

THE FOSSIL INSECTS OF AUSTRALIA

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A taxonomic catalogue of the known fossil insects of Australia provides illustrations of at least one species of every genus so far identified. Every known species is recorded with the age, rock unit (formation) and location (sedimentary basin). Some synonymies and updated taxonomic placements are included but this has not been an exhaustive review of taxonomy. The principal sources for fossil insects are described as the Upper Permian Boolaroo Formation in the Newcastle Coal Measures adjacent to Lake Macquarie, the Hawkesbury Sandstone at Brookvale in Sydney, the Mt Crosby and Blackstone Formations in the Upper Triassic Ipswich Coal Measures of southeastern Queensland and the Lower Cretaceous Koonwarra Fossil Bed in South Gippsland, Victoria. Other minor sites are discussed and potential for further research is outlined. *Austroscarites* is introduced to replace the preoccupied *Scarites* Hamilton not Fabricius. □ *Fossil insects, Australia, Permian, Triassic, Cretaceous, catalogue.*

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The living insect fauna of Australia is obviously abundant and diverse to inhabitants and visitors alike. The importance of the insect fauna to our way of life and our economy has been documented by many people since the first arrival of Europeans. Assuming living diversity is an indication of the insect fauna at any instant of the geological past and in view of the known evolution of insects during geological time we can project an enormous number of species that must have inhabited this continent since the origin of insects during the early Palaeozoic. However, the majority of these were almost certainly never fossilised and have left no record. Marine faunas have a better fossilization potential than terrestrial ones. It is estimated that overall less than 1% of living species at any one instant in time will be fossilized and collectable to enter the palaeontological literature. Thus the known fossil insect record of more than 400 species in approximately 250 genera is only a small fraction of the insect species that have lived in Australia.

In each edition of 'The Insects of Australia' a chapter was devoted to their fossil history. Riek (1970c) and Kukulova-Peck (1991) gave good overviews of the fossil history of Australia and fitted it into the broader story of insect evolution across the globe. The aim of this publication is to complement those accounts with a comprehensive listing of the fossil insect species described from Australia along with illustration of at least one species from each genus.

GEOLOGICAL SETTING OF FOSSIL INSECT SITES

Compared to the number of Australian fossil sites or to the number of insect fossil sites worldwide only a few sites around Australia have yielded fossils of insects (Fig. 1). These sites provide imperfect data for only a very few instants of geological history (Fig. 2).

HELLYER GORGE SITE IN UPPER CARBONIFEROUS WYNYARD TILLITE. The earliest known insect from Australia comes from the Hellyer Gorge district of northwestern Tasmania where the single, almost complete specimen, with 50mm wing span, was found in a 1m fossiliferous band of varve-like sediments within the Wynyard Tillite. Tillites occur in the formation both above and below the finegrained fossiliferous section. The co-occurring fossil plant, *Botrychiopsis plantiana*, and Stage 1 microflora indicate a Late Carboniferous age and the primitive insect structure suggests early Late Carboniferous. The sedimentary environment and paucity of associated insects indicate deposition in cold conditions close to glacial ice. Riek (1976) erected the Psychroptilidae and Suborder Neosecoptera as monotypic taxa for this insect, *Psychroptilus burrettae* Riek, 1976 within the Order Megasecoptera. He outlined the difficulty of classifying this species by indicating features it shares with the Megasecoptera (wing venation except Sc ends abruptly on the costal margin just beyond the midlength of the wing) others it shares with the Palaeodictyoptera (wings

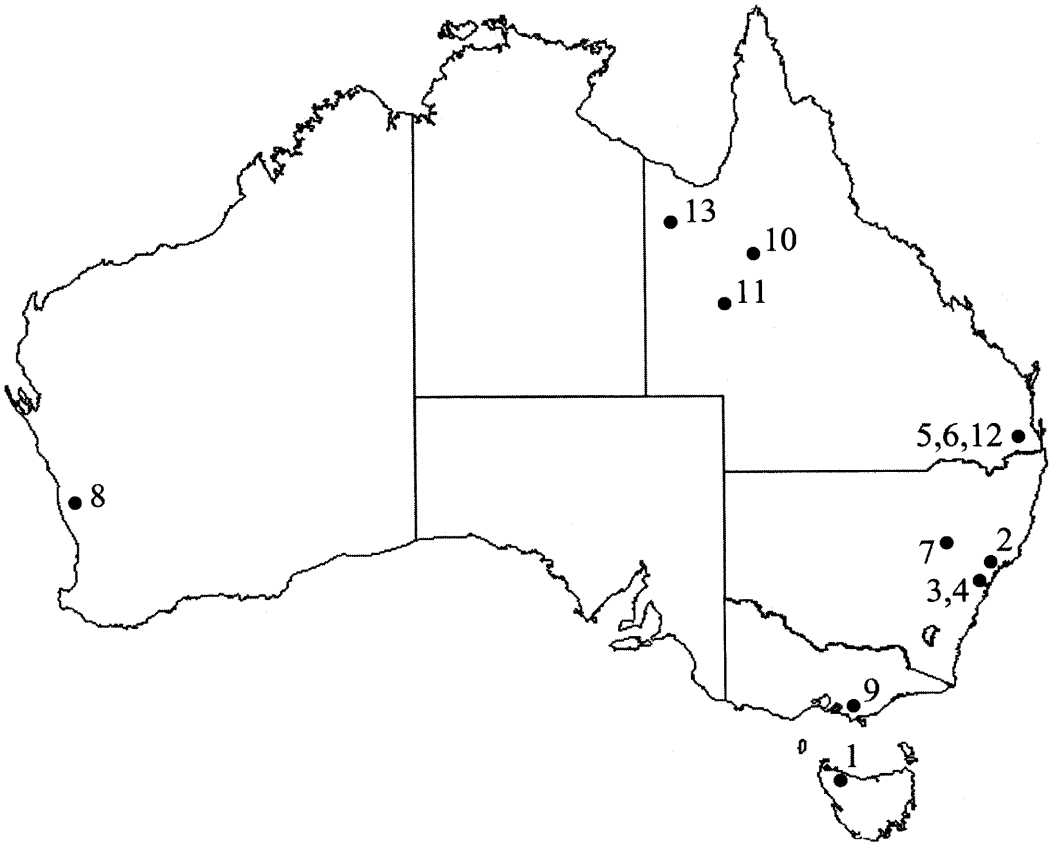


FIG. 1. Distribution of main fossil insect sites. 1=UCarboniferous Wynyard Tillite at Hellyer Gorge; 2=UPerminian Newcastle Coal Measures at Belmont just south of Newcastle; 3=MTriassic (Anisian) Brookvale Shale in Hawkesbury Sandstone near Manly in suburbs of Sydney; 4=MTriassic (Anisian) Ashfield Formation in Wianamatta Group at St Peters near Newtown, suburban Sydney; 5=UTriassic (Carnian) Mt Crosby Formation in lower Ipswich Coal Measures just north of Ipswich; 6=UTriassic (Carnian) Blackstone Formation at top of Ipswich Coal Measures on Denmark Hill in suburban Ipswich; 7=LJurassic Talbragar Fish Bed in the Purlawaugh Formation near Gulgong; 8=LCretaceous Cockleshell Gully Formation in Hill River area, northern Perth Basin; 9=LCretaceous (Aptian) Koonwarra Fossil Bed on the South Gippsland Highway near Tarwin in the Gippsland Basin; 10=LCretaceous Wallumbilla Fm near Richmond, Great Artesian Basin; 11=UCretaceous Winton Formation near Winton, Great Artesian Basin; 12=Palaeocene Redbank Plains Formation east of Ipswich; 13=Late Oligocene/Early Miocene Upper Site in Riversleigh Limestones north of Mount Isa.

broad at the base) and others not previously known in either of those orders. By comparison to the Northern Hemisphere faunas the Carboniferous insect fauna of Australia is virtually unknown.

BELMONT INSECT FAUNA IN UPPER PERMIAN NEWCASTLE COAL MEASURES. The Upper Permian insects from the Newcastle Coal Measures described mainly by Tillyard came from an area of 10-20km² between the town of Belmont and Warners Bay on the eastern side

of Lake Macquarie some 10km southwest of Newcastle. A sand and conglomerate fan was probably braiding through coal swamps along the southeastern flank of the Hunter Trough in the Late Permian, sourcing its clastic material primarily from higher land to the north and northwest (Engel, 1966). The widespread and persistent insect beds, which are fine grained volcaniclastic units (tuffs) associated with plenty of plant detritus mainly *Glossopteris* leaves and *Phyllothea*, were apparently deposited during a brief, episodic event and fairly rapidly buried.

The insects were very likely a wing-float concentration, with the wings remaining buoyant until the waterbody was choked with ash, possibly enhanced by storm action during or just after the eruption. Adjacent coal seams, conglomerates and tuff beds indicate a dynamic environment with swamp conditions prevailing when and where short term quiet conditions became established. Details of stratigraphic relationships in the Belmont area are provided by Hawley & Brunton (1995) and Little et al. (1996). Rare insects have been found in the Lambton Formation adjacent to the Dudley Coal Seam (*Permoscarta mitchelli* Tillyard, 1918b, *Mitchelloneura permiana* Tillyard, 1921b and *Lophioneura ustulata* Tillyard, 1921b) at the base of the Newcastle Coal Measures but the major horizon is within the Boolaroo Formation in the upper half of the coal measures. As with many coal measure stratigraphies there is an extremely fine subdivision to reflect the various coal seams but these units are often of restricted extent so the listing below refers to the Newcastle Coal Measures as the provenance of the insects from this area. This fauna is rich in Homoptera, Psocoptera, Neuroptera, Mecoptera but lacks blattoids or palaeoptera.

MIDDLE TRIASSIC HAWKESBURY SANDSTONE AT BROOKVALE, SYDNEY. The Middle Triassic (Anisian) Hawkesbury Sandstone in the Sydney Basin envelops a lens of fine mudstone referred to as the Brookvale Shale lens (about 8m thick) which was best exposed in the Brookvale Quarry on Beacon Hill, Brookvale, near Manly, north of Sydney Harbour where it yielded many fish, many plants (*Dicroidium zuberi* flora), amphibians, unionid bivalves, crustaceans, insects, trace fossils and some enigmatic fossils. This mudstone lens may be interpreted as a lacustrine interval on a quartz sandstone coastal plain and from the fauna a freshwater environment is most probable. The insect fauna includes the large titanopteran, *Clatrotitan*, a mecopteroid, a protorthopteroid, orthopteroids and a stonefly.

MIDDLE TRIASSIC ASHFIELD FORMATION AT ST PETERS, SYDNEY. The Ashfield Shale (40-60m thick in the Wianamatta Group) overlies the Mittagong Formation (up to 15m thick) which in turn overlies the Hawkesbury Sandstone in the area immediately west and southwest of Sydney known as the Cumberland Basin. Outcrop of the Ashfield Shale defines the shape of the basin. Siltstone and

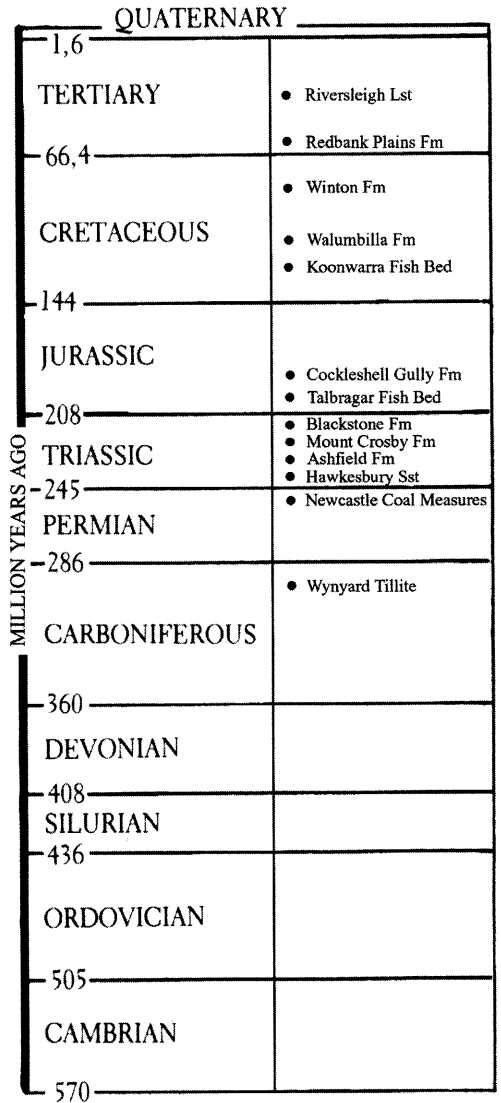


FIG. 2. Stratigraphic succession of important known insect sites.

clay from low in the formation was extensively quarried in the St Peters district for manufacture of house bricks. An extensive fauna of bivalves, fish, a shark, labyrinthodonts, an isopod, the insects and plants has been collected from these quarries and indicates a freshwater environment. Its age is Middle Triassic (late Anisian) based mainly on the floral components of the fauna. The insects are predominantly beetle elytra, a large blattodea and the large titanopteran, *Mesotitan*,

but nothing has been added to the work of Tillyard (1916). Tillyard (1918b) described another Ashfield insect fauna from a railway cutting at Glenlee, 6.5km south of Campbelltown on the main southern line with a very similar assemblage to that from St Peters i.e. dominated by beetle elytra, the same blattodean genus and a mecopteroid rather than the large titanoptera.

UPPER TRIASSIC MT CROSBY FORMATION, IPSWICH COAL MEASURES AT MT CROSBY, NORTH OF IPSWICH, SOUTHEASTERN QUEENSLAND. The Mount Crosby Formation, the oldest in the Ipswich Coal Measures occupies an area north of Ipswich adjacent to the Brisbane River of some 30km². It is 20-30m thick and consists mainly of polymictic, poorly sorted conglomerate but has 3 shale units, up to 6m thick near the bottom, middle and top of the unit. The upper two shale units are fossiliferous with prolific plant and insect remains. The conglomerates of the formation indicate rapid erosion from an adjacent highland (the Daguilar Block) and little transport. The shale units indicate restricted quiet lacustrine conditions at various times on this piedmont fan. The insect fauna is dominated by Blattodea and Homoptera with Mecoptera, Diptera, Orthoptera, Neuroptera, Coleoptera, Odonata, Plecoptera, and Hymenoptera represented.

UPPER TRIASSIC BLACKSTONE FORMATION, IPSWICH COAL MEASURES AT DENMARK HILL, IPSWICH, SOUTHEASTERN QUEENSLAND. At Denmark Hill very close to the centre of Ipswich the upper part of the Ipswich Coal Measures underlies an urban park reserve. In 1890 insects were first found in this locality and much geological interest followed. The richly fossiliferous horizon is a finely arenaceous siltstone about 15cm thick assigned to the Blackstone Formation, the youngest formation of the Ipswich Coal Measures. Coal seams are known above and below the fossiliferous sequence indicating a lacustrine environment. Plant fossils are prolific and among the fauna freshwater bivalves and estherid crustaceans accompany the insects while dinosaur footprints are known in the formation. Dunstan (1916) gave a detailed account of the small quarry in which the insects were collected. The fauna is dominated by beetle elytra, Blattodea and Homoptera and includes fewer Orthoptera, Phasmatodea, Neuroptera, and Mecoptera.

LOWER CRETACEOUS (APTIAN) KOONWARRA FOSSIL BED NEAR LEONGATHA, SOUTH GIPPSLAND, VICTORIA. During road widening excavations on the South Gippsland Highway between Koonwarra and Tarwin council workers recognised fossil fish in the spoil. A short succession of varved lake deposits is within a thick fluvial succession, the Korumburra Group (=Strzelecki Group). The lacustrine sequence contains some beds with abundant fish (Waldman, 1971) and other beds with numerous insects, plants and a few other arthropods, some annelid worms (Jell & Roberts, 1986) and a few feathers (Talent et al., 1966), the earliest indications of birds in Australia. The insects include many aquatic larvae and numerous terrestrial adults. By analogy with present day lakes in western Victoria it was possible to identify representatives of the insect fauna that lived in the lake, a fauna of larvae that lived in a feeder stream and insects that lived on the surrounding land and then fell onto the surface of the water (Jell & Duncan, 1986). Mayfly nymphs from the stream fauna and dipteran and beetle larvae from the lake dominate the aquatic fauna while Hemiptera, Mecoptera, hymenopterans, beetles, flies and blattodea are common among the winged adults. The beds are dated palynologically (Dettmann, 1986) as Aptian and a fission track date (Drinnan & Chambers, 1986) of 116±5Ma has been obtained.

PALEOCENE REDBANK PLAINS FORMATION NEAR IPSWICH, SOUTHEASTERN QUEENSLAND. The Tertiary Booval Basin which overlies the Mesozoic Ipswich Basin extends over 50km² in the Ipswich-Bundamba-Dinmore area. The Palaeocene Redbank Plains Formation consists of about 70m of mudstone, claystone, shale and fine sandstone which were deposited in a freshwater lake in structural depressions on the eroding upper surface of the Ipswich Basin sediments. The fossil content includes fish, turtles, crocodiles, ostracodes, cladocerans, insects and plants. Riek (1952a) noted two different faunas: one at Redbank Plains in a hardened band of ferruginous mudstone is dominated by Homoptera and Coleoptera with a few Diptera, Mecoptera, Neuroptera and Hemiptera and the other, at Dinmore in compact clays and clay shales, contains Orthoptera, Isoptera, Megaloptera, Homoptera and possibly Odonata.

**Order
EPHEMEROPTERA
(mayflies)**

Family **BAETIDAE** Leach, 1815

Cleon Leach, 1815

Larva: small, shrimp-like; head very small; cerci short.

emmavillensis Riek, 1954b; Pliocene;
Vegetable Ck, Emmaville, NSW.



Cleon emmavillensis,
AMD115, x5

Family **LEPTOPHLEBIIDAE** Banks, 1900

Atalophlebia Eaton, 1881 [*Ephemera australis* Walker, 1853]

Nymph dorsoventrally depressed, with widely flattened femora; head rectangular; eyes small, posterolateral, protruding slightly at margin, well separated medially; thorax slightly wider than head; insertions of foreleg close together, of mid and hindlegs well apart; femora 3 times as long as wide; tibiae not strongly flattened, not quite as long as femora; abdominal segments gradually increasing in length but narrowing, with 9th segment as long as wide; caudal cerci as long as abdomen.

culleni (Etheridge & Olliff, 1890); Plio;
Vegetable Ck; Emmaville, N.S.W.

Family **SIPHLONURIDAE** Banks, 1900

Promirara Jell & Duncan, 1986 [*cephalota*]

Nymph only. Similar to living *Mirawara* but with mouthparts less highly adapted for predation. Abdomen with 7 pairs of subequal gills, first pair not reduced. Cerci with hairs on the lateral as well as the median margin but hairs on lateral margins shorter and not extending to the base of cercus.

cephalota Jell & Duncan, 1986; LCret;
Koonwarra FB; Gippsland.

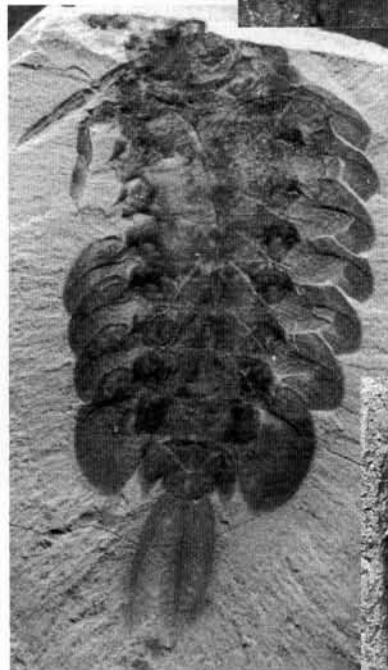
Australurus Jell & Duncan, 1986 [*plexus*]

Nymph only. Head elongate; mandibles large; antenna long; face above antennal insertions ridged. Legs long, thin; tibia shorter than tarsus; tarsal claw apparently long. Mesonotum raised, produced caudally; pronotum large. Abdomen with 7 pairs of unmodified lamellar gills; gill structure imperfectly known but each gill with a strengthened longitudinal ridge at or close to fore margin, possibly with a fibrillar tuft at base; segments 1-9 strongly produced posterolaterally into spines. Caudal filaments with dense fringes of fine hairs except on outer margins of each lateral filament.

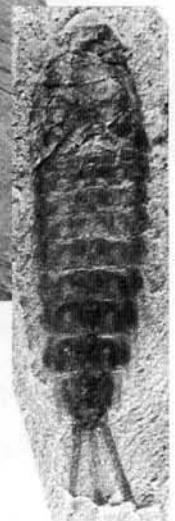
plexus Jell & Duncan, 1986; LCret; Koonwarra FB; Gippsland.

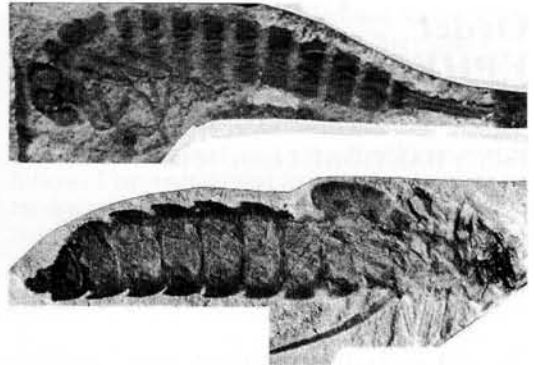
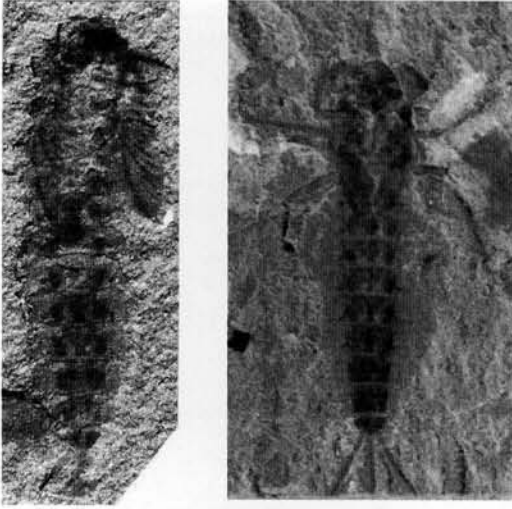


Atalophlebia culleni,
AMD113, x5

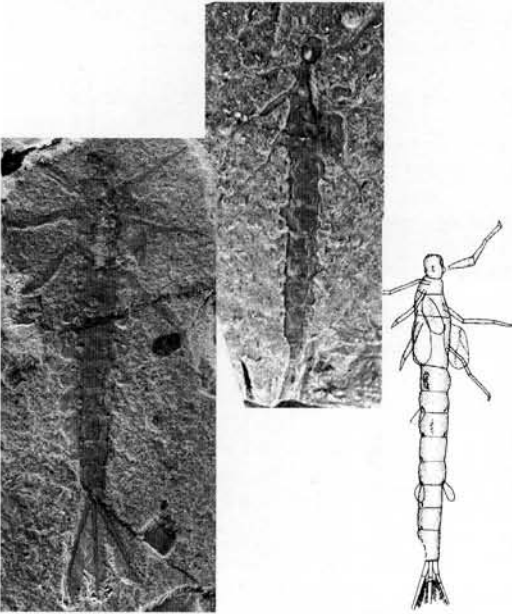


Promirara cephalota;
large nymph NMVP
102472B (above), x3;
immature nymph
MUGD3757 (right), x9.





Australurus plexus; nymphs; MUGD3754 (far left), x8; NMVP102450 (left), x6; NMVP48610 (top, above), x8; NMVP103120 (above), x4.



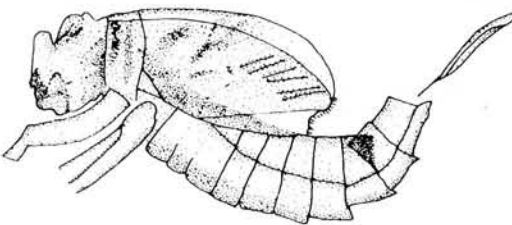
Dulcimanna sculptor; NMVP102507 (above centre) and AMF66758 (above left); x3. Line drawing (above right) of Jell & Duncan, 1986, fig. 2H

Dulcimanna Jell & Duncan, 1986 [*sculptor*]
Nymph only, large, elongate body 10 times as long as wide. Head rounded, relatively small, with large bulging dorsal eyes, with entire margin on labrum. Legs with femora of approximately equal length from fore to hind legs, with tibiae and unsegmented tarsi becoming longer to hind leg, with strong curved relatively long tarsal claw. Abdomen with flat lobate gills on segments 1-7, with gently convex internal margins not spinose posterolaterally. Caudal filaments equal, with dense comb of fine long hairs along lateral margins except on outer edges of cerci.

sculptor Jell & Duncan, 1986; LCret; Koonwarra FB; Gippsland.

Siphonuridae gen. nov. Jell & Duncan, 1986
Nymph only. Head rounded; mouthparts conspicuous; eye small; pleural spines at least on segment 9. Caudal filaments moderately long, slightly more than half length of abdomen.

gen. et sp. nov. Jell & Duncan, 1986; LCret; Koonwarra FB; Gippsland.



Siphonuridae gen. et sp. nov., NMVP103210, x6. Line drawing (left) of Jell & Duncan, 1986, fig. 2E.

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