black.

Melittin: A poisonous protein-like substance present in the venom of the bees.

Melittology: The scientific study of bees.

Melittophile: An organism that must spend at least part of its life cycle with bee colonies.

Melittophily: Pollination of plants by bees.

Generally bees are regarded as the most important group of insect pollinators. Plants that depend on bees for pollination often have bright yellow or blue colour sweet smelling flowers with nectar guides on the petals that direct the pollinators to the nectar. Honeybees, are the main bee pollinators of crops and fruit trees throughout the world.

Membrane: A very thin piece of tissue, often transparent; the apical part of the front wing (hemelytron) of Heteroptera.

Mendelian Population: A population with unrestricted interbreeding of individuals and free reassortment of genes.

Menotaxis: In some ant species the movement in a direction that makes a constant angle with a source of light so as to keep a constant visual pattern.

Mentum: Part of the base of labium of an insect between submentum and prementum. It bears the palpi and the ligula. The entire labium is primarily sensory.

Meristem: Undifferentiated plant tissue at shoot and root tips, and in buds that is capable of division.

Meroistic Ovariole: An ovariole or egg tube containing food cells or trophocytes for nourishing the developing oocytes. In some insects these food cells are contained in all the ovarian follicles - a state known as 'polytrophic' (e.g., Dermaptera and the majority of Holometabola). In others they are only at the apex of the ovarioles ('acrotrophic' or 'telotrophic' as in Siphonaptera and Heteroptera).

Mesadenia: Accessory glands arising from the mesodermal lining of the seminal vesicles of certain insects; evaginations of vasa deferentia.

Mesal: Nearer to the middle of the body.

Mesenteron: The midgut or ventriculus of the digestive tract. It is lined by endoderm, and has no cuticular lining. In most insects this region is lined by a thin peritrophic membrane made of chitin fibrils set in a protein carbohydrate matrix whose function is to prevent mechanical damage to the midgut

cells, and perhaps entry of microorganisms into body cavity. Peritrophic membrane is generally absent in fluid feeding insects (e.g., Hemiptera, adult Lepidoptera and blood sucking Diptera). Peritrophic membrane is permeable to the products of digestion and to digestive enzymes released from the epithelial cells. However, it is not permeable to other large molecules, such as undigested proteins and polysaccharides, indicating that the membrane has a distinct polarity and is not merely an ultrafilter. The midgut is usually not differentiated into structurally different regions but in many Heteroptera, however, the midgut is divided into three or four easily visible regions.

Mesh (Screen): Number of grids per inch/centimeter through which the described particles will pass is known as mesh size of screens. Standard screens are used to separate solid particles into size ranges. The 325-mesh screen is finest which has openings of 44 microns in diameter. This screen has over 10,500 openings per square inch (6.45 cm²). Fine dusting sulphur preferably has 95% of the particles passing through a 325-mesh screen. A common range for granular formulations is the 15/30 range. Particles small enough to pass a 60-mesh screen are considered dusts.

Mesocerebrum: Also called the 'deutocerebrum', the middle part of the brain of an insect, including the antennary lobes.

Mesocuticle: A procuticular layer lying between exo-and endocuticle. In this layer proteins are untanned like the endocuticle but impregnated with lipids and proteins like the exocuticle.

Mesoderm: In insects, the embryological tissue that forms a middle layer and give rise to muscles, heart, blood cells, fat body, reproductive organs, etc. Small, paired, coelomic cavities arise within the segmented mesoderm. However, these cavities are lost before embryonic development is completed.

Mesonotum: The notum or dorsal cuticular plate covering the middle segment of an insect's thorax.

Mesophyll: Parenchyma tissue in the leaf, located between the epidermal surfaces, with cells specialized for photosynthesis.

Mesopleuron: The lateral sclerite(s) of the mesothorax; the upper part of the episternum of the mesothorax (Diptera).

Mesoscutellum: A scutellum or shield-like plate covering the hind part of the mesothorax of an insect.

Mesoscutum: The middle and largest of three sclerites which typically form the mesonotum or cuticular covering of the middle segment of an insect's thorax.

Mesosoma: The middle of the three major divisions (tagmata) of the insect body, equivalent to the thorax but in apocritan Hymenoptera including the propodeum; called the alitrunk in adult ants.

Mesosternum: The ventral portion of the mesothorax.

Mesothorax: The middle of the three thoracic segments. It bears one pair of legs and one pair of wings in adults of pterygote insects. The two wing-bearing segments, e.g., mesothorax and metathorax, are together known as 'pterothorax'. The terga of mesothorax is known as 'mesonotum'. Eusterna (ventral plate of a thoracic segment) of mesothorax is known as mesosternum. Pleurite region of the mesothorax which provide support and points of articulations for legs and wings is known as mesopleuron.

Metabola: Also known as Pterygota. The major subclass of insects which undergo metamorphosis whether complete or incomplete and which usually possess wings in the adult stage.

Metabolism: Comprising all the chemical processes occurring within the living body. It includes 'anabolism' (reactions that result in the formation of more complex molecules and are, therefore, energy requiring) and 'catabolism' (reactions from which simpler molecules result and energy is released). Through metabolism substances absorbed through the gut wall occasionally the integument (e.g., certain insecticides) are

quickly converted into other compounds. Anabolic reactions include the formation of structural proteins or enzymes from amino acids, and the formation from simple sugars of polysaccharides which serve as an energy store. Catabolic reactions result in the production of large quantities of energy required by the organism for doing work.

Metabolites: A compound derived in the case of a pesticide by chemical action upon the pesticide within a living organism (plant, insect, higher animal, etc.). The action varies (oxidation, reduction, etc.) and the metabolite may be either more toxic or less toxic than before.

Metacerebrum: Also called the tritocerebrum; the hind part of the brain of an insect, consisting of the fused ganglia of the embryonic third somite.

Metameres: Essentially identical primary body segments found in the embryos and thought to be characteristic of the primitive arthropod; also called somites.

Metamorphosis: The change of body form through which insects pass in developing to the adult stage. In primitive wingless insects (Thysanura and Collembola), body proportions and internal organs remain similar after each moult or ecdysis is categorized as 'ametabola'. Less than 1% of all the insect species exhibit this growth pattern. The immatures live in the same habitat and feed on the same food as adults, and both immatures and the wingless adults are capable of moulting. When a change from the immature to the adult occurs but the change is not extreme, metamorphosis is incomplete or hemimetabolous (cockroaches, grasshoppers, leafhoppers and bugs). Immatures or 'nymphs' are normally characterized by possessing external wing pads, except when the wings are secondarily absent as in lice. Most structures of nymphs and adults with incomplete metamorphosis are alike, although body proportions differ and changes in the thoracic plates and reproductive system occur in the moult to an adult. Food and ecology are similar in all stages except where nymphs are aquatic and adults terrestrial. Aquatic

immature stages are known as naiads (Odonata). But the majority of insect species have a pupal stage and undergo drastic changes. Metamorphosis in such cases is called 'complete' (holometabolous development), and often majority of larval characters are broken down by histolysis, and adult structures within the immatures are built from either small groups of adult tissues, 'imaginal discs', or from larval cells which transform to adult cells. Wing pads are internal in larvae but evert to become external in the pupa and enlarge to functional wings in the adults. This type of development is found in most advanced species (Endopterygota). Larvae are dominant feeding stage, the pupa becomes essentially a transformation stage, and the adult is specialized for dispersal and reproduction.

Metanotum: The tergum or notum of metathorax is known as metanotum. The pterothoracic nota (notum of meso- and metathorax together) are each divided into a wing-bearing sclerite, the 'alinothum', and a phragma bearing sclerite, the 'postnotum'. Phragmata provide attachment for the large longitudinal muscles. Each alinothum is divided anteriorly into 'prescutum', followed by an anterior 'scutum' and a smaller posterior 'scutellum'.

Metapleuron: The lateral sclerite(s) of the metathorax is known as metapleuron which has a 'pleural wing process' on which the wing articulates, and a 'ventral pleural coxal process' which provides an articulation for the coxa. Extending between the two pleural processes is a strong internal 'pleural ridge' which provides mechanical support for the pleuron.

Metapneustic: Respiratory system in which only last pair of abdominal spiracles is functional as in mosquito larva.

Metascutellum: The scutellum or dorsal cuticular shield covering the metathorax or third segment of an insect's thorax.

Metasoma: In apocritan Hymenoptera, the 'petiole' plus 'gaster' region is called metasoma.

Metasternum: Ventral sclerite of the metathorax; the eusterna and spinasterna of metathorax is designated as metasternum. Eusternum may have a pair of large invaginations 'sternal apophyses' which may be well separated and their positions externally are marked by a pair of 'furcal pits', or fused medially to form a 'sternal furca'.

Metatarsal Spinners: Insects such as the Embioptera have numerous silk glands which open on the enlarged metatarsus (basitarsus) or first tarsal segment on each of front leg. With these glands, both sexes make communal underground silk-lined nests. These glands are also found in males of *Hilara* sp. (Diptera : Empididae). As the colony grows, galleries and tunnels are extended to take in new food material by the insect.

Metatarsus: An erroneous term used for the first segment of the tarsus (basitarsus).

Metathetely: The appearance of an abnormal monster resulting from an adult insect retaining some characteristics of the larva or pupa. Metathetely may be caused due to an upsetting of the balance between the hormones from the corpus allatum and from the thoracic gland.

Metathorax: The third and last segment of the thorax. Metathorax bears hind pair of legs and hind pair of wings. A pair of lateral spiracles is present at the anterior edge of this segment. In adult pterygote insects, two wing bearing segments e.g., mesothorax and metathorax, are together known as pterothorax. The pterothoracic segments are similar in structure and nearly equal in size in insects that provide almost equal muscular power to both pairs of wings (as in Odonata and Orthoptera), they fly with the wings unattached to each other. But in insects which couple their wings together have enlarged mesothorax but there is reduction in size of the metathorax. However, in Diptera where hind wings no longer function in flight, the metathorax is virtually absent. But in insects which fly mainly with hind wings (as in Dermaptera, Phasmatodea, Strepsiptera, and Coleoptera), metathorax is enlarged.

Metecdysis: The period after a moult, in insects or other arthropods, when the new cuticle is still soft.

Metepimeron: The epimeron of the metathorax.

Metepisternum: The episternum of the metathorax.

mg/kg: Milligrams of pesticide (or any toxicant) per kilogram of animal body weight.

Micergate: A dwarf worker ant.

Micraner: An abnormally small male ant.

Microapplicator: Instrument used to apply small quantity of insecticide to the body of an insect in the LD₅₀ studies. For this very fine steel needles of 27 or 30 gauge (0.41 or 0.16 mm in diameter) are used. Small glass needles of 6.1–0.16 mm in diameter may be used for injection to small insects. The insecticide is commonly dissolved in propylene glycol or peanut oil and injection is made intraperitoneally into the body cavity. Care must be taken to avoid bleeding by insect.

Microbial Control: The use of pathogenic microorganisms to control pest species. Microbial control (the use of pathogenic, bacteria, viruses, fungi, nematodes and protozoa) plays an increasingly important role in the control of insect pests. Strategies for the use of microorganisms includes introduction, augmentation and conservation. The occurrence of an epizootic depends on the pathogenesis, virulence, infectivity and viability on the host's density, distribution and mobility, and abiotic factors such as temperature, humidity, light and wind. The normal route of entry of pathogens is via the midgut, though fungi commonly enter via the integument. Bacteria may damage the midgut epithelium causing starvation, or may invade other tissues causing septicemia and/or liberating toxins. Viruses disrupt the metabolism of host's cells. Fungi may disrrupt the tissues or may even secrete histolyzing or toxic substances. Protozoa have a debilitating effect and may release toxins. Nematodes also has a debilitating effect, causing protracted or

morphologically abnormal development, or reduced fecundity.

Microbial Insecticide: A microorganism applied in the same way as conventional insecticides to control an existing pest population is known as microbial insecticide. Bacteria, viruses, fungi, nematodes and rickettsiae are the microorganisms which are used as microbial insecticides. Some of microbial agents may occur naturally in the field, but most of the work and promise of research is directed at agents that can be mass produced and applied as pesticides. These agents are harmless to man, animals and plants because most agents are selective and kills only certain groups of pests. The bacterial preparation of *Bacillus thuringiensis* is exempted from tolerance limit. To date the greatest successes have resulted from use of bacteria and viruses. Fungi also cause disease in insects, and there have been some success in their use as well. In fact most entomopathogens used in pest management are quite specific to insects and are very different from microbes that cause pathology in humans. Microbial pesticides in general are usually harmless to other forms of life, they are highly specific, have slow development of resistance in host, and are often compatible with chemical control and show promise for integrated control. Moreover, microbial pesticide is applied for a short term control but there is a possibility that the disease will persist within the residual population and prevent resurgence.

Microbiota: The combined microflora and microfauna of an organism.

Microclimate: Climate of a microhabitat (e.g., crevice, plant foliage, hole etc.) typically more constant and less variable than general climate.

Microfauna: Soil invertebrates in the small size class, usually less than 2 mm in width.

Microgeographic Race: A local race, restricted to a very small area.

Micrometre (µm) : A unit of length=one thousandth of a millimeter (0.001mm or 1 micron (µm); 0.000001 metre (10⁻⁶m) or 0.00003937 of an inch; also a disc or slide of

glass ruled lines forming a metric scale for measuring objects under a microscope in microns.

Micron (μm): One-millionth of a metre (m) = 0.001 mm = 0.00003937 of an inch. Same as micrometre.

Micronair Sprayer: Spraying equipment, usually aircraft-mounted, generating spray droplets by impingement of a jet of spray fluid onto a spinning metal mesh cage. Sprayers are designated as AU-4000 and AU-8000 and are specialized for different delivery systems.

Microorganism: A heterogenous assemblage of simple organisms consisting of the protozoa, algae, fungi, rickettsiae, viruses, and bacteria. All these forms have in common a relatively simple organization which sets them apart from true plants and true animals. They are either unicellular, their tissues are relatively undifferentiated.

Micropipettes: Constant volumes of pesticidal solutions are delivered by micropipettes, constructed from narrow glass tubing with a sharply defined constriction a short distance from the tip. The tube can be filled by capillary up to the constriction, and the liquid expelled by blowing down an aspirator tube. All the micropipette techniques are time consuming and for this reason can not always be used when many insects have to be treated.

Micropterous: Having small or vestigial wings; a term often used with particular reference to the various castes of insects such as ants and termites.

Micropyle: A minute opening or group of openings into the insect egg which permits the entrance of sperm(s).

Microscope: An instrument used to obtain an enlarged image of a small object. The image may be seen, photographed or sensed by photocells or other receivers depending upon the nature of the image and the use to be made of the information of the image. A simple microscope, hand lens, or magnifier usually is a round piece of transparent material, ground

thinner at the edge than at the centre, which can form an enlarged image of a small object. Commonly simple microscopes are double convex or planoconvex lenses, or systems of lenses acting together to form the image. The compound microscope utilizes two lenses or lens systems. One lens system forms an enlarged image of the object and the second magnifies the image formed by the first. The total magnification is then the product of the magnifications of both lens systems. The typical 'compound microscope' consists of a stand, a stage to hold the specimen, and mechanical controls for easy movement of the body and the specimen. The lens system nearest the specimen is called the objective, the one nearest the eye is called the eyepiece or ocular. A mirror is placed under the stage to reflect light into the instrument when the illumination is not built into the stand. For objectives of higher numerical aperture than 0.4, a condenser is provided under the stage to increase the illumination of the specimen. Various optical and mechanical attachments may be added to facilitate the analysis of the information in the doubly enlarged image.

Microsyringes: Syringes are suitable and are fitted with a hypodermic needle or preferably a canula (0.3-0.4 mm diameter). The plunger is moved by the piston of a micrometre. As repeated adjustment of a micrometre is tedious, various mechanisms have been designed to simplify regular dosing. A number of precision made glass syringes are available commercially.

Microthorax: A thin neck-like prothorax of some insects, e.g., dragonflies.

Microtomy: The cutting of thin sections of objects, as of tissues, or cells, in preparing specimens for microscopic or ultramicroscopic examination.

Microtrichia: Small and irregularly scattered fixed hairs that lack the basal articulation characteristic of setae. These are found on the wings of some Mecoptera and Diptera.

Microvilli: Numerous finger-like processes that serve to increase in the absorptive surface area, for example, in midgut epithelial cells.

Middorsal Striae: A longitudinal stripe running down the middle of the back or dorsum.

Midgut: The midgut or ventriculus of the digestive tract. It is lined by the endoderm, and has no cuticular lining. In most insects this region is lined by a thin peritrophic membrane made of chitin fibrils set in a protein carbohydrate matrix whose function is to prevent mechanical damage to the midgut cells, and entry of microorganisms into the body cavity. Peritrophic membrane is generally absent in fluid-feeding insects (e.g., Hemiptera, adult Lepidoptera and blood sucking Diptera). Peritrophic membrane is permeable to the products of digestion and to digestive enzymes released from the epithelial cells. However, it is not permeable to other large molecules such as undigested proteins and polysaccharides indicating that the membrane has a distinct polarity and is not merely an ultrafilter. The midgut is usually not differentiated into structurally different regions but in many Heteroptera, however, the midgut is divided into three or four easily visible regions.

Migrants: Adult, winged, parthenogenetic viviparous female aphids, that develop on the primary host and then disperse to secondary hosts.

Migration: Also sometimes known as 'adaptive travelling'. Migration has been described as essentially a transference of adults of one generation from one breeding habitat to the others. Relatively a few insect species engage in dramatic geographical mass movements each year. Those that do are usually characterized by, **1.** Undergoing this behaviour soon after adulthood is reached, **2.** Females with developing ovaries being the consistent migrant sex, and **3.** The migration often being a one-way movement, although some of the best known examples, such as certain populations of the monarch butterfly do make at least partial return flight. Migrations often start in an area where populations are increasing and where environmental carrying capacity pressures are

building. Under these conditions, nymphal *Schistocerca gregaria*, becomes morphologically and behaviourally differentiated into a migratory phase. When these grasshoppers reach adulthood, there is an exodus flight that normally encounters and gains assistance from the wind. Big swarms may extend over 250 km². Flight of migratory insects is maintained until other stimuli like convergence of wind-flow patterns, matured ovaries, wing muscle deterioration, energy exhaustion, length of day and other settling responses redirect behaviour. A major function of migration in most species is dispersal of individuals to new and suitable habitats.

Migratory Flight: Insect flight that involves a phase in adult life during which flight activity dominates over all other forms of behaviour. In many insects, such activity is restricted to a short period, after which only appetitive flights occur; in some, the flight muscles may break down after migration so that no further flight is possible.

Milbemycins: Milbemycins are a mixture of macrocyclic lactones, are obtained from a soil actinomycete, *Streptomyces hygroscopicus* subspecies *aureolacrimosus*. It has a remarkable miticidal activity. Milbemycins consist of 24 or more components similar to avermectins but without disaccharide moiety. They are effective against all the stages of various mites by acting as GABA agonists. Milbemycins (a mixture of milbemycin A₃ and A₄) is more miticidal among the homologues to all developmental stages of spider mites, and leaf-curl causing mites all the year round because its activity is not affected by ambient temperature. Although non-persistent, it shows a long-lasting effects on mite population by decreasing oviposition with sublethal doses.

Mildew: A fungus disease characterized by the appearance of a white, mycelial growth and spores on the surface of infected plant parts.

Milk Glands: Specialized accessory glands in certain adenotrophically viviparous flies

(Diptera : Hippoboscidae) that produces secretions fed upon by larvae.

Milky Disease: Any of a group of maladies of scarabaeid larvae, caused by species of the genus *Bacillus*. Type 'A' milky disease of white grubs of Japanese beetle is caused by *Bacillus popilliae*, whereas Type 'B' is caused by *Bacillus lentimorbus*.

Milky Stage: Stage occurring during ripening phase of the crop growth and development when the inside of the grain is at first watery but later turns milky in consistency.

Millilitre (ml): 1cm^3 (approximate)=0.001 litre= $0.0161\text{m}^3=0.03815$ fl.oz.

Millimetre (mm) : $0.1\text{cm}=0.01$ decimetre = $0.001\text{m}=1000\mu\text{m}=0.03937\text{in}$ (about 1/24 in).

Millimicron (m μ) : One thousandth of a micron; a nanometre (nm).

Mimetic Polymorphism: Polymorphism in Lepidoptera in which the various morphs resemble other species distasteful or poisonous to a predator; often restricted to females.

Mimic: One of the three components of a 'mimicry' system, the emitter of false signal(s) received by an 'observer' ; an individual, population or species resembles a 'model', usually another species or part thereof.

Mimicry: The adaptive resemblance of one organism (the mimic) usually in colour, pattern, form or behaviour to another organism (the model) is known as mimicry. There are four types of mimicry : **1.Aggressive mimicry**- involves a resemblance which enables the mimic to approach the prey, the model. This is usually found in parasites and predators. The distinctive characteristics of this type of mimicry is the inherent conflict between the mimic and model, **2.Weismanian mimicry** - involves resemblances which facilitate cohabitation with a mimic's host, its model. This type of relationship may consist of exploitation of the model by a mimic but may also be a mutually advantageous relationship.

Ants and termites are common examples of this type of mimicry. **3.Batesian mimicry** – it results from the resemblance of one organism (the mimic) to a protected model, thereby providing the mimic some protection from its enemies. Automimicry can be described as a type of Batesian mimicry within a species. **4. Mullerian mimicry** - results when both model and mimic are unpalatable and their conspicuous colouration and pattern serve mutually as learning stimuli for predators.

Mineral: An inorganic homogenous substance; an inorganic foodstuff.

Mines: Mines are tunnels produced when a larva pushes its way between the upper and lower surfaces of a leaf. Mines show up in a pattern either in a paler green, yellow or white, and are often very complicated.

Minima: In ants, a minor worker.

Minimum Tillage: Practices that utilize minimum cultivation for seed bed preparation and may reduce labour and fuel costs, and damage to soil structure may also be reduced.

Mining Bees: Solitary bees that burrow in the earth to make their nests. Although a large number may nest together, they do not form a true colony as each leads an independent life (e.g., Andrenidae and Halictidae).

Minor Pest: When the general equilibrium position (GEP) lies below the economic injury level (EIL), the species is known as a minor pest. However, under favourable environmental conditions the population may cross EIL.

Minute: Very small; an insect which is a few millimetres in length or less is considered as minute.

Minuten Pins: Minuten pins are very fine steel pins. One end is pushed through the specimen and the other end inserted into a piece of cork or other spongy material. A regular insect pin is inserted through the cork.

Miscible Liquid (S) : Two or more liquids capable of being mixed in any proportions and of remaining mixed under normal

condition ; a formulation in which the technical product is dissolved in an organic solvent which is then on dilution dissolved in the water carrier.

Miscible Oils: Miscible oils are those which form a uniform mixture with water.

Mist Blower: Also known as 'air blast sprayer'. Spray equipment in which hydraulic atomization of the liquid at the nozzle is aided by an air blast past the source of spray. Through mist spraying concentrated spray is atomized into an air stream. Spectrum of droplets produced by the mist blowers range from 20-500 μm in diameter. Decreasing the liquid feed rate and increasing the air speed both cause a reduction in the droplet-size spectrum produced. These sprayers are widely used in plantation crops where it is impossible to use the machine mounted sprayers and where good coverage of spray on a complex target (a tree) is required.

Mite: A member of subclass Acari related to but distinct from insects. Mites may be distinguished from insects by the single body region, four pairs of legs and absence of antennae. However, in larval stage, there are three pairs of legs. They may be free living or parasitic. Many species of suborder Trombidiformes are important pests of agriculture, the family Tetranychidae comprising spider mites (so-called for their ability to spin webs of silk around plants they feed on), and Eriophyidae comprising gall mites being of the greatest consequence. Some are of medical and veterinary importance. *Acarapis woodi* (Tarsonemidae) inhabit tracheal tubes of a honeybee causing 'Isle of Wight' disease or 'Acarine disease' resulting in mortality of bees.

Mitochondria: Minute bodies present in every living cell, the site of many 'enzymes' notably those concerned in oxidation.

Mitosis: Nuclear division characterized by a complex movement of chromosomes, which results in the formation of new nuclei having the same number of chromosomes as the original nucleus.

Mixed-Function Oxidase (MFO): An enzyme that metabolizes many foreign substances. Refers to the oxidation system which requires NADPH. MFOs system is located in the microsomal portion of various tissues. The important role of MFOs in insecticide metabolism is well established. Their role in resistance to insecticides is shown from the action of certain synergists known to inhibit these enzymes. In particular the group of compounds containing the methylenedioxyphenyl moiety, such as piperonyl butoxide, sulfoxide and sesamex are found to inhibit the oxidation of organophosphates and oxidative metabolism of other compounds, extending to juvenile hormones, hormone mimics, precocenes etc.

Mixed Nest: A nest containing colonies of two or more species of social insects, in which mixing of both the adults and brood occurs.

Mobbing: A type of group defence in which a predator is harassed by a number of manouverable prey individuals, (e.g., sand wasp, *Bembix* sp., nest in aggregation when a potential predator approaches).

Mode of Action: A term used to describe the way or method by which a pesticide may alter or adversely affect physiological or biochemical events in an organism resulting in a toxic effect, usually ending in death. Some pesticides are protoplasmic poisons (e.g., arsenic), nerve poisons (e.g., organochlorines and organophosphates), respiratory inhibitors (e.g., oils), or growth regulators (e.g., methoprene). The precise ways in which they interfere with the normal biochemical processes are often not known.

Model: In Batesian mimicry, the distasteful organism which is mimicked.

Moiety: Part or component of a molecule.

Molar Lobe: The basal portion of the mandible, usually modified as a grinding surface. Also known as 'mola'.

Molecular Weight: Sum of the atomic weights of constituent atoms in a molecule.

Mollicutes: A class of wall-less microorganisms, surrounded by a membrane

and related to bacteria. They are small, gram-negative, and highly variable in appearance.

Mollusca: A phylum of invertebrate animals containing snails, slugs, clams, oysters, octopus, and others. The body structure of slugs and snails is essentially identical except that snails produce a shell. Molluscs possess a single 'foot' on which they move. They create the slime layer between themselves and the substrate over which they are moving resulting in a familiar silvery trail. Slugs and snails typically require a relatively cool and moist environment. Some of the molluscs are agricultural pests. In general snails are better able to tolerate hotter and drier conditions than slugs.

Molluscicide: A chemical used to kill or control snails and slugs (e.g., metaldehyde, methiocarb, triphenyltin acetate). There are two kinds of snails from the pest control point of view : vectors of diseases such as bilharzia (Schissmiasis), and pests of crops (e.g., brown garden snail). So molluscicides like copper sulphate for the control of vectors of diseases are applied. Snails and slugs which are particularly harmful to seedling crops are best controlled by metaldehyde, a polymer of acetaldehyde. It is toxic to snails by contact and by ingestion but also appear to immobilize them and induce them to produce a copious slime. The snails eventually die through desiccation.

Moltinism: A polymorphism in which different strains undergo a different number of larval moults.

Moniliform: Bead-like, with rounded segments (e.g., antennae of the termites).

Monitoring: To observe or check, especially for a special purpose, so as to keep track of crop development and insect infestation. Sex attractant pheromones are commonly used in insect pest management for monitoring of pest populations. Pheromones combined with sticky traps are capable of detecting insect populations at extremely low densities, and are useful in monitoring dispersal of insect pests into previously manifested areas.

Pheromones are also used to monitor insect activity for proper timing of insecticide applications.

Monitoring System: A regular system of keeping track of and checking up on whether or not pesticides are escaping into the environment; or the numbers, life stages, evidences of feeding damage and locations of pests in a crop.

Monocondylic: In entognathous hexapods mandibles are monocondylic and adapted for externally triturating food particles into minute pieces before digestion.

Monocropping: Alternatively known as monoculture. The practice of growing the same crop (and often the same cultivar) on the same land year after year. In some situations it may involve the same crop plant over large areas.

Monoculture: The extensive cultivation of a single species of plant over the same large area of land for many years consecutively for the necessity of producing more and cheaper food. However, monoculture has two faults, **1.**The ecosystem is simplified, and **2.**The crop plant is frequently graminaceous (a member of the grass family, including wheat, barley, oats, rice and corn), the ecosystem is artificially maintained at an early stage of ecological succession. By simplifying the ecosystem, humans encourage the build-up of the insects that compete with them for the food being grown.

Monogamy: A mechanism in which each breeding adult is mated to only one member of the opposite sex.

Monogenic: A characteristic (such as resistance) controlled by a single gene.

Monograph: In taxonomy, an exhaustive treatment of a higher taxon in terms of all available information pertinent to taxonomic interpretation usually involving full systematic treatment of comparative anatomy, biology, ecology and detailed distributional analysis of all included taxa.

Monogyny: Existence of only one functional queen in the nest. Monogyny is advantageous

in very stable and secure environment with low nest predation.

Monomorphic: Developing with no or very slight change of form from stage to stage.

Monomorphism: The existence within a species or colony of only a single worker subcaste.

Monophagous: Feeding on single species of plant. Monophagy is advantageous in the sense that of the plants utilized by monophagous or narrowly oligophagous insects are in fact avoided by generalist feeders because of their toxic or repellent properties.

Monophyletic: A group of species that share a common ancestor.

Monophyly: The derivation of a taxon through one or more lineages from one immediately ancestral taxon of the same or lower rank.

Monothallamous Galls: Galls with a single cavity containing an insect larva, e.g., the oak marble gall.

Monotrysian: In Lepidoptera, referring to the condition in which the genital system opens through a single pore into a cloaca.

Monotypic Genus: A genus having only one (distinctive) species.

Monoxene: A parasite restricted to one host.

Moribund: Dying; near death.

Morphogenesis: All events occurring between the formation of zygote and the emergence of a sexually mature adult.

Morphology: Science which deals with the form or shape of structures.

Morphospecies: A typological species recognized merely on the basis of morphological difference.

Morphs: Physiologically and morphologically distinct forms of the same insect species. Differences exist in colour and patterns within the same species (polymorphism), very often the variability includes distinct dark and light individuals. In addition to morphological adaptations, some

insects conceal themselves with available material from the environment. For example, certain leaf beetles cover their bodies with fecal material during their larval stages and become less conspicuous.

Mortality Rate: Death rate; the number of deaths per unit population during a given period of time.

Mosaic Disease: Disease characterized by variegated patterns of green and yellow on the foliage of plants affected by certain viruses; disarrangement or unequal development of the chlorophyll content.

Mosaic Evolution: Evolution that involves unequal rates for different structures, organs or other components of the phenotype.

Moth Proofing: Chemical treatment of cloth ideally given during dyeing in order to render it toxic or distasteful to fabric pests such as clothe's moth and carpet beetles, for the lifetime of articles. Moth proofing can be done during dry cleaning.

Motor Neuron: A neuron leading from the central nervous system to an effector organ. They are monopolar and carry impulses from central nervous system.

Mottle: Also called mottling. Disease symptoms of alternate light, dark irregular patterns more subtly differentiated than mosaic; symptomatic of viral disease

Mould: A fungus with conspicuous mycelium or spore masses.

Moult: With reference to insect, mites and nematodes-the shedding of the exoskeleton or cuticle before entering the next life stage. Moulting is a necessary pre-requisite to grow and attain the adult stage. The period of moulting is a vulnerable stage for insects, as they are susceptible to desiccation and easy prey for predators.

Moulting: The process of shedding the skin (exoskeleton). Moulting is a complex process involving hormonal, behavioural, epidermal and cuticular changes that lead to the shedding of the old cuticle. From the time of hatching from the egg to adulthood the individual

passes through a period of growth and change. The insect integument has no stretch, and so to accommodate increase in size the insect periodically sheds its old skin and replaces it with a larger one. In *Campodea* and *Japyx* (Diplura), there is a single moult. Most insects moult at least 3 or 4 times, and in some cases 30 or more moults occur, during normal development as in some cicadas. The average is 5 or 6 moults. The process of moulting is sometimes also known as **ecdyses**, the old skins cast off by the insects are called 'exuviae'. The number of moults varies according to the latitude and is affected by temperature, moisture, and food supply.

Moulting Fluid: A substance secreted by the epidermal cells, contains chitinase and protease, and it digests old endocuticle. The moulting fluid is reabsorbed through the epidermal cells shortly before ecdysis in many insects, though in some insects the new instar apparently swallows the old fluid.

Moulting Glands: Epidermal glands that secrete a fluid which softens the lower layer of the cuticle prior to moulting.

Moulting Hormone: A hormone or group of hormones which stimulate the production of moulting fluid from glands in the epidermis. They are secreted by the thoracic glands under the influence of neurosecretions from the brain. Three major types of hormones control moulting and metamorphosis : neuropeptides including prothoracicotropic hormone (PTTH), ecdysis triggering hormone, eclosion hormone (EH) ecdysteroids, and juvenile hormones (JH).

Moulting Suture: Line in the cuticle along which the substance is not 'sclerotized' and, therefore, splits after digestion by the 'moulting fluid'.

Mound Nest: A nest at least part of which is constructed of a mound of soil or carton material that projects above the ground surface. The architecture of the mound is often elaborate, specific in plan to the species, and evidently adapted to contribute to microclimate control within the nest. The giant

mounds of tropical termites mostly belong to species in the Termitidae (*Amtermes* and *Macrotermes*).

Mouth Hooks: Chitinous hooks with which maggots and other larvae of Diptera tear open plant or animal material on which they feed; well-developed in leaf-miners. They take the place of normal mandibles and maxillae.

Mouthparts: These are the organs concerned with feeding comprising the unpaired labrum in front, a median hypopharynx behind the mouth, a pair of mandibles and maxillae laterally, and a labium forming the lower lip. The labium or the maxillae bear sensory appendages or palps. In biting insects, the mandibles and maxillae are strong, movable and sometimes toothed. In insects that suck blood or suck the juices of plants - each of the labium, mandibles and maxillae may be extended and modified in different ways to form a suctorial proboscis/piercing stylets. Some insects (mayflies, most caddisflies, and many moths) do not feed at all as adults and bear only non-functional vestiges of the mouthparts. Such insects rely totally on food stored when immature and do not live long as adults.

Mulch: A layer of wood chips, dry leaves, straw, hay, plastic strips, or other material placed on the soil around plants to hold moisture in the ground, keep weeds from growing, soak up rain, reduce soil temperatures, or keep fruits and vegetables from touching the ground. Also help in controlling insect pests and nematodes.

Mullerian Mimicry: In this type of mimicry both model and mimic are unpalatable, and the ingestion of either by the vertebrate predators results in the avoidance of both species. This type of mimicry is named after German naturalist, Muller - a proponent of Darwinism.

Multicolonial: Pertaining to a population of social insects which is divided into colonies that recognize nest boundaries.

Multiple Crops: Two or more crops in the same field in a year.

Multiple Parasitism: Attack simultaneously by two or more primary parasites of different species on the same host. Multiple parasitism occurs, perhaps because the parasitoid species are less able to recognize the marking pheromones placed by species other than their own.

Multiple Resistance: The concurrent existence in a single insect population of two or more defence mechanisms against insecticide. This is far more serious and extends to a variety of classes of insecticides with differing modes of action and different detoxification pathways.

Multivoltine: Those insects that may manage a variable number of the generations in a given year continuing to reproduce until the weather becomes unfavourable or food becomes scarce.

Mummy: Unharvested fruit or nut remaining on the tree; remains of an aphid whose body contents have been consumed by a parasite.

Murine Typhus Fever: A human disease caused by a bacterium like microorganisms, *Rickettsia mooseri*, and transmitted from rat to man by the oriental rat fleas.

Muscardine: A term used generally in connection with those mycoses of insects in which the fruiting of the pathogenic fungi (muscardine fungi) arise on the exterior of the insect. The most commonly used fungi in insect control are *Beauveria bassiana* (white muscardine disease) and *Metarrhizium anisopliae* (green muscardine disease), both of which are fungi imperfect. Most entomogenous fungi are internal pathogens. The infective unit is usually a spore which germinates on the surface of the host's integument. Muscardine is the major fungal disease of silkworms. Since high humidity and temperature favours the germination of pathogen, it is imperative to keep the humidity low and good ventilation in rooms where silkworms are reared. Regular bed cleaning and burning of infected larvae, litter and unconsumed leaves helps in minimizing the infections.

Muscles: Muscles provide power for the locomotory and other movements. All the muscles of insects are striated, in contrast vertebrates and many other invertebrates possess both striated and smooth muscles. The muscular system of insects differs in many ways from that of vertebrates. The most conspicuous difference is the relation to the skeleton : the muscles of insects are inside the skeleton, while those of the vertebrates are outside. As a consequence of the tubular construction, which resists bending, and the general absence of calcium salts, the insect skeleton compared to the vertebrate skeleton is comparatively lighter and stronger and provides greater space and attachment areas for the muscles. In insects, the attachment of muscles to the skeleton is by the 'tonofibrillae' but not by connective tissues as in vertebrates. The power of insect muscles is measured by the cross-sectional area of the muscle in relation to the greatest load it can lift.

Mutagen: Substance causing genes in an organism to mutate or change. The property of a substance in inducing mutagenic actions in subsequent generations is known as mutagenicity.

Mutant: An individual having an abnormality of structure, properties of behaviour in which it differs distinctly from the type and which has internal (genetic) rather than environmental origin, so that there is probability of transmission to offspring.

Mutation: Any relatively stable heritable change in the genetic material.

Mutualism: Intimate relationships between two or more kinds of insects or between plants and insects that are advantageous to both. Certain insects, such as a few Homoptera, are mutualistic and provide some nutritive substances for ants; these 'trophobionts' are protected by their hosts and are analogous to domestic cows, for they yield food sugar solution, 'honey-dew' from the hindgut upon request.

Mycangium: An invaginated cuticular pouch in which fungal spores are carried.

Mycelium: Vegetative structure of a fungus composed of a network of fine filamentous hyphae.

Mycetocytes: Specialised cells in the bodies of insects that contain symbiotic bacteria or protozoa necessary for the life of the host. Those which break down cellulose in termites and cockroaches are an example, others are believed as a source of necessary vitamins, particularly in some blood-sucking insects. Sometimes the cells are grouped together in a special organ i.e. mycetome.

Mycetomes: Tissues composed of mycetocytes and associated with the gut, fat body or gonads.

Mycoplasma: A group of very small bacteria-like organisms intermediate between viruses and bacteria, but they have some features in common with bacteria. They can be cultured on agar media apart from the host, and they are susceptible to certain antibiotics, especially tetracycline. Mycoplasmas are pleomorphic, the cells undergoing changes in form through their life cycle. The most common disease symptoms are yellowing, stunting, and the development of 'witches broom'.

Mycotoxine: Mycotoxins are the compounds (metabolites) produced by fungi. Such toxins may be present in infected seeds, feeds or foods and may cause illness or death in animals (including humans) that consume the contaminated produce. Aflatoxins are a group of polyketides produced mainly by strain of fungus *Aspergillus flavus*. The most biologically active aflatoxin is B₁, it is considered the most potent naturally occurring carcinogen known.

Myiasis: Diseases of man and other animals due to infestation by the maggots of Diptera which are not necessarily parasitic. Most of human myiasis are accidental infestations of the intestine through swallowing larvae in food.

Myoneural Junction: The site of transmission of an impulse from a nerve to a muscle.

Myophily: Plant pollination by flies, when they visit to obtain nectar. Fly-pollinated flowers tend to be less showy than other insect-pollinated flowers but may have a strong smell. Families Bombyliidae (bee flies), and Syrphidae contain major pollinator taxa.

Myriapod: Members of the Uniramian superclass Myriapoda which includes the millipedes (2mm to >25cm), centipedes (5mm - 20cm), pauropods (2mm) and symphylans (1-8mm).

Myrmecochory: The collection and dispersal of seeds by ants which are otherwise inedible to the ants themselves.

Myrmecodomatia: Structures in higher plants that seem to have evolved, through mutualistic association, to serve as dwelling places for ants.

Myrmecology: The scientific study of ants.

Myrmecophile: An organism (insects, mites, spiders etc.) that must at least spend part of its life cycle with ant colonies.

Myrmecophilous: 'Ant loving'. Refers to organisms other than ants that interact with ants symbiotically.

Myrmecophily: Plant pollination by ants. Ants are commonly anthophilous (flower loving) but rarely pollinate the plants they visit.

Myrmecophytes: Higher plants that live in the obligatory mutualistic relationship with ants.

Myrmecotrophy: The feeding of plants by ants, notably through the waste products of an ant colony.

Mystax: A patch of bristles or stiff setae above the mouth, often called the moustache (e.g., Diptera).

Naiad: An aquatic nymph that uses gills to breathe and does not generally resemble the adult (e.g., mayflies, dragonflies and stoneflies). They are mandibulate and most of the naiads are predacious.

Naphtha: A hydrocarbon fraction of crude oil, the crude is distilled and separated into naphtha, kerosene, gas oil, fuel oil, lube oil and residues, with each of the fraction itself a mixture of many different chemicals. Naphtha is especially valuable as a raw material for both chemicals and gasoline.

Naphthalene: A coal tar derivative long used as a fumigant for clothe's moth. Relatively non-toxic to mammals but is very toxic to plants. The oral LD₅₀ value of naphthalene is 2400 mg/kg, while dermal LD₅₀ is more than 2500 mg/kg. Naphthalene is readily absorbed, if inhaled or ingested. Ordinary use of naphthalene is safe but danger is almost exclusively to children who eat them in forms of moth balls.

Narrow-Spectrum: Insecticides which are effective against only a narrow range of insects are known as narrow-spectrum insecticides.

Nasanov Glands: Worker bees, during swarming release a mixture of chemicals from the 'Nasanov glands' which are located on the dorsal surface of seventh abdominal segment. This chemical or scent is released by bees located near the hive entrance, and this chemical (contains geraniol, citral and geranic acids) assists the foraging bees to locate the nest on return. However, this chemical odour does not serve to distinguish

one colony from another. But the nasanov substance stimulates the assembly of workers that ultimately leads to the familiar cluster of bees around their queen. While emitting odour from this gland, the abdomen of bee is flexed in such a manner that the surface of the gland is exposed, thus releasing chemicals into the air stream.

Nasus: The snout-like organ possessed by soldiers of some species in the Nasutitermitinae. The nasus is used to eject poisonous or sticky fluid at intruders.

Nasute: In some Termitidae the mandibles of soldiers are atrophied, the head is drawn into a nozzle-shaped projection bearing the opening of frontal gland. These soldiers are known as 'nasutes' In case of *Nasutitermes* spp., nasutes deter invaders by spraying or exuding repellent or entangling the substances.

Natality: An increase in number of births.

Natatorial: Legs specially adapted for swimming by having a fringe of long hairs. Middle and hind legs of diving beetles are of this type.

Native: Indigenous; not exotic; originating locally.

Natural Classification: A classification that groups the organisms together on the basis of the sum total of all their characteristics, and tries to indicate evolutionary relationships.

Natural Control: Maintenance of a more or less fluctuating population density within certain definable upper and lower limits over a period of time by the combined actions of

abiotic and biotic elements of the environment (e.g., climatic factors, parasites, predators, disease, etc.) without human interference.

Natural Enemy: Any living organism which is harmful to a species by way of its predatory, parasitic or disease inducing habit.

Natural Reduction: Deaths or other losses to the population caused by naturally existing abiotic and biotic elements of the environment in a given period of time.

Natural Selection: An increase in the frequency of occurrence of some genes or gene combination and a decrease in the frequency of others because of the selective action of the environment. Natural selection results in a gradual change in a genetic combination of the population over a period of time. This gradual change may result in the population eventually taking on quite a different appearance or biological role and may even divide the population into subgroups, some of which can no longer interbreed.

Naturalized: Species introduced into a country from elsewhere and now are locally established and breeding normally.

Neck: The neck or cervix is a membranous region between the head and thorax, it gives freedom of movement to the head.

Necrophoresis: Transport of dead members of the colony away from the nest.

Necrosis: Localized death of living tissue, i.e. death of a certain area of a leaf or of a certain area of an organ; commonly a symptom of fungus, nematode, virus or bacterial infection; a symptom of disease or injury.

Nectar: Nectar is an aqueous fluid rich in the sugars and contains amino acids, proteins, lipids, ascorbic acid, and alkaloids. Nectar is highly attractive to flower visiting insects.

Nectar Guides: Series of markings on petals of flowers, aiding insects in finding nectar.

Nectariferous: Feeding on nectar.

Nectary: Gland from which nectar is produced; normally located within the flowers

but sometimes external to them. Nectaries are associated with the vascular phloem system of plants.

Negligible Residue: A tolerance set for a food or feed crop which contains a very small amount of pesticide at harvest as a result of indirect contact with a chemical.

Nematicide: A material often a soil fumigant used to control nematodes infesting roots of crop plants. Nematicides in commercial use are categorized into four groups, **1.** Halogenated aliphatic hydrocarbons (e.g., methyl bromide, ethylene dibromide); **2.** Methyl isothiocyanate precursor compounds (e.g., methamsodium, dazonet); **3.** Organophosphates (e.g., ethoprophos, thiomazin); and **4.** Carbamates (e.g., aldicarb, carbofuran). The first two groups are soil fumigants while the latter act as nemostats (the compounds that reduce movement of nematode as doses rise to lethal concentrations). In such cases only small amounts are required for control, and such amounts are usually non-toxic to plants. Hence they can be applied before sowing or even around the roots of the established plants. In contrast, soil fumigants need to be applied in large amounts in order to kill nematodes and their eggs in the soil. The nematicides like methyl bromide have the advantage that they also kill or inhibit soil fungi.

Nematode: A member of a phylum Nematoda. Nematodes are also known as threadworms, roundworms, eelworms etc. Nematodes range in size from 80µm (marine nematode) to 8m (on placenta of whales). Some larger kinds are internal parasites of man and other animals. Nematodes injurious to crop plants are slender, unsegmented, free living, microscopic worm-like organisms in soil. Most plant parasitic nematodes are less than 2mm long and possess a small, protrusible oral spear called a stylet, which is used to penetrate plant cells to obtain nutrition. Most plant parasitic nematodes are soil inhabitants and feed on roots but some species feed on stems and leaves, or even cause galls on flowers or fruits. Some cause abnormal host

growth such as the galling by root-knot nematodes. Nematodes enter into a variety of interactions with insects, including phoresy, parasitism, and pathogenesis, and are probably important natural regulators of insect populations. Most insect-associated nematodes are parasitic and in most instances do not directly cause death but rather result in protracted larval development, abnormal morphology (including wing shortening), and reduced fecundity. Nematodes seem to be the only possible natural enemy of flies and thrips infesting mushroom.

Necolassical Biological Control: The use of exotic natural enemies to control native pests.

Neonate: An insect that has only recently hatched.

Neonicotinoids: Are a new class of synthetic insecticides. Just as pyrethroids resemble the natural product pyrethrum, neonicotinoids are analogs of the natural product nicotine. Imidacloprid is an important compound of this class and is a systemic and contact insecticide primarily active against piercing and sucking insects such as aphids, thrips, leafhoppers and whiteflies. Its mode of action is quite different from other conventional insecticides, therefore, has potential for managing insects that have become insecticide resistant. This compound has low mammalian toxicity and generally has good environmental characteristics.

Neoptera: An infraclass of subclass **Pterygota**. A name sometimes given to all the more highly developed winged insects : those that can fold the wings back over the body and whose wing venation has a definite pattern other than a simple network. The group comprises all present day winged insects except the dragonflies and mayflies. Based on their modes of growth and development, neopterous insects are divided into two major divisions, **Exopterygota** and **Endopterygota**. In Endopterygota, wings and other presumptive adult structures develop as internal buds in the immature (larva), which usually differ from the adult in many features.

Neotenic: Retaining features of the immature stages in the adult.

Neotenin: A substance better known as juvenile hormone secreted by the corpus allatum of larval insects. It seems to maintain the juvenile characters of the larva after each moult. At a later stage, production of this hormone ceases and metamorphosis then takes place.

Neoteny: Retention of immature characteristics in the adult stage. For example the scale insects (Hemiptera : Coccoidea) appear to have neotenuous females. In males, a moult to the winged adult follows the final immature instar but the reproductive female involves omission of one or more instars relative to the male. In appearance the female is a sedentary larviform instar, resembling a larger version of the previous (second or third) instar in all but the presence of developing eggs. Neoteny also occurs in the order Strepsiptera.

Neotropical: Zoogeographical regions of the South and the Central America including the Caribbean Islands. It is characterized by having sloths, armadillos and anteaters.

Neotype: A specimen selected as type subsequent to the original description in cases wherein original types were destroyed or were suppressed by the commission.

Nephrocytes: Sometimes called pericardial cells. Nephrocytes are group of cells found in localized regions of the body. Nephrocytes generally occur near the dorsal vessel and appear to function as ductless glands. They take up foreign chemicals of relatively higher molecular weight from the haemocoel which can not be taken up by malpighian tubules.

Nereistoxin: Nereistoxin is a pesticide chemical derived from marine annelids, *Lumbrineris brevicirra* and *L.heteropoda*. Nereistoxin has systemic properties, stomach and contact action that lead to paralysis. Synthetic compounds like Cartap hydrochloride (Padan) is widely used against pests on rice, cotton and vegetable pests.

Nerve: The bundles of sensory and/or motor

axons that issue from the segmental ganglia are called nerves.

Nerve Fibre: An axon or dendrite with or without a sheath.

Nerve Poison: They are of three kinds :
1.Anticholinesterase compounds, such as organophosphatic and carbamate pesticides, which increase excitation of the nervous system; **2.**Compounds that affect the tonic permeability of nerve membranes such as DDT, chlordane and pyrethrins ; and **3.**Compounds that affect the nerve receptors or synaptic ganglia such as nicotine.

Nervous System: Insects have central nervous system, consisting of a ganglionic mass or brain, situated in the head, and a chain of ventrally placed ganglia, interconnected to form the **ventral nerve cord**. These ganglia form the main coordination centres of the body. They receive information directly from the sense organs, located on the associated segments of the body, and generate the motor impulses that flow outward to the appropriate muscles. The brain is divided into three major regions. The front part or protocerebrum which give rise to two large optic lobes. The middle portion or deutocerebrum, consists mainly of a pair of lobes that contains the sensory and motor pathways to and from the antennae. The base of the brain, or tritocerebrum, consists of a pair of lobes that lead into thick connectives, which extend around the oesophagus to the first ganglion, the suboesophageal ganglion which represents the united ganglia of three segments of the head. The main sensory and motor nerves that arise from this ganglion runs to the mandibles, the maxillae, and the labium and their muscles. Posterior to the suboesophageal ganglion are the segmentally arranged ganglia of the three thoracic segments and the first eight abdominal segments. Each thoracic ganglia typically gives off to each side five or six nerves, which innervate the sense organs and the muscles of the segment and its appendages. All of the abdominal ganglia except the last give off one or two pair

of nerves to the relatively simple sensory and muscular system of the abdominal segments. The last ganglion, representing the fused ganglion of the four terminal segments, gives off nerves to the muscles of these segments and to the reproductive organs and accessory structures.

Nervule: Branch or terminal portion of nervure of an insect wing.

Nervure: One of the 'veins' of an insect's wing; a chitinous tube usually containing a central trachea surrounded by haemolymph.

Nest Odour: The distinctive odour of a nest, by which its inhabitants are able to distinguish the nest from those belonging to other colonies or at least from the surrounding environment. In some cases the insects, e.g., honeybees and some ants, can orient toward the nest by means of the odour. It is possible that the nest odour is the same as the colony odour in some cases. The nest odour of honeybees is often referred to as the 'hive aura' or 'hive odour'.

Nest Parasitism: The relation found in some termites, in which colonies of one species live in the walls of the nests of a second host species and feed directly on the carton material of which they are constructed.

Net-Winged: Having membranous wings with numerous cross-veins as in Odonata, Ephemeroptera and Neuroptera.

Neurohormone: A hormone produced by the neurosecretory cells and released from a neurohemal organ into the haemolymph. Neurohormones constitute the third and largest class of insect hormones. They are generally peptides (small proteins) and hence have the alternative name 'neuropeptides'. These protein messengers are the master regulators of many aspects of insect development, homeostasis, metabolism and reproduction, including the secretion of JHs and ecdysteroids.

Neurone: A basic functional unit of the nervous system; an elongated, excitable cell that carries information. Motor (efferent) neurons, which carry impulses from the

central nervous system, are monopolar. Sensory (afferent) neurons are usually bipolar, and their cell bodies are adjacent to the sense organ. Internuncial neurons (interneurons), which transmit information from sensory to motor neurons or other interneurons, may be mono- or bipolar and their cell bodies occur in a ganglion. Neurons are not directly connected to each other or to the effector organ but are separated by a minute space, the synapse or neuromuscular junction respectively. Impulses may be transferred across the synapse either electrically or chemically. Neurons are aggregated into nerves and ganglia.

Neuropile: Central region of a ganglion consisting of the intermingling, synapsing axons encapsulated by glial cell processes.

Neuroptera: An insect order belonging to subdivision endopterygota. Possess conspicuous compound eyes. Antennae are generally short but often long and thread-like. Mouthparts biting type. Possess two pairs of uniform sized wings held roof-like over body at rest. Wing venation typically net-like. Main veins forked at wing margins. Metamorphosis is complete. They are worldwide in distribution. The larvae of all species are highly predacious.

Neurosecretory: Pertaining to the secretion of hormones by nerve cells. Neurosecretory cells are specialized glandular nerve cells which produce hormones and exert biological effect some distance away.

Neurotoxin: A poison which acts on the nervous system.

Neurotransmitters: Molecules, such as acetylcholine, that are secreted at the terminal arborizations of the neuron and that initiate an action potential via the dendrites or axon of other neuron.

New Name: A replacement of name for a preoccupied name.

Niche: The collection of requirement that must be satisfied in order for a species to survive and reproduce under natural conditions is described as a 'niche'. Thus a

niche includes both physical and biotic requirements, and its complexity varies with the environment in which a species finds itself. The more closely two species are related the more nearly identical will be their requirements, i.e. their niche, and the greater will be the degree of competition between them where they coexist. In the absence of competition, a species niche will be broader (less complex), i.e. a species requirements will be less stringent and form the so-called fundamental niche. Conversely, the niche occupied by a species that co-exists with others is known as the 'realized' niche.

Nidi: Groups of regenerative cells in the midgut.

Nidification: Phenomenon of nest building by the insects, not a common insect behaviour. Nidification is found in certain earwigs and a few burrowing cricket genera, but is widely found among both solitary and social Hymenoptera, Isoptera and Scarabaeinae.

Nit: The egg of a human louse which is glued firmly to the hair of host.

Nocturnal: Seeking food and moving about at night only. Most nocturnal insects require nonvisual cues for discrimination. In certain moths, the virgin female assumes a calling position and emits from near the tip of the abdomen specific sex attractant pheromones, which diffuse out into the environment. These pheromones are usually species specific and are detected by antennal receptors located on the male antennae as the insect flies cross-winged in a searching behaviour.

Node: Also known as nodus. In Hymenoptera, the knob-like segments at the base of the abdomen; in Odonata, a stout cross-vein near the middle of costal margin.

Nomadic Phase: The period in the activity cycle of an army ant colony during which the colony forages more actively for food and moves frequently from the bivouac site to another. At this time the queen does not lay eggs, and the bulk of the brood is in the larval stage.

Nomadism: The relatively frequent movement by an entire colony from one nest to another.

Nomen Conservandum: A name preserved by action of the commission and placed on the appropriate official list.

Nomen Dubium: The name of a nominal species for which the available evidence is insufficient to permit recognition of the zoological species to which it was applied.

Nomen Oblitum: A name losing its validity under the stature of the limitation.

Nomenclator: A book containing a list of scientific names assembled for nomenclatural, rather than taxonomic purposes.

Nomenclature: The making and giving distinguishing names for species of all groups of animals. The scientific names for organisms and for the higher taxa in which they are placed form a system of communication or language. The role of nomenclature is to provide labels for taxa at all level in order to facilitate communication among scientists and to provide universality in the scientific names of animals so that each name is unique and distinct.

Nominal Taxon: A named taxon, objectively defined by its type (e.g., species, genus).

Nominalism: A school of philosophy, denying the existence of universals and emphasizing the importance of man given names for the grouping of individuals.

Nominate: A subordinate taxon (subspecies, subgenus, etc.) which contains the type of the subdivided higher taxon and bears the same name.

Nondimensional Species: The species concept, represented by the noninterbreeding of species at a given place and time.

Noninclusion Virus: Insect viruses that occur free in tissues as viruses do in animals and plants; the viruses are not included in crystals, granules, or other inclusion bodies, as yet only a small number of these viruses have been found in insects. These viruses are

found in larval Diptera, Lepidoptera, Coleoptera, and in larval and adult Hymenoptera.

Nonionic Surfactant: A surfactant that does not ionize in solution and is, therefore, compatible with both anionic and cationic surfactants.

Nonionic Wetting Agent: Wetting agent that is not dissociated into ions, and is chemically inert.

Non-Persistent Insecticide: Insecticides which when applied lasts only for a week or less. These pesticides may disappear as they are broken down by light or microorganisms or they may evaporate.

Non-Persistent Viruses: Also known as stylet-borne viruses. These viruses are picked up in seconds and transmitted in seconds. For example, chilli mosaic virus transmitted by *Aphis gossypii* is a non-persistent virus. Stylet-borne viruses are lost soon they are picked up. Aphids mainly serve as vectors of stylet-borne viruses. Many of the viruses transmitted by aphids occur in high concentration in host plant epidermis so are readily picked up when the aphids probe the tissue with their mouthparts. Some aphids like *Myzus persicae*, transmit many kinds of stylet-borne viruses, whereas others are quite specific as to the viruses they transmit.

Non-Preference: A mechanism of plant resistance to pests whereby the pest chooses not to feed (or oviposit) on the resistant plant in comparison with susceptible ones. This may be caused by modifications in the substances that attract the pests, lack of or modified substances used by the pest as a feeding stimulant, by the use of repellants, or by changes in the interaction between the factors given above. A cline exists between strong resistance and susceptibility.

Non-Selective: A chemical that is generally toxic to plants or animals without regard to species. A non-selective pesticide may kill or harm all insects including beneficials.

Non-Target Organism: Any organism other

than that against which control measures especially chemicals are applied.

Nontoxic: An economic poison with an LD₅₀ greater than 5,000 mg/kg. Not poisonous to humans.

Non-Volatile: A compound is said to be non-volatile if it does not evaporate at ordinary temperature or exposure to the air.

Notal Wing Process: The pterothoracic nota are each divided into a wing bearing sclerite, 'alinetum' and a phragma bearing sclerite, 'postnotum'. The lateral edges of the alinetum are modified for the articulation of the wings. At each wing base are anterior and posterior notal wing processes.

No-Till: Growing crops without tillage.

Notonectal: Swimming on the back, as for instance the water boatmen (Hemiptera : Notonectidae).

Notopleural Bristles: Bristles on the notopleuron (Diptera).

Notopleural Suture: A groove between the notum and the pleural sclerites (e.g., Diptera).

Notopleuron: In flies (Diptera), the dorsal area on the thorax of the lateral end of the transverse suture.

Notoptera: An alternative name for the orders of primitive insects, also known as Grylloblattodea.

Notum: The dorsal surfaces of a body segment of thorax are called 'nota' to distinguish them from the abdominal terga. They are known as 'pronotum', 'mesonotum' and 'metanotum' according to their positions. Notum is usually divided into an anterior wing-bearing 'alinetum' and the posterior 'postnotum'.

Nozzle: Device which control drop size, rate, uniformity, thoroughness and safety of a pesticide. They may be of different types :

1.Air blast : Nozzle using high velocity air to break up the spray liquid supplied at low pressure; **2.Anvil:** Nozzle in which the spray liquid jet strikes a smooth, solid surface at a high angle of incidence; **3.Cone (or swirl):**

Nozzle in which the liquid emerges from the orifice with tangential velocity imparted by passage through one or more tangential or helical channels in the swirl chamber;

4.Hollow cone : Nozzle in which spray jet has a core of air breaking to give drops in an annular pattern ; **5.Fan nozzle :** The aperture is an elongate horizontal slit, producing a fan-shaped spray pattern, and **6.Deflector :** Nozzle in which a fanshaped sheet of spray is formed by directing the liquid over a sharply inwardly curving surface.

Nuclear Polyhedrosis Viruses: Also known as nucleopolyhedrosis. The virions consist of an enveloped nucleocapsid that contains a DNA genome in the form of a double-stranded circular molecule typically of about 130 Kb. The occlusion bodies are commonly referred to as polyhedra as they are typically polyhedral in shape. Polyhedra are large (usually ca. 0.5-2 µm) and form in the nuclei, where each occludes as many as several hundred virions. NPVs are easily transmitted per os and replicate in the nuclei of cells, causing an acute fatal disease. Most of the nuclear polyhedrosis viruses (NPVs) have been found in the caterpillars and the larvae of sawflies. They affect the epidermis, fat body and blood cells. Virus particles may infect the host through the mouth or the cuticle or be passed from one generation to the next within the egg. Once the NPVs start to multiply in the host larval tissue, larvae become sluggish but often crawl to high branch tips where they die hanging by the prolegs at the tip of the abdomen. At this stage, the larval skin becomes fragile and ruptures easily, releasing a shower of virus particles onto the foliage below.

Nucleus: The spheroid body within a cell that has the major role in controlling and regulating the cell's activities and contains the hereditary units or genes.

Nudum: Small bared area, as sensitive portion of antennae of butterflies.

Nulliparous: Describing a female that has laid no eggs.

Numerical Response: Population change among the predators and parasitoids in response to changes in the availability of food. The presence of more prey increases food availability, nutrition, and reproductive rate among predators and parasitoids.

Nuptial Flight: Also called mating flight. In Isoptera and Hymenoptera, the dispersal flight of sexual forms.

Nurse Cells: Polytrophic ovarioles have nutritive cells known as nurse cells or

trophocytes. Nurse cells are located in the ovarian tubes and furnish nutriment to the developing eggs. They are found in Neuroptera, Lepidoptera, some Coleoptera, Diptera and Hymenoptera.

Nurses: Young worker bees whose chief occupation is the feeding of the larvae.

Nygma: In Neuroptera, Trichoptera and some Hymenoptera—a small sensory organ, sometimes present in the radial or medial portion of the wing membrane.

Obligate Parasite: A parasite which is obliged to follow a parasitic mode of life and which can not exist in any other way.

Obligatory Diapause: Insect species in which diapause occurs in every generation regardless of environmental conditions. This form of development arrest is usually controlled by photoperiod. Species that exhibit obligatory diapause have only one generation per year (i.e., they are univoltine). But species that enter into facultative diapause complete two or more generations per year (i.e. they are bivoltine, trivoltine, etc.).

Oblongum: In Coleoptera, a closed cell in the median part of the wing.

Obtect Pupa: The type of pupa or chrysalis found in most butterflies and moths in which the wings and appendages are closely appressed to the body and most of the abdominal segments are immovable.

Occasional Pest: An insect species which reaches significant levels only occasionally and sporadically exceed the economic injury level; a pest with a general equilibrium position substantially below the economic injury level.

Occipital Arch: Area of the cranium between the occipital and postoccipital sutures, dorsal part is known as 'occipital proper' and its lateral parts are called 'postgenae'.

Occipital Foramen: Opening in the back of an insect's head through which the oesophagus, nerve cord etc. enter the thorax.

Occipital Sulcus: A transverse suture in the posterior part of the head which separates the vertex from the occiput dorsally, and the genae from the postgenae laterally. This is commonly found in orthopteroid orders.

Occiput: Posterior part of the head capsule, defined by an anterior occipital suture and a posterior postoccipital suture.

Ocluded Virus: A virus that produces a dense protein crystal, polyhedral in shape, and containing virions. This virions containing structure is called a polyhedral occlusion body (PIB). PIBs are large enough to be visible with a light microscope.

Oclusion Body: Proteinous body (polyhedron, capsule etc.) in which the virions of the same virus groups are embedded; the virus particles are thus 'occluded'. Sometimes referred to in more general terms 'inclusion body'.

Ocular Sulci: The grooves indicating internal cuticular ridges bracing the compound eyes.

Ocult Virus: A special phase of some viruses, characteristic of latent infections, in which the pathogenic agent is presumed to differ from the infective phase, and in which virions can not be detected.

Oceanic Insects: Oceans are largest aquatic habitat, but few insects have successfully utilized this resource; and of those that have nearly all are surface dwellers. Only five species of water striders mainly *Halobates* spp., live in open water, and these wingless

gerrids have been found great distances from land and feed on wind-blown insects. Other truly marine insects included mainly hemipteran species in the families Veliidae, Mesoveliidae, and Hermatobatidae, all of which are also surface inhabitants but are located near shore in estuaries or rock pools.

Ocellar Triange: A somewhat raised triangular area on the head that encloses the ocelli (e.g., Diptera).

Ocellus: One of the three simple eyes of adult insects and some insect larvae located on or near the centre line of the dorsal surface of the head. It consists of a few sensory cells and one cuticular lens. Ocelli of adults are dorsal but in larvae they are lateral in position.

Odonata: An order of pterygote insects. Representatives are commonly known as dragonflies and damselflies. Their head is large and very mobile, have downwardly projecting mouthparts, possess short hair-like antennae. Very large compound eyes and three ocelli are found. They have incomplete metamorphosis, adults possess two pairs of almost uniform sized wings. They are often brightly coloured. Dragonflies are accomplished fliers and prey on a variety of insects while in flight; damselflies tend to fly poorly. Nymphs are aquatic and predaceous in habit. Commonly seen near or over water and are worldwide in distribution.

Odour Trail: A chemical trace laid down by one insect and followed by another. The odorous material is referred to either as the trail pheromone or the trail substance.

Oenocytes: Large cells present in various parts of the bodies of insects. They are usually amber, but may be of other colours, or colourless. Oenocytes usually reside between the basement membrane and the epidermal cells, they appear to synthesize wax. Oenocytes secrete the lipoprotein of procuticle and the epicuticle, and probably are involved in the synthesis of wax.

Oenocytoids: Oenocytoids are spherical or ovoid cells with one, occasionally two, relatively small, eccentric nuclei. They

resemble oenocytes and are almost never phagocytic. The oenocytoids are fragile cells that easily lyse.

Oesophageal Ganglia: A pair of small ganglia behind the main parts of an insect's brain and joined to it by thin connecting nerves. They rest upon the dorsal surface of the oesophagus, are closely connected with the 'corpora allata' and form part of the visceral or sympathetic system.

Oesophagus: It is an undifferentiated part of the foregut serving to pass food back from the pharynx to the crop. The oesophagus is usually narrow but may be dilated posteriorly to form the crop where food is stored. Posteriorly the foregut is invaginated slightly into the midgut to form oesophageal (stomodeal) invagination. Its function is to ensure that food enters the midgut within the peritrophic membrane, and also seems to assist in moulding the peritrophic membrane into correct shape in some insects.

Oil Immersion (Objective): A high magnification (x90-100) microscope objective lens that functions only when a film of immersion oil unites it to the material to be examined on the microscope slide.

Oil Solution: A type of pesticide formulation. Oil solutions are formulated by dissolving the insecticide in an organic solvent or for direct use in insect control. They are rarely used on crops because they can cause severe burning of foliage. They are used effectively on livestock, as weed sprays along roadsides, in the standing pools for mosquito larvae control, and in the fogging machines for adult mosquito control. Concentrated solutions may be diluted with kerosene or diesel oil before application.

Oils: Refers to aromatic paraffinic oils used as diluents in formulating the products or carriers of pesticides or for direct use.

Olfaction: The sense of smell. Chemoreceptor that perceive chemicals in a gaseous state in relatively low concentrations (usually referred to as smell, or olfaction), normally have a large number of sensory

neurons. Each neuron responds to a range of compounds or some special compound of importance. The olfactory receptors enable the insect to detect chemical in the air at some distance away from their source. The olfactory receptors are more commonly found on the antennae but are also found in large numbers on the mouthparts, particularly on palps.

Olfactory Pits: Small pits on the antennae and palps of insects, containing a number of hair like receptors and nerve connections by which the insect perceive smell.

Olfactory Sense: The sense of smell in insects is stimulated by low concentrations of the vapour phase of a great variety of substances which are relatively volatile at ordinary temperatures. The olfactory receptors are trichoid, basiconic, coeloconic and placoid sensilla which are usually provided with cuticular pores. Chemoreceptors of various kinds are generally distributed over the antennae but are sometimes also on the palps. It has been estimated that each antennae of a drone bee may have as many as 30,000 such receptors. Sometimes, in houseflies and related flies, there are definite olfactory organs each consisting of a small pit with a number of hair-like cells connected to the nerve endings. The antennae may be held out in a particular direction when the insect is flying so that these pits are exposed to airflow and the maximum sense of smell is achieved.

Oligogenic Resistance: Also called major-gene resistance. Host plant resistance conferred by one or a few genes.

Oligogyny: The occurrence in a single colony of two to several functional queens. A special case of polygyny.

Oligolectic: In Hymenoptera, especially wild bees visiting restricted range of plants for pollen or nectar. For example certain species of *Andrena* (Andrenidae) collect the pollen only from the night blooming, *Oenothera* spp. (Onagraceae).

Oligoneoptera: A group name used in some

systems of classification to denote insects with a substantial degree of reduction in the number of veins in the wings. The insect orders of this group are usually classed as Holometabola or Endopterygota.

Oligophagous: Feeding on a limited range of plants, usually within a single family. For example, cabbage worms feed on plants related to cabbage (Cruciferae) and tobacco worm prefers various solanaceous crops but prefer tobacco or tomato. Oligophagous / monophagous herbivores show a preference for unpredictable resources such as younger leaf tissues that are often protected by toxins. Such insects often have detoxification systems that can cope with these specific defences.

Oligopneustic: A type of hemipneustic respiratory system, having a reduced number of spiracles. Found in Diptera specialized for life in water or liquid medium.

Oligopod Larva: A larva with well-developed thoracic legs but without abdominal appendages. They are of two types, **1.Campodeiform larvae**-which are usually active predators, and **2.Scarabaeiform larvae**-which are grub-like, with a very swollen soft abdomen. Carabiform, elateriform and platyform larvae also are oligopod type and lack abdominal appendages.

Ommatidia: Individual functional unit of the compound eye of an insect. Each ommatidium is a cone-shaped structure consisting of a cuticular lens, a crystalline cone and retinulae or sensitive cells at the base. The whole eye is roughly hemispherical with all the ommatidia converging inwards towards the optic nerve. The corneal lens and crystalline cone of each ommatidium focus light onto the distal tip of the rhabdome from a region about 2-5 degrees across.

Ommochrome Pigments: Red, brown, or yellow pigments which give the characteristic eye colours of many insects but are sometimes also found in other parts of the body; derivative of the amino acid, tryptophane.

Omnivorous: Insects eating plants or animals whether they are dead or alive. Generally cockroaches are omnivorous in nature.

Onchocerciasis: Infection with filarial nematodes (*Onchocerca* sp.) The adults live and reproduce in subcutaneous fibroid nodules; the young, called microfilariae, are carried by the lymph and found chiefly in the skin and eyes; transmitted by certain black flies.

Oncogenicity: Property of a substance which produces or induces either benign or malignant tumours in living animals. Main purpose of this study is to examine whether the substance has potential to cause carcinogenicity.

Onisciform Larva: A flattened platyform larvae like that of a wood louse.

Ontogeny: The developmental history of an individual organism from egg to adult.

Onychium: A term applied to a variety of hook-like or pad-like structures associated with the feet of insects.

Oocytes: The egg cells within an ovariole. Oocytes rapidly increase in size as protein, carbohydrate and lipid yolk bodies are formed by vitellogenesis. This process is under endocrine control, often by corpora allata. The nutrients that make up the yolk are derived from food eaten and stored in the fat body during the immature instars. Within the germarium, oogonia derived from primary germ cells, give rise to oocytes. As oocytes mature and enter the vitellarium, they tend in some insects arranged in a linear sequence along the ovariole.

Oogenesis: Formation, development and maturation of the female gamete or ovum. The ovariole is essentially a tube and is divided along its length into the 'germarium', 'vitellarium', and 'pedicel'. In the germarium are the oogonia and by mitotic divisions of the oogonia, the oocytes are produced and these pass in the vitellarium. Each oocyte is surrounded by follicular cells, forming a cyst like follicle. Within the follicle, the yolk is deposited in the oocyte during vitellogenesis and the chorion is added.

Oogonia: The first stage in the development in the germarium of an egg from a female germ

cell. Oogonia are located in the terminal region of ovary. They enlarge into primary oocytes as they move down the ovariole and as they receive yolk from the follicular epithelium (panoistic ovarioles) or from special nurse or nutritive cells (meroistic ovarioles). Enlargement of the descending oocyte produces a distension of the ovariole into the follicle. After leaving the ovariole, eggs are often stored in the calyx, particularly in insects that deposit large numbers of eggs at a single laying. The egg 'oocyte' at this stage, is then moved by peristalsis down the lateral oviduct and the median oviduct to the spermathecal duct pore when sperms are released and penetrate the micropyle. The sperm entry initiates oogenesis. Once the sperm has penetrated, the egg is moved down the genital tract and is coated with various materials from the accessory glands (when present) for sticking the egg to a particular substrate, oviposition then occurs.

Oophagy: Also known as egg cannibalism. In social Hymenoptera, the eating by a colony member of its own eggs or those laid by a nestmate is known as oophagy.

Ootheca: In majority of the insects the eggs are simply glued onto, or inserted into the substratum. But a number of species lay their eggs in ootheca formed by the secretions of the female accessory glands (colleterial glands). Characteristic ootheca are produced by cockroaches (Blattodea). Ootheca is a protective covering which may prevent an egg mass from desiccation and/or parasitism. Ootheca are also sometimes named as 'egg purse'. Oothecae of cockroaches are leathery or horny in which 15-40 eggs are enclosed, glued together by a secretion. Ootheca are often seen protruding from a female's genital chamber prior to deposition. Mantids lay their eggs in a mass of frothy material that hardens to form an ootheca which is attached to an object some distance from the ground.

Open Cell: A wing cell that extends to the wing margin, may not be entirely surrounded by wing veins.

Open Coxal Cavity: Front coxal cavity surrounded posteriorly by the mesosternum; middle coxal cavity touched by lateral (pleural) portions of the mesothorax.

Open Tracheal System: A gas exchange system comprising tracheae and tracheoles and with spiracular contact with the atmosphere.

Operating Speed: The constant rate at which a pesticide sprayer moves during application; usually measured in kilometres per hour or metres per minute.

Operculum: A cover or lid, usually circular in case of eggs of body louse (Mallophaga).

Opisthognathous: Having the mouthparts directed posteroventrally; having retreating jaws. Found both in Heteroptera and Homoptera.

Opisthosoma: The hind body region of acarines (spiders, mites, ticks). In mites, the region of metapodosoma and opisthosoma is collectively known as hysterosoma.

Optic Lobes: Lateral extensions of the protocerebrum of an insect innervating the compound eyes and ocelli; they form the largest part of an insect's brain and are situated immediately above the oesophagus.

Opticon: The inner zone, or internal medullary mass of the optic lobes.

Oral: Pertaining to the mouth.

Oral Toxicity: Toxicity of a compound when given by mouth. Usually expressed as number of milligrams of chemical per kilogram of body weight of animal when given orally in the single dose that kills 50% of the animals. The smaller the number, the greater the toxicity.

Oral Vibrissae: In Diptera, a pair of stout bristles arising laterally near the oral region.

Order: A subdivision of a class or subclass, composed of a group or groups of related families.

Ordinal: In chaetotaxy studies, it refers to the length or arrangement of the tip ends of crochets.

Organ: Any part/structure of an organism adapted for a special function(s).

Organelles: Organized microstructures inside the cells to which certain biochemical processes are confined (e.g., mitochondria).

Organic Compounds: A very large group of chemical compounds that contain carbon.

Organic Farming: A means of food production which discourages use of the organic fertilizers and the plant protection chemicals. Pest control within organic production systems is largely based upon the cultural techniques of crop rotation, host-plant resistance and various agronomic practices that are designed to improve plant health. Biorational insecticides such as neem and rotenone are permitted for use in organic production systems. Fine meshes and polyester sheets are used to protect plants from whitefly attack.

Organic Matter: Plant or animal debris or remains found in soil in all stages of decay. The major elements in organic matter are oxygen, hydrogen and carbon.

Organism: Anything capable of carrying on life processes.

Organochlorine: Alternatively known as chlorinated hydrocarbon. A group name applied to insecticides in which chlorine forms an important part of the molecule. Their high efficacy as both contact and stomach poisons and their inexpensiveness had made them initially most widely used of all pesticides. They are broad-spectrum, highly persistent, and are most effective against biting and chewing insects. DDT, BHC and lindane are common examples of organochlorine insecticides.

Organophosphate: A group name applied to insecticides which have a phosphorous atom at the core of the molecule. The organophosphates form the largest and most versatile group of insecticides and acaricides. They can be used as contact poisons, stomach poisons, and fumigants. Several are excellent plant systemics and provide a high level of

protection against aphids, leaf-miners, spider mites, scales and other sap feeders (e.g., diazinon, disulfoton, dimethoate). They are less persistent than the organochlorines and their timing of applications has to be more accurate. The organophosphates combine with the enzyme acetylcholinesterase at nerve junction and prevent transmission of nerve impulses. Some are highly selective while others have an extremely high mammalian toxicity and needs handling with care.

Organothiocyanates: Synthetic organic insecticides, that have rapid knockdown effects against the household insects. Lethane 384 and Thanite have been marketed as pesticides. These compounds have a rapid paralytic action on insects.

Organotins: A classification of miticides containing tin as the nucleus of the molecule. Cyhexatin (Plictran®), and fenbutatin-oxide (Torque®) are the common organotin compounds effective against mites on citrus, deciduous fruits, and ornamentals, as well as in greenhouses.

Origenesis Flight Syndrome: Migration is a distinct behavioural and physiological syndrome closely intertwined with reproductive timing and strategy. Most migration takes place prior to egg development, and while the development of flight system is maximized, that of the reproductive system is minimized—a phenomenon that results in migration occurring chiefly in young female adults. This theory has been termed as ‘oogenesis flight syndrome’.

Oribatid Mite: Also known as beetle mites. They belong to the suborder Oribatida (Order Acariformes). They are soil and humus dwelling, have minor importance as intermediate hosts of certain tapeworms of domestic animals. Oribatid mites are the free living, dark coloured mites with a rigid exoskeleton from which the popular name of beetle mite is derived.

Oriental: Far East; zoogeographical region including India through South East Asia, to South China.

Orientation: In describing the relative position of various parts of an insect, several sets of terms are used to indicate direction or position. Certain regions of the body are used as a basis for orientation, chiefly the following:

1. Anterior : The portion of the body bearing the head; or that portion of any part that is toward the head end ; **2. Posterior :** The portion of the body bearing the cauda or ‘tail-end’ of the abdomen or that portion of any part that is toward the posterior end ; **3. Dorsum :** The top or upper side of the body or one of its parts ; **4. Venter :** The underside or lower side of the body or one of its parts ; **5. Meson :** The longitudinal centre line of the body, projected on either the dorsal or ventral aspects, or any point in between ; **6. Lateral :** The side portion of the body or one of its parts ; and **7. Base, Apex :** In referring appendages or outgrowths of the body, such as antennae or legs, the point or area of attachment is called the **base**; the tip or furthestmost point from the attachment is called the **apex**.

Orifice: The opening or hole in a nozzle through which liquid material is forced out and broken up into a spray.

Orifice Velocity: Velocity at which the spray leaves the nozzle orifice.

Original Container: The package (can, bag bottle, etc.) in which a company sells a pesticide chemical. A package with a label telling what the pesticide is and how to use it correctly and safely, is pasted on the container and an additional leaflet giving more information regarding use and safety is also provided with the container.

Original Description: A statement of characters accompanying the proposal of a name for a new taxon.

Orthognathous: Having straight jaws; having axis of head at right angles to the body.

Orthokinesis: This is an activity response to a stimulus. For example, day time active insects will often remain motionless in the dark. But if the light intensity is gradually increased, a point is reached at which the insect starts to move.

Orthoptera: An exopterygote order of insects. Commonly known as katydids, locusts, grasshoppers and crickets. Elongate, compound eyes well developed, with downward pointing biting mouthparts. Pronotum enlarged, saddle or shield-shaped. Front wings toughened often narrower than hind wings. Hind wings are larger, folded in longitudinal pleats. Some species are wingless. Hind legs are large and modified for jumping. Abdomen with a pair of short cerci. Metamorphosis is incomplete. Most of the representatives are phytophagous and many are known as economic pests of crops but some katydids are predators. They have worldwide distribution but mostly found in warm regions.

Orthopterist: An entomologist who specializes in the study of orthopteroid insects.

Orthopteroid Orders: A group of exopterygote orders (Phasmida, Orthoptera, Dermaptera, Grylloblattodea, Isoptera, Blattaria, Mantodea and Zoraptera), external genital appendages in males, presence of abdominal styli on ninth abdominal segment of males in many cases, vannus of hind wings forming pleats when folded and fore wings leathery or sometimes sclerotized.

Oscillations: Regular cyclic population changes which are the consequence of delayed density dependant factors, and have peaks in the generative curve which are five or more generations apart.

Oscillogram: An instrument that shows volume of sound; the greater the deflection/amplitude of the tracing above and below the abscissa baseline, the louder the sound.

Osmetrium: A usually Y-shaped eversible glandular structure located behind the head in butterfly larvae of Papilionidae. It secretes a repugnatorial fluid, which is an efficient defence mechanism.

Osmoregulation: Regulation of the salt and water concentration in cells and organisms. System responsible for excretion and osmoregulation is referred to loosely as the

excretory system, and its activities are performed largely by malpighian tubules and hindgut. In freshwater insects, haemolymph composition must be regulated in response to constant loss of salts (as ions) to the surrounding water, and ionic regulation involves both the typical excretory system and special cells, called chloride cells, which are usually associated with hindgut. Chloride cells are capable of absorbing inorganic ions from very dilute solutions and are commonly found in dragonflies and damselflies.

Osmosis: Transfer of materials that takes place through a semipermeable membrane which separates two solutions, or between a solvent and a solution that tends to equalize their concentrations. The walls of living cells are semipermeable membranes and much of the activity of the cells depends on osmosis.

Osmotic Pressure: The maximum pressure which can be developed in a solution which is separated from pure water by a rigid membrane permeable only to water.

Ostia: Valvular openings on the side of the heart through which the blood enters and is pumped forward, either by peristaltic contraction or by a single uniform contraction of the entire heart, through the aorta to beneath the brain where it flows out into the haemocoel. The heart may be constricted between the successive ostia, giving it a chambered appearance but its lumen is nearly continuous throughout.

Ostiole: External opening of the stink gland in Hemiptera and Homoptera.

Outbreaks: Those occasions when a species population can escape from predator-prey cycle for a short time. In such cases the prey population expands more rapidly than the predator population and reaches a threshold level beyond which the predator population growth can not keep it in check. The prey species reaches outbreak or epidemic proportions, and eat nearly all its available food resources. At this level of population density, the carrying capacity of the prey population's food source is the limiting factor.

Ovarian Cycle: The length of time between successive ovipositions.

Ovariole: One of the egg tubes which collectively form the ovary. Ovarioles are mainly of two types, (i) **Panoistic** : in which there are no specialized nurse cells. They are found in Entognatha, Apterygota, most Orthopteroidea and Thysanoptera; and (ii) **Meroistic** : which have nurse cells or trophocytes, distinct from oocytes or egg cells. Meroistic ovarioles may be, 'telotrophic' in which all trophocytes are gathered at one end, and 'polytrophic' in which each of the oocyte has its own nurse cells. Polytrophic ovarioles are found in the exopterygotes (Phthiraptera, Dermaptera, Psocoptera), and in most of the endopterygotes except Siphonaptera and Coleoptera (Adephaga). Telotrophic ovarioles are found in Hemiptera and Coleoptera (Polyphaga).

Ovary: The ovaries are usually found dorsolateral to the gut in the body cavity of the female insects. Each ovary comprises of tubular branches known as 'ovarioles' in which eggs are produced. Ovarioles are ensheathed by network of connective tissue in which numerous tracheoles and muscles are embedded. Ovarioles are grouped together loosely and are held in position by a terminal ligament. The number of ovarioles per ovary, though approximately are constant within a species, varies widely among species. For example in some viviparous aphids and in dung beetles (Coprinae) there is only one ovariole per ovary in contrast to more than 2000 ovarioles per ovary in some higher termite queens. There are only 8 ovarioles in each ovary of a cockroach while queen bee ovary may have more than 200 ovarioles. Generally fertilization takes place after an egg leave the ovary. The egg passes down the lateral oviduct and enters the common oviduct. As it passes the duct of sperm storage organ or spermatheca, fertilization takes place. In some insects the release of spermatozoa for fertilization can be controlled by the female. For example in the honeybee, unfertilized eggs

develop into drones, and fertilized eggs develop into workers or queens.

Ovicide: Toxicant very effective against insect or mite eggs. Tetradifon (Tedion®) is an excellent example of ovicide effective against mite eggs.

Oviduct: The duct leading from the ovary through which the eggs pass. Two oviducts join to form a median oviduct which in primitive insects has an opening (gonopore) in the 8th abdominal segment, however, in Dermaptera it opens in seventh abdominal segment. In most of the present day insects this original aperture is closed and oviduct becomes connected to a wider duct or vagina with an opening in the 9th abdominal segment. Accessory or colleterial glands open into the vagina.

Oviparae: In aphids, the oviparous females.

Oviparity: The majority of the insects undergo the type of reproduction in which an egg is produced, fertilized, and oviposited by the female. Eggs are normally deposited in the precise microhabitats, near or on the required food. Sufficient yolk is present to permit embryology to be completed within the egg.

Oviparous: Producing eggs that hatch outside the body of the female. Eggs are surrounded by an egg shell or chorion. Depending on the species involved, the chorion ranges from very thin and delicate to very hard and thick, and the developmental stage of the insect within it varies from being in early cleavage to being ready to hatch as an active free living individual.

Oviposition: Act of depositing or laying eggs by female insect is known as oviposition. Insects differ tremendously in egg laying habits. The phasmids (walking-stick insects) drop their eggs singly onto the ground; butterflies glue their eggs to leaves; sawflies and some crickets saw out a cavity in leaf or stem forming a recess for each egg. The eggs may be laid separately, or they may be grouped together in large masses. Eggs are generally coated with the secretion of the

accessory glands which may serve to glue them to the surface. In cockroaches the eggs are glued together as they emerge from the body and are cemented by glandular secretions, forming a compact capsule or **ootheca** which is deposited. In most instances at least two responses are necessary for oviposition. The first involves only general discrimination as to an area, shape of plant, or animal. The second response requires specific sensory conditions in order to initiate the behaviour needed for egg deposition. Chemoreceptors and tactile receptors on the tarsi and ovipositor, tasting the substrate by the mouthparts, and other senses are employed for selecting the surfaces for egg laying.

Ovipositor: Also known as external genitalia—the organs concerned with mating and the deposition of eggs. In higher insects these organs may be largely internal. The form of the components of external genitalia of insects are very diverse and often have considerable taxonomic value. Most female insects have an egg-laying tube, or ovipositor. It is absent in Isoptera, Phthiraptera, many Plecoptera and most Ephemeroptera. Ovipositors take two forms, i) True or appendicular - formed from appendages of abdominal segments 8 and 9. They are found in most Archeognatha, Thysanura, many Odonata, Orthoptera, some Hemiptera, some Thysanoptera and Hymenoptera. In some Hymenoptera, ovipositor is modified as a poison injecting sting and the eggs are ejected at the base of the sting; ii) Substitutional - composed of extensible posterior abdominal segments. This is found in most Lepidoptera, Coleoptera and Diptera.

Ovipositor Valves: External parts of ovipositor used in digging. The postgenital segments include the 10th and when present, the 11th abdominal segment. In the lower orders where both postgenital segments are present, the 10th segment is usually united

with the 9th or 11th segments and it never bears appendages. The 11th segment comprises a somewhat triangular tergal plate, the ‘epiproct’, and a pair of venterolateral plates, the ‘paraprocts’. It bears appendages, the ‘cerci’, inserted in the membranous area between the 10th and 11th segments on each side of the body.

Ovoviviparity: Many species retain the eggs in the genital tracts until the larvae are ready to hatch, and the hatching occurring just before or as the eggs are laid. All the nourishment for the embryo is present in the egg and no special nutritional structures are developed. Viviparity of this sort is called ovoviviparity and it differs from normal viviparity only in the retention of the eggs. This is found in flesh flies, cockroaches (Blattidae), some aphids and scale insects (Hemiptera), a few beetles (Coleoptera) and thrips (Thysanoptera), and some flies (Calliphoridae and Tachinidae).

Ovulation: The passage of the oocyte into the oviduct is known as ovulation, it involves escaping from the follicular epithelium and the breakdown of the epithelial plug at the entrance to the pedicel. Ovulation may or may not be well separated in time from the actual process of egg laying (oviposition). In most of the insects, especially those that lay their eggs singly, oviposition immediately follows ovulation. But in insects that deposit eggs in batches or are viviparous the two events may occur several days apart. For example in locust, *Schistocerca gregaria*, the eggs accumulate in the lateral oviduct for a week prior to being laid. Ovulation is induced by a neurosecretory factor from the brain.

Ovum: A female gamete.

Oxidation: To combine with oxygen. The oxidation is accompanied by the release of energy; it is very common process in nature (burning, rusting, putrefaction, etc.).

Paedogenesis: Reproduction by the juveniles. This is an unusual form of parthenogenesis, occurring chiefly in the gall midges (Cecidomyiidae), in which the larvae or rarely the pupae give birth to living young. Other insects speed up reproduction by depositing their young in an advanced stage of development. This occurs chiefly in the parasitic Diptera. The fully grown larva or puparia are deposited by adults of these species. Paedogenesis is usually associated with both the parthenogenesis and viviparity. This phenomenon occurs apparently as a result of hormone imbalance and is often associated with generation cycles. This strange means of reproduction seems to be rather good way to exploit favourable food conditions without wasting energy on the development of winged adults, unless needed.

Palaerctic: Zoogeographical region of the Holarctic, including Europe, Asia and the Himalayas and the fringe of North Africa.

Palaeoptera: An infraclass of subclass Pterygota. A group of insects comprising the two orders, Ephemeroptera and Odonata both of which have primitive wing venation. In these insects the wings can not be flexed over the back at rest.

Palaeontology: The science that deals with the study of fossils (=the remains of animals or plants in rocks), serves as a guide to the history of life on earth.

Palaeopterous: Having a flight mechanism involving direct musculature and lacking the ability to flex the wings over the back at rest.

Palaeodictyoptera: Prime insects of the carboniferous period having resemblance of dragonflies but having a pair of short wing-like appendages on most of the segments of the body. Possibly in the first place these helped the insect to glide and at a later stage two pairs became greatly enlarged to form true wings. The Palaeodictyoptera showed variation in size (with wingspans up to 56 cm), and in morphology notably in mouthparts, wing articulation and venation. This diversified order became extinct at the end of Permian.

Palp: Paired appendage of second segment, with prehensile and/or sensory function. The maximum number of palpal segments in mites is six (trochanter, femur genu, tibia, tarsus, apotele). A free palpal coxa is not known from mites. A papal apotele is known from all groups of Anactinotrichida, except Ixodida; it is unknown from the Actinotrichida. The number of palpal segments can be reduced by union or integration, or suppression of segments.

Palpi: Sensory feeler in the mouthparts of insects. There are usually two pairs of palps, one pair (maxillary palps) attached to the maxilla, and the second pair (labial palps) attached to the labium. These are used in the feeding process. Both labial and maxillary palpi are sensory in function and are equipped with a variety of mechano- and chemosensilla.

Palpifer: Small lobe/sclerite articulated to the stipes which bears maxillary palpus. Palpifer serves as a sensory organ to distinguish food.

Pandemic: Cosmopolitan, very widely distributed.

Panicle: Branching inflorescence made up of a group of spikelets.

Pantropical: A species occurring widely throughout the tropical and the subtropical parts of the world.

Papilla: Small, raised, finger-like process usually of minute size.

Parabiosis: The utilization of the same nest and sometimes even the same odour trails by colonies of different species, which nevertheless keep their brood separate.

Paraglossa: Corresponds to maxillary galeae. One of two lobes at the tip of labium and on the outside of the glossae. When the paraglossae and glossae are fused, they form a single structure known as 'ligula'.

Paralysis: A fatal disease of adult honeybees and of certain bumblebees, caused by a virus. There is an abnormal trembling motion of the wings and bodies of affected bees. These fail to fly but often crawl on the ground and upon grass stems, sometimes in thousands. Many times they huddle together on the top of the cluster in hive. They often have bloated abdomens and partially spread, dislocated wings. Then there is onset of dysentery and sick individuals die within a few days. Severely affected colonies suddenly collapse.

Paramere: One of a pair of lobes lying lateral to the penis, forming part of the aedeagus. They may have a clasping or sensory function. Their origin is uncertain; they may be homologous with the gonocoxites and gonostyles of lower insects.

Parameter: Some varying factor which influences the nature of an observed effect.

Paraneoptera: A group of insects consisting of 5 insect orders namely Psocoptera (book lice), Mallophaga and Anoplura (lice), Thysanoptera (thrips) and Hemiptera (bugs).

Paraneuroptera: An alternative name for Odonata (dragonflies).

Paranotal Lobe Theory: In a paranotal

theory a critical step in the transition from gliding of flapping flight would be the development of a hinge so that the winglets became articulated with the body. In this hypothesis the earliest flying insects would rest with their wings spread at right angles to the body, as do modern dragonflies and mayflies. Paranotal theory is based on evidence like the occurrence of rigid tergal outgrowths (wing pads) of modern larval exopterygotes, the occurrence in fossil Palaeodictyoptera of rigid pronotal expansions whose venation is homologous with that of wings, and the assumed homology of wing pad and lateral abdominal expansions, both of which have rigid connections with the terga and internally both are in direct communication with the haemolymph.

Parapatry: Of populations or species, in non-overlapping geographical contact without interbreeding.

Paraprocts: The 11th abdominal segment comprises a somewhat triangular tergal plate, the epiproct, and a pair of venterolateral plates, the 'paraprocts'. It bears appendages, the 'cerci', inserted in the membranous area between the 10th and 11th segments on each side of the body.

Parasite: An insect that lives in or on the body of another living insect or other animal (its host), at least during a part of its life cycle and at the host's expense. A parasite may feed on one to several hosts but does not kill them.

Parasitic Castration: The induction by internal parasites of the morphological traits of the opposite sex; stylopization.

Parasitiformes: An order of subclass Acari. Their representatives possess one to four pairs of lateral stigmata posterior to the coxae of the second pair of legs. Actinochitin is lacking in their tactile and chemosensory hairs. The Parasitiformes have four suborders, of which the Gamasida (=Mesostigmata) and Ixodida (=Metastigmata) are of great medical and veterinary importance.

Parasitoid: A species that develops by

consuming the body tissues of a single host, eventually causing its death. Most parasitoids are hymenopterans, the rest are tachinids, conopids and some other flies. Parasitoids can feed inside or outside the host's body, in which case they are termed 'endoparasitoids' and 'ectoparasitoids', respectively. If the female wasp kills or paralyzes its host when laying an egg, and thus prevents the host from developing any further, it is called an 'idiobiont parasitoid'. The larvae of idiobiont species are often ectoparasitoids. If, however, the female does not kill the host when egg laying, thus allowing the host to develop further, it is known as a 'koinobiont' which tend to be endoparasitoids. Parasitoids differ from predators in the following features, (i) Only one host is required, (ii) the host is larger than the parasitoid, (iii) parasitoids are frequently host-specific attacking one or several related species, and (iv) a lower density of host population will sustain a parasitoid population. When the larva of a species characteristically develops in the ratio of one to a host, the species is termed a 'solitary parasitoid'. When several larvae of the same species normally develop in a single host, the species is called a 'gregarious parasitoid'; if the host is phytophagous, the parasitoid is a 'primary parasitoid'. Parasitoids which attack the other parasitoids are called hyperparasitoids or secondary parasitoids. 'Multiple parasitoidism' occurs when two or more species of primary parasitoids attack one host individual. 'Superparasitoidism' occurs when a host is attacked by more larvae of the same species than can reach maturity in the one host.

Parasocial: Progression of social stages from communal to quasisocial to semi-social to eusocial is termed the 'parasocial' route to eusociality. Parasocial insect societies are simply any colonies in which the adults consist of a single generation rather than two generations as are ordinarily present in eusocial forms.

Parasporal Body: A particle which lies alongside spore or is included in the

sporangium along with the spore formed during sporulation of a number of *Bacillus* spp. If inclusion is crystalloid the species is called crystalliferous.

Paratype: A specimen other than holotype which was before the author at the time of preparation of the original description and was so designated or indicated by the original author.

Parenchyma: A plant tissue composed of thin-walled cells which often store food and usually retain the capacity to divide.

Parental Care: A social behaviour. In some insects, females select an appropriate oviposition site, affording protection to the eggs and ensuring an appropriate food source for the hatching offspring. The ovipositing female may protect the eggs in an ootheca, or deposit them directly into suitable substrate with her ovipositor or modify the environment as in nest construction. Tending of the eggs and young ones which suffer highest mortality is common in insect orders Blattodea, Orthoptera, Dermaptera, Thysanoptera, Hemiptera, Coleoptera and Hymenoptera.

Parental Investment: Behaviours (investments of time and energy) that increases the probability of some offspring surviving to reproduce at the cost of the parent's ability to generate additional offspring.

Parous: Describing a female that has laid at least one egg.

Parthenogenesis: Method of producing living young ones without the necessity of mating is known as parthenogenesis. Among the aphids, parthenogenesis is the common form of reproduction during the summer. Also found among some Hymenoptera and Diptera. Parthenogenesis increases the reproductive possibilities because there are no casualties or loss of time in mating. This process continues almost uninterrupted. Based on the sex of the offspring produced there may be three types of parthenogenesis, **1. Arrhenotoky-** only males are produced as in some Hymenoptera and Thysanoptera;

2.Thelytoky- only females are produced as in some Thysanoptera; **3.Amphitoky-** where individuals of any sex may be produced as in some scale insects and whiteflies.

Partial Metamorphosis: Also known as incomplete metamorphosis or gradual metamorphosis. In this type of metamorphosis, there is a gradual and often not very marked transformation from immature to adult stage. There is no pupal stage and immature stages are referred to as nymphs.

Partial Population Curve: Population density of a given developmental stage plotted against time.

Parts Per Billion (ppb): Number of parts of toxicant per billion parts of the substance in question (parts in 10^9 parts); one ten millionth of a percent; equal to micrograms per litre.

Parts Per Million (ppm): The number of parts of toxicant per million parts of the substance in question (parts in 10^6 parts); one ten thousandth of a percent; equals to milligrams per litre.

Patagium: Also known as tegula. In Lepidoptera, one of the small lobes that overlie the fore wings.

Patch: A discrete area of microhabitat.

Patella: A leg segment between the femur and tibia in arachnids.

Pathogen: A disease-causing organism (e.g., bacteria, fungus, virus etc). Some of these pathogens can be used effectively in controlling pest insects. Insect haemocytes defencively phagocytize the smaller agents and encapsulate the larger ones. Insects do not produce specific antibodies against pathogens but lysozymes in the gut, fat body, and haemolymph can destroy microbes by enzymatic action.

Pathogen Reservoir: A host or group of hosts harbouring a disease causing organism.

Pathogenesis: The sequence of processes in disease development from time of infection to the final reaction in the host; production and development of disease.

Pathogenicity: Causing, or capable of producing disease.

Pathology: The study of the cause, nature, processes and effects of disease.

Patrolling: A behavioural characteristic in males of some butterflies, which take up position in their own territory and patrol up and down to find mates.

Paurometabola: Insects with simple metamorphosis and with young and adults living in the same habitat; young are called nymphs and having feeding habits usually similar to those of the adults. Wing pads can be seen in nymphs prior to development of functional wings of adults. Grasshoppers, termites, stoneflies and true bugs are common examples of insects with simple metamorphosis. A greater deviation of metamorphosis occurs among some of the groups whose immature stages are aquatic. These are sometimes called 'hemimetabola' and their nymphs are referred as 'naids'.

Pebrine: A disease of the silkworm caused by the microsporidian, *Nosema bombycis*. Pebrine infection occurs either by the ingestion of spores through contaminated leaves or from mother moths to its offspring through its eggs. It is very difficult to detect initially the worms suffering from disease. But as the disease advances, silkworms loose their appetite and becomes sluggish, show retarded growth, irregular development and look slightly paler. Moreover, the worms pass their moults irregularly and when intensity of infection is severe, black and dark brown spots which are irregular in form and size appear on the whole body surface especially the midgut, the distinct symptom of the disease, hence the name pebrine meaning pepper like spots. The disease is noticed more in young worms and causes considerable mortality.

Pecten: A comb; in Hymenoptera, the rigid setae on the basal parts of the maxillae and labium; in Lepidoptera, a row of setae on the antennal scape.

Pectinate: Projections/branches like teeth of

a comb; certain antennae, tarsal claws (e.g., antennae of moths).

Pectination: Having comb-like or pectinate antennae with exceptionally long side branches; a characteristic of some male moths that have a good sense of smell, the olfactory receptors being situated on the antennae. This is more prominent in moths whose male is attracted from long distances by the scent-glands of the female.

Pedicel: Second segment of the antenna; in Hymenoptera, the narrowed anterior end of abdomen formed by the basal one or two segments of abdomen.

Pediculosis: Infestation with the lice, *Pediculus humanus* and *P. capitis* (Phthiraptera) resulting in severe itching and eczema-like eruption of the skin. Lice is an important agent involved in the transmission of relapsing and trench fever, epidemic typhus etc.

Pedipalp : The second pair of appendages of an arachnid, used to crush the prey. They are homologous to mandibles, multisegmented and are variously modified in some scorpions and pseudoscorpions, pedipalpi are chelate and are greatly enlarged for capturing the prey. In male spiders they become copulatory organs. In most arachnids, however, pedipalpi are sensory structures and also form the base of the preoral cavity in which the chelicerae function. Male spiders spin sperm webs, a structure onto which sperm is deposited, which is subsequently withdrawn by the copulatory pedipalp.

Pelagic: Living out in the open ocean.

Pellet: Seed coated with inert material, often incorporating pesticides, to ensure uniform size and shape for precision drilling.

Penellipose: The figure formed by the crochets in a uniserial circle with a part of them absent as in some caterpillars.

Penetrant: Oil added to a spray to enable it to penetrate the waxy cuticle more effectively.

Penis: A male intromittent/copulatory organ containing the gonopore from which seminal

fluid is discharged. It is formed from two elongated outgrowths of the 9th abdominal segment and is situated between the two claspers. In the primitive insects such as the mayfly the paired structures can be seen but in most insects these are fused together to form a single tubular structure.

Penultimate: Next to the last.

Percent by Weight: A percentage which expresses active ingredient weight as a part of the total weight of the formulation. For example 250 gms of active ingredient if added to and mixed with 750 gms of inert materials, results in a formulation which is 25% pesticide by weight.

Percent Concentration: Weight or volume of a given compound in the final mixture expressed as a percentage.

Perching: A behavioural characteristic of some butterflies, often males, which seek to intercept and drive off other insects, including butterflies which penetrate their territories. This behaviour is used by males to find females, in which case mating may take place.

Perennial: A plant that normally lives for more than two years. Trees and shrubs are perennial plants. Some perennials die back to the roots each winter but new shoots grow again in the spring.

Pericardial Cells: Nephrocytes in the heart region of an insect. These cells seem to be connected with excretion as they can absorb nitrogenous waste substances from the blood.

Pericardial Sinus: A part of the haemocoel or body cavity surrounding the heart in an insect. Blood flows from this cavity directly into the dorsal tubular heart by way of a number of ostia or valvular openings.

Periodic Release: The regular release of biological control agents that are effective in control but unable to establish permanently.

Periodicity: Recurrence of particular behaviour(s)/physiological events in a regular time.

Periopticon: The outer layer of the optic lobes, nearest the eyes.

Peripheral Nervous System: All the nerves emanating from the ganglia of the central and visceral nervous systems plus the sensory neurons of the cuticular sensory structures (the sense organs) that receive mechanical, chemical, thermal or visual stimuli from an insect's environment.

Peripneustic: A type of hemipneustic respiratory system in which metathoracic spiracle is non-functional. It is found among the terrestrial larvae of Neuropteroidea.

Periproct: The unsegmented part of the body surrounding the anus.

Peristalsis : Movement of muscular tubes, as of digestive tract by means of successive contractions in a definite, usually anteroposterior direction. Food is chewed into small pieces, mixed with salivary secretions from labial glands for lubrication and very limited carbohydrate digestion, and pushed into the mouth and swallowed with the assistance of a muscular pharynx. Food is then swallowed down the tubular oesophagus by waves of muscular contractions termed peristalsis. The posterior part of stomodeum is modified into an expandible crop for temporary food storage and a muscular preventriculus that acts primarily as a valve.

Peristome: The ventral margin of the head, bordering mouth.

Peritreme: Small plate perforated by spiracle opening in ticks, mites, and some insects. Peritreme is associated with a stigma. It is either a taenidium or a closed (or partly closed) canal connected with the stigma, or a more or less, concave plate surrounding the stigma. It is known as a paired structure from many Actinotrichida (Holotrichida, Ixodida; in these groups its position is more or less lateral) and from one group of Actinotrichida (prostigmatic Actinedida; in this group it is associated with the chelicerae).

Peritrophic Membrane : A non-cellular membrane produced within the midgut of insects which encloses the food as it passes along the alimentary canal. It is permeable to the enzymes and to digested food. The

membrane is usually pulled loose from the midgut, remains around the food, and passes out with the faeces. Peritrophic membrane is reported to be absent in Hemiptera and adult Lepidoptera. In case of insects eating solid food products, peritrophic membrane protects the midgut cells from abrasion, lubricates and facilitates the movement of food. It also acts as a barrier to microorganisms. Insect orders which commonly possess peritrophic membrane includes, Orthoptera, Odonata, Ephemeroptera, Isoptera, Neuroptera, Coleoptera, Hymenoptera, Diptera and larval Lepidoptera.

Perivisceral Sinus: Body cavity region below the dorsal diaphragm and above the ventral diaphragm (if present).

Per Os : By way of the mouth; a pathogen may be administered per os.

Persistence : 1.Term applied to pesticides that remain active for a longer period of time after application. They persist as an effective residue due to their low volatility and chemical stability, e.g., certain organochlorine insecticides. These pesticides often accumulate and are stored in animal and plant tissues. 2.Circulatory viruses that remain infectious within their living vector for long periods without lysis, and are transmitted via salivary fluids.

Persistent Viruses: Viruses are acquired by insects from minutes to hours and are transmitted after a definite latent period. For example, little-leaf disease of brinjal (Vector : Leafhopper). In case of these persistent viruses which multiply in their insect vector, the latent period is usually protracted. Age of the vector population when it comes in contact with a virus reservoir, and the weather conditions thereafter can have a great impact on the pattern of the disease transmission. If the population is composed largely of older adults, or if the environmental conditions are such that the latent period is lengthened while the vectors life span is shortened, there may be little or no disease transmission.

Pest: A pest has been variously defined as, 1.An animal or the plant whose activities

interfere with human health, convenience, comfort or profits ; **2.**As a living organism which causes damage or illness to man or his possessions or is otherwise in some sense 'not wanted'; **3.**A creature that reduces availability, quality or value of a resource; **4.**An animal or plant whose population density exceeds some unacceptable, arbitrary threshold level, resulting in economic damage.

Pest Complex: The group of pests that attack a host at any one time.

Pest Control Advisor: Individual who is qualified to make recommendations for use of agricultural chemicals, including pesticides.

Pest Management: Also known as integrated pest management (IPM). Control of pest populations by a programme that selects and utilizes available control methods so that economic damage is avoided and adverse side effects on the agroecosystem are minimized; or the reduction of pest problems by actions selected after the ecology or 'life systems' of the pests are understood and the ecological as well as the economic consequences of these actions have been predicted to be in the best interest of man. Pest management has also been defined as an ecologically based pest control strategy that relies heavily on natural mortality factors such as natural enemies and weather, and seeks out control tactics that disrupt these factors as little as possible. While devising management of pest–interactions among insects, plants, pathogens and natural enemies must be considered in some depth. An economic injury level must be established because not all potential population densities of an insect (or other pest) are likely to cause enough loss to justify management efforts. Moreover an insect known to cause damage in one region might justifiably be regarded as a 'potential pest' where it is less abundant, or even absent. Pest management uses selective control techniques, management procedures that pinpoint the vulnerable life stages of a pest, with minimal deleterious impact on beneficial organisms in the associated ecosystem. Pest management techniques include introduction or augmentation of biological control agents, use

of resistant crop varieties, application of narrow spectrum insecticides, more efficient timing, dosage, application of short-residual chemicals and/or timely planting, harvesting and tillage.

Pest Management Strategy: An overall plan for eliminating or alleviating a pest problem.

Pest Spectrum: The complete range of pest organisms that are attacking a crop or particular host.

Pest Status: The ranking of a pest relative to the economics of dealing with the species.

Pest Technology: Approaches to eliminate or reduce the pest numbers and/or prevent losses from undesirable species.

Pesticide: Any substance or mixture of the substances used to prevent, destroy, repel or mitigate any insect, mite, rodent, nematode, fungus, weed or any other form of aquatic or terrestrial plant or animal life (e.g., insecticides, acaricides or miticides, rodenticides, nematicides, fungicides, herbicides etc.).

Pesticide Application: Most of the pesticides are usually applied by, **1.**Spraying pesticide droplets with water, oil or air as a diluent, **2.**Spreading the compound absorbed on or impregnated into an inert solid carrier (dusts and granules), and **3.**Burning the compound to create a pesticidal smoke which will penetrate all parts of a more or less enclosed space (e.g., on dense orchard, a glasshouse). Formulation (the solvent, carrier, additives etc.) and the method of application can have greater influence on the efficiency and selectivity of kill than the choice of an active ingredient. Pesticide application technology can be improved in a variety of ways to reduce the volume of pesticide use and make substantially safer. For example, electrostatic applicators could place pesticide material directly on the target plant eliminating drift.

Pesticide Dealer: Any distributor or retailer who sells pesticides for agricultural use, methods and devices for the control of agricultural pests, or soliciting pesticide sales.

Pesticide Nomenclature: Pesticide nomenclature is the formal process by which pesticides are named. Pesticides are designated by three names : the approved common name, the trade name, and the chemical name.

Pesticide Treadmill: The situation where the number of pesticide applications that has to be made increases year after year has been called the pesticide treadmill. In some of the cases it has led to the complete collapse of agroecosystem. On cotton, application of synthetic pyrethroids for bollworm control resulted in development of whitefly as a secondary pest.

Pestilence: Any epidemic contagious disease.

Petiole: In Apocrita (Hymenoptera), is a marked constriction-the petiole, separates the first from the remaining abdominal segments; the latter constitute the gaster (metasoma) which normally has a posterior pair of unsegmented cerci (pygostyles), though these are reduced to pads of sensory hairs in some species and lost entirely in female Aculeata.

Petri Dish: A round shallow-bottomed glass or plastic dish with a vertical side, together with a similar slightly larger loose fitting lid.

Petroleum Oils : Pesticides used to control insects in plants; they are refined from crude oil. They are used to safeguard fruit trees and also serve as solvents or carriers. Diesel fuel serves as a carrier for insecticides in aerial application and over water for controlling mosquitoes. As insecticides and acaricides, the less refined products are referred to as 'dormant oils' because, they are injurious to actively growing vegetation and must be used during the plant dormant period. The more highly refined 'summer oils' can be used on verdant vegetation, although phytotoxicity is the major limitation in the use of oil sprays. Oils are particularly effective against the eggs and dormant stages of mites and scale insects, because they act to interfere with the organism's gas exchange and respiration.

pH Value: The degree of acidity or the alkalinity. The pH scale of 0 to 14 expresses

increased intensity of acidity or alkalinity in the same manner that degrees in the thermometer express intensity of the heat. The pH value of 7.0, halfway between 0 and 14 is neither acid nor alkaline. However, pH values below 7.0 indicate acidity with its intensity increasing as the numbers decrease. Conversely, pH values above 7.0 indicate alkalinity with its intensity increasing as the numbers increase.

Phagocyte: A blood cell capable of engulfing foreign matter that enters the body. The process of envelopment is called phagocytosis. Most multi-celled animals, including insects, possess this defence mechanism.

Phagostimulant: Any substance that induces feeding is said to be a phagostimulant. Sinigrin, a glucoside that is characteristic of the cabbage family induces feeding by cabbage worm. The larvae would eat non-host plants when these are smeared with the sap of cabbage plants or with sinigrin. These substances serve both as attractants for the ovipositing females and as stimulants for larval feeding.

Phalaenophily: Pollination of flowers by moths. It is associated with light-coloured, pendant flowers that have nocturnal or crepuscular anthesis.

Phallomere: Penis valve. In all insects, the basic genitalia are derived from a pair of primary 'phallic lobes' which are ectodermal growth belonging to 10th segment. The primary lobes are each divided into two secondary lobes, the 'phallomeres' (e.g. orthopteroid insects).

Phallus: The male intromittent organ including any processes that may be present at its base.

Pharate: A developmental stage which is enclosed in the integument of the previous instar especially adults which are pharate in the pupal integument.

Pharyngeal Glands: These are well-developed in workers of honey bees. These

glands produce brood feed which play an important role in caste determination.

Pharynx: The part of the foregut between the mouth and the oesophagus. It is concerned in swallowing of the food. Attached to the pharyngeal intima are dilator muscles that are well developed in sucking insects and form the pharyngeal pump. Food is chewed in the preoral cavity, mixed with salivary secretions from labial glands and swallowed with the assistance of muscular pharynx.

Phase: This term is used to describe the forms of a single species of locust, which differ in colouration and in their migratory habits.

Phase-Contrast Microscope: A microscope used for making the visible differences in phase or optical path in transparent/reflecting specimens. It is one of the most important equipment available for studying living cells and is widely used in biological researches. The phase-contrast microscope is the routine instrument for the examination of living cells because it is possible to study the cell structure under excellent optical conditions and with no loss in resolving power. The method is also useful for the study of unstained tissue sections and has found considerable use for the comparison of material in the electron and optical microscopes.

Phase Theory of Locusts: The alternation between a solitary non-migratory phase and a gregarious migratory phase in the life of a locust. Solitary and gregarious phase individuals differ in morphometrics, colour and behaviour. At low densities, locusts develop into the solitary phase, but at high density gregarious phase is induced. Solitary phase individuals have characteristic uniform-coloured hopper (nymph), and a large-sized nymph with large hind femora. Gregarious phase individuals are of comparatively smaller size with shorter hind femora, and nymph have a dark stripe.

Phasmatodea: An orthopteroid order of insects. Body stick-like or leaf-like. Cryptic colouring common. Prothorax short, two pairs of wings or none. Front wings narrow,

toughened; legs elongated. Metamorphosis is incomplete (egg, nymph, adult). They are mainly distributed in tropical and subtropical climates.

Phenetic Ranking: Ranking into categories, strictly based on degrees of overall similarity.

Phenetics: A school of systematic thought based on the assumption that phylogeny can not be deduced with certainty and, so classification should be based on as many different characteristics as possible.

Phenogram: A diagram indicating degree of similarity among taxa.

Phenological Asynchrony: Lack of synchrony between the life cycle of a pest and the appropriate stage of its host plant.

Phenology: Recording and study of seasonal biotic events in selection to climate, time and other factors; periodicity of biological phenomenon.

Phenon: A sample of phenotypically similar specimens.

Phenotaxes: In acoustic pair formation, direct locomotory response of a silent female to a single sedentary male's calling song.

Phenotype: The totality of characteristics of an individual (its appearance) as a result of the interaction between genotype and environment.

Phenylpyrazoles: A new class of insecticides (e.g. fipronil). Fipronil acts as a potent blocker of the GABA-regulated chloride channel. It is effective against the insects that are resistant or tolerant to pyrethroid, cyclodiene, OPs and/or carbamate insecticides. Fipronil is mostly used as a seed treatment and developed as a bait for cockroaches, termites and ants.

Pheromonal Parsimony: This phenomenon is particularly characteristic of the class of pheromones releasing alarm in the social insects. These pheromones evoke an almost astonishing diversity of behavioural responses depending upon the physiological condition of the recipient, concentration differences,

duration for which the pheromone persists, and the context in which the signal is presented.

Pheromone: Pheromones are chemicals produced by one individual that induce a particular behavioural or developmental response in other individuals of the same species. Like hormones, they are produced in small quantities and serve as chemical messengers. In the older literature, they are referred to as 'ectohormones'. Pheromones may be volatile and, therefore, capable of being detected as an odour over considerable distances, or they may be nonvolatile, requiring actual physical contact among individuals for their dissemination. Pheromones are released only under appropriate conditions, i.e. in response to appropriate environmental stimuli. Pheromones may be arranged in different categories based on their functions such as sex pheromones, caste-regulating pheromones, alarm pheromones and trail-marking pheromones. Pheromones are used to monitor many crop pest species and in this way greatly improve the correct timing of insecticide sprays.

Pheromone Traps: Pheromone traps serve to catch those insects that are attracted by the pheromone that is released. Such traps should be highly species-specific and no expert knowledge may be required to count insects caught in these traps. Critical features of a trap include its colour, size, shape and height above the ground. Pheromone traps can be divided into 3 categories: those that trap insects on a sticky surface, those that kill insects in a liquid, and those that kill insects by exposure to the pesticide-impregnated plastic strips. Pheromone traps can be used to monitor pest species counts, mass trap pest species, to disrupt mating, and to attract species to poisoned bait. This approach of attracting pests to poisoned baits is known as 'lure and kill'. By far the most successful application of pheromones has been in monitoring.

Phloem: The main transport vessels of the

plants taking nutrients from the leaves to the other parts.

Phobotaxis: A reflex action by which an insect turns to avoid an adverse stimulus and by repeated trial and error eventually moves away from it.

Phosphorylation: The attachment of the phosphate moiety of an OP insecticide to one of the OP-sensitive enzymes (e.g., cholinesterase, acetylcholinesterase, carboxyesterase), rendering it inactive.

Photodegradation: The conversion of the molecules of an insecticide into simpler molecules due to the action of light.

Photoperiod: Duration of daily exposure to light.

Photoperiodism: A response by an organism to the duration or pattern of light and dark period.

Photoreceptors: Many of the insects are able to detect light energy by means of specialized photosensory structures—compound eyes, ocelli, or stemmata. But insect species that lack these structures, sensitivity to light is perceived through general body surface.

Photosynthesis: The enzymatic conversion of light energy into the chemical energy in green plant cells resulting in the formation of carbohydrates and oxygen from carbon dioxide and water.

Phototaxis: A directional movement in relation to a source of light. Moths for instance, are positively phototactic, flying towards the light. The larvae of many insects on the other hand show negative phototaxis, moving away from the light.

Phragma: Transverse, plate-like invaginations of the skeleton, usually increasing the area available for muscle attachment; are homologous to the antecosta of a secondary segment.

Phragmosis: The condition in which the head or tip of the abdomen is truncated and is used as a living plug for the nest entrance. Occurs in ants and termites, usually in the soldier caste.

Phthiraptera: Hemipteroid order, representatives are commonly known as parasitic lice. They are flexible, dorsoventrally flattened, wingless, ectoparasitic insects. Mouthparts are of biting type or piercing/sucking type. Compound eyes very small or absent, ocelli absent; antennae are short and stout. Legs are short, robust with the tarsi and claws modified for grasping hair or feathers. Incomplete metamorphosis. Several species are vectors of human and animal diseases. The order Phthiraptera in older literature has been treated as two separate orders, the Mallophaga (chewing lice) and the Anoplura (sucking lice).

Phyletic: Pertaining to a line of descent.

Phylogenetic Tree: A diagrammatic presentation of inferred lines of descent, based on palaeontological, morphological or other evidence.

Phylogeny: The study of the history of the lines of evolution in a group of organisms; the origin and evolution of higher taxa.

Phylogram: A tree-like diagram indicating degree of relationship among taxa.

Phylloplane: In the region of the leaf surface.

Phylum: Major division of the animal kingdom corresponding to the main types, e.g., Arthropoda and Mollusca. Phylum is comprised of the classes and superclasses.

Physical Control: Pest control which involves either modification of some physical factor in the environment (e.g., temperature, humidity) or use of a physical factor (e.g., light) to attract insects. Other physical means of pest control may be electricity and sound waves. Physical control aims to reduce pest population by using devices which affect them physically or alter their physical environment. In earlier times hand picking and crushing under feet of larger pests was economically viable and effective. Grease bands around the trunks of mango trees is still very useful practice in trapping the flightless mealybugs.

Physical Factor Ecology: Also known as

production ecology, biocoenology and population ecology. The study of events and processes which determine the distribution, abundance and persistence of specific populations.

Physical Poisons: The pesticides which kill the insect by some physical action. For example, the mineral oils exclude air, and silica aerogel dust leads to a loss in water.

Physical Properties : Pertains to solubility, volatility, inflammability, state (solid, liquid, or gas) of the toxicant.

Physical Selectivity: Use of broad-spectrum insecticides in such ways so as to obtain selective action. This may be accomplished by timing, dosage, formulation etc.

Physiogenic Disease: Also called physiological disease. A disease (or disorder) produced by some unfavourable genetic, physical or environmental factor (e.g., excess or deficiency of the light, water, soil nutrients, chemicals, physical, or other injury etc.) that often mimics virus disease symptoms.

Physiological Selectivity: Refers to the insecticides that are inherently more toxic to some insects than to others.

Physiology: The study of the processes which go on in the living animal at cell, tissue or 'organisms as a whole' level.

Physiopath: Any physical or environmental factor capable of producing symptoms of disease in plants.

Physogastry: Morphological adaptation in social insects wherein the abdomen in case of females gradually becomes swollen or physiogastric, in its membranous parts. This condition may be produced due to the hypertrophy of the fat bodies, ovaries, or both. Physogastry is especially evident in the more specialized termites of the families Termitidae and Rhinotermitidae, in which the abdominal sclerites are isolated as small islands on the bloated, membranous abdomen.

Phytoecdysones: Compounds found in certain plants that mimic the action of

ecdysone. The phytoecdysones content in some plants is astonishingly high. One gram of the rhizomes of an oriental fern contain ecdysone activity equivalent to 200,000 grams of silkworm pupae.

Phytomones: Substances given out by plants that integrate host-finding or ovipositing behaviour of phytophagous insects on their hosts. Moulting hormones and hormone mimics have been synthesized. Specific attractants obtained from olfactory pheromones and phytomones can be used to lure pests to suitable baits where they can be destroyed by conventional pesticides or hormone mimics, or sterilized by chemosterilants.

Phytophagous: The insects consume leaves, buds, stems, roots, fruits and seeds. They feed externally or internally, either by chewing or sucking the plant juices. Orthoptera, most Lepidoptera, Hemiptera, Thysanoptera, some of the Coleoptera (Cerambycidae, Curculionidae), Hymenoptera, and some Diptera are phytophagous in habit. Insects that accept a wide variety of plants as food are called **polyphagous**; those insects feeding on a few plant species are known as **oligophagous**; and insects feeding on one species are known as **monophagous**.

Phytoplasma: Also called mycoplasma-like organisms (MLO). Mollecatates that infect plants and cause disease.

Phytosanitation: Measures requiring the removal or destruction of the infected or infested plant material likely to form a source of reinfection or reinfestation. This is done by disposal of unwanted crops and crop residues and the elimination of weeds or volunteers that can harbour pests. Since many pests can survive the dormant periods in alternative hosts or crop residues etc., it is important that these be disposed off to reduce colonization in the next season. *Pectinophora gossypiella*, can be controlled by uprooting and destroying the cotton plants after harvest, which result in killing the diapausing larvae thereby reducing subsequent population

levels. The practice of roguing a crop, which involves removing and destroying plants as soon as they become diseased can reduce the rate of pest population development. Burning of the stubbles from a harvested field is one of the oldest practice to control the weeds, diseases and insects and in addition returns bound nitrogen to the soil. However, burning can also lead to the loss of organic matter and soluble nutrients and increase soil erosion on sloping land.

Phytosaprophagous: A general name for insects that feed on dead or decaying plant material, e.g., Collembola and Thysanura, the larvae of many Diptera and numerous species of Coleoptera.

Phytotoxemia: Also known as 'toxicosis' It is a group of diseases that are caused by the toxins produced by insects while feeding. An insect whose feeding produces symptoms of disease is said to be 'toxicogenic', and the condition is spoken of as 'phytotoxemia'. In toxemia caused diseases-toxins does not reproduce in plants, symptoms subside when insects are removed, recovery is common, degree of injury is related to the number of insects and length of time they feed, and such disease symptoms are not transmitted by the propagation or grafting.

Phytotoxicity: Poisonous or chemically injurious to plants. Generally oils in their natural state are highly phytotoxic, but when used in an emulsion form, they may be safely applied to plants. The quality of the oil is based on the viscosity, boiling or distillation range and sulfonation rating. Generally, the lower the viscosity the safer it is to use pesticide with respect to phytotoxicity. Phytotoxicity increases with increase in distillation range, because greater the distillation range the less volatile the oil. Oils are composed of both saturated and unsaturated hydrocarbons, the unsaturated hydrocarbons are unstable and readily form compounds which are toxic to plants.

Pigments: The wide variety of colours in insects is due partly to chemical pigments and partly to the effect of optical interference

caused by the physical structure of the surface. Melanins, biliverdins, ommochromes, anthraquinones, carotenoids, and pterines are important pigments associated with insects.

Pile: Thick, short hairs giving the appearance of velvet.

Pilose: Covered with hairs (e.g., antennae of female mosquitoes).

Pincers: Claspers or gonopods at the hind end of the abdomen of certain insects. They may be present in both sexes such as in earwigs, but more often they are found on the males only. They may be used for attack or defence or for grasping the female when mating.

Pinning: Insects should be mounted only when they are fully relaxed, i.e. when their legs and the wings are freely movable rather than stiff or dry, and brittle. All dry mounting methods use entomological 'macropins' which are stainless steel pins and mostly 32 mm long and come in a range of thickness. Such pins are having either a solid or a nylon head. For scientific and professional collections, insects are pinned directly with a macropin, micropinned or pointed. Direct pinning involves inserting a macropin of appropriate thickness for the insect's size directly through the insect's body; the correct position for pinning varies among different orders. Micropinning also known as 'staging' or 'double mounting' is used for many small insects and involves pinning the insect with a micropin to a stage that is mounted on a macropin.

Piping: The sound emitted by young honeybee queens after their emergence. Piping induces return calls (quacking) from other virgin queens still in the royal cells and stimulates swarming behaviour by the workers.

Piroplasmiasis: Infection with piroplasma, genus *Babesia*. Infestation by parasitic protozoans that attack the red blood corpuscles of cattle, dogs and other animals result in high fever, destruction of red blood corpuscles, enlarged spleen, engorged liver,

emaciation, and often death. The organism is transmitted by ticks.

Piscicide: Chemical used to kill fish.

Pitfall Traps: Ground inhabiting insects are collected by such traps. A tin or plastic container with holes in the bottom for water drainage is sunk in the ground until the rim is at ground level. Baits such as molasses, candy, fruit, meat, fish, manure, fermented solids or liquids, 3% formalin etc. is placed in the bottom and attracted insects will fall in the traps and generally be unable to leave. Traps located in fields, sandy trails, shore lines, etc., all yield different types of insects.

Pith: Undifferentiated ground tissue occupying the centre of roots or stems.

Placoid Receptors: Sensory organs, present on the antennae of some insects. They are often called 'pore plates' and consist of a number of sensory cells beneath a very thin plate of cuticle. They seem to be olfactory in nature.

Planidium: In Hymenoptera which undergo hypermetamorphosis—a type of primary larva with sclerotized, fusiform body and spine-like locomotory organs; a larva that is legless and somewhat flattened.

Plankton: Tiny marine or fresh water organisms floating and drifting with the surrounding water (e.g., phytoplankton, zooplankton).

Plant Cover: The degree to which plants within a sprayed area receive a deposit of pesticide.

Plant Density: Row spacings and manipulation of plant densities are important characteristics to achieve rapid canopy shading by crops. Spacings that favour control of one of the pest may act to the detriment for the control of another. Dense stands of a crop often result in the high humidities which may encourage many diseases. Even the reduced distance between plants increases rate of spread of some aerial spores of diseases. Given the degree of variation in response between different pests and their

hosts, every situation and pest-cropping system has to be evaluated on an individual basis. Selection of appropriate planting densities is based on the density that provides the best yield while providing economical control of key pests.

Plant Protection Chemicals: Also called pesticides. These are chemicals, or mixtures of some chemicals used for killing, repelling, mitigating, phasing or even regulating pests with a view to minimize the damage caused to crops.

Planta: Distal portion of a proleg on which the crochets are borne. The planta is protracted by means of blood pressure; the basal joint of the posterior tasses in pollen gathering Hymenoptera.

Planthopper: Small, leaping, homopterous insects with piercing-sucking mouthparts (Delphacidae). They are known to transmit plant infecting viruses and mycoplasma-like organisms.

Plantulae: Adhesive pads on the tarsal sclerites of some insects.

Plasmolysis: Shrinkage of cell protoplasm away from its wall due to removal of water from its large central vacuole.

Plastic Strip: Some volatile insecticides such as dichlorvos that have been impregnated onto plastic strips which are hung in a closed room or room having minimal ventilation. The concentration of vapour released from the strip is sufficient to control some insects. This type of formulation is also used to disperse pheromones.

Plastron Respiration: When the density of hydrofuge hairs on the cuticle is high, the bubble of air that insect captures when surfacing is held tightly enough when it is under water so that it may serve as a physical gill to extract oxygen from the water. This is quite common in mayflies.

Platyform Larvae: Also alternatively called the onisciform larva. A larva that is extremely flattened, as the larva of the Psephenidae (Coleoptera).

Plecoptera: An order of pterygote insects. Representatives are known as the stoneflies. They are soft and slender insects with slightly flattened bodies. Possess two pairs of membranous wings which have complex patterns of crossveins. The head has bulging eyes, mouthparts are weakly developed or nonfunctional. They have elongate abdomen and have a pair of cerci at the posterior end. They are not good fliers. Metamorphosis is incomplete. They have worldwide distribution but mainly found in cool temperate regions. Adults typically rest with wings held flat along the body. They are important in aquatic food chains.

Plecopteroid: Exopterygote insect orders (Plecoptera, Embioptera) in which case external appendages are associated with male genitalia that may be reduced or absent, abdominal styli lacking, accessory clasping structures in males includes extensions of 10th abdominal tergum and modified paraprocts, and trochantin attached to epimeron with no suture between.

Pleometrosis: Phenomenon of initiation of hymenopteran colonies by multiple queens. This appears to be widespread, and the digging of the initial nest may be shared, as in the honeypot ant, *Myrmecocystus mimicus*.

Plerergate: A worker ant with its stomach enormously distended with food.

Pleural: Pertaining to the pleura, or lateral sclerites of the body; lateral.

Pleural Apophysis: Arm-like projection of the pleural ridge.

Pleural Membrane: The unsclerotized cuticle in the pleural region of the abdomen that separates the terga and sterna.

Pleural Suture: The suture running between the coxa and the pleural wing process separating the episternum and epimeron.

Pleural Wing Process: The pleuron of a pterothoracic segment has a pleural wing process, on which the wing articulates, and a ventral pleural coxal process which provides an articulation for the coxae or leg base.

Pleuron: Lateral part of the cuticle in each segment of an insect. A typical segment has four main cuticular plates, viz., a dorsal tergum, two lateral pleura and a ventral sternum. These may be further differentiated into tergites, pleurites and sternites.

Pleuropodia: Vestiges of former abdominal limbs converted to other uses in present day insects.

Plot: Refers to an area of ground or any other kinds of experimental unit such as a single tree or a part of a tree, a sample of seed used for a germination test, even a colony of insects. The essential feature is that plots for experiment are units selected to be as alike as possible but thereafter to receive different treatments.

Plumose: Feather-like, as in plumose antennae (e.g., mosquitoes).

Podex: Pygideum or hind part of the abdomen of an insect consisting of the last two or three segments sometimes fused together or modified for specific functions.

Podical Plates: Lateroventral plates formed by modification of the 10th abdominal segment of certain insects. These plates are on each side of the anus and may bear anal cerci.

Podeon: Also called podeum. A narrow stalk or petiole connecting thorax with the abdomen in some insects.

Podites: The leg segments of an insect are known as 'podites'. A podite is a hollow, sclerotized tube that articulates with the other podites or the body at membranous joints and is moved by muscles at its base.

Podosoma: In mites and ticks, the idiosoma is subdivided into podosoma (the area of legs), and opisthosoma (the area behind leg region). Gnathosoma and podosoma are collectively known as prosoma.

Poekilothermic: Varying body temperature, more or less following that of the surroundings. Insects are poekilothermous or cold blooded. Within certain limits, as the temperature rises, metabolism rises leading to an accelerated

development, increased reproductive activity and ultimately increases population number.

Poison: Any chemical or agent that can cause illness or death when eaten, absorbed through the skin, or inhaled by humans or animals.

Poison Bait: A substance that has a poison mixed with it that is attractive as a food for certain animals (e.g., rats). Formulated baits contain low levels of toxicants incorporated into material such as foodstuffs, sugar, molasses etc. that are attractive to the target pest.

Poison Control Centre: An agency, generally a hospital, which has current information as to the proper first aid techniques and antidotes for all the human poisoning emergencies arising out of the use of pesticides and other poisons. These centres are usually located in major hospitals.

Poison Glands: Poison glands are best developed in bees and wasps in which they are modified accessory reproductive glands associated with the ovipositor or sting. Their secretions are generally a complex mixture of several substances such as protein melittin of honeybee venom, and polypeptide kinins of *Vespula* venom. Several lepidopteran larvae (Saturniidae, Lymantriidae and Arctiidae) are provided with epidermal poison glands associated with setae or spines which, when broken, allow the discharge of a secretion causing urticaria in man. Secretions of poison glands induce an allergic response in some persons.

Poisonous Insects: There is a large class of insects that sting or irritate the skin of man. The sting of the honeybee is generally transitory and not serious. It may cause severe swelling and in rare cases, owing to other complications cause death. The sensation is caused by an acid and an alkali which are forced into the wound made by the sting. When the bee attacks, the sting including the tip of the abdomen, is torn loose. The muscles attached to the sting continue to contract and force the sting and the poisons into the victim's flesh. Many other hymenopterous insects also sting.

The bold-faced hornet and the yellow-jacket perhaps are most ferocious. Assassin bugs (Reduviidae) are capable of inflicting very painful wounds. The back swimmers (Notonectidae) and the giant water bugs (Belostomatidae) also cause severe pain.

Poisons: Insects may produce poisonous substances for killing or paralyzing their prey, at weaker concentrations, merely for repelling their enemies. Poison may be discharged piercing through a sting which may be a modified ovipositor, as in bees and wasps; or it may be squirted, as in the case of some ants. In bugs, fleas, mosquitoes etc., the poison may be contained in the saliva and is injected into a wound made by a piercing proboscis prior to blood-sucking. Arctiid caterpillars have stinging hairs; others discharge poisons from special glands or by reflex bleeding. In such cases mere contact with the poison may have a toxic effect on the victim.

Pollen: A microgamete of a seed plant. Sexual outcrossing among gymnosperms is assured because individual plants are unisexual, producing either pollen or ovules. Large quantities of wind-borne pollen are needed in order for a small fraction to land by chance in the correct spot for fertilization. Pollen must be collected and ingested efficiently, pollen is often chewed from the anther by beetles. Bees, however, have higher degree of specialization. As honeybees move about the flower, pollen is picked up by plumose body hair; then the pollen is brushed off by their legs into pollen baskets on the hind legs.

Pollen Basket: Also called a corbiculum; a part of the hind leg of a bee specially modified for carrying pollen. The hind tibia is flattened and its outer surface bordered by two rows of long stiff hairs making a trough into which the pollen collected by a foraging worker is stored for transport. In leaf-cutting bees and some other solitary species the pollen basket is situated underneath the abdomen.

Pollen Brush: Also known as scopa. A brush from the rings of stiffened setae on the first

tarsal segment of the hind leg of a honeybee or similar species. This is used for brushing pollen off the body and into the pollen basket of the corresponding leg on the opposite side.

Pollen Comb: **1.** An alternative name for the bees' pollen brush. **2.** A comb-like structure in the joint between the tibia and tarsus of the first leg of the honeybee used for cleaning pollen off the head and antennae.

Pollen Compressor: Sometimes called the auricle on hind leg of a bee. A flattened plate forming the base of a concavity at the upper end of the first tarsal segment. Pollen is brushed into here and compressed by flexing the leg before being pushed into the pollen basket on the tibia.

Pollen Pot: A container made by stingless bees from soft cerumen and used to store pollen.

Pollen Storers : Bumblebee species that store pollen in the abandoned cocoons. From time to time the adult females remove the pollen from their cocoons and feed it into a larval cell in the form of a liquid mixture of pollen and honey.

Pollination: Transfer of pollen from the male parts of flowers (anthers) to the females' receptive organ (stigma). Pollination may be : **cantharophily** (by beetles), **myophily** (by syrphids and bombyliid flies), **melitophily** (by bees), **sphingophily** (by hawk moths) and **psychophily** (by butterflies). Insect pollination has value for insects themselves, to plants and to ourselves. Bees and many adult Lepidoptera, have developed total dependance on floral products for food. Nectar, which is composed of the different sugars and traces of other materials, provides the sole energy source for flower visitors and traces.

Pollinators: Bees (honeybees, bumblebees and solitary bees), flies and other insects which visit flowers and carry pollen from flower to flower in order for many plants to produce fruit, vegetables and seeds.

Pollinium: A mass of pollen grains

characteristic of orchid family; often bearing a stalk with an adhesive disc that facilitates its transfer by the insects. Pollinia are usually sticky and attach to the pollinating insect in such a position that they are only removed when the insect enters another flower with an appropriate removal structure.

Pollinizer: Refers to the plant that produces the pollen.

Pollutant: A harmful chemical or waste material discharged into the water, soil or atmosphere.

Polyandry: When a single female mates with several males. It is relatively a rare phenomenon in insects.

Polyculture : The cultivation of several crops intermingled.

Polydelphic: Having more than one set of ovaries.

Polydemic: Refers to species occurring in several different habitats/areas.

Polydomous: Pertaining to single colonies that occupy more than one nest.

Polyembryony: The production of several embryos from a single egg, as in some chalcids. This process increases the reproductive potential of the insect involved (e.g., endoparasitic insects). This phenomenon is known to be a common occurrence in some parasitic Hymenoptera (mostly Encyrtidae and Braconidae) and some Strepsiptera. In these insects it is always associated with either parasitism or viviparity and is presumed to have evolved in conjunction with the abundance of food offered by those two modes of life. Characteristically the eggs of polyembryonic species are minute and devoid of yolk. Because they depend on external source of nutrients, the chorion which is initially thin and permeable soon disappears.

Polyethism: Division of labour among members of a colony. In social insects a distinction can be made between caste polyethism in which morphological castes are specialized to serve different functions, and

age polyethism in which the same individual passes through different forms of specialization as it grows older.

Polygamy: Mating more than once, strictly referring to males which mate with more than one female.

Polygenic: A characteristic such as resistance conferred by more than one gene.

Polygyny: Refers to multiple queens within the nest. This phenomenon is advantageous in conditions where nests become unstable due to high predation which removes queens.

Polyhedral Inclusion Body (PIB): There are many types of viruses that infect insects, but baculoviruses of which there are two occluded viruses of primary importance are most common. The polyhedral and granulosis viruses are characterized by occlusion of virions in a paracrystalline protein matrix; the whole particle is known as a polyhedral inclusion body (PIB). This polyhedral structure protects the virions from adverse environmental conditions.

Polyhedron: A faceted crystal-like proteinaceous body usually enclosing a number of (often many) virus particles ; especially characteristic of NPVs and CPVs. However, sometimes polyhedra form without enclosing viruses.

Polyhedrosis: Virus disease of insects characterized by the presence of polyhedral inclusions. The polyhedrosis are characterized by a number of virus particles embedded in polyhedral-shaped protein matrix, whereas granulosis have single virus particles, each enclosed in a separate protein coat or capsula. The polyhedrosis are divided in nuclear and cytoplasmic forms, based on the site of virion multiplication within the cells of the host.

Polylectic: In Hymenoptera, especially wild bees, visiting a broad range of plants for pollen and nectar. But frequently only a single species of plants is visited on sequential trips for pollen.

Polymerase Chain Reaction (PCR): A method by which a specific nucleic acid

sequence can be exponentially amplified in vitro resulting in a quantity of DNA sequence. The technique allows the detection and retrieval of a DNA sequence that constitutes a minor component of original DNA mixture.

Polymorphism: Polymorphism refers to the existence of several different forms of the same stage of a species. In many insects polymorphism is the result of variation in the hormonal milieu, especially the concentration of juvenile hormone. Examples of hormonally controlled polymorphism are caste differentiation in the social insects, polymorphism in aphids, and continuous polymorphism of locusts.

Polynactins: Polynactins are mitocidal antibiotics that are produced by *Streptomyces aureus*, which consist of tetranactin, trinactin and dinactins. The major component is tetranactin. Polynactin act as a uncoupler of oxidative phosphorylation in mitochondria.

Polynomial Nomenclature: A system of nomenclature consisting of scientific designation of a species through more than two words; the antecedent of Linnaean 'binomial' system.

Polyphagous: Insects that accept a wide variety of plants for food. A polyphagous insect species may be able to extend its range widely, even to other continents if opportunities are provided. Polyphagous species feed on a variety of the plant species that may contain a diversity of defences. Lacking specific detoxication mechanisms, they are forced to use less nutritious tissues that may be heavily defended by quantitative defences.

Polyphagy: Insects that accept a wide variety of foods, although they may still show decided preferences (e.g., migratory locusts). Robberflies and preying mantises are polyphagous predators, while cockroaches are polyphagous detritivores. Polyphagy is advantageous to the insect species in the sense that food is available with limited searching and these species are in no danger of food shortage if a particular plant is decimated.

Polyphenism: A phenotypic difference between generations that lacks a genetic basis and is entirely determined by the environment often is termed polyphenism. This phenomenon often occurs in pierid butterflies and aphids.

Polyphyletic: A group of species having different ancestors.

Polyploidy: A condition in which the nuclear complement of chromosomes is an integral multiple (greater than 2) of the haploid number.

Polypod Larva : Sometimes also known as **eruciform** larva. A typical caterpillar with soft cylindrical body, a thin skin, six short legs on the thorax, several pairs of prolegs or cushion feet on the abdomen and reduced or no caudal appendages.

Polysaccharide: A carbohydrate produced by the combination of many molecules of a simple sugar or similar substance.

Polythetic: Of taxa, in which each member has a majority of a set of characters.

Polytopic: Occurring in different places as, for instance, a subspecies composed of widely separated populations.

Polytrophic Ovarirole: A type of egg tube present in most insects, consisting of a successive series of chambers, each of which contains trophocytes for nourishing the developing egg cells.

Polytypic Species: A genus which includes several related species.

Polyvoltine: Producing several broods in one season.

Pome: A simple, fleshy fruit formed by the development of floral parts that surround the ovary, characteristics of certain genera of the rose family.

Population: Population is a group of individuals of the same species within given space and time constraints.

Population Dispersion: The pattern of spacing shown by numbers of a population

within its occupied habitat and the total area over which the given population may be spread.

Population Dynamics: Population is a group of individuals of the same species living in limited and defined area. Many insect species may have extremely stable population generation after generations but on the other hand some insect species could be extremely variable in their population size with numbers rising rapidly in one or two generations to extremely high levels and then falling just as rapidly to very low numbers. Stability in insect populations have been well documented through light trap collections. In contrast many other insect populations experience such outbreaks of high population levels as to constitute serious and disastrous economic pests. Locusts are an example of unpredictable history of reaching epidemic levels in some years but not in others. Population growth may be positive or negative, this results respectively in an increase or decrease in the number of individuals. In order to follow the changes it is necessary to determine the number of individuals in a population.

Population Growth: The study of changes in populations of organisms and of the reasons for such changes. Populations under ideal conditions have the capacity for exponential increase. Such an increase in population is described by the equation : $\frac{dN}{dt} = (b-d) N$, where $\frac{dN}{dt}$ = instantaneous rate of increase ; N =population, t =time, b and d =average birth and death rates per individual per unit. The average birth (natality) and death (mortality) rates b and d can be represented as $(b-d)=r$, where r is the intrinsic rate of increase of a population. The population equation then becomes $\frac{dN}{dt} = rN$. If b is greater than d , then the population is growing; if b is equal to d , the population is stable ($r=0$); if b is less than d , the population is decreasing in size.

Population Replacement : A somewhat different form of biological control potentially useful against insects and involves the

replacement of an injurious population with an innocuous or less harmful one. The methodology may involve the gradual replacement of a pest by an introduced species or eradication of a pest by some other means of control followed by introduction of a more desirable species to fill the void and prevent reestablishment of the original pest. It may be possible to replace vectors of plant, animal, or human diseases by species that are non-vectors or species that attack other plants or animals so as to reduce their nuisance.

Population Resilience: Capacity of a population to adapt to change or to persist in a changing environment.

Population Stability: The ability of a population to absorb disturbance and to return to an equilibrium state.

Pore Canals: Tiny tubes connecting the cellular and cuticular layers of the insect integument. The pore canals contain very thin filaments within which are coiled epicuticular filaments. Within the pore canals, they run from the surface of epidermis and through epicuticular layer to open in the wax layer. In the integument of cockroaches, approximately 200 pore canals arise from each epidermal cell, equivalent to 1.2 million/mm². The pore canals transport lipids produced by the epidermal cells to the surface of the newly formed epicuticle. Pore canals are absent in the transparent cuticles, such as those that cover the compound eyes.

Porrect: Extending forward horizontally; head or antennae that project anteriorly and horizontally.

Posterior: Hind or rear.

Posterior Cell: One of several cells extending to the hind (posterior) wing margin.

Posterior Tentorial Pits: The points of formation of posterior arms of the tentorium arise from the postoccipital sulcus, and these points are seen externally as deep pits in the occipital groove, the posterior tentorial pits.

Postgena: Part of the head which extends

downward and back of the gena. In Hemiptera (Heteroptera), the postgenae unite forming a postgenal bridge. In the Coleoptera and Neuroptera who have prognathous head, the postgenae are usually enlarged.

Postgenital Segments: Abdominal segments 10 and 11, the last of the insect's body are postgenital segments. They are quite small and often fused or not externally visible. In many insects segment 11 bears a pair of the appendages, the 'cerci'.

Posthumeral Bristle: A bristle on the anterolateral surface of the mesonotum, near the margin of the humeral callus (Diptera).

Postlabium: The basal region of the labium, which hinges with the head membranes. It represents the fused cardo of the maxillae. Postlabium is often divided into two parts, a basal 'submentum' and an apical 'mentum'.

Postmarginal Vein: Vein along the anterior margin of the front wing, beyond the point where the stigmal vein arises.

Postmentum: The proximal part of the labium of an insect. Prementum articulates basally with the postmentum by the labial suture. The postmentum is subdivided into a distal sclerite, or mentum, and a proximal sclerite, the submentum. Postmentum corresponds to the maxillary cardines plus the sternal component.

Postnotum: Also called the **postscutellum**, the hindmost dorsal sclerite on either of the wing-bearing segments of an insect. A typical notum or tergum, is at any rate in its early stages is divided into three parts: **prescutum**, **scutum** and **scutellum**. Postscutellum when present is immediately behind the scutellum and is formed by hardening of the intersegmental membrane.

Postoccipital Sulcus: A groove bordering the foramen magnum, and running dorsally between the posterior tentorial pits. It separates the maxillary and labial segments and internally forms a strong ridge to which are attached the muscles used in moving the head.

Postocciput: The extreme posterior rim of the head. It lies between the postoccipital suture and the foramen magnum. It is quite narrow and bears a pair of occipital condyles.

Post-Plant: Reference to treatments applied to a crop after planting.

Postscutellum: In flies (Diptera), the area just behind or beneath the mesoscutellum.

Postural Hairs: Rows of specialized hairs/setae with sensory receptors (proprioceptors) at their bases so that a change of position of the hairs give the insect information about its posture. Postural hairs are chiefly situated at the joints, especially between the head and thorax, and between thorax and abdomen.

Postvertical Bristles: A pair of converging or diverging bristles behind the ocelli on the head of flies (Diptera).

Potential Pest: A pest which has the potential to be serious but which remains usually suppressed by natural regulating factors. In these pests, general equilibrium position (GEP) does not cross economic injury level (EIL) even under favourable conditions. Any changes in the cropping pattern or cultural practices in the ecosystem may, however, push their GEP higher and there is a danger of economic damage from these pests if control operations against other categories of pests are undertaken indiscriminately.

Potentiation: An increase in the bioactivity of two compounds to produce an effect greater than would be expected from a simple algebraic summation of the effects of the two compounds individually administered.

Potter Tower: A twin-fluid nozzle carefully centred at the top of an open-ended metal tube to spray vertically down onto a horizontal plate 125 mm below the lower flange of the tube. The tower is tapered at the top to create turbulence which evens up the stream of spray. Various improvements in the nozzle design and modification to the tower have been incorporated into the original design.

Pouch-Makers: Bumblebee species that build special wax pouches and are adjacent to groups of larvae and fill them with pollen.

Preaccess Interval: The interval of time between the last application of pesticide to an area and the safe access to the area for domestic livestock and man.

Prechelicera: Anterior to the chelicera, as applied to segment of mouth region or gnathosoma in Arachnida.

Precision: A statistical measure of repeatability of an estimate relative to a group of estimates from the same population at the same time. Precision measures the degree of error in making estimates and is usually expressed as percent standard error of the mean. This value, known as relative variation (**RV**), is calculated as : $RV = (SE / \bar{x}) \times 100$, where **SE** is the standard error of the mean and \bar{x} is the mean. With RV as a measure of precision, a good criterion for practical pest management programs is to obtain values near 25. For population research, greater precision is desirable and values near 10 are sought. Because SE decreases with increasing numbers of samples, precision can be improved by taking more sampling units.

Precipitation: Amount of rain, snow, sleet or hail that falls; a chemical process in which solid material is separated from a liquid.

Precocenes: Substances which kill the cells of corpora allata when applied to the cuticle of some species. By destroying the source of juvenile hormone, precocenes accelerates metamorphosis to yield a precocious (and sterile) adult. But many species are insensitive to precocenes. Resistant insects can degrade precocenes and thus nullify the effect of the poison.

Predacide: Chemicals used to poison predators.

Predaceous: Preying on other insects.

Predator: A free living organism that feeds on other, commonly smaller, living organisms (prey) ; the prey is killed and eaten. Predators kill their prey more or less immediately. A

predator kills and consumes a number of the prey insects during its life. Predatory insects may be searchers, stalkers, or trappers. Searchers move about actively, capturing insects in the air (dragonflies), on the ground (ground beetles), or on vegetation (lady-bird beetles). Stalkers lie in wait for prey, then approach it stealthily and pounce on it (preying mantids). Antlions behave as trappers, their larvae build conical pits in sandy soil into which ants and other insects fall. Insects like dragonflies employ more than one strategy, the immature stages are stalkers while the adults are aerial searchers. Mouthparts of different predators are modified for chewing or piercing the exoskeleton of their prey. In many cases, predators inject digestive fluids into the prey rendering it immobile and flaccid while the body fluids are sucked out (robber flies). The most important predators in biological programme are insects and mite.

Predisposing Factors: Factors which through their actions render an organism susceptible to a certain disease; conferring a tendency to decrease.

Pre-Emergence Treatment: Treatment of a plant usually with a pesticide, before the plant has emerged from the soil.

Preference: This term is used for the group of plant characters and insect responses that cause the insect to use or avoid a particular plant or a variety of plants for oviposition, for food or for shelter. The plant characters that seem to be involved in the operation of preference include type of food (nectar, growing shoot tissue etc.), type of leaf or other plant surface (flat, smooth, hairy etc.), chemical constituents of plant in relation both to odour and to taste, and colour of plant.

Pregenital: Anterior to the genital segments of the abdomen. There are eleven abdominal segments in an insect embryo, the first segment joins the abdomen to the thorax and may be quite reduced. Segments 2 to 7 are quite similar to each other, and the segmental nature of an insect is most apparent in this

region. In most adult insects, each of these segments bears a dorsal sclerite, the 'tergum', and a ventral sclerite, the 'sternum'. The lateral area is largely or wholly membranous, allowing the segment to expand and contract dorsoventrally. The terga and sterna of adjoining segments are connected by membranes, allowing anterior-posterior expansion, contraction and twisting are controlled by muscles. In all adult insects excepting bristletails, pregenital segments lack appendages. Segments 8 and 9 are genital segments, and these segments usually bear external organs that assist in reproduction. Tenth and eleventh segments are postgenital.

Pre-Harvest Interval: The time interval between the last application of pesticide and the safe harvesting of edible crops for immediate consumption.

Prehensile: Adapted for grasping.

Prelabium: The apical region of the labium including various lobes and processes. The central portion or body is 'prementum' (sometimes also called 'stipulae') which bears a pair of labial palpi, one on each side of the prementum. Each palpus is 3-segmented in generalized forms.

Pre-Linnaean Name: A name published prior to January 1, 1758, the starting point of Zoological Nomenclature.

Premenum: Distal part of the labium. It is homologous with the maxillary stipites. The prementum bears a pair of inner 'glossae' and a pair of 'paraglossae' homologous with the maxillary lacinia and galea respectively, and a pair of labial palpi. When the glossae and paraglossae are fused, they form a single structure known as 'ligula'. Like ligular lobes and palps, prementum is also independently movable.

Preoral Cavity: Anterior to or in front of the mouth. Preoral cavity is formed by the anterior labrum, the lateral mandibles and maxillae, and posterior to the labium. Food is chewed into small pieces, mixed with salivary secretions from 'labial glands' for lubrication

and very limited carbohydrate digestion, and pushed into the mouth and swallowed with the assistance of a muscular 'pharynx'.

Preoviposition Period: The period between the emergence of an adult female and the start of its egg laying.

Preplanting Treatment: Any pesticidal treatment given before the crop is planted.

Prepupa: A quiescent stage of the last larval instar immediately preceding pupation. During this stage, feeding usually ceases and sometimes a cocoon is produced. It is found in some Diptera, in thrips (Thysanoptera) the next to the last nymphal instar in which the wing pads are present and the legs are short and thick. Also occurs in male scale insects.

Prescription: Recommendation of a strategy or course of action.

Prescutum: Anterior portion of the scutum, usually delimited by a suture. On the meso- and metanotum transverse or prescutal ridge are developed.

Presocial: Applied to the condition or to the group possessing it in which individuals display some degree of social behaviour that is short of eusociality. Presocial species are either subsocial, i.e. the parents are for their own nymphs and larvae, or else parasocial, i.e. showing one or two of the three traits namely cooperation in the care of young, reproductive division of labour, overlap of the generations of life stages that contribute to colony labour.

Presternum: A sclerite on the anterior part of the sternum divided by the presternal suture.

Prestomal Teeth: In Diptera which merely suck or sponge up their food (e.g., housefly and blowfly), the mandibles have disappeared and the elongate feeding tube, 'proboscis', is a composite structure that includes labrum, hypopharynx and labium. The proboscis is divisible into a basal 'rostrum' bearing the maxillary palps, a median flexible

'haustellum' and two apical 'labella'. The latter are broad sponging pads, equipped with 'pseudotrachea' along which food passes to the oral aperture. Tsetse flies and stable flies have lost their pseudotracheae, and labium is elongated into a beak terminating into sharp teeth for piercing the tissues and liberating blood.

Pressure: The amount of force produced by a particular amount of gas or liquid in an enclosed space or container. Pressure of a liquid pesticide forced out of a nozzle to form a spray is measured in pounds per square inch or kilogram per square centimetre.

Prestomium: A 'mouth' to which the food channels or pseudotrachea converge at the bases of the two labella or oral lobes on a blowfly, housefly etc. It is not a true mouth, since this is further back at the entrance to the pharynx. In biting and sucking insects, the aperture between the tip of the mouthparts serving for the intake of food.

Presumptive Organization: Arrangement of cells in the embryo into groups which in normal development become a particular organ or tissue.

Pretarsus: The tarsus is divided into 2 to 5 subsegments, or 'tarsomeres'. The pretarsus is the smallest segment after the tarsus and is moved by muscles that originate from the tibia and femur and pass to the pretarsus by a slender apodeme. In most of the insects, pretarsus is represented by a pair of 'ungues' or 'tarsal claws'. In addition, two-lobed pulvilli are also present in the pretarsal area. Claws enable insects to move on rough surfaces. The arolium and pulvilli or other types of adhesive pads and hairs on the tarsi assist in movement across smooth surfaces. Tarsal pads are either coated with a sticky secretion produced by gland cells in the pad or covered with a dense mat of special adhesive hairs. Some authors consider pretarsus as a terminal part of the tarsus.

Preventive Measure: A measure applied in anticipation of pest attack. Preventive control measures can be applied only when one

knows through long experience that a certain pest will develop to a damaging degree in a given area year after year. Pesticide applications early in the season are more efficient than later one. Early treatments tend to control a pest species before it has reached its maximum rate of development. Tree fruit pests are often controlled this way.

Prey: Insects killed and eaten by the predators. If the insect is killed by a parasitoid or pathogen, the insect is called a host but not the prey.

Primar Pheromone: A chemical produced by individual of one species that has a fundamental physiological effect on another individual of the same species.

Primary Homonym: Each of two or more identical species-group names which at the time of original publication were proposed in combination with the same generic name.

Primary Host: A host in which a parasite lives for much of its life cycle and in which it becomes sexually mature.

Primary Infection: The initial introduction of a disease into a crop by insect vectors invading from elsewhere.

Primary Parasite: One which is parasitic on a plant feeding, predatory or scavenging species but never on another parasite.

Primary Reproductives: In termites the queen and king which are former alate (winged) adults from an established colony are a pair of primary reproductives. They shed their two pairs of wings after a short dispersal or the nuptial flight. Primary reproductives are large, more sclerotized individuals whose sole job is to reproduce.

Priority: The principle that of two competing names for the same taxon (below the rank of an infraorder), ordinarily that is valid which was published first.

Probit Analysis: Insect populations are made up of individuals which vary in a variety of ways, including their susceptibility to the poisons. So it is necessary to have a standard

measure to determine the toxicity of pesticides both for target and nontarget organisms. This is derived from a statistical method called the 'probit analysis', which provides a measure of the response of a population sample over a predetermined period of time to various doses of the pesticide. If several geometrically increased doses are applied to a population sample, the cumulative percentage killed increases with increased dose level. When cumulative percent mortality for each dose is plotted against the logarithm of the dose, a sigmoid curve results. However, such a curve based on real data is difficult to plot, so the normal procedure is to convert the cumulative percent mortality values to probit values, using standard statistical tables. For the sake of convenience in calculation, 5 is added to each standard deviation. Thus, probits for 0, 50 and 100% mortality are $-\infty$, 5.0, and $+\infty$, and if the data fit a normal distribution, probits 4.0 and 6.0 would represent 16% and 84% mortality respectively. When the data are plotted in this manner, it is possible to fit a straight line to the data points. Each probit thus represents a theoretical mortality that can be expected to result from the application of a particular dosage of a pesticide. However, from the shape of the sigmoid curve, the relationship between dosage and mortality can be known. It is more accurate at 50% than at the extremes, consequently the standard measure of toxicity is the LD_{50} or the log dosage that will kill 50% of the population.

Probit Regression Line: Equation of the line showing relationship between percent mortality and dose or dosage; used to calculate LD_{50} .

Proboscis: Also known as rostrum. The extended tubular mouthparts of an insect; particularly of the piercing-sucking pattern. The basic mouthparts of all insects are the labrum, mandibles, maxillae, hypopharynx and the labium. The proboscis may be formed by a lengthening of any or all of these. Proboscis is found in many Diptera, Hymenoptera, Lepidoptera and Hemiptera. In butterflies and moths, it consists of a coiled

spring-like structure derived from two fused portions of the maxillae. In the sponging mouthparts of housefly and its close relatives, elbowed proboscis is formed by the fusion of the labium and maxillae. In Homoptera, different mouthparts are modified into a group of piercing stylets that work as a unit known as 'fascicle'. Both the food and salivary channels are found between a pair of stylets developed from the maxilla and these maxillary stylets are grooved to slide on one another, and mandibular stylets outside of them are connected functionally by interlocking grooves; the four stylets make up the fascicles. The tips of the stylets may have minute teeth for tearing tissues. The labium is a relatively coarse and jointed enveloping sheath that holds the other mouthparts when at rest, it does not enter the tissue during feeding. In mosquitoes the mouthparts also consist of stylets but their component parts differ from Homoptera. In them, labrum-epipharynx and hypopharynx form a food channel. The maxillae and mandibles form paired, piercing stylets that may bear fine teeth at their tips. The labium has at its tip a lobed and soft sensory structure—the labellum. The labium is unjointed and serves as a sheath for the rest of the mouthparts. It flexes back during feeding and does not actually pierce the animal tissue.

Procerebrum: A term sometimes used synonymously with protocerebrum (the fore-brain of an insect), but more strictly including the protocerebrum plus parts derived from presegmental ganglia.

Proctodeal Valve: In insects, a valve in the anterior end of the hindgut that serves as an occlusor mechanism.

Proctodeum: The hindgut extending from the ventriculus to the anus. It is ectodermal in origin and is lined by cuticle, 'intima'. The malpighian tubules develop as evaginations of the proctodeum immediately posterior to the mesenteron.

Procuticle: The cuticle which is mainly

produced by the epidermal cells, usually includes two primary layers, the inner procuticle and the outer epicuticle. Both layers are present over much of the body surface and in the cuticle that lines major invaginations such as the foregut, hindgut and tracheae. However, the procuticle is very thin or absent. The procuticle forms the bulk of the cuticle and in most species is differentiated into two zones, endocuticle and exocuticle, which differ markedly in their physical properties but only slightly in their chemical composition. Procuticle is composed almost entirely of protein and chitin. Chitin makes up between 25 and 60% of the dry weight of procuticle but not found in the epicuticle.

Produced: Projecting ; extended.

Producer: An autotrophic organism or population, usually green plants which procure energy from outside the ecosystem and through the process of photosynthesis convert this energy into living organic matter within the system.

Product: A term used to describe a pesticide as it is sold. It usually contains the pesticide chemical plus a solvent and additives.

Progeny: Offspring; young; produced either sexually or vegetatively.

Prognathous: Having the head horizontal and the mouthparts projecting forward (e.g., many beetles).

Prognosis: 1.Forecast of a probable course of a disease, 2.Anticipation of pest problems before they occur and prediction of the outcome of these if left unattended.

Progressive Provisioning: In solitary bees and wasps, the practice of providing the larval food over a period of time. Such species oviposit on one of the first prey items acquired or in an unprovisioned cell, later supplying additional food as needed by the growing larva. In the most advanced species several larvae are tended simultaneously. The resultant close contact between the adult females and their offspring is probably

requisite to true sociality ('eusociality') occurring in Vespoidea and Apoidea. However, eusociality is rarely found in the Sphecoidea.

Proinsecticides: Proinsecticides are compounds that require metabolic activation to release the toxophore. Proinsecticidal compounds may be activated by the primary biochemical target, by a detoxication system, by symbiont metabolism, or by an abiotic route.

Prokaryote: Microorganisms that lack membrane-bound organelles (e.g., bacteria and mollicutes).

Prolegs: Stumpy leg-like appendages segmentally arranged, are present on the abdomen of caterpillars and sawfly larvae. They are known as prolegs, pseudopods and larvapods. Most caterpillars of butterflies and moths have five pairs of prolegs. But loopers (Geometridae) have only two pairs of prolegs. Larvae of sawflies have 6-7 pairs of prolegs. Such abdominal appendages are used for the grasping and for this purpose in caterpillars, there are numerous small hooks called 'crochets'. In larvae of sawflies, crochets are not found. In caterpillars, characteristic arrangement of crochets is found in different groups.

Prolonged Exposure: Contact with a pesticide chemical or its residue for a long time.

Promotion: The movement of the coxa resulting in protaction.

Pronotum: The dorsal surface or sclerite of the prothorax. In some of the insects it is enlarged to form a shield covering the remaining thoracic portion (e.g., grasshoppers). The pronotum is commonly quite small and undeveloped compared to the nota of the wing-bearing segments. In beetles, mantids and many bugs the pronotum is expanded. In cockroaches, it forms a shield that covers part of the head and mesothorax.

Pronymph: A newly hatched first instar nymph of a dragonfly or other

hemimetabolous insects. The pronymph is covered with a loose cuticle that serves to protect the insect as it emerges from the substrate. This cuticle is shed usually within a few minutes of hatching.

Prop Roots: Adventitious roots arising from the stem above ground level.

Propagative Viruses: Viruses that multiply in the insect body (e.g., circulative viruses).

Propellent: An inert ingredient in self-pressurized pesticide products that produces the force required to dispense the active ingredient from the container.

Prophylactic: This term is used to qualify a chemical or treatment used to prevent a disease producing organism from invading the individual or crop so treated, as distinct from one used 'curatively' on the individual or crop. Eradicant is often used in the sense of 'curative' when describing the treatment of fungus diseases of crops. 'Protectant' is sometimes used in the sense of prophylactic. Prophylactic control measures are favoured under conditions where, **1.**Regular and frequent pest attack occurs, **2.**Pests are endogenous, **3.**There are multiple pest complexes, **4.**High rate of pest increase and high pest damage cost, **5.**Poor natural control, **6.**Limited choice of control measures, **7.**Monitoring techniques are difficult, and **8.**There is poor access to advice.

Propleuron: The pleuron or lateral cuticular plate of the prothorax.

Propneustic: A term used to denote the insects whose only functional spiracles are those in the prothorax. Such a condition is rare but is found in the pupae of certain mosquitoes (Diptera), and these pupae are susceptible to oil treatment.

Propodeum: Also known as the 'propodeon'. In the higher Hymenoptera (Apocrita), the entire first abdominal segment, the 'propodeum' is fused with the metathorax and the conspicuous waist of these insects occur between the first and second abdominal segment.

Propodosoma: Body region (of idiosoma) bearing first two pairs of legs in mites and ticks. Propodosoma in family Trombiculidae is separated from the metapodosoma (region bearing last two pairs of legs) by a deep furrow, that is why sometimes gnathosoma and propodosoma together are referred to as the proterosoma. Sensilla that arise from pits, pseudostigmata, or sensillae bases, are usually found on the propodosoma. In Astigmata, propodosomal shield is almost absent.

Propolis: A collective term for the resins and waxes collected by bees and brought to their nests for use in construction and in sealing fissures in the nest wall. Propolis is the sticky, resinous material gathered by workers from buds and bark of trees, and possibly from other vegetation. Propolis is a highly complex mixture of waxes, resins, oils and a small amount of pollen, its composition is highly variable and is probably related to the species of plants from which collected. In the hive propolis is used to fill cracks and crevices, varnish over rough surfaces, and reduce or close openings to the outside. It is considered as a contaminant in beeswax.

Proprietary Chemical: A chemical made and marketed by a person having the exclusive right to manufacture and sell it.

Proprietary Name: Distinguishing name given by the manufacturer to his particular formulated product.

Proprioceptors: Also sometimes called postural hairs. The groups of sensilla that provides the insect with the information about its position in its environment and the position of the different parts of the body relative to one another. Five types of proprioceptors occur in insects: hairs, plates, campaniform sensilla, chordotonal organs, stretch receptors and nerve nets. In common, they respond tonically and adapt very slowly to a stimulus.

Prosoma: The foremost body region of arachnids (e.g., spiders, mites, ticks) to which the walking legs are attached. Prosoma

includes the gnathosoma and podosoma but excludes the opisthosoma.

Prosternum: The ventral surface or sclerite of the prothorax.

Prostomium: The unsegmented part of the body in front of the mouth.

Protraction: The complete movement forwards of the whole limb relative to its articulation with the body.

Protandry: In hermaphrodites, the phenomenon of development of male reproductive system before the female system.

Protectant: A chemical applied to the plant or animal surface in advance of the pest (or pathogen) to prevent infection or injury by the pest.

Protection: The means taken to control a pest organism on a given host or to prevent damage.

Protective Clothing: Clothing worn by a spray operator to protect from the toxic effects of crop protection chemicals. This may include rubber gloves, boots, apron, respirator, face mask, etc.

Proteins: Highly complex organic compounds made up of hundreds of 'amino acid' molecules.

Proterosoma: In mites, the gnathosoma and propodosoma are collectively known as the proterosoma.

Prothetely: The appearance of an abnormal monster resulting from a larva or pupa developing some of the characteristics of pupa or adult. Prothetely may sometimes be induced by microbial or virus infections in insects.

Prothoracic Gland: The prothoracic (thoracic or ecdysial) glands are inconspicuous tissues often associated with the first pair of thoracic spiracles. They produce a group of hormones, the 'ecdysones' (=growth and differentiation or moulting) that activate the epidermal cells to produce both a new exoskeleton and moulting

fluid. When juvenile hormone is absent or is in low concentrations, ecdysones may induce metamorphosis of the immature to an adult. The prothoracic glands degenerate at the last moult to adulthood in most insects but remain functional in those Apterygota that continue to moult as adults.

Prothorax: The first or anterior segment of the thorax. It bears first pair of legs. The terga of prothorax is known as pronotum. The pronotum is usually a simple plate, but in some insects it is greatly enlarged to cover the head or other parts of the body. In the grasshopper the pronotum extends back over the pterothorax and has several transverse sutures. The sutures are related to the musculature and do not correspond with sutures on the pterothoracic nota.

Protocerebrum: The front part of the brain of an insect is known as protocerebrum which gives rise to two large optic lobes. Special cells within the protocerebrum secrete a substance that indicates the insect hormone system. Protocerebrum is the largest and most complex system of brain and contains both neural and endocrine (neurosecretory) elements. Anteriorly it forms the proximal part of the ocellar nerve, and laterally is fused with the optic lobes. A pair of 'corpora pedunculata' (mushroom-shaped body) lies within the proto-cerebrum.

Protonymph: The second instar in the development of mites and ticks, it bears four pairs of legs and looks like adults in most mites but in oribatids, uropodids and acarid mites, however, nymphs differ markedly from the adults in some cases.

Protopam Chloride (2-Pam): An antidote for certain organophosphate pesticide poisoning, but not for carbamate poisoning.

Protoplasmic Poisons : Pesticides which kill insects by precipitating protein from the tissues. Arsenicals are covered in this group.

Protopod Larva: Most primitive type of insect larva with unsegmented abdomen and rudimentary appendages. Such larvae are

usually endoparasites and can only survive where food is abundant, making locomotion unnecessary; are characteristic of Proctotrupeoidea—a group of minute parasitic Hymenoptera.

Protozoa: Protozoa especially in the genus *Nosema* have been reported as important insect pathogens for biological control. *Nosema locustae* has been successfully used against the grasshoppers in rangelands. A real problem with protozoa is that they can only be propagated on living insect hosts, which makes their commercial multiplication extremely expensive.

Proventriculus: A structure posterior to the crop that often bears the sclerotized teeth or spines. Proventriculus is muscular and acts primarily as a valve regulating the rate at which food enters midgut. It acts as a filter separating liquid and solid components, or as a grinder to further break up solid material. Its structure is accordingly varied, in species where it acts as a valve the intima of the proventriculus may form longitudinal folds and the circular muscle layer is thickened to form a sphincter. When it acts as a filter, the proventriculus contains spines which hold back the solid material, permitting only liquids to move posteriorly. When the proventriculus acts as a gizzard grinding up food, the intima is formed into strong radially arranged teeth and a thick layer of circular muscles cover the entire structure.

Proximal: Nearer to the body or to the base of an appendage.

Prozona: Portion of pronotum in front of principal sulcus.

Przibram's Rule: An empirical rule observed in certain insects according to which the weight of an insect doubles during each instar and the linear dimensions are increased at each moult by the ratio 1.26. This can be explained on the assumption that during each stage every cell divides once and grows to its original size. Przibram showed as support for his rule, that the density of epidermal cells beneath the

cuticle remained constant from one instar to the next. However, it is now known that it is the increase in area of cuticle that determines the increase in number of epidermal cells. Even in many insects growth is not simply a matter of cell division, too much of histolysis and rebuilding of tissues occurs in each moult cycle, and in many Hymenoptera and Diptera cell division does not occur in larval instars. This rule is more applicable to Hemimetabola than to Holometabola, but is of doubtful value for many insects where the weight increases several fold with each moult.

Pseudoposematic Characters: False warning colours. Batesian mimicry in which a harmless insect bears a resemblance to a poisonous or dangerous one and is thus given a degree of protection since predators will tend to avoid both.

Pseudergates: In family Termitidae, pseudergates are last instar worker nymphs that have lost the capacity to develop further into soldiers or reproductive. These older nymphs are without wing pads and these may remain 'arrested' and worker-like throughout rest of their instars. Pseudergates may also be derived from other partly differentiated castes by regressive moults resulting in loss of wing pads. Soldiers and sexually functioning reproductives are final instars and do not regress to pseudergates.

Pseudocelli: Skin pores on springtails (Collembola).

Pseudocone Eyes: Compound eyes in which the crystalline cones are imperfectly formed and consist of a mass of liquid (e.g., housefly eyes). In eyes of this type, the cuticular lenses form the main part of the optical system.

Pseudohalteres: Reduced or vestigial fore wings of Strepsiptera in the form of small club-shaped process. They resemble but are not homologous with the halteres or balancers of Diptera, the latter being reduced hind wings.

Pseudoplacental Viviparity: In this type of viviparity insects produce eggs, containing

little or no yolk, which are retained by the female and the embryo is nourished by the wall of the genital tract but not orally. A placenta like organ for transfer of nutrients may be developed by maternal or embryonic tissues or both. Examples are found in Hemiptera (Aphidoidea, Polyctenidae).

Pseudopods: False legs on the abdomen of the larvae of butterflies, moths and sawflies.

Pseudopupa: A resting stage resembling a pupa between two larval instars (e.g., Meloidae). In blister beetles, early larval instars are parasitic on grasshopper eggs or bee larvae and their food stores; a non-feeding, over-wintering stage, the pseudopupa or coarctate larva then follows, after which it develops into either another active feeding stage or a true pupal stage.

Pseudoresistance: Apparent resistance that results from the expression of transitory characteristics of potentially the susceptible hosts. Host evasion, induced resistance, and escape are included in this category.

Pseudoscorpions: Small arachnids, seldom over 5 mm long, scorpion-like in general appearance but without sting. They have large pedipalps, pincer-like, but abdomen is short and rounded. Pseudoscorpions are predaceous, chiefly found in leaf litter and crevices. They are not of major importance, sometimes phoretic on insects.

Pseudotracheae: In family Tabanidae (Diptera), the apex of the labium is greatly enlarged in two lobes called the labellum. The undersides of the lobes are traversed by grooves known as pseudotracheae. The pseudotracheae direct the flow of blood to the tip of the labrum and the blood is sucked into the labral food canal.

Pseudovipositor: The slender tube to which the posterior part of the abdomen is reduced in the female of certain insects.

Psocoptera: Hemipteroid order, representatives have large head which bulges at the front. Compound eyes bulging, mouthparts biting, downward facing.

Antennae long and thread like. Wings held roof like over the body at rest. Thorax slightly humped in side view. Short winged and wingless forms frequent.

Psychophily: Pollination of plants by butterflies. Such plants generally have red, yellow or blue upright flowers that have upright anthesis.

Pteralia: The small sclerites at the base of an insect's wing which make up the articulation, including the humeral plate of the wing and the axillary sclerites.

Pterergate: An exceptional form of worker ant having the rudiments of wings.

Pterines: Pterines are most common pigments contributing bright colours to insect cuticle and are also important as the pigment that separates the individual receptor elements that make up the compound eyes. Leucopterin is white, xanthopterin is yellow, and erythropterin is red.

Pteroic Acid: An essential substance for growth; a constituent of the vitamin folic acid, used for the formation of pterin pigments (pterines) in insects.

Pteropleuron: A sclerite on the side of the thorax just below the base of the wing.

Pterostigma: A thickened opaque or dark spot along the costal margin of the wing, near the tip (e.g., Hymenoptera, Odonata, and Psocoptera).

Pterotheca: The part of a pupal skin that covers the developing wings of an insect.

Pterothorax: In most adult insects, the wing-bearing segments of the thorax i.e. the mesothorax and metathorax, are together called the pterothorax. These segments are usually tightly fused and enlarged to each other to provide support for the wings. Both the segments bear one pair of legs on them.

Pterygium: A small basal wing-lobe of certain insects. Sometimes this term is used for any other wing-like lobes on any part of the body.

Pterygota: A subclass of class Insecta.

Representatives of pterygota are primarily winged but sometimes secondarily wingless. Mesothoracic and the metathoracic segments enlarged and bear the wings or secondarily wingless; mandibles primitively dicondylic, adapted for the chewing or highly modified; abdomen primitively with 11 segments, the anterior 10 segments with appendages and the eleventh segment frequently with cerci; employ direct insemination via copulation and moult only until sexual maturity.

Ptilinum: A bladder like organ that when inflated extends from the front of the head of the adult of some species of flies and ruptures the puparium thereby facilitating emergence. After emerging, the ptilinum deflates and is retracted into the head and is lost.

Pubescent: Covered with short densely set hairs. It affects ease of wetting of foliage ; also retention of spray on foliage.

Puddling: The habit of male butterflies, especially in tropics, of congregating at damp soil and the margins of puddles in order to imbibe mineral salts.

Pulsatile Organs: Accessory pumping organs sometimes present in the blood system of an insect at the bases of the antennae and the wings.

Pulvillus: Paired, pad like structures on the lower surface of tarsi in some Orthoptera or in association with each pretarsal claw or 'ungue' as in Diptera. These pads are either coated with a sticky secretion produced by gland cells in the pad or are covered with a dense mat of special adhesive hairs. These adhesive structures help insects to traverse waxy plant leaves or smooth window panes.

Punctate: Pitted, covered with small punctures.

Pupa: The term pupa is derived from the Latin word meaning baby or child. Pupa is defined as the resting or inactive period in all holometabolous insects, this is an intermediate stage between a larva and the adult. In this stage insect is non-feeding, usually delicate and helpless. Most

conspicuous changes take place during this period. In many species, during pupal stage an insect survives adverse conditions through diapause. Pupa of insects are classified taking into consideration the degree of freedom of the appendages. They may be: **1.Obtect type** : Appendages are closely appressed to the body (Lepidoptera, many Coleoptera and primitive Diptera), **2.Exarate type** : Appendages are not closely appressed to the body but are free as in Neuroptera, Trichoptera, most Coleoptera, and a few Lepidoptera, **3.Coarctate type:** If the appendages are not visible at all but are obscured by the last larval skin, it is said to be a coarctate pupa. Found in Diptera (Cyclorrhapha) and in some Coccidae and Stylopidae. In the Lepidoptera all butterflies have naked pupae which are generally called **chrysalis**.

Pupa Libra: A 'free' pupa, i.e. one with soft integument and freely moving appendages; an exarate pupa.

Puparium: In the higher Diptera, the pupal case formed from the strongly sclerotized cuticle of the last larval instar which becomes thickened and tanned. At the larval-pupal moult, the cuticle is not shed but remains as a rigid coat around the pupa.

Pupation: To change from larval stage to the pupal stage. Many provisions are made to protect the pupa during this period when the insect is helpless and decidedly vulnerable. Insects frequently retreat to the protected places, before transforming. Many insects pupate in the ground, within curled leaves, or beneath bark. If the natural protection is sufficient, no further covering is necessary. Other insects produce various protective coverings, silk is the most common. Silken cocoons are spun by larvae of the majority of the moths, Neuroptera, Trichoptera, a few Coleoptera, some Diptera, Siphonaptera and Hymenoptera.

Pupation Hormones: The phenomenon of pupation appears to be controlled by the balance of several hormones. The corpus

allatum secretes a juvenile hormone known as 'neotenin' and as long as this is being produced the insect will remain in a larval stage after each moult. After a certain number of instars, however, the production of this hormone slows down, growth hormones take over pupation and metamorphosis follow.

Pupigerous: Containing a pupa.

Pupiparous : Giving birth to mature larvae which are ready to pupate.

Pygidial Glands: Glands opening in the pygidium. They may secrete poisonous or obnoxious substances as a protection for the insect.

Pygidium: The tergum of the last segment of the abdomen; in diaspine coccids a sclerotized region ending the abdomen of the adult female.

Pygofer: The last abdominal segment in leafhoppers.

Pygopodia: A pair of eversible foot-like organs at the hind end of the abdomen of some insect larvae. They are used to assist locomotion in cases where true legs are reduced or absent. For example, dobsonfly and caddisfly larva have appendage on the 10th abdominal segment which helps the larva in grasping the rocks and maintaining position in swift water. These appendages are most often noted in species found in moving water.

Pyloric Caeca: Also called enteric caeca. They are sac-like branches or diverticula from the midgut just behind the gizzard in some insects (e.g., the cockroach). They provide additional surface area for secretion and absorption.

Pyloric Valve: Valvular structure at the anterior extremity of the insect hindgut. It is important regulator of food movement. The valve like function is best developed in caterpillars and beetles.

Pylorus: First part of the hindgut, and from it the malpighian tubules often arise. The pylorus may have a well-developed circular muscle layer (pyloric sphincter) which regulate the movement of material from midgut to hindgut.

Pyrazoles: The pyrazoles are a new class of acaricides with high activity against mites, whiteflies, thrips, aphids and psyllids. They have both contact and stomach action. Fenpyroximate (Acaban®) and Tebufenpyrad (Pyranica®) against mites in field, vegetable and fruit crops are quite effective compounds.

Pyrethroids: A class of insecticides with chemical structure similar to pyrethrum. Natural pyrethroid compounds are derived from pyrethrum flowers and are unstable in light and air. Earlier synthetic pyrethroids (e.g., allethrin, resmethrin) were also unstable in light and air. But the synthetic pyrethroids developed later (e.g., permethrin, cypermethrin, deltamethrin), are much more stable and are very effective against most groups of insects. Most synthetic pyrethroids are relatively safe for the spray operator during mixing and application. Allethrin was the first generation of the pyrethroids. Allethrin proved to be more stable and of longer residual activity than natural pyrethrins, it is very effective against flies and mosquitoes but less toxic to cockroaches and other insects. Its volatility, heat stability, and rapid knockdown effect makes it ideal for use in smoke coils and smoke mats for repellency, biting detergence, and control of adult mosquitoes. Dimethrin, tetramethrin, resmethrin and bioresmethrin are second generation pyrethroids. These compounds have greater activity and possess much greater toxicity. Fenprothrin is the third generation pyrethroid which is more light stable compound. Permethrin, cypermethrin and fenvalerate are other such compounds. Cyprothrin for tick control, flucythrinate and flualinate for spider mite control are the fourth generation pyrethroids. Cycloprothrin and fenpyrithrin are other broad-spectrum pyrethroid compounds.

Pyridazinones: Pyridazinones are novel group of pesticides. Pyridaben (Sanimite®) is a representative compound of this group. These are selective, contact insecticides and are effective against mites, leafhoppers,

psyllids and the whiteflies on fruit trees, vegetables, ornamental plants, and field crops. Pyridaben has rapid knockdown and long residual action. It acts by inhibiting mitochondrial electron transport.

Pyriform: Pear-shaped.

Pyrophyllite: A mineral used as a dust carrier for the insecticides; chemically, H_2O , Al_2O_3 , $4SiO_2$.

Pyrroles: The pyrroles are a new group of insecticides/acaricides having both contact and stomach action. Chlorfenapyr (Pirate® and Alert®) is a representative insecticide of this group. This pesticide is reported effective against whiteflies, thrips, leaf-miners, aphids, caterpillars and mites. Chlorfenapyr kills by uncoupling oxidative phosphorylation in pests. Also ovicidal in some species.

Q

Q/K Ratio: These ratios are used for studying pheromone communication systems. Sex pheromones and alarm pheromones have high ratio of emission rate 'Q' to behavioural threshold concentration 'K'.

Quacking: The calls emitted by virgin honeybee queens in their cells in response to the piping sounds of the first virgin queen to emerge in the same hive.

Quadrat: A sample area enclosed within a frame, usually a square within which an insect or plant community is analysed.

Quantal Response: All-or-nothing response of an organism to a stimulus. Quantal response is predetermined by the researcher but is usually death of the test organism.

Quarantine: **1.** Place where people or animals are kept for the inspection. **2.** Regulations designed to prevent the spread of agricultural pests through the commerce involving certain agricultural products and the restriction of the movement of infected plant and animal material comprise what is referred as quarantine. This type of control is based on the old adage, 'Prevention is better than control'. The objective of quarantines is to exclude potential pests or prevent the spread of established pest with the well-defined limited distribution, establishment of quarantine stations at major ports of entry into an area. Usually the stations are located at international borders though in some cases domestic quarantines are necessary particularly where certain parts of a country are widely separated from the rest. As an

adjunct to quarantine many countries (or areas within countries) have legislation that requires international or interstate shipments of animals or plants or their products to be certified as disease or insect free by qualified personnel prior to shipment.

Quasisocial: A type of social behaviour in which the adults of the same generation use the same nest and cooperate in the care of the young.

Queen: Also known as **gyne** A member of the reproductive caste in semi-social or eusocial, also of a worker caste at some stage of the colony life cycle. Queen is a primary reproductive and in termites typically queen has dark, sclerotized (at least compared to other castes) body with completely developed wings and compound eyes. Queens may or may not be morphologically different from the workers. In family Termitidae, queen undergo extraordinary **physogastry** in which the head and thorax appears as minute stubs on a huge and plump abdomen (with greatly distended tergal and sternal sclerites due to stretching of body wall). In honeybees, queens are 16 to 20 mm long and their sole responsibility is egg production in the hive.

Queen Ant: The fertile female and founder of a colony of ants; a winged insect very similar in appearance to the winged males and usually larger than the wingless workers or incomplete females. When fully grown and when weather conditions are just suitable, the queen flies out for her **nuptial flight** followed by the males. This is the only time she flies

and after being fertilized, she will either return to the same nest or start a new one. Her wings are shed by being rubbed or pulled off and this loss of wings in some way evokes in her an instinct causing her to go underground to avoid the light, and to start laying eggs. A large ant colony may have many queens.

Queen Bee: The fertile female and founder of a colony of bees. In Italian bees, the queen is slightly longer than the workers, with a larger and more pointed abdomen but with relatively shorter wings. Her abdomen is wasp-like, usually without colour bands, and this distinguishes her from both workers and drones. The queens sting is scarcely barbed and is retractible and reusable, allowing repeated assaults on pretenders to the queens' position. Queens have a shorter proboscis than workers and lack several glands. There is normally only one queen in a hive; after being fertilized on her 'nuptial flight' she will return to the hive and remain there unless driven out by a younger queen. She may live for 4-5 years during the course of which she will lay thousands of eggs. The honeybee queen is essentially an egg-laying machine, has lost the ability to build a nest, forage for food, and feed larvae. In the bumblebees (*Bombidae*), the queen hibernates and is normally the only member of a colony to survive the winter and a new colony being started each year.

Queen Cell: The special cell in which a queen honeybee develops from egg to the adult stage. Queen cell is one inch or more (25mm). On the other hand, drone cell measures about 6.25 mm, and the worker cell measure about 5.0 mm. Queen cells are usually located on the lower edges of combs; these cells originally are made by workers and known as 'cups', but after the queen lays an egg in them, then they are called queen cells. As the larvae grow, these cells are enlarged, elongated by adult worker bees, and gradually take on a peanut like appearance. Drone and worker cells lie horizontally on the comb, but queen cells hang vertically.

Queen Control: The inhibitory influence of the queen on the reproductive activities of the workers and other queens.

Queen Right: Referring to a colony, especially a honeybee colony, that contains a functional queen.

Queen Substance: A chemical substance, identified as 9-oxo-2-decenoic acid, produced by the mandibular glands of the queen bees. During the nuptial flight the scent of this substance seems to attract the male bees. Afterwards during her life in the hive, the worker bees lick it and pass it on to each other as a means of recognizing the presence of the queen. Mutual feeding among workers also results in the dispersal of queen substance through the colony where the pheromone serves to stimulate foraging activity (in older workers) and household duties (by young workers). This secretion is responsible for the formation of the cluster of 'court bees' that constantly surround the bees. During swarming, worker bees located near the hive entrance release a mixture of scents from their 'Nasanov glands' and these scents stimulates the assembly of workers that ultimately leads to the familiar cluster of bees around their queen. The mandibular glands also produce a volatile pheromone, 9-hydroxy-2-decenoic acid, which together with queen substance, inhibits ovarian development in workers. As the queen ages when the number of individuals in a colony increases, the amount of pheromone available to each worker declines and their behaviour changes.

Queen Termite: As in the case of the bees and wasps, the queen is the only fertile female in termites. After fertilization and having lost her wings, she stays underground for the rest of her life. She hardly moves and becomes merely a vast 'egg laying machine'. Her abdomen, becoming full of eggs, grows to many times its normal size and resembles a giant caterpillar sometimes attaining a length of 10 cm or more.

Queen Wasp: The fertile female or queen wasp is usually distinctly larger than the

workers and males. In temperate climates, the queen hibernates and is the only member of a colony to survive the winter. In the spring she starts the building of a nest, lays a few eggs in it, and the workers which emerge continue to enlarge it. This enables the queen to continue egg-laying so that throughout the summer the colony continues to grow in size and numbers.

Quiescence: Also known as 'torpor'. Inactivity induced by unfavourable environmental conditions, and the activity resumes immediately upon the return of favourable conditions. Development or

reproduction may be interrupted by periods of cold or heat, drought, or a scarcity of food. During quiescence the hormonal stimulation of growth or reproduction remains suspended. For example, a few chilly days in spring may lower metabolism, but growth continues with the return of sunny weather.

Quinones: Organic compounds, benzene derivatives, known to play a role in the hardening and darkening of arthropod cuticle. Quinones are also present in poisonous or repellent secretions emitted by cockroaches, earwigs and beetles.

R

r-Strategists: Insect species that have life history characteristics that make them more likely than are others to become agricultural pests. Such species normally frequent habitats of low stability, the insects in these species tend to be small and mobile and reproduce rapidly. Insect species with above set of attributes are known as r-strategists. In general, r-strategists quickly utilize resources available to them, often achieving the pest status and sometimes destroying their hosts before dispersing. Their resilience is seen in the rapidity with which they adapt to new resources. Natural enemies are often unable to keep up with and to regulate populations of r-strategists. Rather they are frequently suppressed by shortage of food or by unfavourable weather. Aphids, American bollworms, houseflies and some locusts are examples of r-strategists, which can be controlled with insecticides although the use of resistant hosts is likely to prove more effective in the long run because of the resilience these pests exhibit. Polygenic resistance is more likely to be durable against r-pests. In all instances of pest management it is important not to disrupt that natural enemy population, as this can lead to biotic release of the pest and attainment of higher population levels. Changes in sowing times, cultivation practices, sanitation and rotation are the other principal control strategies appropriate for such pests.

Race: A naturally occurring group within a species visually indistinguishable but with some physiological difference from other

members of the species, e.g., with a different plant host range.

Radial Cell: A cell bordered anteriorly by a branch of the radius; the marginal cell (Hymenoptera).

Radial Cross-Vein: A cross-vein connecting R1 and the branch of the radius immediately behind it.

Radial Sector: The posterior of the two main branches of the radius.

Radicola: A gall dweller, more particularly a stage in some of the aphids (including Phylloxeridae) that induces root tuberosities on the host plant.

Radioactive: Giving off atomic energy in the form of radiation, such as in alpha, beta or gamma rays.

Radioisotopes: One of a broad class of elements capable of becoming radioactive and giving off atomic energy. Some radioisotopes occur naturally, others are produced artificially. The word is synonymous with radioactive elements and includes tracer elements.

Radio-Medial Cross-Vein (r-m): A cross-vein connecting the radius and the media.

Radius: The longitudinal wing vein between the subcosta and the media. The radius is generally the strongest of wing vein, it fuses with the anterior edge of the median plate which articulates with the second axillary sclerite.

Radula: The rasp-like tongue of slugs and snails.

Random Sampling: A method of allocating sampling units within a sampling universe in which each sample unit has an equal chance of being selected. Random sampling ensures an unbiased estimate, but is rarely used in the practice of arthropod sampling due to time and cost constraints. A simple random sample can be selected by use of random numbers and lottery method.

Randomization: Refers to the allocation of treatment to various experimental units, such that each treatment has an equal chance of being allocated to the experimental unit. For an objective comparison between treatments, their random allocation to various plots is essential because statistical procedures hold good under chance theory. Randomization forms the basis for the test of significance to be valid to compare observed differences among treatment means against the difference brought about by unequal environment.

Randomized Block Design (RBD): An experimental design in which the experimental area is divided into blocks and all of the treatments are randomly arranged within each block. The treatments are applied to these units by any random process. RBD takes care of fertility gradient in one direction. But in RBD if number of treatments used exceeds 12 then the block size is increased and the exemption of homogeneity in a block is violated.

Rake: In hind legs of bees, a fringe of hairs at the distal end of the tibia. Rake collects the pollen from the comb on the opposite and transfers it to the pollen press.

Ramification: Branching a branch of nerve, artery etc.

Range: In insect population studies, range is the difference between the smaller and the largest sample number. Although the range gives some idea as to the spread of data about the mean, it depends only on extremes, some of which may be accidental and / or very rare.

Ranking: The placement of a taxon in the appropriate category in the hierarchy of categories.

Raphidioptera: An insect order of subdivision Endopterygota. Commonly known as snakeflies. Head is slightly flattened with biting forward-facing mouthparts. Prothorax is elongate, antennae are thread-like. Possess two pairs of uniform sized clear wings. Females with conspicuous ovipositor, they have complete metamorphosis and are distributed in northern hemisphere.

Raptorial Legs: Usually enlarged and often spined front pair of legs, are used to grasp prey, but other pairs are also occasionally used for this purpose. In fore legs, large muscles are flexors and the tibia is pulled back against the femur when the muscles contract. The spines may also be present on the femur and tibia to impale the prey and decrease the likelihood of escape by the victim. Fore legs of mantids are raptorial. In a few parasitic wasps, the hind legs are raptorial.

Rate: Refers to the amount of active ingredient material applied to a unit area regardless of percentage of chemical in the carrier (dilution).

Ratoon: New tillers which grow from the stubble of harvested plants. These new tillers constitute the ratoon crop.

Raw Agricultural Commodity: Any food in its raw and natural state including fruits, vegetables, nuts, eggs, raw milk, and meat.

Receptaculum Seminis: An alternative name for the spermatheca, a sac leading off the oviduct of a female insect where seminal fluid can be received and stored so that it can be released a little at a time as eggs are laid. In this way an insect can mate once in her life time and retain enough sperm cells in her body to fertilize all subsequently produced eggs.

Receptor Cell: Portion of a sense organ in which stimuli are converted to a nervous impulse.

Receptor Potential: The peripheral part of any sensory cell reacts to an adequate stimulus with a temporary change in the electric charge of its membrane, in a measurable response is termed as receptor potential.

Receptors: The sensory cells or receptors of insects include the **photoreceptors** such as the retinulae of simple or compound eyes; **chemoreceptors** or organs of taste and smell chiefly on the antennae and palps; **mechanoreceptors** which perceive touch, sound and changes of position. The latter are in the skin and may be situated anywhere on the body. Some have simple sensory hairs connected to nerve cells beneath the skin, others have more elaborate structures.

Reclinate: Inclined backward or upward.

Recommendation: Suggestion or advice from the university, research organization, an extension specialist, or from any other authorized agricultural authority.

Recovery Rate: Amount of insecticide recovered in relation to the amount applied.

Recruitment: Communication that brings conspecific individuals, often nestmates, to some point in space where work is required. This phenomenon is highly developed in ants, bees, wasps and termites.

Recruitment Trail: An odour trail laid by a single scout worker and used to recruit nestmates to a food find, a desirable new nest site, a breach in the nest wall, or some other place where the assistance of many workers is needed.

Rectal Gills: Rectal gills are thin-walled projections well supplied with tracheae, arranged in longitudinal rows inside the rectum of an aquatic dragonfly nymph (Odonata : Anisoptera). Water is continually pumped in and out of the rectum.

Rectal Glands: Pads of enlarged cells in the rectum which absorb water and salts. They are concerned with the reabsorption of water and chloride ions from the malpighian tubules and preventing undue loss of water from the insect.

Rectal Papilla: Also called rectal pads. Most part of the rectum is thin-walled, however, rectum includes 6-8 thick-walled rectal pads which project into the lumen of the rectum that play an important role in the excretory system. Rectal papillae conserve water and

ions by extracting them from the gut contents and returning them to the haemolymph. As a result, the faeces of terrestrial insects are expelled as a more or less dry pellet.

Rectum: Last portion of the hindgut which is highly muscular and enlarged and terminates within the anus. Rectum and the malpighian tubules, functioning as a unit, form the major excretory system in most insects. The blindly ending tubules, which usually lie freely in the haemocoel, open into the alimentary canal at the junction of the midgut and hindgut. They usually enter the gut individually but may fuse first to form a common sac that leads into the gut. A cryptonephridial arrangement of malpighian tubules is found in larvae and adults of many Coleoptera, some larval Hymenoptera and Neuroptera, and nearly all larval Lepidoptera. Here the distal portion of the malpighian tubules is closely apposed to the surface of the rectum and enclosed within a perinephric membrane. The system is particularly well developed in insects living in very dry habitats and in such species its function is to improve water resorption from the material in the rectum.

Recurrent Nerve: Neural connection between the frontal ganglion and the hypocerebral ganglion.

Recurrent Vein: One of the two transverse veins immediately posterior to the cubital vein (Hymenoptera); a vein at the base of the wing between costa and subcosta, extending obliquely from the subcosta to the costa (Neuroptera). Recurrent veins are found in fore wings of Braconidae and Ichneumonidae (Hymenoptera).

Recurved: Curved upward or backward.

Redistribution: Movement of pesticide subsequent to the initial application to other parts of the plant, usually by rain.

Re-Entry Interval: Length of time between the pesticide application and entry into the field to conduct manual labour. They are established on a case-by-case basis, but generally speaking for insecticides, particularly the cholinesterase inhibitors such as OPs.

Reflex: The simplest form of innate behaviour in which a certain stimulus evokes at once one specific kind of simple response. Taxes and the kineses are usually regarded as reflexes, that is, simple built-in responses to simple stimuli. Simple form of reflex involves a nerve cell or neuron with receptor dendrites that are associated with a sensory receptor and an axon that runs to and terminates in central nervous system.

Reflex Action: Simplest expression of principles according to which nervous system acts, involuntary action on activation of reflex arc.

Reflex Bleeding: Some of the insects when threatened are capable of squeezing out drops of haemolymph from specialized skeletal weak points. Blister beetles and the lady bird beetles are good examples. Usually this blood contains toxic substances malachines and canthardines or repellents. This occurs when some insects are disturbed and presumably have a protective function.

Refuge: An area, usually untreated with insecticides, where insects can be preserved. This term is used in the context of preserving beneficial insects or pesticide susceptible insects.

Regeneration: Reproduction of a host part which may be at the molecular, cellular, tissue, or organ level. Many immature insects (e.g., walking sticks and preying mantids) can completely regenerate a lost appendage, and this regeneration usually requires a moult.

Registered Pesticides: Pesticide products that have been approved by the Environmental Protection Agency of a particular country for the uses listed on the label.

Regression: Pertains to a statistical method for the study and expression of the amount of change in one variable associated with a unit change in another variable.

Regression Coefficient: Defined as the increase in the dependant variable for a unit increase in the independent one. If the change is in such a way that an increase in one variable

is also accompanied by an increase in the another, the two variables are said to be positively correlated. But on the other hand if the increase in one is accompanied by the decreases in the other the two variables are said to be negatively correlated.

Regulation: As related to population dynamics, the control of population density (e.g., density dependant and density independent factors).

Regulatory Management: Any of the practice that must be instituted area-wide in order to be effective. This might include mandatory host-free periods, host-free zones, crop termination dates, or limits on the cultivars or seeds that can be planted. Usually these practices must be enforced by law or by grower groups. Regulatory management also includes in nutshell enactment and enforcement of the quarantines which are designed to prevent the entry of potential pest species to confine them to as small an area as practicable once introduced or to prevent them from being exported to other countries.

Reiterative Behaviour: Behavioural rhythms that occur with a regular repeated periodicity in the life of an individual (e.g., feeding and locomotory cycles). These behaviours may cycle about a relatively long period, and prevent the potential pest species to confine in as small an area as practicable once introduced or to prevent them from being exported to other countries.

Relapsing Fever: A disease caused by bacteria, *Borrelia* sp., transmitted by body lice. The disease is marked by alternating periods of fever.

Relative Humidity: The amount of moisture in the air compared to the total amount that the air could hold at that temperature. When the temperature and pressure of the air change, the relative humidity changes even though the absolute amount of water does not. High temperatures permit more water to remain as a gas than do low temperatures, when temperatures drop relative humidity increases. If the saturation or dew point is reached, water

condenses to form dew, rain or snow depending on the temperature and other existing environmental factors.

Relative Sampling: Relative sampling methods involve using different types of traps such as pheromone traps, host mimic traps and emergence traps. These methods allow only comparisons in space or time, and are especially useful in extensive work in studies on insect activity or in the investigation of the constitution of a polymorphic population. Many IPM programs are based on relative sampling methods, because such methods are much more efficient than obtaining absolute estimates of population densities.

Relaxing: A process of resoftening the insects which are brought from the field in a dead condition which otherwise become hard and fragile. Relaxing is the first step towards preservation. It is carried out in a relaxing jar made of a rustless metal (tin or glass) with a tightly fitting lid or screw cap. In the jar a 5cm thick layer of sand or any other absorbent material is kept and soaked with water and a few drops of formaline or carbolic acid are put to prevent mould. It is then covered with a disc of filter or blotting paper. Insects are placed in the jar as naked or are put in envelope and its cap padded with filter paper and tightly screwed. Specimens are left in the relaxing jar for 1-3 days depending on their size. Most smaller insects will be relaxed within 24 hours but larger specimens will take longer, during this time they should be checked regularly to ensure that they do not become too wet.

Releaser Pheromone: A chemical released by an individual of one species that has an immediate effect on releasing same behaviour of other individuals of that same species.

Relict: Isolated or left behind when geological or climatic changes occurred.

Remote Sensing: Examination of a site from a distance, typically from an airplane but also by satellite.

Remotion: The corresponding movement of the coxa.

Reniform: Kidney-shaped.

Repellent: A compound that is annoying to a certain animal or other organism, causing it to avoid the area in which it is placed. Generally the distance from the source at which insects respond to repellents is relatively short. Insects tend to avoid treated surfaces rather than leave the area. For this reason, repellents are more important in providing protection for humans and domestic animals against irritating and disease-vectoring species than in providing protection for crops. Pyrethrum, citronella oil, diethyl toluamide, ethyl hexanediol and dimethyl phthalate are good mosquito repellents.

Replacement: Also called pest replacement or secondary pest outbreak. When a major pest is suppressed and continues to be suppressed by a tactic but is replaced in importance by another pest previously with minor status.

Replete: An individual ant whose crop is greatly distended with liquid food, to the extent that the abdominal segments are pulled apart and the intersegmental membranes are stretched tight. Repletes usually serve as the living reservoirs, regurgitating the food on demand to their nestmates. Repletes are common in honeypot ants and abdomen of repletes are so distensible that they become virtually immobile honeypots.

Replication: Repetition of the treatments under investigation at the same time and place (one of several identical experiments, procedures, or samples) is known as replication. Number of replications in an experiment are increased in order to obtain a greater precision in the field experiments. This will reduce the error to a great extent. Standard error of the mean decreases as the number of replications in a treatment increases and hence the precision is increased.

Reproduction Curve : The relationship between the numbers of a given stage in generation (n+1) plotted against the numbers of that stage in generation (n).

Reproductive Capacity: The capacity of

individuals in a population to increase in number by the production of progeny. The reproductive capacity of insects is dependant upon many factors, chiefly the number of eggs or young produced, the short life cycle which is often coupled with numerous egg-laying periods following in rapid succession, and special provisions to speed up reproduction. Insects generally lay large number of eggs. The Sanjose scale produces 400 to 500 young. Social insects are heavy egg layers. The queen honeybee may lay 2000 or 3000 eggs a day. The queen termite is able to lay 60 eggs per second until several millions are laid. However, average number of eggs laid by insects varies from 100 to 150, of course no insect ever reaches its maximum reproductive capacity. There are many adverse conditions, parasitic and predacious enemies that prevent such things from happening and thus these insects are held in check. Special methods of reproduction such as polyembryony and parthenogenesis aid in building up a great insect population.

Reproductive Isolation: A condition in which interbreeding between two or more populations is prevented by intrinsic factors.

Reproductive System: In almost all insects, the males and females are separate. The two reproductive systems are basically similar, the major difference being the larger size of the mature ovaries compared to the mature testes. Both the male and female organs are located in the hind portion of the abdomen and open posteriorly. In general the reproductive system of insects consists of a pair of ovaries in the female and a pair of testes in the male. Each ovary is joined by its own lateral oviduct to a main or common oviduct. The common oviduct leads to the single vagina or genital chamber. Each testis is joined by means of a duct, known as 'vas deferens' to a common ejaculatory duct. This common duct takes the sperm to the external genitalia of which the aedeagus is the most important component. Eggs are fertilized by the sperms and stored inside the body of the female. The fertilization of eggs by sperm is internal and requires the male to introduce sperm by means of an

aedeagus via the female's vagina. Sperm is deposited in or near a sperm storage organ, known as the **spermatheca** and is subsequently used to fertilize the eggs.

Reproductives: In termites the caste of kings and queens. They have compound eyes and fully developed wings (before dealation) and are usually heavily pigmented.

Repugnatorial Glands: Many dermal glands, in various parts of the body of different insects, produce a variety of chemical substances which are probably defensive as they have a nauseous smell and other repellent properties. In many nymphal Heteroptera, dorsal abdominal scent gland is of this type. In Adephaga (Coleoptera), there are often complex pygidial glands which open near the anus and secrete pungent or corrosive material. Among lepidopteran larvae there are eversible repugnatorial glands (osmetria) on the 6th and 7th abdominal segments (Lymantriidae).

Residual: Having a continued killing effect over a period of time.

Residual Activity: The insecticidal activity resulting from the presence of an insecticide and its metabolites or in a treated site after an insecticide is applied.

Residual Pesticide: A pesticide chemical that can destroy the pests or prevent them from causing disease, damage, or destruction for more than a few hours after it is applied. The insect picks up the pesticide through tarsal contact or in the case of plant pests by contact and/or ingestion.

Residue: Refers to the chemical regardless of locale on or within a substrate and with the implication of ageing by time lapse or alteration or both. Deposit becomes a residue as soon as it has been affected by weathering, by metabolic conversions, or by other processes that may cause degradation or migration. Insecticide chemicals in animal flesh or other tissues are considered as residues whether distributed by ingestion or by penetration. Penetrating residues of the insecticides tend to disappear or decompose at a constant rate which is a function of

concentration; the percentage of fractional decreases, however, are independent of initial concentration or magnitude of the deposit.

Resilience: The capacity of a species to adapt to change or to persist in a changing environment.

Resilin: An elastic protein that forms an important part of the cuticle of an insect. It is a rubber like material found in cuticular structures that undergo spring like movements e.g., wing hinges the proboscis of Lepidoptera, and the hind legs of fleas. Like rubber, resilin when stretched is able to store the energy involved. When the tension is released, the stored energy is used to return the protein to its original strength.

Resistance: 1. Insecticide resistance is defined as the ability of a strain of insects to survive normally lethal doses of insecticides, the ability having resulted from selection of tolerant individual in populations exposed to the toxicant for several generations. The development of resistance to insecticides is normally the result of increased ability of an insect to degrade the insecticides to less harmful and excretable products, but may be related also to increased physical resistance, i.e to structural changes that prevent insecticides from reaching their site of action. Metabolic resistance normally develops through the production of more specific or greater quantities of insecticide degrading enzymes. **2.** Plant resistance is defined as any inherited characteristic of a host plant which lessens the effects of parasitism. In epidemiological terms two main types of resistance can be distinguished, (a) **Vertical resistance** : occurs when a crop is highly resistant to only certain genetic variants of a particular pest ; and (b) **Horizontal resistance** : is generally polygenic and effective against a greater number of pests, if not all to the same extent. Horizontal resistance is preferable as the variety is likely to remain resistant for a longer period. Plant resistance is specific usually limited to a single key pest or a small pest complex, is cumulative, persistent and is compatible with

routine crop management and maintenance of environmental quality and is, therefore, more appropriately referred to as 'durable resistance'. Plant breeders have relied on vertical resistance, especially where the life cycle of the host crop is short and new cultures with differing resistance can be introduced rapidly. Horizontal resistance is more complex and requires selection from relatively large outbreeding populations.

Respiration: The processes by which energy is acquired in a living organism or cell by the breakdown of organic molecules especially hexose sugars with the release of waste carbon dioxide; the conveyance of oxygen from air or water to the living tissues via tracheae, gills, etc.

Respirator: A face mask used to filter out the poisonous gases and dust particles from the air so that a person can breathe and work safely despite the presence of a toxicant. A person using the most poisonous pesticide chemicals must use a respirator as directed on the pesticide label to protect from pesticide poisoning.

Resting Potential: The potential difference existing across a nerve or muscle cell membrane when it is not being stimulated.

Restricted-Use Pesticide: One of the several pesticides that can be applied only by the certified applicators, because of their inherent toxicity or potential hazard to the environment.

Resurgence: The term resurgence is used to express a sudden increase in population numbers. One type occurs when the target species which was initially suppressed by the insecticidal treatment, undergoes rapid recovery after the decline of the treatment effect. Resurgence may also occur as a result of the development of a new biotype of the pest, or if the insecticide treatment kills a disproportionate number of the natural enemies of the pest species. Resurgence can be managed by avoiding hormoligosis, avoiding natural enemy destruction, and through adopting approaches of using pesticides considering their physiological selectivity and ecological selectivity.

Retention Period: In insect disease transmission studies the period after acquisition feeding during which an insect is able to transmit a virus disease.

Reticulate: Covered with a network of veins or ridges.

Retina: The light sensitive apparatus of the eye. Light is detected by specialized light sensitive cells that are grouped into eyes. The cells are typically clustered in a 'retina' beneath a transparent lens-shaped area of the cuticle called the 'cornea'.

Retinaculum: 1. A locking mechanism beneath the base of the fore wing in some Lepidoptera, part of the wing-coupling apparatus. **2.** In Collembola, the unsegmented appendage of the third abdominal segment.

Retinal Rod: The rod-like structure formed from the united sensory borders of the retinal cells. It is a part of the optical system which absorbs the light, cornea and crystalline cone are other parts of the system.

Retinene: A light sensitive pigment in the retinal cells of insects, similar to 'rhodopsis' in the human eye and derived from Vitamin A.

Retinue: A group of workers, not necessarily permanent or even long lasting in composition, who closely attend the queen.

Retinula: The sensory part of the ommatidium, composed of seven or eight elongate cells which surround the rhabdom. Retinula cell is a monopolar sensory neuron with one axon. From 6-12 (basically 8) retinula cells are packed together in a tall cylinder. In cross-section, each retinula cell is wedge-shaped, and all contribute to the rhabdom that runs down the centre of the retinacular cylinder. Each retinula cell contributes a 'rhabdomere' as its share of the rhabdom.

Retractile: Capable of pushed out and back in.

Retraction: The backward movement of the leg between the time it is placed on the ground and the time it is raised.

Retractor: A muscle which by contraction withdraws the part attached to it, bringing it towards the body.

Revision: In taxonomy, the presentation of new material or new interpretations integrated with previous knowledge through summary and reevaluation.

Rhabdom: The central, rod-like element in an ommatidium consisting of several rhabdomeres, one from each retinal cells.

Rhabdomere: One of the seven or eight units comprising a rhabdom or retinal rod of an insect's eye.

Rheotactic Receptors: Sensory cells, hairs or other structure that detect changes in the flow of water over the surface of a body in aquatic insects.

Rheotaxis: Moving of aquatic insects in a definite direction in relation to the flow of water.

Rheotropism: Orientation (as distinct from locomotion) in relation to direction of flow of water, as for instance in the case of some aquatic insect larvae.

Rhizome: Underground root-like stem that produces roots and leafy shoots, usually serving as a means of asexual reproduction.

Rhizosphere: A zone surrounding the roots of plants, usually richer in fungi and bacteria than elsewhere in the soil.

Rhynchota: Alternative name for order Hemiptera.

Rhythm: Periodic occurrence; seasonal variation; regular movement.

Ribaga's Organ: Also known as Berlese's organ. A sac-like organ for receiving the spermatozoa on the ventral surface of the abdomen of the female bedbug, *Cimex*.

Ricker Mount: A thin, glass topped exhibition case filled with cotton.

Rickettsiae: Obligate intracellular parasitic bacteria like microorganisms that infect arthropods and also may be pathogenic in vertebrates. In size they lie somewhere between viruses and most other kinds of

bacteria, but unlike viruses they are capable of independent metabolism in vitro. Rickettsiae are pathogenic for insects (e.g., *Wolbachia*, *Rickettsiella*) but are very slow in killing their hosts. Because of their slow killing power to kill host insects and their potential danger for mammals, rickettsiae are unlikely to be used in insect control.

Rind: 1. The thick outer covering of certain fruits, **2.** The bark of a tree.

Ring Gland : The composite endocrine gland of larval dipterans consisting of the prothoracic gland, corpus allatum, and corpus cardiacum.

rm : The intrinsic rate of natural increase.

RNA: Ribonucleic acid. A nucleic acid, a polymer of nucleotides incorporating phosphoric acid, ribose and nitrogenous bases (adenine, cytosine, and uracil). Present in cytoplasm and microsomes of plant and animal cells, participates in biosynthesis of proteins.

Robbing: Bees of one hive taking honey from another.

Rocky Mountain Spotted Fever: A human disease caused by a bacterium like microorganism, *Rickettsia rickettsi* characterized by a rash, fever, headache, backache, and marked malaise; transmitted by the Rocky Mountain wood tick and the American dog tick.

Rodent: All animals of the Order Rodentia such as rats, mice, gophers, and squirrels. Rodents have only two incisors in the upper jaw and two in the lower; they have no canine teeth. Rodents have opposable jaws, and their lower jaws move forward and backward as well as from side to side.

Rodenticide: Pesticide applied as a bait, dust, or fumigants to destroy or repel the rodents and other animals such as moles and rabbits. Traditionally rodenticides have been characterized by two classes, **1.Acute** (single dose, quick acting), or **2.Chronic** (multiple dose, slow acting) rodenticides. Acute rodenticides cause death within 24 hours but tend to be more hazardous for human beings

and hence there are severe instructions on their use. Because of their high toxicity only small quantities are required which reduces labour and product costs. They have the disadvantage that surviving rodents are shy of poisoned bait making it difficult to control them on subsequent occasions. This problem does not come with use of chronic poisons because a lethal dose is usually consumed before the onset of any symptoms. Chronic poisons which are mostly blood anticoagulants (causing death through haemorrhage) have advantage in that the concentrations of the rodenticide in the bait can be kept low, sufficient to cause cumulative toxicity but low enough to reduce the hazard to non-target animals. Chronic poisons are usually preferred to acute ones because of their high efficacy and relative safety. For the vast majority of applications, rodenticides are used in the form of poisoned baits. Almost every kind of edible material has been used as a bait. They are used either in a preventive way in places continually subject to infestation or as a remedial measure after unacceptable damage have occurred.

Roguing: The removal of undesired individual plants from a group of plants.

Root Coat: Coating the roots of seedlings by dipping into a liquid formulation of an insecticide that contains a sticky agent such as gelatin which causes the insecticide to stick to the roots.

Root Dip: Placing the roots of the plants in a solution of insecticide for a period of less than 12 hours, after that it becomes a root soak.

Root Stock: The root system of a plant to which the scion is grafted or budded.

Root-Zone Application: Application of a systemic insecticide into the anaerobic layer of soil about 2-10 cm below the soil surface where the roots of rice and other cereals are generally located.

Rosette: A group of leaves which are arising from a short stem, and therefore lying close together on or near the ground.

Rostellum: Tubular mouthparts of certain apterous insects; a beak-shaped process.

Rostrum: Alternatively known as proboscis. The extended forepart of the head of an insect consisting of or bearing the mouthparts. The term is applied to weevils in which biting mouthparts are at the tip of the snout as well to insects with piercing and sucking mouthparts.

Rot: Physical decay of plant and plant products caused by fungi and bacteria. Rots are especially important as post-harvest diseases.

Rotation: The practice of growing different crops on the same land in a regular and recurring sequence. Rotation is adopted because of complimentary effects, or demands on the soil or for convenience of spreading times of peak labour demand. The most important reason, however, is to hinder the development of weeds or other pests to damaging population levels. A good rotation will usually give better average yields than continuous cultivation of the same crop or taking a session of exhausting crops. Rotations tend to be most effective against pest species that have a narrow host range and limited rate of dispersal. Soil pests can also be successfully controlled by employing crop rotations.

Roundworm: A representative of the Phylum Aschelminthes and the Class Nematoda. Roundworms are cylindrical having unsegmented body with a straight digestive tube from anterior mouth to posterior anus. Some of the roundworms are free living in moist soil and all aquatic situations, including hot springs and the glaciers. However, parasitic nematodes are the best known. *Necator* and *Ancylostoma* are hookworms that attack man; *Trichinella* is a dangerous parasite acquired by eating infected/improperly cooked pork. *Filaria* causes elephantiasis.

Royal Cell: In honeybees—the large, pitted, waxed cell constructed by the workers to rear queen larvae. In some species of termites, the special cell in which the queen is housed.

Royal Jelly: A material supplied by workers to female larvae in royal cells which is necessary for the transformation of larvae into queens. Royal jelly is secreted primarily by the hypopharyngeal glands and consists of a rich mixture of nutrient substances (biotin and pantothenic acid). All female larvae (from fertilized eggs) have the potential to develop into either workers or queen, depending on the time they are fed royal jelly. If larvae are fed royal jelly for only 2 - 3 days they develop into worker adults, but if they are fed royal jelly throughout the larval stage, they develop into queens.

Ruderals: Plants (other than the crops) which grow in artificial habitats created by man, such as roadsides, gardens, waste grounds ; weeds.

Rudimentary: Poorly developed, greatly reduced in size.

Runaway Pest: Any pest organism which enter a new territory where they have no natural enemies and, therefore, reproduce with little interference, resulting in a large population which can overrun an area.

Runner: A horizontal stem from which other plants develop by asexual reproduction.

Run-Off: The process of spray shedding from a plant surface during and immediately after application when droplets to form a continuous film and surplus liquid drops from the surface.

Runway: Area regularly walked on by rodents resulting in a path.

Russeting: Brownish roughening on the skins of fruits as a result of disease or injury.

Rust: A disease with symptoms that usually include reddish brown or black pustules on the leaves or the stems. Rust is caused by fungi belonging to the 'Uredinales'. Some rusts are able to complete their life cycle on two different hosts (heteroecious rusts) whereas some on one host only autoecious rusts).

Sacbrood: A lethal disease of larvae of the honeybee caused by a virus. Larva about 2 days old are most susceptible. Diseased larvae fail to pupate and remain stretched on their backs with their heads toward the cell capping. Body colour of larvae changes from pearly white to yellow-white to the yellow, and becomes dark brown. The head and thoracic region darken first and at this stage, the signs are most distinctive and specific.

Safener: Chemical that reduces the phytotoxicity or harmfulness of another chemical.

Sagittal Plane: The longitudinal vertical plane or meson which divides an insect or other organism into right and left halves.

Saliva: Insect saliva often contains digestive enzymes. In the blood feeding insects, anticoagulants may be present. In insects with extraintestinal digestion such as predatory Hemiptera, digestion enzymes are exported into the food and the resulting liquid is ingested. Most Hemiptera produce an alkaline watery saliva that is a vehicle for enzymes (either digestive or lytic).

Salivarium: The cavity between the hypopharynx and the labium into which salivary duct commonly opens.

Salivary Glands: Glands that open into the mouth and secrete a fluid with digestive, irritant, or anticoagulatory properties. Salivary glands are present in most insects, though their form and function are extremely varied. Frequently they are known by other names according to either the site at which

their duct enters the buccal cavity, e.g., labial glands and mandibular glands; or by their functions, such as silk glands and venom glands. Typically, saliva is a watery, enzyme-containing fluid that serves to lubricate the food and initiate its digestion. Saliva generally contains only carbohydrate-digesting enzymes (amylase and invertase). But saliva of some carnivorous species contains protein and or fat digesting enzymes only; that of blood-sucking species has no enzymes. Anticoagulants are present in the saliva of blood-sucking species such as mosquitoes. Toxins which paralyze or kill the prey are present in the saliva of some assassin bugs (Pentatomidae) and robber-flies (Asilidae). In some gall-inhabiting species, substances that induce gall-formation are present in their saliva. In some species the salivary glands have taken on functions quite unrelated to digestion, e.g., production of silk by the labial glands of caterpillars and caddisfly larvae, and pheromone production by the mandibular glands of the queen honeybee.

Saltatorial Leg: To 'saltate' means to jump or vault. Legs modified for this function commonly have greatly enlarged femur to accommodate the enlarged extensor muscles that strengthen out the tibia. These legs are well anchored by large tarsal pads, claws and often spines. A rapid contraction results in the entire body being propelled. Metathoracic legs of grasshoppers are saltatorial type.

Sample: 1. The portion of a true population which is actually available to the taxonomist. 2. A part of population, consisting of one or

more sampling units selected and examined as representative of the whole.

Sample Size: The number of sampling units taken in a program is usually the result of a compromise between precision on the one hand and cost on the other. In most instances the most affordable number is the prime determinant. As a rule many pest management sampling programs call for taking at least five sampling units in an average-sized cropping area of a locality. When greater precision is required, the sampling unit should be increased. For finding out a number of sampling units required to achieve a given degree of precision following formula is useful : $N = [(t \times s) / (D \times x)]^2$, where, N=number of sampling units, x = mean density; D = required precision (RV) expressed as a decimal; s = standard deviation; and t = student's t -value (usually the value of t for 0.05 probability and sample number used to calculate the mean). The mean and standard deviation values in the formulae are obtained by using data from preliminary sampling.

Sampling: Taking a small portion of a substance which is representative of the entire lot for a test or analysis.

Sampling Plan : A structured set of rules for collecting a sample that is based on delineation of the sample universe, knowledge of dispersion, a specific sample unit, a predetermined sample size, the time of sampling, and a given allocation of sample units throughout the sample universe.

Sand-Baskets: A cluster of large spines at apex of hind tibia of certain crickets.

Sanguinivorous: Blood feeding.

Sanitation: Insect pests can be controlled through sanitation. Sanitation is the nonagricultural equivalent of cultural control. Sanitation practices directed at reducing pest population through the removal of suitable plant material or sites in which pests pass dormant periods have great relevance for management of pests. The cutting and destruction of cotton plants after harvest is an important measure in control of pink

bollworm. Cleaning field margins of wild vegetation is a means of eliminating refuges that can be used by insect pests during the absence of the crop and of reducing pests that require alternate plant hosts. Clean up of spillage, proper insect-tight storage of dried food and woolen goods, all contribute to reduction of insect infestations.

Sap: Water and dissolved materials moving through the conductive tissues of plants.

Saprophagous: Feeding on dead or decaying organic matter. Saprophagous scavengers feed on the dead organisms and have been subdivided into **xylophagous**—boring into or feeding on the sound or decaying wood; **phytosaprophagous** forms - feeding on decaying vegetables; **scatophagous/copro**phagous forms—feeding on faeces or dung; and **zoosaprophagous** or **necrophagous** forms—feeding on dead animals.

Sarcolemma: The outer sheath of a striated muscle fibre.

Sarothrum: The pollen brush on the basitarsus of the hind leg of a bee.

Savanna: Dry, scrub dominated grasslands with *Acacia* trees and patches of bare earth.

Scabies: A contagious skin disease of animals caused by parasitic mites, *Sarcoptes scabiei* (Acari : Astigmata). The mites which causes scabies in man and mange in a wide range of domestic and wild mammals throughout the world are also known as itch mites. Human infections with this mite from infected horses or dogs produce mild infestations which cure spontaneously but spontaneous recovery never happens with infestations of itch mites of human origin. Itch mite nymphs and adults are whitish in colour and have eight short pointed legs equipped with suction devices on the two front pairs and long hairs on the remaining hind legs. The most common infested areas include : wrists, elbows, penis, between the fingers, and between the buttocks. Ointments containing 5% permethrin cream (Elimite®), benzyl benzoate, malathion, sulphur or 1%

lindane (Kwell®) are the most commonly recommended medications for itch mite control.

Scald: 1.An injury to the bark of a plant caused by frost or excessive drying by sun or wind. **2.**A fungal disease of cereals that causes leaf browning and plant death.

Scale: 1.One of numerous, flattened pieces of cuticle on the body and wings of butterflies and moths; the wing stub of termites. The scales of Lepidoptera and Trichoptera are highly modified macrotrichia. **2.**A type of homopteran insect.

Scalloped: Edge formed of rounded depressions, concavities or hollows.

Scalpellum: A piercing, needle-like stylet formed from one or more of the mouthparts, as for instance in mosquitoes and bugs.

Scansorial Legs: Legs with a single large claw which can fold against the end of the tibia and act as a climbing or grasping organ as in lice (Anoplura).

Scape: The first segment of the antennae. The whole antennae is moved by muscles from the head that insert on the scape.

Scarabeiform Larva: Are C-shaped grub like larva, body thick and cylindrical, well-developed head and thoracic legs, and no prolegs, usually sluggish, (e.g., Scarabaeidae).

Scarification: Scarring ; appearing scratched; term often applied to leaf surfaces after feeding by thrips or spider mites.

Scatophagous: Alternatively known as 'coprophagous'. Feeding on dung; a characteristic of many beetles and the larvae of many flies.

Scavenger : An insect that feeds on dead and decaying plant and animal wastes. Termites that break down wood, springtails that assist in the decomposition of dead leaves, carrion beetles and fly maggots feeding on dead animals act as scavengers.

Scent Glands: Scented substances that are secreted by many different types of glands on the body, wings or legs of insects. These

secretions may be, a) Repellent or unpleasant scents exuded in self defence usually from glands situated on the abdominal region. Disagreeable odours produced by stink bugs, earwigs, bed bugs and some beetles come under this category, b) Attractive substances chiefly secreted before mating and often recognizable in equally small amounts and at long distances by insects of the opposite sex. Queen bee substance, the secretions from scent scales or 'androconia' of male butterflies and the secretions from the abdominal glands of some female butterflies fall under this category.

Scholechiasis: The vomiting or evacuation of caterpillars.

Scientific Name: A latinized name, internationally recognized, of a species or subspecies. The scientific name of a species consists of the generic and a trivial name, and that of a subspecies consists of the generic and two trivial names. Scientific names (excluding authors name) are always written in italics.

Sclerite: A plate on the body wall surrounded by membrane or sutures; the exoskeleton plates between the sulci are termed sclerites. The insect skeleton is composed of a series of plates or sclerites, of varying degrees of hardness. These sclerites are either separated by soft membranous areas called connectivae, or by external grooves that indicate internal inflexions, or very narrow lines of thin, sometimes flexible integument. The sclerite located in the forehead region is termed the frons. Below this plate is the clypeus and the flap-like labrum. Beneath the compound eye is the gena, above is vertex. A sulcus separates the gena from the occiput. Only the ventral (feeding) and posterior (communication with the remaining portion of body) parts of the head capsule remain uncovered by sclerites.

Sclerotin: A proteinaceous material that contributes to the hardness of the cuticle. The process of hardening called 'sclerotization', involves the tanning or cross linking of the proteins to form sclerotin in the outer zone of the procuticle. Sclerotin alone may give dark colour to the cuticle. This hardened zone

becomes the exocuticle and is resistant to digestion during moulting.

Sclerotization: The hardening and darkening processes in the cuticle (involves the epicuticle and exocuticle). Also known as 'tanning'. Maximum sclerotization is found in the mesonotum of adult and mandibles of nymph or larvae because these structures are used in flight and cutting. Cuticular sclerotization stabilizes the protein matrix of the cuticle to make it stiffer and harder, more insoluble and more resistant to degradation. Sclerotization provides the integument greater strength for muscle attachment and locomotion, and provides stability against hydrolytic enzymes produced by the fungal pathogens. Sclerotization is regulated by hormones, ecdysteroids and bursicon.

Scoli: Tubercles in the form of spiny projections on the body of some insect larvae (of some Lepidoptera and Coccinellidae).

Scolopale: Alternatively known as scolops. A sensory rod forming the apex of a chordotonal receptor on an insect. Movement of vibration of the scolopale sets up impulses in the sensory cell beneath it.

Scolopidium: An alternative name for a chordotonal receptor. Each of the scolopidium contains two neurons, the outer segments of whose dendrites are both enclosed in a scolopale, an intracellular structure of the surrounding scolopale cells. The dendrite tips are covered by an extracellular 'cap' that attaches to the cuticle. Sclopodia may contain from 1 to 4 neurons. The trichogen and tormogen cells of a typical sensillum are represented by the scolopale and accessory cells respectively, and the dendrite sheath is represented by the cap. Many thousands of these scolopidia are in the elaborate Johnston's organ of mosquitoes and black flies.

Scolopophorous Organ: Also called chordotonal organ. Typically a bundle of sensilla consisting of one or more specialized, bipolar neurons (scolopidia; also called scolopophores) stretched between two

internal integumental surfaces; often has a proprioceptive function.

Scolytoid Larva: A fleshy larva resembling the larva of a scolytid beetle.

Scopa: Also known as pollen brushes. Female bees methodically groom themselves and pack the pollen into special devices known as pollen brushes or 'scopae' which consist of long dense hairs on the hind legs of most bees, or on the underside of the abdomen in Megachilidae.

Scopula: A small, dense tuft of hair.

Scorch: Sudden browning and death (necrosis) of large indefinite areas on a leaf, fruit or stem from infection, lack or excess of some element, chemical injury or unfavourable weather conditions.

Scorpion: Any member of the arachnid order Scorpionida. Scorpions have an elongated body and a poison sting at the end of the abdomen. Their pedipalps are large and pincer like. They are predaceous, seize prey with pincers, may also sting it. They are most abundant in warm, dry climates. When humans are stung by most species of scorpions, the effect of the poison - a neurotoxin, is painful but not usually dangerous. However, the sting of some species found in Mexico, for example the Durango scorpion (*Centruroides suffuses*) can be fatal.

Scout: To sample and to observe insects infesting a crop and their damage, also including beneficial insects.

Scramble Competition: A type of competition where the resource is shared equally amongst the competitors. Insects occurring in limited widely spaced habitats (e.g., maggots in a carcass) exhibit such competition.

Scraper: The sharpened anal angle of the front wing (tegmen) of a cricket or long-horned grasshopper, a part of the stridulating mechanism.

Screens and Drift Nets: A piece of 20 mesh wire or plastic screening about 45 cm long and 30 cm high can be attached at each end to

a wooden handle. The screen is held vertically in stream as another person disturbs the stream bed while walking about 2 m upstream, or the collector may walk backward upstream while holding the screen. Drift nets are usually made of netting rather than screening.

Scrobes: A pair of grooves, one on each side of the snout of a weevil, in which the antennae can rest when the snout is being used for boring.

Scrub Typhus: A disease prevalent in the Far East caused by a bacterium—like microorganism *Rickettsia tsutsugamusi* which is transmitted by chigger mites, *Leptotrombidium* spp. and *Eutrombicula* spp. The main vectors of disease are : *L.akamushi* and *L.deliense* which have a wide geographical distribution. In the life cycle of a mite, only the larval stage of these mites is parasitic. The disease is characterized by headache, apathy, general malaise and fever. Japanese people long back named this disease as **tsutsugamushi**.

Sculpturing of Eggs: The outer shell or chorion of an insect's egg is often elaborately patterned with pits, ridges or reticulation. Those of hover flies, some leaf-mining flies and many other insects show a microscopic network of hexagonal or polygonal ridges but the most strikingly sculptured eggs are those of butterflies and moths. The cabbage butterfly lays yellow flask-shaped eggs with vertical ridges. Most nymphalids lay green, almost spherical eggs with white ribs arranged like meridians. The sculpturing is not merely decorative, but has a great deal to do with respiration and water regulation.

Scutellum: Posterior division of the notum; in Hemiptera and Coleoptera, the triangular or shield-shaped posterior portion of the mesothorax.

Scutum: 1. In ticks the sclerotized plate covering all or most of the dorsum in males, and the anterior portion in females, nymphs, and larvae of the Ixodidae (hard ticks). Dorsal scutum is absent in Argasidae (soft ticks). **2.**In insects the middle sclerite of a thoracic notum, anterior to the scutellum.

Seasonal Cycle: The sequence of insect life cycle of a species that occurs over a one year period.

Seasonal Polymorphism: Changes of body in different seasons as in Aphididae and certain other Homoptera.

Sebaceous Gland: A gland producing a greasy lubricating substance.

Secondary Homonym: Each of two or more identical specific names which at the time of original publication, were proposed in combination with different generic names but which, through subsequent transference, reclassification, or combination of genera, have come to bear the same (or an identical) combination of a generic and specific name.

Secondary Host: The host plant on which the asexual aphid form occurs.

Secondary Infection: The infection of healthy plants within a crop after the disease has entered the crop from outside.

Secondary Parasite: A parasite which establishes itself in or upon a host that is a primary parasite.

Secondary Pest: A pest that usually does little damage but it can become a serious pest under certain conditions. For example when insecticide applications against key pests destroy natural enemies of spider mites which attain the pest status.

Secondary Pest Outbreak: The rapid numerical increase to the pest status of a scarce, noneconomic, phytophagous population after use of a broad-spectrum pesticide for control of another pest of the crop, brought about by the destruction of the natural enemies which were otherwise holding the secondary pest in check.

Secondary Plant Substances: An array of diverse chemicals not known to have any function in plant growth or metabolism are present in plants, the insects utilize these as distinctive cues to identify and discriminate among their host plants for feeding and breeding (e.g., alkaloids, terpenoids, essential oils, and quinones). Secondary plant

substances may also act as repellents, kairomones, and allomones to some insects.

Secondary Reproductive: In termites, the same as nymphoid reproductive. These individuals are also called supplementary reproductives, or neotenic. They are arrested in their development, either with wings present as buds or without wings (ergatoids), and can take on the reproductive role if the primary reproductives die.

Secondary Sexual Characters: Characters which distinguish the two sexes of the same species but which do not like gonads or accessory sexual characters function directly in reproduction.

Sector: A major wing vein branch and all of its subdivisions.

Sectorial Cross-Vein: A cross-vein connecting two branches of the radial sector.

Sedentary: Term referring to insects that do not change their feeding site after they have become established (e.g., scale insects).

Sedimentation: A settling of suspended solid particles to the bottom of a liquid under the action of gravity. The phenomenon is used in the sedimentation analysis.

Seed Dressing: A coating (either dry or wet) of protectant pesticide applied to seeds before planting. Dry seed dressings are often physically stuck to the testa of the seed by a sticker such as methyl cellulose. This is done to protect the plants from injury or destruction by insects, fungi and other soil pests. The aim of using this formulation is to place the pesticide as near as possible where it is required to control seed or soil-borne pests and for uptake by the underground parts of the plants. This technique is more efficient to use, results in less environmental contamination, and reduced exposure of non-target organisms.

Seedling: A small plant after it has germinated from a seed.

Segment: A subdivision of the body or of an appendage between joints or areas of

flexibility. Segments have their own musculature.

Segmentation: Insects have the body divided into a number of segments with some repetition of organs in each. Segmentation is shown most completely in larvae of the caterpillar type, but is observed in adult insects owing to the high degree of specialization and enlargement of certain organs. It remains most evident, however, in the thorax and abdomen. A hypothetical ancestral type of insect derived from a crustacean, has twenty segments, six in the head, three in the thorax and eleven in the abdomen. In an adult insect of the present day the head shows no obvious segmentation, all the original segments having become fused to form a capsule. The thorax has three segments with a pair of legs on each segment; abdomen rarely shows more than eight or nine, the last few being fused together and specialized to form parts of the reproductive apparatus. The repetition of internal organs is shown most clearly in the nerve ganglia (one pair in each segment except where several are fused together), the compartments of the heart, and the tracheal system with a pair of spiracles in each segment.

Selective Insecticide: An insecticide which while killing the pest individuals spares much or most of the other fauna, including beneficial species either through its differential toxic action or through the manner in which the insecticide is utilized (formulation, dosage, timings, placement etc.). Selective toxicity may also be because of intrinsic capabilities of insects in metabolizing a toxicant that has entered the body. Sometimes the metabolites are less toxic, sometimes more toxic than the original compound. Selective toxicity can also arise from differences between the targets in two different kinds of animals. The cholinesterases concerned in insects, for example, react more readily with many organophosphates than do those in vertebrates. It is also possible that some insects can withstand greater damage to the target than can others, but this is more likely to favour them.

Self Pollination: Transfer of pollen from anther to stigma within the same flower, to other flowers on the same plant, or to flowers of another plant having the same genetic make-up. Self pollination may occur without any external agent involved, or as a result of some vector.

Sematectonic: Signals which communicate information between insects of the same species and are incorporated in structures built by insects, such as nests.³

Semelparous: A type of life history in which the animal reproduces only once during its life time.

Semen: Fluid discharged at ejaculation by the male, consisting of spermatozoa and secretions of glands associated with the genital tract.

Semiaquatic: Living in wet places, or partially in water.

Semilooper: A caterpillar with one or two pairs of ventral prolegs wanting; in crawling small loops of the body are formed as in Noctuidae.

Seminal Vesicle: A sac-like, usually paired storage reservoir for sperms in the reproductive system of the male insects. The seminal vesicles are dilations of vasa deferentia. The sperms are moved to the seminal vesicles by peristaltic contractions of the vas deferens. Their walls are well tracheated and frequently glandular, which may indicate a possible nutritive function.

Semiochemicals: All chemicals produced by one organism that incite responses in another organism are known as semiochemicals. One group of these substances, the 'pheromones', acts on individuals of the same species and induce biological activities at very low concentrations. Although some pheromones consist of a single compound, most are mixtures of chemicals. Some have an immediate effect on central nervous system and behaviour 'releaser substances', whereas others trigger a chain of developmental events

'primer substances'. Releaser pheromones release or induce such behaviour as sex attraction, trail following, alerting etc. Primer substances include social pheromones that influence castes in termites. The best known examples of semiochemicals used in pest control are those associated with the use of sex pheromones.

Semisocial: Applied to the condition or to the group showing it in which members of the same generation cooperate in brood care and there is also a reproductive division of labour, i.e. some individuals are primarily egg layers and some are primarily workers.

Semispecies: The component species of superspecies, also populations that have acquired some but not yet all attributes of species rank; borderline cases between species and subspecies.

Senescence: Changes in structure and function that decrease an individual's capacity for survival and lead to death; ageing; condition of advancing age usually in the post-reproductive period.

Senior Homonym: The earliest published of two or more identical names for the same or different taxa.

Jaws: In insects there are two horizontally moving jaws, namely the 'mandibles' or the upper lips, and the 'maxillae' or the lower lips. In biting insects (e.g., cockroaches and beetles), the mandibles are highly sclerotized and toothed. Each maxillae bear a palp, two movable lobes, i.e. an inner 'lacinia' and an outer sheath-like 'galea'. In predators such as Dytiscidae the mandibles may be very sharp and sickle like and have openings at their tip through which the juices of their preys are sucked. Mandibles, maxillae and labium bear teeth in case of dragonflies. In nectar sucking insects such as butterflies, mandibles are reduced or absent but the galea of maxillae are greatly enlarged to form a tubular proboscis. But in Hemiptera both the mandibles and maxillae are extended to form long, piercing stylets which when not in use are bent back under the head and thorax. In female

mosquitoes and related Diptera the arrangement is somewhat similar but the stylets are very thin, sharp and sometimes toothed for piercing the skin of their prey.

Jet: Liquid emitted from a nozzle orifice.

Jet Agitator: A device that keeps a tank mix from settling out of suspension by means of water flowing under pressure.

Johnston's Organ: A sense organ similar to the chordotonal organ. It is located in the second antennal segment of many insects and particularly well-developed in male mosquitoes and certain other Diptera. In insects these organs seem to perceive movements of their antennae and thus to become aware of air vibrations either as sounds or as air currents.

Joint: An articulation of two successive segments or parts. Exocuticle is not found in the joint areas, and the cuticle, therefore, remains membranous and flexible. Presence of these cuticular membranes facilitates movement between adjacent hard parts (sclerites). The degree of movement at a joint depends on the extent of the cuticular membrane. In the case of intersegmental membranes there is complete separation of adjacent sclerites and, therefore, movement is unrestricted. Joint operates like a hinge. Joint may be 'monocondylic' which has only one articular surface, (e.g., the articulation of antennae with the head) or 'dicondylic' in which there are two articulations and the joint operates like a hinge (e.g., most leg joints).

Jugal Area: The posterobasal area of the wings, delimited by the jugal fold and wing margin.

Jugal Fold: The posterior basal fold between the jugal and anal regions of the wing. The jugal lobe of the fore wing overlies the humeral region of the hind wing in Megaloptera (Corydalidae).

Jugal Lobe: A lobe present at the base of the wing, on the posterior side, proximal of the vannal lobe (Hymenoptera).

Jugate: This is a type of wing coupling as found in some Lepidoptera and Trichoptera,

in which the jugal lobe is finger like in certain moths and clasps the hind wing.

Jugum: In certain Lepidoptera and Trichoptera, a basal lobe of the fore wing which overlaps the hind wing thereby coupling the wings during flight.

Jumping: This is the principal means of locomotion in some insects. They may use it only for sudden escape movements when disturbed. Femur and tibia of hind legs in these insects are usually strong and enlarged (e.g., grasshoppers, fleas, flea-beetles, leafhoppers, etc). Fleas have been reported to jump about 30 cm or nearly 100 times their own length. Collembolans use the furcula and the retinulum for jumping, while click beetles jump by the sudden movement of a projection beneath the thorax. Hind legs are greatly developed as a jumping device in Orthoptera, many Homoptera, fleas (Siphonaptera) and flea beetles (Alticinae, Chrysomelidae). The middle legs of Encyrtidae (Hymenoptera) are modified for jumping.

Junior Homonym: More recently published of two or more identical names for the same or different taxa.

Junior Synonym: The more recently published of two or more available synonyms for the same taxon.

Juvabione: A substance isolated from the wood of balsam fir trees of the genus *Abies balsamea* and found to have juvenile hormone characteristics. Such compounds are sometimes also called 'hormone mimics'. Some plants, such as ferns, which have a high concentration of these compounds are almost devoid of insect herbivores. Such compounds may be present in a variety of plants and these compounds may function in part as defensive mechanisms against insect herbivores.

Juvenile Hormone (JH): The hormone secreted by the corpora allata that maintains the expression of juvenile characteristics and suppresses adult characteristics. Synthetic chemical analogues have been developed as insecticides.

Juvenile Hormone Analogues: These function in the same way as the juvenile hormones in the regulation of metamorphosis, and may or may not be similar in chemical structure to the natural hormone. Methoprene and kinoprene are two such analogues. The effects of these compounds are usually seen during larval to pupal metamorphosis and various degrees of incomplete metamorphosis become apparent. Larval-pupal mosaics may be produced, or strange deformations may appear on the pupal structure. Other uses of juvenile hormone analogues are in disrupting embryogenesis in the eggs and preventing adult diapause. They have been extensively tested in public health and stored products work because of their relative safety to human beings.

Senior Synonym: The earliest published of two or more synonyms for the same taxon.

Sense Organs: The function of a nervous system is to acquaint to the insect with changes in its environment. For this it is necessary to have a variety of receptors (sensory and organs) which detect and interpret these changes (stimuli) and translate them into nerve impulses that ultimately produce responses in muscles or glands. Mechanoreceptors and chemoreceptors are important sense organs. The principal senses of insects are : **1. Sight:** detected by compound eyes and by ocelli. Most insects can perceive colours (including ultraviolet), movements and distances. **2. Hearing :** Perceived by receptors on the antennae, by hairs and special receptors all over the body and by tympanal organs usually situated on the sides of abdomen or on the legs. Many insects can detect high frequency sounds that are inaudible to humans. **3.Smell and taste :** Perceived by chemoreceptors located chiefly on the antennae and palps but occasionally also on the legs. **4.Touch, vibration, movement and balance :** These are detected by sensory hairs and miscellaneous receptors found on most parts of the body.

Sensillum: A small dorsal area near the tip of a flea's abdomen.

Sensilla: Specialized structures that collect information from the external and internal environment and transmit this information to the central nervous system. Based on the receptors on sensilla five functional categories: 'mechanoreceptors' (touch, position, sound); 'chemoreceptors' (taste and smell), 'hygroreceptors' (humidity); 'photoreceptors' (sight) and 'thermoreceptors' (heat) of sensilla have been recognized.

Sensitivity: Susceptible to effects of toxicant at low dosage; not capable of withstanding effect. For example, many broad-leaved plants are sensitive to 2,4-D.

Sensory Hairs: Many of the hairs or setae of insects have nerve endings close to their bases and are extremely sensitive to touch, vibration, sound etc. This is especially true of the hairs on the antennae as in mosquitoes. Other types of mechanoreceptors **chordotonal, campaniform, placoid** are derived from sensory hairs and associated structures.

Sensory Neuron: A neuron leading from a receptor cell to the central nervous system. Sensory neuron are bipolar, and their cell bodies are adjacent to the sense organs.

Septicemia: An infection carried throughout the body by the blood.

Sequential Sampling: Sequential sampling is based on a thorough knowledge of variance and distribution of a population. The number of samples is variable and sampling stops once it is known that pest population is at a certain density. This is one of the most efficient sampling schemes used for making treatment recommendations in IPM programs.

Serial: Refers to the distribution of the bases or points of attachments of the crochets.

Serial Dilution: Preparation of a series of gradient solutions step by step from a concentrated stock solution.

Sericin: A water soluble gelatinous protein forming an outer layer surrounding an inner core of **fibroin** in the silk threads of insects.

Sericulture: The rearing of silkworms for silk production. There are five major varieties of silk obtained from different species of worms that feed on a variety of food plants. Mulberry silk is considered the finest of silks, it comes from *Bombyx mori* that feeds on the leaves of mulberry. These worms are completely domesticated and reared indoors. The other four varieties are called non-mulberry silk or wild silk. Among them is the 'tassar' silk. From Asia and Europe about 45000 metric tons of silk is produced annually, and for this much production an estimated 2000 billion silkworms must be reared on more than 90 million tons of mulberry leaves each year. Sericulture is believed to have developed in China as far back as 2500 B.C. Sericulture industry is concentrated in China, Japan and India.

Series: In taxonomy, the sample which the collector takes in the field or the sample available for taxonomic study.

Serology: The study of the nature and interactions of antigens and antibodies.

Serosal: The membrane covering the embryo.

Serpentine Mines: In Lepidoptera and Diptera, winding larval feeding tunnels in leaves or stems of plants.

Serrate: Notched on edge like a saw (e.g., serrate antennae of beetles of family Buprestidae).

Sessile: Attached or fastened, incapable of moving from place to place. Refers to immobile stages of some scale insects and whiteflies that lack the ability to move.

Seta: A bristle or hair-like outgrowth of the integument. Setae are greatly varied in both form and function. The common types are hair like or 'simple' setae, feather like or 'plumose' setae, and plate like 'scales'. 'Poison setae' are hollow and filled with toxic fluids for defence. Setae of diverse shapes are innervated by the peripheral nervous system and function as sensory organs called 'sensilla' (e.g., macrotrichia or trichoid sensilla).

Setaceous: Bristle-like, tapering from the

base to the apex (e.g., dragonfly and cockroach antennae).

Setting Board: Setting boards are used for mounting of wings of the insects collected. They can be constructed from pieces of polyethylene foam or soft cork glued to sheets of plywood or masonite. Several boards with a range of groove and board widths are required to hold insects of different body sizes and wing spans. Mounted insects must be allowed to dry thoroughly before removing the pins and/or setting paper.

Setting Tapes: These are transparent strips of paper of varying widths running the length of the setting board. Their purpose is to hold the wings in position until the insect dries out, when it can be taken off the board and will retain its position indefinitely if stored in a dry place.

Severe Pest: A pest with the general equilibrium position that is above the economic injury level, which makes the pest a constant problem.

Sex Attractant: A volatile chemical substance produced by one sex of an insect (nearly always the female) to attract the opposite sex. Both natural or synthesized sex attractants for male insects (pheromones) are used routinely in traps to estimate pest numbers to aid decisions about when to apply pesticides. The distances over which the pheromones are able to elicit a response are situation and species specific. In some of the cases pheromones may act over many kilometres, in other instances it may just be a few hundred metres. This is excellent IPM but pheromones are still expensive to be used in combination with pesticides.

Sex Chromosome: A special chromosome, not occurring in identical number/structure in the two sexes and usually concerned with sex determination.

Sex-Linked Character: A character controlled by a gene located in the sex chromosome.

Sex Lure: Synthetic chemical that acts as

the natural lure (pheromone) for one sex of an insect species.

Sex Pheromone: A volatile chemical substance produced by one sex of an insect which produces some specific reaction in the opposite sex. Most of the sex pheromones are powerful attractants but male pheromones may act as approposiacs. Male attracting substances are produced by the virgin females of species mainly in Lepidoptera and Coleoptera. Pheromone production is under the control of the endocrine system, especially the corpora allata. Typically, the pheromone producing glands of female Lepidoptera are eversible sacs located in the intersegmental membrane behind the eighth abdominal sternite. In the queen honey bee, mandibular glands are the source of pheromones. In houseflies, sex pheromones are secreted evenly over the second through seventh abdominal segments. In Coleoptera the glands producing pheromones are abdominal.

Sex Ratio: The ratio of males to females in a population. Sex ratios in most populations are 1:1. Exceptions to this rule are most common in parasitic Hymenoptera.

Sexual Dimorphism: Both sexes are frequently alike in appearance, particularly in the immature forms. However, sexual dimorphism in adults may be very marked. There is a tendency for female insects to be larger than males, although males of many species are bigger and are armed with large mandibles. In many species of moths, the antennae of the males are decidedly fringed and in mosquitoes the antennae are plumed. Females in many insect species have well-developed ovipositors, while males have prominent genital claspers. Extreme overall body differences are found in scale insects (Coccoidea), where the adult females are flattened, inactive, wingless and usually lacks legs and the males are active, with well-developed legs and one pair of wings.

Sexual Reproduction: In most insect species, both females and males are prevalent

and mating occurs with the eggs fertilized in the female oviduct, as they pass the duct of the sperm sac (spermatheca).

Sexuales: A term used with reference to aphids and similar insects to denote the generation which contains male and female individuals capable of normal sexual reproduction.

Sexuparous: Producing sexual offspring, as after bearing parthenogenetic females in Pterygota.

Shelf Life: Shelf life (storage life) is the time during which the pesticide may be stored without becoming unfit for use. Actual shelf life will depend not just upon the formulation *per se* but also upon the ambient environmental and storage conditions, quality of packaging and kind of transport used. Chemical manufactured typically undertake storage stability tests to evaluate half-lives under worst-case conditions. For most pesticides, two years would be a satisfactory minimum for a shelf life. Commercially produced *Bt* formulations also possess 1-3 years shelf life. The crops may be adversely affected if pesticides are applied after the expiry date. Partial or total damage of the crops may occur because of the presence of the toxic degradation products.

Shellac: Commercial lac produced as a red resinous substance from the scales of female lac insects.

Short-Term Pesticide: A pesticide which breaks down almost immediately after application, into non-toxic byproducts.

Shot-Hole: 1. Disease symptom in which small, roundish to irregular dead fragments drop out of leaves, making them appear as if riddled by shot. 2. The visible holes left by wood-boring beetles of the family Scolytidae, as they leave their host (e.g., shot-hole borers).

Shoot: The growth of a plant in the form of a stem and its leaves.

Shrub: A low growing perennial woody plant with branched stem near the ground or with multiple stems.

Sibling Species: Pairs or groups of closely related species which are reproductively isolated but morphologically identical or nearly so.

Side Dressing: To put fertilizer, or a pesticide in granular form on or in the ground near plants after they have started to grow.

Sifters: Small insects in trash and other debris may be captured by sifting the material through a box with a screen bottom, or a series of screens of increasing mesh, and onto a white sheet or shallow enamel pan. Bottom samples from streams, ponds and lakes are flushed through a series of sieves of increasing mesh that are placed on top of each other. The contents of each sieve are sorted under a little water in a shallow enamel pan.

Sigmoid: Shaped-like the letter 'S'. The S-shaped growth curve representing development of either an individual organism or a population plotted graphically.

Sign: Evidence of disease as indicated by the presence of the disease producing organisms or of any of their parts or products.

Signal Words: Words which must appear on pesticide labels to denote the relative toxicity of the product. The signal words are : **Danger-Poison** (for highly toxic); **Warning** (for moderately toxic); and, **Caution** (for low order toxicity). The symbol of the skull and crossbones must appear on the labels of highly toxic pesticides, alongwith the words **Danger-Poison**.

Significance: Measure of reliability of a difference between observation and that of expectation.

Silk: The silk fibres spun by the silkworm is formed from the secretions of the paired salivary (labial) glands which have a common opening, the spinneret on the labium. During the growth of the larva, these glands fill with relatively enormous quantities of clear viscous liquid. When extruded from the glands, this secretion form the two cores of fibroin a tough, elastic insoluble protein which comprises 75 percent of the weight of the

fibre, and these are cemented together by cericin—a gelatinous like protein which is readily soluble in warm water. Small amounts of wax and carotenoid pigments are also present. Good quality pure silk is expensive, luxurious in appearance and is durable. It is one of the strongest of textile fibres. However, it is weak when wet even though it regains the strength once dry. Silk is lustrous, elastic and does not wrinkle badly. It is also hygroscopic and absorbs about 10 percent of moisture, but still looks and feels comparatively dry. Because of this quality, even when a person wearing silk perspires, does not feel damp or clammy as in other fabrics that are hydrophobic. Silk is also warmer than cotton or linen and is, therefore, good wear for winter. However, it is not resistant to very strong light, and very hot iron can scorch the fabric. White silk for example, can turn yellow if ironed with a very hot iron. To test whether the material is pure silk, one can use 'burning test'. In this method a small piece of cloth is burnt with a match stick, silk fibres will burn slowly and leave a residue that is black and round (like beads) on burning, pure silk also give out the smell of burning hair.

Silver Shoot: In case of leaf, the gall produced by an abnormal growth of the leaf sheath in response to the attack of gall midge.

Simple Eye: Commonly known as ocelli, occur with or without compound eyes in adults of many insects, larvae usually possess only simple eyes. Adult insects, in addition to their compound eyes usually have three ocelli arranged in a triangle on the top of the head. They probably inform the insect of changes in the intensity of the light but their simple structure is incapable of forming any kind of clear picture.

Simple Metamorphosis: Metamorphosis in which the wings (when present) develop externally during the immature stage and there is no prolonged resting stage preceding the last moult; stages included are the egg, nymph, and adult. Also known as gradual or partial

metamorphosis, and paurometabolous development.

Sinigrin: Mustard oil glucoside, characteristic of the plant family Cruciferae, acts as a feeding stimulant for the turnip aphid and cabbage aphid.

Sinus: A recess, cavity, hollow space; an air cavity in a cranial bane - a partitioned chamber of the body cavity.

Siphon: A breathing tube which usually has two spiracles and two tracheae, projecting from the hind end of an aquatic insect such as mosquito larva. In the case of culicine mosquitoes the larva hangs from the surface of the water with its head down and its siphon piercing the surface film and enabling the insect to breathe. In some cases it is modified for piercing the tissues of aquatic weeds and obtaining air from these. The siphon attains extreme size in the aquatic larva of the dronefly, *Eristalis* sp. (Diptera: Syrphidae).

Siphonaptera: An endopterygote insect order. Commonly called fleas. They are soft, tough-bodied and laterally flattened. Antennae are very short and lie in lateral grooves on head. Mouthparts short, piercing type. Simple lateral eyes similar to ocelli, no compound eyes. The legs are usually long and well-developed with hind legs enlarged for jumping. Body and legs often bear stout backward pointing spines. Complete metamorphosis. The adults are blood feeding ectoparasites on birds and mammals. They are worldwide in distribution.

Siphoning Mouthparts: They are found in almost all adult Lepidoptera. In this type of mouthparts, mandibles are completely lacking, and the galea (parts of the maxillae) are fastened together forming a proboscis, or tongue which is coiled at rest and which uncoils to form a tube for sucking liquids - nectar, water, fruit juices and plant exudates.

Siphunculi: Also called cornicles. The paired protruding organs near the terminal end of the abdomen of Aphidoidea, through which a waxy secretion is extruded.

Size of Insects: Largest insects are found in order Coleoptera, *Megasoma elephas* attains a length up to 150 mm. *Pharnacia serratipes* (Phasmida) may exceed 260 mm long and the hemipteran bug, *Belostoma grande* attains a length of 115 mm. Size of lepidopteran insects is measured by taking their wing-span, and on this basis moth, *Erebus agrippina*, have a wing-span of 280 mm. Wing-span of Atlas moth, *Attacus atlas* measure 240 mm. Smallest insects, which does not exceed 0.25 mm, are also representative of Coleoptera (Ptiliidae). However, egg parasites of family Mymaridae (Hymenoptera) are even more minute.

Skeletal Muscle: A muscle that stretches across the body wall and serves to move one segment to another.

Skototaxis: A reflex response by which an insect will move towards a dark object or the darkest part of a room.

Slide Mounting: The features of insects that are needed to be seen for the identification of many of the smaller insects can be viewed satisfactorily only under the higher magnification of a compound microscope. For this the specimens must, therefore, be mounted either whole on glass microscope slides or dissected before mounting. Discrimination of minute structures may require the staining of the cuticle to differentiate the various parts or the use of special microscope optics such as phase, or interference-contrast microscopy. Mountants used for slides are either aqueous gum-chloral based (Hoyer's Medium) or resin-based (e.g., Canada balsam, Euparal). Hoyer's medium is more convenient for preparing temporary mounts whereas the Canada balsam or Euparal are used for permanent mounts that are intended for long term storage. Prior to slide mounting, the specimens generally are cleared by soaking in either alkaline (e.g., 10% KOH or 10% NaOH) or acidic solutions (e.g., lactic acid or lactophenol) to macerate and remove the body contents. After hydroxide treatment, specimens must be washed in a weak acidic solution to halt the maceration. Cleared

specimens are mounted directly into gum-chloral mountants. Mounted slides can be dried in an oven at 40-45°C.

Slow Release Insecticides: A type of insecticide formulation. These are relatively new insecticides and only a few are available commercially. The method of slow release involves the incorporation of insecticide in a permeable covering, microcapsules or small spheres with diameters ranging from 15-50µm. The insecticide escapes through the small sphere wall at a slow rate over an extended period of time thus preserving its effectiveness much longer. An example is the Shell-No-Pest Strip which incorporates dichlorvos (DDVP) into strips of polychlorovinyl resin. Microencapsulated diazinon, fenitrothion, lacquer preparation of chlorpyrifos, and adhesive tapes containing propoxur or diazinon or chlorpyrifos; and briquettes containing the insect growth regulator methoprene for mosquito larva control are available. These formulations are used to kill flying and crawling insects over a long period of time.

Slug: A relative of snails but having the shell rudimentary or entirely wanting. They are greyish or greyish-brown slimy, legless, soft-bodied creatures, from 2 to 10 centimetres in length. A shiny trail, composed of a sticky, viscid secretion given off from the body of slug will mark the course of its travels over soil and plants. They feed on the foliage of plants particularly in the damper parts of greenhouses. They feed on potted plants and other annuals. Trapping and hand picking are fairly effective under greenhouse conditions. But they require a relatively cool, moist environment and face difficulty in tolerating hotter and drier conditions. Layers of diatomaceous earth or ashes may also be sprinkled around plants. These materials are abrasive, and slugs will not cross them when they are dry. Slugs can be controlled satisfactorily by broadcasting poison baits in the evening.

Slurry: Slurry is a thick suspension of a pesticide made from wettable powder and

water. Fungicides and some insecticides are applied to seeds as slurries to produce thick coating and reduce dustiness.

Smoke: Particles of a pesticide chemical between 0.001 and 0.1 µm in the diameter. The particles are released into the air by burning. Smokes have been used in glasshouses and in warehouses and ship's holds. Care must be taken to avoid the smoke diffusing into nearly living quarters which should be evacuated during treatment. Mosquito coils are a special form of smoke generators. These coils are made from an extruded ribbon of wood dust, starch and various other additives and colouring matter (often green), together with natural pyrethrins or allethrin. Smokes from a coil has deterrence, expulsion, interference in the host finding, bite inhibition, knockdown and eventually death of mosquitoes entering a room. The coils provide a relatively cheap way of alleviating the nuisance from mosquitoes during the night.

Smut: Smuts are the plant diseases caused by fungi belonging to the order Ustilaginales in the phylum Basidiomycota. Smut diseases are characterized by the formation of a mass of teliospores called a sorus in the plant organs. Smut fungi can be categorized as inflorescence smuts, leaf smuts, stem smuts, or root smuts, depending on the location of the sorus in the infected plant. The term smut, which means to soil or blacken, comes from the powdery mass of dark spores (teliospores).

Snail: A representative of phylum Mollusca having a single, usually coiled shell and a broad, flat foot. They have thin skin and can easily desiccate under dry conditions. Snails and slugs typically require a relatively, cool and moist environment. Snails are better able to tolerate hotter and drier conditions than slugs.

Social: Living in more or less organized communities of individuals. Social insects are ecologically successful and have important effects on human life. Among the social insects we can recognize eusocial (true social) and subsocial (below social). In contrast, insects

which exhibits no social behaviours are termed solitary.

Social Facilitation: Increase in the pace or frequency of a given behaviour due to the presence or activities of another conspecific individual.

Social Homeostasis: The maintenance of steady states at the level of the society either by control of the nest microclimate or by the regulation of the population density, behaviour, and physiology of the group members as a whole. Most social insects are able to control temperature and humidity of the nest at least to some extent. In temperate climates, many ant species start to breed under stones in early spring, then they move deeper into the soil in summer. Aerial nests of wasps are built in protected places and those of hornets and yellow jackets are enclosed in protective paper sheaths. Fanning at nest entrance and carrying of water to the nest play important role in cooling the nest in hot weather for many species. Honeybees survive the winter by clustering in the hive.

Social Insect: In the strict sense, a 'true social insect' is one that belongs to a eusocial species, in other words it is an ant, a termite, or one of the eusocial wasps or bees. In the broad sense, a 'social insect' is one that belongs to either a presocial or eusocial species. In eusocial insects brood care is cooperative, there is a caste system involving a reproductive division of labour and there is an overlap of generation so that some offspring assisting the parental generation in the rearing of further offspring.

Social Organization: Development of animal society with cooperation and often polymorphism. The basic purpose of such a system is to increase efficiency through a division of labour and to extend life of the female. A colony functions like an individual; it gathers and consumes food, protects itself, grows, and reproduces. A highly developed colony like that of the honeybee does not die, although individual components die and are replaced. A well-developed social organization also occur in ants (Hymenoptera) and termites (Isoptera).

Social Parasitism: The coexistence in the same nest of two species of social insects, of which one is parasitically dependant on the other. The term can also be applied loosely to the relation between symphiles and their social insect hosts.

Social Pheromone: Colony cohesion in bees, wasps, and termites is often maintained by pheromones. A queen pheromone in honeybees and in some wasps inhibits maturation of ovaries of workers. Pheromones in termites also influence caste development in reproductives and soldiers.

Social Wasps: The primitive wasps are least specialized social Hymenoptera. Their colonies are small, often numbering only several dozen individuals. Each colony may have several to many queens, although one queen is normally aggressively dominant and the remainder tend to function as workers. A sterile worker caste when present is difficult to distinguish from queens and consists of few individuals. Nests consist of an open layer of brood cells suspended by a single pedicel. In the temperate region, each colony survives only for several months during the summer and disorganizes during the autumn. In the more advanced social wasps such as yellow jackets, castes become distinct. In temperate regions and also in many tropical species, usually one queen is present per nest, and she is considerably larger than her daughters (the workers). Colonies may be founded either by a single queen or by swarming. soon number into thousands and produce a large enclosed nest of papery material constructed from masticated wood mixed with salivary secretions.

Sociality: The condition of living in organized communities. Sociality is limited to a more restricted range of cooperative behaviours. Amongst the social insects, we can recognize eusocial (true social) insects which cooperate in reproduction and have division of reproductive effort, and subsocial (below social) insects which have less strongly developed social habits, falling short of extensive cooperation and reproductive

partitioning. Solitary insects exhibit no social behaviours.

Society: A group of individuals belonging to the same species and organized in a cooperative manner. Some amount of reciprocal communication among the members is implied.

Sociobiology: The study of all the aspects of communication and social organization.

Sociotomy: Method of nest formation among social insects in which immatures and secondary reproductives separate from the parent colony or a migrating colony divides into two daughter colonies.

Soft Water: Water with few minerals or other chemicals dissolved in it. Soaps make leather easily in soft water.

Soil Injection: Mechanical placement of the pesticide beneath the soil surface with a minimum of mixing or stirring. It is a common method of applying liquid fumigants which change into gases.

Soil Persistence: Length of time that a pesticide application on or in soil remains effective.

Solarization: Development of mulches with the use of transparent polyethylene film for solar heating of the soil. This technique utilizes solar radiation to raise the temperature of the soil above 32°C, a temperature at which many organisms are killed. In appropriate circumstances it has been used to control pest fungi, bacteria and nematodes.

Soldier: A member of a worker subcaste specialized for colony defence. It is a reproductive caste. In termites, soldiers have well-developed head for defence. In some cases soldiers have enlarged mandibles, and in other types known as 'nasute', has a nozzle like frontal projection from which defensive fluid is secreted. In some species soldiers have both large mandibles and nasute head.

Solid Formulations: Refers to pesticide formulations which are in solid form and are generally free of organic solvents, and are easy to pick up in case of spillage and in general

there is less packaging waste. Wetttable powders (WP) and water dispersible granules (WG) are examples of solid formulations.

Solitaria: A name given to locusts in the solitary, non-migratory phase. Solitary and gregarious phases differ in morphometrics, colour and behaviour. At low densities locusts develop into the solitary phase, with a characteristic uniform-coloured 'hopper' (nymph) and large-sized adult with large hind femora.

Solitary: Occurring singly or in pairs, not in colonies. These insects possess none of the three traits involving cooperative care of the young, division of labour, and assistance to parents. Each insect is primarily concerned with satisfying the biological requirements for self-survival.

Solitary Bees: Solitary bees, as the name implies have little or nothing to do with one another except to mate. They do not live in colonies. Solitary bees are valuable pollinators of specific crops in many parts of the world but like bumblebees their value is limited because of great fluctuations in their population levels. Mining bees, carpenter bees, and cuckoo bees are all examples of solitary bees.

Solitary Phase: A sedentary or stationary form or 'solitary phase' in case of migratory locust, *Schistocerca gregaria*. In solitary phase, adults has little black pigmentation and normal-sized wings and the prothoracic glands persists into adulthood indicating a continued role of juvenile hormones. Adults remain in the same general region where they develop. Solitary wasps are structurally more juvenile than gregarious adults. Solitary females lay more eggs than their gregarious counterparts. Both of these features are related to the enhanced activity of the corpora allata. The moult glands of solitary individuals do not degenerate at eclosion, though they never trigger further moult.

Solitary Wasps: Wasps that do not live in colonies, e.g., potter wasps, mason wasps, and spider-hunting wasps.

Soluble Powder (SP): A powder formulation in which the parent compound is soluble in water and can be dissolved directly in spray solution for application. Some are packaged in bags that look like plastic and dissolve when thrown into water. Some agitation is needed to get SPs into solution, but after SPs are dissolved, additional agitation is not needed. Usually SPs are formulated with 50 percent or more active ingredient and always require dilution.

Solution: Solution is a liquid containing in it another liquid or the solid suspended or dissolved in it, and having perfect homogeneity and complete absence of a tendency for the dissolved substance(s) to settle out. It is separated into its components only by freezing or boiling. They have the good spreading characteristics and can be applied with simple equipment, because no agitation or mixing is required. Most synthetic organic pesticide compounds are insoluble in water, so more expensive organic solvents must be used. This increases phytotoxicity and hazard to the applicator. However, the solvents can increase the effectiveness of the pesticide by enhancing penetration. Solutions are mainly used as household sprays, moth proofers, livestock sprays, and space sprays in barns. A special kind of high concentrate solution is ultralow volume concentrated (ULV). Ultralow volume formulations are applied without dilution with special aerial or ground equipment to produce an extremely fine spray.

Solvent: In case of the pesticides, a carrier solution in which the technical product is dissolved to form the concentrate. Many of the organic compounds used for insecticides are insoluble in water. Before they can be turned into spray concentrates or aerosols, they must be dissolved. The solvent chosen depends on the planned use of the material. Solvency, phytotoxicity, animal toxicity, combustibility, odour, and cost are major considerations for selecting a solvent. Carbon tetrachloride, kerosene, and xylene are commonly used as solvents.

Soma: The animal body as a whole with the exception of germinal cells.

Somite: A body segment of a metamerically segmented animal.

Sonagram: Also called as sound spectrogram - an instrument that records the frequency spectrum of a sound, as a function of time and is commonly used to study bird sounds because it permits one to distinguish pitch differences.

Sooty Mould: A fungus with dark mycelium that grows on honeydew of insects.

Sounds of Insects: Many insects produce sounds audible to humans (30-30,000 cycles per second) and many more produce sounds which are of frequencies beyond the range of human perception but perceptible to other insects. Some sounds made by insects are merely incidental. Chirpings of grasshoppers are made by special sound producing organs. Insects produce sound through rapid wing beats, and stridulation (sound produced by rubbing the hind femora against the edges of the wings or by rubbing the tegmina together as in grasshoppers and crickets). Cicadas produce loud sound by two resonating drums with air spaces situated beneath them on the base of the abdomen. Click beetles produce clicking sound by tapping its head against a burrow.

Space Bomb: An aerosol spray that can be used in rooms or buildings. A container having a pesticide plus a chemical under pressure which forces the pesticide out as a spray or mist.

Space Spray: A pesticide forced out of an aerosol container or sprayer as tiny droplets which fill the air in a room or building and destroy insects and other pests.

Spatial Orientation: It is the self-controlled maintenance or change of an organism's body position relative to environmental space.

Spatulate: Like a spatula; flat, thin and narrow.

Speciation: The splitting of a phyletic line; the process of the multiplication of species;

the origin of discontinuities between populations caused by the development of reproductive isolating mechanisms. Speciations may be instantaneous through single mutation in asexual species, and by chromosomal mutations or aberrations or gradual (the geographical speciation or allopatric speciation and sympatric speciation).

Species: A group of individuals or populations which are similar in structure and physiology and are capable of interbreeding and producing fertile offspring, and which differ in structure and/or physiology from other such groups and normally do not interbreed with them. The species category plays the central role in system of classification. All other categories of the hierarchy are based on the species category. Specific name of the species always begin with a lower-case letter.

Species Odour: The odour found on the bodies of social insects which is peculiar to a given species. It is possible that the species odour is merely the less distinctive components of a larger mixture comprising the colony odour.

Spectrum of Activity: The range of insect species against which an insecticide is active.

Speed of Insects (Flight): Upper limit of flying speed is about 25–48 km/hour achieved by horseflies, deer botfly, and some of the larger dragonflies. A bee flies at about 8–22 km/hour, desert locust's sustained flight speed is 16km/ hour. Most insects fly considerably more slow than this. For example mayflies, bumblebees and rose chafers fly at less than 3 km/hour.

Spermatheca: Receptacle in the female which receives and stores the sperms of the male until required for fertilizing the eggs. The spermatheca opens into the genital chamber independantly as in Orthoptera, but where the genital chamber form a vagina it opens into it as in Lepidoptera. As the egg passes the duct of sperm storage organ or spermatheca, fertilization takes place. In some

insects release of spermatozoa for fertilization can be controlled by the female. For example in the honeybee, unfertilized eggs develop into drones and fertilized eggs develop into workers or queens. Spermatozoa can be maintained for long periods in the spermatheca of many female insects. A small gland in conjunction with the spermatheca may produce secretions responsible for sperm longevity.

Spermathecal Gland: A gland associated with the spermatheca in the reproductive system of female insects. The gland or glandular cells within the storage part of spermatheca provide nourishment to the contained spermatozoa.

Spermatocytes : A male reproductive cell that arises from the division of a male germ cell, the spermatogonium.

Spermatogenesis: Development of male reproductive cells (spermatozoa) in the testicular follicles. This process usually occurs during the last larval instar or pupal stage and in some species continues in the adult stage.

Spermatogonia: The primordial male germ cell.

Spermatophore: Spermatozoa enclosed in a gelatinous pocket that is introduced into the female reproductive tract or deposited on the substrate and taken up by the female. Spermatophores are common in the lower orders (many apterygotes) and are rare or absent in some of the higher orders such as Hymenoptera.

Spermatozoon: The mature male sexual cell or sperm cell, whose function is the fertilization of the egg. Insect sperms are quite slender and long, their narrow diameter is probably correlated with the diameter of micropyles in the egg chorion.

Sphecology: Scientific study of wasps.

Sphecophile: An organism that must spend at least part of its life cycle with wasp colonies.

Sphecophily: Plant pollination by wasps.

Many wasp species found in superfamilies Ichneumonoidea and Vespoidea are pollinators. Many chalcid wasps are specialized pollinators of many species of figs.

Spicule: A small needle like spine.

Spider: Small arachnoids belonging to the order Araneae, closely related to insects. They have eight-jointed legs, two body regions, no antennae and no wings. Spiders are often grouped with ticks and mites. Spiders feed mainly on insects. Silk spinning organs are located on the underside of the abdomen, permitting spiders to build webs. Insects and other prey become snared in the web and are killed outrightly or are paralyzed by venom from the spider's bite. As a group, spiders benefit humans by serving as natural enemies of insect pests. Some spiders are medically hazardous pests because of their dangerous bites. these include the black widow (*Latrodectus mactans*) and the brown recluse (*Loxosceles reclusa*).

Spillage: The leaking, running over, or dripping of any pesticide chemical. For safety reasons it should be cleaned up immediately with dry soil or with any other suitable absorbent material.

Spina: Internally inflected median process on the spinasternum.

Spinasternum: The eusternum and the following intersegmental sclerite or intersternite, is commonly called the spinasternum because it usually has an internal apodeme called the spina, except that the metasternum never has a spinasternum. The eusterna of the prothorax and mesothorax may fuse with the spinasternum of their segment.

Spine: A multicellular, thorn-like process or outgrowth of the integument not separated from it by a joint. Spines differ from spine-like setae in being produced by undifferentiated epidermal cells and are usually multicellular in origin.

Spinner: The fully mature adult form of

mayflies after moulting of the dun (subimago) has taken place.

Spinneret: Organs found in certain insect larvae and in spiders, which are used in spinning silken threads. In insect larvae, these organs have an opening beneath the labrum but in spiders the spinnerets open at the hind end of the abdomen. The spinning apparatus, the spinneret, in insect larvae is composed of the maxillae, hypopharynx and labium.

Spinning Disc Sprayers: These sprayers use centrifugal energy in atomizing liquids by throwing droplets from the edge of spinning disc. The rotating disc of these sprayers has grooves and teeth that promotes the formation of droplets. Droplet-size spectrum produced in such sprayers is much narrower and permits the controlled-droplet application. Monosize droplets can be produced for specific crop and pest situations. Typical monosize sprays comprise droplet of 50, 100, 200 or 300 µm in diameter. The droplet size produced depends on the physiochemical properties of the formulation, the rotational speed of the disc, the size of the disc and the flow rate of liquid onto the disc. Spinning disc sprayers permits a vast reduction in the volume application rates for many pesticides. For example most hydraulic systems apply pesticides at volume application rates of 200 - 500 litres per hectare, whereas spinning disc sprayers can operate at rates as low as 5 litres per hectare. These sprayers are a great success where there is a shortage of water.

Spiracle: An external opening of the tracheal system through which diffusion of gases takes place. On the basis of functional spiracles, the respiratory system is classified as : **I. Polypneustic**-in which there are at least 8 functional spiracles on each side of the body. Polypneustic type of system is further classified as, (i) **Holopneustic**-system in which 10 spiracles are functional (1 mesothoracic, 1 metathoracic and 8 abdominal); (ii) **Peripneustic** -9 spiracles are functional (1 mesothoracic and 8 abdominal) as in many insect larvae; (iii) **Hemipneustic**

: 8 spiracles are functional (1 mesothoracic and 7 abdominal). **II. Oligopneustic** - in which only 1 or 2 functional spiracles are found on each side of the body. It is further classified as : (i) **Amphipneustic** - 2 spiracles are functional (1 is mesothoracic and 1 is post-abdominal) as in many of the immature Diptera; (ii) **Metapneustic**-only one pair of post-abdominal spiracle is functional (as in aquatic Diptera); and (iii) **Propneustic**-in which only 1 mesothoracic spiracle is functional.

Spiracular Bristle: A bristle very close to spiracle (Diptera).

Spiracular Plate: A plate like sclerite next to or surrounding a spiracle.

Spiracular Sound Organ: An organ formed from a series of leaf-like folds inside the tracheae of some insects. When air is rapidly expelled from the spiracles these folds vibrate and produce a high pitched sound. This type of arrangement is not common but found in a few Diptera and Coleoptera.

Spittle: A frothy fluid known as 'cuckoo spit' is produced by the nymphs of spittle bugs (Cercopidae). Slimy material is secreted from malpighian tubules via the anus, and air bubbles are forced into it from tracheal system. It provides protection for the nymph as it feeds upon the sap from the host plant.

Split Application: Refers to a pesticide dosage given in instalments, but not at one time. This gives more effective action of the pesticide, and is a more economic one.

Split Plot Design: An experimental design in which two or more series of treatments are simultaneously tested, one series being confined to whole plots within each of which all of the treatments of the second series are included. Randomization of the subplot treatments are independent of the randomization of the whole plot treatment. Split plot design provides more validity, precision and more accuracy for subplot treatment than the whole plot treatments. But the disadvantage of this design is that whole plot treatments are estimated and tested with

lesser precision and accuracy than the subplot treatment and interaction effects.

Sponging Mouthparts: Sponging type mouthparts are found in housefly and many other higher Diptera. At their tip is a fleshy labella bearing many tiny holes—entrances to tubules that lead to a central food channel. These flies lap or sponge liquids and often spit enzyme-containing saliva into solid foods such as sugar or bread crumbs to liquefy them.

Sporadic Pest: Also called secondary pest. Pest species whose numbers are usually controlled by biotic and abiotic factors which occasionally breakdown, allowing the pest to exceed its economic injury level (e.g., spider mites and the locusts).

Spore: A single to many-celled reproductive body in fungi that can develop a new fungus colony. Many of the small spheres exuded from the tips of special mycelial cells. They are called asexual spores because no nuclear fusion is required for their formation. They are green or blue-green. Most fungi have a sexual process for forming spores after the fusion of nuclei from the different mycelia or within multinucleated mycelia. Some species of bacteria produce dormant forms that are more resistant to killing by heat, drying and chemicals than are original cells.

Spot Treatment: A treatment directed at specific plants or areas rather than a general application.

Spray: To apply minute particles of liquids containing a pesticide. Sprays may be of different types : **1.Air-carried** : Spray propelled to target in a stream of air; **2.Coarse** : Dispersion of droplets of mass median diameter over 200 μm ; **3.Concentrate** : Undiluted commercial pesticide preparation; **4.Fine** : Dispersion of droplets of mass median diameter from 50-150 μm ; **5.Floor** : Spray applied to the litter on the ground surface; and **6. High Volume** : 400-1200 l/ha.

Spray Angle: Angle between the sides of a jet leaving the orifice.

Spray Booms: The boom is a light hollow tube or pipe which is used to carry the spray liquid under pressure from the pump to one or more nozzles. The simplest type is the spray rod or lance, which is a tube from 1-3.5 m in length, with a cut-off valve at one end and a simple swirl spray or flat fan nozzle at the other. For row crop and field crop spraying, horizontal booms of many designs have been developed. These are aluminium, brass, or stainless steel tubes (2.5 to 5.0 cms in diameter) and range from 4 - 14 row coverage. Vertical booms with alternating nozzles pointing to either side and with mechanical oscillation to improve penetration and coverage are used in orchard spraying. The larger booms are equipped with a hydraulic mechanism for lifting over obstructions and are tractor-mounted. The efficiency of coverages with such equipment is a function of nozzle discharge, oscillation rate, and driving speed.

Spray Concentrate: A liquid formulation of pesticide that is diluted with another liquid (usually water or soil) before using.

Spray Deposit: The amount of pesticide chemical that remains on a spray surface after the droplets have dried.

Spray Drift: The movement of air-borne spray particles from the intended area of application.

Sprayer: Equipment/machine for applying pesticide sprays. Water-based pesticide application systems rely on some kind of sprayer. Sprayers come in a variety of sizes. Some are small, hand held or back pack, for use in domestic or in small commercial vegetable and fruit gardens. Large tractor-pulled, or self-propelled units are capable of dispersing hundreds of litres of spray. The basic components of a sprayer, i.e. tank, filters and strainers, and pump, are essentially the same for all kinds of sprayers.

Spread: Local movements within a region of favourable environment. Spread occurs in all insect species and ensures among most sexual species, sufficient local genetic recombination

to maintain a relatively diverse population, uniformity and completeness with which spray deposit covers a continuous surface such as a leaf or seed.

Spreader: Material added to a spray to lower the surface tension and to improve spread over a given area. These additives are intended to stop spray droplets from rolling of their target.

Spreading: In mounting insects, spreading involves holding the appendages away from the body while the specimens are drying. Legs and antennae can be held in seminatural position with pins and the wings can be opened and held at horizontally on a setting board using pieces of tracing paper, cellophane, grease- proof paper etc.

Spur: An articulated spine, often on a leg segment usually the tibia, and are movable (e.g., Homoptera).

Spurious Claw: A false claw; a stout bristle that looks like a claw (as in spiders).

Spurious Vein: An extra, incomplete wing vein between the radius and media. Used in the identification of flies of family Syrphidae (Diptera).

Squama: A scale like structure ; a calypter ; the palpiger (Odonata).

Square: An unopened flower bud of cotton with its subtending involucre bracts.

Stability: The ability of a pesticide formulation to resist chemical degradation over a period of time.

Stadium: The time interval between moults in a developing insect.

Stage: A distinct, sharply different period in the development of an insect (e.g., egg stage, larval stage, pupal stage, adult stage); in mites and ticks, each instar.

Stage Of Development: A defined period of growth, usually refers to an insect. An insect goes through many changes in its growth, from an egg to an adult; each such stage is a stage of development.

Staggered Planting: Planting different fields

in a community or a farm over a period of several weeks in contrast to simultaneous planting where planting of all fields is done over a period of a week or less. In staggered planting everything like flowering and fruiting is not occurring at the same time.

Stalked: With a stalk or stem; with a narrow stem like base ; fused together to form a single vein.

Stamen: Male part of the flower consisting of the pollen bearing anther and the filament.

Standard: Measure of knowledge and ability which must be demonstrated as a requirement for certification.

Standard Deviation: The square root of the sum (Σ) of the squared deviations (d) from the mean, divided by N.

$$SD = \sqrt{\frac{\Sigma d^2}{N}}$$

The standard deviation of a set of sample numbers eliminates the problem of sole dependance on extremes by averaging deviations of sample counts from the mean count. The standard deviation 's' of a set of insect samples can be readily calculated on hand-held calculators, many of which are programmed for this statistic.

Standard Error of the Mean: Standard deviation divided by the square root of the sample size, N.

$$SE = \frac{SD}{\sqrt{N}}$$

where SE = standard error; SD = standard deviation of the sample numbers; and N = number of sampling units taken. An important characteristic of the standard error is that its magnitude decreases as the number of sampling units increases. This statistic is particularly important in insect sampling programs because it can be used as a measure of precision. The lower the standard error, the more precise the sampling program. It is possible to increase sampling unit number and thereby increase precision.

Statary Phase: The period in the activity cycle of an army ant colony during which the colony is relatively quiescent and does not move from site to site. At this time the queen lays the eggs and the bulk of the brood is in the egg and pupal stages.

Statocyst: A sense organ of balance.

Statute of Limitation: A provision in the Code to protect universally adopted junior names against the revival of forgotten senior synonyms.

Stelocyttrous: Pertaining to nests and especially wasp nests, in which the combs are attached to the support by pillars.

Stemma: The simple eye in holometabolous larvae. Also called lateral ocellus. These are of three types. **1.**In sawfly and beetle larvae each stemma, one on either side of the head, resembles a dorsal ocellus. **2.**In larvae of Neuroptera and Lepidoptera, there are usually several laterally placed stemmata on each side of the head. **3.**In larvae of cyclorrhaphus Diptera there are no external signs of stemmata. Stemmata relatively formed a focussed image and are important in colour vision, predator avoidance, prey capture, etc. They can also detect the plane of polarized light.

Stenoecious: Having a narrow range of habitat selection.

Stenogamy: The ability to mate in a confined space, an ability that is rather rare among insects since most species mate while flying and this often involves the swarming of a large number of males, or at least some form of extended courtship flight.

Stenogastrous: Having a shortened or narrow abdomen.

Stenophagy: The restriction of the animal to the consumption of but a narrow range of closely related species of food organisms.

Stenotopic: Restricted to living in a single type of habitat.

Stereokinesis: A phenomenon by which the reflex movements and responses of an insect

to light or other stimuli are inhibited by the action of tactile stimuli. When an insect is in contact with any solid body, particularly with a rough surface, it tends to remain motionless. Stimuli which would normally cause the insect to fly are apparently not strong enough to overcome the immobilizing effect induced by a sense of touch. The phenomenon is said to explain why bed bugs, cockroaches and other insects come to rest in crevices and narrow places and why large numbers of plant lice crowd together in contact with one another.

Stereomicroscope: The normal microscope provides only a flat image, stereomicroscope provide a 3-dimensional impression of the observed object. It consists of two microscope tubes inclined towards each other at an angle of 15° and directed at the object. With 3-dimensional structures; the two microscopes show two pictures which are not identical and which present to the observer a stereoscopic effect. In the beam of the two microscopes are inserted prismatic reflections, which erect the inverted picture of the normal microscope—a fact which provide real relief for manipulation under the microscope. Stereomicroscopes permit the production of optimum beam of light and the creation of pictures of the highest quality which may be magnified up to 200 times.

Sterilant: Any agent or chemical that destroys all living organisms in a substance or renders it barren.

Sterile Male Technique: Also called sterile insect release method. A genetic control of pests involves the release of large number of sterile male insects. Sterilization of native population by chomosterilants can also be done but in this the success comes only when sterilized insects are able to compete effectively with their unaffected and fertile conspecifics and drastic reductions in populations are not frequent. In contrast, mass sterilization and releases have their greatest potential against pests when populations are low. These mass-reared insects must also be competitive, must be released at the proper time and place, and

preferably the females mate only a single time. Sterile male technique have been used with success against screwworm fly, mediterranean fruitfly and melon fruitfly. Advantages of this technology are its specificity, the permanency of its effects, and it also does not pollute the environment. But this method is not useful for species that mate only once or a very few times. Moreover this technique has proved useful for insects belonging to Diptera and Lepidoptera, in many species of which female mate only once or a very few times. This method is also not feasible to control pests that appear sporadically or in high density. Moreover, the use of irradiation of chemosterilants to achieve sterility (induced sterility) may not always be feasible because of health hazards, costs etc.

Sterilize: To treat with a chemical or other agent that kill every living thing in a certain area.

Sternacostal Suture: A suture of the thoracic sternum, the external mark of the sternal apophysis or furca, separating the basisternum from the sternellum.

Sternal Apophysis: An invagination of the thoracic sternum to which muscles attach.

Sternellum: The part of the eusternum posterior to the sternacostal suture.

Sternite: A sclerite on the ventral side of the body, the ventral sclerite of an abdominal segment.

Sternopleural Bristles: In flies (Diptera), bristles found on a sclerite (sternopleuron) just above the base of the middle leg.

Sternopleuron: A sclerite in the lateral wall of the thorax, just above the base of the middle leg (Diptera).

Sternum: The skeletal plate on the ventral side of each segment of an insect. It may be a single plate or may be made up of several parts known as sternites.

Sticker: A material of high viscosity used to stick powdered seed dressings onto the seeds. Paraffin and methyl cellulose are two commonly used stickers. A solution of methyl

cellulose can be added to a spray to increase retention on plant foliage. The amount of insecticide residue adhering to a treated surface is partly governed by the wetting and spreading properties of the mixture. Stickers are sometimes added in formulations used as emulsions or wettable powders, to retain the active ingredient on a surface longer after application. Casein, galatin, and vegetable oils are commonly used as insecticide stickers or adhesives. Rain or water resistant formulations containing latex have been used to extend residues (e.g., Sevin XLR).

Sticky Trap: Traps containing a sticky substance that holds insects to be counted. Raisins, greases and castor oil are common sticky substances. Sticky traps are commonly used to catch and monitor population of small air-borne insects.

Stigma: A darkened or thickened area of the wing along the anterior (costal) margin near the tip (Odonata); coloured wing spot of certain butterflies and other insects.

Stigmal Vein: A short vein extending posteriorly from the costal margin of the wing, usually a little beyond the middle of the wing (Hymenoptera: Chalcidoidea).

Stigmata: Breathing pores located on the dorsal side of arachnids near the mouthparts. In subclass Acari, order Acariformes is characterized by being without visible stigmata posterior to the coxae of second pair of legs. But in order Parasitiformes, one to four pairs of lateral stigmata are found posterior to the coxae of the second pair of legs.

Stimulant: A chemical or physical factor which increases some specific activity. It is of two types; **1.Locomotor stimulant:** A chemical that causes by a kinetic mechanism the organisms to disperse from a region more rapidly than if the area did not contain the chemical, and **2.Feeding, mating or ovipositional stimulant :** Chemical that elicits feeding, mating or oviposition in an organism. Feeding stimulant is synonymous with 'phagostimulant'.

Sting: Also known as stinger. Among the insects, only the order Hymenoptera contain species that possess a specialized stinging apparatus with an associated venom gland. The sting of Hymenoptera is believed to have evolved primarily as a means of paralyzing the prey, but in some species it has lost this function but serves as defence. The so-called aculeate hymenopterans belong to seven superfamilies that include the hornets, bees, yellow-jackets, wasps, velvet ants, and cuckoo wasps. Some species are more aggressive than others, but most stings are used for defence rather than offense. The nature of the venom of social species differs considerably from that of solitary forms, consisting of a mixture of pain producing substances. In the social species, multiple stings can result from the release of an alarm pheromone with the venom that incites other individuals to attack. Some ant species also sting in an offensive manner.

Stink Gland: Many insects secrete substances with a dischargeable odour. These are not necessarily poisonous but act as a deterrent to would be predators. In some insects these substances come from hypodermal cells, and in others from the salivary glands or the accessory sex glands. Stink glands are present in bed bugs (Cimicidae), stink bugs (Pentatomidae), oil beetles (Meloidae), some ground beetles (Carabidae) and some caterpillars.

Stipes: The second segment or division of a maxilla, which bears the palpus, the galea, and the lacinia. The area on the stipes where the palp articulates may be differentiated into a segment like structure called the palpifer. Muscles from the cranium insert on the cardo and stipes, producing various motions of the maxilla about the single articulation. The innervation of the maxilla is from the suboesophageal ganglion.

Stochastic Theory of Mass Behaviour: The theory that transition probabilities in the behaviour of individual social insects are programmed to produce optimal mass responses of the colony as a whole, that the

probabilities have been determined by selection at the colony level, and that they represent a sensitive adaptation to the particular environmental conditions in which the species has existed during recent evolutionary time.

Stolon: A creeping stem that sends down roots and produces new shoots.

Stomach Poison: A pesticide that must be eaten by an insect or other animal in order to kill or control the animal (e.g., Paris green). A stomach poison has a major advantage over a contact poison because it is addressed only to a pest consuming the leaves, and predators can move safely over the deposit. However, the stomach poisons are also rather persistent and therefore, there is a risk of ingestion by man. The limitation of stomach poison is that they must be ingested effectively in order to ensure transfer to the insects. Insecticide deposits applied to surface not frequented by the insects will not be effective.

Stomata: Minute pores present in the leaves of plants, utilized in exchange of gases for respiration and photosynthesis. Stomata open or close in response to light intensity and time of day.

Stomatogastric : In insects, recurrent nerve from frontal to stomachic ganglion.

Stomatogastric Nervous System: The stomatogastric nervous system is a part of the visceral (sympathetic) nervous system, arises during embryogenesis as an invagination of the dorsal wall of the stomodaeum. It includes two median ganglia on the surface of the foregut, **1.Frontal ganglion** - is situated medially in front of the pharynx, usually just behind the frontoclypeal suture. It receives the frontal connectives from the tritocerebrum and the 'recurrent nerve' from the hypocerebral ganglion. Motor nerves from the frontal ganglion innervate the foregut. **2.Hypocerebral ganglion** - is situated behind the brain, between the aorta and foregut. Two pairs of endocrine glands, the 'corpora cardiaca' and the 'corpora allata' are also associated with the hypocerebral ganglion.

The stomatogastric system exerts some control over the movements of the gut, labral muscles, mandibular muscles, and the salivary glands.

Stomodaeal Valve: The funnel-shaped or cylindrical invagination of the foregut into the midgut.

Stomodeum: Foregut is also known as 'stomodeum'. It is concerned with ingestion, storage, grinding and transport of food to the next region.

Stone Brood: A disease of larvae and adult bees, caused by the fungi, *Aspergillus flavus*.

Storage Pots: Containers made of soft cerumen for the storage of food in the nests of social bees. Some of the pots constructed by meliponine bees contain only honey (honey pots) and others only pollen (pollen pots).

Stover: Corn stalks used as fodder for animals.

Straight Run: The middle run made by a honeybee worker during the waggle-tail dance and the element that contains most of the symbolical information concerning the location of the target outside the hive. The dancing bee makes a straight run, then loops back to the left (or right), then makes another straight run, then loops back in the opposite direction, and so on the three basic movements together form the characteristic figure-'8' (eight) pattern of the waggle dance.

Strain: A group within a species that is in some way physiologically different from other members of the species, e.g., resistant to an insecticide.

Strepsiptera: A neuropteroid insect order. Adults are dimorphic females usually endoparasitic and are without eyes. Females are larviform parasitoids but the males are free-living insects with functional wings. They have flabellate antennae, small elytra-like fore wings and large fan-shaped hind wings with greatly reduced venation. Strepsipterans are endoparasites of a number of insects especially homopterans and aculeate

Hymenoptera. Metamorphosis is complete, they are worldwide in distribution.

Stress: A condition of (often subtle) bodily changes induced by inimical extrinsic or intrinsic factors.

Stria: In Coleoptera, the longitudinal impressed lines usually visible on the elytra; any fine longitudinal line or furrow.

Striate: 1. Virus disease of wheat transmitted by the painted leafhoppers, 2. Sculptured with fine, parallel lines or furrows as in elytron of beetles.

Striated Muscle: Muscle that is composed of fibres with alternate light and dark bands.

Strickland Code: A Code of nomenclature prepared by a committee of the British Association for the Advancement of Science under the Secretaryship of H.E. Strickland and first published in 1842.

Stridulation: Phenomenon of sound production by rubbing of one body part against another as in crickets and tettigoniid grasshoppers, Homoptera, some Hemiptera (Pentatomidae) and Lepidoptera (Arctidae). In male cricket (*Acheta assimilis*), file on front wing is rubbed across a scrapper on the other fore wing as the wings are moved resulting in vibration of the wings and a sound that attracts female cricket. In cicadas, males possess an abdominal 'tymbal' that vibrates in a resonant chamber formed from the metathoracic epimeron and first two abdominal segments. Each species of cicada has a typical song, and male cicadas join together into local mating groups through synchronizing their calls. Sounds are received by the ears or tympana of the female located on the fore tibia in crickets and long-horned grasshoppers.

Strigil: A comb-like structure on the bee's legs used for cleaning of the antennae; a similar structure on the fore-tibia of some Lepidoptera is also found.

Stripe: A longitudinal colour marking.

Structural Colours: Brilliant iridescent colours produced not by pigments, but by

reflection, refraction, diffraction or interference of light of differing wavelengths. Such colours are found in the wings of some butterflies, in the bodies of dragonflies and the elytra of beetles. In butterflies, the optical effect is brought about by the presence of numerous extremely thin, transparent plates either in the cuticle itself or in the scales that cover the wings.

Structural Pests: Pests that attack and destroy buildings and other structures, clothings, stored food, manufactured and processed goods (e.g., termites, cockroaches, clothes' moths and rats).

Stubble: The stumps of small grain, corn etc. left standing after harvest. They sometimes serve as sources of carry-over of root feeding or root inhabiting insects, their removal helps in management of these pests.

Stunted: Plant reduced in size and vigour due to unfavourable environmental conditions caused by a range of pathogens or abiotic agents.

Stupefacient: Also known as 'soporific'. Drug used as a pesticide to cause birds to enter a state of stupor so that they can be captured and removed, or to frighten other birds away from the area.

Style: Also called accessory walking appendages. In apterygote insects, small appendages on abdominal segments, homologous to abdominal legs (e.g., Protura, Thysanura). Styles may be present on abdominal segments 2-9 but usually on fewer segments (7-9).

Stylet: Mouthpart modifications for piercing and sucking insects are seen in true bugs (Hemiptera), thrips (Thysanoptera), fleas (Siphonaptera) and sucking lice (Anoplura). In each of these insect orders, different mouthpart components form needle-like stylets capable of piercing the plant or animal tissues upon which the insect feeds. Bugs have extremely long, thin paired mandibular and maxillary stylets, which fit together to form a flexible stylet-bundle containing a food canal and a salivary canal. Thrips have three

stylets-paired maxillary stylets (lacinia) plus the left mandibular one. Sucking lice have three stylets, fleas possess a single stylet. Needle-like digit of chelicerae in some phytophagous and parasitic mites is also known as stylet.

Stylet-Borne Viruses: The viruses which are non persistent and are collected on the tips of stylets of their vectors. These viruses have casual relationship with insect vectors. Stylet-borne viruses are lost soon after they are picked up while circulative viruses are retained by their vector for long periods. Aphids mainly serve as vectors of stylet-borne viruses. In terms of the number of viruses transmitted most of which cause mosaic symptoms and the number of insect species involved, aphids are the most important plant disease vectors. Most of the viruses transmitted by aphids occur in high concentrations in the host plant epidermis so are readily picked up when the aphids probe the tissue with their mouthparts. Tobacco mosaic transmitted by aphids and tomato spotted wilt transmitted by thrips are common examples of stylet-borne viruses.

Stylophore: The part of the head (capitulum) of mites that bears the stylets.

Styloplization: Parasitization by the strepsipterans typically produces morphological and the physiological changes in the host insect. Such hosts are styloplized and can be rendered reproductively sterile because of the physical destruction of tissues or hormonal balances. Strepsipterans mainly are endoparasites of Hemiptera and Hymenoptera.

Stylostome: The feeding tube formed by the host as a result of the feeding of a chigger at the point of larval attachment on its host. During secreting salivary fluids, the chigger partially digests skin tissues which induces the host to form a proteinaceous tube walling off the injury.

Stylus: A short, slender, finger-like process of the ventral surface of the abdomen of Thysanura and Diplura. Styli are also present on the 9th sternum of some male orthopteroid

insects. In most bristletails the styli serve to raise the abdomen off the ground during locomotion. In Diptera, style is the fine dorsal appendage on the third segment (antennal) of head.

Subantennal Suture: A suture on the face extending ventrally from the base of the antenna.

Subapical: Just before the apex or tip.

Subclass: A major subdivision of a class, containing a group of related orders (e.g., Apterygota).

Subcosta: The longitudinal wing vein between the costa and radius.

Subcoxa: A segment preceding the coxa on the legs of certain primitive insects. In the majority of insects, however, this segment has become fused with the body wall and the second segment, the coxa forms the functional limb-base.

Subcutaneous Toxicity: The toxicity of a pesticide determined after its injection just below the skin.

Subdiscal Vein: Also known as subdiscoidal vein. The vein forming the posterior margin of the third discoidal cell (Hymenoptera).

Subfamily: A major subdivision of a family, containing a group of related genera. Subfamily names end in **-inae** (e.g., Vespinae).

Subgena: Below the gena is a narrow area—the subgena, on which mandible and maxilla are articulated.

Subgenal Bridge: Sometimes sclerotized area, if present, between labium and cervix, which is an extension of the subgenae that fuse in the midline to form a subgenal bridge.

Subgenal Sulcus: This is a lateral groove in the cranial wall running slightly above the mouthpart articulations.

Subgeneric Name: The name of the optional category between the genus and the species, it is enclosed in parentheses when cited in connection with a binomial or trinomial combination and, therefore, excluded from

considerations when determining the number of words of which a specific or subspecific name is composed.

Subgenital Plate: A ventral sclerite covering the gonopore, as in the Blattodea and some other insects; usually the eighth sternum in females and the ninth in males.

Sub-Imago: Winged but sexually immature mayfly adult which has to undergo another moult to become the reproductively mature adult.

Subjective Synonym: Each of two or more synonyms based on different types, but regarded as referring to the same taxon by those entomologists who hold them to be synonyms.

Submarginal Cell: One or more wing cells below the marginal cell, used in the identification of Hymenoptera.

Submarginal Vein: A vein immediately behind and paralleling the costal margin of the wing (Chalcidoidea).

Submentum: Labium is divided into two primary regions, a proximal post-mentum and a distal prementum. The postmentum is usually subdivided into a proximal sclerite 'submentum' and into a distal sclerite or mentum; the basal portion of the labium in insect mouthparts.

Subocular Sulcus: Sometimes a groove running dorsolaterally beneath the compound eye is present and it is known as subocular sulcus.

Suboesophageal Ganglion: Suboesophageal ganglion is a large nerve centre, and is situated in the head, beneath the oesophagus and joined to the brain by a pair of large connectives. This ganglion innervates sense organs and muscles associated with mouthparts, salivary glands and the neck region, and also appears to be the centre for maintaining (though not initiating) the locomotor activity. It also coordinates the sensory and motor activities of the appendages of fourth, fifth and sixth segments (the mandibles, maxillae and labium respectively).

Suborder: A major division of an order, containing a group of related families (e.g., Auchenorrhyncha of Hemiptera).

Subphylum: A major subdivision of a phylum (e.g., Mandibulata of the Arthropoda).

Subquadrangle: A cell immediately behind the quadrangle (Odonata: Zygoptera).

Subsocial: A type of social behaviour in which the adults care for their own immature offspring for some period of time.

Subspecies: A subdivision of a species, usually a geographic race. Different subspecies of a species are ordinarily not sharply differentiated, intergrade with one another, and are capable of interbreeding.

Substitute Name: A name proposed to replace a preoccupied name and automatically taking the same type and type-locality (= New name).

Subterranean Insects: A subterranean insect is one that extends a part or all of its existence beneath the surface of the soil. The subterranean habit approaches the **cavernicolous** (the cave inhabiting habit), the **subcutaneous** (leaf-mining or boring habit), and the **subaqueous** (the aquatic habit). All these species live in environments where the light is reduced or absent, the moisture is generally high, the temperature is somewhat constant, and the parasitic and predacious habit is somewhat reduced.

Subtriangle: One or more cells on the inner (toward the wing base) side of the triangle in dragonflies.

Subtropical: The region on the geographical globe lying between the Tropic (23.5°) and 34.0° in either hemisphere. The climate is usually a mild winter with a hot and wet summer.

Successions: Groups of species that successively occupy a given habitat as the conditions of the habitat changes; the progressive changes in vegetation and animal life that occur over time.

Successive Percentage Mortality: Also known as apparent mortality. The mortality in each developmental stage expressed as a percentage of the number alive at the beginning of the stage.

Suction Hose: A hose through which water is pulled from a pond or stream or spray from the pump to the pump.

Suctorial: Suited for sucking.

Sulcus: As in most animals, the insect head is covered by hardened elements to assist both in the protection of the coordinating centres and in the process of feeding. Least modifications occur in primitive or the least specialized species in which linear invaginations or sulci (sometimes referred to as sutures) may be seen along the base near the mouthparts and extend dorsally. These folds are braces to prevent collapse of the head during feeding or when subjected to external physical stresses. Sulci can brace heads without substantial thickening. Postoccipital suture, epicranial suture and frontoclypeal or epistomal suture, are all external grooves or lines in head.

Summer Oil: A highly refined petroleum oil that can be applied to trees in full foliage without having phytotoxic effects. Oils safer for plants have lesser content of unsaturated hydrocarbons. Through sulfonation process, amount of unsaturated hydrocarbons is determined. Oils with a unreacted residue (UR) value of 50-90 percent are called dormant oils which being less purified are phytotoxic. But oils with a UR value of 90-96 percent are known as summer oils which are highly purified. Summer oils are being currently used as acaricides as they are relatively cheaper, possessing good spreading quality, are easy to mix and handle, and are safer for animals.

Supercooling: The ability to stay in an unfrozen state below the melting point, often as low as from -40° to -60°C in some Alaskan species. Glycerol and sugars (glucose and trehalose) aid in cold tolerance in many insects, and excess water is removed to prevent the formation of damaging ice crystals in others.

Superfamily: A group of closely related families; superfamily names end in **-oidea** (e.g., Papilionoidea).

Superlinguae: In a few primitive insects (bristletails and mayfly larvae), a pair of lobes which arise embryonically in the mandibular segment, occur in close association with the hypopharynx.

Supernatant: The material remaining above the pellet after centrifugation of a suspension of macromolecules.

Superorganism: Any society, such as the colony of a eusocial insect species, possessing features of organization analogous to the physiological properties of a single organism. The insect colony for example is divided into reproductive castes (analogous to gonads) and worker castes (analogous to somatic tissue), it may exchange nutrients by trophallaxis (analogous to the circulatory system), and so forth.

Superparasitism: In superparasitism, a host receives multiple eggs either from a single individual or several individuals of the same parasitoid species, although the host can not sustain the total parasitoid burden to maturity. Superparasitism will increase as unparasitized hosts are depleted, or parasitoid numbers searching any patch, or if the parasitoid species have high fecundity and its eggs are of smaller size.

Superposition Eye: A type of compound eye occurring in nocturnal insects in which the ommatidia are not surrounded by a shield of pigment. It differs from the type of eyes of insects that fly during the day. Superposition eyes have a clear zone between the light gathering and light sensing apparatus, permitting light from many lenses to be focussed on a single sensing area, thereby brightening the image.

Supersedure: In honeybees, the replacement of the resident queen, usually an old or sickly individual with a new queen reared by the workers. The process is distinct from colony multiplication by swarming.

Superspecies: A group of closely related species having many morphological similarities.

Supervised Insect Control: Control of insects and related organisms supervised by qualified entomologists and based on conclusions reached from periodically measured population densities of pests and beneficial species.

Supplement: Same as adjuvant. Substance added to a pesticide to improve its physical or chemical properties. May be a sticker, spreader, wetting agent etc., but usually not a diluent.

Supplementary Reproductive: In termites the caste of males and females with short wings, light pigmentation and small compound eyes. The females lay their eggs in the colony, supplementing the work of the queen. Supplementary reproductives are less sclerotized than kings and queens and these will become reproductive if anything happens to the queen or the king.

Supraalar Bristles: A longitudinal row of bristles on the lateral portion of the mesonotum, immediately above the wing base (Diptera).

Supraoesophageal Ganglion: Also named **suprpharyngeal**, **hyperpharyngeal**, or **cerebral** ganglia. The anterior three pairs of the ganglia fuse to form the brain or supraoesophageal ganglion. As the name indicates, the supraoesophageal ganglion is located dorsal to the oesophagus. The first pair of lobes, the **protocerebrum**, receives nerves from the compound eyes and ocelli. The protocerebrum is the major association region in the central nervous system and its direct connection to the photoreceptors indicates the great effect light stimuli have upon most insects. The **deutocerebrum** or second pair of ganglionic lobes receives impulses from the antennae, coordinates this sensory input with the brain, and controls the movement of the antennae. The **tritocerebrum**, unlike the other sections of the brain, remains separated into two lobes

and receives nerves from the frontal ganglion, labrum and suboesophageal ganglion. All lobes of the brain are interconnected through nerve fibre tracts.

Supraspecific: A term applied to a category or evolutionary phenomenon above the species level.

Surface Active Agent: Also known as surfactants. A substance that reduces the interfacial tension of two boundary lines. Most pesticide adjuvants may be considered surface active agents.

Surface Pheromone: A pheromone with an active space restricted so close to the body of the sending organism that direct contact, or something approaching it, must be made with the body in order to perceive the pheromone. Examples include the colony odours of many species.

Surface Spray: A pesticide spray which is applied in order to completely cover the outside of the object to be protected.

Surface Tension: Property of a liquid surface by which it acts as if it were a stretched elastic membrane. Surface tension depends upon the forces of attraction of molecules of a liquid towards each other.

Surfactant: Also called surface active agents. Surfactant is a compound that reduces surface tension when dissolved in water or water solutions, or which similarly affects interfacial tension between the two liquids. They are used as detergents, wetting agents, penetrants, spreaders, dispersing agents, and foaming agents. Most insecticidal emulsifiable concentrates contain mixtures of non-ionic surfactants such as the polyglycol ethers, and anionic surfactants which include dodecylbenzene. These additives can be used in much smaller quantities than soaps which formerly were commonly employed and which in any case form an insoluble scum in hard water. Cationic surfactants are sometimes used in pesticide formulation, but if these are mixed with anionic agents—an insoluble grease is formed and the surfactant properties are destroyed. For this reason pesticides should

be mixed with one another only after it has been established that they are compatible. If the instructions are followed carefully the emulsifiers and other agents added to a particular insecticide should not cause any damage to the object sprayed. But if two products are mixed together in order to control two different kinds of pests at once then there is a danger of damage.

Surveillance: Also called scouting. Refers to the constant watch on a pest for the detection of the species presence and determination of population density, dispersion and dynamics on each crop at fixed interval. Surveillance means vigilance on the build up of pests for forewarning their flare up based on parameters of weather conditions, natural enemies and other biotic and abiotic influences in relation to the biology of pest. Pest surveillance forms an integral part of any and all control measures applied to a crop and that no pesticide should be applied without sufficient justification which can only be obtained through surveillance. Through surveillance-actual damage caused by pests during different growth stages of the crop, seasonal influence on the pests, behaviour of minor pests before they assume major status, natural enemies of pests, and shift in pest status on different cropping patterns or cropping systems, can be studied.

Suspension Concentrates (SC): Suspension is a liquid in which very fine solid particles are dispersed but not dissolved. These formulations have an advantage over emulsion concentrates because they are generally water based and normally contain only small amounts of glycols or similar materials as antifreeze agents. However, the preparation of suspension concentrates is limited to solid active ingredients having low water solubility. The solid active ingredient is generally heavier than water, and thus tends to sediment during storage. Residues of the often viscous products are not easy to rinse out of the packaging. Mixtures of two pesticides, which are not easily co-formulated in an emulsifiable concentrate (EC), can be

formulated as suspension concentrate (SC). Deposits of SC formulation have been reported to retain better than an EC or WG formulation.

Sustained Baiting: A type of rat control in which the poison bait is continuously available in bait holders shortly after transplanting until bait consumption stops.

Suture: Same as sulci.

Swarm: A large number of flying insects of a species moving together in the same direction and viewed collectively (as in bees and locusts).

Swarming: Refers to a behaviour, in which a group of insects remains more or less stationary, flying over one spot, may be regarded as a special instance of insects showing a common reaction to a feature of the environment. In honeybees, normal method of colony reproduction, in which the queen and a large number of workers depart suddenly from the parental nest and fly to some exposed site. There they cluster while scout workers fly in search of a suitable new nest cavity. In ants and termites the term swarming is often applied to the mass exodus of the reproductive forms from the nests at the beginning of the nuptial flight. Swarming is a characteristic and perhaps fundamental behaviour of insects. It occurs in some primitive insects like mayflies, and also in many higher insects such as flies and butterflies. Swarming sites are identified by visual markers and are usually species specific.

Swath: 1.The width of a treated area when a spray equipment or spray plane makes one trip across a field. **2.**Row of harvested crop placed in the field to dry.

Sweeping: Swinging the insect net mouth first through grass or soft herbage so that the insects that are disturbed are trapped in the bag of the net.

Sweeping Nets: The net bag is made of strong muslin or fine mesh bolting cloth to withstand damage when sweeping vegetation. The rim is reinforced with canvas. The bag should be deep enough to trap the catch by

gathering the material together in one hand below the frame. Apart from suction sampling, it is the only way to sample insects quickly from low growing vegetation and grasses. A sweep net is considerably lighter and easier to use than any motorized suction sampler. But through this method leaf-mining, stem boring insects, and insects that live close to the soil surface can not be collected.

Swine Pox: A virus disease of swine characterized by small, red skin lesions, weakness, loss of the appetite, chills, and fever, transmitted by the hog louse (*Haematopinus swis*).

Sylvan: Forest inhabitant; belonging to a forest.

Symbiont: An organism living in intimate association with another organism.

Symbiosis: The intimate, relatively protracted, and dependant relationship of members of one species with those of another. The three principal kinds of symbiosis are commensalism, mutualism, and parasitism.

Symbiote: An organism that lives in association with another. Most of the symbiotes are harmless to their hosts or are distinctly beneficial to them; in some cases the host can not live without its symbiote.

Symmetry: Similarity of organs or body parts on either side of a dividing line or plane. Insects like mammals are bilaterally symmetrical, i.e. most of their external and internal structures are divided into left and right halves that are mirror images. Only minor variations of this scheme occur. There are occasional subtle differences in the mouthparts and genital structures, and major asymmetry is possible in the digestive tract.

Sympatric: Having overlapping ranges.

Sympatric Hybridization: The occasional production of hybrid individuals between two otherwise well-defined sympatric species.

Sympatric Speciation: Speciation without geographic isolation ; the acquisition of isolating mechanisms within a deme.

Sympatry: The occurrence of two or more populations in the same area; more precisely the existence of a population in breeding condition within the cruising range of individuals of another population.

Symphile: A symbiont, in particular a solitary insect or other kind of arthropod, which is accepted to some extent by an insect colony and communicates with it amicably. Most symphiles are licked, fed or transported to the host brood chambers or treated to a combination of these actions.

Symphilid: A member of the order Symphyla within the class Myriapoda. Symphylans have two body regions, i.e. head and body. They have flattened form with one pair of legs per segment, one pair of long antennae, no eyes, and breathe through tracheae. Garden symphylans feed on roots and sometimes appear as pests in some areas.

Symptomatology: Also called symptomology. The study of symptoms of disease caused by pathogens for the purpose of diagnosis; symptoms diagnostic for a particular disease.

Symptoms: Visible changes in a plant that develop and become obvious as a disease or disorder are called symptoms. Examples of symptoms of disease include wilt, leaf spots, cankers, chlorosis, ring spots and blights. Symptoms may be classified as specific types. Acute symptoms usually are characterized by rapid development or sudden onset, such as the development of rapid wilt symptoms that often happen with bacterial wilt diseases. Chronic symptoms occur as frequent recurrences or when specific symptoms develop over a longer duration. Virus induced mosaic, mottling, and ring spots, which commonly persist over a longer period of time, are examples of chronic symptoms.

Synanthropy: A close association with man.

Synapse: The usual point of contact, or 'synapse', between connecting axons is at the tips of the axons. The tips are finely divided into terminal arborizations and separated by a gap. Nervous impulses are transmitted from

the presynaptic axon by a chemical transmitter substance. The impulse probably crosses the gap by the quick release of the chemical acetylcholine. The transmitter substance is then destroyed by the enzyme acetylcholinesterase. Some compounds derive their toxic effect by acting as inhibitors of the enzyme.

Synaptic Cleft: The tips of the axons are finely divided into terminal arborizations and separated by a gap. Nervous impulses are transmitted from the presynaptic axon by a chemical transmitter substance. The postsynaptic or receptive axon is also called the dendrite.

Synchronic Species: Species which occur at the same time level.

Synchronous Flashing: A phenomenon observed occasionally in the tropics (e.g., in Thailand) when large number of fireflies (Lampyridae) or other luminescent insects flash rhythmically in unison. This usually takes place at dusk.

Syndrome: Totality of symptoms. A group of concomitant symptoms usually characterizing a particular abnormality which may be a characteristic of a disease or pest attack.

Synecology: Study of groups of interacting species and their environment.

Synergism: Increase in the bioactivity of two compounds to produce an effect greater than the one expected from a single algebraic summation of the effects of two compounds individually administered. Often one component is not toxic or far less active than the counterpart component at the dosage employed, but when combined with the latter markedly increases the activity and is called a 'synergist'. There are several types of synergism: **1.**Inhibition of mixed-function oxidase enzymes; **2.**Inhibition of hydrolyzing enzymes; **3.**Release of hydrogen cyanide from organothiocyanates by glutathion S-transferases; and **4.**Two compounds interact with different sites of the target.

Synergist: A chemical substance that when used with an insecticide, drug, etc. will result in greater total effect than the sum of their individual effects. Piperonyl butoxide is a commonly known synergist and when it is added to pyrethrins, it enhances the knockdown effect by inhibiting enzymatic oxidation of pyrethrins thereby increasing speed at which the nervous system is poisoned. Synergism is sometimes an undesirable side effect when insecticides are mixed with certain fungicides, as in management of orchard pests.

Syngamy: The fusion of male and female gamete to form a zygote.

Synomone: A substance produced or acquired by an organism that when it contacts an individual of another species in the natural context, evokes in the receiver a behavioural or physiological reaction that is adaptively favourable to both emitter and receiver.

Synonymy: A chronological list of the scientific names which have been applied to a given taxon, including the dates of publication and the authors of the names.

Synopsis: In taxonomy, a brief summary of current knowledge of a group.

Synthetic: Compound in the laboratory, as opposed to occurring naturally.

Synthetic Pyrethroids: They are also residual contact insecticides which have more photostability to increase their persistence as against natural pyrethrum. The first synthetic pyrethroids which were highly toxic to insects and still had low mammalian toxicity and also had increased stability were reported in 1973 (e.g., cypermethrin). They are purely broad-spectrum residual contact poisons and these don't possess fumigant, translaminar or systemic action. They are very harmful to natural enemies, and pest flare-ups resulting from destruction of natural enemies, and development of resistance to them have been reported in many cases.

Syntype: Every specimen in a type species in which no holotype was designated.

System Analysis: It is a set of techniques and procedures-mathematical, statistical and mechanical, for analyzing complex systems such as agroecosystems. System analysis for pest management is based on ecological concepts which have long been recognized but which have had limited application of the limited technological means at our disposal. These concepts can be summarized as follows : (a) Complex ecological processes that can be separated into a large number of relatively small and simple components, although these subsystems or parts may still involve complexity and interaction with other components of the full system; (b) Historical processes involving time (past, present and future) can be dealt with or stimulated in terms of existing recurrence formulae; and (c) Complex multi-dimensional, interacting processes that can be explained or simulated by existing formulae, or are amenable to mathematical description when (a) and (b) are known.

Systema Naturae: The taxonomic treatise first published in 1735 by C.V. Linne (Linnaeus). Sixteen editions were completed in his life time. He originated the Linnaean System of 'binary nomenclature' used to this date. The insistence of Linne' on the constancy and objective classification of species posed the problem of the method of origin of the species.

Systematics: Systematics is the study of biological diversity, sometimes it is merely portrayed as classification of organisms. Morphological, biological and behavioural informations are useful in such studies. The major tasks of systematics are identification, description, proper application of the rules of nomenclature and study of speciation.

Systemic Disease: The disease in which pathogen spreads throughout the plant body.

Systemic Pesticide: Nonherbicide pesticide capable of absorption into plant sap or animal blood and lethal to insects feeding on or within the treated host (e.g., oxydemeton methyl). These insecticides are absorbed by the leaves and roots of plants and mobilised upwards and outwards to other parts of the plant. If a systemic insecticide is moderately persistent it will also protect parts of the plants which have not emerged at the time of spraying. Such systemic action can compensate for the poor initial coverage with the pesticide and is especially effective against piercing and the sucking insects and several other groups which suck a poisoned sap, yet the plant surface may be quite safe for other insects including parasites and predators to walk over.

Systole: Contraction phase of the heartbeat cycle.

T

Tachygenesis: A shortened development involving omission of several larval instars.

Tactile Receptors: An insect's organ of touch e.g., simple hairs, bristles or spines with sensory cells and nerve endings at their bases. Receptors of this sort are situated all over the body but are most numerous on the antennae and sometimes on the cerci. They may also be sensitive to low-pitched sounds which cause them to vibrate. A campaniform sensillum includes all of the components of the tactile hair.

Taenidium: A spiral chitinized thickening in the inner wall of the tracheae. The main function of taenidia is to prevent the collapse of the trachea when the pressure within is reduced. In the smaller tracheae the folds of the intima may be annular. Properties of compression stretching in trachea are important in insects in which the abdomen becomes greatly distended with food as in several blood-sucking insects.

Tagma: A distinct region of the body, i.e. head, thorax, or abdomen. The grouping together of segments into the functional unit of the body (head, thorax, abdomen) is called tagmosis.

Tailored Insecticide: This term is used to stress that the insecticide material will be completely selective in its action in the near future.

Taint: Unwanted flavour in fresh or processed food from a pesticide used on the growing crop.

Talc: Powdered soapstone; anhydrous magnesium sulphate.

Tandem Running: A form of communication, used by the workers of certain ant species during exploration or recruitment, in which one individual follows closely behind another, frequently contacting the abdomen of the leader with its antennae.

Tanglefoot: A sticky substance used in the traps to immobilize insects. Sometimes applied in a band around tree trunks to prevent insects from climbing the trunk. Tanglefoot is commonly used as a barrier on leaf-discs for studying development of mites, and for pesticidal efficacy against mites. In this technique mites are released in the encircled area of leaf-discs treated with pesticide and response is studied.

Tank Mix: Mixture of two or more compatible formulated pesticides that are combined in a spray tank for single application.

Tap Root: The large primary root that grows vertically downwards from which lateral roots arise.

Tapetum: A basal layer of tracheae in an ommatidium that reflects light. The eyes of many insects particularly certain nocturnal Lepidoptera, when illuminated will appear to glow as a result of reflection from the tapetum.

Tapping Hills: To strike hills of rice with the hand to dislodge insects.

Target: Object onto which a pesticide is to be deposited by spraying or other means.

Target Cover: The degree to which the crucial portion (target) of a plant (or other sprayed object) receives a deposit of insecticide.

Target Pest: Pest against which control measures are directed.

Target Surface: The surface intended to receive a spray or dust application.

Tarsal Claws: The pretarsus, in most insects, takes the form of a pair of lateral claws (also called **ungues**) and usually a median lobe the **arolium** as in hind leg of cockroaches. But in Diptera there may be a central spine-like or pad-like empodium (not homologous with the arolium) and a pair of lateral pulvilli.

Tarsal Formula: The number of tarsal segments on the front, middle and hind tarsi respectively.

Tarsation: Touching with the tarsi, especially the touching of another insect as a tactile signal.

Tarsomeres: Subsegments of the tarsus of an insect, usually numbering from 2 to 5. Tarsomeres are commonly called 'segments'. Independant tassomeres lack musculature.

Tarsus: The part of the leg beyond the tibia, appears to have 2-5 segments which are actually pseudosegments or tarsomeres since each lacks independant musculature. The tarsi in fossorial legs, are reduced and usually fold back out of the way during excavation activity. In clasping legs of certain aquatic diving beetles, several tarsomeres of forelegs are usually enlarged with suckers and large claws to produce effective holdfast organs.

Tassel: The staminate inflorescence of corn.

Taste Organs: Taste receptors in insects may be of various types and their degree of complexity ranges from simple hairs to placoid and basiconic types. They are situated on the antennae, the palps and on labellum (mouthparts) and frequently on the foot (tarsus). Chemoreception, essentially taste (contact chemoreception) and smell (distance chemoreception), is an extremely significant process in the Insecta, as it initiates some of their most important behaviour patterns e.g.,

feeding behaviour, selection of an oviposition site, host or mate location, behaviour integrating caste functions in social insects, and responses to commercial attractants and repellants.

Taxis: Orientation in response to a stimulus, the location of which can be perceived by an insect. To locate the stimulus, an insect uses either paired sense organs (compound eyes, antennae, and the tympanal organs). Taxis may be : **1. Phototaxis**—A response to light; **2. Anemotaxis**—A response to an air current; **3. Geotaxis**— A response to gravity; and **4. Thermotaxis** – A response with respect to temperature.

Taxon: A group of real organisms recognized as a formal unit at any level of a hierarchic classification.

Taxonomic Category: Designates rank or level in a hierarchic classification. Various taxonomically defined groups, also called taxa, are recognized amongst the insects. The basic biological taxon lying above the individual and population is the **species**. Multispecies studies allow recognition of **genera**, which are more or less discrete higher groups. In similar manner, genera can be grouped into **tribes**, tribes into **subfamilies**, and subfamilies into **families**. The families are placed in relatively large but easily recognized groups called **orders**. The hierarchy of ranks (or categories) thus extends from the species level through a series of 'higher' levels of greater and greater inclusivity until all the true insects are included in one **class**, the Insecta. Order, family, genus and species are obligatory categories. There are standard suffixes for certain ranks in the taxonomic hierarchy. Standard suffix for superfamily is **-oidea**; for family is **-idae**; for subfamily is **-inae**; and for tribe is **-ini**.

Taxonomic Character: Any attribute of a member of a taxon by which it differs or may differ from a member of a different taxon.

Taxonomic Diversity: The insects have evolved into many strikingly different kinds of organisms which are classified into (26 to

29) orders in different classification systems, and these orders are grouped under two subclasses, i.e. **Apterygota** and **Pterygota**. Subclass Apterygota (wingless insects) is comprised of orders Diplura, Protura, Collembola and Thysanura. Subclass Pterygota (winged and secondarily wingless insects) is further divided into two divisions : **Exopterygota** and **Endopterygota**. Division Exopterygota includes insects with simple body change during growth (Ephemeroptera, Odonata, Orthoptera, Dermaptera, Isoptera, Embioptera, Plecoptera, Zoraptera, Psocoptera, Mallophaga, Anoplura, Thysanoptera, Hemiptera and Homoptera). Division Endopterygota includes insects with their complex body change during growth (Neuroptera, Coleoptera, Strepsiptera, Mecoptera, Trichoptera, Lepidoptera, Diptera, Siphonaptera and Hymenoptera). Seven orders namely Orthoptera, Hemiptera, Homoptera, Coleoptera, Lepidoptera, Diptera and Hymenoptera are the most diverse and account for greatest share of our pest problems. Most of the entomologists, however, differ considerably on the classification of class Insecta. Many systematists feel that the orders Protura, Collembola, and Diplura are sufficiently different from the rest of the insects, hence excluded from the class Insecta.

Taxonomy: The science of describing, naming, and classifying organisms, based on their similarities and differences. But taxonomists are also concerned with the development of variation in order to discover how they evolved, with the identification of 'evolutionary units', and with determination by experiments of the genetical interrelationships between such units as well as the role of the environment in their formation.

Technical Product: The usual form in which a pesticide is prepared and handled prior to formulation, usually at a high level of purity (95-98%) but not completely pure. It is then formulated with other materials to make it usable in wettable powder, dust, liquid or other form.

Tectostracum: Thin, waxy outer covering of exoskeleton, as of acarines.

Tectum: External prolongation of the exoskeleton, more or less in the shape of a blade, the function of which is protective. In acarines tectum can arise by extension of a sclerite (a border tectum), and by increase in size of the carina (a carinal tectum).

Tegmen: The thickened and leathery fore wing in the Orthoptera, Mantodea, Blattodea and Dermaptera. Thickened fore wings help in protection of hind wings when they are flexed.

Tegula: A small articulated sclerite of the costal base of the wing, especially in Vespidae (Hymenoptera); a small lobe or alula at wing base of Diptera.

Telarian: Web-spinning.

Teleology: The study which suggests that natural events purposefully occur to fulfil a goal. For example, the female earwigs broods her young because she loves them (anthropomorphism) or so that they will grow up (teleology).

Teleiochrysalis: Nymph during the resting stage preceding the adult form of certain mites.

Telofemur : Distal segment of femur in mites.

Temperature Regulations: Also called **thermal regulation**. The large surface area to volume ratio of insects can make it difficult to keep cool and expensive to keep warm. Insects are ectothermic but they regulate their temperature to some extent by confining in their microhabitats and through different other strategies. Bees and moths, for example, need to warm up their flight muscles before take off, and when flying in hot conditions, need to lose heat by increasing haemolymph flow to the abdomen where excess heat can be lost. Even in the hottest of environment, insects can survive. For example desert beetles and ants often have very long legs and run fast to minimize contact with the scorching sand. The important point to remember, however, is that in any habitat there will always be a great range of temperatures

available. Cooler moister microhabitats will exist near plants or under stones and in burrows underground, even a small distance will ameliorate the hottest desert conditions.

Temporary Equilibrium Position: Average density of a population over a large area temporarily modified by a procedure such as continued use of insecticides.

Temporary Social Parasitism: Parasitism in which a queen of one species enters an alien nest, usually belonging to another species, kills or renders infertile the resident queen, and takes her place. The population of the colony then becomes increasingly dominated by the offspring of the parasite queen as the host workers die off from natural causes.

Tenacity: The property of a pesticide deposit or residues to resist removal by weathering.

Tenacity Index: Ratio of the quantity of residue per unit area at the end of a given period of weathering to that present at the beginning.

Tenaculum: A minute structure on the sternum of the third abdominal segment which serves as a 'catch' for the furcula prior to 'springing' (Collembola).

Tendrils: Refers to a stem, leaf, leaflet, or stipule of a plant, modified into a slender structure that coils around an object giving support to the plant bearing the tendril (e.g., pea vines).

Tenant Hairs: Tiny hairs on the pulvilli and tarsal pads that allow some insects and mites to cling to smooth surfaces. They help the insects to walk over smooth surfaces.

Teneral: Term describing newly emerged, pale, soft-bodied individuals prior to the completion of melanization and sclerotization.

Tensor: Muscles which stretch parts of the body.

Tentorial Bridge: The median fusion of the anterior tentorial arms and posterior tentorial arms inside the cranium, it is often enlarged and is also known as **corporotentorium**.

Tentorial Pits: Pit like depressions on the surface of the head that mark the points of invagination of the arms of the tentorium with the outer wall of the head. The anterior tentorial pits lie in epistomal suture, whereas the posterior tentorial pits lie in postoccipital sulcus.

Tentorium: The endoskeleton of the head for the attachment of muscles usually consisting of two pairs of apodemes, i.e. tentorial bridge, and paired anterior and posterior arms. Its morphology varies considerably in different insect groups. Sometimes anterior and posterior tentorial arms may meet and fuse within the head. The junction of the anterior and posterior arms is often enlarged and known as the 'tentorial bridge' or 'corporotentorium'.

Teratogen: Substance that causes physical birth defects in the offspring following exposure of the pregnant female.

Teratogenicity: Teratogenicity is the property of a substance which produces or induces functional deviation of developmental anomalies in an animal embryo or foetus. Teratogenicity studies provide information on the safety for the applicator against teratogenic substances particularly for women during pregnancy.

Teratology: The study of structural abnormalities, especially monstrosities malformations.

Tergite: Any sclerite in the tergal region of the segment, a subdivision of the tergum.

Tergum: Dorsal region of the thorax and abdomen, usually called notum when referring to thorax.

Terminal: At the end (often the posterior end).

Terminalia: The terminal abdominal segments involved in the formation of the genitalia. Generally consists of segments 8 or 9 to the abdominal apex. Segment 10 is visible as a complete segment in many lower insects but always lack appendages. Small segment 11 is represented by a dorsal **epiproct** and

pair of ventral **paraprocts**. A pair of **cerci** articulates laterally on segment 11.

Termitarium: The structure or nest inhabited by a termite colony. As air conditioning engineers, termites maintain the warmth and humidity of their microclimates in various ways. The humidity inside the nest usually range from 96-99 percent. Part of the moisture that is so essential (apparently termites dry out easily, either because the outer layer of their waxy cuticle is poorly developed or because they constantly scrape it off in their tunnels) results from the metabolic processes of the members of the colony. In addition, some termites make tunnels to water outside the nest. However, temperature does not yield easily to such close regulation and the temperature in the nests of most termite species tends to vary with that of the atmosphere. Some species build thin-walled nests in the open under the sun, where the temperature rises and falls throughout the day and night. Others construct mounds only deep in the shade of tropical forests, where the temperature normally remains fairly uniform. Tropical termites do best at 30°C; the corresponding temperature for temperate zone species is 26°C. At lower temperatures, the growth and development of individuals and colonies slows down and eventually stops. A medium-sized nest contains two million individuals.

Termitology: The scientific study of termites.

Termitophile : An organism which lives with termites, either as predator or commensal (termitophilous). Beetle, *Trichopsenius frosti*, is termitophilous.

Terrestrial: Strictly, living on the ground, usually, living on 'dry land', i.e. not in association with water.

Territoriality: Broadly speaking, any space associated intolerance of others, and more narrowly an intolerance that is based on real estate holdings. Territoriality is almost always but not exclusively, associated with competition for mates or food.

Tertiary Parasite: One which is parasitic on a secondary parasite.

Tertiary Reproductive: In termites, the same as ergatoid reproductive

Test Animals: Laboratory animals usually rats, fish, birds, mice or rabbits that are used as test animals to determine the toxicity and hazards of different pesticides.

Testis: The male internal reproductive organ which produces sperm. In most apterygotes the testes resemble the ovaries in form and size but in majority of insects they are much smaller. They are variably located in relation to the gut, lying dorsal, lateral or even ventral to it. The testes are maintained in position by tracheae and fat body and lack the suspensory filaments found in the ovary. As a rule each testis is a more or less ovoid body, partly or completely divided into a number of lobes or 'follicles'.

Tetrasternum: In the acarines, sternite of fourth segment of prosoma or second segment of podosoma.

Thanatosis: Hypnotic response often called 'death feigning' in which insects go into a rigid, motionless position when disturbed. This behaviour as used by many beetles and weevils, can be successful as predators lose interest in apparently dead prey or may be unable to locate a motionless insect on the ground.

Thelytoky: Parthenogenetic reproduction in which all of the offspring produced are females. Aphids (Hemiptera) are thelytokous. Certain Diptera and a few Coleoptera are also thelytokous.

Theory: Speculative statement as to the cause of phenomenon. A very broad generality which relates a series of scientific laws to each other explaining how they operate.

Thermal Constant: The number of degree days required for an event (e.g., pupation) to occur.

Thermoreceptors: Perception of electromagnetic waves mainly in the form of heat. In blood sucking bugs, *Rhodnius* sp., groups of

thick-walled setae on the antennae seem to be temperature sensilla; in the cockroach, *Periplaneta americana*, thermoreceptors are present on the arolium and pulvilli of tarsi, but in some other insects they may be present on legs.

Thermoregulation: Same as the temperature regulation. Insects are poikilothermic, i.e. they lack the means to maintain homeothermy - a constant temperature independent of the fluctuations in ambient (surrounding) condition. Insects can vary their temperature by behaviour using external heat (ectothermy) and by physiological mechanisms (endothermy). Endothermy relies on internally generated heat, predominantly from metabolism associated with flight.

Thigmotactic: Showing a tendency to press the body against a surface, or into crevices and corners.

Thinning: The removal of some plants or plant parts from row crops or orchard trees so that the remaining plants have appropriate space to grow and develop.

Third-Form Reproductive: In termites, the same as ergatoid reproductive.

Third Generation Insecticides: Third generation insecticides are chemicals that cause death or sterility in insects by disrupting growth processes. These include diflubenzuron (Dimilin, micromite®), tebufenozide (Confirm®), buprofezin (Applaud®), and others. These insecticides are the stomach poisons, and second-generation insecticides are the contact poisons. IGRs are like conventional insecticides in many ways. They are used to kill or sterilize insects in a given area and can be applied with insecticide equipment to obtain suppression. Because IGRs act on growth and development, they are effective only when immature insects are exposed to them. So their time of application is even more important and limiting than with conventional insecticides. Because their mode of action requires some time - pest presence, and sometimes level of injury, must be tolerated

longer than with most conventional insecticides.

Thoracic Gland: Also known as prothoracic glands or ecdysial glands. Organ of internal secretion producing the moulting hormone. They are found only in immature insects with the exception of Apterygotes. These glands are irregular masses of tissue of ectodermal origin usually intimately associated with tracheae.

Thorax: The middle part or tagma of an insect's body, between the head and the abdomen. It consists of three segments respectively known as the **prothorax** (in front), **mesothorax** (middle) and **metathorax** (hindmost). The dorsal surface of thorax is called the **notum** and cuticular plates covering the dorsum of thorax are likewise known as the **pronotum**, **mesonotum** and **metanotum**. Ventral plate is called the sternum, and the side walls as pleuron. Each thoracic segment bears a pair of legs; and wings are borne on the mesothorax and metathorax. Since the prothorax does not bear wings, its side or pleural walls are not so well developed but the notum is often enlarged to form a shield that often partially protects the head from above. In those insects in which the wings are roughly equal in size (e.g., dragonflies and termites), the mesothorax and metathorax are similar. When the hind wings are reduced or absent (e.g., bees and flies) the mesothorax is the most highly developed segment.

Thorough Coverage: Application of spray or dust where all parts of the plant or area treated is covered.

Thumb-Claw Complex: A compound structure of palp in some acarines which is adapted to holding. It consists of a tibial seta (the claw) and the palpal tarsus (the thumb). In predatory group the complex can evolve to a raptorial structure. A thumb-claw complex is known from many families of Prostigmata (Actinedida).

Thysanoptera: A hemipteroid order of insects, commonly called thrips. They are

small, slender-bodied with short antennae, compound eyes, and have asymmetrical piercing and sucking mouthparts. Possess two pairs of very narrow, hair-fringed wings. Wings can be reduced, vestigial or absent. Tarsi with bladder-like structure between the claws. Incomplete metamorphosis with resting pupa-like stages. Predaceous species are of use in controlling natural populations of other thrips, aphids and mites.

Thysanura: An order under subclass Apterygota. Thysanurans form the sole living true insects which are primitively wingless (never having possessed wings). These insects are elongate or oval, flattened or slightly convex, with or without body scales. Antennae are long and multi-segmented. Compound eyes small, bears up to three ocelli or none. Their maxillary palp is 5-segmented and they have simple downward facing mouthparts. Abdominal segments with small appendages called styles. They are fast running but do not jump. Abdomen with three equal terminal filaments. Commonly known as silverfish. They are ametabolous, worldwide in distribution but predominantly found in the tropical regions. They are scavengers, live in the soil, litter, trees and sometimes in the buildings. Some species damage books and can be minor pests in kitchens.

Tibia: The fourth segment of the leg, between the femur and the tarsus. The tibia of many insects is armed with large movable tibial spurs near the apex. Tibia is often long and slender, equipped with strong spines. Tibia is pulled back against the femur when the muscles contract. In the fossorial legs, large toothed projection from the tibia are used to 'rake' through the soil to dislodge soil particles.

Tibial Spur: A large spine which is movable is found near the apex of tibia, as in Gryllacrididae (Orthoptera).

Tick: Ticks are relatively large acarines, are blood-sucking ectoparasites of vertebrates. They possess movable capitulum which consists of basis capituli, paired 4-segmented

palps, paired chelicerae and ventrally a median hypostome. The hypostome is armed with rows of backwardly-directed teeth which securely attach the tick to its host. The genital opening and anus are both located ventrally, the genital opening being at the level of the second pair of legs, and the anus a little posterior to the fourth pair of legs. Haller's organ, which is used for host seeking, is located on the tarsus of the first pair of legs.

Tick Paralysis: A flaccid, febrile (without fever), ascending, motor paralysis produced by the attachment of certain species of ticks and believed to be caused by a neurotoxin secreted by the salivary glands of the feeding female tick. *Ixodes holocyclus* and *Dermacentor andersoni* are the most important paralysis causing ticks from the human standpoint.

Tillage: Tillage is defined as the disturbance of the soil for the purposes of preparing it for planting, for improving water penetration and conservation, or as a means of destroying soil inhabiting pests by exposure or mechanical injury. Insect pests that are affected either indirectly by the creation of inhospitable conditions and by exposing the insects to their natural enemies or directly by physical damage inflicted during the actual tillage process. Deep ploughing can be applied as an indirect measure to bury or expose the diapausing larval or pupal stages of insect pests.

Tiller: An erect shoot arising from the crown of a grass.

Tillering Stage: The development of side shoots from the base of a single stemmed cereal or grass plant.

Timberline: The latitude above which trees are unable to grow.

Time Interval: The time that is required between the final application of pesticide and the harvesting, the time interval ensures that the legal pesticide residue tolerance will not be exceeded.

Tissue: The fabric of the body composed of cells and the products of cells.

Tissue Culture: Tissues explanted from animals and maintained or grown *in vitro* for more than 24 hours. Protoplast fusion, clonal propagation, somaclonal variation, and mutant selection are commonly employed tissue culture techniques. The overall aim of most tissue culture techniques is to regenerate whole the crop plants from a few cells with desirable qualities. At present the use of these techniques have not been used to produce species that are resistant to herbicides or that have improved agronomic qualities, however, these techniques have not been used to produce species useful for pest control.

Token Stimuli: Secondary chemicals which have no nutritional value but may serve in the process of host selection.

Tolerance: 1. The condition when the host plant may show an ability to grow and reproduce itself or to repair injury despite the presence of an insect population adequate to damage a normally susceptible host beyond repair. This type of response is of course subject to considerable variation with environmental conditions. Environmental factors seems to have a great influence upon this type of resistance to pests since growth rates are so temperature-dependant. 2. The amount of a pesticide that may safely and legally remain as a residue on a food plant or in meat or fat.

Tonofibrillae: Fine connecting fibrils that link the epidermal end of the muscle to the epidermal layer. The tonofibrillae are discarded with the cuticle at each moult. At the site of tonofibrillar attachment, the inner cuticle is often strengthened through ridges or 'apodemes', which when elongated into arms, are termed 'apophyses'.

Tonus: The condition of muscle which remains in a continuous state of partial contraction enabling an animal to maintain its posture. This phenomenon is most noticeable when insects remain for hours or even days without moving.

Topical Application: Refers to application to the top or to the upper surface of the plant,

thus applied from above. Many pesticides are applied to the target pest as a topical application, topically applied pesticides should be absorbed by the part of the pest that is sprayed. Pesticides usually applied topically often have limited activity if applied to the soil.

Topochemical Sense: The perception of scents along a path or on either side of it, enabling the ants or other insects to follow a track previously used by themselves or by other insects and to return to it.

Topography: Description and mapping of the surface features of an area of land.

Topotaxis: Any reaction by which an insect or other animal orientates itself and moves in a definite direction in relation to a stimulus.

Topotype: A specimen collected at the type locality.

Tormogen Cell: Also known as membrane producing cell. An epidermal cell that develops into the socket for a seta or hair.

Tornus: The anal angle of an insect's wing, a distinct notch on the hind margin dividing it into two sections.

Torsion: A twisting; in many male Diptera, the rotation of the genitalia 90° to 360° from their primitive position.

Torus: A general name for a thickened part or pedicel on which an organ is borne, e.g., the base of an antenna.

Total Population Curve: The total population density of individual of all stages plotted against time.

Toxaemia: A condition produced by the dissemination of toxins in the blood.

Toxicant: A poisonous substance such as the active ingredient in pesticide formulations that can injure or kill plants, animals, or microorganisms.

Toxicity: Ability to poison, or to interfere adversely with vital processes of the organism by physicochemical means. The toxicity of an insecticide is established by exposing test

animals (insects and vertebrates) to a range of doses and determining the number killed at each dose. By plotting the number killed against the range of doses using log-probit paper, it is possible to extrapolate the dose that kills 50% of the test animals. When the exact amount of insecticide being applied is known, the lethal dose which kills 50 percent population can be determined (LD_{50}). Likewise LC_{50} can be found by dipping insects in different concentrations, or by allowing insects to feed on foliage dipped in different concentrations.

Toxicogenic: Capable of producing a toxin; said of insects that introduce a toxin into a plant while feeding.

Toxicology: Branch of science dealing with the nature, properties, effects on insects and other organisms and detection of pesticides etc.

Toxin: Any of the various unstable poisonous compounds produced by some microorganisms and causing certain diseases; any of various similar poisons secreted by plants and animals.

Toxinosis: Any disease caused by the action of a toxin.

Toxophore: The toxic component of a toxic molecule, or that portion of a molecule responsible for its toxic action.

Tracer Element: A radioactive element used in biological and other research to trace the fate of a substance or follow stages in chemical reaction, such as the metabolic pathway or a nutrient or growth formulation in plants or animals.

Tracheal Gills: Integumental evaginations, covered by thin cuticle and are supplied with the tracheae and tracheoles; found in many aquatic and some endoparasitic insects. In mayfly nymphs, larvopods present on most abdominal segments are modified into tracheal gills. Tracheal gills when vibrates help in increasing the water flow across the respiratory organs. These gills often become important under oxygen deficient conditions. Body wall (hindgut in dragonfly larvae) have

richly tracheated outgrowths and these are collectively known as tracheal gills.

Tracheal System: Also sometimes called ventilatory system. Generalized tracheal system consists of ten pairs of segmentally arranged **spiracles** that lead to a system of tracheal branches within the segment, plus several interconnecting longitudinal trunks that run between the segments. The spiracles are located on the mesothorax, the metathorax, and the first eight abdominal segments. Generally there is a pair of dorsal tracheal branches to the heart, aorta and dorsal muscles, a visceral branch to the digestive tract and reproductive system, and a ventral branch to the ventral muscles and the nerve cord. However, the number and arrangement of functional spiracles, tracheal trunks and branches is highly variable from species to species.

Trachein: A colloidal or jelly-like material forming the walls of the tracheal air-sacs in the aquatic larvae of gnats (*Corathra* sp.), it can apparently swell upon absorbing water and shrink on losing it. The insects can control their buoyancy with its help.

Tracheoblast: A cell that give rise to tracheoles.

Tracheoles: The fine terminal branches of the respiratory tubes which lack taenidia. Tracheole is considered as the major site of oxygen transfer. Tracheoles are less than 1 mm in diameter and closely contact the respiring tissues, sometimes indenting into the cells that they supply. However, tracheae that supply oxygen to the ovaries of many insects have a few tracheoles.

Trade Name: Also known as trade mark name, proprietary name, brand name etc. Name given to a product by its manufacturer or formulator, distinguishing it as being produced or sold exclusively by that company. This is given to distinguish it from similar products made by other companies.

Trail Pheromone: A substance laid down in the form of a trail by one insect and followed by another member of the same species. Some ants produce trail substances in Dufour's

gland, others in Pavan's gland, the poison gland, or glands in the hind tibia. Trail pheromones are most common in ants and termites with large colonies. Trails serve as routes from the nest to a good source of food. In leafcutter ants, the trails are persistent and last many days permitting the colony to continue contact with good sources of food. Receptors for detection of trail pheromones are located on the antennae.

Transformations of Data: Analysis of variance of data is based on assumptions : random and normal distribution of error terms, homogeneity of variances, independence of means and variances and additivity of main effects. When these assumptions are seriously violated, an analysis of variance is not valid. Transformations of data will correct the failure of the data to meet above assumptions. The log transformation, square root transformation, and arcsine or angular transformations are commonly done to correct the failure of data.

Transgenic: A transgenic plant is simply a normal plant with one or more additional genes from diverse sources. Application of transgenic plants through genetic engineering is the latest concept in insect pest management. Under field conditions, transgenic plants produce insecticidal or antifeedant proteins on the plants, consequently killing feeding insects and protecting the plant. At present, recombinant DNA technology has been used to develop resistant plants. This technology involves inserting the gene responsible for producing delta endotoxin from the insect pathogen *Bacillus thuringiensis* (Bt) into plant genomes. This procedure has been used to transfer Bt delta endotoxin gene to many plants including cotton, tomato, and potato.

Translaminar: A pesticide which passes through from one surface of a leaf to the other (from lamina to lamina) through the leaf tissue. Dicofol - an acaridae has translaminar action and when sprayed on upper surface of leaves kills the mites feeding on the undersurface of leaves.

Translocation: The uptake of a pesticide into part of a plant body and its subsequent dispersal to other parts of the plant body.

Transovarial: Via the egg. For example, transovarial transmission of symbiotic microbes from one generation to the next. Some of the arboviruses in mosquitoes are also passed to the offspring transovarially.

Transplant: To remove seedlings from the nursery (seed bed) and plant in the field either by hand or mechanically.

Transverse: Running across, at right angles to the longitudinal axis.

Transverse Costal Vein: A cross-vein in the costal cell of the wing (Hymenoptera).

Transverse Marginal Vein: A cross-vein in the marginal cell of the wing (Hymenoptera).

Transverse Median Vein: A cross-vein in between the median or discoidal vein and the anal vein (Hymenoptera).

Transverse Orientations: Directed movements in which the long axis of the body is oriented at a fixed angle relative to the source of stimulus.

Transverse Radial Vein: Same as transverse marginal vein.

Transverse Suture: A groove or line across a sclerite or between two sclerites.

Trap Crop: Crop of plants (sometimes wild plants) grown especially to attract insect pests, and when infested are either sprayed or collected and destroyed. Trap plants usually grown between the rows of the crop plants or else peripherally. They can also be grown on orchard floor or on fallow land to reduce undesirable pest populations or provide other benefits. Nematodes may be suppressed through antagonistic or allelopathic effects, or by preferential attraction to the cover crop over the desired crop. Trap crops also may provide habitat for natural enemies of insects, mites, and other pests. Trap crops have been successfully used to reduce the incidence of virus through insect vector as planting of barrier of alternative susceptible crops can significantly reduce the

ratio of virus spread in the field. For example castor is grown as a trap crop in cotton, tobacco and chillies to reduce damage by *Spodoptera litura*, and okra is grown in the vicinity of cotton to reduce attack by flea beetles. Trap crop technique can be improved further by treating the trap crop with pheromone, thereby attracting the insects to the lethal trap in larger numbers and from a greater distance. In this way less insecticide is needed to achieve good control and the effect on beneficial insects is kept to a minimum.

Trauma: Wounds or injuries caused directly by violent contact of external objects with the body of the animal.

Treatment: The objects of comparison in an experiment are defined as treatment. Treatment is that controlled variable or combination of variables which must be investigated. In practice 'treatment' may refer to a chemical substance (e.g., product, formulation, application rate), a procedure (e.g., application method, application timing, application frequency), or any other variable which may be used in a controlled manner (e.g., spray volume, spray particle size, or untreated).

Treatment Threshold: Also known as control action guidelines. This parameter helps to decide whether different management actions including the pesticide applications, are needed to prevent eventual losses from pest damage. Using various sampling methods, researchers can get an accurate estimate of the populations in the field and correlate that with the potential for damage. Treatment thresholds and sampling methods allow growers to avoid extra pesticide applications by giving them a clear idea of the specific pest potential.

Tree Injection: Injection of pesticides in the trees is most successful particularly for pest control on coconuts and palm trees. Power-operated drills are commonly used to make a hole between the base of two-frond butts, and led 45° downwards into the stem using a 10-15 cm long bit. Insecticides are put into the hole as soon as possible with a small hand-

operated injector and then the hole is covered with the fungicide paste to prevent loss of the pesticide. With a suitable power drill and injector about 3 hectares/person/day can be treated. The technique is slow and labour intensive, so injection costs per tree are high and justified only where high value trees need to be saved. There is minimum risk to pollinators, parasites and predators by application of the pesticides through injection in tree.

Trench Fever: A human disease caused by a bacterium like microorganism, *Rickettsia quintana*, nonfatal and is characterized by the sudden onset of fever, headache, dizziness, and pains in muscles and bones; transmitted by the body louse (*Pediculus humanus*) through its faeces.

Triangle: A cell or group of cells near the base of the wing in dragonfly (Odonata : Libellulidae).

Tribe: A taxonomic category intermediate between genus and the subfamily. The name of tribes end in **-ini** (e.g., Bembicini).

Trichobothria : Minute sensory hairs on the tarsi in spiders and mites.

Trichoid Sensillum: Sensory hairs, that develop from epidermal cells that switch from cuticle production. Fully-developed trichoid sensilla fulfil tactile functions. Touch sensilla are stimulated only during actual movement of the hair. The sensitivity of each hair varies, with some being so sensitive that they respond to vibrations of particles caused by noise.

Trichogen Cell: An epidermal cell that develops into a seta or hair.

Trichome: Trichomes are the cellular, hair like outgrowths of the plant epidermis, which may occur on leaves, shoots, or roots. Trichomes are important for various physiological reasons but are of particular value in water conservation and are probably the plant's most important morphological defence against insect attack. These structures may interfere with insect oviposition, attachment of insect to the plant, feeding, or

ingestion. Mechanical effects of trichomes depends on their density, erectness, length, and shape. Some trichomes possess glands that exude secondary plant products which may be sticky in nature and interferes in the locomotion of insects on them.

Trichoptera: An endopterygote order of insects known as caddisflies. They are slender, elongated and moth-like in appearance. Compound eyes are large, and antennae are long. Mouthparts weakly developed; body and wings covered with hairs. Wings uniform sized and held tent-like over the body when at rest. Complete metamorphosis. Caddisflies are mainly nocturnal or crepuscular and commonly found near water. They live in both lakes and streams and are most important groups in the food chain. They are worldwide in distribution excepting Antarctica.

Trilobita: Extinct marine, bottom living and pelagic arthropods. Range from 1 mm to 1 m in length, body divided into 3 regions - a head or cephalon, a mid body or thorax, and a hind body or pygidium.

Trinomial Nomenclature: An extension of the binominal system of nomenclature to permit the designation of subspecies by a three-word name.

Triordinal: Refers to the condition when proximal ends of the crochets are arranged in a single row but their distal ends of three alternating lengths.

Tritocerebrum: Also sometimes called 'metacerebrum'. The hind part of the brain of an insect formed from the fused ganglia of the third embryonic segment. Tritocerebrum, unlike the other sections of the brain, remains separated into two lobes and receives nerves from the frontal ganglion, labrum, and the suboesophageal ganglion. All lobes of the brain are interconnected through fibre tracts.

Tritosternum: Sternite of third segment of prosoma or first segment of podosoma in acarines.

Triungulin: The campodeiform first instar larvae of order Strepsiptera and beetles

(Meloidae). They are free living and possess legs for quite rapid movement and in many species are capable of jumping 2-3 cms with the help of caudal setae. When this larva comes into contact with a host, it burrows through the host's cuticle and becomes endoparasitic or simply gain transportation and access to a food source.

Trivial Flight: Movements or flight of an insect species within its normal habitat, not involving dispersal.

Trivial Name: Name in general or common place usage (e.g., nicotine).

Trochanter: Typically small second segment of the insect leg that articulates with the coxa and usually forms an immovable attachment with the femur. Trochanter is usually a single segment but in order Odonata it is divided into two subsegments. Trochanters are missing entirely on one or more pairs of legs in some insects. In saltatorial legs of grasshoppers, trochanter is fused with the femur.

Trochantin: A small, movable pleurite articulating anteriorly with the coxa (Coleoptera).

Trophallaxis: The exchange of alimentary liquid among colony members and guest organisms; either mutually or unilaterally. In stomodeal trophallaxis, the material is effected from mouth-to-mouth. Stomodeal food is either a semisolid material comprising the regurgitated contents of the crop which is fed to soldiers in lower termite families or saliva which appears to be the only food received by reproductives of all families, very young stages of lower termites, and all juvenile stages and soldiers of Termitidae. Proctodeal food is a liquid containing protozoans and products of digestion and undigested food. This is common in all termite families except Termitidae.

Trophi: Mouthparts of arthropods especially insects.

Trophic Egg: An egg, usually degenerate in form and inviable, which is fed to other members of the colony.

Trophic Feeding Levels: The system of

sequential levels consisting of organisms with common feeding habits linked and dependant on a continuous energy flow. Plants or autotrophs form the first level, herbivores form the second level, primary carnivores the third level, and other carnivores form the fourth and fifth levels.

Trophic Parasitism: The intrusion of one species into the social system of another, as for example, by utilization of the trail system, in order to steal food.

Trophogenic Polymorphism: Polymorphism resulting from the differences in the quantity or quality of food provided to the larvae. The idea of differential feeding is to produce different caste traits. Caste determination in honeybees, and generally in eusocial hymenopterans is largely trophogenic. In honeybees although cells are constructed according to the type of caste that is to develop within them, the caste is determined neither by the egg laid by the queen nor by the cell itself, but by food supplied by workers to the developing larva. The type of cells guides the queen as to whether to lay fertilized or unfertilized eggs, and identifies to the worker which type of rearing (principally food) to be supplied to the occupant.

Trophothylax: A food packet in the first abdominal segment of the larva, in ants of the subfamily Pseudomyrmacinae.

Tropical: The central region of the geographical globe extending from the 'Tropic of Cancer' in the north and the 'Tropic of Capricorn' in the south. Much of the tropical zone has a dry and hot winter with summer rains, but the central strip is designated as the 'Equatorial belt' and is characterized by evergreen rain forest and continual rainfall.

Tropism: Orientation of an insect with respect to a stimulus, either positive (turning toward the stimulus) or negative (turning away from the stimulus).

Tropophilous: Tolerating alternating periods of cold and warmth or of moisture and dryness; adapted to seasonal changes.

Tropotaxis: A response involving the turning

of an insect followed by movement in a definite direction in relation to a stimulus. It thus combines a tropism and a taxis.

Truncate: Terminating abruptly.

Trypanosomiasis: Also known as sleeping sickness in man. The disease caused by the presence in the body of a protozoan parasite *Trypanosoma brucei gambiense*. Disease is marked by the fever, anaemia, and redness of the skin; transmitted by tsetse flies (*Glossina palpalis*, *G. fuscipes* and *G. tachinoides*).

Tuber: Enlarged, fleshy, underground stem (e.g., potato).

Tubercle: A small bump or knob-like protuberance (tuberculate).

Tularaemia: A bacterial disease occurring mainly in rabbits but also in certain rodents, ungulates, carnivores, birds, livestock, and man; caused by the *Francisella tularensis* and transmitted by arthropod vectors (ticks, lice, fleas, biting flies) and by contact of skin with infected material. But blood-sucking tabanid flies, *Chrysops discalis*, are recognized as being a major mechanical vector of *F.tularensis*. Disease is marked by inflammation of lymph glands, headache, chills and fever.

Tullgren Funnel: A sampling device that uses heat to drive insects from the sample of soil, vegetation or litter. Metal cylinder three to four inches in diameter which terminates in a funnel, for dry extraction of small invertebrates from soil cores; usually in a bank of six to ten funnels. Incandescent lamp is suspended above the sample as a heat source. This technique is based on the principal of making the soil environment so adverse that the insects inside are forced to move out, or providing a direct stimulus to invoke withdrawal. With this technique, care must be taken to prevent undue mortality before insects leave the core. Cores are usually inverted in the funnel so insects can leave the same passages used in entering the soil, and the core is heated gradually so they are not killed from desiccation. These tunnels have been used to sample small, abundant arthropods in the soil like mites (Acari),

springtails (Collembola), and beetles (Coleoptera).

Tumour: Any swelling, whether oedema or a mass, resulting from the malformation, inflammation or repair.

Tymbal: The sound producing membrane in male cicadas. Cicadas make a loud noise with their help. In the male cicadas, paired tymbals are located dorso-laterally, one on each side on the first abdominal segment. Each consists of a tightly stretched skin with an air space beneath it. The sound is produced by the rapid in and out movement of the tymbal, which is brought about by a powerful muscle. Tymbal sound production is most audible to the human ear from cicadas, but many other hemipterans and some moths produce sounds from a tymbal.

Tympanal Hood: One of a pair of tubercles or rounded prominences on the dorsal surface of the first abdominal segment (Lepidoptera).

Tympanum: An auditory membrane that responds to sounds produced at some distance, transmitted by airborne vibration. Tympanal organs are present in the adults of many species of Orthoptera (on the fore tibiae of Tettigoniidae and Gryllidae; on the first abdominal segment of Acrididae), in Lepidoptera (abdominal in Geometroidea and Pyralidoidea; metathoracic in Noctuoidea), and in Hemiptera (abdominal in Cicadidae, thoracic in others). The range of frequency of sound waves that stimulate tympanal organs is high. For example in Acrididae, it extends from less than 1 kcps to about 50 kcps. Insect tympanal organs operate as pressure difference receivers and insects with these organs can locate the source of the sound. In Orthoptera and Hemiptera, these organs are important in species aggregates and in mate location. In Lepidoptera, tympanal organs are used to detect the approach of insectivorous bats. Interestingly, the tympanal organs are most sensitive to frequencies in the range of

15 to 60 kcps, which comes within the frequency range of the sounds uttered by the bats as they echolocate.

Type Locality: The place where the type specimen (and often the accompanying type series as well) was collected.

Type Series: All of the specimens of a new species which the describer had before him and which he considered as representing the new species, at the time he described it.

Type Specimen: The specimen the describer had before him in naming the species and which he designated as typifying the species.

Types: Forms designated when a species or group is described to the most representative or typical, to serve as the reference if there is any question about what the species or the group includes. The type of a species or subspecies (the holotype) is a specimen, the type of a genus or subgenus is a species, and the type of a tribe, subfamily, family, or superfamily is a genus.

Typhoid Fever: An acute infectious disease caused by a bacterium, *Salmonella typhi*. Inflammation of intestine, intestinal ulcers, a rose-spot on the abdomen, and enlarged spleen are the symptoms of fever. Food and water-borne but may be transmitted by house flies.

Typhus Fever: A human disease caused by a bacterium like microorganism, *Rickettsia prowazekii* and transmitted by the body louse, *Pediculus humanus*. The disease is characterized by high fever, backache, intense headache, bronchial disturbances, mental confusion, and congested face.

Tyrosine: An amino acid important in all living organisms. In insects it is the basis for the formation of melanin in the cuticle. In fly larvae the level of the amino acid tyrosine in the haemolymph reaches a maximum prior to puparium formation, then declines as tanning proceeds.

Ubiquitous: Very widely distributed.

Ultra-Low Doses: Ultra-low doses refer to extremely lower doses as compared with those normally recommended.

Ultra-Low Volume (ULV): The application of pesticides in extremely concentrated or undiluted form using less than 5 litres per hectare for field crops and less than 50 litres per hectare for trees and bushes. Excessive rates of application or too large a droplet are likely to have an adverse effect on plants. The lower surface tension of oils used in these formulations allows greater penetration through stomata of certain leaves, and also through lipoidal leaf cuticles. Uptake of the active ingredient may be reduced if high concentrations of active ingredient are applied in minimal volumes when users attempt to apply the same dose per unit areas as used in high volume (HV) sprays. In general, ULV formulations should be checked for phytotoxicity at the proposed field application rate and also at double the rate. Multiple applications may be required to detect any undesirable symptoms which do not show after a single application.

Ultramicroscopic: Structures or organisms that are too small to be seen with the light microscope, but can be made visible with means like electron microscope.

Ungue: Also known as pretarsal claw. Pretarsus in many insects is represented by a pair of ungues.

Unicolonial: Pertaining to a population of

social insects in which there are no behavioural colony boundaries.

Uniform Coverage: The application of a pesticide chemical evenly over a whole area, plant, or animal.

Uninomial Nomenclature: The designation of a taxon by a scientific name consisting of a single word, required for taxa above species rank.

Uniordinal: Refers to the condition when the crochets are arranged in a single row and are of a single length throughout or somewhat shorter towards the ends of the row.

Uniserial: Refers to the condition when the crochets are arranged in a single row or series with their bases in a continuous line.

Unisexual: Consisting of or involving only females.

Univariate Analysis: A biometric analysis of a single character.

Universal Antidote: A mixture of activated charcoal, magnesium oxide and tannic acid in the ratio of 2:1:1 is known as a universal antidote.

Univoltine: Those insects that may have rather fixed developmental patterns consisting perhaps of a single generation each year.

Urate Cell: A cell of the fat body that stores uric acid.

Uric Acid: Uric acid is the major nitrogenous waste product (80-90%) in terrestrial insects; uric acid is relatively non-toxic and highly insoluble. Uric acid is removed from the blood

by the malpighian tubules and is deposited into the hindgut where it crystallizes as the water is resorbed. Elimination is through defecation of the faeces. Some uric acid, however, is incorporated into tissues and the exoskeleton. In some cockroaches, up to 10% of the total dry body waste consists of uric acid.

Urogomphus: Any fixed or movable terminal abdominal process of insect larvae; applied especially to Coleoptera. Some larvae possess appendages on the ninth segment. The development of these varies from cerci-like to fixed horny outgrowths.

Urticating Hairs: Also known as nettling hairs. These hairs are often hollow and filled with a toxin supplied by a poison gland cell in the epidermis. Urticating hairs are basically defensive but under certain circumstances cause severe irritation accidentally. When a

tip of the hair is broken the poison is released. Quite a number of caterpillars possess urticating hairs, in some species fragments of the hairs (setae) break off and cause mechanical irritation. Such fragments when are lodged in the cornea of the eye, they may cause considerable irritation. Nettling hairs of larvae of the family Saturniidae are particularly more irritating.

Uterus: A term that is strictly incorrect when applied to the insects but is commonly used to denote a part analogous with the uterus of a mammal: enlargement of the 'vagina' where the two oviducts join. In some viviparous Diptera, the common oviduct is dilated to form a uterus and the accessory glands produce a nutritive secretion. The eggs hatch here and the larvae remain in the parents body to be deposited only when they are nearly full-grown and ready to pupate.

V

Vagina: External opening of the female reproductive system in which the male intromittent organ is placed during copulation.

Vagrant: An insect which occasionally moves from one place to another, but not with any regularity, the implication is that the movement is accidental.

Valid Name: An available name that is not preoccupied by a valid senior synonym or homonym.

Valvifers: The proximal structure of the ovipositor that bear the valvulae. The ovipositor has a basal part and a shaft. The basal part consists of two pairs of valvifers (gonocoxae) on the eighth and ninth segments which are homologous with the coxae of the leg.

Valvulae: Distal structure of the ovipositor borne on the valvifers; the three pairs of processes forming the sheath and piercing structures of the ovipositor.

Vannal Lobe: A lobe in the anal area of the wing, immediately distal to the jugal lobe when a jugal lobe is present (Hymenoptera).

Vannus: The anal or posterior lobe of an insect's wing; a fan-like expansion separate from the rest of the wing by a furrow.

Vapour Pressure: The property that determines how easily a chemical changes from liquid or solid state into the gaseous phase. The lower the vapour pressure, the more volatile is the compound.

Variables: A variable is a changeable quantity

or quality. The quantitative or qualitative characteristics of a population are said to be variables as they have the property of being different or they vary according to the genetical and the environmental factors.

Variance: The total variation displayed by a set of observations, as measured by the sum of squares of deviation from the mean, may in certain circumstances be separated into components associated with defined sources of variation used as criteria of classification for the observations.

Variant: Individual which differs in some minor way from the ordinary appearing individuals.

Varietal Control: The use of varieties (cultivars) of cultivated plants which are resistant to pests.

Varieties: 1.Plants in a species that differ from each other in certain details such as form, colour, fruit size, fruit flavour, etc. Variety is sometimes used synonymously with cultivar. 2.A loosely defined taxonomic category below the level of subspecies.

Varroasis: Also sometimes called as 'varroaosis'. Parasitic mite *Varroa jacobsoni* is the major pest of honeybees, the mite reproduces mainly on the drone pupae. Varroa mite prefers drone larvae but also invades worker cells, is attracted to fatty acid esters which are found in higher quantities in immature drones than on workers. Varroasis symptoms includes, 1.Presence of pale or dark-brown mites on white pupae, 2.The

colonies are weak with spotty broad pattern, 3. The drone or worker brood has punctured cappings, disfigured, stunted adults with disfigured legs and wings are commonly found on the combs or on the ground outside. Bees are seen discarding larvae and pupae and there is a generally colony malaise. Mites can be detected by pulling up the brood cells using a capping scratcher. Fluvalinate (Apistan®) is quite effective for varroa control. Coumaphos (Bayer beestrips or check mite) - is also effective for mite control.

Vas Deferens: A duct into which the vasa efferentia empty, that connects each testis to a seminal vesicle. Mature sperm pass from the sperm tube through a short 'vas efferens' to the 'vas deferens'. The vas deferens is usually mesodermal in origin, but in Diptera it is ectodermal. It may be dilated into a seminal vesicle where sperms are stored prior to their exit via the ectodermal ejaculatory duct.

Vas Efferens: Tiny ducts that are leading from each testicular follicle to a common lateral duct, the vas deferens.

Vascular Tissues: The fluid conducting tissues of a plant including both xylem (water) and phloem (food) tissues.

Vasiform Orifice: In whiteflies (Aleyrodidae), a dorsal glandular opening on the last abdominal segment.

Vector: A living organism (e.g., insect, mite, bird, higher animal, nematode, parasitic plant, human etc.) able to carry and transmit a pathogen (virus, bacterium, fungus, nematode) thus disseminate disease. For example anopheline mosquitoes are vectors of malaria. Leafhopper, *Cestius phycitis* is a vector of little-leaf disease of brinjal.

Vegetable Oil: Oil extracted from seeds, typically that of corn, cotton, peanut, rapeseed, sunflower, canola or soybean.

Vein: Fine tubes of toughened cuticle which provide a supporting framework for the wings. They contain tracheae, nerves and blood. Veins also vary in their thickness, they are quite thick in the cicadas (Hemiptera) but

are very thin in scorpionfly (Mecoptera). Longitudinal veins and cross-veins serve as braces for the wings. Veins are valuable in demonstrating relationships and are named to permit detailed studies on classification.

Vein Banding: Symptom of a virus disease in which regions along the leaf veins remain darker green than the tissue between the veins.

Vein Clearing: Symptom of a virus or other pathogenic disease characterized by the disappearance of green colour adjacent to the veins of young leaves.

Vena Spuria: A false vein ; a thickening resembling a vein in the wings of such insects as hoverflies (Diptera : Syrphidae).

Venation: The arrangement of veins in the wings of insects. Veins are the most important characters considered for identification of genera and species in some orders. Generalized wing venation is as follows : The **costa** - a thick unbranched vein forming the anterior margin of the wing; the **subcosta** -unbranched vein just below the costa ; the **radius, media** and **cubitus** are usually branched; and the short and unbranched **anal veins**. All the above veins run longitudinally and sometimes are linked by a number of cross-veins which divide the wing into cells. Ephemeroptera and Odonata have numerous cross- veins and cells.

Ventral: Front or lower surface, as opposed to dorsal; pertaining to the underside of body.

Ventral Gland: The paired moult glands. They are organs of internal secretion in the ventral part of head producing the moulting hormone (Thysanura, Ephemeroptera, Odonata and Isoptera). Generally comprise two strips of tissues, frequently branched, which are interwoven among the tracheae, fat body, muscles, and connective tissue of the head and anterior thorax. In accordance with their variable position, they have been described as prothoracic glands, ventral head glands, tentorial glands, pericardial glands, and peritracheal glands, though these structures are homologous. Except in apterygotes, 'solitary' locusts, and in worker and soldier

termites - the glands are found only in juvenile insects, and degenerate shortly after the moult to the adult.

Ventral Nerve Cord: The ventral nerve cord is a chain of segmental ganglia connected anteriorly with the tritocerebrum by the paired circumoesophageal connectives. The ganglia of the three gnathal segments are fused into a compound mass named suboesophageal ganglion. Motor and sensory nerves extend to the mandibles, maxillae, labium, salivary glands, and cervical muscles. The three ganglia of the thoracic segments serve the legs and flight mechanism and are usually the largest ganglia of ventral nerve cord. Sensory and motor nerves extend to the various sense organs and muscles. In the abdomen there are not more than eight ganglia, and the last is a large compound ganglia serving the eighth and following segments, including the genitalia and cerci.

Venteromesal: On the underside or near the middle.

Ventriculus: Alternative name for the midgut, also reported as mesenteron. It is endodermal in origin, so have no cuticular lining. However, it is lined by a thin peritrophic membrane and serves as the insect's stomach. Most of the digestion of food take place in this region.

Venules : The smaller cross-veins of an insect's wing.

Vermin: Pests; usually rats, mice or insects.

Vermiform Larva: A legless worm-like larva without a well-developed head as in some Diptera.

Vernacular Name: The colloquial designation of a taxon. Common name, the agreed local common name for an insect other than the formal latinized scientific name.

Vernalization: The process by which exposure of seeds or plants to low temperature stimulates germination or flower development.

Verruca: A wart like prominence on some caterpillars usually bearing tufts of setae.

Verson's Glands: The moulting glands of caterpillars; epidermal glands which secrete a fluid having the property of liquefying the endocuticle and thus loosening the epicuticle prior to moulting.

Vertebrates: Animals with a spinal column or backbone, such as fishes, birds, mammals, and so on.

Vertex: The dorsal surface of the head, between the eyes and above the frons. Vertex is delimited anteriorly by the arms of the epicranial suture and posteriorly by the occipital sulcus. In the vertex region two ocelli are usually located, the antennae arise from this area and slightly below the ocelli.

Vertical Classification: Classification which stresses common descent and tends to unite ancestral and descendent groups of phyletic line in a single higher taxon, separating from contemporaneous taxa having reached a similar grade of evolutionary change.

Vertical Resistance: Plant resistance to pest attack, is only effective against some races of a pathogen ; a temporary form of resistance easily broken by new phenotypes, it is limited to one or a few genotypes. It is easy to recognize for it is almost absolute, and is relatively easy to find in nature as it is usually controlled by a single dominant gene. Vertical resistance is relatively easy to incorporate into genetic make-up of commercially acceptable crop plan varieties.

Vesicle: A sac or bladder, sometimes extensible.

Vestigial: Having the nature of a degenerate or atrophied organ, more fully functional in an earlier stage of development of the individual or species.

Viability: State of being alive ; in seeds, the ability to germinate and grow.

Vibrissae: A group of bristles inserted around the oral fossa in many Diptera.

Viraemia: The presence of virus in the haemolymph of insects.

Virelure: Synthetic sex pheromone of the

female tobacco budworm moth; a combination of 2-11-hexadecenal (2-11-HDAL) and Z-9-tetradecenal (Z-9-TDAL); attractive to males of the tobacco budworm, experimentally used in traps to disrupt mating.

Viricide: A substance that completely and permanently inactivates a virus.

Virion: The particles of a virus. Polyhedrosis viruses are divided into nuclear and cytoplasmic forms, based on the site of virion multiplication within the cells of the host. In case of granulosis viruses, virion first multiply in the nuclei but later continue to replicate in the cytoplasm.

Viroid: An infectious ribonucleic acid that does not have a seed coat; an infectious pathogen smaller than a virus.

Virulent: 1. The disease producing power of a microorganism; 2. Able to produce the symptoms typical of the disease in a susceptible host.

Viruliferous: Virus carrying; an insect that has been given access to a virus source.

Virus: A sub-microscopic pathogen that requires living cells for growth and is capable of causing disease in plants or animals. It is composed of a protein capsule and a nucleic acid core. Plant viruses are often spread by insects. More than 300 viruses have been isolated from about 250 agriculturally important insect-pests. The successful viruses are in the group Baculoviridae usually either polyhedrosis or granulosis and viruses can be applied at very low dosages. The use of viruses, however, has some limitations due to inability to maintain the viral agent in a stable state outside a living cell. Mass multiplication/ production of virus on an artificial medium has not been achieved. Another problem is the relatively slow kill following virus infection. Unlike the *Bt* toxin, which causes the caterpillar to stop feeding in a few hours, a caterpillar infected with a virus may continue to feed for several days.

Virustatic: Pertaining to the action of a chemical that inhibits the multiplication of a virus.

Viscera: The internal organs in the cavity of the body particularly those in the abdomen.

Visceral Muscles: A muscle which invests an internal organ.

Visceral Nervous System: The nerve system that innervates the gut, reproductive organs, and tracheal system. The visceral (sympathetic) nervous system includes three parts : the stomatogastric system, the unpaired ventral nerves, and the caudal sympathetic system. The stomatogastric system arises during embryogenesis as an invagination of the dorsal wall of the stomodeum. Generally, it includes the frontal ganglion, recurrent nerve which lies mediodorsally above the gut, hypocerebral ganglion, a pair of inner oesophageal nerves, a pair of outer oesophageal (gastric) nerves, each of which normally terminates in an ingluvial (ventricular) ganglion situated alongside the posterior foregut, and various fine nerves from these ganglia that innervate the foregut and hindgut. A single median ventral nerve arises from each of the thoracic and abdominal ganglion in some insects. The nerve branches innervates the spiracle on each side. The caudal sympathetic system, comprising nerves arising from the composite terminal abdominal ganglion, innervates the hindgut and sexual organs.

Viscosity: A property of liquids that determines whether they flow readily or resist flow. Viscosity of liquids usually increases with a decrease in their temperature. The quality of the oil is based on the viscosity, boiling or distillation range, and sulfonation rating (purity or degree of refinement). Generally, the lower the viscosity the safer it is to use with respect to phytotoxicity.

Vision: Insects have two kinds of eyes, i.e. compound eyes, and simple eyes or ocelli. Most adult insects have both types of eyes but larvae usually possess only ocelli. Neither type of eye is well adapted to give a clear picture of distant objects. Ocelli may not form an image at all but merely detect changes of intensity of the light. Compound eyes can

either produce a mosaic image composed of a large number of dots or a superposition image in which the dots merge to form a blurred picture. Compound eyes are, however, well adapted for judging distance and for perceiving movements of objects. Most insects can perceive colour including ultraviolet and infrared. Some insects can also perceive patterns of polarization in the sky and this helps them in direction finding during flight.

Vitelarium: Vitellarium is the region in which an oocyte accumulates yolk, a process known as the vitellogenesis. As oocytes mature and enter the vitellarium, they tend in most insects to become arranged in a linear sequence along the ovariole.

Vitelline Membrane: Cell membrane encasing the egg.

Vitellogenesis: Deposition of yolk in the oocyte, occurs in the lower parts of the ovariole, and it results in a very rapid increase in size of the oocyte.

Vitellogenin: Protein in the fat body that is transferred to oocytes during vitellogenesis.

Vitellophage: Yolk cells considered responsible for the initial digestion of yolk.

Vitrellae: Cells which secrete the crystalline cone in each ommatidium or optical unit of a compound eye.

Vitreous Body: A name sometimes used to denote the crystalline cones in the eye of an insect.

Vitta: A broad longitudinal pigmented stripe.

Viviparae : Female aphids that bear living young (do not lay eggs).

Viviparity: Viviparity is unusual type of development where the female instead of laying eggs produce larvae or nymphs. In viviparous insects the eggs develop in the oviducts or vagina until at least the completion of embryonic growth. There are four kinds of viviparity in adults, **1.Ovoviviparity**—in which eggs are retained in genital tracts so that when they are laid, their embryos have reached advanced stage of development with

the result larvae hatch immediately after oviposition as in some Diptera; **2. Adenotrophic viviparity**—in this eggs are retained in enlarged vagina (uterus). The embryo develops inside eggs and larvae on hatching is retained in the uterus where it is nourished by secretions from accessory glands; **3. Pseudoplacental viviparity**—in this the eggs which are devoid of chorion and yolk are provided with special structures called pseudoplacentae which remain in close contact with the developing embryo. The larvae derives nourishment from these structures. It is found in Aphididae; **4.Haemocoelous Viviparity**—in which the development of embryo occurs in the haemocoel of the mother. It is found in Strepsiptera.

Viviparous: Bearing living young instead of laying eggs. For example flesh flies, tsetse flies and the wingless parthenogenetic females of aphids are all viviparous. The terms larviparous, nymphiparous and pupiparous are commonly used to refer to viviparous larvae, nymphs and pupae respectively.

Volatile: A compound is said to be volatile when it evaporates (changes from a liquid to a gas) at ordinary temperatures on exposure to air.

Voltinism: In insects, the number of generations per year is called voltinism. A univoltine insect has one generation per year, a bivoltine insect has two, and a multivoltine insect has more than two generations per year. Large insects that rely upon nutritionally poor diets develop slowly over many years. For example, periodic cicadas feeding on sap in roots may take 13 or 17 years to mature. Multivoltine insects tend to be small and fast developing, using resources that are available throughout the year. Adult life of multivoltine insects may be as little as a few hours of low tide for marine midges.

Volume Median Diameter (VMD): A measure of spray droplet diameter at which half the spray volume has larger drops and half has smaller drops.

Volunteer: Crop plant growing out of place from shed seeds, without intentional cultivation. Volunteer plants of the crop that remain in turnrows and in parts of a field after harvest are a source of insect infestations as insects continue to multiply on them. The destruction of these volunteer plants is particularly important when crop rotation is

practiced to eliminate pests.

Vulva: The external opening of the copulatory pouch (bursa copulatrix) or vagina of the female genitalia.

Vulvar Lamina: The posterior margin (usually prolonged posteriorly) of the eighth abdominal sternite (female Odonata).

W

Waggle Dance: The type of dance in which workers of various species of honeybees (*Apis* spp.) communicate the location of food finds and new nest sites. The dance is basically a round like a figure eight (8), and communicates the information about the direction and distance of the target. Waggle dance is performed if the food source is more than 35-80 metres away, and more precise information on distance is indicated by the duration of the straight run. The greater the distance the greater the duration of the straight run. If the food source is close to hive, then a 'round dance' is performed which communicates no information on distance or direction.

Waiting Period: Same as time interval.

Walking: Walking is a normal means of locomotion for all insects that have thoracic legs as in case of all terrestrial adults and the immatures of those insects with the incomplete metamorphosis. But insects with complete metamorphosis move by crawling. Movement by walking or running uses the six thoracic legs. In general, walking insects are supported by a tripod, consisting of the middle leg on one side and the front and hind legs on the other side. While these three legs are planted and pushing backward against the ground, the other three are raised and moved forward in preparation for their turn. This alternation of moving tripods results in a slightly zig-zagged path about a line describing the direction of travel. The alternating tripod gait allows an insect (particularly slow moving) to stop at any time because its centre

of gravity is always within the area of the triangle of support on the substrate. Motion is imparted through the thoracic muscles acting on the leg bases. The maximum walking speed of insects is about 4.7 kms/hour. During walking on rough surface, pretarsal claws provide an ample grip. Arolium or pulvillus commonly known as tarsal pads are coated with a sticky secretion which help the insects to walk on smooth window panes or waxy plant leaves.

Wallace's Line: Imaginary line, separating the Australian and Oriental zoogeographical regions, between Bali and Lombok, between Celebes and Borneo, and then eastward of Phillipines.

Warble: The swelling on the host body caused by the larva of a warble fly. (Diptera : Oestridae). The larvae of these flies are endoparasites of mammals.

Warning Colouration: Also called as aposematic colouration. Some insects are so perfectly camouflaged, others seem to flaunt themselves with gaudy displays of colour and ornamentation. Most brightly coloured insects are adequately protected by special defensive structures, chemicals, or by the fact they are unpalatable.

Wasmannian Mimicry: A form of mimicry that allows an insect of another species to be accepted into a social insect colony. It covers some or all of the chemical or tactile mimetic features that allow the mimic to be accepted by a social insect, but the distinction from other forms of mimicry is not always obvious.

Water Balance: Insects are usually able to regulate the salt and water content of the haemolymph within the narrow limits. Different environmental situations pose different salt and water problems for insects. Terrestrial forms are constantly faced with the tendency to lose water through transpiration and are generally dependant on ingested food for needed water and salt. Depending on the water content of their diet the faecal material may be quite watery, as from plant feeding insects that take in an excess of water, or a dry powdery pellet in those insects that feed on materials of very low water content. Fresh-water insects must excrete the large amounts of water absorbed through the integument and by the gut alongwith ingested food and at the same time must conserve the inorganic salts. Materials in excess in the haemolymph are basically filtered through the malpighian tubules (permeable to most salt molecules) and the important materials that were lost in this process or from the faeces are reabsorbed in the rectum.

Water Dispersible Granules (Wg): Also known as dry flowable. Refers to a pesticide formulation consisting of granules to be applied after disintegration and dispersion in water. This type of insecticide formulation combines the advantages of liquid and solid formulations. Wettable dispersible granules (WG) are easy flowing products with constant bulk density and can be measured volumetrically. They are much less dusty, two to three times less voluminous and leave less residues in empty packaging as compared to wettable powders. The WGs are the formulation of choice for highly active solid products such as sulfonylureas. A drawback for products with high use rates may be the high price of WGs; nevertheless the high processing costs may be balanced by reduced storage cost due to the higher bulk density. This is a new generation of formulation type and does not behave like standard emulsifiable concentrate or suspension concentrate formulations and requires training of pesticide user on the characteristic of this formulation.

Water Dispersible Powder (WDP): Water dispersible powder is a pesticide formulation which comprises a finely ground powder, a wetting agent and a dispersing agent, and can remain suspended in water when diluted to field strength for long periods without stirring.

Water Management: All living organisms require water. Excess water (flooding) or lack of water (desiccation) also can be used to control some of the pests. In situations where crops are not solely rainfed, the management of water may be used as a means of pest control. Drip irrigation will favour a crop rather than the weeds and will provide the crop with competitive advantage. Flooding of land shortly after preparation for 2-3 days has been found effective means of killing soil dwelling pupae of *Heliothis* and *Spodoptera* species in cotton. Water can also be used to dislodge some pests (e.g., aphid). In some situations it is possible to increase the relative humidity in plant canopies. Higher humidities discourage spider mites which prefer hot, dry and dusty situations.

Water Miscible Liquids: A pesticide formulation which resemble the emulsifiable concentrates in viscosity and colour but do not become milky when diluted with water. Very few insecticides are formulated in this manner. They are not safe to use and should be applied only by trained personnels.

Water Soluble Powders: Water-soluble powders contain a finely ground water-soluble solid which dissolves readily upon the addition of water. They may contain a small amount of wetting agent to assist their solution in water. Unlike wettable powders, they do not require constant agitation and form no precipitates. There are relatively few insecticides of this type.

Wax: Most insects secrete a mixture of waxy substances which pass out in small quantities through pore canals in the epidermis and impregnate the epicuticle making it water proof. Wax is unique to social bees and is produced by workers that metabolize honey

in fat cells located close to the wax glands. Other waxes include 'China wax' from the scale insect, *Ericerus*, and 'wool' from the woolly aphis. Waxes of scale insects and woolly aphis primarily protect these insects from toxic effect of most insecticides.

Wax Glands: Glands which secrete wax are more especially characteristic of Homoptera, and are distributed in various parts of the integument. These glands are quite peculiar in scale insects, whiteflies and mealybugs (Aphidoidea and Coccoidea). The wax is secreted in the form of a powdery covering as a clothing of threads. Wax glands are also sometimes called epidermal glands and these glands are located ventrally between the overlapping ventral plates of the 4th-7th abdominal segments of honeybees. Bees use the wax to construct honeycomb.

Wax Layer: An epicuticular lipid layer between the cuticulin layer and cement layer that contributes to the permeability characteristics of the cuticle. Wax layer is mainly responsible for water retention. The epidermis just before ecdysis secretes the lipids of the wax layer, which is transported via pore canals, and the finer wax canals, and released to the surface.

Weather: Refers to the day-by-day conditions of temperature, humidity, rainfall etc. which affect individual insects.

Weathering: The wearing away of pesticides from the surfaces they were applied to because of rain, snow, ice and heat.

Web: Network of threads spun by spiders, pseudoscorpions, and spider mites. Silken chambers are spun to cover eggs and form protective retreats. Young spiders and spider mites through ballooning are transported from one habitat to other. Male spiders spin sperm webs - a structure onto which sperm is deposited, which is subsequently withdrawn by the copulatory pedipalpi. Draglines are spun by most spiders and often prevent injury when the spiders fall from a precarious site. Spiders use silk in capturing their prey, web-

spinners construct silken galleries with basitarsi of forelegs (which have silk glands and live in them).

Weed: A plant growing in the wrong place where it is not desired; an aggressive, invasive, easily dispersed plant, one which commonly grows in cultivated ground to the detriment of a crop.

Wet Preservation: Most eggs, nymphs, larvae, pupae and soft-bodied adults are preserved in liquids as drying usually causes them to shrivel and rot. Ethanol (80%) is commonly used for long-term storage of insects. However, aphids and scale insects are usually preserved in lactic phenol (2 parts ethanol + 1 part 75% lactic acid), this liquid prevents them from becoming brittle and facilitates subsequent maceration of the body tissue prior to slide mounting. Most immature insects will shrink, and pigmented ones will discolour if placed directly into ethanol. So immature and soft-bodied insects, as well as specimens intended for study of internal structures, must first be dropped alive into a fixative solution prior to liquid preservation. Each specimen or collection should be stored in a separate glass vial or bottle that is sealed to prevent evaporation.

Wetland: Also known as lowland. Level areas with levees prepared. Wet or dry that are flooded by water from either irrigation or rainfall. Many areas are being set aside as wetland preserves. Potential pesticide runoff or drift into wetlands is of greatest concern. Pesticide use in the vicinity of an area designated as wetlands may be restricted to avoid contamination.

Wettable Powder (WP): Insecticidal dusts to which wetting agents as well as insecticide have been added thus making the product dispersible and suspensible in water. They are the most common solid formulations. To obtain a stable suspension upon dilution with water, wettable powders will have to be grounded to a very fine particle size. This makes them dusty and less safe to use particularly when measuring out. Wettable

powders frequently contain 50 percent active ingredient, but some contain higher concentrations, they have a higher proportion of particles less than 5µm. WPs should flow easily to facilitate measuring into the mixing container. The wettable powder should disperse and wet easily when mixed with water and not form lumps. To ensure good mixing, some pesticides should be premixed with about 5 per cent of the final amount of water and creamed to a thin paste. Normally wettable powder formulations are not compatible with other types of formulation. Mixing wettable powders with an emulsion frequently causes flocculation or sedimentation. Advantages of wettable powders are : **1.**They do not cause damage to materials or places that are sensitive to organic solvents, **2.**Do not dissolve washers/rubber hoses of spray machines, **3.**They leave effective residues in cracks and crevices where sprays can not penetrate, and **4.**They are not phytotoxic when sprayed on foliage even at high concentrations. But wettable powders leave spots in areas which are sensitive to water spots; cause corrosion of valves, nozzles and pumps in sprayers, and also require constant agitation of spray material.

Wetting Agent: Wetting agent is a compound which on addition to a spray fluid causes it to spread over and wet the plant surface more thoroughly. They help in reducing surface tension (e.g., detergents).

Wheat Streak Mosaic: A virus disease of wheat and other grasses marked by yellow streaking of leaves, stunted growth, and reduced seed set, transmitted by the wheat curl mite, *Aceria tulipae* (Acari : Eriophyidae).

Whitehead: White empty panicle resulting from the attack of a stem borer which cuts the lower portion of the stem.

Whorl: The point where leaves or other plant parts unfold or are formed in a circular pattern. For example a corn plant before the tassels grow out.

Wilt: Loss of freshness and drooping of leaves of plants due to inadequate water

supply or excessive transpiration or to a vascular disease which interferes with utilization of water or to a toxin produced by an organism.

Windrow: A row of hay, grain, alfalfa, beans etc. cut and left in a field for drying before being baled or processed further.

Wing: Most insects have two pairs of wings, one each on the mesothorax and the metathorax. In Diptera only the fore wings are functional for flying and the hind wings are reduced to small balancers or halteres. Wings are formed from enlarged folds of epidermis and cuticle which grow out from the thorax. When complete the upper and lower surfaces of a wing are fused together except along the lines of the veins which may contain tracheae and blood vessels. A wing may be membranous and transparent (e.g., as in bees, wasps and flies) or it may be thickened and hardened to form an elytron or tegmen as in fore wings of the beetles, grasshoppers and cockroaches. Thrips have very slender wings but have a fringe of long setae to extend their wing area. In termites and ants, the winged-reproductives or alates, have large deciduous wings that are shed after the nuptial flight. Some insects are wingless or apterous (e.g., silverfish and bristletails), or secondarily wingless (e.g., lice and fleas). Secondary partial wing reduction occurs in a number of short-winged, brachypterous insects. The surface of a wing may be completely smooth as in dragonflies, or covered with fine hairs as in caddisflies. The hairs may be modified to form scales, but in case of mosquitoes these scales are only located along the lines of the veins. In butterflies and moths the whole wing is densely covered with scales of various shapes, sizes and colours which provide the distinctive wing pattern of each species.

Wing Bud: A small fold of epidermis growing out from the thorax of a nymph or of a pupa, eventually to become the wing of the adult insects.

Wing-Coupling: Wing-coupling is the coupling of fore wings and hind wings by

means of lobes, spines etc. present at the base of the wing. Mechanical coupling of fore and hind wings in most of the insects make four winged condition more efficient during flight. Various types of wing coupling mechanisms in insects are **jugate**, **frenulate**, **hamulate** etc. In jugate wing coupling—a jugal lobe of fore wing overlaps the anterior hind wing (Suborder Jugatae, Lepidoptera) ; in the frenulate wing-coupling - one or more hind wing bristles (the frenulum) hook under a retaining structure (the retinaculum) on the fore wing (Suborder Frenatae, Lepidoptera). In hamulate type wing-coupling tiny hooks (hamuli) on the costal margin of the hind wings that attach to the anal margin of fore wing (e.g., Hymenoptera). In insects that have wing-coupling mechanisms, the hind wings are usually somewhat smaller than the fore wings.

Wing Pads: The undeveloped wings of nymphs and naiads, which appear as two flat structures on each side. Insects have also been classified into Division **Exopterygota** (immature insects with external wing pads), and insect species that have internal wing pads as larvae, and the Division **Endopterygota**.

Wing Span: In butterflies twice the measurement from the centre of the thorax to the tip of the fore wing. Usually the fore wing measurement is taken as it is normally greater than that of the hind wing, but there are a few butterflies with longer hind wings.

Wing Veins: Narrow sclerotized tubes between the upper and lower epidermis of an insect's wing. Circulation of the blood or haemolymph takes place along these and in many cases they mark the positions of tracheal tubes. In many insects some of the veins are situated in furrows (convex veins) or on ridges (convex veins) which stiffen the membrane. Primitive insects like mayflies and dragonflies have a complex network of veins. In more specialized insects the number of veins is usually reduced and each of the species is characterized by a definite number and their arrangement.

Wireworm: Elateriform larva of beetle family Elateridae (Coleoptera); long, slender, well-sclerotized, having thoracic legs but no prolegs and with a few setae. Many species are serious crop pests attacking roots and root crops.

Witches's Broom: Disease symptom with an abnormal, massed, brush-like development of many weak shoots or roots of mainly woody plants, arising at or close to the same point or resulting from the proliferation of buds; caused by mites, viruses, fungi, bacteria, nematodes, etc.

Withholding Period: The period of time following application of a pesticide, that livestock must be kept out of a pasture or fodder crop.

Woollybear: A very hairy caterpillar belonging to the family Arctiidae (Lepidoptera). Setae of larvae are sometimes urticating.

Worker: In termites, the sterile males and females that perform most of the work of the colony; they are pale and wingless, and usually lack compound eyes. In social Hymenoptera, females with undeveloped reproductive organs. In case of bees workers differ from queens in being smaller, possessing wax glands, having a pollen collecting apparatus comprising pollen combs and a corbicula on each hind leg, in having a barbed and non-retractible sting. Workers do the jobs of building the hive, collection of food, producing wax, feeding the queen, drones and nursing the young ones.

Worker Jelly: A secreted material supplied by workers to larvae in regular brood cells that causes the larvae to develop into workers. Worker jelly has less sugar content as compared to royal jelly. Worker jelly also has low amounts of the hypopharyngeal gland material mixed with mandibular gland secretions and honey. After 3-days, hypopharyngeal secretions are withdrawn and then larvae are given 'bee bread' (honey mixed with pollen).

X

Xanthophyll: Yellow pigment of leaves which is sometimes absorbed by insects; it is present in the skin of caterpillars (cabbage butterfly) and in the silkworm cocoons.

Xanthopterin: A yellow pigment derived from the pteridine found in the bodies of wasps and in the wings of certain butterflies.

Xenobiosis: The relation in which colonies of one species live in the nests of another species and move freely among the hosts, obtaining food from them by regurgitation or

other means but still keeping their brood separate.

Xenology: The study of hosts in relation to the life history of parasites.

Xerophyte: Plant adapted for survival in desert or physiologically dry soil.

Xylem: A system of more or less continuous channels in plants, formed of fused dead cells, which transport water and soluble minerals from roots to leaves.

Xylophagy: Feeding on xylem tissues; wood-eating.

Y

Yellow Fever: An acute infectious disease caused by a virus transmitted by mosquitoes (*Aedes aegypti*), and is marked by fever, jaundice, albumin and globulin in the urine.

Yellow-Jacket: In the United States, any one of a number of ground-nesting, light-coloured wasps of the genus *Vespula* is known as yellow-jacket. Queens and workers have well-developed stinging organs and can inflict painful stings. These wasps construct nests

from the papery material that they produce by chewing wood fibres with saliva.

Yellows: A plant disease characterized by yellowing and stunting of the affected plant; caused by a fungus, virus or insect toxin.

Yield: Harvest; biological productivity; number of plants, fruits or weight of biomass produced in a given area of habitat; number of test insects or parasitoids reared in a given period of time.

Z

Zero Tolerance: As per law, no detectable amount of the pesticide may remain on the raw agricultural commodity when it is offered for shipment. Zero tolerances are no longer allowed.

Zonation: Stratification; layer or strata ; arrangement or distribution of plants and animals into distinct zones.

Zone: An area characterized by similar fauna; a belt or area to which certain species are limited.

Zoobenthon: The fauna of the sea bottom or of the bottom of inland waters.

Zooecidia: Plant galls induced by the insects, mites and nematodes as opposed to those formed by the plant's response to microorganisms. Organisms which induce such galls are known as **cecidozoa**.

Zoogeography: The study of animal distribution on the earth.

Zoology: The science dealing with the study of animals.

Zoonosis: Any of the disease in man acquired from one of the lower animals including invertebrates.

Zoophagous: Feeding on the living animals. Zoophagous insects may live as parasites on warm blooded animals (chewing and sucking lice); or may live as intermittent vertebrate parasites (mosquitoes); or may be entomophagous (ichneumon wasps). A few such as predaceous diving beetles, kill and eat small fish. Most of the zoophagous insects, however, kill and eat or parasitize other invertebrates, including insects.

Zoraptera: An insect order, representatives are commonly called angel insects. They are very small delicate insects, and look like small termites. Adults are dimorphic—blind, pale and wingless or darkly pigmented with eyes and two pairs of wings. Antennae are thread like, abdomen with a pair of short cerci. Metamorphosis is incomplete. Zorapterans are mainly found under tropical conditions and are associated with rotting wood.

Appendix - 1

Prefixes used as combining forms in compound words

Prefix	Meaning	Prefix	Meaning	
a-	Without, not	ante-	} before, in front of, forward	
ab-	away from	antero-		
abdo-	} abdominal	anthraco-	men (human being)	
abdomino-			arachno-	spider
acanth-	} a thorn, a spine	apo-	from, away from, off	
acantho-			archaeo-	} ancient
acr-	} sharp, sour, pungent	archeo-		
acid-			arthro-	joint
acryl-			aqui-	water
acro-	extremity	argenti-	silver	
actin-	} ray-shaped	auri-	gold	
actino-			auto-	self
acu-	} sharp, pointed like a needle	basi-	belonging to the base	
acute-		} twice, two	bi-	
acumin-			bis-	
acuti-		bio-	life	
ad-	towards	blast-	} a sprout, bud or a germ	
adeno-	glandular	blasto-		
adipi-	fat	bleph-	} eyelid	
aleuro-	flour	blepharo-		
amb-	} both, or both sides	bothrio-	a pit, a depression, a trench	
ambi-			brachio-	arm
amphi-	on both sides, around	brachy-	} short	
amylo-	starch	brevi-		
an-	not, without	calci-	lime	
ana-	up, back up; also against	capit-	a head (e.g., capitate)	
andro-	male	cardio-	heart	
angi-	vessel (blood)	carni-	flesh	
aniso-	unequal	carpo-	wrist	
ant-	} against, counteracting	caseo-	cheese	
anti-			cata-	down
		ceno-	new	

Prefix	Meaning	Prefix	Meaning
centi-	a hundredth	cyto-	cell
cephal-	head	dactyl-	finger
cer- } ceri- }	wax	de-	away, from, reversing
cerebro-	brain	deci-	tenth
cervico	cervix	demi-	half
chaet- } chaeto- }	a hair, a bristle	dent-	tooth
chalco-	bronze	derma- } dermat- }	skin
cheir-	hand	dextro-	to the right
chel- } cheli- }	a claw	dip-	double
chemo-	chemical	dis-	separation, against
chilo-	lip	dorso-	dorsal
chrom- } chromat- } chromato- } chromo- }	colour	dys-	abnormal
cirri- } cirro- } cirrus- }	a curl, a tuft of hair	ecto-	outside, without external
clav-	a club	em-	in
citro-	lemon	en- } end- } endo- }	in, into, within
co- } col- } com- } con- }	together	ent-	within
coleo-	sheath	entero-	intestine
collo-	glue	entomo-	an insect
condyl-	a knuckle	epi-	on, above, upon
contra-	against	erio-	wool
corneo-	horn	ery- } erythro- }	red
crani- } cranio- }	skull	eu-	well, normal
creti-	chalk	eury-	broad, wide
cry- } cryo- }	frost, ice	ex- } exo- }	away from, out, out of
crypt-	hidden	extra-	outside
cten- } cteno- }	a comb	farini-	flour, meal
cupro-	copper	fa-	a honey comb
cysto-	bladder	ferri- } ferro- }	iron
		flagell-	a whip
		flav-	yellow
		fore-	before, in front of
		fructi-	fruit
		fronto-	forehead

Prefix	Meaning	Prefix	Meaning
gala-	milk	iso-	equal
galli-	cock	karyo-	nucleus
galacto-	milk	kerato-	horn, skin, cornea
gastro-	stomach	kypho-	rounded, humped
genicul-	a knee	lact-	milk
genito-	genitals, reproductive	lani-	wool
ge- } geo- }	earth	lepto-	thin, soft
glio-	glue	leuco- } leuko- }	white
glosso-	tongue	ligni-	wood
glyco-	sugar	lipo-	fat
gnatho-	jaw	litho-	stone
gyr- } gyro- }	to rotate, a ring	lympho-	lymphatic, water
haema- } haemato- } haemo- }	blood	macro-	large
halo-	salt	mal-	abnormal, poor
hemi-	half	medi-	middle
hepa- } hepatico- } hepato- }	liver	mega-	large
hetero-	dissimilarity, unlikeness	melano-	pigment, dark
hexa-	six	melli-	honey
histo-	tissue	meso-	middle
homeo-	like	meta-	between, after, beyond
homo-	same	micro-	small
hyalo-	glass	milli-	a thousandth
hydro-	water	mio-	smaller
hygro-	moisture	molybido-	lead
hyper-	above, excessive, over	mono-	one, single
hypo-	below, under	muco-	mucus
idio-	peculiar to the individual	multi-	many
ileo- } ilia- }	ileum	myc-	fungus
in-	not, in, into, within	myo-	muscle
infra-	below	neo-	new
inter-	between	nephro-	kidney
intra-	within	neuro-	nerve
intro-	inward	noct-	night
		nucleo-	nucleus
		oculo-	eye
		odonto-	tooth
		oleo-	oil
		oligo-	deficiency, diminution
		onycho-	tail

Prefix	Meaning	Prefix	Meaning
oo-	egg, ovum	sclero-	hard
opistho-	backward, behind	sebo-	fat
oro-	mouth	semi-	half
ortho-	straight	seri-	whey, silk
oto-	ear	sero-	serum
ovari-	ovary	socio-	sociology
pachy-	thick	steato-	fat
pan-	all	sterno-	sternum
para-	beside, alongside of	suctori-	sweet
patho-	disease	sub-	below, less than, under
ped-	foot	sudori-	sweat
penta- } pento- }	five	super- } supera- }	above, upper
per-	by, through	syn-	together, with, union
peri-	around	tachy-	with
pharyngo-	pharynx	tarso-	foot
phono-	voice	tetra-	four
photo-	light	thermo-	heat
pleuro-	pleura	thio-	sulphur
pluri-	many	thoraco-	thorax
pneumo-	lung	thrombo-	blood clot
podo-	foot	tibio-	tibia
poly-	many, much	tox-	poison
post-	after	Prefix	Meaning
pre- } pro- }	before, in front of	tracheo-	trachea
proct-	anus	trans-	across, through
proto-	first	tri-	three
pseudo-	false	trich-	hair
quadri-	four	tropho-	nourishment
re-	again, back	tyro-	cheese
ren-	kidney	ultra-	beyond
retro-	backward	uni-	one
rhin-	nose	vaso-	vessel
sacchar-	sugar	veno-	vein
sanguini-	blood	xanth-	yellow
sapro-	dead, decaying	xero-	dry
sarco-	flesh	xylo-	wood

Appendix - 2

Suffixes used as combining forms in compound words

Suffix	Meaning	Suffix	Meaning
-able	capable of	-eous	of the nature of, like
-acea	a suffix used in forming the names of some orders and classes of animals	-fid	split into
-aceae	a suffix used in forming names of many family names	-fuge	expelling
-aemia	blood	-genesis } -genetic }	formation, origin
-arium	a place for or container of (e.g., formicarium)	-genic	capable of causing
-al } -an }	pertaining to, belonging to, characterized by	-gerous	bearing, producing
-ary	place	-glea } -gloea }	glue
-ase	catalyst, enzyme, ferment	-gogue	increasing flow
-blast	cell	-gram	a tracing
-bola	from greek bole, bolos meaning a throw (e.g., Metabola)	-graph } -graphy }	a drawing or writing
-cele	tumour	-gynous	a female
-cene	recent	-iasis	condition of, state
-ceptor	a receiver particularly of sensations (e.g., chemoreceptors)	-itis	inflammation of
-cide	destructive, killing	-kinesis	motion
-clae	a small branch of a plate	-logy	science of, study of
-coccus	spherical cell	-lysis	breaking down, disintegration
-cule	little	-malacia	softening
-cyte } -cyto }	cell, a hollow vessel	-megaly	enlargement
-derm	skin	-meter	measure
-desis	bind together	-ogen	precursor
-ectasis	dilation, extension	-oid	likeness, resemblance
-ectomy	removal of	-ology	the study of
		-oma	tumour
		-opia	eye
		-ose	sugar
		-osis	condition, disease, excess
		-otomy	incision of
		-ous	like

Prefix	Meaning	Prefix	Meaning
-pathy	disease	-scope	instrument for visual examination
-ped } -pede }	cell, a hollow vessel	-scopy	to examine visually
-penia	lack of	-somatic	pertaining to the body
-phage	ingesting	-somy	pertaining to chromosomes
-phagia	swallowing	-sonic	sound
-philia	affinity for, loving	-stasis	stagnation, cessation of movement
-phobia	fear	-stomy	to form an opening or outlet
-phragm	a partition	-taxia } -taxis } -taxy }	arrangement, coordination, order
-phylaxis	protection	-thanasia	death
-plasm	similar form	-tome	cutting instrument
-pnoea	breathing	-tomy	incision of
-pod } -poda } -podial }	a foot	-trophy	nourishment
-pter } -ptera } -pterous } -ptero }	a wing, a winged creature	-ura } -urous }	a tail
-rhage	to burst forth	-vore } -vorous }	eating
-rhaphy	suturing	-zoid } -zoon }	an animal
-rhoea	excessive discharge		

Appendix - 3

Technical terms based on colours

Term	Meaning	Term	Meaning
Achromatic	Free from colour	Cupreous	Metallic copper-red
Aeneous	Golden-green colour	Ebonine	Black like ebony
Albidus	White with dusky tinge	Erythrine	Deep brick-red
Alutaceous	Somewhat pale leather brown	Ferrugi- Ferrugin- Ferruginaceous	} Iron red, rusty reddish brown
Amber	A transparent, clear, pale, yellowish-brown colour	Flammate	
Anthracine	Coal black; a deep shining black with a bluish tinge	Flavescent	Somewhat yellow
Aquamarine	Sea green	Flavus	Pure, clear yellow
Argenate	Shinning, silvery white	Fuliginous	Sooty or smoky-brown
Ater	Pure, intense black	Fumous	Smoke-like
Atrocerulus	Deep blue black	Fuscous	Dark-brown
Atropurpureus	Dark purplish, nearly black	Term	Meaning
Aurantius	Orange colour	Griseous	Light-grey
Brunneus	A pure reddish, dark brown	Helvolous	Dull reddish-brown, tawny
Caerulascent	Sky blue	Helvous	Yellow like honey
Carminate	Mixed or tinged with red	Hyaline	Almost transparent, glassy
Carmine	A red colour	Ignitus	Fire red
Castaneus	Chest-nut brown, bright red-brown	Incanus	White with a little admixture of black
Chalceous	Brassy in colour	Infuscated	Smoky grey-brown with a blackish tinge
Cinctus	With a coloured band	Iridescent	Reflecting colours of the rainbow
Cinereous	Grey tinged with black	Lactus	Extremely white colour
Cinnabarine	Colour like red oxide of mercury	Ligneous	Wood-brown
Citrine	Lemon yellow	Luteo	Of an orange-yellow colour
Cretaceous	Chalky white	Magenta	A brilliant dark red with purplish tinge
Coccineous	Cochineal red		

Prefix	Meaning	Prefix	Meaning
Mahogany	Tawny to deep red	Picious	Pitchy black
Nebulo	Dusky shading	Purpureal	Purple colour
Nigr- } Nigro- }	Black	Rufescent	Nearly red in colour
Nitidus	Shining and glossy	Sienna	Brownish-orange colour
Niveous	Snow-white colour	Slaty	Blackish-grey with a reddish tinge
Term	Meaning	Smaragdine	Brilliant crystalline green like that of emerald
Ochraceous	Yellow with a little tinge of brown	Sordido	Dirty
Olivaceous	Olive-green colour	Tephro	Ash, grey
Opalescent	Having a bluish-white lustre	Testaceous	Brownish-yellow colour
Opaque	Not transparent	Umber	Dark brown colour fixed with yellow
Pallidus	Pale or thick pale	Umbresus	Shaded or clouded
Phaco	Dusky		

Appendix - 4

Technical terms based on shape

Term	Meaning	Term	Meaning
Accrescent	Gradually widening towards apex	Geniculate	Elbowed, abruptly bent
Angulate	Forming an angle	Gibbose	Hunch-backed
Annulate	Divided into rings	Globate	Rounded, spherical
Attenuate	Gradually tapering towards apex	Hamatus	Provided with hooks
Baculiform	Rod-like	Hirsutus	When clothed with long strong hairs
Bifasciate	Having two bands	Inclinate	Bent or directed towards the median line
Bifid	Divided into two parts	Inflexed	Bent forward at an angle
Bimaculate	Having two spots	Innotate	Lacking markings
Blotch	Irregular spot or mark	Invaginate	Inwardly turned
Bulbous	Swollen in the form of a bulb	Labilate	With lip-like structure
Campanulate	Bell-shaped	Laevigatus	Smooth, shinning
Cateniform	Chain-like	Lamellate	Leaf-like
Convolute	Twisted spirally	Lenceolate	Spear-shaped
Crenulated	Evenly rounded	Lenticulate	Lens-shaped
Cruciate	Cross-like	Linear	Like a straight line
Cuneate	Elongate triangular	Marginate	Having elevated or attenuated margin
Decumbent	Bending downward	Matted	Tufted
Dentate	Toothed	Mesad	Living towards or in the direction of median line
Digitate	With finger-like projections	Moniliform	Like string of beads
Elliptical	Oblong-oval	Notate	Having a series of depressed marks as sculpture
Emarginate	Notched	Oblong	Longer than broad
Falcate	Sickle-shaped	Obtuse	Not pointed, opposite of acute
Falciform	Curved like a sickle		
Filamentous	Thread-like		
Furcate	Forked		
Fusiform	Spindle-shaped		

Term	Meaning	Term	Meaning
Ovoid	Egg-like	Scabrous	Rough, rugged
Papillate	Surface with small elevations	Scaphiform	Boat-like
Pectinate	Having branches like a comb	Sculptured	Marked with elevation or depressions or both
Pedunculate	Having a stalk	Serrate	Saw-like
Pellucid	Transparent	Serrulate	Finely serrated
Peltate	Shield-like	Setaceous	Slender, bristle-like
Pennaceous	Like feather	Setiform	Seta-shaped, bristle shaped
Pilose	Covered with soft short hair	Setigerous	Bearing a spine, seta or bristle
Pinnate	Feather-like	Shield	A broad plate for protection
Platyform	A flat part	Sinuate	Wavy
Plicate	Having folds	Spinuous	Undulating, S-shaped
Plumose	Feathery, having a plume	Spatulate	Sword-shaped
Porrect	Placed forward horizontally	Spinose	With spines
Proclinate	Inclined or directed forward	Spongy	Soft and porous like a sponge
Pubescent	Clothed with soft, short, fine closely set hairs	Sulcate	Having grooves or furrows
Punctate	Marked with punctures or minute pits or depressions	Tomentose	Covered with wooly or scale-like hairs
Punctiform	Shaped like a point or dot	Translucent	Semi-transparent
Pyriiform	Pear-shaped	Truncate	Squarely cut-off at the apex
Reclinate	Directed backward	Tuberculate	Provided with tubercles
Remiform	Oar-like in appearance	Tubulous	Tube-like
Reniform	Kidney-shaped	Uncinate	Hooked
Reticulate	Capable of being produced and drawn backwards	Varicosus	Swollen irregularly
Rotundate	Rounded, circular	Vesiculate	Bladder-like with swollen appearance
Rugose	Wrinkled	Vitreous	Transparent, glassy appearance
Runcinate	Notched	Vittatus	With stripes
Sacciform	Pouch-like		

Appendix - 5

Combining forms arranged by contrasting pairs,
greek words precede the semicolon, latin words follow it

A. Size and Shape

Big	mega-, megalo-,makro-; magni-; grandi-
Little	micro-; parvi-
Long	macro-; dolicho-; longi-
Short	brachy-; brevi-
Wide	eury-; plati-; lati-
Narrow	Steno-; angusti-
Oblique	loxo-; obliquo-
Crooked	kypho-
Twisted	strepto-; strobo-; spiro-; spiral-; torti-
Light	elaphro-; levi-
Heavy	bary-; gravi-
Straight	euthy-; ortho-; recti-
Curved	scolio-;campto-; curvi-; falci-
Round	cyclo-; gyro-; circuli
Square	quadrati; rectanguli-
Thick	pachy-; pycno-; steato-; crossi-
Thin	lepto-; tenui-
B. Touch	
Hard	sclero-; scripho-; duri-
Soft	malaco-; molli-
Wet	hygro-, hydro-; humidi-
Dry	xero-; sicci-
Sharp	oxy-; acri-
Dull	ambly-; hebeti-

Cold	cryo-; psychro-; frigidi-
Hot	thermo-; calidi-
Smooth	leio-; lio-; levi-
Rough	trachy-; aspri-
Solid	stereo-; solidi-
Perforated	ethmo-; amini-

C. Direction

Front	proso-; proto-; fron-; tali-
Back	opistho-; noto-; dorsali-
Top	hyper-; summi-
Middle	meso-; medio-
Bottom	hypo-; imi-; infimi-

D. Miscellaneous

Many	poly-; multi-
Few	oligo-; pauci-
New	neo-; ceno-; novi-
Old	paleo-; archeo-; veteri-; seni-
Early	eo-; proi-; mature-
Late	opsi-; seri-; tardi-
Strong	stheno-; validi-; potenti-
Weak	astheno-; infermi-; aegri-
Visible	phanero-; pheno-; conspicui-
Hidden	crypto-; calypto-; operti-
Covered	calypto-; tecti-
Uncovered	gymo-; nudi-
Same	tauto-; identi-
Alike	homo-; homeo-; simili-

Right	dexio-; dextri-	Fast	tachy-; rapidi-
Left	scaeo-; levi-; sinistri-	Slow	brady-; tardi-; lenti-
High	hypso-; acro-; alti-	Full	plethyo-; pleni-; sati-
Low	bathy-; cato-; humili-	Empty	ceno-; coelo-; vacuo
Near	engy-; proximi-	Entirely	holo-; toti-
Far	teleo-; teleuto-; ab-	Partly	mero-; parti-
Equal	iso-; equi-	One's own	idio-; proprio-; sui-
Different	hetero-; allo-; vario-	Another's	allo-; alieni-
Good	eu-; kalo-; kallo-; boni-	Sweet	glyco-; dulci-
Bad	dys-; caco-; malli-	Bitter	picro-; amari-
True	ortho-; eu-; veri-		
False	pseudo-; falsi-; spurio-		

Appendix - 6

Common Numerical combining forms as found in scientific terminology

	Cardinals*		Ordinals**	
	Gk ⁺	Lat. ⁺	Gk ⁺	Lat. ⁺
½	hemi-	semi-	–	–
1	–	uni-	proto-	primi
1½	–	sesqui-	–	–
2	dyo (di-, dis-)		duo-(bi-, bis-)deutero-	secundi-
3	tri-	tri-	trito-	terti-
4	tetra-, tessaro		quadri- tetarto-	quarti-
5	penta-	quinque-	pempto-	quinti-
6	hex-, hexa-	sex-	(not comm- only used beyond 5)	sexti-
7	hepta-	septem-	–	septimi-
8	Octo-	octo-	–	octavi-
9	ennea-	novem-	–	noni-
10	deca-	decem-	–	decimi-
12	dodeca-	duodecim-	–	duodecimi-
100	hecatonte-	centi-	–	centimi-
1000	chilio-	milli-	–	–
10000	myri-, myraid- (usually used for any large or countless number).			

* Cardinal : Means a number, such as 1,2 and 3, used to show quantity rather than order.

** Ordinal : Means a number that refers to the position of 5th in a series, for example ‘first’, second, etc.

+ Abbreviations Gk and Lat. stands for Greek and Latin respectively.

Appendix - 7

Singular/plural terminology as used in relation to insects

Singular	Plural	Singular	Plural
Aculea	Aculeus	Empodium	Empodia
Alula	Alulae	Epimeron	Epimera
Ampulla	Ampullae	Epiphysis	Epiphyses
Antenna	Antennae	Episternum	Episterna
Apophysis	Apophyses	Euplantula	Euplantulae
Arolium	Arolia	Eusternum	Eusterna
Atrium	Atria	Femur	Femora
Basalare	Basalaria	Flabellum	Flabulla
Caecum	Caeca	Flagellum	Flagella
Calcar	Calcariae	Foveolae	Foveola
Calypter	Calypteres	Fundatrix	Fundatrices
Calyx	Calyces	Gallicola	Gallicolae
Cardo	Cardines	Ganglion	Ganglia
Carina	Carinae	Gena	Genae
Caste	Castes	Genus	Genera
Cenchrus	Cenchri	Glossa	Glossae
Cercus	Cerci	Gonapophysis	Gonapophyses
Chaetosema	Chaetostemata	Haltere	Halteres
Chelicera	Chelicerae	Hamulus	Hamuli
Chrysalis	Chrysalides	Hemelytron	Hemelytra
Corbicula	Corbiculae	Hypopleuron	Hypopleura
Corniculi	Corniculus	Imago	Imagines or Imagos
Corpora allata	Corpora allatum	Jugum	Juga
Corpora	Corpora	Kinesis	Kineses
Cardiaca	Cardiacum	Labellum	Labella
Coxa	Coxae	Labium	Labial
Ctenidium	Ctenidia	Lacinia	Laciniae
Diverticulum	Diverticula	Lamella	Lamellae
Ecdysis	Ecdyses	Larva	Larvae
Elytron	Elytra	Lorum	Lora

Singular	Plural	Singular	Plural
Macrotrichium	Macrotrichia	Sexupara	Sexuparae
Maxilla	Maxillae	Siphunculus	Siphunculi
Mycangium	Mycangia	Spermatheca	Spermathecae
Nasute	Nasuti	Spermatozoon	Spermatozoa
Nidus	Nidi	Stadium	Stadia
Notum	Nota	Stemma	Stemmata
Nygma	Nygmata	Sternum	Sterna
Ocellus	Ocelli	Stigmata	Stigma
Ommatidium	Ommatidia	Stipes	Stipites
Ootheca	Oothecae	Stylus	styli
Osmetrium	Osmetria	Subalare	Subalaria
Ostium	Ostia	Sulcus	Sulci
Ovary	Ovaries	Superlingua	Superlinguae
Palp or Palpus	Palpi	Taenidium	Taenidi
Paraglossa	Paraglossae	Tagma	Tagmata
Paranotum	Paranota	Tarsus	Tarsi
Patagium	Patagia	Taxis	Taxes
Penis	Penes	Taxon	Taxa
Phragma	Phragmata	Tegmen	Tegmina
Phylum	Phyla	Tegula	Tegulae
Pleuron	Pleura	Tergum	Terga
Pretarsus	Pretarsi	Testis	Testes
Pseudotrachea	Pseudotracheae	Tibia	Tibiae
Pulvillus	Pulvilli	Tracheae	Trachea
Pupa	Pupae	Tympanum	Tympana
Radicola	Radicolae	Unguis	Ungues
Scopula	Scopulae	Urogomphus	Urogomphi
Sensillum	Sesilla	Vas deferens	Vasa deferentia
Seta	setae	Vas efferens	Vasa efferentia

Appendix - 8

Colour spectrum and their meanings in Greek and Latin, meaning given are those of the basic colour but not of exact shades)

Colour spectrum	Greek	Latin
Red	coccinio- 'scarlet' erythro-	purpureo- rubri- rufi- rutuli-
	rhodo- 'rose' eo- 'dawn'	rossi- 'rose red' roseo- 'rose' flammeo- 'flame colored'
Orange	chryso- 'gold' cirrho-	aureo- 'gold' fulvi- reddish yellow
Yellow	xantho- ochreo- 'pale'	fusci- 'tawny, dark' luteo- 'yellow nud'
Green	chloro-	prasini- 'grass' viridi-
Blue	cyano- 'dark' iodo-	ceruleo- 'sky' violaceo
Violet	porphyro-	puniceo- purpureo-
White	leuko-	albo- argenti- 'silver'
Grey	polio- glauco- 'grey-green' amauro- 'dark'	cani- cinereo 'ash'
Black	melano-	nigri-, atri-

Appendix - 9

**Greek and Latin names for common insects and other arthropods
(These words are given in Latin or in Greek transliteration,
combining forms are given if the spelling has been altered by
transliteration)**

Term	Meaning	Term	Meaning
Arachne	Gk spider	Pedis	Lat. louse
Bembico- Bombyx	Gk buzzing insect	Psylla	Gk flea
Cancer, cancri-	Lat. crab	Scorpio (Gk Skorpios)	Lat. Scorpion
Cicada	Lat. cricket	Skolex, Scoleco-	Gk work
Cochlea (Gk Kochlia)	Lat. mollusk	Sphex, Spheci-	Gk wasp
Formica	Lat. ant	Termes, termiti-	Lat. woodworm
Kampe	Gk caterpillar	Tettix, Tettigo-	Gk grasshoppers
Musca	Lat. fly	Tinea	Lat. moth
Myia	Gk fly	Vermis	Lat. worm
Myrmex, Myrmico-	Gk ant	Vespa	Lat. wasp
Papilio Papilioni-	Lat. butterfly		

Appendix - 10

**Greek and Latin meaning of terms regarding different
directions of the compass**

Spectrum	Greek	Latin
North	Arcto-, hyerboreo-	Aquiloni-, boreali-, septentrionali-
East	Anatoli-	Euro-, orientali-
South	Noto-	Australi-, meridionali-
West	Hesperido-, Zephyro-	Favoni-, occidentali-

Appendix - 11

Conversion Factors

			Multiply By
I. Non Metric to Metric			
A. Length			
Inches	→	Millimetres	25.4
Inches	→	Centimetres	2.54
Feet	→	Metres	0.3048
Yards	→	Metres	0.9144
Statute miles	→	Kilometres	1.6093
Nautical miles	→	Kilometres	1.852
B. Area			
Square inches	→	Square centimetres	6.4516
Square feet	→	Square metres	0.0929
Square yards	→	Square metres	0.8361
Acres	→	Hectares	0.4047
Squares miles	→	Square kilometres	2.5899
C. Volume			
Cubic inches	→	Cubic centimetres	16.3871
Cubic feet	→	Cubic metres	0.0283
Cubic yards	→	Cubic metres	0.7646
D. Capacity			
UK fluid ounces	→	Litres	0.0284
US fluid ounces	→	Litres	0.0296
UK pints	→	Litres	0.5682
US pints	→	Litres	0.4732
UK gallons	→	Litres	4.546
US gallons	→	Litres	3.7854
E. Weight			
Ounces (avoirdupois)	→	Grams	28.3495
Ounces (troy)	→	Grams	31.1035
Pounds	→	Kilograms	0.4536
Tons (long)	→	Tonnes	1.016

II. Metric to Non-Metric

A. Length

Millimetres	→	Inches	0.0394
Centimetres	→	Inches	0.3937
Metres	→	Feet	3.2806
Metres	→	Yards	1.9036
Kilometres	→	Statute miles	0.6214
Kilometres	→	Nautical miles	0.54

B. Area

Square centimetres	→	Square inches	0.155
Square metres	→	Square feet	10.764
Square metres	→	Square yards	1.196
Hectares	→	Acres	2.471
Square kilometres	→	Square miles	0.386

C. Volume

Cubic centimetres	→	Cubic inches	0.061
Cubic metres	→	Cubic feet	35.315
Cubic metres	→	Cubic yards	1.308

D. Capacity

Litres	→	UK fluid ounces	35.1961
Litres	→	US fluid ounces	33.8150
Litres	→	UK pints	1.7598
Litres	→	US pints	2.1134
Litres	→	UK gallons	0.2199
Litres	→	US gallons	0.2642

E. Weight

Grams	→	Ounces (avoirdupois)	0.0353
Grams	→	Ounces (troy)	0.0322
Kilograms	→	Pounds	2.2046
Tonnes	→	Tons (long)	0.9842

III. Temperature Conversion

To convert	To	Formulae
°Fahrenheit	°Celsius	$\frac{^{\circ}\text{F} - 32}{9} \times 5$
°Celsius	°Fahrenheit	$\frac{^{\circ}\text{C} \times 9}{32} + 32$

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