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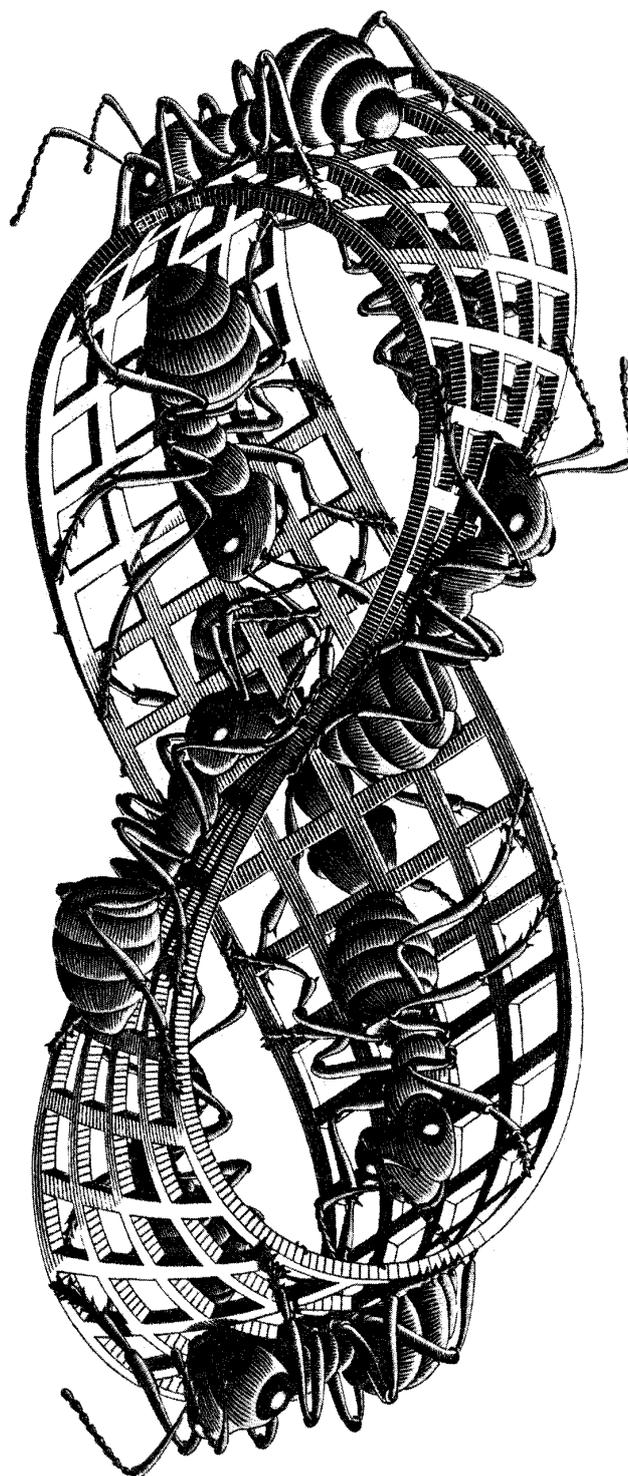
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## Glossary

**Bold** within the text of an entry indicates a cross-reference to another headword. The following abbreviations are used for:

- pl.** plural of a term
- sing.** singular of a term
- adj.** adjective
- lat.** Latin

**abdomen** Third major division of an insect body (fig. 2-1)

**abiotic** Inanimate environmental factors such as climate, temperature, etc., that do not derive directly from the presence of other organisms; see **biotic**

**abundance** (= **population density**) Number of individuals of a species in a particular area

**Acari** (= **Acarina**) Mites, ticks; order of the class **Arachnida**

**acaricide** Any agent suitable for the control or eradication of mites and ticks

**accessory gland** Gland subsidiary to a major one; more specifically, a gland opening into the genital chamber

**acaetylcholine** A **neurotransmitter** of many interneural, neuromuscular and other cholinergic effector **synapses**, relays an electrical signal in chemical form, with transduction back to the electrical signal at the postsynaptic membrane

**activation** In embryology, the commencement of **embryonic** development within the egg

**activator** In applied entomology, any chemical added to a pesticide to increase its toxicity

**active constituent** See **active ingredient**

**active ingredient** (**a.i.**) Actual toxic agent present in pesticide **formulations**

**aculeate** Non-parasitic, phytophagous Hymenoptera

**aculei** Minute, hair-like outgrowths or **microtrichia** of the cuticle covering the wings and other structures beneath the scales of primitive moths

**acute poisoning** Poisoning which occurs when a large amount of a pesticide is incorporated in a single go; the effect of the poisoning is seen quickly; see **chronic poisoning**

**additive** See **adjuvant**

**adecticous pupa** Pupa without articulated **mandibles** (fig. 2-43)

**adenotrophic viviparity** Viviparity (producing living offspring) in which there is no free-living larval stage; eggs develop within the female uterus, nourished by special milk glands until the larvae mature, at which stage they are laid and immediately pupate; occurring in some Diptera

**adfrontal area** Area between the adfrontal **sutures** and the **ecdysial lines** on the larval head

**adhesive** In applied entomology, any material added to increase pesticide retention; different commercial preparations of methyl cellulose are used for this purpose

**adjuvant** Spray additive to improve either physical or chemical properties of a pesticide; see also **adhesive**, **emulsifier**, **sticker**, **supplement**, **wetter**

**aedeagus** Sclerotized tube in male moths through which the **vesica** or penis passes

**aerosol** Suspension of solid or liquid particles in air with droplets smaller than 50  $\mu\text{m}$

**aestivation** Dormancy during hot or dry season

**aetiology** Science and study of the factors causing disease

**age-grading** Determination of the physiological age of an insect

**agitator** Mechanical device in the spray tank to ensure uniform distribution of toxicant and to prevent sedimentation

**air-sac** Thin-walled dilated sections of the **tracheae**

**akinesis** State of immobility due to lack of **stimuli**

**alary muscles** (= **aliform muscles**) Paired muscles that support the heart (fig. 2-24)

**alate** Possessing wings; in the context of termites, winged **reproductives**

**aliform muscles** See **alary muscles**

**alimentary channel** Digestive tract (fig. 2-23)

**alinotum** (pl. **alinota**) Wing-bearing plate on the **dorsum** of the **meso-** or **metathorax**

**alitrunk** Fused thorax and first abdominal segment (**propodeum**) of adult ants (fig. 5-59)

**alkaloids** Group of nitrogen-containing chemicals found in plants, many with important toxic properties and/or pharmacological actions

**allelochemicals** Volatile messengers for communication between individuals of different species; see **kairomone**, **allomone**, **pheromone** and **synomone**

**allomone** Communication chemical that benefits the producer by the effect it invokes in the receiver; see **allelochemicals**

**allopatric** Non-overlapping geographic distribution of organisms or **taxa**; see **sympatric**

**alternate host** The other species of plant that is necessary for the completion of the life cycle of some insects and plant-disease producing organisms

**alternative host** Organism which acts as one of several **hosts** to a **pest** or **pathogen**

**altruism** Behaviour costly to an individual but beneficial to others

**Ametabola** (adj. **ametabolous**) Insects without metamorphosis

**ametabolous development** Development of primitive, wingless insects without **metamorphosis**; there are no marked changes in body form between the immature and adult insects; during their development the insects undergo more than 10 moults and continue to moult after sexual maturity

**amplexiform** Type of wing-coupling mechanism in which an enlarged **humeral** area of the hind wing is broadly overlapped by the forewing

**ampulla** Sclerotized structure on the inner face of the **valva** in certain male moths

**anabolism** See **metabolism**

**anal** In the direction or position of the **anus**, near the anus or on the last abdominal segment

- anal area** The posterior part of the wings, supported by the anal vein(s) (fig. 2-1)
- anal fan** See **vannus**
- anal fold (=vannal fold)** Distinctive fold in the **anal area** of the wing
- anal hooks** Hooked or clubbed **setae** at the posterior end of the pupa, used to attach the pupa to the cocoon or a pad of silk
- anal shield** Sclerotized middorsal plate on abdominal segment 10 of the larva
- anal tube** Membranous posterior end of the intestinal tract
- anal veins** One of three wing veins (IA to 3A) situated posterior of the **cubitus** or **cubital vein** (fig. 2-21)
- analogues** Series of organic compounds similar in function but not identical in structure to the original compound
- analogy** (adj. analogous) Functional similarity of a structure of two or more organisms without common evolutionary origin, eg. the wings of insects and birds or bats; opposite to **homology**
- anatomy** Science of the structure of animal bodies; study of their structures by separation into parts
- anemophily** Pollination by wind
- Annelida** Animal phylum of segmented worms eg. earth worms
- anoxia** (adj. anoxic) Oxygen deficiency in tissues
- antagonist** (adj. antagonistic) (1) Organism interfering or inhibiting growth or presence of another; (2) chemical such as a drug, hormone, etc. producing opposite physiological effects; (3) muscles producing opposite movements so that contraction of one must be accompanied by relaxation of the other; opposite **synergist**
- anteclypeus** Transverse **sclerite** on the anterior border of the **frontoclypeus** in the larva, with which the **labrum** articulates
- antenna** (pl. antennae) Paired, segmented sensory appendages on an insect's head; commonly called 'feelers'
- antennomere** Subdivision of the antenna (fig. 2-2)
- anterior** Situated at or towards the front
- anthropogenic** Caused by humans
- anthropophilic** Associated with humans
- antibiosis** (adj. antibiotic) Property of an organism that adversely affects the well-being of another organism that consumes it
- antidote** Medicine that is given to cancel out the effect of a poison
- antifeedant (=deterrent)** Chemical of bitter taste or unpleasant scent disliked by some insects
- antixenosis** In plant resistance, unsuitability of a plant to a feeding insect
- anus** Posterior opening of the digestive tract (fig. 2-22)
- aorta** Major blood vessel carrying blood away from the heart; in insects, the vessel that carries **haemolymph** from the heart to the head region (fig. 2-24)
- aperture** Opening, hole
- apex** Tip of the wing (fig. 2-21) or other structure
- aphids** Plant lice (Hemiptera: Aphididae)
- aphrodisiac** (adj. aphrodisiac) Substance produced by either sex that facilitates courtship or prepares the opposite sex for **copulation** after the pair has been brought together
- apical** Area at or adjacent to the tip of the wing or other structure (fig. 2-2)
- Apocrita** Sawflies, one of the two Hymenoptera suborders
- apod larva** A larva without legs (fig. 2-42)
- apode** (adj. apodous, apodal, apod) An organism without legs
- apodeme** Enfolded or rod-like projection of the integument to which muscles are attached
- apodous** Without legs
- apolysis** Separation of the new **epidermis** from the old **cuticle** in preparation for **ecdysis**
- apophysis** (pl. apophyses) Rod-like **apodemes** to which the muscles operating the female genital organs are attached
- aposematic coloration** Warning coloration; usually refers to the bright, often contrasting colours of distasteful or toxic species, but applies equally to alerting odours, audible signals or other similar features
- aposematism** Communication system based on warning signals
- appendage** Any structure attached to a part of the body of an organism
- appendicular ovipositor** True **ovipositor** formed from appendages of segments 8 and 9
- applied entomology (=economic entomology)** Study of both beneficial and injurious insects and related organisms like ticks, mites and spiders
- apterous** Wingless
- Apterygota** Wingless insect orders
- aqueous** Watery; made from or of water
- Arachnida** Class of spider-like animals like true spiders, harvestmen, scorpions, mites, ticks, etc.
- arachnophobia** Fear of spiders
- Araneae** Class of the **Arachnida**, the true spiders
- arboreal** Referring to a tree, situated on a tree; eg. a termite nest attached to a branch of a tree
- Archaeognatha** Bristletails
- arista** (pl. aristae) Large bristle located on the dorsal edge of the apical antennal segment in Diptera (fig. 2-5 I)
- aristate** Bearing a bristle
- aroliar pad** Pretarsal ventral adhesive pad (fig. 2-19)
- arolium** (pl. arolia) Central lobe between the claws at the tip of the **tarsus** in the adult (fig. 2-19)
- arthrodial membrane** Soft, stretchable **cuticle**, eg. between segments
- Arthropoda** Largest phylum in the animal kingdom, comprising thirteen classes, eg. insects, spider-like animals, crustaceans, centipedes, millipedes, trilobites
- Articulata** Group of segmented animals comprising **Arthropoda** and **Annelida**
- articulate** (adj. articulated) Connected by a joint, jointed, segmented

**asexual reproduction** Form of reproduction not involving two parents; often by means of **parthenogenesis**

**asynchronous muscle** Muscle that contracts many times per nerve impulse, as in many flight muscles and those controlling the cicada **tymbal**

**atrium** Chamber, especially inside a tubular conducting system, such as the **tracheal system**

**atomiser** Device for breaking up a liquid stream into fine droplets by a stream of air or centrifugal force

**attractant** In applied entomology, any material with an odour that attracts certain insects; lure

**auditory** Relating to the sense of hearing

**augmentation** Use of organisms for biological control by means of periodic **liberation** of organisms that are already present or that are less persistent but will be effective for some time after the release. Augmentation aims at an increase of the natural enemy's population to an effective level of control and can be achieved by **inoculation** and **inundative release**

**aurate** With ears or ear-like structures

**autecology** Ecology of individual species, as opposed to communities (**synecology**)

**autocide** Lethal substance produced within an organism which kills it. In applied entomology, the use of a pest causing its own destruction

**automimic** Condition of **Batesian mimicry** in which palatable members of a species are defended by their resemblance to members of the same species that are chemically unpalatable

**autotrophic organisms (=autotrophs)** Producers like green plants, algae, some bacteria, etc.

**autotomy** The shedding of appendage(s) notably for defence

**avoidance** Disease control measures which rely on crops being grown in localities or seasons where or when a pest or disease is not active

**bactericide** Any substance that destroys bacteria

**bait** Foodstuff used for attracting animals. In applied entomology, baits are usually mixed with a poison to form a **poison bait**

**basal** At or towards either the base or the main body, or closer to point of attachment (fig. 2-2)

**Batesian mimicry** Mimetic system in which a palatable species gains protection from predation by resembling an unpalatable species; see **Müllerian mimicry**

**benign** Of a kind disposition, not malign

**benthos** Bottom sediments of aquatic habitats and/or the organisms that live there

**bifid** Forked

**binatang** Neo-Melanesian Pidgin for certain insects

**binodal** Having two knots or knobs

**biocide** Substance capable of killing a wide range of unrelated organisms

**biological diversity (=biodiversity)** Variety of life forms comprising the different plants, animals and micro-organisms, their genes and the ecosystems of which they are part; species richness or species diversity

# BINATANG (BEEN-A-TONGUE)



Binatang (reproduced with permission from Browne, B.)

**biological control (=biocontrol)** Human use of selective living organisms or viruses to control populations of pest species (plants or animals)

**bioluminescence** Ability of particular organisms, eg. some fungi, algae, fish, fireflies, glow worms (Elateridae, Lampyridae), fungus gnats (Diptera), springtails (Collembola) and lantern bugs (Hemiptera) to display glowing light of different colours

**biomagnification** Progressive build-up of a pesticide residue in the bodies of organisms of a food chain

**biomass** Weight of all individuals of a group of organisms taken together; measurement frequently used in ecology

**biome** Major regional ecological complex of **communities** extending over large natural areas and characterised by distinctive vegetation and climate, eg. tropical rain forest

**biordinal** Of two alternating sizes; refers to **crochets** of the larval **prolegs**

**biotic** Animate features of the environment of organisms arising from the activities of other living organisms; as distinct from **abiotic**

**biotic potential** Potential for reproduction in an optimum environment without limiting factors; see **environmental resistance**, **reproductive potential**

**biserial** In two series, often concentric; refers to **crochets** of the larval **prolegs**

**bivoltine** Having two generations in one year

**black sooty mould** Black stains on leaves caused by particular fungi growing on sweet excretions (**honey-dew**) of aphids

**Blattodea** Cockroaches

**blotch mine** Discoloured patch or blister on a leaf caused by a minute insect larva mining or burrowing between the upper and lower epidermis; see **mine**

**boom sprayer** Horizontal or vertical light frame carrying several spray nozzles

**borers** Organisms that tunnel or bore into wood and other materials; termites, strictly speaking, are not borers

**brachypterous** Short-winged; wings not covering the abdomen

**brain** In insects, the **suboesophageal ganglion** of the **central nervous system** (fig. 2-27) comprising **protocerebrum**, deutocerebrum and tritocerebrum

**brood** Clutch of individuals that hatch at the same time from the eggs produced by one set of parents

**buai** Neo-Melanesian Pidgin for betel nut *Areca catechu*

**bursa copulatrix** Copulatory ducts and sac in adult female moths, comprising the **ostium bursae**, **ductus bursae** and **corpus bursae**

**bursa seminalis** Expansion or **diverticulum** of the **ductus seminalis** in which sperm is stored temporarily

**Bursicon** Neuropeptide hormone that controls hardening and darkening of the **cuticle** after **ecdysis**

**caecum** (pl. caeca) Blind-ending tube or sac

**Caelifera** Short-horned grasshoppers

**calamity** See **outbreak**

**callus** In insects, a swelling on the thorax of some flies, usually near the base of the wings; in botany, a superficial tissue developing in woody plants through cambial activity, in response to wounding, protecting the injured surface

**camouflage** Crypsis, in which an organism is indistinguishable from its background

**campodeiform larva** Larvae which, in their early stage at least, resemble dipteran Campodeidae; these larvae are predacious, **oligopod** and **prognathous** and lack abdominal appendages except cerci; many larval Coleoptera and Trichoptera have campodeiform larvae (fig. 5-33 D)

**cancerogen** See **carcinogen**

**canopy fogging** Method used to study insect diversity of the canopy of tropical rain forests. The method uses insecticides sprayed into the canopy (fogging) to kill insects that can be collected conveniently, when they fall from the canopy

**cannibalism** Act of preying on other members of the same species

**cantharophily** Pollination by beetles

**capitate** With head

**capitulum (=gnathosoma)** (pl. capitula) Head-like mouth-parts of ticks and mites

**caput** Head

**carbamates** Class of synthetic insecticides

**Carboniferous** Geological epoch, 360 to 285 million years before the present

**carcinogen** Any factor resulting in the transformation of a normal cell into a cancer cell; see **mutagen**

**cardo** Proximal part of the **maxillary** base (fig. 2-6)

**carina** Raised ridge, often on the wing covers of beetles

**carnivore** (adj. carnivorous) An eater of flesh of animals or materials of animal origin

**carrier** In applied entomology, any material serving as diluent and vehicle for the **active ingredient** of a pesticide; usually in dusts

**caste** Structurally and functionally specialised, distinct groups in **social insects**, usually differing in behaviour, eg. **reproductives**, **workers**, **soldiers**

**catabolism** See **metabolism**

**caterpillar** Worm-like, larval stage of moths and butterflies

**caudal** At or towards the anal (tail) end

**cathrema** A striated thickening at the base of the ductus ejaculatorius in Nepticulinae (Nepticulidae)

**cecidozoa** Gall-inducing animals

**cell of a wing** An area of the wing membrane partially or completely surrounded by **veins** (fig. 2-21)

**cement layer** Outermost layer of the **cuticle**, often absent

**central nervous system (CNS)** In insects, the central series of **ganglia** extending for the length of the body; see **brain**

**cephalothorax** Term indicating either fusion of, or indistinctness between, head and some or all anterior thoracic segments in crustaceans and arachnids

**cephalon** (adj. cephalic) Head

**cercus** (pl. cerci) Slender, paired and segmented appendages arising from the tenth abdominal segments of some insects (fig. 2-22)

**chaetosema** (pl. chaetosemata) Group of **setal**, usually divergent **sensilla** present on the head of butterflies and some moths

**chaetotaxy** Arrangement and system of naming larval and adult bristles or **setae** on the **exoskeleton**

**chalaza** A sclerotized, conical area of the larval integument, bearing a single plumose **seta** or up to three simple setae

**chela** (adj. chelate) Last joint of an arthropod limb, if it can be opposed to the joint preceding it, so that the appendage is adapted for grasping, as in pincers of lobsters and some Chelicerata; such a limb is termed chelate

**chelicerata** (adj. chelicerate) Paired, prehensile first appendages of **Chelicerata**, contrasting with antennae of other groups; often form **chela**

**Chelicerata** Subphylum of the **Arthropoda**, containing those animals with **chelicerata** like the spider-like animals **Arachnida** and Merostomata

**chemoreceptor** Sense organ responsive to chemical **stimuli** like taste and **olfaction**

**chemosterilant** Chemical used to render an insect sterile without killing it

**Chilopoda** Class of **Mandibulata**, the centipedes

**chitin** A rigid nitrogenous polysaccharide or proteoglycan found in many arthropod **exoskeletons** and hyphal walls of fungi

**chitin synthesis inhibitor** A class of insecticides that prevents chitin formation

- chlorocresol (4-chloro-m-cresol)** Crystalline chemical used to prevent mould attack on preserved insects
- cholinesterase** Enzyme in the blood essential for proper nerve function
- chorion** Egg-shell
- chromosome** (adj. chromosomal) Linear sequences of **genes** plus additional non-genetic sequences in which the genetic material is organised; composed of nucleic acid, commonly **DNA** and proteins
- chronic poisoning** Poisoning which occurs when small amounts of a pesticide are taken into the body over a long period of time.; the small doses eventually add up to enough poison to cause the symptoms of poisoning to appear; see **acute poisoning**
- chronic toxicity (=cumulative toxicity)** Capability of a pesticide to be injurious after repeated exposures
- chrysalis (=chrysalid)** (pl. chrysalides, chrysalids) Obtect pupa of butterflies and moths
- circadian rhythm** Repeated periodic behaviour with an interval of about 24 hours
- clade** Group of organisms proposed to be **monophyletic**, that is, all descendants of one common ancestor
- cladistics** Classification system in which **clades** are the only permissible groupings
- cladogram** Diagram illustrating the branching sequence of purported relationships of organisms, based on the distribution of shared features (fig. 5-11)
- claspers** Paired structure near the end of the abdomen in male insects which engages with the female **genitalia** during **copulation**
- classification** Any method organising and systematising the diversity of organisms, living and extinct, according to a set of rules
- clavate** Clubbed
- clavus** (pl. clavi, adj. claval) Area of the wing delimited by the claval furrow and the posterior margin
- claw** Hooked, usually paired, structure at the tip of the **pretarsus** (fig. 2-19)
- cleptoparasite** Parasite stealing prey from other parasites
- clone** (1) Group of organisms of identical genotype, produced by some kind of **asexual reproduction** and some sexual processes such as haploid selfing, or inbreeding a completely homozygous line; (2) group of cells descended from the same single parent cell
- clypeus** The part of the insect head to which the **labrum** is attached anteriorly (figs. 2-4, 2-6, 2-10, 2-12)
- cocoon** Protective silken covering which encloses the pupa of several endopterygote insect groups, usually spun by their larvae; also used for any kind of enclosure of immature stages eg. eggs, larvae or pupae
- cocoonase** Enzyme secreted by some advanced moths and used to soften or break down **cocoon** silk to allow the escape of the adult
- coevolution** Evolution of two or more species due to mutual influence. Ants for instance have coevolved with plants and other insects in ways that make the relationships more efficient and dependent
- Coleoptera** Beetles and weevils
- coleopteroid** Beetle-like
- Collembola** Springtails; one of the entognathous orders
- colliculum** Sclerotized plate or thickening near the posterior end of the **ductus bursae** in female **genitalia**
- colloidal formulation** Solution in which the particle size is less than 6 µm in diameter, and in which the particles stay dispersed
- colon** The hind gut between the **ileum** and the **rectum**
- colony** Group of individuals, other than a single mated pair, which constructs nests and rears offspring in a cooperative manner; see **social insects**
- commensalism** (lat.: eating at the same table) Two species in which one species profits from the association without harming or benefiting the other
- community** Term describing an assemblage of **populations** living in a prescribed area or physical **habitat**, inhabiting some common environment
- compatible** In applied entomology, term referring to chemical materials that can be mixed together without changing their effects adversely on pests or plants
- competition** Effect of a common demand by two or more organisms upon a limited supply of a resource, eg. food, water, light, minerals, mates, nesting sites, territory, etc. When **intraspecific** (species-specific), it is a major factor limiting population size or density; when **interspecific** (between species), it may result in local extinction of one or more competing species. Competition is an integral factor in Darwin's theory on the evolution of species
- complete metamorphosis** Metamorphosis in **holometabolous** insects which in general has four stages - egg, larva, pupa, adult - each entirely different from the others; see **gradual** and **incomplete metamorphosis**
- compound eye** Major visual sense organ of insects composed of one to some thousand individual sensory units (**ommatidia**) (fig. 2-30)
- compressed** Referring to insects that are flattened from side to side
- concentrate spraying** Direct application of an active ingredient without dilution
- conidiophore** see **conidium**
- conidium** Asexual spore of certain fungi, cut off externally at apex of specialised **hyphae** (**conidiophores**)
- conjunctiva** Membrane between segments, particularly of the abdomen
- conservation** The management, protection and preservation of the earth's natural resources and environment
- conspecific** Referring to individuals of the same species
- constriction** 'Waist' between first and second abdominal segment of ants, bees and apocritan wasps (fig. 5-59)
- consumers** Heterotrophic organisms feeding on plant material (**herbivores**), animal matter (**carnivores**) and decay, litter, carrion (**scavengers, decomposers**); see **food chain, materials triangle, trophic levels**
- contact poison** Chemical that kills when it contacts some external parts of a pest
- control** In applied entomology, prevention or reduction of losses from pests by any method; see **eradication**

- conventional insecticides** Chemical insecticides
- copulation** Sexual unity, mating
- coprophage** (adj. coprophagous) Feeder on animal dung
- coremata** Thin-walled eversible organs of male moths used for the dissemination of **pheromones**
- corethrogync** Specialised scales near the tip of the abdomen in some female moths, usually used to cover the egg-mass
- corium** Hardened, non-transparent basal portion of the forewings of true bugs (Heteroptera)
- cornea** Cuticle covering the eye or **ocellus** (fig. 2-30)
- cornicles** Paired tubes on the upper posterior end of the abdomen of aphids (Aphididae: Hemiptera) which secrete a waxy liquid
- cornutus** (pl. cornuti) A sclerotized spine or other process on the everted **vesica** of a male moth
- corpora allata** (sing. corpus allata) Paired **endocrine glands** associated with the **stomodaeal ganglia** behind the **brain**; the source of **Juvenile Hormone** (fig. 2-28)
- corpora cardiaca** (sing. corpus cardiacum) Paired glands lying close to the aorta and behind the **brain**, acting as stores and producers of **neurohormones** (fig. 2-28)
- corpus bursae** Membranous sac of the female **genitalia** in which the male deposits the **spermatophore** during copulation
- cosmopolitan** Distributed world-wide or nearly so
- costa** (adj. costal) (1) Anterior or leading edge of the wing, between the base and the **apex** (fig. 2-21); (2) anterior margin of the **valva** of the male **genitalia**
- costal fold** Expanded costal area folded over or beneath the forewing in male moths, often covering special pheromone-disseminating scales or hairs
- coxa** Basal segment of the leg (fig. 2-19)
- cranial** Referring to the head
- cranium** Head
- crawler** In entomology, the active first instar of scale insects
- cremaster** Constricted anal area of the pupa, usually bearing hooked **setae** used for attaching the pupa to the **cocoon** silk or a silk pad (fig. 5-51 B)
- crenulate** With small regular indentations, scalloped
- creosote** Complex mixture of phenols and phenolic ethers obtained from the dry distillation of wood; when pure, creosote is colourless and has a pungent odour. Due to impurities the colour of creosote varies between black and yellow; creosote is an excellent wood preservative
- crepuscular** Active at low light intensities, dusk or dawn
- Cretaceous** Geological epoch, 145 to 65 million years before the present
- crochets** Terminal sclerotized hooks on the larval **prolegs**
- crop** (1) Food storage area of the digestive system, posterior to the **oesophagus** (fig. 2-23); (2) cultivated plant
- crop rotation** Successive growing of different crops on the same area of land
- cross-veins** Transverse veins linking the longitudinal veins
- Crustacea** Class of mandibulate **Arthropoda** comprising crabs, lobsters, shrimps, crayfish, isopods, etc.
- cryptis** (adj. cryptic) Camouflage by resemblance to environmental features
- cryptic** Hidden, camouflaged, concealed
- cryptobiosis** State of a living organism during which there are no signs of life and metabolism virtually ceases
- cubitus** Fifth main longitudinal vein (Cu), with two branches CuA and CuP; CuA forms the posterior margin of the **discal cell** (fig. 2-21)
- cucullus** Dorsal lobe at the apex of the male **valva** in certain moths
- cumulative toxicity** Capability of a pesticide to be injurious after repeated exposures; see **chronic toxicity**
- cuneus** Triangular section in the apical tip of the hardened part of the **hemelytra** of Miridae bugs with two enclosed cells (fig. 5-26 E)
- curative** In applied entomology, the application of a pesticide during severe infestation of crop
- cursorial** Running
- cuticle** The non-cellular skin or **integument** of insects consisting of **chitin**, structural proteins and pigments; in larvae it is shed at intervals to allow growth
- cuticular** Referring to or made from the cuticle
- de-alate** Reproductive termite that has lost wings
- deciduous** Falling off, detaching, eg. at maturity
- decomposer** Any **heterotrophic** organism breaking down dead organic matter to simpler organic or inorganic material, eg. dung beetles, isopods
- decticus** Exarate pupa with articulated mandibles for biting through and escaping from cocoon/host during final emergence (figs. 2-43, 5-51 A)
- deflexed** Pointing downwards
- deflocculating agent** Any material added to a spray suspension to delay sedimentation
- defoliant** Chemical that makes the leaves fall off plants
- demecology** See **population ecology**
- demography** (adj. demographic) Numerical and mathematical analysis of populations and their distributions
- dendrites** Long extensions of nerve cells
- dentate** Toothed
- depressed** Referring to dorso-ventrally flattened features
- dermal** Made from or related to skin
- dermal gland** Unicellular epidermal gland that may secrete wax, cement and probably **pheromones**
- dermal toxicity** Poisoning through the skin
- Dermoptera** Earwigs
- deterrent** (=antifeedant) Chemical of bitter taste or unpleasant scent disliked by some insects
- detritus** Broken-up and usually decaying organic matter
- detritivore** (adj. detritivorous) Eater of organic **detritus** of plant or animal origin
- Devonian** Geological epoch, 400 to 360 million years before the present
- diagnosis** Identification of a specimen or the cause of a disease

- diapause** Period of suspended growth or development, usually with greatly decreased metabolism, allowing the animal to survive a seasonal unfavourable period, such as winter cold or summer heat or drought
- diaphragm** Membrane closing the posterior end of the male abdomen, between the bases of the **valvae**
- dichotomy** (adj. dichotomous) Branching or bifurcation into two equal portions; see **identification keys**
- die-back** Progressive death of twigs or leaves beginning at the tips
- differentiation** Process whereby cells or cell **clones** assume specialised functional biochemistries and morphologies previously absent. Such determined cells usually lose the ability to divide. Usually associated with the selective expression of the **genome** previously unexpressed.
- diffusion** Tendency of particles like atoms or molecules to disperse randomly and occupy available space; the process is accelerated by temperature, the source of movement being thermal agitation
- diluent** Any liquid or powdered material that is used to reduce the concentration of a chemical for spraying or dusting purposes
- dimorphic** Occurring in two forms; differences in size, form or coloration; see **sexual dimorphism**
- dimorphism** Structures or features of members of the same species existing in two clearly separable forms; see **sexual dimorphism**
- diploidy** (adj. diploid) **Nuclei** or cells in which the **chromosomes** occur as **homologous** pairs, so that twice the **haploid** number is present; most **somatic** cells (body cells) are diploid
- Diplopoda** Class of **Mandibulata**, the millipedes
- Diplura** Diplurans; one of the three entognathous orders
- Diptera** True flies, mosquitoes, gnats, midges, sandflies, punkies, etc.
- direct flight muscles** Muscles that power flight and are directly attached to the wing; see **indirect flight muscles** (fig. 2-32)
- discal cell** Central area of the wing, bounded anteriorly by veins R or Rs, posteriorly by CuA and distally by the **discocellular veins**
- discocellular veins** Short and often weak transverse veins or cross-veins which form or close the distal end of the discal cell in the wings
- disinfectant** Substance that removes contaminant organisms from surfaces
- disinfect** In applied entomology, to kill or inactivate pests present on the surface of plants or plant parts or in the immediate vicinity, eg. in soil
- dispersal** Movement of an individual or population away from its birth site
- dispersant** Substance that facilitates the production of **suspensions** or **emulsions** in chemical sprays
- distal** At or near the furthest end from the attachment of an appendage, opposite to proximal (fig. 2-2)
- distribution** In population ecology, the spread of individuals of a population in an area
- ditrysian** Having separate copulatory and oviposition **apertures** in the female, with the **bursa copulatrix** connected to the **vagina** by an internal duct, the **ductus seminalis**
- diurnal** Active during the day
- diverticulum** Blind lateral sac of the alimentary canal or other organ
- DNA (Desoxyribonucleic Acid)** Nucleic acid, a linear polynucleotide, forming the genetic material of all cells, some organelles and many viruses; a major component of **chromosomes**
- dormatia** Cavities produced specifically to house certain arthropods like mites and ants; see **myrmecophytes**
- dorsal** To, near or belonging to the back (fig. 2-2)
- dorsal diaphragm** Main fibromuscular septum that divides the **haemocoel** into pericardial and perivisceral **sinuses** (fig. 2-2)
- dorsal vessel** Longitudinal, tubular organ or 'heart' responsible for circulating **haemolymph** (fig. 2-24)
- dorsolateral** Area between dorsal and lateral areas
- dorsoventral** Relating to both the dorsal (the back) and the ventral (the belly) sides of an organism; a dorsoventrally flattened insect is one that appears flattened as if pressed down from above
- dorsum** Upper surface; sometimes applied to the inner margin of the wing
- dose (=dosage)** In applied entomology, the quantity of a pesticide applied per individual, or per unit area or per unit volume or per unit weight
- drift** In applied entomology, spray or dust carried by natural air currents beyond the target area
- drone** Male bee, especially of honey bees and bumble bees, derived from an unfertilised egg
- duct, ductus** Channel, tube or canal for carrying a secretion from a gland to the point of discharge
- ductus bursae** Duct leading from the **ostium bursae** or copulatory **aperture** to the **corpus bursae** in the female **genitalia**
- ductus seminalis** Duct joining the **bursa copulatrix** to the **vagina** of the female
- duster** In applied entomology, equipment suitable for the application of pesticide dusts to a target
- ecdysial lines** Lines of weakness lateral from the **adfrontal sutures** of the larval head along which the head capsule splits at **ecdysis**
- ecdysis** Shedding of the larval or pupal **cuticle**
- Ecdysone (=Ecdyson)** Insect **hormone** secreted by the **prothoracic gland** involved in **moult** (fig. 2-35)
- echolocation** Method used by several nocturnal, cave-dwelling or aquatic animals for determining position of objects by reflection of high-pitched sounds (ultrasound); common in many bats, oil birds and platypus
- eclosion** Release of the adult insect from the **cuticle** of the previous instar; sometimes used for hatching from egg
- eclosion hormone** Neuropeptide with several functions associated with adult **eclosion** including increasing **cuticle** extensibility

- ecology** Study of relationships of organisms or groups of organisms to their environment, both animate (**biotic**) and inanimate (**abiotic**); see **synecology**, **autecology** and **population ecology**
- economic damage** Injury done to a crop that will justify the cost of artificial control measures
- economic entomology** See **applied entomology**
- Economic Injury Level (EIL)** Pest density at which the damage caused by a pest equals the costs of its control
- Economic Threshold Level (ETL)** Pest density at which control must be applied to prevent the **Economic Injury Level** being reached
- ecosystem** Interacting system comprised of all the living organisms in an area and their inanimate environment
- ecotone** Zone of transition between clearly demarcated groups of organisms or communities of two different **habitats**; see **edge effect**
- ectoderm** Outermost germ layer of **metazoan** embryos developing mainly into epidermal and nervous tissue
- ectognathous** Referring to mouthparts lying outside the head
- ectoparasite** External **parasite** living at the expense of the **host**, but which it does not kill
- ectoparasitoid** External **parasite** living at the expense of the **host** which it eventually kills
- ectothermia** (adj. ectothermic) Inability to regulate the body temperature relative to the surrounding environment
- edge effect** Ecological effects in the zone of transition between ecosystems; often results for instance in increased species diversity in the zone of transition compared to the adjacent **habitats**; see **ecotone**
- elaiosome** Food body forming an appendage on seeds
- elytra** (sing. elytron, adj. elytral) Hardened forewings of beetles which form a protective cover for the membranous second pair of wings; the elytra extend over the **meso-** and **metathorax** and in most beetles cover the abdomen as well
- Embioptera** Foot- and webspinners
- embryo** In zoology, the structure produced from an egg (usually fertilised), by generations of **mitotic** cell divisions while still within the egg membranes, or otherwise inside the maternal body; embryonic life is usually considered to be over when hatching from membranes occurs (or birth)
- emergence** In entomology, the adult insect leaving the last nymphal skin or pupal case
- emetic** (adj. emetic) Chemical inducing vomiting eg. to get rid of a poison in the stomach; a tablespoon of salt in a glass of water can be used as an emetic
- empodium** (pl. empodia) Central pad or spine on the **pretarsus** of Diptera
- emulsifiable liquid** 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 solutions or aqueous solution in oil
- emulsion** Dispersion of one liquid in another in the form of tiny droplets
- encapsulation** In applied entomology, the encapsulation of a pesticide in a non-volatile envelope of gelatine, usually of minute size, for delayed release
- endemism** (adj. endemic) Confined to certain localities. For instance a species native to a particular place and found only there or a disease occurring in certain individuals or areas
- endite** Inwardly directed appendage or lobe of a limb segment
- endocrine gland** Hormone gland releasing its product(s) directly into the haemolymph not via ducts
- endocuticle** Flexible, unsclerotized inner layer of the cuticle (fig. 2-3); see **exocuticle**
- endoderm (=entoderm)** Innermost germ layer of **metazoan** embryos developing mainly into gut lining and associated glands
- endogenous rhythm** Clock or calendar-like activity patterns, commonly **circadian**, unaffected by external conditions
- endoparasite** Internal **parasite** living at the expense of the **host**, but which it does not kill
- endoparasitoid** Internal **parasite** living at the expense of the **host** which it eventually kills
- endophilic** Indoor loving, as of an insect that feeds inside a dwelling
- Endopterygota** (adj. endopterygote) Group of holometabolous insect orders with wings developing internally during pupal stage
- endothermy** (adj. endothermic) Ability to regulate the body temperature higher than the surrounding environment
- Ensifera** One of the two Orthoptera suborders, including the longhorn grasshoppers (katydids), crickets, mole crickets, etc.
- entoderm** See **endoderm**
- Entognatha** Class of **Hexapoda** with the orders **Protura**, **Diplura** and **Collembola**, in which the mouthparts lie inside the head
- entomology** Study of insects and their allies
- entomoparasite** (adj. entomoparasitic) Parasite of insects
- entomopathogen** (adj. entomopathogenic) Pathogen that particularly attacks insects
- entomophage (=insectivorous)** (adj. entomophagous) Eater of insects
- entomophily** Pollination by insects
- entomophobia** Fear of insects
- environmental resistance** Total of limiting environmental factors, working against the **biotic potential** of reproduction in an optimum environment, thus restricting populations from growing indefinitely and getting out of control
- enzyme** Protein catalyst produced by a cell, responsible for the high rate of one or more intracellular or extracellular biochemical reactions
- Ephemeroptera** Mayflies

- epicormic shoot** Shoot growing from the trunk of a plant
- epicuticle** Inextensible and unresponsive outermost layer of the cuticle (fig. 2-3), lying outside the procuticle
- epidemism** (adj. epidemic) Referring to the spread of a disease from its **endemic** area or from its normal host
- epidermis** The unicellular layer of **ectodermally** derived integument that secretes the **cuticle** (fig. 2-3)
- epimeron** (pl. epimera) Posterior division of the **pleuron** of the thorax, separated from the episternum by the pleural suture
- epiphysis** Usually movable lobe of the fore **tibia**, found only in Lepidoptera
- epiphyte** Plants of various species that live attached to other plants
- epithelium** Sheet or tube of firmly coherent cells of **ectodermal** or **endodermal** origin, lining cavities and tubes and covering exposed surfaces: one surface of epithelium is therefore free, the other usually resting on a basement membrane over connective tissue; epithelial cells are often secretory cells or part of secretory glands
- eradicant** Substance which eradicates a **pathogen** from the tissues of a **host**
- eradication** Complete removal or elimination; see **control**
- erineum** (pl. erinea) Abnormal development of epidermal plant cells or a deformation of the plant hairs caused by gall, rust and blister mites; erinea appear as brightly coloured patches on the foliage and might be mistaken for fungal growth
- eruciform larvae** Larvae resembling a caterpillar or polypod larva in form or appearance, ie. having a fleshy body, a thin skin and prolegs on the abdomen. Larvae of Symphyta (Hymenoptera) and of some Coleoptera are eruciform (figs. 5-33 A, 5-55 A)
- esophagus** See **oesophagus**
- estivation** See **aestivation**
- ethanol** Spirit, ethyl alcohol
- ethology** The study of animal behaviour
- ethyl acetate** Acetic acid ethylester; common killing agent for insects
- etiology** See **aetiology**
- eukaryota** (=eukaryote) (adj. eukaryotic) Organisms in whose cell or cells **chromosomal** genetic material is contained within one or several **nuclei** and so separated from the cytoplasm by two nuclear membranes; for instance, insects and vertebrates are eukaryotic organisms
- eusociality** Social behaviour exhibiting cooperation in reproduction and division of labour, with overlapping generations
- evolution** Theory of the development of more complicated forms of life from earlier and simpler forms is referred to as macroevolution (**speciation**), whereas the changes in appearance of populations and species over generations are called microevolution
- exarate pupa** Refers to appendages like antennae, legs, wings, that are free from the body of a pupa (figs. 2-43, 5-51 A), see **obtect**
- exclusion** Control of pests or diseases achieved by excluding them from an area or country, often as a result of **phytosanitation** or **quarantine** legislation
- excretion** Elimination of metabolic wastes from the body, or their storage in an insoluble form
- exocrine glands** Glands producing and releasing transmitters like **pheromones** or **allelochemicals** to the outside of the body
- exocuticle** Rigid, sclerotized outer layer of the **procuticle**; see **endocuticle** (fig. 2-3)
- exogenous rhythm** Activity patterns governed by variations in the external environment, eg. light, day length, temperature, etc.
- exophily** Out-of-doors loving, used of biting insects that do not enter buildings; see **endophilic**
- exoporian** Having separate copulatory and oviposition **apertures**, with an external groove along which sperm passes from the **bursa copulatrix** to the **vagina**
- Exopterygota** (adj. exopterygote) Group of insect orders with **incomplete metamorphosis**; wings develop externally during the last larval instars
- exoskeleton** Capsule-like skeleton covering the outside of the body of insects and other arthropods; the hardened **cuticle** of Arthropods is made from **chitin**
- extant** Still in existence; as opposed to **extinct**
- extinct** In conservation biology, the status of a species without records of existence in the past 50 years
- extracellular** Referring to processes outside a cell
- extra-oral digestion** Digestion that takes place outside the organism, by secretion of salivary enzymes on or into the food, with soluble digestive products being sucked up
- exudate** Liquid discharge from diseased or injured tissues
- exuviae** (used only in the plural) Cast off cuticle of the larva or pupa after a moult
- eye-spot** Coloured, eye-like spot, usually ringed with one or more contrasting colours
- facultative** Not compulsory, optional behaviour such as facultative parasitism, in which a free-living organism adopts a parasitic mode of life; opposite of **obligatory**
- faecal mottling** Spotting in timber caused by termites applying faecal pellets to their gallery walls
- faeces** (=feces) (adj. faecal) Solid excretions of the alimentary channel
- false eye** See **eye spots**
- false leg** See **proleg**
- fat body** A more or less loose aggregation of cells suspended in the **haemocoel**, responsible for storage and excretion and of major metabolic importance, comparable to the vertebrate liver
- fecundity** Average number of eggs laid by an insect; see **natality**
- femur** (pl. femora) Third segment of the leg, between the **trochanter** and **tibia** (fig. 2-19)
- fermentation** Breakdown of complex molecules by microbes, such as carbohydrates by yeast
- fertilisation** Fusion of a **haploid** sperm and egg cell to form one **diploid** fertilised **oocyte**

- fertility** Ability to reproduce; reproductive rate of a female; see **fecundity** and **natality**
- filament** Term used to describe long thread-like structures or molecules
- file** Toothed or ridged structure used in sound production by stridulation through contact with a **scraper** (figs. 3-2, 3-3)
- filiform** Thread-like
- filler** In applied entomology, the inert component of pesticide dust or granule formulation
- flabellate** Fan-shaped
- flagellum** Third part of an antenna, distal to the **scape** and **pedicel** (fig. 2-5); more generally any whip or whip-like structure
- fluorescent tracer** Fluorescent material added to a pesticide to aid the assessment of spray deposits on plants
- food chain** Chain of organisms, existing in any natural **community**, through which energy and matter are transferred; each link in the chain feeds on, and hence obtains energy from, the one preceding it and is in turn eaten by and provides energy for the one succeeding it; the number of links in the chain is usually three or four and rarely exceeds six; at the beginning of the chain on the **producer** level are the plants (**autotrophs**); all other levels are **consumer** levels: the **herbivores** or **phytophages** as primary consumers, the **carnivorous predators** and **parasites** as secondary consumers and the **decomposers**. All food chains in a community make up the **food web**; see **materials triangle** and **trophic levels** (fig. 4-1)
- food web** See **food chain**
- forage** To seek and gather food
- fore** Anterior, towards the head
- foregut (=stomodeum)** Part of the gut that lies between the mouth and the **midgut**, derived from the **ectoderm** (fig. 2-23)
- forensic entomology** Study of insects in relation to legal matters
- formulation** Components and proportions of additional substances that accompany an insecticide when prepared for application
- fossil** Remains of an organism, or direct evidence of its presence, preserved in rock, ice, amber, tar, peat or volcanic ash
- fossorial** Digging
- frass** Solid faecal material and discarded waste produced by insects, eg. sawdust of wood boring beetles
- frenulum** One or more bristles, arising at the base of the hindwing, which couple the wings together by hooking behind the **retinaculum** beneath the forewing (fig. 5-49)
- frons** Anterior part of the head (figs. 2-4, 2-6)
- frontoclypeus** Fused **frons** and **clypeus** of larval head
- fructivore** (adj. fructivorous) Fruit-eater
- fultura superior** and **inferior** Upper and lower areas of the **diaphragm** of the male **genitalia**
- fumigant** Any material that when in the form of gas or vapour destroys organisms
- fumigation** Application of gases or vapour to infiltrate soil, or stored products to kill pests
- fungicide** Any agent that kills or inhibits fungi
- fungivore** (adj. fungivorous) Fungus-eater
- furcula** Forked springing apparatus on the ventral side of the abdomen of springtails (**Collembola**)
- fusiform** Spindle-shaped
- galea** (pl. galeae) Lobe of the **maxilla** (figs. 2-6, 2-10); in most Lepidoptera modified to form the tubular **proboscis** (fig. 2-17)
- gall** Aberrant growth (**tumor**) of plant tissues eg. leaves, stem, petiole, etc. (figs. 6-1 I, J, 6-2 A), caused by the activity of another organism, often by oviposition or piercing-sucking action of some mites, Homoptera and gall wasps (Hymenoptera)
- galleries** Enclosed tunnels and chambers made by insects
- ganglion** (pl. ganglia) Small mass of nervous tissue containing numerous cell bodies; the **central nervous system** of the idealised insect contains one ganglion per segment besides the **brain** (fig. 2-27)
- gas exchange** System of oxygen uptake and carbon dioxide elimination via the **tracheal system** or **gills**
- gaster** Swollen part of the abdomen of **aculeate** Hymenoptera, lying posterior to the **petiole** (fig. 5-59)
- gena** (pl. genae) Literally, a cheek; on each side of the head; area lying beneath the compound eye (fig. 2-4)
- gene** (adj. genetic) Usually regarded as the smallest physical unit of heredity encoding a molecular cell product (protein). Commonly also considered to be a unit of selection
- gene manipulation** See **genetic engineering**
- generation time** Interval between the production of eggs in one generation and the production of eggs in the next generation (fig. 4-23)
- genetic engineering (=gene manipulation)** Set of procedures by which selected pieces of a **genome** (**genes**) are cut out and inserted into another organism; important tool in molecular biology and biotechnology
- genetic resources** Any wild genetic material for experimentation or for incorporation by breeding or **genetic engineering** into existing agricultural **hybrid** species in order to revitalise or improve the performance of species of economic value
- geniculate** Elbowed
- genitalia** Ectodermally derived structures of both sexes associated with **reproduction** (eg. **mating**, **fertilisation**, **oviposition**)
- genome** Total genetic material within a cell or individual
- genotype** Genetic constitution of a cell or individual, as distinct from its **phenotype**
- gill** Gas exchange organ found in aquatic insects
- glossa** (pl. glossae) ‘Tongue’, one pair of lobes on the inner apex of the **prementum** (figs. 2-6, 2-10)
- gnathos** Single or paired structure beneath the **uncus** in male **genitalia**
- gnathosoma (=capitulum)** In ticks and mites the fused segments bearing **chelicerae** and **pedipalpi** forming a minute tagma; see **idiosoma**

- gonad** Gland that produces reproductive cells, ie. sperm cells in male **testes** or egg cells in female **ovaries**
- gonoduct** In insects, a **duct** leading from the **gonads** (**testes** or **ovaries**) to the **gonopore**
- gonopore** Genital opening
- gradual metamorphosis** (=paurometabolous development) Simple **metamorphosis** of **exopterygote** insects in which the **nymphs** are terrestrial and resemble the adults in general form and mode of life except for the absence of functional wings and reproductive organs; see **complete** and **incomplete metamorphosis**
- granule** Coarse particle of inert material such as pumice or rice husks, that is impregnated or mixed with a pesticide mainly for soil application
- granule applicator** Device able to apply measured quantities of **granules**
- granulose** Having a granular surface
- grease band** Adhesive material such as resin, applied as a band around a tree to trap or repel ascending wingless insects (fig. 8-19 K)
- gregarious** Forming aggregations; see **phase polymorphism**
- gressorial** Walking
- grub** Larva of a beetle
- Grylloblattodea** Ice crawlers
- gyne** Reproductive female Hymenoptera, **queen**
- haematophage** (adj. haematophagous) Feeder of blood
- haemocoel** In insects, the body cavity which is filled with **haemolymph**
- haemocoelous viviparity** Form of **viviparity** in which embryos develop free in the female's **haemolymph** with nutrients taken up by osmosis
- haemocyte** Blood cell
- haemoglobin** Red pigment of blood in red blood cells of vertebrates carrying oxygen
- haemolymph** Insect blood
- habitat** Place or environment ('address of a species') in which specified organisms live; see **niche**
- habituation** Learning, in which an animal's response to a **stimulus** declines with repetition of the stimulus at the same intensity
- hair-pencil** Tuft of long, parallel hairs in male moths which are often expanded and displayed during courtship and which often disseminate **pheromones**
- halteres** Clubbed, reduced second pair of Dipteran wings (fig. 5-46 A)
- hamuli** (adj. hamulate) Hooks along the anterior (**costal**) margin of the hindwing of Hymenoptera which couple the wing in flight by catching on a fold of the forewing
- haplodiploidy** (adj. haplodiploid) Sex determination system in which **diploid** eggs give rise to females, **haploid** ones to males
- haploidy** (adj. haploid) Condition of a **nucleus** or cell in which **chromosomes** are represented singly and unpaired. The haploid chromosome number **n** is thus half the **diploid** number **2n**; haploid cells are commonly the direct product of **meiosis**, but haploid **mitosis** is relatively common too.; no haploid cell can undergo meiosis. Diploid organisms generally produce haploid egg and sperm cells
- harpe** Sclerotized structure on inner surface of **valva** in some male moths, associated with **sacculus**
- haustellate** Sucking, as of mouthparts
- haustellum** Proboscis, coiled in Lepidoptera (fig. 2-17)
- hazard** (adj. hazardous) In applied entomology, the chance that harm will come to beneficial forms of life from the use of a pesticide
- hemelytron** (pl. hemelytra) Partly thickened forewing of Heteroptera
- hemimetaboly** (adj. hemimetabolous) Insect orders with **incomplete** or **gradual metamorphosis**
- Hemiptera** Hemipteran suborders Heteroptera, Stenorrhyncha and Auchenorrhyncha, comprising true bugs, cicadas, aphids, scale insects, mealy bugs, tree, plant and leaf hoppers, spittlebugs, lerps, psyllids, etc.
- hematophage** See **haematophage**
- hemocoel** See **haemocoel**
- hemocoelous viviparity** See **haemocoelous viviparity**
- hemocyte** See **haemocyte**
- hemoglobin** See **haemoglobin**
- hemolymph** See **haemolymph**
- herbicide** Any agent or chemical used in the destruction or control of weeds
- herbivore** (=phytophage) (adj. herbivorous) Eater on plants
- hermaphroditism** Having individuals that possess both testes and ovaries, and being capable of self-fertilisation
- heterometabolous development** (=paurometabolous development, gradual development) Development of insects with external wing development (**Exopterygota**); see **hemimetaboly**
- heteromorphosis** (=hypermetamorphosis) (adj. heteromorphic) Having two or more different forms; usually applied to the major change in morphology between larval instars of certain families of Lepidoptera
- heteroneurous** Having the venation of the hind wing reduced, without R2 to R5
- Heteroptera** Suborder of the order **Hemiptera**, comprising the true bugs
- heterotrophy** Designation of heterotrophic organisms (**heterotrophs**) depending on organic compounds as a source of food; all **herbivores**, **carnivores**, **omnivores**, **saprophages**, **parasites** and **decomposers** are heterotrophs
- hexapod** Six-legged
- Hexopoda** Superclass of animals with six legs, comprising the classes **Insecta** and **Entognatha**
- hibernate** To pass the winter in a dormant state
- hind** At or towards the posterior
- hindgut** (=proctodeum) Posterior section of the gut, extending from the end of the midgut to the anus (fig. 2-23)
- holometaboly** (adj. holometabolous) Insect orders having **complete metamorphosis** with pupal stage
- holopneustic** Referring to gas exchange with all the **spiracles** open and functional
- holoptic** Round-view

- homeostasis** In physiology, various processes which help regulate and maintain constancy of the internal environment of a cell or organism at appropriate levels
- homologues** Series of organic compounds with similar properties but differing from each other by some radical
- homology** (adj. homologous) Morphological identity or similarity of a structure of two or more organisms due to common evolutionary origin, eg. the wings of birds and bats; opposite to **analogy**
- homoneurous** Having the full complement of veins in both fore- and hindwings
- Homoptera** The two Hemipteran suborders Stenorrhyncha (aphids, plant lice, scale insects, psyllids, mealy bugs, etc.) and Auchenorrhyncha (cicadas, spittle bugs, tree, leaf and plant hoppers)
- honeydew** Sweet secretions of water and carbohydrates released by aphids and other Homoptera as liquid faeces; honeydew dripping onto leaves is often stained black by mould, called **black sooty mould**
- hormone** Molecules that are secreted directly into the hemolymph (or blood of higher animals) by ductless glands and carried to specific target cells or organs by whose response they bring about a specific and adaptive physiological response. Hormones are sometimes incorrectly referred to as chemical messengers
- host** Organism that harbours another, especially a **parasite** or **parasitoid**, either internally or externally
- host preference** Host specificity, host selectivity, to prefer one host over another
- humeral vein** Short vein arising near the base of the wing and running towards the base of the **costa** (fig. 2-21)
- hyaline** Transparent
- hybrid** In its widest sense, describes a **progeny** resulting from a cross between two genetically non-identical individuals; commonly used where the parents are from different **taxa**
- hydro-** Referring to water, moisture or humidity
- hydrostatic skeleton** Turgid structural support provided by fluid pressure maintained by muscle contractions on a fixed volume of liquids within especially larval insects
- hygro-** See **hydro-**
- Hymenoptera** Sawflies, wasps, ants, bees, bumblebees
- hypermetamorphosis** See **heteromorphosis**
- hyperparasitism** (adj. hyperparasitic) Parasitization of another **parasite**
- hyperparasitoid** Secondary **parasitoid** that develops upon another **parasite** or parasitoid
- hypha** (pl. hyphae) Filament or thread of the simple, vegetative fungal body (**thallus**)
- hypognathous** Having the mouthparts directed ventrally
- hypopharynx** Median lobe of the preoral cavity of the mouthparts (figs. 2-6, 2-11, 2-12, 2-15)
- identification** Discovery of the name of a specimen usually by the use of **identification keys** that are commonly constructed so as to lead the investigator through a sequence of choices between mutually exclusive character descriptions, so chosen as to eliminate all but the specimen under observation; a common format of identification keys is **dichotomous**. The disadvantages of dichotomous keys can be overcome by computer-supported interactive keys
- idiobiont** Parasitoid that prevents its host from developing any further, by paralysis or death; see **konobiont**
- idiosoma** In mites and ticks, the much larger of the two **tagmata**; see **gnathosoma**
- ileum** Second section of the **hindgut** (fig. 2-23), preceding the **colon**
- imaginal disk** or **bud** Latent adult structures in an immature insect, visible as groups of undifferentiated cells
- imago** (pl. imagines, imagos) Adult insect
- immunity** (adj. immune) Ability of animals or plants to resist infection by **parasites** and effects of other harmful agents; essential requirement for survival, since most organisms are continuously menaced by viruses, bacteria, fungi or parasitic animals
- incompatible** Not compatible; not able to live together; in applied entomology, incapable of forming a stable mixture with another chemical
- incomplete metamorphosis** Development in which the immature aquatic stages (**naiads**) differ significantly from the adults, and which lacks a pupal stage; see **complete** and **gradual metamorphosis**
- indigenous** Native, not foreign or exotic
- indirect flight muscles** Muscles that power flight by deforming the thorax rather than directly moving the wings; see **direct flight muscles**
- induced defence** Chemical change, deleterious to **herbivores**, induced in foliage as a result of feeding damage
- inhalation poison** Insecticide with **fumigant** action
- inert** Without active biological or chemical properties
- infect** To enter and establish a **pathogenic** relationship with a **host**; to enter and persist in a carrier organism
- infection** (adj. infected) Process of, or state arising from, being infected with a protozoan, fungal or bacterial pathogen or parasite
- infect** To occupy and cause injury to either plants, animals, soils or products valuable to man
- infestation** (adj. infested) Process of, or state arising from, being infested with a metazoan pathogen or parasite
- infraspecific** See **intraspecific**
- injector** Device for positioning a pesticide into soil or below the surface or into the transport system of a plant
- innate behaviour** Behaviour requiring no choice or learning
- inner margin** Posterior or trailing edge of the wing, joining the base to the **ternus** (fig. 2-21)
- inoculation** In biocontrol, the periodic release of a natural enemy, which breeds so that the progeny provide control
- inoculum** Part or quantity of a pathogenic organism which can infect a host
- inoculum potential** Quantity of a pathogen required to successfully infect a host, ie. to overcome the host's **resistance**

- inquiline** Organism that lives in the home of another, sharing food; in entomology, used particularly of residents in the nests of **social insects**, or in pitcher plants, or in plant **galls** induced by other organisms
- Insecta, insects** Class of **Arthropoda** whose members have a body with distinct head, thorax and abdomen; the head bears one pair of antennae and paired mouthparts; the thorax bears three pairs of legs and one or two pairs of wings in winged insects (**Pterygota**) and none in primarily wingless insects (**Apterygota**); the abdomen bears no legs but other appendages might be present; insects are the most diverse class of organisms
- insecticide** Any agent effective against insects
- insectivore (=entomophage)** (adj. insectivorous) Eater of insects
- insemination** Conception or transfer of male sperm into female during **copulation**
- in situ** In natural position, on site
- instar** Period between the hatching of the egg and the first larval **ecdysis**, and the period between two successive ecdyses; synonym for **stadium**
- integrated pest management (IPM)** Integration of chemical means of pest control with other methods, notably **biological control** and habitat manipulation
- integument** Outer protective covering of an animal, such as skin or **cuticle**
- intercropping** Mixed planting of crops; see **polyculture**
- interference colours** Iridescent colours resulting from the reflection of light from a series of superimposed surfaces separated by distances comparable to the wavelengths of light, as the scales of Lepidoptera
- intersegmental membrane (=conjunctiva)** Membrane joining two segments of the insect body, particularly abdominal segments
- interspecific** Between individuals of two or more different species, eg. interspecific **competition**
- intracellular** Referring to processes in a cell
- intraspecific (=intraspecific)** Within individuals of the same species, eg. intraspecific **competition**
- intrinsic factors** Factors or influences produced within an organism, eg. as a result of its inheritance
- inundative release** In biocontrol, swamping a pest with large numbers of control agents, with control deriving from the released organisms rather than any of their progeny
- in vitro** 'In glass'; biological process occurring, usually under experimental conditions, outside the cell or organism, eg. in a test tube
- in vivo** 'In live'; biological process occurring within a living situation, eg. in a cell or organism
- Isopoda** Order of the class **Crustacea**; sowbugs, pillbugs
- Isoptera** Termites
- jet (of sprays)** Liquid emitted from a nozzle
- jugum** Small, usually expanded area of the forewing near the base, found in primitive moths
- Jurassic** Geological epoch, 210 to 145 million years before the present
- juvenile** Immature, not yet fully developed
- Juvenile Hormone (JH)** Insect hormone released by the **corpora allata** involved in **moulting** process, suppressing the final moult (fig. 2-35)
- juxta** Sclerotized plate beneath the **aedeagus** of the male, to which the aedeagus may be hinged or fused; part of the **fulcra inferior**
- kairomone** Communication chemical that benefits the receiver and is disadvantageous to the producer; see **allelochemicals**
- karyokinesis** See **mitosis**
- kinesis** (pl. kinesis) Movement of an organism in response to a **stimulus**, either in direction of the stimulus (**positive kinesis**) or away from it (**negative kinesis**)
- king** Male primary **reproductive** in termites and ants; see **drone**
- klinokinesis** 'Random walk' with course changes (turns) made when unfavourable **stimuli** are perceived and with the frequency of turns depending on the intensity of the stimulus
- klinotaxis** Behaviour of an insect in which it moves relative to a gradient of stimulus intensity such as the concentration gradient of a **pheromone** (eg. fig. 3-5)
- konobiont** Parasitoid that allows its host to continue to develop; see **idiobiont**
- kunai** Neo-Melanesian Pidgin for the common tall grass *Imperata cylindrica*
- kurakum** Neo-Melanesian Pidgin for the arboreal ant *Oecophylla smaragdina*
- labella** (sing. labellum) In certain flies, paired lobes at the apex of the **proboscis**, derived from **labial palps** (figs. 2-9, 2-12, 2-15)
- labial palp** (pl. labial palpi) Paired appendages of the **labium** (figs. 2-6, 2-10, 2-12, 2-17)
- labium** (pl. labia, adj. labial) Fused **sclerites** forming the ventral part of the mouth ('lower lip') (figs. 2-6, 2-11, 2-12, 2-17)
- labrum** (adj. labral) Upper, hinged **sclerite** of the insect mouth ('upper lip') (figs. 2-6, 2-9, 2-10, 2-11, 2-12, 2-15, 2-17)
- lacinia** Small lobe of the **maxilla** (fig. 2-6); also present in some primitive moths
- lamella antevaginalis** and **postvaginalis** Sclerotized areas of the abdomen anterior and posterior of the **ostium bursae** in the female
- lamellate** Leaf-like or fan-like
- larva** (pl. larvae) The feeding, wingless, sexually immature, developmental stage of an insect after emerging from the egg, eg. caterpillar, maggot, grub; often restricted to **holometabolous insects**, but sometimes used for any immature insect that differs strongly from the adult; in mites, the first immature instar followed by the **protonymph** (fig. 5-7); see **nymph, naiad**
- larvicide** Any agent effective against insect larvae
- latent** Present, but inactive, not apparent
- lateral** Relating to the side (fig. 2-2)

- LC<sub>50</sub> value** Lethal concentration of a poison in air or liquid, causing the death of 50 % of a large group of test animals of the same species by inhalation or otherwise; measured in mg **a.i.** per kg body weight
- LD<sub>50</sub> value** Lethal dose of a poison, orally or dermally, causing the death of 50 % of a large group of test animals of the same species; measured in mg **a.i.** per kg body weight
- leaf miner** Feeder on the mesophyll layer between the upper and lower epidermis of a leaf
- Lepidoptera** Moths and butterflies
- lerp** In nymphal Psyllidae (Hemiptera) a delicate and complex shelter produced from a carbohydrate secretion from the anus; see **scale**
- lesion** Disruption and **necrosis** of host tissue caused by a **pathogen**, or the toxic saliva of certain Heteroptera
- lethal** Fatal
- liberation** In applied entomology, the release of organisms for biological control
- life cycle (=life history)** Time it takes for an insect to develop from egg to adult; during its life cycle an insect undergoes a progressive series of changes; sometimes considered as lineal succession of organisms from fertilisation to death; life cycles also take into account environmental factors, the method of **reproduction, polymorphism**
- lipophilic** Fat-soluble
- litter** Layer of dead vegetative matter overlying the soil
- locomotion** Act or process of moving from place to place by means of walking, jumping, crawling, flying, floating or swimming
- longitudinal** In the direction of the long axis of the body
- looper** 'Earth measuring worm'; caterpillar of the moth family Geometridae with only one pair of abdominal **prolegs** and which moves by looping its body
- Macrolepidoptera** see '**macros**'
- macrophage** Eater of large particles
- macropterous** Large or long-winged insect
- 'macros'** (=Macrolepidoptera) Commonly used term for large moths with broad, large hindwings and butterflies; 'macros' include for instance the families Notodontidae, Saturniidae, Noctuidae, Arctiidae, Lasiocampidae, Geometridae, Sphingidae and all butterfly families; the term 'macro' is of no taxonomic relevance; see '**micros**'
- maggot** Legless larval insect, usually with a reduced head, frequently the larva of a fly
- male confusion** See **mating disruption**
- malign** Malicious, evil, spiteful, not benign
- Malpighian tubules** Excretory organ of insects draining between mid- and hindgut (fig. 2-23)
- mandible** (adj. mandibulate) Sclerotized, sometimes **dentate** jaw of mandibulate insects
- Mandibulata** Subphylum of the **Arthropoda**, comprising the classes **Chilopoda, Crustacea, Diplopoda, Entognatha, Insecta**, etc.
- mandibulate** Possessing mandibles
- mantid** Referring to praying mantids
- Mantodea** Praying mantids (sing. praying mantis)
- masquerade (=mimesis)** Form of **crypsis** in which an organism resembles features of the environment such as a leaf or thorn that is of no interest to its predator
- materials triangle (=pyramid of biomass)** Diagram in pyramidal form representing the trophic levels of a community or **food chain** with **producers** at the top, followed by primary and secondary **consumers** and the **decomposers** (fig. 4-1)
- mating** See **copulation**
- mating disruption** Form of insect control in which synthetic sex **pheromones**, usually of the female are maintained artificially at a higher level than the background, interfering with mate location; sometimes also referred to as **male confusion**
- maturation** Becoming mature, past the juvenile stage
- maxillae** (sing. maxilla, adj. maxillary) Paired mouthparts situated between the **mandibles** and **labrum**, (fig. 2-6) serving as accessory jaws, provided with **sensilla** that assist in selection of food
- maxillary palp** Paired, usually segmented, appendages of the **maxillae** (figs. 2-6, 2-9, 2-10, 2-12, 2-15, 2-17)
- Mecoptera** Scorpion flies, hanging flies
- media** Fourth main longitudinal vein (M) of the wing; its stem may be branched within the discal cell, but is more often vestigial or absent (fig. 2-21)
- median (=medial)** At or towards the middle or midline (fig. 2-2)
- Megaloptera** Dobson- and Alderflies
- meiosis (=reduction division)** Process whereby a **nucleus** divides by two divisions into four nuclei, each containing half the original number of **chromosomes**; a necessary aspect of eukaryotic **sexual reproduction**, for without it fertilisation would usually double the chromosome number every generation; also ensures genetic variation between offspring
- melanic** Darkened, having a liberal deposition of the black pigment **melanin**
- melittophily** Pollination by bees
- membranous** Pertaining to wings, the usually transparent, flying wings, as in dragonflies
- menotaxis** Orientation with respect to a constant angle of light; also referred to as 'light compass'
- mesal** Nearer to the midline of the body, see **medial**
- mesoseries** Arrangement of the **crochets** of the larval **proleg** in a single, inner or mesal, longitudinal band
- mesosoma** Middle of the three major divisions (**tagmata**) of the insect body, equivalent to the thorax, but in **Apocrita** including the **propodeum** (fig. 5-59)
- mesothorax** Middle segment of the thorax bearing the mid legs and, in the adult, the forewings
- metabolic resistance** Ability to avoid harm by biochemical detoxification of an insecticide
- metabolism** (adj. metabolic) Sum of chemical and physical processes occurring in a living organism, often intended to refer only to its enzymatic reactions; may be regarded as comprising **anabolism** (build-up of molecules) and **catabolism** (breakdown of molecules)

- metamerism** See **segmentation**
- metamorphosis** Relatively abrupt change in body form between the end of immature development and the onset of the adult phase; see **incomplete**, **gradual** and **complete metamorphosis**
- metasoma** In apocritan Hymenoptera the **petiole** plus **gaster** (fig. 5-59)
- metathorax** Third or posterior segment of the thorax, bearing the hind legs and, in the adult, the hind wings
- metazoa** Multicellular animals like insects and mammals
- Microlepidoptera** See 'micros'
- microphage** Feeder on small particles, such as spores
- micropyle** In zoology, one or more microscopic openings in the **chorion** of the egg through which the **sperm** enters to fertilise the egg
- microorganisms** Microscopically small organisms including unicellular plants (algae) and animals (**protozoa**, **protista**), bacteria and many fungi
- '**micros**' (= **Microlepidoptera**) Common term used for smaller, slender moths with extremely narrow and pointed hindwings or with hindwings bearing a long posterior fringe; 'micros' include for instance the families Aegeriidae, Psychidae, Gelechiidae, Oecophoridae, Tineidae, Yponomeutidae, Tortricidae and Pyralidae; the term 'micro' is of no taxonomic relevance; see '**macros**'
- microtrichium** (pl. microtrichia) Minute outgrowths or spines of the **cuticle**; those of wings are called **aculei**
- midgut** Middle section of the gut (fig. 2-23)
- migration** Mass movement over a considerable distance, often in one general direction at any one time
- mimesis** Resemblance to an inedible object in the environment; see **masquerade**
- mimic** (adj. mimetic) One of the three components of a **mimicry** system, the emitter of false signal(s) received by the **observer**; an individual, population or species that resembles a **model**, usually another species or part thereof; see **automimic**, **Batesian mimicry**, **Müllerian mimicry**
- mimicry** Resemblance of a **mimic** to a **model** by which the mimic gains protection from being eaten provided to the **model** by being either unpalatable, poisonous, noxious, or being otherwise distasteful; mimicry is often associated with **aposematic coloration**
- mine** Gallery or burrow, visible beneath the epidermis of plant tissue made by a larva. A **leaf mine** for instance is a gallery in the mesophyll layer between the upper and lower epidermis of a leaf
- miscible** Having the property to mix well
- miscible liquid (m.l.)** Formulation of pesticide in which the technical product is dissolved in an organic solvent, which on dilution, is dissolved in the water carrier
- mist blower** Spraying device that produces a fine air-carried spray (fig. 8-19 H)
- miticide** See **acaricide**
- mitosis** (= **karyokinesis**) Method of nuclear division which produces two daughter nuclei, usually identical to each other and to the parent **nucleus**
- model** One of the three components of a **mimicry** system, the emitter of signal(s) received by the **observer**; the organism resembled by the **mimic**, protected from predation, for example by distastefulness
- mola, molar** (adj. molar) Ridged or roughened grinding surface of the mandible (fig. 2-6)
- mold** See **mould**
- molt** See **moult**
- molluscicide** Any agent effective against molluscs like slugs and snails
- moniliform** Bead-like
- monitoring** Observation for a particular purpose as to keep track of crop development and insect **infestation**
- monoculture** Extensive cultivation of only one crop species resulting in very low species diversity and high **susceptibility** of the crop to pest attack; see **polyculture**
- monogyn** Colony of **eusocial** insects dominated by one queen
- monophage** (adj. monophagous) Eater of only one kind of food, used particularly by specialised **phytophages**
- monophyletic** Of common ancestry
- monotrysian** Having a single genital **aperture** serving both for **copulation** and **oviposition**
- monoxene** (adj. monoxenous) Parasite restricted to one host
- morph** Genetic form or variant
- morphology** Study of forms and structures of organisms
- mortality** Death rate
- mould** Microfungus, often visible as black or dark stains on surfaces
- moult** In insects, the formation of a new **cuticle** followed by shedding of the old cuticle (**ecdysis**)
- motile** Mobile, being able to move; opposite to **sessile**
- Müllerian mimicry** Mimetic system in which two or more unpalatable species obtain protection from predation by resembling each other; see **Batesian mimicry**
- multiordinal** Of several sizes; refers to **crochets** of the larval **prolegs**
- multiparasitism** Parasitization of a host by two or more **parasites** or **parasitoids**
- multiple resistance** Concurrent existence of two or more 'defence' mechanisms against an insecticide in a single pest population
- multiporous** Having several openings
- multiserial** Arranged in several series; refers to **crochets** of the larval **prolegs**
- multivoltine** Having more than one generation annually
- mutagen** (adj. mutagenic) Any influence capable of increasing **mutation** rate, usually caused by chemicals, ultraviolet radiation, x-rays, beta and gamma radiation
- mutation** Alteration in the arrangement or amount of the genetic information in a cell or virus
- mutualism** (adj. mutual) **Symbiotic** relationship between two or more species, in which both species benefit, eg. ants and antplants
- mycophage** (= **fungivore**) (adj. mycophagous, fungivorous) Eater of fungi

- myophily** Pollination by flies
- myrmecochory** Seed dispersal by ants
- myrmecology** Study of ants
- myrmecophily** Pollination by ants
- myrmecophyte** Plants housing ants; 'ant plants'
- naiad** Immature stage of aquatic **hemimetabolous** insects; see **nymph, larva**
- nasute** With a pronounced snout; in termites, soldiers possessing a snout
- natality** Birth rate, the reproductive rate of all females of a population; see **fecundity**
- natatorial** Swimming
- native** Indigenous, originated locally, not exotic
- necrophage** (adj. necrophagous) Eater of dead and/or decaying animals
- necrosis** Death of cells or tissues, especially through disease
- nectar** Nutritious liquid produced in intra- or extrafloral **nectaries** of mainly insect-pollinated plants, containing sugars, amino acids, minerals, etc.
- nectaries** Nectar-secreting glands of flowers, either in the flower (intrafloral) or outside (extrafloral)
- Neem tree** *Azadirachta indica* (Meliaceae), traditionally used multipurpose tree having insecticidal properties
- nematicide** Any agent effective against **nematodes** such as eelworms
- Nematodes** Roundworms, eelworms or threadworms
- Neoptera** (adj. neopteran) Group of more advanced insect orders with foldable wings
- neotenic** Reproductive termite assisting the queen in laying eggs
- neoteny** (adj. neotenous) Retention of **juvenile** features into the adult stage
- neurohormone** (=neuropeptide) Largest class of insect **hormones**, being small proteins secreted within different parts of the nervous system
- neurone** Nerve cell
- neuropeptide** see **neurohormone**
- Neuroptera** Lacewings and antlions
- neurosecretory cells** Modified **neurons** found throughout the nervous system, producing insect **hormones** except ecdysteroids and **Juvenile Hormone**
- neurotransmitter** Chemical transmitting nervous signals between nerve cells
- niche** Role within a **community** enacted equivalently by different species in different communities; for animals largely defined by feeding habits and size; modern niche theory is concerned particularly with resource competition between species; sometimes referred to as 'profession of a species'; see **habitat**
- nit** Egg of lice or other parasitic insects
- nocturnal** Active during the night
- nodiform** In the form of a knot or knob
- nomenclature** Science of naming plants and animals
- non-target organism** See **target organism**
- notum** Dorsal sclerites of the thorax (fig. 2-18)
- noxious** Harmful; opposite of innocuous
- nucleus** (pl. nuclei, adj. nuclear) Organelle in **eukaryotic** cells making up about 10% of the cell volume and containing the cell's **chromosomes**
- nuptial flight** Mating flight of winged queens and males of Hymenoptera and termites
- nymph** Larval instar of **hemimetabolous** insects; see **larva, naiad**
- obligatory** Compulsory, exclusive; opposite of **facultative**
- obligatory diapause** Resting stage that occurs in every individual of each generation of a **univoltine** insect
- observer** One of the three components of a **mimicry** system, the receiver of the signal(s) emitted by the **model** and **mimic**
- obtect pupa** Pupa with body appendages fused to the body, not free (figs. 2-43, 5-51 B); see **exarate pupa**
- occipital foramen** Posterior **aperture** of the insect head through which the alimentary canal, central nervous system and other organs pass
- occlusion** Blocking, shutting or closing; eg. the closing of the bark around an injury
- ocellus** (pl. ocelli) Simple organ of sight found above or between **compound eyes** of many insects; usually three, but can be reduced to two, one or none (fig. 2-4)
- ocular** Referring to vision and eyes
- Odonata** Dragon- and damselflies
- oesophagus** (=esophagus) Gullet or **foregut** that lies between the **pharynx**, and the **crop** (fig. 2-23)
- offspring** (no plural) Descendant from an ancestor; sons, daughters, grandchildren, etc.
- olfaction** (adj. olfactory) Sense of smell
- oligophage** (adj. oligophagous) Eater of few kinds of food, eg. several plant species within one genus or one family; used particularly of **phytophages**
- oligopod larva** Larva with legs on the thorax only and not on the abdomen (fig. 2-42)
- oligoxene** Parasite restricted to a few host species only
- ommatidium** (pl. ommatidia) Facet of the **compound eye** in insects (fig. 2-30)
- omnipresent** See **ubiquitous, cosmopolitan**
- omnivore** (adj. omnivorous) Eater of any type of food
- ontogeny** Development from egg to adult
- oocyte** Immature egg cell formed in the **oogonium** within the **ovariole** (fig. 2-33 B)
- ootheca** Egg pack of several eggs laid together in a protective structure (eg. fig. 5-18 A)
- open cell** Area of the wing membrane partially surrounded by **veins** but including part of the wing margin
- operculum** Lid-like cover of an opening, eg. of an egg
- ophistognathous** With the head deflexed such that the mouthparts are directed posteriorly as in many Hemiptera and some Orthoptera.; see **hypo-, prognathous**
- Opiliones** (=Opiliona) Order of **Arachnida**, harvest men
- opistosoma** One of the **tagmata** of **chelicerate** arthropods (Merostoma and **Arachnida**); comprises the trunk segments, devoid of walking limbs; often, eg. in scorpions separable into an anterior **mesosoma** and a posterior **metasoma**

- oral** Referring to the mouth
- organochlorines** Class of insecticides containing chlorine
- organophosphates** Class of insecticides containing phosphorous
- orthognathous** See **hypognathous**
- Orthoptera** Locusts, grasshoppers, crickets, katydids, etc.
- osmeterium** (pl. osmeteria) Eversible pair of stink glands of some Papilionidae caterpillars, located dorsally between head and prothorax
- osmoregulation** Regulation of water balance, maintaining the **homeostasis** of osmotic and ionic content of the body fluids
- ostium** (pl. ostia) Paired, slit-like openings (fig. 2-24) in the wall of the insect heart through which the **haemolymph** enters from the body cavity (**haemocoel**)
- ostium bursae** Copulatory **aperture** of the female **bursa copulatrix**
- outbreak (=calamity, plague)** Temporary condition that is characterised by excessive insect numbers and - if it is a pest species - injury to valuable materials or products; sporadic calamities occur suddenly in a small, restricted area and vanish after a short period of time; periodic outbreaks happen at more or less regular intervals
- ovarium, ovary** (pl. ovaria, ovaries) Main reproductive organ in female animals, each comprised of several **ovarioles**, producing eggs (fig. 2-33 B)
- ovariole** One of several ovarian tubes that form the **ovary** (fig. 2-33 B)
- ovicide** Any factor or chemical that destroys eggs
- oviduct** Duct carrying the eggs from the ovary to the genital opening (**gonopore**)
- oviparity** (adj. oviparous) Reproduction in which eggs are laid
- oviposition** Act of laying or depositing eggs
- ovipositor** Modified hollow or sheath-like, paired abdominal appendages of female insects for laying eggs
- ovoviviparity** (adj. ovoviviparous) Retention of the developing fertilised egg within the mother, considered to be a form of viviparity but in which there is no nutrition of the hatched young; see **viviparity, oviparity**
- ovulation** Release of an **ovum** or **oocyte** from the female **ovary**
- ovum** (pl. ova) Egg
- paedogenesis** Asexual reproductive system in which the juvenile stages reproduce
- palaeontology** Study of **fossils** and evolutionary relationships and ecologies of organisms forming the fossils
- Palaeoptera** Group of primitive insect orders of Odonata and Ephemeroptera that are unable to fold their wings
- palp, palpus** (pl. palps, palpi) One of a pair of segmented appendages, eg. of the **maxillae** or **labium**, provided with **sensilla** (eg. figs. 2-6, 2-9, 2-10, 2-12)
- pan-tropical** Species occurring widely throughout the Tropics and Subtropics
- pandemism** (adj. pandemic) Referring to a universal, widely spread disease
- papillae anales** Pair of lobes at the tip of the abdomen of female moths used in **oviposition**; usually clothed with sensory **setae**, but sometimes fused, sclerotized and dentate and used to pierce plant tissues
- paraglossa** (pl. paraglossae) One pair of lobes distolateral on the **prementum** of the **labium**, lying outside the **glossae**, mesal to the **labial palp** (eg. fig. 2-6)
- parasite** (adj. parasitic) Organism that lives at the expense of another (**host**) which it does not necessarily kill; see **parasitoid, ectoparasite, endoparasite**
- parasitism** Symbiotic relationship between two species in which one species, the **parasite** benefits to the detriment of the other, the host but usually without causing its death; see **multiparasitism, superparasitism, hyperparasitism**
- parasitization** Condition of being **parasitized** by either a **parasite** or **parasitoid**
- parasitized** State of a **host** that supports a **parasite** or **parasitoid**
- parasitoid** Internal or external **parasite** that ultimately causes the death of its **host**
- parthenogenesis** (adj. parthenogenetic) Non-sexual reproductive system in which the eggs undergo full development without having been fertilised by a male
- parts per million (ppm)** Measurement of concentration, eg. the proportion of a toxicant present in relation to that of plant material on which it has been deposited; usually used in connection with the edible proportion of a crop and its suitability for consumption
- paurometabolous development** See **gradual metamorphosis**
- patagium** (pl. patagia) One of a pair of anterior **sclerites** of the **prothorax**
- pathogen** Disease-causing **parasite**, often microorganisms
- pathogenesis** Period during which a **pathogen** is actively attacking the living tissue of its **host**
- pathogenic** Disease-producing
- pathogenicity** Ability to overcome the body defence of a **host**, to invade and injure the tissues of the host and to eventually produce diseases
- pecten** Comb-like series of **setae** or **scales**, sometimes present either on the **scape** of the antenna or vein CuA on the upper side of the hind wing
- pectinate** Comb-like
- pectinifer** Comb of special **setae** or **sensilla** on the **valva** in males of some Nepticuloidea and Incurvarioidea
- pedicel** Second segment of the antenna (figs. 2-5, 2-6)
- pedipalp** Second pair of head appendages of spider-like animals (**Arachnida**)
- periodic release** Regular release of biocontrol agents that are effective in control but unable to establish permanently
- peripneustic** System of **gas exchange** in many insect larvae with 9 functional pairs of **spiracles**
- persistence** Property of some pesticides that can remain unaltered in the environment for a considerable long period of time

- pest** Organism that is judged by man to cause harm to himself, his crops, livestock or his property
- pest resurgence** Rapid increase in numbers of a pest following cessation of control measures or resulting from development of **resistance** and/or elimination of natural enemies
- pesticide** Toxic or poisonous chemical used to control or kill pest organisms; a term of wide application which includes all the more specific applications, eg. **insecticide**, **molluscicide**, **nematicide**, **rodenticide**, **acaricide**, **fungicide**, **herbicide**, etc.
- pesticide resistance** Result of a selection of individuals that are genetically predisposed to survive a pesticide; see **multiple resistance**, **pesticide tolerance**
- pesticide tolerance** Ability of an individual to survive an insecticide not necessarily due to genetic predisposition
- petiole** In entomology, the narrow 'waist' of symphytic Hymenoptera as part of the abdomen (fig. 5-59)
- phalaenophily** Pollination by moths
- pharate adult** Fully developed adult insect after **apolysis** but before it sheds the pupal cuticle
- pharynx** Anterior part of the **foregut**, anterior to the **oesophagus** (fig. 2-23)
- phase polymorphism** Occurrence of distinct morphological features of **solitary** individuals (occurring singly) and **gregarious** individuals (forming aggregations) of a species; phase polymorphism can be found in some Lepidoptera and Orthoptera
- Phasmatodea** Stick and leaf insects, walking sticks
- phenotype** Total appearance of an organism, determined by interaction during development between its genetic constitution (**genotype**) and the environment
- pheromone** Volatile substance secreted by an individual, that produces a certain response in other individuals of the same species; pheromones can act as sex attractants, or can be engaged in communication, courtship, identification of individuals of the same nest and warning of danger
- phoresy** Transportation of small non-parasitic animals, such as mites, on the bodies of larger animals
- photosynthesis** The light-dependent manufacture of organic molecules like sugars from inorganic molecules like carbon dioxide by photo**autotrophic** organisms like plants, blue-green algae and cyanobacteria
- Phthiraptera** Lice
- phylogenetics** Approach to biological **classification** concerned with reconstructing **phylogeny** and recovering the history of **speciation**
- phylogeny** (adj. phylogenetic) Evolutionary history of a group of organisms, the family tree and relationship of the species in a group
- physical poison** Chemicals that are applied to suffocate target insects by means of dust or to disrupt the cuticle by using petroleum oil, detergents or organic solvents
- physiology** Study of processes that occur within living organisms; in multicellular organisms, includes interactions between cells, tissues, and organs and all forms of intercellular communication
- phytochemical** See **secondary plant compound**
- phytophage** (=herbivore) (phytophagous) Eater of plants or materials of plant origin
- phytosanitation** Measures requiring the removal or destruction of diseased or **infested** plant material likely to form a source of re-infection or re-infestation
- phytotoxic** Toxic to plants
- pigment** Colouring matter in tissues and cells
- pilifer** One of a pair of lateral lobes of the **labrum**, usually bearing **setae**
- pinaculum** (pl. pinacula) Sclerotized plate bearing one or more primary larval **setae**
- pin-hole** Smaller hole in wood of a living or dead tree made by wood boring beetles; see **shot-hole**
- plant resistance** Range of inherited mechanisms by which plants resist insect and, in general, pest attack; see **antibiosis**, **antixenosis**, **tolerance**
- planta** In entomology, flat terminal part of the ventral **proleg** in larvae
- plastron** Layer of fine hair which holds a layer of air on the underside of some aquatic insects
- Plecoptera** Stoneflies
- pleural membrane** Lateral membrane connecting the **sclerites** of the **tergum** and **sternum**
- pleuron** (pl. pleura, adj. pleural) Enlarged lateral plate of an insect's winged abdominal segment (fig. 2-18)
- plumose** Bearing whorls of **setae**
- poikilothermia** (adj. poikilothermic) Inability to regulate the body temperature relative to the surrounding environment; synonym to **ectothermia**
- poison bait** See **bait**
- poison glands** Accessory glands that produce poison, as in the **stingers** of Hymenoptera
- pollination** Transfer of pollen from male to female flower parts
- polyculture** Cultivation of several crops in the same area, resulting in higher species diversity and lower pest **susceptibility**; see **monoculture**, **intercropping**
- polyembryony** Asexual reproductive system in which two or more, often very many **embryos** are produced from a single egg
- polygyny** (adj. polygyn) **Social insects** that have several female **reproductives** (**queens**)
- polymorphism** (adj. polymorphic) Major category of discontinuous variation within species as genetic and non-genetic **polymorphism**; see **dimorphism**
- polyphage** (adj. polyphagous) Eater of several species of plants or of a variety of different foods
- polypod larva** Type of larva with jointed legs on the thorax and **prolegs** on the abdomen (fig. 2-42)
- population** Group of **conspecific** individuals (of the same species), commonly forming a breeding unit and sharing a particular **habitat** at a given time
- population biology** See **population ecology**
- population density** (=abundance) Number of individuals per area or volume
- population dynamics** Changes in size and structure of a population through time and space

- population ecology (=population biology)** Study of populations, their structures, functions and dynamics; population ecology is integrated by some authors in **synecology**, others consider it as equivalent to synecology and **autecology**
- population size** Number of individuals of a population
- population system** Total of factors or **variables** having an impact on the **population dynamics**
- posterior** Situated behind, after, at the rear (fig. 2-2)
- powderpost beetles** Beetles of the subfamily Lyctinae (Bostrichidae) and the closely related furniture beetles (Anobiidae) that bore seasoned and unseasoned timber causing structural damage
- predation** (adj. predacious, predatory) Preying on other organisms; see **predator**, **prey**
- predator** Animal that uses in its life two or more other individual animals (**prey**) as food
- predisposition** Condition increasing the susceptibility of a plant to a pest or disease, usually the result of environmental or cultural defects
- pregenital segments** First seven abdominal segments
- prehensile** Grasping, clasping
- prementum** Free distal end of the **labium** usually bearing **labial palps**, **glossae** and **paraglossae** (fig. 2-6, 2-12, 2-15)
- prepupa** Quiescent stage between the larval period and the pupa, found in some Diptera and Thysanoptera
- presoldier** In termites, an intervening stage between soldier and worker
- pretarsus** (pl. pretarsi, adj. pretarsal) Terminalia of the last **tarsal** segment of an insect leg (fig. 2-19), eg. a pair of claw-like appendages
- prevention** (adj. preventive) In applied entomology, the protectant application of a pesticide before a predicted **infestation** of a crop
- prey** Food item for a **predator**
- primary reproductives** In termites, the **queen** and **king**, founders of a colony
- proboscis** Tubular organ of insects used to suck in liquid food; in Lepidoptera formed from the paired **galeae** (figs. 2-11, 2-17)
- proctodeum** See **hindgut**
- producers** **Autotrophic** organisms like plants that produce carbohydrates during **photosynthesis**; see **food chain**, **materials triangle**, **trophic levels** (fig. 4-1)
- progeny** Offspring, descendants, young
- prognathous** With the mouthparts directed anteriorly
- proleg** Unsegmented, fleshy, leg-like, ventral, abdominal organ in larvae, used for walking; ‘false leg’
- pronotum** Dorsal, sometimes greatly enlarged **notum** of the first thoracic segment (**prothorax**) (fig. 2-1)
- propodeum** In **Apocrita**, the first abdominal segment if fused with the thorax to form a **mesosoma** (fig. 5-59)
- prophylactic** In applied entomology, measures that are continuously applied for the prevention of **outbreaks**
- protandry** Applied to the situation in many insects in which adult males always shed the pupal cuticle some time before the females
- protectant** In applied entomology, the **preventive** application of a pesticide before a predicted **infestation** of a crop
- prothoracic gland** Thoracic or cephalic glands that secrete ecdysteroids (figs. 2-28, 2-35)
- prothoracic shield** Sclerotized middorsal plate on the **prothorax** of larvae
- prothoracicotropic hormone (PTTH)** Neuropeptide **hormone** secreted by the **brain** that controls aspects of moulting and **metamorphosis** via action on the **corpora cardiaca** (fig. 2-35)
- prothorax** First, anterior segment of the adult insect’s thorax, carrying the forelegs
- protista** Simple, unicellular **eukaryotic** organisms including **protozoa**, algae and certain fungi
- protocerebrum** Anterior part of the insect **brain**, the **ganglia** of the first segment, comprising the ocular and associative centres
- protonymph** Second instar of mites, the first nymphal instar after the **larva** (fig. 5-7)
- protoplasm** Cell contents within and including the plasma membrane
- protozoa** Unicellular and colonial animals
- protraction** Withdrawal, the converse of extension
- protrusible** Capable of being extended or protruded
- Protura** Proturans, one of the three **entognathous** orders
- provenance** Variety of defined geographic origin
- proximal** Part of an appendage being closer to or at the body (fig. 2-2); opposite to **distal**
- pseudergate** In ‘lower’ termites the equivalent of the **worker** caste, comprising immature nymphs or undifferentiated larvae that have the ability to change into other **castes**
- pseudocopulation** Attempted **copulation** of an insect with a flower
- pseudoplacental viviparity** Viviparity (producing living offspring) in which an egg develops via nourishment from a presumed placenta
- psocid** See **Psocoptera**
- Psocoptera** Booklice, barklice, psocids
- psychophily** Pollination by butterflies
- pterostigma** Pigmented and denser spot near the anterior margin of the fore and sometimes hind wings
- pterothorax** The enlarged second and third segments of the thorax bearing the wings and the flight muscles
- Pterygota** Orders of winged insects
- pterygote** Winged
- pubescent** Covered with fine short hair; downy
- pulvillus** (pl. pulvilli) Paired lobes at the tip of the **tarsus** associated with claws (fig. 2-19)
- pupa** (pl. pupae) Resting stage between the last larval **instar** and the adult in the life cycle of **holometabolous** insects; also termed **chrysalis** in Lepidoptera
- puparium** Hardened skin of the final instar larva in which the pupa forms
- pupation** Becoming a pupa
- pylorus** Anterior hindgut where the **Malpighian tubules** enter (fig. 2-23)

- pyramid of biomass** See **materials triangle** (fig. 4-1)
- pyrethrin** One of the insecticidal chemicals of pyrethrum *Taneacetum cinerariaefolium* (Compositae)
- pyrethroids** Class of insecticides with structural similarity to **pyrethrin**
- quarantine** Examination, observation, treatment and/or isolation of organisms or particular products for a certain period of time in order to prevent the spread of pests and diseases. Quarantine is one of the most important pest management tools for islands nations
- quasisocial** Social behaviour in which individuals of the same generation cooperate and nest-share without division of labour
- queen** Female belonging to the **reproductive caste** in **eusocial** or **semisocial** insects; see **gyne**
- quiescence** (adj. quiescent) Temporary suspension of activity or development in response to a brief period of unfavourable conditions; see **diapause**
- race** Category of **infraspecific** variation; a non-formal category used chiefly in zoological contexts; geographical races approximate to **subspecies**
- radius** In wing venation, the third main longitudinal wing vein, usually with five branches, some of which may be fused or lost (fig. 2-21)
- rami** Branches of a pectinate antenna
- Raphidioptera** Camelneck flies, snake flies
- raptorial** Clasping, grasping
- receptaculum seminis** See **spermatheca**
- receptor** Sense cell responding to some variable features of an animal's internal or external environment by a shift in its membrane voltage; receptors can be sensitive to the quality of temperature (**thermo-**), light (**photo-**), smell and taste (**chemo-**), sound, touch, gravity, currents of air, etc. (**mechanoreceptor**)
- rectum** (adj. rectal) Last part of the **hindgut** (fig. 2-23)
- reflex** Simple response to a simple **stimulus**
- reflex bleeding** Faculty by which some insects like ladybirds (Coccinellidae) can eject blood through certain weak spots in the **intersegmental membranes** as a defensive response
- refractory period** Time taken for nerve and muscle membranes to recover their resting ionic imbalance after passage of an impulse
- remigium** Anterior part of the wing, usually more rigid than the posterior **clavus** and with more veins (fig. 2-1)
- reniform** Kidney-shaped
- repellent** Substance disliked by particular insects, driving them back
- reproduction** Process of multiplication of living organisms whereby the species is perpetuated, either **sexual** or **asexual reproduction**
- reproductive potential** Potential of reproduction limited by environmental factors; the result of reduced **biotic potential** depending on fertility, length of the life cycle and sex ratio; see **environmental resistance**
- reproductives, reproductive caste** In **social insects**, individuals that are responsible for the production of offspring; see **queen, king, neotenic, alate, de-alate**
- residual poison** Poison remaining in the pest's body for some time after the application and being still capable of harming the pest
- residue** In applied entomology, the amount of pesticide remaining in or on plant tissue or in soil after a given time, especially at harvest time
- resistance** (adj. resistant) Ability of an organism to withstand, suppress or retard the injurious effects, eg. of pesticides or pathogens; see **environmental resistance, pesticide resistance, plant resistance, metabolic resistance, multiple resistance**
- respiration** (adj. respiratory) Metabolic process in which substrates (food) are oxidised using molecular oxygen; also used inappropriately to mean breathing through **spiracles** or **gas exchange** across a thin **cuticle**
- retinaculum** Membranous hook, a series of hooks, or groups of specialised scales beneath the forewing, behind which the **frenulum** hooks (fig. 5-49)
- rhizosphere** Zone surrounding the roots of plants, usually richer in fungi and bacteria than elsewhere in the soil
- rigor mortis** State of muscle rigidity that follows death in most organisms
- rodenticide** Any agent suitable for the control of rodents
- rostrum** Mouth; the beak-like piercing-sucking mouthparts of bugs; also applied to the 'snout' of weevils
- rot** Disease symptom in which plant tissues are destroyed
- rotenone** Chemical derived eg. from *Derris spp.* (Leguminosae) with insecticidal and other toxic effects
- round dance** Communication dance of honey bees (fig. 3-16 A)
- rust** Type of disease characterised by the production of pustules on the surface of the host caused eg. by fungi or mites
- sacculus** Sclerotized basal area of the ventral margin in the **valva** of the male **genitalia**
- saccus** Usually hollow **apodeme** directed forwards mid-ventrally from the **vinculum** into the body cavity of the males of some species
- salivary gland** Gland that produces saliva, sometimes modified to silk gland, eg. in some caterpillars
- saltatorial** Jumping
- sanitation** Removal and/or destruction of diseased material in order to reduce **inoculum**; **phytosanitation** refers to plant material
- saprophage** (adj. saprophagous) Eater of decaying organisms, **scavenger**
- scale** (1). Flattened and modified hair or **seta** of Lepidoptera (2). in most scale insects (Hemiptera: Coccoidea) a covering made of waxy substances for the protection of eggs, nymphs and adults; the scale is called **lerp** in Psyllidae (Hemiptera) and **test** in Diaspididae (Hemiptera)
- scale insect** Member of the superfamily Coccoidea (Hemiptera); see **scale**
- scape** Basal segment of the antenna (figs. 2-5, 2-6)
- scarabaeiform larva** **Oligopod** larva, having a curved, fleshy abdomen and possessing limited mobility, eg. the grub of Scarabaeidae (Coleoptera) (fig. 5-33 B)

- scavenger** Animal feeding on carrion, dead plants, decaying matter and animal faeces
- sclerite** Sclerotized plate forming part of the **exoskeleton** or body wall of an insect
- sclerotin** Brown substance produced by tanning of protein; it is deposited in certain areas of the **exoskeleton** and produces hard, often thickened plates or **sclerites**
- sclerotization** (adj. sclerotized) Stiffening of the **cuticle** by cross-linkage of protein chains
- scolus** (pl. scoli) Outgrowth of the body wall in larvae, bearing branches or **setae**
- scraper** Ridged surface drawn over a **file** to produce **stridulatory** sounds
- scutellum** Posterior third of the **alinothum** (either meso- or metanotum), lying behind the **scutum**; in many Hemiptera, Homoptera, Coleoptera and Diptera, the scutellum is a more or less triangular sclerite between the base of the wings
- scutum** Middle third of the **alinothum** (either meso- or metanotum), lying in front of the **scutellum**; in hard-bodied ticks, the shield-like protective structure
- secondary pest** Previously harmless insect or other organism becoming a pest following a primary pest attack or pesticide treatment against a primary pest
- secondary plant compounds** Poisonous or noxious plant chemicals assumed to be produced by plants for defensive purposes
- sedentary** Sitting, seated or **sessile**, opposite of mobile
- segment, segmentation** (adj. segmented) In zoology common synonym for metameric segment or **metamerism**, to indicate production of a body plan of repeating organisational units, variably distinguishable, along the antero-posterior body axis (eg. fig. 5-1)
- selective pesticide** Pesticide that destroys certain species of pests and leaves others relatively unharmed
- semi-aquatic** Living in saturated soils but not immersed in free water
- semi-looper** Caterpillar from the Noctuidae subfamily Plusiinae with two or three pairs of prolegs, moves in a somewhat looping manner; see **looper**
- semen** Sperm
- seminal** Referring to **semen** or **sperm**
- seminal vesicle** Male sperm storage organs
- semiochemical** Any chemical used in **intra-** and **inter-specific** communication, classified as **pheromones** and **allelochemicals**
- semisocial** Social behaviour in which individuals of the same generation cooperate and nest-share with some divisions of reproductive labour
- sense organ** Group of sensory **receptors** and associated non-sensory tissues specialised for detection of one sensory quality such as light, sound, scent, taste, etc.
- sensillum** (pl. sensilla) See **sense organ**
- serpentine** Winding like a snake
- serpentine mine** Mine that is curved or coiled, becoming gradually larger to a head-like end
- serrate** Saw-like
- sessile** Immobile, not capable of moving freely
- seta** (pl. setae) Hair arising from a socket; the hairs present in first-instar larvae are primary setae; those acquired later may be subprimary or secondary setae
- setaceous** Tapering
- setal map** Diagrammatic representation of the arrangement of **setae** in larvae
- setose** Bearing setae
- sexual dimorphism** Distinct sets of **phenotypic** secondary sexual characteristics for females and males of a species; in other words: a male looks different from a female; males and females might differ in body size, coloration of body or wings, patterns of songs, presence and shape of wings and appendages like antlers, feelers, etc. (fig. 2-44); see **dimorphism**
- sexual reproduction** Form of reproduction involving two 'parents' in **eukaryotic** organisms; during **fertilisation** a **haploid** sperm cell fuses with a haploid egg cell to form one **diploid oocyte**; see **meiosis**
- shot-hole** Larger hole in wood of a living or dead tree made by wood boring beetles; see **pin-hole**
- sibling** Full brother or sister
- signum** (pl. signa) Sclerotized area or structure on the inner wall of the **corpus bursae** in the female **genitalia**
- sinus** Space or recess between two lobes or organs
- Siphonaptera** Fleas
- social insects** All termite and all ant species as well as some bee and wasp species that form **colonies** and have structurally and functionally specialised, distinct groups of individuals; see **caste, sociality**
- social stomach** Temporary holding pouch inside the **gaster** of ants for food to be shared with the rest of the colony (fig. 3-21)
- sociality** Condition of living in an organised community; see **quasi-, semi-, sub-** and **eusociality**
- socius** (pl. socii) One of a pair of lobes clothed with **setae**, sometimes present beneath the **uncus** in the male **genitalia**
- soldier in social insects**, an individual belonging to the soldier caste involved in colony defence
- solitary** Non-colonial, occurring singly or in pairs; see **phase polymorphism**
- solvent** In applied entomology, carrier solution in which the pesticide is dissolved to form the concentrate
- soma** (adj. somatic) Body of an animal excluding the germ cells
- sonogram** Graphic representation of the vocalisation of an animal; a sound spectrogram recording the frequency as a function of time (eg. fig. 3-1)
- speciation** Origin of species
- species** Group of individuals sharing the same features and forming a reproductive community, producing fertile offspring; abbreviated **sp.** (singular) and **spp.** (plural)
- specificity** (adj. specific) Preference, eg. of host
- spermatheca** Small sac with an opening to the **vagina**, used for storing **sperm** (fig. 2-33 B)
- spermatophore** Sac containing sperm introduced into the female **bursa copulatrix** by male during **mating**

- sphecomophily** Pollination by wasps
- spine** Multicellular, unjointed, cuticular extension, often thorn-like
- spinneret** Organ through which silk is extruded from the silk glands; in insects, beneath the larval head or on legs; in true spiders, on tip of abdomen
- spinule** Minute, thorn-like projections from the cuticle of larvae
- spinulose** Covered with **spinules**
- spiracle** Lateral opening of the body wall through which air passes to the **tracheal system** (figs. 2-25, 2-26)
- sprayer** Device for the application of pesticide sprays
- spreader (=wetter, surfactant)** In applied entomology, any material added to a spray to lower the surface tension and to improve spread over a given area
- spur** Movable, spine-like structure on the insect leg (fig. 2-19)
- stability** In applied entomology, the ability of a pesticide formulation to resist chemical degradation over a period of time, either in storage or after application
- stadium** Period between **moult**s, **instar** duration or inter-moult period
- stemma** (pl. stemmata) Simple visual organ usually present on each side of the larval head of **holometabolous** insects
- stenogastrous** Having a shortened or narrow abdomen
- sterigma** (pl. sterigmata) Sclerotized plate or plates surrounding the **ostium bursae** of the female
- sterilant** Any substance suitable for **sterilisation**
- sterile** Devoid of living organisms, infertile
- sterile male technique** Means of controlling insects by swamping populations with large numbers of artificially sterilised males, competing with the lower number of fertile males
- sterilisation** To make sterile by killing any micro-organisms present; to render infertile
- sternite** Ventral plate of abdominal segments (fig. 2-22)
- sternum** (pl. sterna, adj. sternal) Ventral surface of the body (fig. 2-22)
- sticker** In applied entomology, material of high viscosity used to stick powdered seed dressings on to seeds
- stigma** Darkened area in the upper margin near the end of the wings of Odonata and some Hymenoptera
- stimulus** (pl. stimuli) Any change in the internal or external environment of an organism intense enough to evoke a response from it without providing the energy for that response
- sting, stinger** Piercing organ at the end of the abdomen of ants, bees and wasps which ejects poisons or venoms to kill, injure or disable enemies or prey
- stipes** Distal part of the **maxilla**, bearing **galea**, **lacinia** and **maxillary palp** (figs. 2-6, 2-9, 2-17)
- Stobbe's gland** Pheromone-producing gland on **sternum** 2 in the males of some Noctuidae, which discharges its **aphrodisiac** secretion on to a special expendable brush of hairs for dissemination
- stomach poison** Insecticidal poison that acts after ingestion into the gut
- stomatogastric (=stomodeal or sympathetic) nervous system** Nerves associated with the fore- and midgut
- stomodeal nervous system** See **stomatogastric nervous system**
- stomodeum** (adj. stomodeal) See **foregut**
- stratification (=layering)** Existence of horizontal **strata** within undisturbed vegetation assemblages
- stratum** (pl. strata) Layer; see **stratification**
- Strepsiptera** Stylops
- stridulation** (adj. stridulatory) Production of sounds by rubbing a structure with a series of hard projections against a ribbed or file-like surface; common in Orthoptera and other insect orders
- style** In **Apterygota**, small appendages on abdominal segments, homologous to abdominal legs
- stylet** One of the elongate parts of piercing-sucking mouthparts (fig. 2-14), a needle-like structure
- subcosta** Second main longitudinal vein of the wing (fig. 2-21)
- subcuticular** Occurring or found under the integument
- subdermal** Occurring or found under the skin or cuticle
- subimago** In **Palaeoptera**, the last **nymphal** instar which has functional wings but is not yet sexually mature
- suboesophageal ganglion** Fused **ganglia** of the **mandibular**, **maxillary** and **labial** segments, forming a ganglionic centre beneath the **oesophagus** (fig. 2-27 A)
- subsociability** Social system in which adults look after immature stages for a certain period
- subspecies** Geographical **race**; one or more taxonomically distinct populations within a species, occupying only part of its whole geographical range
- subterranean** Under the surface of the earth, underground
- sulcus** See **suture**
- superfamily** Group of families more closely related to one another than to other families
- superparasitism** Occurrence of more **parasitoids** within a **host** than can complete their development within the host
- supplement** See **adjuvant, additive**
- supplementary reproductive** In termites, a potential replacement **reproductive** within a nest which does not become **alate**; also called **neotenic**
- surfactant** See **spreader**
- susceptibility** (adj. susceptible) Capability of being **infected** or **infested**, easily becoming diseased, not resistant
- suspension** In physics, a liquid containing very small particles of solid material that will not dissolve
- suture (=sulcus)** Groove or furrow
- syconium** Any fleshy fruit developed from an enlarged succulent receptacle, such as a fig
- symbiont** Organism that lives in **symbiosis** with another organism
- symbiosis** (adj. symbiotic) Dependent relationship of members of one species with those of another, regardless of whether it benefits or harms either species; the three main forms of symbiosis are **commensalism** in which one species profits from the

- association without harming or benefiting the other, **mutualism** in which both species benefit and **parasitism**, in which one species benefits to the detriment of the other, but usually without killing it
- sympathetic nervous system** See **stomatogastric nervous system**
- sympatric** Having the same or overlapping areas of distribution
- symptom** Evidence of a disease, expressed by the reaction of the plant or animal to the presence of the irritating factor or organism; see **syndrome**
- Symphyla** One of the two hymenopteran suborders
- synapse** Gap-like site of approximation of two nerve cells or a nerve cell and its effector at which they may communicate
- synchronous muscle** Muscle that contracts once per nerve impulse
- syndrome** Group of concomitant **symptoms**, often characteristic of a particular disease or pest attack
- synecology** Ecology of **communities** as opposed to ecology of individual species (**autecology**)
- synergism** Enhancement of the effects of two substances that is greater than the sum of their individual effects; in applied entomology, the increased toxic effect of a pest-control chemical
- synergist** (adj. synergistic) Chemical which when added to a pesticide improves its performance; very often the synergist on its own is not a pesticide
- synomone** Communication chemical that benefits both receiver and producer; see **kairomone**, **allomone**
- synonym** In taxonomy, one of two or more names that have been applied to the one species; the older, valid name is the senior synonym, and the more recent, invalid name is a junior synonym
- synthetic** Compounded in the laboratory, as opposed to occurring naturally
- systematics** Study of diversity of life including its organisms and evolutionary relationships; sometimes used as synonym to **taxonomy**
- systemic insecticide** Referring to insecticides incorporated by the body of a host (plant or animal) that kills insects feeding on the host; eg. an insecticide is absorbed through leaves, then spread via the vascular system to all parts; insects acquire the poison by eating any part of the plant
- tagma** (pl. tagmata) Group of segments that form a major body unit, eg. head, thorax and abdomen
- tagmosis** Organisation of the body into major units; see **tagma**
- tannins** Group of complex astringent substances occurring widely in plants, dissolved in cell sap; particularly common in tree bark, unripe fruits, leaves and galls; also found in some animals like in insects and other arthropods, where it is employed in the enzymatic tanning process of the cuticle; tannins include phenols, hydroxy acids or glycosides and are used by plants to deter herbivores or by some animals for defence, eg. by millipedes
- target organism** In applied entomology, the species of a pest organism intended to be controlled by means of chemical methods
- tarsal formula** Number of **tarsi** of the fore leg (x), mesothoracic leg (y) and hind leg (z) indicated in some **identification keys** as (x-y-z)
- tarsomere** Tarsal segments, subdivision of the **tarsus**
- tarsus** (pl. tarsi, adj. tarsal) Most distal part of the leg, usually containing five segments (fig. 2-19)
- taxis** (pl. taxes) Orientated movement of an organism which varies according to stimulus intensity
- taxon** (pl. taxa) Any taxonomic unit, eg. species, genus, family, phylum, etc.
- taxonomy** (adj. taxonomic) Classification of organisms including the reconstruction of evolutionary history
- technical product** In applied entomology, the usual form in which a pesticide is prepared and handled prior to formulation; usually at a high level of purity of 95 to 98% but not completely pure
- tegmen** (pl. tegmina) Leathery, hardened forewing
- tegula** (pl. tegulae) Sclerotized lobe, clothed with scales and hinged at the base of the forewing
- tegumen** Modified ninth **tergum** of the male abdomen, forming the upper basal half of the **genitalia**
- telotaxis** Visual fixation of an object such as prey and the movement towards it
- tenacity** In applied entomology, the property of a pesticide deposit or **residue** which enables it to resist removal by weathering
- teratogen** (adj. teratogenic) Factor or agent such as X-rays or certain chemicals causing malformation in **embryos**
- terebrant** Parasitic families of Hymenoptera
- tergite** Dorsal plate of abdominal segments (fig. 2-22)
- tergum** (pl. terga, adj. tergal) Upper surface of the body, connected laterally by the pleural membrane to the **sternum**
- termen** Outer margin of the wing, joining the **apex** and **tornus** (fig. 2-21)
- terminal filament** Impaired and usually long hair-like appendage on the abdomen of larval Odonata and Ephemeroptera (figs. 5-13, 5-14)
- terminalia** Terminal abdominal segments involved in the formation of the **genitalia**
- termitarium** (pl. termitaria) Termite nest (figs. 3-11 to 3-14)
- test** See **scale**
- testis** (pl. testes) Main reproductive organ in male animals, produces sperm cells (fig. 2-33 A)
- thallus** (pl. thalli) Simple, vegetative body of a fungus
- thantosis** Feigning, pretending or shamming death upon disturbance
- therapeutants** Chemicals which have a **curative** action on diseases
- therapeutic** Curative, capable of eradicating or reducing the effects of a disease
- thermoregulation** (=temperature regulation) Regulation of the body temperature, either **poikilothermic** (cold blooded) or **endothermic** (warm blooded)

- thorax** The middle of the three major divisions (**tagma**) of the adult insect body bearing the legs and the wings (fig. 2-1); made up of three segments, the **prothorax**, **mesothorax** and **metathorax**
- threshold** Minimum level of a stimulus required to initiate a response; see **economic threshold level (ETL)** and **economic injury level (EIL)**
- Thysanoptera** Thrips
- Thysanura** Silverfish
- tibia** (pl. tibiae, adj. tibial) Fourth segment of the leg (fig. 2-19)
- tissue** Mass of cells which make up organs of organisms
- tolerance** Ability of a plant to withstand pest attack and recover from it; also used for the amount of toxic residue allowable on or in edible substances under the law
- tornus** Outer angle of the wing, between the **termen** and the inner margin (fig. 2-21)
- toxicant** See **toxin**
- toxicity** Ability to poison or to interfere adversely with the vital processes of organisms
- toxicology** Science dealing with the nature and effects of poisons and venoms
- toxin** (adj. toxic) Poisonous or venomous substance produced by an organism; see **venom**
- trachea** (pl. tracheae, adj. tracheal) System of **ducts** carrying oxygen from the **spiracles** to the internal organs of the insect body (figs. 2-22, 2-25, 2-26)
- tracheal system** Gas exchange system of insects, comprising **tracheae** and **tracheoles** (fig. 2-25)
- tracheole** Finely branched subdivision of a **trachea** which directly supplies insect tissues with oxygen
- transgenic** Describing an organism whose normal **genome** has been altered by introduction of a **gene** by a manipulative technique; such organisms are potentially valuable in plant and animal husbandry as well as in genetic and medical research
- transtilla** Sclerotized transverse band forming the upper margin of the **diaphragm** and the **fultura superior** of the male **genitalia**
- transverse** At right angles to the longitudinal axis
- trap crop** Crop, sometimes of wild plants, grown especially to attract pests or diseases and, when **infested** or **infected**, either sprayed or collected and destroyed; trap plants are usually grown between the rows of the crop plants or around the edges of the field
- tribe** Group of similar genera with common evolutionary origin; taxonomic category between subfamily and genus
- trichoid** Hair-like
- Trichoptera** Caddis flies
- triordinal** Of three, usually alternating sizes; refers to **crochets** of the larval **prolegs**
- triungulin larva** Active, first larval instar of Meloidae (Coleoptera) and Strepsiptera
- trochanter** Small second segment of the leg, between the **coxa** and the **femur** (fig. 2-19)
- trochantin** Small sclerite anterior to the **coxa** (fig. 2-19)
- trophallaxis** Exchange of food between members of Hymenoptera or termite colonies, either through regurgitation from the crop or through defecation
- trophic** Relating to food; of an egg of a social insect, degenerate and used in feeding other members of the colony
- trophic level** Theoretical term in ecology; one of a succession of steps in the transfer of matter and energy through a **community**, as may be brought about by such events as grazing by **herbivores**, **predation** and **parasitism** by **carnivores** and **decomposition**; see **food chain**, **food web**, **autotrophy**, **heterotrophy**, **materials triangle**, **producers** and **consumers** (fig. 4-1)
- trophogenesis** (adj. trophogenic) In social insects, the determination of **caste** type by differential feeding of the immature stages in contrast to the genetic determination of caste type
- tumor** (=tumour) Swelling caused by uncontrolled growth of cells
- tymbal** Stretched, elastic membrane capable of sound production when flexed (fig. 3-4)
- tympanal organ** See **tympanum**
- tympanum** (=tympanal organ) (pl. tympana) Auditory organ sensitive to sound waves (often **ultrasound**), comprising a tympanal membrane (thin cuticle), an air sac and a sensory organ attached to the tympanal membrane (fig. 2-29)
- ubiquitous** (=cosmopolitan) Occurring world-wide, omnipresent
- ultra-low-volume (ULV) spraying** Application method of sprays using very low volumes of a pesticide
- ultrasound** (adj. ultrasonic) Sound waves beyond the range of normal human audibility with frequencies above 20,000 Hertz (= 20 kHz)
- ultraviolet light (UV)** The for human beings invisible wavelengths of the spectrum beyond violet, between 400 nanometers (400 nm) and 150 Angstroms (150 Å = 0.15 nm)
- uncus** Upper, usually lobed part of the male **genitalia**
- unguis** (pl. ungues) Claw (fig. 2-19)
- uniordinal** Of one more or less uniform size; refers to **crochets** of the larval **prolegs**
- uniporous** Having a single opening
- univoltine** Having a single generation per year
- urea** Minor component of insect nitrogenous excretions
- uric acid** Main component of insect nitrogenous excretions
- urticaria** Itchy and sometimes purulent type of skin rash caused by contact with hair of some caterpillars
- vagina** Pouch-like or tubular genital chamber of the female **genitalia**
- valva** (pl. valvae) One of the paired lateral claspers of the male **genitalia**
- valvula** Ventral part of the **valva**, the dorsal apical part of which is differentiated to form a **cucullus**
- vannus** Fan-like expansion of the **clavus** of the hind wing, separated from the **remigium** by the claval furrow; also referred to as **anal fan** or lobe (fig. 2-1)

- variable** In population biology, the total of factors having an impact on **population dynamics**
- variety** Formal taxonomic category in botany below the level of subspecies; often used loosely to mean a variation of any kind within a species
- vector** Literally a bearer; specifically a host of a disease transmissible to another species
- vein** In entomology, a structural strut of the insect wing (fig. 2-21); in Lepidoptera, usually tubular and containing a **trachea** and **haemolymph**
- venation** In entomology, system of wing **veins** (fig. 2-21)
- venom** (adj. venomous) Poisonous substance produced by an organism and injected into another organism
- venter** Lower surface of the body, 'belly'
- ventilate** To pass air or oxygenated water over a gas exchange surface
- ventral** Belonging to the belly, underside; opposite of **dorsal** (fig. 2-2)
- ventral diaphragm** Membrane lying horizontally above the nerve cord in the body cavity, separating the perineural sinus from the perivisceral sinus
- ventral nerve cord** Chain of ventral **ganglia** (fig. 2-27)
- ventriculus** Tubular part of the **midgut**, the main digestive section of the gut
- vermicular, vermiform** Worm-like, worm-shaped
- verruca** Slightly convex plate bearing divergent secondary **setae**, usually occupying the position of a primary larval seta
- vertex** Top of the head (fig. 2-4)
- vesica** Penis, a membranous organ normally contained in the tubular **aedeagus** but everted during **copulation**
- vestigial** Occurring as a rudimentary, non-functioning structure sometimes persisting from an earlier evolutionary form
- viable** Alive, even if in a dormant state
- vinculum** Modified ninth **sternum** of the male abdomen, forming the ventral, basal part of the **genitalia**
- virion** Virus particle
- virulence** (adj. virulent) Ability to overcome the body defence of a host, to invade and injure the tissues of the host and to eventually produce diseases
- virus** Minute intercellular disease agent
- visceral (=sympathetic) nervous system** Nerve system that innervates the gut, reproductive organs and tracheal system
- vitamin** Organic substance usually not synthesised by an organism which it must obtain from its environment in minute amounts (micronutrient)
- viviparity** (adj. viviparous) Bearing of life young (ie. post egg hatching) by the female; see **ovoviviparity** and **adenotrophic viviparity**
- volatile** Able to form a gas from a liquid or solid at room temperature
- voltinism** Number of generations per year
- vulva** External opening of the copulatory pouch (**bursa copulatorix**) or **vagina** of the female **genitalia**
- waiting period** See **withholding period**
- waggle dance** Communication dance of the honey bee (figs. 3-16, 3-17)
- Wasmanian mimicry** Form of **mimicry** which allows an insect of another species to be accepted into a **social insect colony**
- wax** Complex lipid mixture, giving water-proofing to the cuticle providing covering or building material
- wax canals** Fine tubules that transport lipids from the pore canals to the surface of the **epicuticle**
- wax layer** Lipid or waxy layer outside the **epicuticle**
- weed** Any plant in the 'wrong place', particularly used of plants away from their natural range, or invading human monocultural crops
- weedicide** Any agent suitable for the control of weeds
- wettable powder (w.p.)** Powder that is easily wetted by water and will go into suspension
- wetter** See **spreader**
- withholding period** Recommended period of time that has to be allowed between the application of an insecticide and the harvest of a crop, so that residues of the insecticide can be degraded and eliminated; the withholding period depends on the crop species, the insecticide used, the temperature and the intensity of sunlight and varies between several days and weeks
- wireworm** Long and slender larvae of click beetles (Elateridae: Coleoptera)
- worker** In social insects, a member of the sterile **caste** that assists the **reproductives**
- xylophage** (adj. xylophagous) Eater of wood
- zoocecidia** Plant **galls** induced by animals such as insects, mites and nematodes, as opposed to those formed by the plant response to microorganisms
- Zoraptera** Insect order (no common name)

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**Abbreviations**

<b>A.I. or a.i.</b>	active ingredient
<b>BPU</b>	Benzoylphenyl Urea
<b>Bt</b>	<i>Bacillus thuringiensis</i>
<b>CITES</b>	Convention on the International Trade in Endangered Species
<b>CRC TPM</b>	Cooperative Research Centre for Tropical Pest Management
<b>CRI</b>	Christensen Research Institute
<b>CSIRO</b>	Commonwealth Scientific and Industrial Research Organisation
<b>DAL</b>	Department of Agriculture and Livestock
<b>DEC</b>	Department of Environment and Conservation
<b>DPI</b>	Division of Primary Industries
<b>EC, EEC</b>	European (Economic) Community
<b>EIL</b>	Economic Injury Level
<b>ETL</b>	Economic Threshold Level
<b>FAO</b>	Food and Agriculture Organisation
<b>FRI</b>	PNG Forest Research Institute
<b>IFTA</b>	Insect Farming and Trading Agency
<b>IGR</b>	Insect Growth Regulator
<b>INC</b>	Intergovernmental Negotiation Committee
<b>IOCU</b>	International Organisation of Consumers Unions
<b>IPM</b>	Integrated Pest Management
<b>IUCN</b>	International Union for the Conservation of Nature and Natural Resources
<b>JH</b>	Juvenile Hormone
<b>JHA</b>	Juvenile Hormone Analogue
<b>LAES</b>	Lowlands Agricultural Experiment Station Kerevat
<b>NAQIA</b>	National Agriculture Quarantine and Inspection Authority
<b>NARI</b>	National Agricultural Research Centre
<b>NGO</b>	Non-Governmental Organisation
<b>PAN</b>	Pesticide Action Network
<b>PIC</b>	Prior Informed Consent
<b>PNG</b>	Papua New Guinea
<b>QABB</b>	Queen Alexandra Birdwing Butterfly
<b>QABW</b>	Queen Alexandra Birdwing
<b>sp.</b>	species (singular)
<b>sp. nov.</b>	<i>species nova</i> , new species
<b>sp. nr.</b>	species near.
<b>SPC</b>	South Pacific Commission
<b>spp.</b>	species (plural)
<b>SPREP</b>	South Pacific Regional Environment Programme
<b>UDC</b>	University Development and Consultancy
<b>und.</b>	underside
<b>UNDP</b>	United Nations Development Programme
<b>UNEP</b>	United Nations Environment Programme
<b>upp.</b>	upperside
<b>WEI</b>	Wau Ecology Institute
<b>WHO</b>	World Health Organisation
<b>w/v</b>	weight per volume
<b>w/w</b>	weight per weight

## Questions for Self Assessment

### A. Insects and Biodiversity

Which four insect orders have the highest species diversity in the tropical rain forest?

### B. Structure and Function

What are the three major body parts (tagmata) of insects and what are their main functions?

Which important organs/structures does the insect head bear?

What type of mouthparts do the following insects have: adult grasshopper, larval bug, beetle grub, adult butterfly, caterpillar?

Which statements are right?

- insects generally have three pairs of legs and two pairs of wings
- the wings are part of the 2nd and 3rd abdominal segment
- all insects have wings
- insects are close relatives of spider-like animals and crustaceans

What are the five parts of an insect leg?

Which type of activity are the following insect legs adapted to: praying mantis foreleg, grasshopper hind-leg, cockroach legs?

What is the scientific term for the forewings of a beetle?

What are the major functions of the abdomen?

How does the gas exchange system of a terrestrial insect work?

Where can spiracles be found?

- there is one pair laterally on each thoracic segment
- on the abdomen

### C. Insect Development

What are the differences between holo- and hemimetabolous development?

- there is a striking resemblance between holometabolous larvae and adults
- the wings of hemimetabolous larvae develop externally
- the wings of holometabolous larvae develop during the pupal stage
- holometabolous insects always have a pupal stage and this never occurs in hemimetabolous insects

What is a nymph?

Why do insects have to undergo moults?

State four holo- and hemimetabolous insect orders.

### D. Evolution and Classification

How is the term species defined?

What are the differences between insects and spider-like animals?

How many legs do spiders have?

How many legs do insects have?

Which body part are the legs attached to?

Do spiders have compound eyes?

How many body regions do insects have and how many do spiders have?

Which insects are social insects?

How is eusociality defined?

Define the term caste system and state the three castes of a termite colony.

What is the function of 'alates' and which caste do they belong to?

What are the distinguishing features between beetles and heteropteran bugs?

What are the differences between butterflies and moths?

What is the most conspicuous feature of most ants, bees and wasps?

### E. Insects and Ecology

How are the terms mutualism, parasitism and commensalism defined? Which categories do herbivory and pollination belong to?

Insect pollination is the major type of pollination in Angiosperms. Both, insects and Angiosperms, owe their evolutionary success to the fact that they have closely coevolved. What is the reward for insects doing all the hard work of pollinating plants?

Another type of interaction between insects and plants is herbivory. Which mechanisms did plants evolve in order to be protected from being eaten by insects?

Explain the term predator-prey relationship. Draw a graph and indicate the alterations to the predator and prey populations during the course of time.

Name five different predacious insects and another five examples of non-insects feeding on insects.

State five possibilities of insect defence and give named insects as examples.

What is the meaning of the term osmeterium?

### F. Population Biology

State five factors that contribute towards the regulation of insect populations. Which factor is the most important one?

How is the term population defined?

Which factors favour unstable pest populations?

- large body size of the pest
- large number of pest's offspring
- constant, predictable climate
- slow development of the pest
- short life cycle of the pest
- early reproduction of the pest
- variable population size of the pest
- low competition
- the pest's predator develops slowly

### G. Insect Signs and Damage Categories

Why is it important for foresters and agriculturalists to be familiar with insect signs and damage categories?

State three examples of insect signs.

Which type of damage is caused by an insect with piercing-sucking mouthparts and which type is caused by chewing mouthparts?

Which layers of a leaf are affected by mines and by window feeding?

What does the term shelter feeding mean and what is the advantage of it?

What is a gall and how are galls induced?

### H. Forest Insect Pests of PNG

Which conditions encourage termite attack and why?

What are the differences between *Coptotermes elisae* and *Nasutitermes novarumhebridarium* in terms of their soldiers, their nest and their respective host species?

What are the symptoms of termite attack on Hoop pine?

By looking at the leaves and the crown of a young Hoop pine, how can you tell whether it is infested by termites or *Hylurdretonus*?

What are signs of damage caused by *Hylurdretonus araucariae*?

When are trees or logs particularly vulnerable to pin- and shot-hole borer attack?

Which measure would you apply as an effective remedy to minimise pin- and shot-hole borer attack in the log yard?

Imagine you are supervising thinning operations in a Hoop pine compartment. How would you carry out the operations in order to minimise the risk of pest attack?

What are the symptoms of *Lymantria ninayi* attack of *Pinus patula*?

### I. Collection and Preservation of Insect Specimens

What information has to be provided on the label of an insect specimen?

How many specimens of a particular species have to be collected and why?

Which trap is commonly used to catch nocturnal insects like moths?

Describe a pheromone trap.

Explain the terms 'mating disruption' and 'male confusion' technique.

Which insects are not suitable for drying? Why is it not possible to dry these specimens?

### J. Insect Pest Management

How is the term pest defined.

Apart from insects, which other pests attack crops?

Contrast monoculture with polyculture in terms of susceptibility to insect attack. Which one is more vulnerable and why?

Which cultural methods can be applied in order to create less favourable conditions for pests?

How should silvicultural methods be applied in tree plantations in order to create conditions less favourable for insect pests like termites?

Keeping trees in a healthy condition is the best way to avoid insect attack. Improper nursery techniques and silvicultural treatments put trees under stress and thus promote insect attack. Describe possible damage to seedlings and trees that might contribute towards insect attack. What can be done in order to minimise this damage and thus reduce the risk of insect attack?

Pest control measures can be either curative (usually meaning to spray a chemical control agent once there is a problem with 'bugs') or prophylactic (to prevent infestation). We should always aim at prophylactic measures since they are more sustainable, feasible, appropriate and often cheaper. Which steps can be taken for the prevention of insect infestation in tree or crop plantations?

Which control measures are included in mechanical and physical methods?

What do the terms plant resistance and resistance to insecticides mean?

What does the term biomagnification mean?

Why can biological control sometimes become a disaster?

State organisms suitable for biological control from the following groups: plants, bacteria, fungi, viruses, insects and spider-like animals

Imagine you were repeatedly applying a chemical insecticide against cutworms in a nursery. After the sixth spraying the insecticide fails to fulfil its task and it does not kill the cutworms any more. What has probably happened?

What are the disadvantages of chemical control?

Which statements are right?

- some insecticides accumulate in the food chain and can be found as residues in food
- more and more powerful insecticides have to be developed since insects become resistant
- some insecticides like DDT are very persistent
- chemical control is always very specific and there are hardly any side-effects on non-target organisms
- chemical control might affect beneficial insects like predators

State the only control strategy that insects cannot become resistant to?

State guide-lines for the safe use of insecticides.

What does the term 'withholding period' mean?

Which techniques and methods are used in Integrated Pest Management?

What is the basic concept of Integrated Pest Management? Draw a graph (pest population versus time). Explain the terms 'Economic Threshold Level' and 'Economic Injury Level' and indicate these levels on the graph.

What has to be taken into account in order to calculate the 'Economic Threshold Level'?

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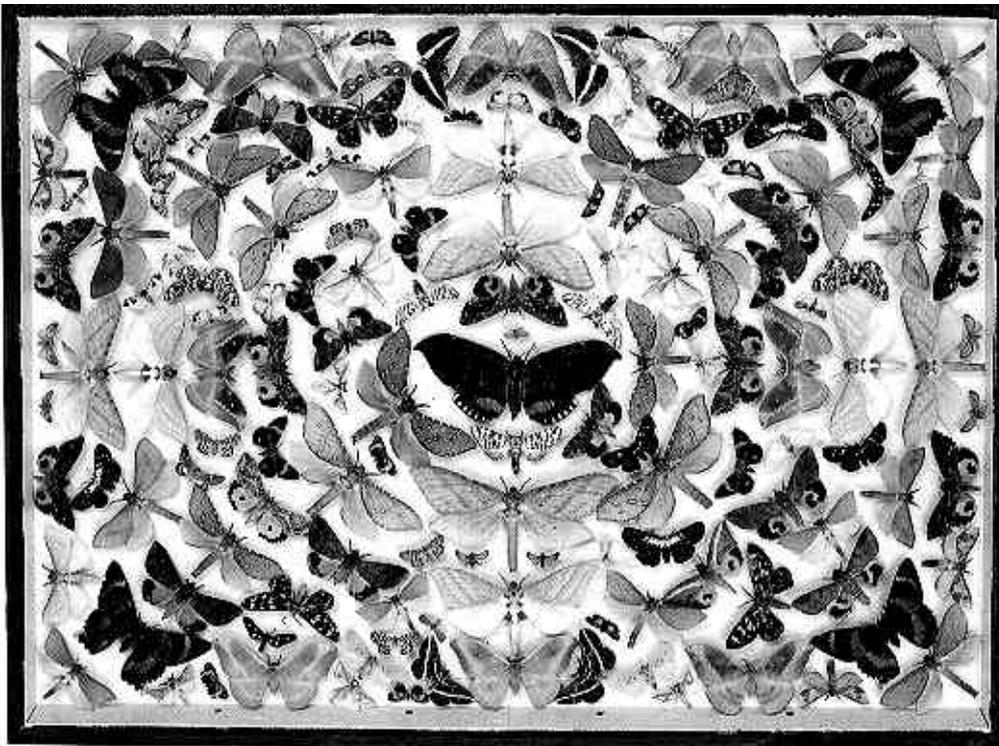
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The moth in the centre is the Giant Fruit-Sucking Moth *Phyllodes imperialis* (Noctuidae), the bigger light coloured moths are rare ghost moths (Hepialidae) (reproduced from Monteith, G., 1991)

## Units

figure		prefix	unit	figure		prefix	unit
10	$10^1$	deca-	d	1:10	$10^{-1}$	deci-	d
100	$10^2$	hecto-	h	1:100	$10^{-2}$	centi-	c
1,000	$10^3$	kilo-	k	1:1,000	$10^{-3}$	milli-	m
1,000,000	$10^6$	mega-	M	1:1,000,000	$10^{-6}$	micro-	$\mu$
1,000,000,000	$10^9$	giga-	G	1:1,000,000,000	$10^{-9}$	nano-	n
1,000,000,000,000	$10^{12}$	tera-	T	1:1,000,000,000,000	$10^{-12}$	pico-	p

## SI-Measures

### Metric Linear Measures:

1 cm = 10 mm = 1,000  $\mu$ m  
 1 m = 100 cm = 1,000 mm  
 1 km = 1,000 m = 10,000 cm

### Metric Area Measures:

1 cm<sup>2</sup> = 100 mm<sup>2</sup> = 10<sup>6</sup>  $\mu$ m<sup>2</sup>  
 1 m<sup>2</sup> = 10,000 cm<sup>2</sup> = 10<sup>6</sup> mm<sup>2</sup>  
 1 hectare (ha.) = 100 m x 100 m = 10,000 m<sup>2</sup>  
 1 km<sup>2</sup> = 100 ha. = 10<sup>6</sup> m<sup>2</sup>

### Metric Cubic and Fluid Measures:

1 cm<sup>3</sup> = 1 ml = 1,000 mm<sup>3</sup> = 1,000  $\mu$ l  
 1 litre (l) = 1,000 cm<sup>3</sup> = 1,000 ml  
 1 m<sup>3</sup> = 1,000 l = 10<sup>6</sup> cm<sup>3</sup>

### Metric Weight Measures:

1 gram (g) = 1,000 mg = 10<sup>6</sup>  $\mu$ g  
 1 kilogram (kg) = 1,000 g = 10<sup>6</sup> mg  
 1 ton (t) = 1,000 kg = 10<sup>6</sup> g

## Conversion of Imperial Measures

### Imperial Linear Measures:

1 inch (in.) = 2.54 cm  
 1 foot (ft.) = 12 inches = 30.48 cm  
 1 yard (yd.) = 3 feet = 91.44 cm  
 1 land mile (mi.) = 1609.34 m  
 1 nautical mile (n. m.) = 1852 m

### Imperial Area Measures:

1 square inch (sq. in.) = 6.45 cm<sup>2</sup>  
 1 square foot (sq. ft.) = 929.03 cm<sup>2</sup>  
 1 square yard (sq. yd.) = 0.836 m<sup>2</sup>  
 1 acre (a.) = 4046.4 m<sup>2</sup> = 0.40 ha.  
 1 square mile (sq. mi.) = 640 acres = 2.59 km<sup>2</sup>

### Imperial Cubic and Fluid Measures:

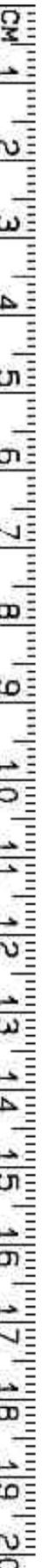
1 fluid ounce (fl. oz.) = 33.3 ml  
 1 pint (pt.) = 0.568 l  
 1 quart (qt.) = 2 pt. = 1,136 ml  
 1 gallon (gal. Imp.) = 4 qt. = 8 pt. = 4.546 l  
 1 gallon (gal. U.S.) = 3.846 l

### Imperial Weight Measures:

1 weight ounce (oz.) = 28.57 g  
 1 pound (lb.) = 545.45 g

### Temperature Measures:

- to convert °C (Celsius) to °F (Fahrenheit), multiply by 1.8 and add 32
- to convert °F to °C, subtract 32 and divide by 1.8



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