

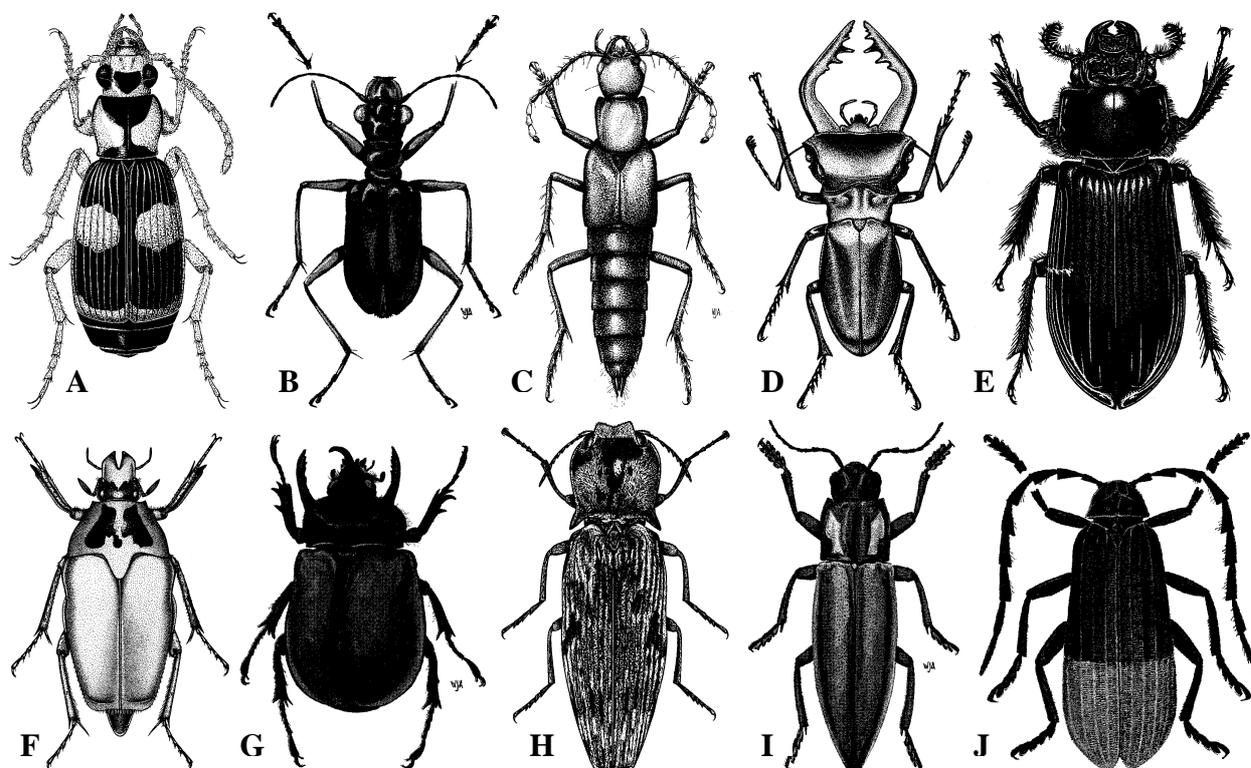
shining underside is a characteristic feature of the otherwise brownish or black water scavengers like *Hydrophilus picicornis*

- **Histeridae**
- **Pselaphidae**
- **Silphidae** Carrion beetles are not well represented in PNG
- **Staphylinidae** The rove beetles are a numerous group of relatively large, up to 25 mm long, mostly black beetles with truncate elytra that nearly always leave two-thirds to three-fourths of the abdomen exposed (fig. 5-34 C). The animals are very active, sometimes running over the ground like ants. The abdomen is very flexible and might be displayed upon disturbance. Rove beetles can often be encountered in rotting fruits and decaying vegetable matter and fungi. The campodeiform larvae are often associated with the adults. Most species are polyphagous predators, feeding on mites and other small creatures. This family is plentiful in PNG, eg.

*Hesperus abnormis* (fig. 5-34 C), *Priochirus*, *Creophilus*, *Hesperus*, *Philonthus*, *Oxytelus*, *Osorius*, *Leucitus*, *Scelotrichus*, *Stichostigma*, *Pachypelmopus*, *Eleusis*, etc.

#### Scarabaeiformia:

- **Lucanidae** Stag beetles include larger, handsome beetles with huge, extended stag-like mandibles which in males are often half as long as the body. They have 5-segmented tarsi, and often clubbed antennae. The body coloration is mostly black, brown or bronze. Common genera in PNG are *Cyclommatus* (fig. 5-34 D, plate 3 F), *Serrognathus*, *Aegus*, *Neolamprina*, *Prosopocoelus* (plate 3 G)
- **Passalidae** Passalid beetles are close relatives of the Lucanidae and are often of black or red-brown colour with reddish hairs. They can be found under the bark of old rotting logs, where their larvae (fig. 5-35 A) feed. The antennae are short with a flattened club. Common genera in PNG are *Pelopides* (fig. 5-34 E), *Analaches*, *Gonatas*, *Aulacocyclus*, and many more.



**Fig. 5-34:** Coleoptera (Beetles): (A<sup>†</sup>) Bombardier beetle *Pheropsophus verticalis* (Carabidae, Brachyninae), (B) *Therates labiatus* (Carabidae, Cicindelinae), (C<sup>†</sup>) *Hesperus abnormis* (Staphylinidae), (D) *Cyclommatus sumptuosus*, ♂ (Lucanidae), (E) *Pelopides schraderi* (Passalidae), (F) *Lomaptera lutea* (Scarabaeidae, Cetoniinae), (G) *Eupatorus beccarii* ♂ (Scarabaeidae, Dynastinae), (H) *Alaus* sp. (Elateridae), (I) *Cyphogastra* sp. (Buprestidae), (J) *Cladophorus* sp. (Lycidae) (reproduced from Gressitt, J. L. & Hornabrook, R.W., 1985; CSIRO, 1991<sup>†</sup>)

- **Geotrupidae** Dung beetles have the ability to bury large quantities of dung in oviposition burrows. Together with the Scarabaeidae, these beetles play an important role in decompositional habitats and are further outlined in **chapter 4.6**
- **Scarabaeidae\*** Amongst the scarabs or cockchafers some of the world's largest beetles can be found. The Goliath Beetle *Goliathus goliathus* occurs in Africa and is not only the world's largest beetle, but also the heaviest insect. In ancient Egypt the scarabs were a symbol for good luck. The Scarabaeidae are the second largest beetle family. Characteristic of these small to large mainly nocturnal beetles is the robust, stout body with well developed mandibles that are invisible from above. Most of the adults are of black or dark brown coloration, but many **Cetoniinae** are brilliantly coloured. The males of many **Dynastinae** species possess more or less long horns, as shown in **fig. 2-44 C, D** and **fig. 5-34 G**. The terminal segments of the antennae mostly form a club of 3 to 7 movable plates or lamellae. The forelegs of adults are often fossorial. The grub-like larvae are scarabaeiform, white and C-shaped with a prominent dark head and three pairs of legs (**figs. 2-38, 2-42 F, 5-33 B**). The Scarabaeidae can be divided into phytophages and coprophages. The ecological importance of adult and larval dung beetles is outlined in **chapter 4.6**. Dung beetles were introduced into many countries, eg. PNG for the rapid turn-over of cattle dung and the control of dung-related fly-problems. The adults of phytophagous species usually feed on foliage and their larvae on the roots of various plants. Many species are considered as serious pests in agriculture, like the *Oryctes centaurus*, feeding on sago, the **Taro beetle** *Papuana*, *Oryctes rhiconeros* on coconut and *Xylotrupes gideon*. Common subfamilies are the nectar-feeding diurnal colourful, mainly metallic green **Cetoniinae** (**flower** or **rose chafers**, **flower scarabs**) with the genera *Lomaptera*, *Ischiosopa* and *Trichaulax* (**figs. 5-34 F, plate 3 I - M**). The whole or the elytra of *Lomaptera* are used for body decoration

during traditional *singsings*. The huge sized **Dynastinae** include the very common **Rhinceros beetles** *Xylotrupes gideon*, *Scapanes australis* (**fig. 2-44 C, D**), *Eupatorus beccarii* (**fig. 5-34 G, Plate 3 H**), the introduced *Oryctes* and the **Taro beetles** *Papuana spp.* The **Melolonthinae** (**chafers**) are the largest subfamily and they are usually of brown to black colour. Most species are phytophagous, some are pests like the cane beetle. The **Rutelinae** comprise the defoliating beetles that are called Christmas beetles in Australia and May beetles or June beetles in the northern temperate areas.

#### **Elateriformia:**

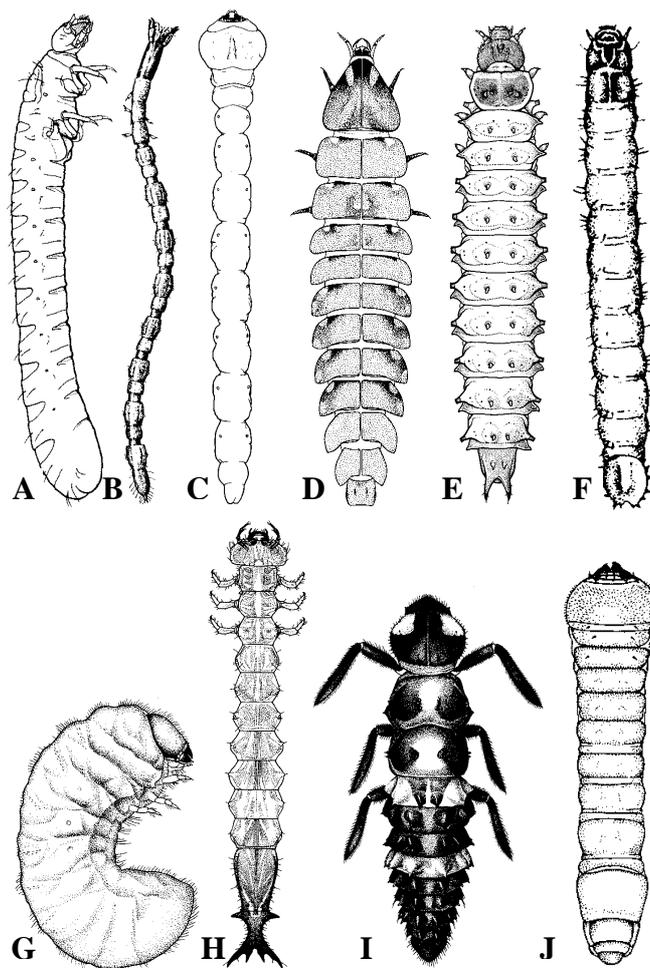
- **Elateridae\*** The click beetles or snap beetles received the name from a peculiar but quite effective defence and right mechanism: a muscular articulation between prothorax and mesothorax enables the beetle to snap its body with an audible click, launching the beetle vertically. The small to medium-sized beetles are somewhat flattened, elongated and heavily sclerotized. Their legs are small and weak, the antennae usually serrate or flabellate. The colours are variable but mainly mottled brown or black and grey due to tiny hairs all over the body. Some Elateridae have the ability to produce glowing **bioluminescent** light for courtship signalling like 'fire flies'. The campodeiform larvae called '**wire worms**' (**fig. 5-35 B**) are often long, slender and hard-bodied, feeding on the roots of various plants and thus may be pests of agricultural crops. Common genera in PNG are: *Agonischius*, *Alaus* (**fig. 5-34 H, plate 3 R**), *Oxystethus*, *Elater*, *Tetrigus*, *Lacon*, etc.

- **Buprestidae\*** The beautiful jewel beetles are also known as metallic wood borers, indicating their often blue, green, gold or coppery iridescent, metallic body coloration and the habit of the larvae to feed on cambium, to bore wood of trees and to mine other parts of plants. The body of the typical jewel beetle is long, flattened and posteriorly tapered. The size is variable from very small to large (3 - 30 mm). The adults possess large compound eyes and short, serrate antennae. The larvae shown in **fig. 5-35 C**, are called

'flat-headed wood borers'. They are pale and strongly flattened with an expanded thoracic region. Regarding their economic importance, many species are pests of agricultural and forestry crops, like the under-bark borers *Agrilus opulentus* and *Agrilus viridissimus* (figs. 6-3 Q and R) attacking *Eucalyptus deglupta* and *Terminalia brassii*. However, some rare species eg. of the genera *Calodema* and *Metaxymorpha* (plate 3 N, O) are valuable and highly esteemed by insect collectors due to their beauty and selling price of up to several hundred Kina per specimen. A number of the shiny iridescent species is traditionally used for body decoration, as shown in fig. 1-3. Common genera in PNG are *Agrilus*, *Anthaxia*, *Belionota*, *Callopistus*, *Cisseis*, *Coraeus*, *Cyphogastra* (plate 3 P, Q, fig. 5-34 I), *Demostis*, *Endelis*, *Helperella*, *Iridotaenia*, *Polycesta*, *Merimna*, *Melobasis*, *Paracupata*, *Stigmodera*, *Calodema*, *Metaxymorpha*, etc.

- **Lampyridae** The adult 'fire flies' and the larval 'glow worms' (fig. 5-35 D) obtained their name from the luminous hind portion of the abdomen and other body parts (see chapter 3.1.2). The larvae and even the eggs of particular species have the ability to emit light for mate-finding and for prey-luring. The term 'glow worm' is misleading, since Lampyridae do not look like worms at all (although some do not look like beetles). The beetles are soft and flat-bodied with very large compound eyes. The short antennae of Lampyridae are serrate, the legs rather short, the elytra flattened, leathery and separately rounded behind. The body colour is black or brown and the prothorax sometimes pale or red. Common in PNG are *Lampyris*, *Luciola*, *Photinus*, *Pterophanes*, *Pteroptyx*, *Atyphella*

- **Cantharidae** The small family of Soldier beetles is very similar to Lycidae and is characterised by flattened, soft bodies with leathery, velvet-like elytra. The antennae of the small elongate predacious beetles are filiform, the body coloration is mostly golden and black. The animals can often be encountered on flowers. Eg. *Chauliognathus*, *Neogresitta* and *Silvanotelus* are found in PNG



**Fig. 5-35:** larval Coleoptera (Beetles): (A) *Aulacocyclus* sp. (Passalidae), (B<sup>+</sup>) larval Elateridae, (C) larval Buprestidae, (D) *Luciola* sp. (Lampyridae), (E) *Lasiodactylus* sp. (Nitidulidae), (F<sup>+</sup>) larval Tenebrionidae, (G) *Stegobium* sp. (Anobiidae), (H) *Platysus* sp. (Cucujidae), (I) *Coccinella* sp. (Coccinellidae), (J) *Phoracantha* sp. (Cerambycidae) (reproduced from CSIRO, 1991; Ross, H.H. et al., 1982<sup>+</sup>; Pyenson, L.L., 1980<sup>++</sup>)

- **Lycidae** The mainly phytophagous members of this family are soft, flattened, slender and of medium body size. They are easily recognisable by their ridged or reticulated prothorax and the long, flat, finely net-veined elytra. The antennae are serrate or flabellate and moderately long. Lycidae have quite often bright **aposematic coloration** like red, orange with black, blue and green, since many of them are distasteful for birds and other predators. Poisonous Lycidae are often the models for **mimicry** in other families of

beetles and even wasps, flies and moths (**fig. 4-16 A-D, chapter 4.4.5**). Common genera in PNG are *Calochromus*, *Xylobanomorphus*, *Leptotrichalus*, *Metriorhynchus*, *Malacolycus*, *Xylobanus*, *Cladophorus* (**fig. 5-34 J**), *Plateros*

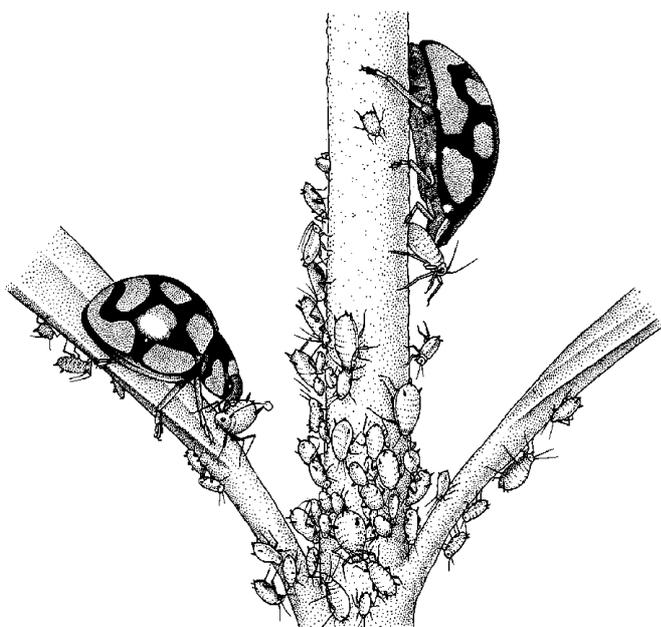
### **Bostrichiformia**

- **Dermestidae** This group is important in temperate areas but poorly represented in PNG. Some species were accidentally introduced with imported dried food products. The stout, often spherical beetles are usually minute to small, covered with short bristles and are of black or brown body coloration. Some species are pests of stored products such as food stuff, others like the museum beetles *Attagenus* and *Anthrenus* can infest animal and insect collections as well as herbarium specimens
- **Bostrichidae** (& **Lyctidae**) The family of powderpost or auger beetles was recently merged with the Lyctidae. The short antennae of the smaller beetles are characterised by three flattened terminal segments. The black or brown powderpost beetles often have vertical elytra and are similar in shape and habits to some bark beetles. Both adults and the white, soft larvae are destructive borers of dry seasoned, unpainted or untreated timber and cane products. The presence of the pest species is indicated by tiny holes and fine, powder-like **frass** on the surface, eg. of furniture. A common pest of timber products occurring in PNG is *Xylothrips religiosus* (**fig. 6-3 S**), others of which some are introduced are *Lyctus*, *Bostrychopsis*, *Heterobostrychus*, *Dinoderus*, etc.
- **Anobiidae** The furniture beetles have similar habits to the powderpost beetles, boring dry organic matter such as furniture, seeds, woody fruits, coniferous cones and stored products. In Europe, the peculiar pest species *Xestobium rufovillum* infests old furniture. The beetles drum their head on the substrate indicating their presence by producing a clock-like clicking noise. Therefore, the common name of this species is '**death's clock**'. Common are *Anobium punctatum* and the cosmopolitan *Stegobium paniceum* (**fig. 5-35 G**)

**Cucujiformia** are beetles with more or less strongly clubbed antennae and the tarsal formula 5-5-4

- **Cleridae** are a family of medium-sized, colourful beetles. The body of adults is elongate, subcylindrical and covered with hairs or bristles. They possess strong cursorial legs and large eyes, resembling tiger beetles (**Cicindelinae**), that lack hairs. Both, larvae and adults are active beneficial predators. In PNG: *Omadius* (**fig. 5-37 A**), *Stigmatium*, *Tenerus*, *Cylindrus*, *Tillus*
- **Melyridae** (= **Malachiidae**) Adults of this family are often similar to the **Cantharidae**, however, New Guinea species have short elytra (**fig. 5-37 B**) and can therefore be confused with **Staphylinidae**. The small to medium-sized active beetles are of dark blue, red, brown or black colour and covered with bristles. The larvae resemble the closely related **Cleridae**. In PNG *Carphurus*, *Attalus* and *Neocarphurus* can be encountered
- **Nitidulidae** The souring beetles are small and of oval flattened body shape. The short antennae are clubbed and the elytra somewhat shortened so that the tip of the abdomen is exposed. The beetles can be encountered on rotting fruits and fungi. Common in PNG are *Megauchenia*, *Haptonchus*, *Carpophilus* (**fig. 5-37 C**), *Cryptarcha* and *Lasiodactylus*, the latter was reported to attack *Syzygium*
- **Cucujidae** This family includes the **Passandrinae**. The flat medium-sized, mainly brown beetles live under the bark of trees. The antennae are long and slender with longitudinal ridges on the elytra. Some species are pests of stored foods. Genera occurring in PNG are *Ancistria*, *Heliota* (**fig. 5-37 D**)
- **Coccinellidae** Ladybird beetles are small to medium sized beetles with hemispherical shaped bodies. PNG has a tremendous variety of ladybirds to offer, most of them are rather small and inconspicuous, uniformly dark brown or black in colour and hardly as colourful as the species of the temperate climates. The antennae are short and clavate, the tarsi are 3-segmented. The campodeiform larvae (**fig. 5-35 I**) and adults are well known

as predators of mites and homopterans, mainly aphids (**Aphididae**) which they consume in large numbers (**fig. 5-36**). Therefore, ladybirds play an important role in controlling aphids in natural habitats and are commonly used as biocontrol agents in agricultural systems. Species of the genera *Rhyzobius*, *Cryptolaemus* and *Chilocorus* (**figs. 8-7 B, C**) are commercially mass reared for release as biological control agents of scales and aphids. Coccinellidae excrete yellowish haemolymph upon disturbance (**reflex bleeding**). The eggs are laid next to an aphid or scale colony. Many species of PNG's Coccinellidae fauna have yet to be described and it certainly bears a tremendous potential of species suitable for biocontrol. Common genera in PNG are *Anisolema*, *Scymnus*, *Neda*, *Coccinella* (**fig. 5-37 E**), *Cryptolaemus*, *Synia*, *Verania*



**Fig. 5-36:** Ladybird beetles (Coccinellidae) feeding on aphids (Aphididae) (reproduced from Gullan, P.J. and Cranston, P.S., 1994)

- **Tenebrionidae** The pie-dish beetles or darkling beetles are a larger group of oblong or oval beetles of either dull or shiny black body coloration. The tarsal formula is in most species 5-5-4. Most Tenebrionidae are nocturnal scavengers, living and hidden in rotting logs or in cavities of bark. Many species are without or with reduced wings or fused elytra

and thus have lost the ability to fly due to their cryptic way of living. The larvae, as shown in **fig. 5-35 F**, are slender, cylindrical and brown due to the their sclerotized cuticle and might be confused with larval **Elateridae**. A number of species are serious pests of stored products, like the cosmopolitan mealworms or flour beetles eg. *Tenebrio molitor*. Some of the many genera occurring in PNG are *Bradymerus*, *Byrsax*, *Platydema*, *Orcopagia*, *Louverensia*, *Lyphia*, *Tabarus*, *Lyprops* (**fig. 5-37 F**), *Neotheca*, *Platolenes*, *Strongylium*

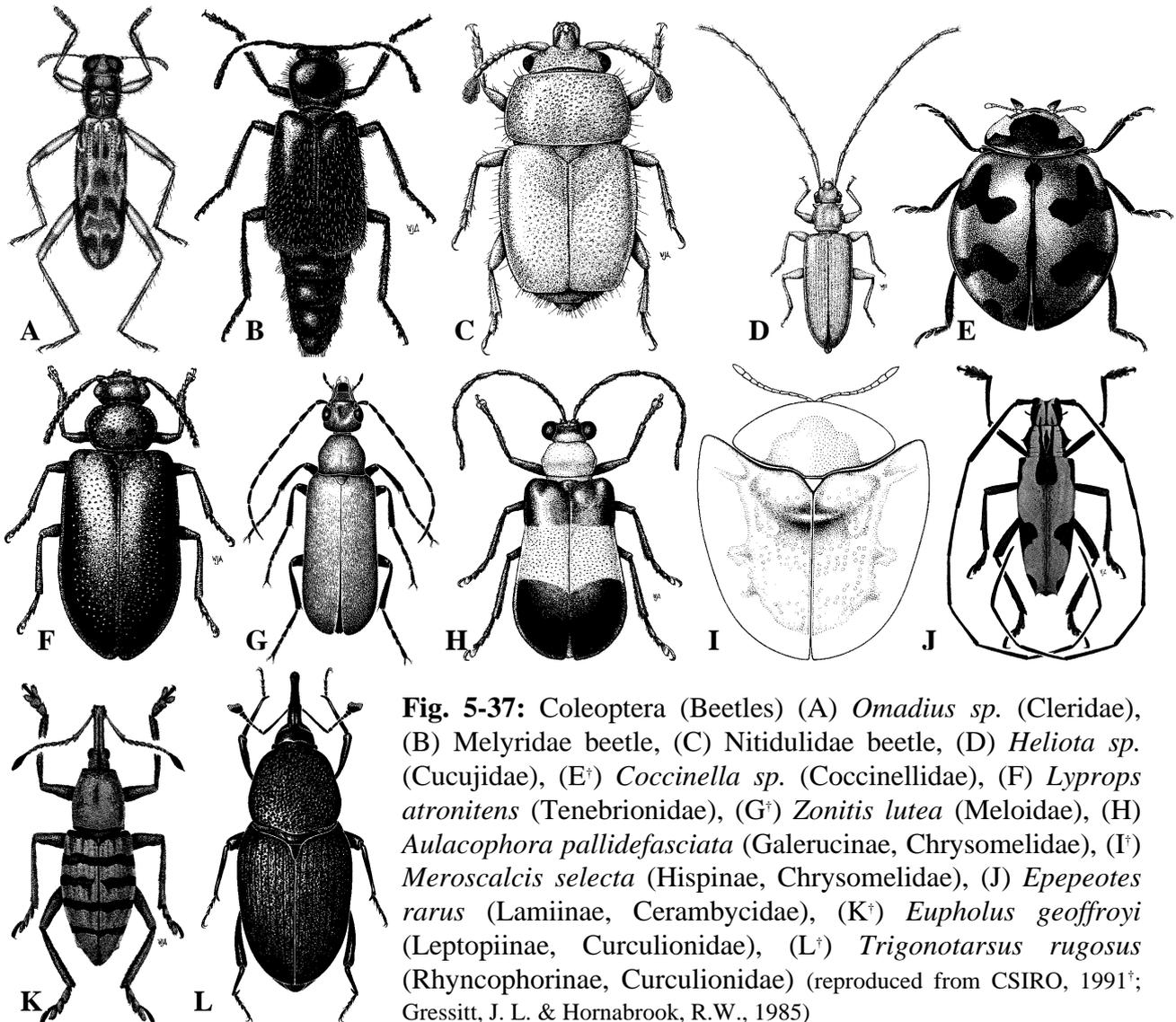
- **Meloidae** The blister beetles are medium-sized, usually soft and flexible and of narrow and elongate body shape. The pronotum is narrower than the head and the elytra (**fig. 5-37 G**), the latter are in some species shortened. Most species are parasites in nests of **Hymenoptera**, however a few species are important pests of vegetables.

- **Cerambycidae\*** The longicorn beetles include probably several thousand species on New Guinea and nearby islands among which some of the longest and most striking species can be found. The world's longest beetle *Batocera kibleri*, sometimes reaching an antennae length of more than 20 cm in males, occurs on New Guinea island. Beetles of the this genus feed on breadfruit (*Artocarpus*). Generally, the large elongate and slender beetles are variable in colour, pattern and form. In males, the filiform or serrate antennae are often two to three times as long as the body. The compound eyes are notched at the base of the antennae. The larvae are almost without exception wood borers, feeding more or less host specific on wood or cambium of living and dead trees. The apod larvae are slender, slightly tapering towards the end and of white or creamy colour, except for the brown or dark head with strong mandibles (**fig. 5-35 J**). Some species tunnel deep into the heartwood or bore largely under the bark. The edible larvae form a pupal cell inside the wood and pupate in this chamber. The adults emerge through the bark after their exoskeleton is fully hardened. Many species of Cerambycidae are severe pests, especially

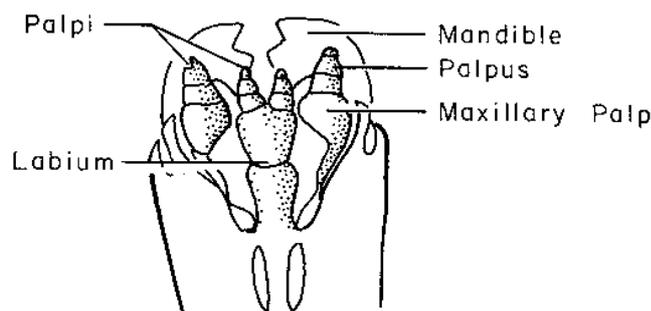
in forestry, like *Potemnemus*, *Dihammus*, *Hyplocerambyx severus* (figs. 6-3 W and 6-14 B) and *Paranda*, that are associated with Hoop and Klinkii pines (*Araucaria spp.*). A peculiar pest species of Northern Queensland is the Hoop Pine Branch Pruner *Strongylurus* that develops in branches of Hoop pines. The adult ringbarks and prunes the branch apically to the nest resulting in the branch breaking off as if it was chopped off nicely. Pruning the branch prevents the branch from breaking where the nest is located. The large and colourful Cerambycidae are of economic importance for local and international insect collectors. There are several subfamilies and genera found in PNG: **Prioninae** (*Xixuthrus*, *Olethrius*, *Osphryon*, *Agrianome*), **Lamiinae** (*Glenea*, *Sphingnotus* [plate 3 T], *Gnoma*, *Batocera* [plate 3 S], *Dihammus*, *Potem*

*nemus* [fig. 6-3 U and V], *Tmesisternus*, *Rosenbergia* and *Epepeotes* [fig. 5-37 J], **Lepturinae** (*Elacomia* and *Papileptura*), **Parandrinae** (*Paranda*) and **Cerambycinae** (*Coptopterus*, *Hyplocerambyx*, *Xylotrechus*, *Ceresium*, *Tethionea*, *Demonax*)

• **Chrysomelidae\*** The leaf beetles are probably the third largest beetle family and there might be a total of 5,000 species in PNG. Unfortunately only about 1,000 species are named so far. Many of the mainly herbivorous leaf beetles are severe pests of agricultural crops. As indicated by the name, the adult beetles mainly feed on leaves. The grubs are called 'root worms' (fig. 5-33 A) and feed on roots, leaves or other parts of plants. The size of the slender, ovate or nearly round beetles is mainly small to moderately large in a few species. Some are flattened,



**Fig. 5-37:** Coleoptera (Beetles) (A) *Omadius sp.* (Cleridae), (B) Melyridae beetle, (C) Nitidulidae beetle, (D) *Heliota sp.* (Cucujidae), (E<sup>†</sup>) *Coccinella sp.* (Coccinellidae), (F) *Lypros atronitens* (Tenebrionidae), (G<sup>†</sup>) *Zonitis lutea* (Meloidae), (H) *Aulacophora pallidefasciata* (Galerucinae, Chrysomelidae), (I<sup>†</sup>) *Meroscalcis selecta* (Hispiinae, Chrysomelidae), (J) *Epepeotes rarus* (Lamiinae, Cerambycidae), (K<sup>†</sup>) *Eupholus geoffroyi* (Leptopiinae, Curculionidae), (L<sup>†</sup>) *Trigonotarsus rugosus* (Rhyncophorinae, Curculionidae) (reproduced from CSIRO, 1991<sup>†</sup>; Gressitt, J. L. & Hornabrook, R.W., 1985)



**Fig. 5-38:** Chewing Curculionidae mouthparts (reproduced from Barbosa, P. and Wagner, M., 1989)

others are convex and are easily confused with ladybird beetles. Important diagnostic signs are the number of tarsal segments, being 4 at all legs (actually 5, but the fourth is minute) and the antennae that are slender and not clubbed. The elytra are often smooth and shiny and most leaf beetles are colourful. There are 16 subfamilies in PNG, for instance the **Galerucinae** (fig. 5-37 H), **Hispininae** (fig. 5-37 I), **Sagrinae**, **Chrysomelinae**, **Eumolpinae**, **Alticinae**, **Cassidinae**, etc. The metallic green *Sagra spp.* have strong and large saltatorial hind legs.

- **Curculionidae\*** The weevils are the largest family of animals and organism group in general. Weevils can be easily recognised by the long **rostrum** or snout, an elongated part of the front portion of the head. Quite often **rhynch-** (meaning **nose**) is part of the species or generic name. The snout is sometimes mistaken as the piercing-sucking proboscis, however, the tip of the rostrum bears tiny little chewing mouthparts, as shown in fig. 5-38. The rostrum can be of considerable length, sometimes as long as the body of the weevil and is housed in an abdominal groove during rest. The antennae are usually clubbed and mostly 'elbowed'. The weevils' general body form is variable, some species are quite long and slender as in the closely related **Brentidae** whereas others are small, stout and nearly spherical. The legs can be quite long and well developed for running and can be retracted in many species against the very hard body. Upon disturbance weevils usually drop and feign death. The apod weevil larvae (fig. 5-33 C) in general lack legs and

are of white or pale creamy colour. Most Curculionidae larvae are cryptic miners or borers that feed within plant tissue.

Almost all weevils are associated with woody plants and all parts are fed upon: wood, cambium, roots, leaves, seeds, fruits, flowers and terminal shoots. Therefore weevils are severe pests of agricultural and forestry crops as well as stored products. There is hardly any plant that cannot be infested by at least one weevil species. Weevils that negatively interfere with tree crops in PNG are *Vanapa oberthuri*, *Aesiotes*, *Sympiezoscelus*, *Illacuris laticollis* and *Oribius destructor* boring in *Araucaria*. Weevils in general are difficult to control due to their cryptic way of life, their tough and heavily sclerotized cuticle and the long life span of the adults. However, there is also a number of good bugs that are in use as biocontrol agents, like the introduced *Cyrtobagous salviniae*, that is used to control the noxious **water fern** *Salvinia molesta* on the middle and lower Sepik (fig. 4-2). Two other weevil species, *Neochetina eichhorniae* and *N. bruchi* are currently being tested to control another noxious weed, the water hyacinth on the River Sepik (see page 228).

Some of the subfamilies and genera occurring in PNG are the **Zygopinae** (*Arachnopus* and *Mecopus*), **Lixinae** (*Lixus*), **Otiorhynchinae** (*Oribius* [fig. 6-3 Y], *Apocyrthus*, *Trigonopus*, *Hellerhinus*), **Eirrhinae** (*Cyrtobagous salviniae*), **Brachyderinae** (*Pantorhytes* [plate 1 B], *Sphenomorpha* and *Cataphracta*), **Leptopiinae** (the very handsome and metallic blue, green or reddish Painted Weevils like *Gymnopholus* and *Eupholus* [fig. 5-37 K, plate 3 U]), **Rhyncophorinae** (*Trigonotarsus rugosus* [fig. 5-37 L]), the sago and palm beetles *Rhyncophorus*), **Baridinae** (*Pseudochlus*), **Hylobiinae** (*Vanapa*, figs. 6-3 X, 6-15), etc.

- **Scolytidae** and **Platypodidae\*** The bark beetles, ambrosia beetles or pin- and shot-hole borers are closely related to the Curculionidae and included in the latter by some authors, however considered as separate families in the recent literature. The beetles are always associated with under-bark habitats like many Curculionidae and Cerambycidae. Animals of

Feature	Scolytidae	Platypodidae
common name	bark beetles and ambrosia beetles or pin- and shot-hole borers	ambrosia beetles or pin- and shot hole-borers
colour of adults	reddish, black or light to brown dark	light to dark brown
size of adults	1 - 6 mm	2 to several mm
shape of adults	cylindrical, slender or stocky in build, with reduced, bowl-shaped prothorax	elongate, less cylindrical, sometimes flattened above
colour of larvae	creamy white	creamy white
shape of larvae	slightly curved, more stocky in build	curved with humped thorax
size of hole in wood	smaller holes, sometimes with resin or long frass pellet	slightly larger hole often with discharged powdery frass
duration of life cycle	4 weeks to several months	4 weeks to 12 months

**Box 5-5:** Characteristics of Scolytidae and Platypodidae

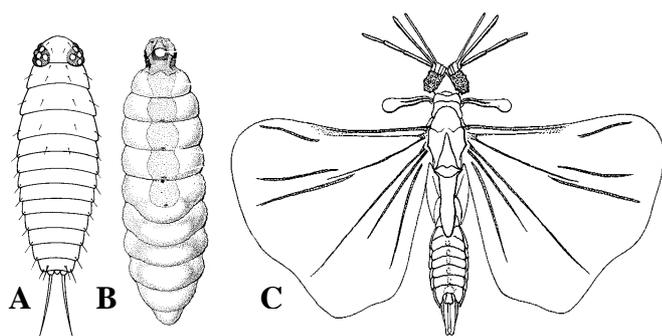
both families are very small, hardly exceeding 10 mm. **Scolytids** are slender and cylindrical but others are short and stout and the coloration is reddish, brownish or black. The antennae are always very short and strongly clubbed. The **Platypodidae** are more elongate, a bit less cylindrical and slightly flattened above, parallel-sided and truncate or oblong. The antennae are also short and strongly clubbed, the tarsi are long and slender. The apod larvae (**fig. 6-11 D - F**) are pale and soft and tunnel under bark in the cambium or right into the heartwood. The female lays eggs in a chamber from which the larvae bore at right angles in all directions. **Bark beetle** larvae engrave typical patterns in the cambium (**fig. 6-2 C**) that are used for diagnostics. Their attack often results in the death of the infested tree due to the damage to the cambium. The name 'ambrosia beetle' comes from a fungus that is cultivated by all species of Platypodidae and some species of Scolytidae. This fungus, a yeast, releases a beer-like scent, that acts as an **allelochemical**, inviting even more beetles to approach and infest the particular tree (see **chapter 3.1.3**). In Greek mythology 'ambrosia' is the food of the Gods. More details on the biology of Scolytidae and Platypodidae and their significance for forestry in PNG are outlined in **chapter 6.2.5**. There is a large number of severe pests of living trees and timber products belonging to both families. In PNG pest species like *Hylurdrectonus*, *Crosso-*

*tarsus*, *Xyleborus*, *Platypus* and *Diapus* (**figs. 6-3 Z - Z3, 6-11 and 6-13**) are mainly associated with dead or living **Araucariaceae**, timber and various timber products. The Hoop Pine bark beetle *Hylurdrectonus piniarius* is a severe pest in Northern Queensland but of minor significance in PNG.. Another Scolytidae pest is *Ips grandicollis* that severely damages *Pinus* plantations. It originated from North America and was discovered in Australia in 1943. Fortunately *Ips* has not yet been introduced into PNG. Genera occurring in PNG are the **Scolytidae** *Xyleborus*, *Scolytus*, *Ozopemon*, *Allarthrum*, *Poecilips*, *Hylurdrectonus*, *Hylesinus* and the **Platypodidae** *Crossotarsus*, *Diapus*, *Platypus* and *Spathidicerus*.

#### 5.6.3.24 Strepsiptera (Stylops)

[twisted wings]

**General biology:** Small entomoparasitic, exopterygote Neoptera showing extreme sexual dimorphism. The males and females look very different, as shown in **fig. 5-39 B and C**. Male adult stylops have reduced mandibulate mouthparts, 4 - 7-segmented flabellate antennae and berry-like compound eyes with 15 to 150 ommatidia. The prothorax is reduced whereas the metathorax is extremely developed. The fan-shaped hindwings of the males are large and show reduced venation and the forewings are reduced to a **halterelike** structure (**fig. 5-39 C**); the females are wingless (**fig. 5-39 B**) and extremely de



**Fig. 5-39:** Strepsiptera (Stylops): (A) larva, (B) adult female, (C) adult male of *Coriophagus* spp. (reproduced from CSIRO, 1991)

degenerate. Coxae and trochanter are absent in particular legs of both sexes. Stylops undergo complete metamorphosis.

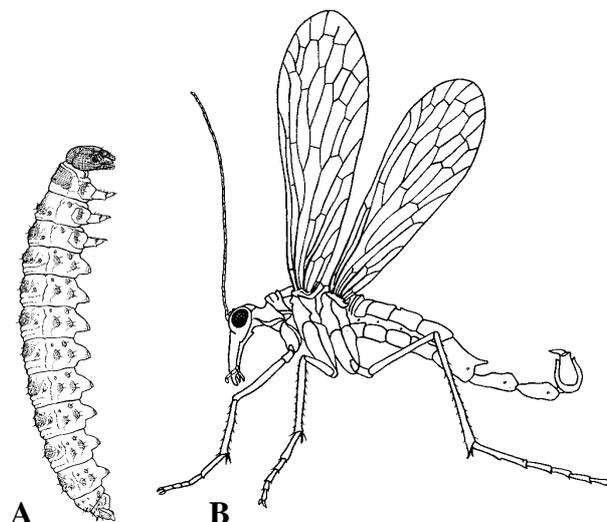
**Economic and ecological significance:** Insects of this small group are entomophagous parasites. The adult male is free living, whereas the females of most species live permanently in the host. Therefore, the wings of females are absent. Apart from the male adults, the first larval instar is also free living in search of a new host. The effects of the parasite on the host are quite severe and an infestation results often in sterility, reduction of activity and decreased life span of the host. Therefore Strepsiptera contribute towards the natural control of their host species. The parasites are of restricted use as biocontrol agents due to unspecific parasitization. However, some agricultural insect pests are affected by stylops and thus exert some control over their hosts.

### 5.6.3.25 Mecoptera (Scorpion Flies, Hanging Flies) [long wings]

**General biology:** Minor endopterygote group of insects with chewing hypognathous mouthparts located on an often snout-like elongation of the head. The compound eyes are large and the number of ocelli is three. The long, multisegmented antennae are filiform. The legs are long and well developed, the tibiae are equipped with two conspicuous spurs, the tarsi are 5-segmented with mostly two claws. The fore- and hindwings are either large,

membranous and equal in size and shape with complete venation, or are sometimes short and hook-like or sclerotized or reduced or absent in flightless species. The males of some families have a bulb-like genital capsule, that resembles the abdominal tip of scorpions (**fig. 5-40 B**). The grub-like or caterpillar-like larvae shown in **fig. 5-40 A**, are usually mandibulate. The larvae always have thoracic legs and sometimes false abdominal prolegs. The pupae are exarate and decticious. Mecoptera undergo complete metamorphosis.

**Economic and ecological significance:** The adults are omnivores feeding on small insects, pollen, fruits and mosses. The larvae feed on various types of organic matter. Both larvae and adults are associated with humid or damp habitats, some larvae are aquatic. The order is of insignificant economic importance and only in a few cases predacious Mecoptera species are effective in the control of their prey species.

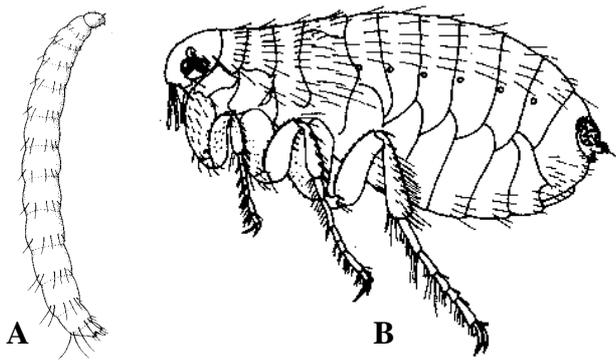


**Fig. 5-40:** Mecoptera (Scorpion Flies): (A) larval *Chorista* sp., (B) adult Mecoptera (reprod. from CSIRO, 1991; Coulson, R.N. & Witter, J.A., 1984<sup>†</sup>)

### 5.6.3.26 Siphonaptera (Fleas)

[tube wings]

**General biology:** Small, wingless, highly specialised ectoparasitic endopterygote Neoptera. The sessile head has piercing-sucking mouthparts in adults and is of the chewing type in larvae. Fleas lack compound eyes, but some species have large lateral ocelli. The antennae are 3-segmented, the legs are long



**Fig. 5-41:** Siphonaptera (Fleas): (A) larva, (B<sup>†</sup>) adult of *Pulex irritans* (reproduced from CSIRO, 1991; Brohmer, P., 1982<sup>†</sup>)

and well presented. Typically the hindlegs are greatly enlarged and adapted for jumping. The wings are always absent. The body is laterally compressed, strongly sclerotized (try to kill a flea!) and covered with backwards directed setae and spines (**fig. 5-41 B**) for attachment to hair and feathers of the host. The arrangement of the setae is important for the identification of fleas. The larvae are apod and **vermiform** (**fig. 5-41 A**) and usually live in nests or resting places of the host. They feed on coagulated blood of sores caused by the adults or caused by the scratching action of the host. The larvae of some species feed subdermally. The pupae are adecticous and exarate. Fleas undergo complete metamorphosis. The lifespan of a flea can be up to two years and it can survive several months without feeding.

**Economic and ecological significance:** Fleas are usually host specific, but can feed on a false host for a short period of time if the true host is absent. Common are fleas of humans like *Pulex irritans* (**fig. 5-41 B**), dogs (*Ctenocephalides canis*), cats (*C. felix*) and various species of livestock, birds, rats, etc. Apart from being a nuisance to the host - especially after becoming sensitised to flea bites - fleas play an important role as vectors of diseases. The rat flea *Xenopsylla cheopis* transmits severe diseases like **plague**, **tularemia** and **murine typhus**. Other species of fleas are intermediate hosts for tapeworms. Fleas do not have any natural enemies. Fleas can be controlled effectively only by the use of a combination of insecticides, eg. an organo-

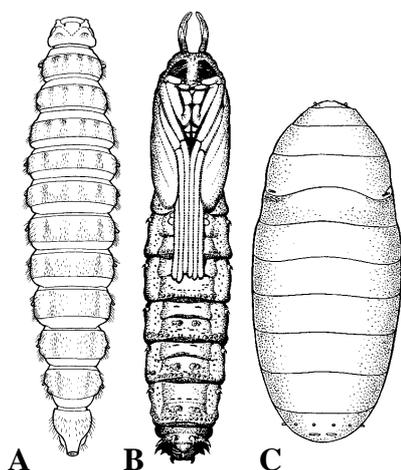
phosphate to eradicate adults and larval instars and a juvenile hormone analogue such as Fenoxycarb<sup>®</sup> to disrupt egg and larval development.

### 5.6.3.27 Diptera (True Flies, Mosquitoes, Gnats, Midges, Sandflies, Punkies, etc.)

[two wings]

**General biology:** Endopterygote Neopteran group of tiny to medium-sized insects with a highly mobile, relatively large head. The mouthparts are variable, usually sucking, piercing, sponging, lapping or a combination of two types. The compound eyes are in general large and well developed. The eyes often show **holoptic** condition ('round view') which is gained by the eyes occupying most of the head's surface area. Usually all three ocelli are present although in some species the median or all three ocelli might be absent. The antennae are variable in shape, but mostly short and **aristate** (reduced to a flagellar structure). Sometimes the antennae have a greatly enlarged surface area or are filiform. Dipteran legs are usually long, have 5-segmented tarsi and are greatly variable, either cursorial or gressorial, but in some species 'raptorial'. The pretarsus bears a pair of terminal claws plus a hairy, pad-like structure, the **pulvillus** or **empodium** for attachment to smooth surfaces. The Diptera possess only one pair of membranous transparent wings. The second metathoracic pair is reduced to a pair of club-like **halteres** (**fig. 5-46 A**), that vibrate rapidly during flight and act as a sense organ of balance. Some species however are wingless. Prothorax and metathorax are often greatly reduced, since these two segments do not house any flight muscles. Females of particular species have a tubular, eversible ovipositor. The soft, elongate, cylindrical and dorsoventrally flattened larvae or maggots (**figs. 2-40** and **5-42 A**) lack true legs and possess chewing mouthparts. The larvae are of pale or white coloration, possess a reduced pointed head and often look worm-like. The larvae of a few **Mycetophilidae** have the ability to produce light (**bioluminescence**) for prey-catching. The pupae

(figs. 2-40 and 5-42 B, C) are adecticous and obtect or exarate. True flies undergo complete metamorphosis with usually 4 larval instars. Diptera are ubiquitous and one of the four largest insect orders. About 7 % of the world's described species are Diptera. There are probably many more than 150,000 species world-wide.



**Fig. 5-42:** Diptera (Flies): (A) larva (maggot), (B) pupa, (C) puparium (reprod. from CSIRO, 1991)

**Economic and ecological significance:** Most Diptera are terrestrial, but there is a number of species with aquatic larvae. Adult Diptera are polyphages, phytophages or omnivorous scavengers, feeding on the blood of animals and humans, on nectar of flowers or on various types of solid organic matter. They either bite the food or regurgitate saliva for liquefying solid food prior to ingestion. The larvae feed in plant tissues, in decaying plant or animal matter or they live in the bodies of humans and other animals. There is a wide range of predators feeding upon flies, however the predators can hardly reduce Diptera populations due to their incredible reproductive potential. There is no other insect order outranking dipterans in terms of the transmission of diseases: blood-sucking species like mosquitoes (**Culicidae**), Tsetse flies *Glossina morsitans* (**Glossinidae**), horse flies (**Tabanidae**), black flies (**Simuliidae**), and sand flies (**Ceratopogonidae**) are the vectors for **malaria**, **yellow fever**, **dengue fever**, **trypanosomiasis** (sleeping sickness), **filariasis**, **leishmaniasis** and a number of **encephalitides** of humans.

Diptera like louse flies (**Hippoboscidae**), bot flies (**Oestridae**), stable flies (**Muscidae**), black flies (**Simuliidae**) and horse flies (**Tabanidae**) are also the cause of various virus, helminth and protozoan diseases in pets, livestock, poultry and wildlife. Apart from those biting pests, flies like the house fly *Musca domestica* (**Muscidae**) or blowflies (**Calliphoridae**) are responsible for the transmission of a wide range of **enteric diseases**. However, in comparison to the African and Asian continents, PNG is blessed, having 'only' a few fly-borne diseases that threaten humans.

Almost any cultivated plant, however can suffer from the impact of a large number of Diptera species. In agriculture and horticulture they are mainly fruit flies (**Tephritidae**), stem borers, gall formers and leaf miners of the families **Agromyidae**, **Anthomyiidae**, **Cecidomyiidae**, **Chloropidae** and **Muscidae**. Tree crops like *Eucalyptus* are affected in PNG by some gall-forming **Fergusoninidae**.

However, the ecological importance of beneficial Diptera as pollinators, predators and parasites of other pest insects should not go unmentioned, hence a few species of the families **Sarcophagidae**, **Syrphidae**, **Tachinidae** are already in use for the control of weeds, insect pests and rabbits in Australia.

The more than 100 Dipteran families are divided into the two suborders **Nematocera** and **Brachycera**. Some common dipteran families are outlined in the following section:

Suborder **Nematocera**: Smaller flies with longer, filiform, 6 - 14 segmented antennae

#### **Division Tipulomorpha:**

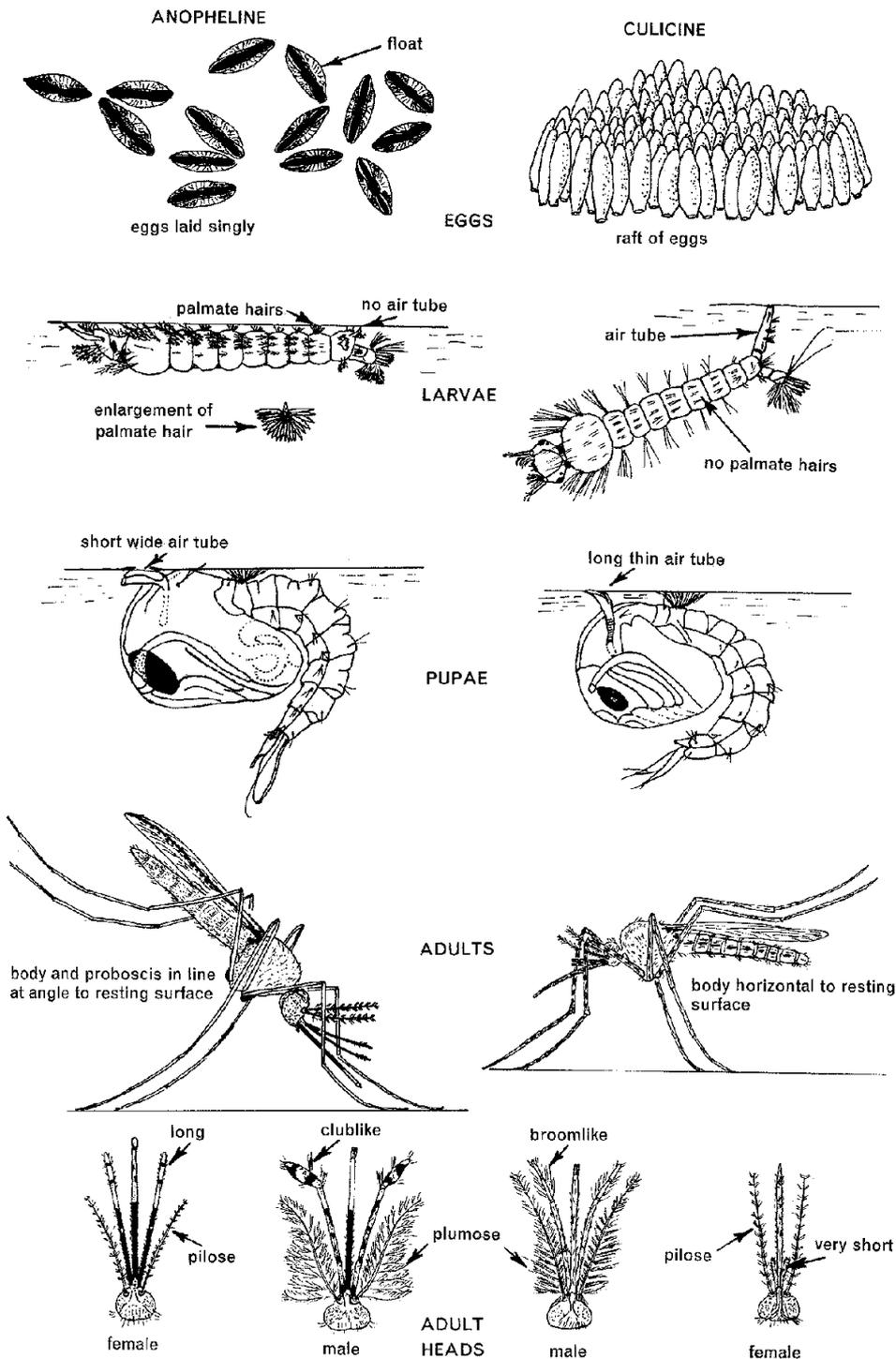
- **Tipulidae** The Crane flies are an immense group of large, cosmopolitan, slim insects with long and slender, brittle legs. Their wingspan can reach up to 7.5 cm (**fig. 5-46 A**). The adults are often attracted to light. The larvae of many species are aquatic

#### **Division Culicomorpha:**

- **Culicidae** Mosquitoes are a large cosmopolitan family of flies with scales along the veins of the wings and piercing-sucking mouthparts. Mosquitoes are usually host-

specific, preferring and depending on one particular host species. There is a number of mosquito species transmitting diseases of man. **Malaria** is spread by females of the **Anophelinae** mosquitoes of the genus *Anopheles*. This name is derived from Greek, meaning useless or futile. Another disease is **dengue**, transmitted by female *Aedes* of the subfamily **Culicinae**. Some of the typical characteristics of these two subfamilies are

shown in **fig. 5-43**. Females require a blood meal, before the eggs can mature. The harmless males are not blood-sucking and can be distinguished from the females by their bushy, plumose antennae. The aquatic larvae breathe either by means of a tube-like siphon or by a dorsal spiracle on the abdomen. They live in permanent ponds, pools or streams but also breed in water-filled containers such as water tanks or septic tanks and dumped garbage like tins, coconut shells, etc. found around human dwellings. Since the mosquitoes do not travel more than about 100 metres, the presence of mosquitoes can be markedly reduced by removing all potential breeding sites in the close vicinity of houses. Therefore it is advisable to stack coconut shells in a way that rain water can't collect inside. Water tanks can be sealed with screens and empty cans and tins can be exposed to the heat of fire, so that they rust away quickly. Styro foam beads in a septic tank can markedly decrease the number of mosquito larvae. The life cycle of *Plasmodium spp.*, the



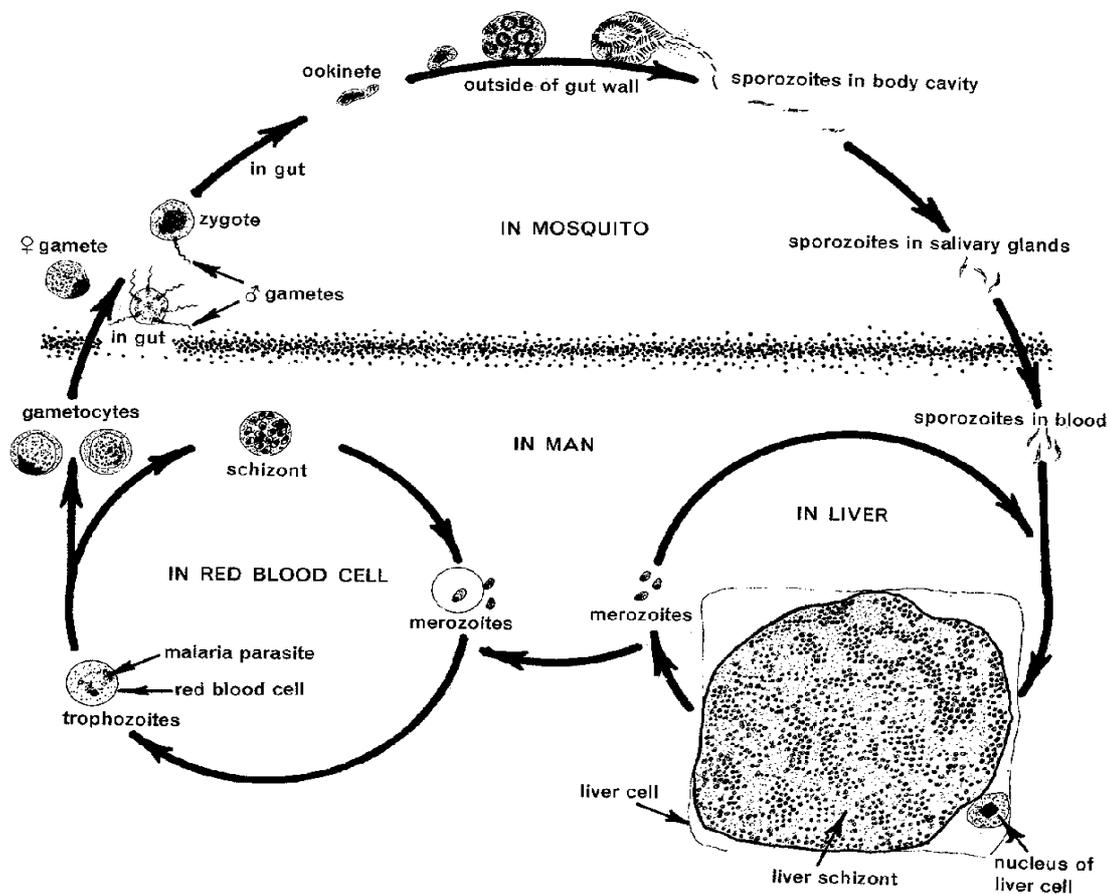
**Fig. 5-43:** Features of Anophelinae and Culicinae mosquitoes (reproduced from Ewers, W. H., 1971)

**Protozoa** causing malaria is shown in **fig. 5-44**. There are four types of malaria caused by different *Plasmodium* species: *P. vivax* causes malaria with fever every second day, *P. malariae* causes **Malaria tertiana** with fever every third day, *P. ovale* causes a 'mild' but lengthy malaria and *P. falciparum* causes the severe **Malaria tropica**. There is a number of pharmaceuticals available for the cure and prophylaxis of malaria:

chloroquine (eg. Nivaquine ®)	prophylaxis, cure
quinine	cure
proguanil (Paludrine ®)	prophylaxis
primaquine	cure
halofantrine (Halfan ®)	cure
pyrimethamine (Fansidar ®)	prophylaxis, cure
mefloquine (Lariam ®)	prophylaxis, cure
tetracycline (eg. Terramycin ®)	prophylaxis, cure

However, many strains of *Plasmodium* became resistant to those chemicals making it more and more difficult to find effective remedies to malaria. Chemical control programmes aimed at the eradication of the vectors, the mosquitoes, also failed due to the fact that

the mosquitoes acquired resistance to the involved insecticides. The use of the insecticide **DDT** for mosquito control in the past and the related problems of **resistance, accumulation in the food chain, persistence and toxicity** are outlined in **chapter 8.8.2**. The best and most appropriate remedies for the mosquito problem are the removal of potential breeding sites of mosquitoes and protection from being bitten by the female mosquitoes. The latter can be gained by tight mosquito screens in front of windows or the use of mosquito nets. The wearing of shirts with long sleeves and long trousers as well as the application of a mosquito repellent are also recommended. A very effective repellent is the essential oil of Lemon grass or Citronella (*Cymbopogon citratus*) which can be obtained from pharmacies. Lemon grass is grown in many locations in PNG and it is used as a spice and for preparing tea. Lemon grass is also effective in repelling mosquitoes, if planted around houses or if the leaves are crushed and rubbed onto the skin.



**Fig. 5-44:** Lifecycle of *Plasmodium spp.* in humans and female *Anopheles spp.* (reproduced with permission from Jacaranda Wiley Pty. from Ewers, W.H.; Parasites of Man in Niugini; Jacaranda Wiley; 1971)

- **Chironomidae** Midges are a large cosmopolitan family of small mosquito-like flies, mainly associated with aquatic systems. The adults are brownish or black or sometimes green, yellow or reddish. The males often have plumous antennae. Huge swarms of adults can be observed at sundown or are attracted to light during the early evening hours causing a nuisance, if close to residential areas. The larvae are aquatic scavengers and are an important part of aquatic food chains. The larvae of some species are called blood-worms. Their red colour is due to the red blood pigment **haemoglobin** that can cause humans to have severe allergic reactions to midges

- **Ceratopogonidae** Sand flies and biting midges are a widespread family of small to minute blood-sucking flies with piercing-sucking mouthparts. The Ceratopogonidae are not to be confused with certain species of the family **Psychodidae**, that are also referred to as sand flies in some countries. Sandflies have a wingspan smaller than 5 mm. The species annoying humans live mainly in tidal zones, some of them being vectors for viral and parasitic worm diseases like minor **filiariasis**. Others are carriers of severe diseases of livestock

- **Simuliidae** Black flies are another family of vicious, cosmopolitan biting hump-backed flies of black body colour, stout build and broad wings (**fig. 5-46 B**). The little flies of 1.5 to 3.5 mm wing length attack humans as well as livestock. The females of some species require a blood meal for egg maturation. The larvae are aquatic. Many species are the vectors for severe filarial diseases of humans and livestock. Common in Queensland is *Austrosimulium pestilens* and *A. bancrofti* in southern Australia. The species name of the latter, *bancrofti*, means bankrupt, leaving it to one's imagination how the target of a black fly attack might end up

#### Division Psychodomorpha:

- **Psychodidae** Moth flies are minute to small, hairy, moth-like flies, shown in **fig. 5-46 C**. The hairy wings are held roof-like over the body during rest. Some of the blood-

sucking species are sometimes called 'sand flies' and can transmit severe human diseases.

#### Division Bibionomorpha:

- **Cecidomyiidae** Gall midges or gall gnats are minute, delicate, slim-bodied flies with long legs and fairly long antennae. The wing venation is reduced. The tiny, sometimes colourful maggots of particular species produce galls of plants or feed on plants

- **Mycetophilidae** The fungus gnats are a large family of flies with long legs (**fig. 5-46 D**). Some of these gnats might be mistaken for spiders. The larvae of most species are fungivores. A number of species are able to produce light (**bioluminescence**), eg. the predacious *Arachnocampa spp.* These flies can be found in caves in New Zealand and Australia. The production of light is involved in mate-finding by the adults and prey-catching by the larvae. The light is produced in modified **Malpighian tubules** and collected in a reflector. The predacious larva lures its prey, mostly small flies, to the light. The prey gets trapped on a sticky thread suspended by the larva from the cave's ceiling

Suborder **Brachycera**: mostly stouter and larger flies than the Nematocera with reduced antennae and mainly terrestrial larvae

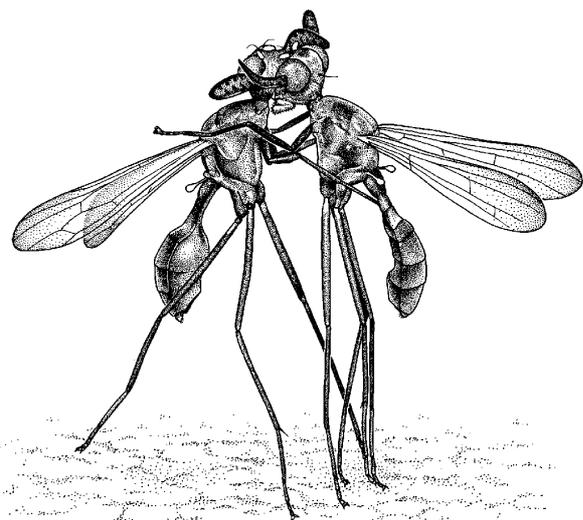
#### Division Orthorrhapha:

- **Tabanidae** March flies and horse flies (**fig. 5-46 E**) are a large family of blood suckers and plant feeders of veterinary and medical significance. These medium-sized to large robust flies have large, well developed, often iridescent, brightly coloured compound eyes and a strong proboscis (**fig. 2-9**). The bite of a female horse fly is quite painful and causes bleeding of the wound. A large number of species are vectors for diseases of humans and livestock. The larvae of some species are aquatic.

- **Asilidae** Robber flies are a very large family of small to very large predacious flies with prominent, well separated eyes, and strong, and long legs. Most species have a stout and tapered abdomen, however, it is narrow and elongate in some species (**fig. 5-46 F**). Some species mimic wasps. The adults are aggressive predators of other Diptera,

Hymenoptera, Odonata and almost all other insect orders. Robber flies catch their prey on the wing using the powerful legs. Once caught, neurotoxins and digestive enzymes are injected into the prey prior to sucking its body juices

- **Bombyliidae** The bee flies are a very large cosmopolitan family of small to large, stout and often hairy flies (**fig. 5-46 G**). Quite a number seem to parasitize various instars of other insects like Hymenoptera, Lepidoptera, Diptera and Neuroptera
- **Dolichopodidae** A large family of slender, medium to small flies (**fig. 5-46 H**) with a metallic coloured thorax. The adults can often be encountered on the bark of trees or on the foliage. All species seem to be beneficial predators feeding on all kinds of Arthropoda and a few species live specifically on aphids



**Fig. 5-45:** Territorial fight of male *Phytalmia* sp. (Tephritidae) (reproduced from Gullan, P.J. and Cranston, P.S., 1994)

#### Division Cyclorhapha, Series Aschiza:

- **Syrphidae** Hover flies, flower flies or drone flies are a common, widespread family of flies, typically with yellow markings on the body (**fig. 5-46 I**). Some are of stout build and resemble bees or Muscidae flies. Others mimic wasps and have a constricted abdomen but do not sting or bite. The small to large adults are remarkable fliers that hover apparently motionless in the air. During sunny days they visit blossoms, therefore they are important pollinators of plants. The larvae of

certain species are beneficial predators of aphids. Other species like the 'rat tailed maggots' live in rotting fruits and other decaying organic matter

#### Series Schizophora:

- **Lauxaniidae (Sapromycidae, Celyphidae)** are one of the largest and commonest fly families, however little is known about them. Most larvae live on leaf litter and rotting vegetation, a few are fungivores
- **Platystomatidae** The genus *Achias* of this family is called stalk-eyed flies, very peculiar flies with the eyes of the males on long stalks or lateral extensions of the head. These stalks are absent in the female (**fig. 5-46 J, K**). The eye-stalks are apparently involved in territorial fighting. The adults of many species are attracted to and feed on faeces of mammals including humans, a fact that makes it easy for the entomologist to make collections. In PNG there are some 80 species of the genus *Achias*. *Achias rothschildi* found in PNG is the world's widest-headed fly. Other stalk-eyed flies belong to the small endemic genus *Laglaizia*, like *L. biroi*

- **Pyrgotidae** are similar to Platystomatidae
- **Tephritidae** Fruitflies are small to medium-sized flies with spotted, banded or mottled wings that are slowly moved up and down during rest. Fruitflies are destructive pests of various fruits. The adults lay their eggs in the fruits, which are then tunnelled by the maggot-like larvae. A few species are leaf miners. A severe pest is the Mediterranean fruit fly *Creatitis capitata* (**fig. 5-46 M - O**), attacking *Citrus spp.*, mango, pawpaw and a variety of other cultivated fruits. Its close relative, the Asian Papaya fruit fly *Bactrocera papayae* is one of the most destructive horticultural pests occurring in South East Asia. Effective management strategies of this pest call for stricter quarantine procedures in PNG
- **Agromyzidae** Small or minute flies mainly occurring in Australasia. The larvae are leaf or stem miners or gall formers. A number of species are pests interfering with cultivated plants, others are suitable biocontrol agents against weeds

- **Fergusoninidae** This family includes only the genus *Fergusonina*. The larvae live in leaf and flower galls on myrtaceous plants like *Eucalyptus*, preventing flower and seed production. *Fergusonina* (**fig. 6-3 P** and **chapter 6.2.4**) is a forest insect pest in PNG
- **Drosophilidae** A family of small widely distributed flies that are sometimes incorrectly referred to as fruit flies. The larvae feed on decaying fruits, other plant material, urine, faeces or are fungivores. Some larvae are predators or parasites of Hemiptera. The most famous representative of this family is definitely the vinegar fly *Drosophila melanogaster* that is a commonly used model in genetic and cytological research
- **Chloropidae (Oscinidae, Siphonellopsidae)** These flies are almost ubiquitous. The larvae of many species feed on grasses and other plants. The larvae of *Anatrichus* live on rice, causing considerable damage. Others are parasites and hyperparasites of amphibians, molluscs and many insects
- **Anthomyiidae** The rootmaggot flies are a family of dark-bodied flies similar to house flies. The wings have fine hairs and are held flat and parallel to the body. The larvae of many species are destructive to roots, some are leaf miners. The larvae of the cosmopolitan pest species *Delia platura* damage seedlings of onions, beans and other cultivated plants
- **Muscidae** House flies or stable flies are a large and variable family of flies with medical significance. The greyish, small to medium-sized, robust flies with aristate antennae have sponging (**fig. 2-15**) or piercing-sucking mouthparts. The wings are usually held flat and away from the abdomen during rest. The larvae of many species live in the excrement of various animals and the adults are attracted to all sorts of organic material like food and faeces. Many of the blood-sucking species are vectors of serious human and animal diseases. A common cosmopolitan species, the house fly *Musca domestica* (**fig. 5-46 P**), carries different kinds of enterogastric bacteria that can affect humans and domesticated animals
- **Calliphoridae** Blowflies and bluebottles are small to large, variable cosmopolitan flies with stout bodies and generally with a metallic blue or green abdomen. The antennae are usually plumose. The flies live on nectar, honeydew and other sweet liquids and breed in carrion and manure. The larvae of the screw-worm fly infest living animal tissues and can transmit diseases mainly of livestock like the **cutaneous myiasis** of sheep. Calliphoridae are therefore of veterinary significance
- **Sarcophagidae** Flesh flies are medium-sized, cosmopolitan flies with stout bodies and typically a grey thorax with three black stripes and a checkered grey and black abdomen (**fig. 5-46 Q**). The larvae live on carrion and animal matter, some are parasitoids of insects. A number of species transmit diseases and are therefore of medical significance
- **Tachinidae** Tachina flies are an immense and taxonomically difficult family of ubiquitous, small to large, stout-bodied, strongly bristled flies of drab coloration. Adults of many species look much like Calliphoridae or Sarcophagidae, however some are more elongate and mimic wasps. The larvae are generally valuable endoparasites or endoparasitoids of Arthropoda, mainly insects. Tachina flies play an important role as natural regulators of insect numbers, particularly of lepidopteran, coleopteran, hemipteran and orthopteran pests
- **Oestridae** Bot flies are a small family of large, dark brown, robust, densely haired flies that resemble bees. The larvae are endoparasites in the respiratory passages of wild and domesticated animals and can seriously affect their health. However, this family is, apart from a few introduced species, poorly represented in PNG
- **Hippoboscidae** Louse flies, wallaby flies or keds are small, winged or wingless flies with piercing-sucking mouthparts. Due to their leathery, flattened body and their strong legs, these flies look like lice or ticks. The adults are blood-sucking ectoparasites of birds and