AUSTRALIAN BEETLES

JOHN F. LAWRENCE AND E. B. BRITTON

MELBOURNE UNIVERSITY PRESS
1994

Suborder POLYPHAGA

This is the largest and most diverse group of Coleoptera, containing more than 90% of the species and families. Members of the Polyphaga differ from those of the other three suborders in having the prothoracic pleuron fused with the trochantin and entirely concealed, forming a *cryptopleuron*, the hind wing without an oblongum cell and with the transverse fold never crossing MP, the cervical sclerites present and the ovarioles telotrophic. In addition, the metepisternum almost never meets the mid coxal cavity (rare exceptions occurring in Derodontidae) and the hind coxae are usually motile and do not divide the first ventrite. The earliest fossil definitely attributed to Polyphaga is *Peltosyne triassica* from the Triassic of Central Asia (Ponomarenko, in Arnoldi *et al.* 1977), but Crowson (1975) and Ponomarenko (1969b) have suggested that the archostematan family Ademosynidae may represent polyphagan ancestors in which the prothoracic pleuron has not yet become internalised.

Series STAPHYLINIFORMIA

Staphyliniform adults are characterised by having reduced wing venation (except in Hydrophilidae) and a high grade type of wing folding mechanism which does not involve an intrinsic spring; larvae have articulated urogomphi in all but a few clearly derived taxa. The recognition of only two superfamilies, Hydrophiloidea and Staphylinoidea, and the inclusion of Hydraenidae in the latter are discussed by Lawrence and Newton (1982). Newton and Thayer (1992) have reviewed the classification of the Staphyliniformia.

Superfamily HYDROPHILOIDEA

Adults have relatively short antennae with long scape and 3-segmented, densely pubescent club, with segment preceding club transverse, concave, and in aquatic forms used to assist in replenishing air supply. Procoxae very large, legs often spinose or dentate, wings almost always with R-M loop and without spring mechanism, abdominal spiracles 7 or 7 and 8 atrophied, aedeagus of trilobed type (with fused parameres in most Histeridae), 6 free Malpighian tubules. Larvae predacious with large, protruding, falcate mandibles, no mola, fused labrum, maxillae almost always without apical lobes, maxillary palpifer complete and usually bearing articulated appendage, spiracles almost always biforous with closing apparatus, abdomen largely membranous, and urogomphi relatively small and articulated or sometimes absent.

11 Hydrophilidae (Figures 23A–J) ADULT: ANT 7–9(1A/1R/3), FCOX TRANS–PROJ(EXP–CONC), FCAV OPEN–CLOS(CLOS), MCOX CONT–VWIDE(OPEN–CLOS), 5-5-5/4-4-4R, ABD 4R/5/6R(0–2), 0.9–42 (2–35) MM. LARVA: HEAD PRO(PRO), STEM 1A/6, ANT 3, FSUT 0, LABR FU, MOLA 0, VMP PRO/RETR, MALA 0/+R, MP 4, LP 1R/2, HSC 0, HRD 0, VER 0/+R, LEGS 0/3/5, PTS 1/2/M, UROG 0A/0R/+R, SPIR BI/ANR/RED.

Most adults may be distinguished by the short, 7- to 9-

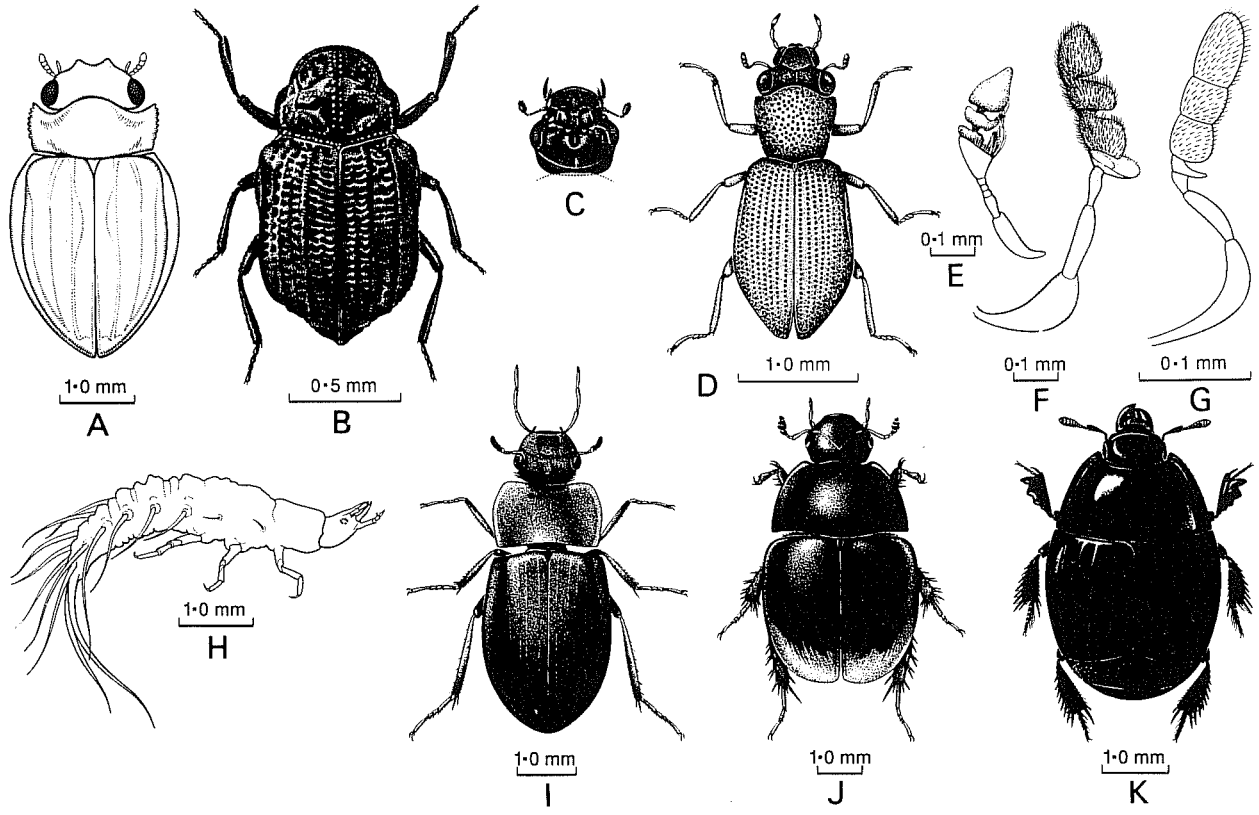

Figure 23 A–J, Hydrophilidae: A, *Spercheus platycephalus*, Spercheinae; B, *Georissus australis*, Georissinae; C, same, head; D, *Hydrochus serricollis*, Hydrochinae; E, *Hydrophilus* sp., Hydrophilinae, antenna; F, *Berosus australiae*, Berosinae, antenna; G, *Hydrochus* sp., Hydrochinae, antenna; H, *Berosus* sp., larva; I, *Helochares australis*, Hydrobiinae; J, *Sphaeridium discolor*, Sphaeridiinae. K, *Hister walkeri*, Histeridae. [F. Nanninga]

segmented antennae, with a 3-segmented, pubescent club, preceded by a glabrous, cup-like segment (cupule) (Figures 23E–G), the large clypeus and more or less angulate frontoclypeal suture, often attached to a median line (endocarina), and the well-developed maxillary palps, which are usually longer than the antennae. Larvae vary somewhat in form, but are typical for the superfamily, except for the presence of a maxillary mala in *Spercheus*. They differ from histerid larvae by having 6 stemmata on each side and usually possessing a metapneustic respiratory system, with only the 8th spiracles functional and these located in a respiratory chamber (atrium) at the end of the abdomen. Adult and larval hydrophilids have very different habits, although occupying the same habitats; the former are phytophagous or saprophagous, while the latter are predacious (except in a few exotic *Helophorus*).

Spercheus platycephalus (Figure 23A) (SPERCHEINAE) is a brown beetle with coarsely punctate and costate elytra and a pubescent cupule; larvae differ from those of most hydrophilids in having an apical lobe (mala) on the maxilla and reduced spiracles. Spercheines inhabit stagnant ponds and adults and larvae are reported to walk on the underside of the surface film. *Georissus* (Figures 23B, C) (GEORISSINAE) is minute, black and tuberculate, with a deflexed head concealed from above, a compact 1- or 3-segmented antennal club, large fore coxae fused to their trochanters, and 2 connate ventrites; larvae are typical for the family but lack a respiratory chamber and have 8 pairs of laterally placed spiracles. *Hydrochus* (HYDROCHINAE) (Figure 23D) resembles hydraenids in being elongate, narrow and somewhat metallic; it is found attached to plants in ponds or slow-moving creeks. The related Epimetopinae and Helophorinae do not occur in Australia.

The remaining groups of Hydrophilidae include the mainly terrestrial SPHAERIDIINAE and the aquatic BEROSINAE, AMPHIOPINAE, CHAETARTHRIINAE, HYDROBIINAE and HYDROPHILINAE. The sphaeridiines are small to minute and may be abundant in decaying vegetable matter, dung, carrion and damp soil. The introduced *Cercyon haemorrhoidalis* and *Sphaeridium discolor* (Figure 23J) are common dung inhabitants; species of the endemic genus *Notocercyon* may be abundant in forest litter; and *Pseudohydrobius* species may be found in flowers (especially of *Leptospermum*). Most aquatic hydrophilids are oval to globose, smooth and glabrous, often resembling Dytiscidae, from which they differ in having short, clubbed antennae and long maxillary palps. A ventral plastron, which communicates with the subelytral air reservoir, is also present; when the beetle rises to the surface, it breaks the surface film using its specialised antennal club, allowing communication between atmosphere and plastron. Larvae of Berosinae (Figure 23H) are unique in lacking functional spiracles (apneustic) and in having 7 pairs of lateral gills. The largest Australian species belong to *Hydrophilus*. [J. M. E. Anderson 1976; van Emden 1956; Hansen 1990a, 1990b, 1991a, 1991b; Newton 1989; Watts 1987, 1988b, 1989, 1990]

12 Histeridae (Figure 23K) ADULT: ANT 8–11(1/3), FCOX TRANS(CONC), FCAV OPEN(OPEN), MCOX VWIDE(OPEN), 5-5-5/5-5-4, ABD 5(0), 1–16 (1.3–12) MM. LARVA: HEAD PRO(PRO), STEM 0/1, ANT 3, FSUT 0, LABR FU, MOLA 0, VMP PRO, MALA 0, MP 4/5, LP 2/3, HSC 0, HRD 0, VER 0, LEGS 5, PTS 0/2, UROG 0R/+, SPIR BI.

Although adults vary considerably in shape, histerids are relatively easy to recognise by their compact form, deeply inserted head, large, transverse fore coxae, dentate fore tibiae, antennae which are almost always geniculate and have a compact, pilose club, and elytra which have 6 or fewer striae and are truncate, exposing 1 or 2 abdominal tergites. Most are black, glabrous and shiny, but some *Saprinus* are metallic green, CHLAMYDOPSINAE are often red and may have erect setae or setal tufts, and *Epiechinus* are clothed with scale-like setae. The body is usually oblong to ovoid or globose, but some histerids (*Trypeticus*, *Niponius*) are elongate and cylindrical, while others (*Hololepta*, *Platysoma*) are strongly flattened. Larvae resemble those of Hydrophilidae in general form and head structure, but they have a full set of functional, biforous spiracles, a penicillus of hairs at the base of each mandible, and (almost always) 2-segmented urogomphi, and they lack an apical respiratory chamber and have either no stemmata or only 1 pair.

Both adults and larvae are carnivorous, feeding mainly on the larvae of other insects. They are commonly found in carrion, dung and decaying vegetable matter or under bark of dying or dead trees, where they usually prey on fly larvae. Some species (in Teretriini, Trypeticini and NIPONIINAE) inhabit the burrows of wood-boring insects, such as Bostrichidae and scolytine weevils; some Saprinini and Histerini may be found in carrion and dung; *Hypocaccus*, *Halacritus* and some *Saprinus* are common in beach drift; and *Hololepta* and *Platysoma* occur under bark. The myrmecophilous chlamydopsines have setose secretory structures (trichomes) which apparently produce an appeasement substance (Wilson 1971) necessary for their acceptance within ant colonies. [Froggatt 1927; J. C. M. Gardner 1930; Hinton 1945b; Mazur 1984]

Superfamily STAPHYLINOIDEA

Adults variable but characterised by reduced hind wing venation without R-M loop, aedeagus with phallobase reduced or absent, and 4 free Malpighian tubules. Procoxae usually strongly projecting, metasternum almost always lacking median suture or line, legs often spinose with simple tarsi (at least on hind legs), 2nd abdominal sternite usually visible only laterally, elytra often truncate, exposing 1 to several tergites. In larvae, galea and lacinia closely associated or fused to form mala, mandibles often without mola, 2nd antennal segment apically oblique and with sensorium attached basad of segment 3, segment 9 usually with pair of articulated urogomphi, spiracles usually annular with closing apparatus.

Two recent and substantially different views on staphylinoid phylogeny and classification have been published by Lawrence and Newton (1982) and Naomi (1985); the latter suggested formal changes in classification, which have been criticised by Newton and Thayer (1988). The system used here is more or less that of

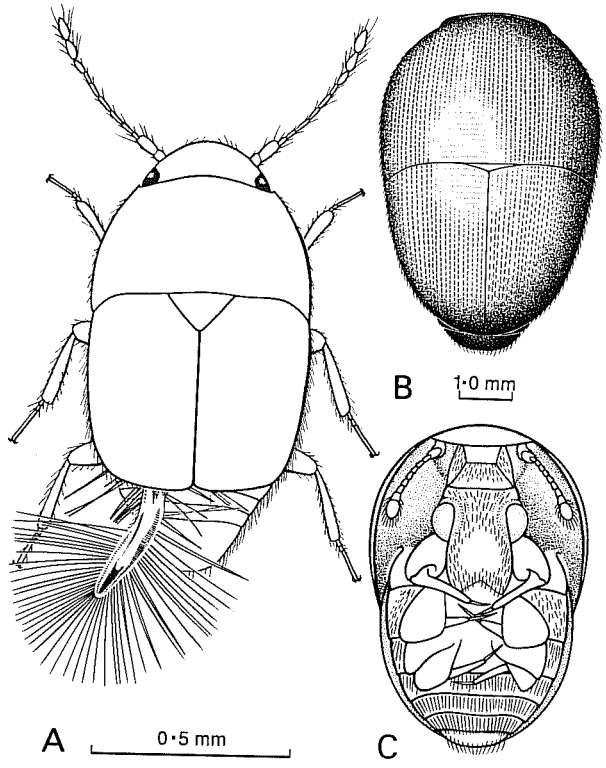

Figure 24 Ptiliidae: A, *Acrotrichis* sp., with part of one hind wing exposed; B, *Rodwayia orientalis*, dorsal; C, same, ventral.
[A by A. Hastings; B, C by F. Nanninga]

Britton (1970), except for the inclusion of Hydraenidae and the submerging of Limulodidae and Scaphidiidae into Ptiliidae and Staphylinidae, respectively.

13 Hydraenidae (Limnebiidae; Figures 25A, B) ADULT: ANT 8R–9(5–6R), FCOX TRANS–GLOB (EXP), FCAV OPEN–CLOS(OPEN–CLOS), MCOX NARR–MWIDE(OPEN), 5-5-5/4-4-4A, ABD 6–7(0), 0.8–2.6 MM. LARVA: HEAD PRO(PRO), STEM 5, ANT 3, FSUT +, LABR FR, MOLA +, VMP RET, MALA/GLAC, MP 3, LP 2, HSC 0/+, HRD 0, VER 0, LEGS 5, PTS 2, UROG +, SPIR AN.

Small beetles with relatively inconspicuous antennae, often concealed within grooves beneath head and cavities between prosternum and pronotal hypomera, and well-developed maxillary palps, which may be as long as or longer than antennae. The segment preceding the antennal club usually forms a cupule like that in Hydrophilidae, but this is not always the case and sometimes it is the pedicel which is cupule-like. Larvae usually elongate and campodeiform, with well-developed legs, articulated urogomphi, and a pair of hooks on segment 10, but those of *Tympanogaster* species are more flattened, with paired lateral thoracic and abdominal plates and a pair of spiracular tubes projecting dorsally from between prothorax and mesothorax. Hydraenids feed on algae in a variety of aquatic, riparian and littoral habitats, including streams, waterfalls, wet rock faces, ponds and ditches, marine rock pools, seabird nests, and inland salt lakes. Most adults are capable of breathing in water by means of a plastron formed by hydrofuge hairs on their ventral surfaces, but most larvae have no aquatic modifications. Exceptions occur in the genus *Tympanogaster*, where both larvae and adults live in the splash zone beneath waterfalls and larvae breathe through the spiracular tubes mentioned above. *Hughleechia giulianii* is a marine intertidal species, living in rock crevices and pools within the high tide splash zone. The family is represented in Australia by two genera of HYDRAENINAE (*Hydraena* and *Limnebius*) and five described genera of OCHTHEBIINAE (*Ochthebius*, *Gymnochthebius*, *Tympanogaster*, *Hughleechia* and *Meropathus*). [Newton 1985; Perkins 1980, 1981; Zwick 1977a]

14 Ptiliidae (incl. Limulodidae; Figure 24) ADULT: ANT 10–11(2–3), FCOX TRANS–GLOB (EXP/CONC), FCAV OPEN(OPEN/CLOS), MCOX NARR–MWIDE (CLOS), 2-2-2/3-3-3R, ABD 6–7(0), 0.4–1.1 MM. LARVA: HEAD HYPO, STEM 0, ANT 3, FSUT 0, LABR FR, MOLA +, VMP RET, GLAC/MALA, MP 3, LP 2, HSC 0/+, HRD 0, VER 0, LEGS 5, PTS 2, UROG 0R/+, SPIR AN.

Minute beetles with filamentous antennae clothed with whorls of long hairs and narrow hind wings fringed with very long hairs (Figure 24A). Body usually somewhat flattened and pubescent; elytra entire or truncate, exposing 1–3 abdominal tergites; tarsi almost always 2-segmented and may appear to be 1-segmented. Hind coxae transverse and contiguous to oval and widely separated, and coxal plates strongly developed to absent. Species of *Cochliarion* and species of *Rodwayia* (Figures 24B, C) differ from other Australian ptiliids in having the body more convex and compact, the hind wings and eyes absent, the head more deflexed and the antennae shorter. Larvae elongate and lightly sclerotised, with short, articulated urogomphi (rarely absent); pupa obtect.

Ptiliidae are relatively abundant in decaying organic matter, including leaf litter, compost heaps, rotten logs, tree holes and dung, where their major food source appears to be fungal spores and hyphae. Some species live within the pore tubes of bracket fungi (Polyporaceae), where they feed on developing spores. *Actinopteryx fucicola* occurs in decaying seaweed on sea coasts throughout the world. Species of *Rodwayia* occur in the nests of ants; they are largely ignored by their hosts and appear to feed on larval exudations. [Dybas 1976; Seevers and Dybas 1943]

15 Leiodidae (Anisotomidae, Catopidae, Cholevidae; Figures 25C, D) ADULT: ANT 10–11(3–5), FCOX GLOB –PROJ(EXP), FCAV OPEN(OPEN/CLOS), MCOX CONT–MWIDE(OPEN), 5-5-5/5-5-4/5-4-4/4-4-4/3-3-3, ABD 4R/5R/6(0), 1.2–5 MM. LARVA: HEAD PRO(PRO), STEM 1–3/5, ANT 3, FSUT 0, LABR FR, MOLA 0/+, VMP RET, GLAC/MALA, MP 3, LP 2, HSC 0/+, HRD 0, VER 0, LEGS 5, PTS 2, UROG +, SPIR AN/AB.

Moderately small beetles with more or less spiny legs and simple tarsi (fore and occasionally mid tarsi modified in some males and in *Colon*), differing from most other staphylinoids in having the abdomen entirely concealed by the elytra. Almost all species with 5-segmented antennal club, having 2nd segment (8) smaller (shorter or shorter and narrower) than either 1st (7) or 3rd (9); club

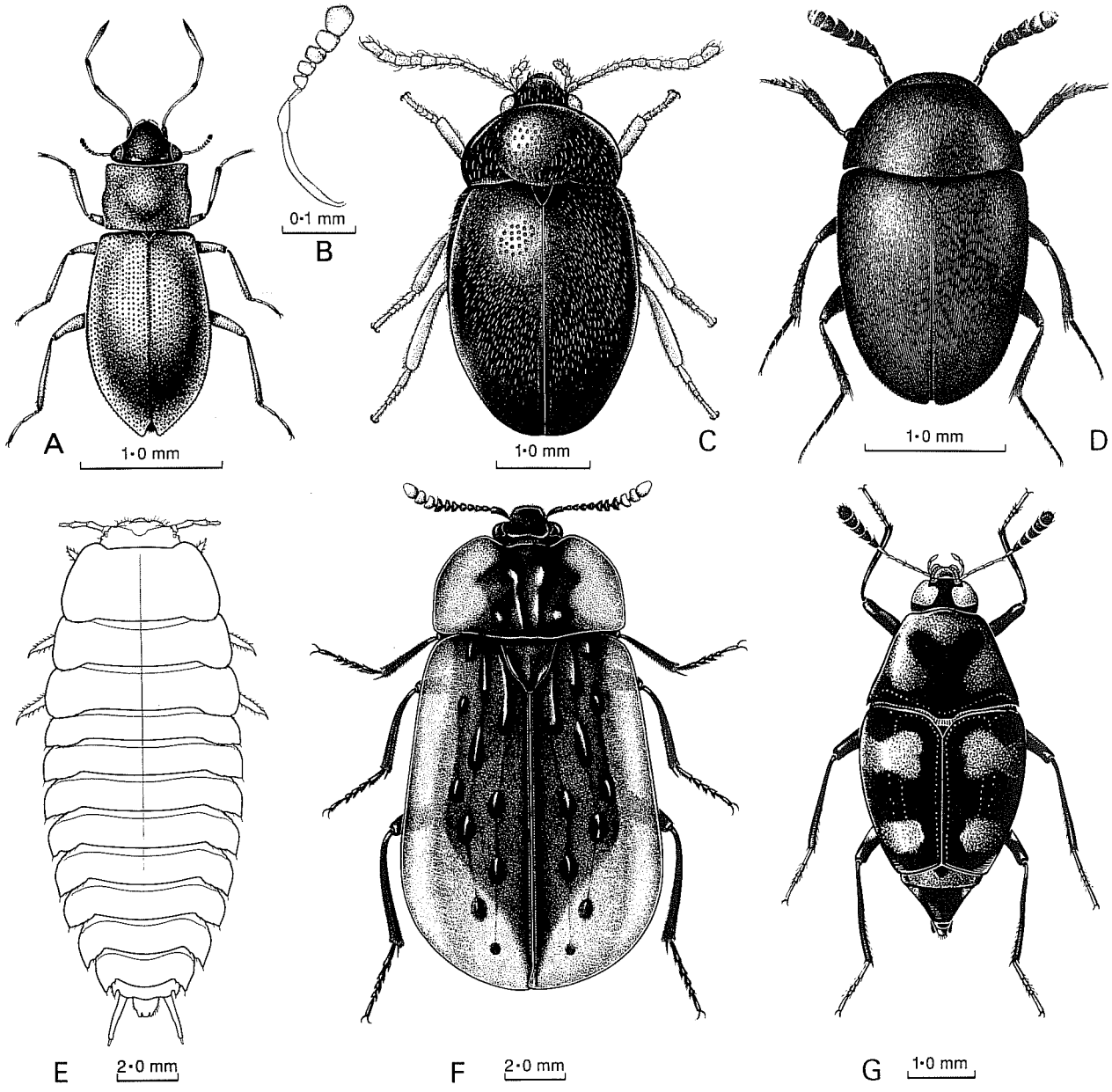

Figure 25 Staphylinoidea: A, *Hydraena luridipennis*, Hydraenidae; B, *Ochthebius* sp., Hydraenidae, antenna; C, *Eublackburniella* sp., Leiodidae-Camiarinae; D, *Pseudonemadus australis*, Leiodidae-Cholevinae; E, *Ptomaphila lacrymosa*, Silphidae, larva; F, same, adult; G, *Scaphidium punctipenne*, Staphylinidae-Scaphidiinae. [A, B, D, F, G by F. Nanninga; C by A. Hastings; E by A. Klinkenberg]

sometimes very weak (*Eublackburniella*, Figure 25C; *Nargiotes*) with segment 8 only slightly reduced, or very strong (*Dietta*, *Zeadolopus*) with 8 greatly reduced or absent. *Colon* differs in having a 4-segmented club with segment 8 larger than 7. Leiodids also possess a unique type of internal sensory vesicle usually opening on the distal surfaces of segments 7, 9 and 10 (Corbière-Tichané 1974; Peck 1977). Larvae, like those of most staphylinoids, are of the active, campodeiform type with urogomphi which are almost always articulated at the base; they differ from staphylinid larvae in usually having mandibular mola and 2 apical maxillary lobes (galea and lacinia).

Leiodidae are abundant in decaying organic matter and also occur in carrion, fungus fruiting bodies, some types of dung and nests of vertebrates; they are abundant in caves in most parts of the world but have not yet been recorded from Australian caves. Many are general scavengers, but certain groups are associated with particular fungi (*Neopelatops* with slime moulds; some *Nargomorphus* with puffballs; some leiodines and probably *Colon* with hypogean fungi) (Newton 1984). Species of *Myrmecholeva* are very unusual in that both larvae and adults have suctorial mouth-parts consisting of a labrolabial tube and styliferous mandibles and maxillae; they have been recorded from ant nests (Lea 1910a) but appear to be more generally distributed and may be mycophagous, rather than predacious.

LEIODINAE are usually glabrous and strongly convex

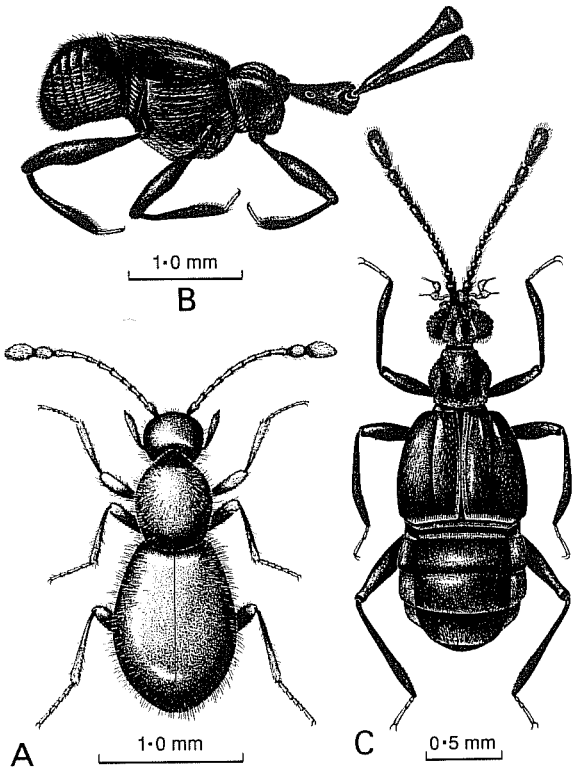

Figure 26 Staphylinoidea: A, *Scydmaenus myrmecophilus*, Scydmaenidae; B, *Tiracerus foveicollis*, Pselaphidae; C, *Ctenicellus major*, Pselaphidae. [F. Nanninga]

and may have burrowing adaptations, such as enlarged legs (*Dietta*, *Zeadolopus*); most other leiodids are pubescent. CAMIARINAE, including *Eublackburniella*, *Myrmecholeva* and the Agyrtodini, are restricted to the Southern Hemisphere, while the CHOLEVINAE occur throughout the world and are represented in Australia by *Austronemadus*, *Catoposchema*, *Nargiotes* and several other genera. COLONINAE (*Colon*) also occur in Australia, but Catopocerinae and Leptininae are absent from the fauna. [Newton 1985; Zwick 1979b]

16 Scydmaenidae (Figure 26A; Plate 5H) ADULT: ANT 11(INC/3–5), FCOX TRANS–PROJ(CONC), FCAV OPEN(OPEN), MCOX NARR(CLOS), 5-5-5, ABD 6(0), 0.8–2.9 MM. LARVA: HEAD PRO(PRO)/HYPO, STEM 0/1/3, ANT 2/3, FSUT 0, LABR FU, MOLA 0, VMP RET, MALA, MP 2/3, LP 2, HSC 0, HRD 0, VER 0, LEGS 5, PTS 2, UROG 0/+R, SPIR AN.

Small to minute beetles usually distinguished by their 'waisted' body form, with distinct constriction at junction of prothorax and elytra and usually another at base of head, so that neck is formed. Most species reddish and pubescent, with coarsely faceted eyes, large maxillary palps with reduced apical segment, approximate fore coxae and distant hind coxae, no lateral pronotal carinae and clavate femora. Species of Cephenniini are exceptional in lacking the neck and waist, but in most respects they are typical scydmaenids. Larvae elongate to ovate and setose, with large, club-like antennae and usually without or with very small urogomphi.

Scydmaenids occur in a variety of habitats, such as leaf litter, rotten wood, moss, tree holes, sawdust piles and ant nests. They are predaceous beetles, feeding primarily on oribatid mites, and Schmid (1988) has described sructures on the adult legs (Plate 5H) and mouth-parts which are used for grasping and penetrating the cuticle of their heavily armored prey. Schuster (1966) and Newton (1991) have described adhesive discs in scydmaenid larvae which are also used for capturing mites.

The family is represented in Australia by four tribes of the subfamily SCYDMAENINAE: Cephenniini (*Coatesia*, *Neseuthia*), Syndicini (*Syndicus*), Scydmaenini (*Scydmaenus*, *Palaeoscydmaenus*), and Euconnini (several genera including *Euconnus*, *Horaeomorphus* and *Stenichnus*). [Franz 1975]

17 Silphidae (Figures 25E, F) ADULT: ANT 11(3), FCOX PROJ(EXP), FCAV OPEN(OPEN), MCOX MWIDE(OPEN), 5-5-5, ABD 7(0), 14–42 MM. LARVA: HEAD HYPO, STEM 6, ANT 3, FSUT 0, LABR FR, MOLA 0, VMP RET, GLAC, MP 3, LP 2, HSC 0, HRD +, VER +, LEGS 5, PTS 2, UROG +, SPIR AN.

Relatively large and flattened beetles with a distinctive antenna (large, 3-segmented, slightly asymmetrical and finely pilose club preceded by at least one glabrous, strongly transverse, concave segment reminiscent of hydrophilid cupule, Figure 25F, cf. Figure 23F); unlike Hydrophilidae, silphids have relatively long, 11-segmented antennae. Body either glabrous or clothed with very short, fine hairs; eyes moderately large and protuberant; fore coxae large and projecting, all tarsal segments clothed beneath with yellow hairs. In *Ptomaphila* the elytra are provided with short, longitudinal ridges and tubercles and completely conceal the abdomen, while in *Diamesus* they are carinate and truncate, exposing 4 or 5 abdominal tergites. Larvae (Figure 25E) broad, depressed, and heavily sclerotised, with lateral, plate-like expansions on thorax and abdomen.

Australian Silphidae are associated with vertebrate carcasses, but *Ptomaphila lacrymosa* adults have also been observed feeding on maggots; in other parts of the world there are phytophagous forms, as well as carrion feeders and those which prey on snails. *Diamesus osculans* is widely distributed from India and Indonesia, through Papua New Guinea to northern and eastern Australia; *P. lacrymosa* occurs in the south-eastern and south-western part of the continent; and *P. perlata* is confined to the eastern coast from East Gippsland to Cape York. *Oxelytrum*, the apparent sister group of *Ptomaphila*, occurs in Central and South America. [Peck and Anderson 1985; O. P. Young 1983]

18 Staphylinidae (incl. Scaphidiidae; Figures 25G, 27A–G; Plates 3B; 4E, F; 8J; 10C) ADULT: ANT 10–11 (FIL/INC/2–6), FCOXTRANS–PROJ(EXP/CONC), FCAV OPEN–CLOS(OPEN–CLOS), MCOX CONT–MWIDE (OPEN–CLOS), 5-5-5/4-5-5/4-4-4/4-4-5/5-5-4R/3-3-3, ABD 6–7(0), 1–20 MM. LARVA: HEAD PRO (PRO), STEM 0–6, ANT 3/4, FSUT 0, LABR FR/FU, MOLA 0, VMP RET/PRO, MALA, MP 3/4, LP 2/3, HSC 0, HRD 0, VER 0/+, LEGS 5, PTS 0–M, UROG 0R/+, SPIR AN.

This is the 5th largest family in Australia, and many

species remain to be discovered. Adults usually more or less elongate with truncate elytra that nearly always leave more than half the abdomen exposed; all but first 1 or 2 tergites heavily sclerotised and often flanked by paratergites; abdominal intersegmental membranes usually with pattern of minute sclerites. Larvae always without mandibular mola and usually with articulated urogomphi. In three of the largest subfamilies (Aleocharinae, Paederinae and Staphylininae) the body is rather loosely organised and flexible, and the prothorax has strongly projecting coxae, reduced notal projections, and much exposed membrane (Figure 27C). Staphylinid larvae are usually of the active, campodeiform type with well-developed legs, characteristic antennae in which the apex of segment 2 is oblique so that the sensorium arises before the apex, and a pair of articulated urogomphi on T9. A few forms are onisciform, however, and some may have fixed or no urogomphi.

Key to the Subfamilies of Staphylinidae Known in Australia

1 Antennal insertions located posterior to a line drawn between anterior edges of eyes 2
Antennal insertions located anterior to a line drawn between anterior edges of eyes 4

2(1) Elytra concealing all but last 1 or 2 abdominal tergites; body short, stout and wedge-shaped, with long and slender legs and antennae ..... SCAPHIDIINAE
Elytra exposing at least 3 abdominal tergites; body not wedge-shaped 3

3(2) Hind coxae oval and distinctly separated; eyes large and protruding, so that head is wider than prothorax ..... STENINAE
Hind coxae strongly transverse and contiguous; eyes not large and protruding ..... ALEOCHARINAE

4(1) Head with paired ocelli, about level with the posterior edges of the eyes, or if ocelli indistinct, then elytra concealing all or all but 1 or 2 tergites and antennae with distinct 3-segmented club ..... OMALIINAE
Head without paired ocelli; without other characters in combination 5

5(4) Antennae with distinct 2-segmented club 6
Antennae without distinct club 7

6(5) Eyes very large and protuberant; labrum deeply emarginate and partly concealed, so that only a pair of narrow, setose processes are visible; length more than 2.5 mm ..... MEGALOPSIDINAE
Eyes not very large and protuberant; labrum not as above; length usually less than 2.5 mm ..... EUAESTHETINAE

7(5) Apical segment of maxillary palp enlarged and cultriform, with a groove along one side ..... PAEDERINAE-Pinophilini
Apical segment of maxillary palp not enlarged, without a groove 8

8(7) Abdomen with 7 ventrites (S2–S8) ..... OXYTELINAE (pt)
Abdomen with 6 ventrites (S3–S8) 9

9(8) Antennal insertions concealed from above by paired frontal ridges 10
Antennal insertions exposed 14

10(9) Abdomen without paratergites; usually cylindrical without any sutures or carinae separating tergites and sternites, occasionally with sharp lateral edges in flattened, yellowish forms with basally constricted prothorax ..... OSORIINAE
Abdomen with paratergites separating the tergites and sternites 11

11(10) Fore coxae small and globular; body elongate and narrow, with long, filiform, setose antennae and anteriorly projecting horns on head ..... PIESTINAE
Fore coxae larger, projecting; head without horns 12

12(11) Fore coxae transverse, cavities partly closed behind by triangular spiracular sclerite ..... PROTEININAE (pt)
Fore coxae projecting, not transverse; without visible spiracular sclerite behind fore coxae 13

13(12) Apical segment of maxillary palp much longer than preceding segment ..... OXYTELINAE (pt)
Apical segment of maxillary palp reduced, much shorter than preceding segment ..... PAEDERINAE (pt)

14(9) Tarsi 3-segmented; minute (less than 1.5 mm), extremely slender, wingless and eyeless ..... LEPTOTYPHLINAE
Tarsi with more than 3 segments; size larger or not very slender 15

15(14) Elytra long, leaving only 3 or 4 abdominal tergites exposed, and hind coxae with vertical posterior face ..... PROTEININAE (pt)
Elytra shorter, or if long, hind coxae with oblique posterior face visible from below 16

16(15) Head without distinct neck visible from above (head more or less deeply inserted into prothorax) ... 17
Head with distinct neck visible from above 18

17(16) Elytral epipleuron not separated by a carina ..... PHLOEOCHARINAE
Elytral epipleuron separated by a carina ..... TACHYPORINAE

18(16) Pronotum with distinct, post-coxal projection, usually concealing mesothoracic spiracle in lateral view; abdominal intersegmental membranes with brick-like pattern of minute rectangular sclerites; apical segment of maxillary palp always reduced, much shorter than preceding segment ..... PAEDERINAE (pt)
Pronotum without post-coxal process; abdominal intersegmental membranes with pattern of minute triangular or rounded sclerites; apical segment of maxillary palp variable, usually longer than preceding segment ..... STAPHYLININAE

The OMALIINAE and PROTEININAE include a number of small and usually flattened species occurring in the southern part of the continent and having affinities with the New Zealand and South American faunas (Newton 1985; Thayer and Newton 1978). In two unusual omaliine genera, *Glypholoma* and *Microsilpha*, the elytra are nearly complete. TACHYPORINAE are a moderately sized group with a characteristic fusiform shape, inserted head, and tapered abdomen with the segments capable of being telescoped. A common genus is *Sepedophilus*; some species

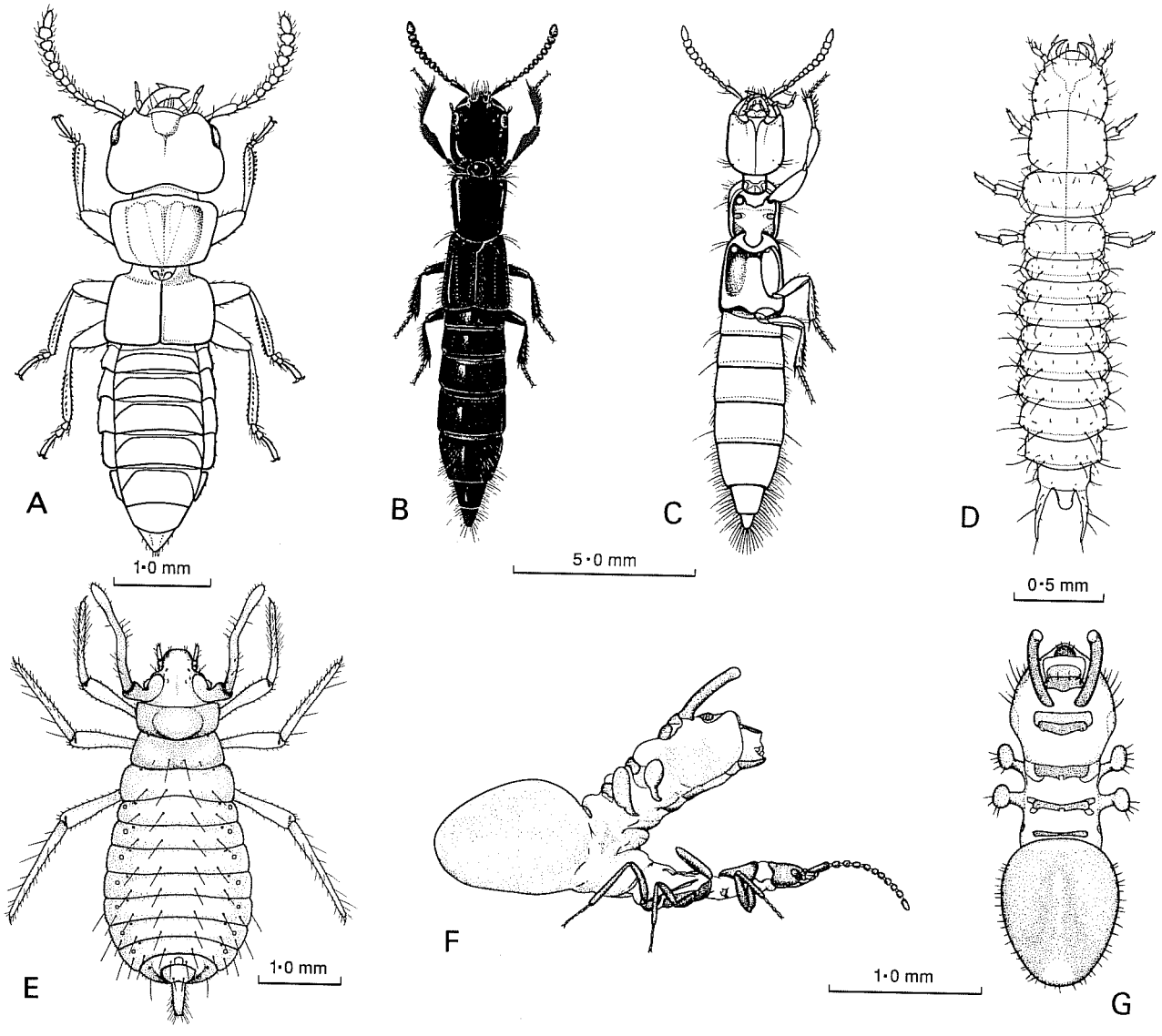

Figure 27 Staphylinidae: A, *Anotylus* sp., Oxytelinae; B, *Thyreocephalus chalcopterus*, Staphylininae, dorsal; C, same, ventral; D, *Omalium* sp., Omaliinae, larva; E, *Drepanoxenus ardea*, Aleocharinae, larva; F, *Austrospirachtha mimetes*, Aleocharinae, adult, lateral; G, same, dorsal.
[A by A. Hastings; B, C by F. Nanninga; D by A. Klinkenberg; E by R. Kohout; F, G by B. Rankin]

graze on the undersides of bracket fungi. ALEOCHARINAE are the largest group of staphylinids, with more than 200 described Australian species and many more awaiting study. The vast majority of aleocharines are free-living predators, but *Aleochara* species are ectoparasitoids of Diptera pupae (Drea 1966) and *Gyrophaena* and their relatives feed on Basidiomycetes (Ashe 1984). Inquilinism has evolved a number of times in aleocharines. In Australia, *Polylobus* and many Myrmedoniini occur with ants, while seven tribes (including Coroticini, Drepanoxenini and Trichopseniini) and three subtribes of Athetini are composed of termitophiles (Kistner 1979, 1982; Watson and Kistner 1985; Watson and Howick 1975).

The SCAPHIDIINAE are often considered to be a separate family because of the distinctive wedge-like form and relatively long elytra. Most scaphidiids feed on the spores and hyphae of various Basidiomycetes, but species of *Baeocera* and *Scaphobaeocera* are slime mould spore feeders. A common genus associated with polypores is *Scaphisoma*. PIESTINAE are represented by *Prognathoides mjobergi*, a distinctive flattened staphylinid with paired horns on the head. OSORIINAE are primarily tropical, saprophagous and found under bark and in rotten wood. Included are the large, flattened *Priochirus miles* from northern Qld, cylindrical species of *Osorius*, and the very small, flattened Eleusinini. *Thoracophorus* are thought to be mycetophagous. Newton (1990) has provided a key to all Australian osoriine genera. OXYTELINAE are primarily saprophagous and some are abundant in leaf litter and dung; our commonest genus is *Anotylus*. The flightless, litter-inhabiting *Oxypius peckorum*, from south-western W.A., is a relict form most closely related to species of *Euphanias* from the Mediterranean Region and South America (Newton 1982). *Sartallus signatus* occurs under seaweed on beaches, and species of *Bledius* construct burrows in moist sand adjacent to rivers, lakes and oceans

and feed on algae and diatoms (Herman 1986). *Stenus* (STENINAE) live in marshes and at the edges of streams, where they are able to move on the surface of water by secreting from the pygidial glands a surfactant, which reduces the surface tension behind them (Schildknecht 1970; Schildknecht *et al.* 1975). *Stenus* also possesses a unique adult prey capture mechanism, consisting of a protrusible, adhesive labium (Weinreich 1968).

PAEDERINAE and STAPHYLININAE are the two largest groups of highly motile, specialised predators. *Paederus* (Plate 8J) is well known, brightly coloured and, when irritated, produces a fluid that causes severe blistering of the skin (Frank and Kanamitsu 1987; Whelan and Weir 1987). Other common genera are *Lathrobium*, *Scopaeus*, *Hyperomma* and *Pinophilus*. Among the staphylinines, *Creophilus erythrocephalus*, the devil's coach-horse (Plate 10C), which is black with a red head bearing a central black spot, is often associated with cadavers, where it preys on maggots. Large and metallic species of *Actinus* occur in northern Qld, while *Cafius* are predators in seaweed on beaches. Other major groups are the genera *Philonthus*, *Quedius*, *Heterothops* and the tribe Xantholinini. *Myotyphlus jansoni* lives in the fur of native *Rattus* and may be related to South American species with similar habits (Hamilton-Smith and Adams 1966). [Frank and Thomas 1984; Kasule 1966; Moore and Legner 1979; Newton 1984]

19 Pselaphidae (Figures 26B, C) ADULT: ANT 2–11 (FIL/INC/2–5), FCOX PROJ(CONC), FCAV OPEN (OPEN), MCOX CONT–NARR, 3-3-3/2-2-2R, ABD 6(0), 0.8–3.6 MM. LARVA: HEAD PRO(PRO), STEM 0/2/3, ANT 2/3, FSUT 0, LABR FU, MOLA 0, VMP RET, MALA, MP 3, LP 2, HSC 0, HRD 0, VER 0/+, LEGS 5, PTS 0/2, UROG 0/+, SPIR AN.

Small beetles resembling Staphylinidae in having short, truncate elytra exposing most of abdomen, but differing from staphylinids in having shorter, broader and non-flexible abdomen, enlarged apical maxillary palp segment, setose foveae on head, prothorax and other parts of body, and 2- or 3-segmented tarsi usually with unequal claws or 1 claw only. The colour is usually reddish or yellowish, and the antennae are almost always incrassate or variously clubbed. Larvae elongate to fusiform and clothed with erect setae; antennal sensorium enlarged or complex; paired eversible glands arising from antennal sockets; urogomphi reduced and fixed or absent. Pselaphidae are abundant in leaf litter, rotten wood, moss, tree holes, caves and animal nests; except for some myrmecophilous forms, adults and larvae are predators on minute organisms. The European *Batrisodes oculatus* was observed feeding on a collembolan, which it captured by sticking the prey to its abdomen, which was covered with a viscous substance secreted by dorsal glands (De Marzo 1986); the same species formed a silken cocoon for pupation.

The family is well represented in Australia by members of all recognised subfamilies: FARONINAE with the genus *Sagola*, EUPLECTINAE and BATRISINAE with about 80 described species between them, GONIACERINAE and PSELAPHINAE, the most diverse and abundant groups together comprising over 300 species, and CLAVIGERINAE, represented mainly by about 50 species of *Tiracerus*. The last are highly specialised myrmecophiles which are tolerated in ant nests and even fed by workers; they bear setose secretory structures (trichomes), which in an American species, *Adranes taylori*, are fed upon by larvae of the ant *Lasius niger* (Akre and Hill 1973). [Newton and Chandler 1989; Besuchet 1956b]

Series SCIRTIFORMIA
Superfamily SCIRTIOIDEA

The three families Scirtidae, Eucinetidae and Clambidae retain many primitive polyphagan features but share a type of compacting mechanism in which the head is strongly hypognathous and fits against the fore coxae or metasternum (Clambidae) when at rest. Larvae of Clambidae and Eucinetidae are similar to those of many Cucujoidea, usually differing in the presence of a distinct galea and lacinia and annular spiracles. Scirtid larvae are of a unique type reminiscent of the immature stages of some exopterygote insects, with multiannulate antennae, complex, filter-feeding mouth-parts and a metapneustic respiratory system.

20 Scirtidae (Helodidae, Cyphonidae; Figures 28B, C; Plate 2G) ADULT: ANT 11(FIL), FCOX TRANS–PROJ (EXP), FCAV OPEN(OPEN), MCOX CONT(OPEN), 5-5-5, ABD 5(0–2), 1.5–11 MM. LARVA: HEAD PRO (PRO), STEM 1–3, ANT M, FSUT 0, LABR FR, MOLA +, VMP RET, GLAC, MP 4, LP 2, HSC +, HRD 0, VER 0, LEGS 5, PTS 2, UROG 0, SPIR RED.

Moderate to small, oblong to ovoid beetles, usually somewhat flattened, with large, strongly deflexed head, short and broad prothorax with large, projecting fore coxae and reduced sternal region, moderately broad and complete elytral epipleura, and lobed 4th tarsal segments. A pair of sharp genal ridges (Figure 15G) rest against the fore coxae when head is fully deflexed. Hind coxal plates present except in *Scirtes*, which has enlarged hind femora for jumping. Male genitalia are complex and variable within the family (Nyholm 1972). Larvae elongate and somewhat flattened, with large head, multisegmented antennae (unique in beetle larvae), complex mouth-parts with maxillary comb-hairs (Plate 2G) and comb-like hypopharyngeal armature, a single pair of large spiracles at abdominal apex and a set of 5 anal papillae. Adult scirtids are often found on vegetation near water, while the larvae usually occur in lentic habitats, such as ponds, marshes, bogs or tree holes (Kitching and Allsopp 1987), but have also been found in wet, rotten wood. Larvae are filter-feeding detritivores (Beier 1952). They use the 8th spiracles to breathe at the surface, while the anal papillae are thought to be osmoregulatory in function (Treherne 1954). Scirtids are (e.g. *Macrohelodes*, *Pseudomicrocara*, *Macrocyphon*) most abundant and diverse in the cool temperate parts of Australia. *Scirtes*, which is more common in the north, has enlarged hind femora and is capable of jumping. [Armstrong 1953; Pope 1976]

21 Eucinetidae (Figure 28A) ADULT: ANT 11 (FIL /INCR), FCOX PROJ(EXP), FCAV OPEN (OPEN), MCOX NARR(CLOS), 5-5-5, ABD 5–7(2), 1.3–3 MM.