FOSSIL CHELICERATES OF AUSTRALIA

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Abstract: The fossil chelicerates, and similar forms, of Australia are reviewed. The fauna comprises two aglaspidids (Cambrian, Tas.), five xiphosurans (Devonian, NSW; Permian, Tas; Triassic, NSW; Cretaceous, Vic.), two named eurypterids (Silurian, Vic.) and several other occurrences (Silurian, NSW; Devonian, WA & Vic.), three species of spider (Cretaceous and Pliocene, Vic.), one opilionid (harvestman; Cretaceous, Vic.), and one mite (Pliocene, Vic.). Eurypterid trackways have been reported from the Silurian of Western Australia.

Chelicerates are a large and important group of arthropods which get a generally bad press in Australia on account of the few noxious living forms such as red-back and funnel-web spiders, scorpions mites and ticks. The repulsiveness of the living animals, however, is more than matched by their fossil relatives, which include the largest arthropods that ever lived: the eurypterids. At up to 2m long, and armed with huge pincers or spiny forelimbs, they were the dominant predators of mid-Palaeozoic seas. An excellent account of the lives of these creatures was given by Gill (1951), who included an inventory of Australian forms known to that date - but more on eurypterids later!

Chelicerates are distinguished from all other arthropods by a number of features including a lack of antennae; in their place is a pair of pincers, or chelicerae (Fig. 2B). These are extremely elongated in the largest eurypterids, the Pterygotidae. Note that the pincers of scorpions are not the chelicerae (which scorpions also have) but a specialised development of the second pair of appendages: the pedipalps. The pedipalps can be variously modified in the chelicerates - in male spiders they carry sexual organs. Behind the pedipalps on the body are four pairs of walking legs.

The oldest known chelicerate-like animals (though not true chelicerates because they apparently lack chelicerae) are the aglaspidids, which are known from the Cambrian of Tasmania (Jago and Baillie 1992; Quilty 1972; Fig. 1C). Among the most primitive of all the main lines of true Chelicerata, and also the longest surviving, are the Xiphosura: horseshoe crabs (or 'king crabs' as they are called by British zoologists, though they are not crabs at all, of course). Living horseshoe crabs can be found along the coasts of south-east Asia (*Tachypleus*) and eastern North America (*Limulus*) and fossils are known as far back as the Cambrian period. Xiphosura are comparatively rare as fossils (as are all chelicerates), so those known from Australia form a significant

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contribution to our knowledge of the group. Specimens do turn up occasionally; one was found by workmen splitting flagstones of Devonian Mandagery Sandstone on the Bumberry Ridges, New South Wales (Pickett, 1993). This is currently the oldest fossil xiphosuran known from Australia. The next youngest is *Paleolimulus* from the Permian Jackey Shale of Poatina, Tasmania (Ewington, Clarke and Banks, 1989), which was found by a student on a field excursion from Launceston College. Though small, this inch-long specimen is nicely preserved in the shale which was laid down in a river during Australia's cold climate of the Permian. This find is the only known *Paleolimulus* from the southern hemisphere.

Triassic rocks have yielded two genera of Xiphosura which, so far, appear to be restricted to Australia: *Dubbolimulus peetae* Pickett, 1984, from middle Triassic rocks near Dubbo in the Sydney Basin, New South Wales (Fig. 1B), and *Austrolimulus fletcheri* Riek, 1955, from a similar horizon near Brookvale, New South Wales (Fig. 1A; see also Riek, 1968). Despite both animals occurring in sediments of similar lithology and age in the Sydney Basin, the animals could not be more different in appearance. *Dubbolimulus* is a fairly 'normal'-looking horseshoe crab but *Austrolimulus* is quite bizarre, with long genal spines more than twice the length of the animal.

The Cretaceous sediments of Koonwarra, South Gippsland, Victoria, are well known for the interesting terrestrial and freshwater plant and animal fossils they contain. Riek and Gill (1971) described a xiphosuran, *Victalimulus mcqueeni*, from a road cutting locality, where it was found by an amateur collector James McQueen. There is nothing odd about the appearance of *Victalimulus*, compared with other Mesozoic Xiphosura but, like the other Australian forms, it occurred in freshwater sediments. Most other fossil Xiphosura have occurred in near-shore marine environments, although living horseshoe crabs are known to travel many miles up estuaries to breed.

Additional Australian xiphosurans were described by Chapman (1932): *Pincombella belmontensis* from the Permian Belmont Beds of New South Wales, and *Hemiaspis tunnecliffei* from a road cutting in the Silurian rocks at Studley Park, Kew, Melbourne, Victoria. Careful re-examination of these specimens by John Pickett of the Geological Survey in Sydney revealed them both to be misidentified. *Pincombella* turned out to be part of a hemipteran insect (a bug), which are common in the Belmont Beds, and *Hemiaspis tunnecliffei* is actually a poorly preserved trilobite. Shortly after Chapman described these supposed horseshoe crabs from Permian and Silurian rocks, an apparently new genus of hemiaspid xiphosuran was found by amateur collector Mr. P. Junor in Silurian rocks of Kinglake West, Victoria. Withers (1933) named the fossil Rutroclypeus junori. However, this fossil proved later not to be of a xiphosuran, but a new carpoid echinoderm (Gill and Caster, 1960).

Eurypterids are extinct, having lived from Ordovician to Permian times. At their acme in the Silurian they were a very diverse group, including gigantic forms and types with scorpion-like tails, as well as small, streamlined animals (Fig. 1A,B). Most were swimmers, as evidenced by the typical paddle-shaped posterior limbs of many species, although the stylonuroids had stilt-like legs. McCoy (1899) described the first Australian eurypterid from a fragment of cuticle showing typical scaly ornament, found in a sewer trench in Domain Road, South Yarra, Melbourne. He named it Pterygotus australis but characters which could distinguish it from any other pterygotid eurypterid are lacking. The problem with most eurypterids is that they are large animals, so you are very lucky to find more than just a fragment, and whole animals are very rare. Collectors of dinosaurs have the same difficulty! The South Yarra Improvements produced further specimens which were described by Chapman (1910, 1914). Chapman also discovered that McCoy's holotype of Pterygotus australis had a number of small oval despressions on it which he described as Capulus melbournensis, a limpet-like gastropod which may have been a parasite or commensal on the Pterygotus (Chapman, 1929). Such a vision of a giant Pterygotus encrusted with epizoans cruising the Silurian seas brings to mind the barnacle-studded great whales (there are particularly fine examples at the entrance to the Queensland Museum in Brisbane).

Sewer trenches are not ideal places in which to collect fossils; that they are temporary excavations is but one inconvenience. A good place to find eurypterid fossils is in the many small quarries along the Yarra Track, which are famous for their abundant Silurian plant fossils. The association of early land plants and eurypterids is quite common, and points to the possible non-marine environments in which the eurypterids lived, or at least became buried after death. Eurypterids occur rarely in fully marine rocks with characteristic fossils, and are found in progressively more terrestrial environments later in their geological history. The collections at the Museum of Victoria in Melbourne contain many fragments of eurypterid collected at Cootamundra,

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New South Wales. Gill (1951) identified these fragments as belonging to the genus *Hughmilleria*, a much smaller eurypterid than *Pterygotus australis* (which Gill estimated to have been about 70 cm long). Caster and Kjellesvig-Waering (1953) re-examined the Cootamundra eurypterid fragments and concluded that the largest piece probably belonged to *Pterygotus* (I agree), and the others were indeterminable. Quite possibly the Cootamundra locality is in the same horizon as that from which *Pterygotus australis* originated (Caster and Kjellesvig-Waering, 1953).

So far, this survey of the Australian eurypterid fauna has revealed no surprises. The eurypterids are quite similar to those which occur in Silurian rocks elsewhere in the world. But just as many of the Australian xiphosurans are weird, so the eurypterids have their oddballs too. *Melbournopterus crossotus* was described by Caster and Kjellesvig-Waering (1953) from the Silurian of Heathcote, Victoria (Fig. 2C). Only the carapace is preserved (although the authors mention many scraps of eurypterid in the same slabs) which is remarkable for its enormous, subrectangular eyes and frilled rear margin. The specimen comes from the Dargile Formation (Upper Silurian) and the siltstone preserving it is rich in monograptids. The graptolites confirm not only the Silurian age of the beds but also their marine nature.

Eurypterid remains in Australia are not confined to the Silurian nor are they exclusively south-eastern. A single eurypterid specmen is known from the Devonian Gogo Formation of Western Australia (Rolfe, 1966). The Gogo is famous for its calcareous nodules which yield exquisitely preserved fossil fish. The eurypterid has been referred tentatively to *Rhenopterus* by Waterston (in Rolfe, 1966) but is yet to be formally described. In addition, fragments of eurypterid have been reported from Lower Devonian siltstones at Middendorp's Quarry, Kinglake West, Victoria (Jell, 1992).

Before leaving eurypterids, mention must be made of their distinctive trackways. Eurypterid legs are of differing lengths and in most species the last pair are modified to function as swimming paddles. When they walk, eurypterids leave behind a trail of footprints in the mud or sand consisting of converging rows of 3 or 4 imprints, the outermost having a curved outline (the paddle). Circumstances which preserve the trackways are different from those in which body fossils of eurypterids are found - you almost never find a dead eurypterid at the end of its trail! In the deep gorge of the Murchison River at Kalbarri in Western Australia, bedding

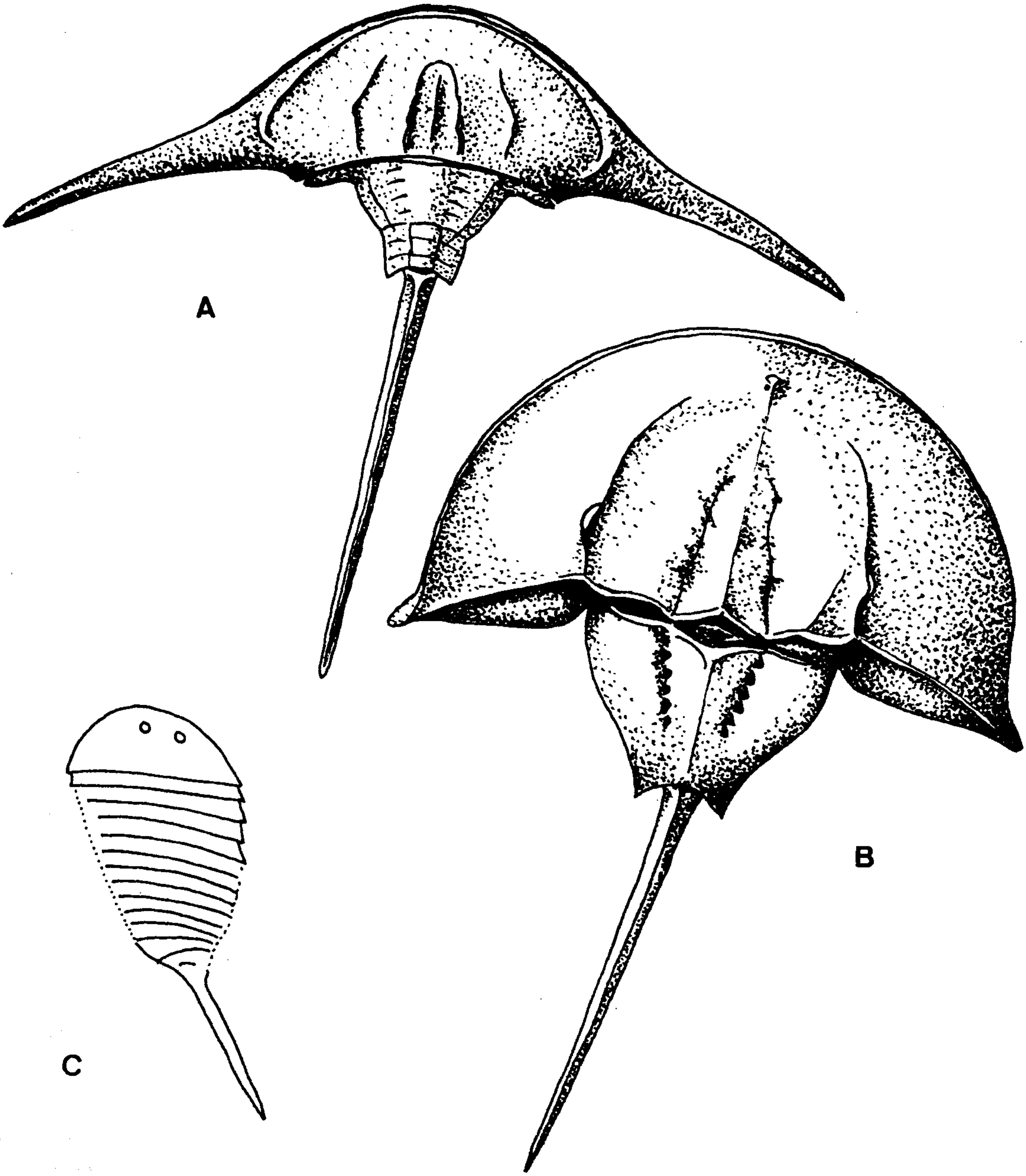

FIGURE 1. Australian Xiphosura (A, B) and Aglaspidida (C). A, Reconstruction of Austrolimulus fletcheri Riek, 1955, Triassic, NSW, dorsal aspect x 2/3 (after Riek, 1968); B, Reconstruction of Dubbolimulus peetae Pickett, 1984, Triassic, NSW, dorsal aspect, x 3 (after Pickett, 1984); C, Line drawing of Idamean aglaspidid from Tasmania, x 3 (after Jago and Baillie, 1992).

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planes of ripple-marked, red Tumblagooda Sandstone (?late Silurian) are traversed by a wide range of arthropod trackways. Many of these were apparently made by eurypterids. A huge slab of the sandstone bearing the trails is on display at the Western Australian Museum, Perth, complete with a reconstruction of the type of eurypterid which might have made them. The eurypterids and other arthropods were apparently walking from pool to pool across emergent rippled sand surfaces, thus they were among the first animals to have walked on land, for which we have any evidence. The palaeoecology of the Tumblagooda Sandstone is currently under study by Nigel Trewin (Aberdeen University, Scotland) and Ken McNamara (Western Australian Museum, Perth).

Living terrestrial chelicerates are commonly referred to as arachnids. Arachnid fossils are even rarer than eurypterids and xiphosurans in Palaeozoic rocks. No Palaeozoic arachnids are known from Australia, but a few specimens have been found in Mesozoic and Cenozoic strata. The Cretaceous Koonwarra beds in Victoria have yielded a poor but recognisable opilionid (harvestman or harvest-spider; Jell and Duncan, 1986). In these animals the two body parts (prosoma and opisthosoma) appear fused into one blob, and the legs are commonly very elongated. The Koonwarra specimen has such a shape but cannot be placed with certainty into a lower taxon within the Opiliones.

Koonwarra has also produced two out of the three currently known fossil spiders from Australia (Jell and Duncan, 1986). Like harvestmen, true spiders have four pairs of walking legs, but unlike them their body parts are distinct and connected by a narrow pedicel. The Koonwarra spiders are recognisable as spiders but, like the opilionid, the family to which they belong cannot be determined.

The first fossil spider described from Australia was identified as belonging to the family Segestriidae and was named _Ariadna resinae_ Hickman, 1957. _Ariadna_ is a living genus which occurs in Victoria, Tasmania, South Africa, South America and Indo-China. The reason for the certainty of the identification is that the spider is very well preserved in amber of Pliocene age. Thus, not only are the taxonomic characters used in identification preserved but also the fossil is not very old. Indeed, the possibility exists that a living _Ariadna resinae_ is still alive somewhere. Such spiders live in silken tubes in holes in trees. During the summer, males wander in search of females. Not surprisingly,

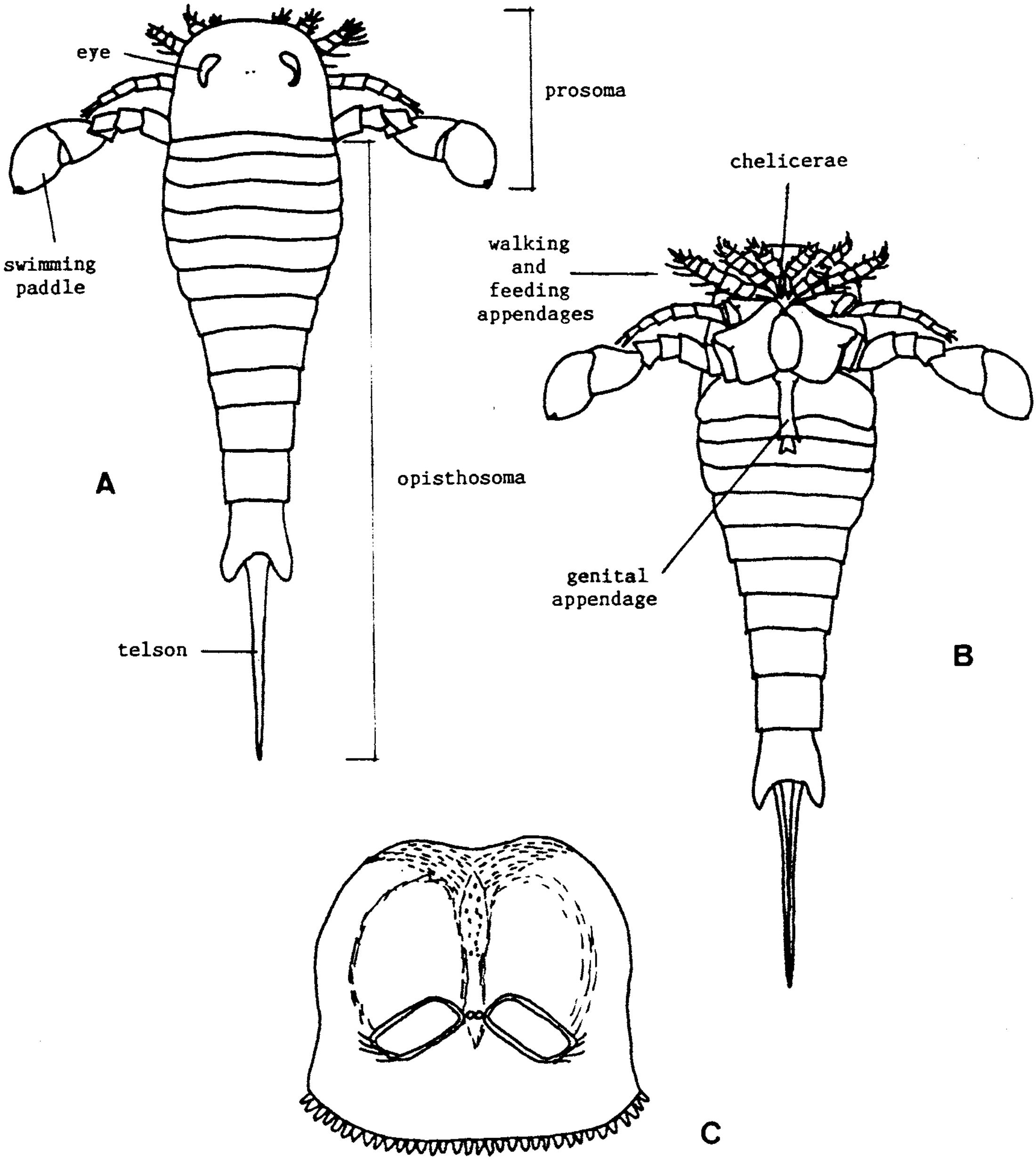

FIGURE 2. Eurypterida. A & B, reconstructions of Baltoeurypterus tetragonophthalmus Fischer, 1839, Silurian, Europe; A, dorsal aspect, B, ventral aspect, x 1/2 (after Størmer, 1955). C, Dorsal reconstruction of the carapace of Melbournopterus crossotus Caster and Kjellesvig-Waering, 1953, Silurian, Vic., x 1 (after Caster and Kjellesvig-Waering, 1953).

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the fossil is of an adult male, presumably trapped in the sticky resin while on walkabout.

The piece of amber which produced the spider was a large (34 lb.) lump recovered from a mine at Allendale, Victoria. The resin seems to have flowed from a wound in a Kauri Pine (Agathis sp.). The amber piece contained many interesting fossils including leaves, a millipede, some insects, and a mite. Mites are also arachnids, but they turn up as fossils only rarely because they are so small. Not seen by regular collecting methods, only microscopic examination reveals them. The Pliocene mite from Allendale was, like the spider, placed in a living genus and called Acronothrus ramus Womersley, 1957. Living Acronothrus inhabit moss and humus, and the nearest species to A. ramus appear to be A. cophinarius from New Zealand.

Finally, the most impressive arachnid in the fossil collections at the Museum of Victoria, Melbourne, is an external mould of a huge huntsman spider (Heteropoda) in a sandy matrix. This came from a pile of stones in the Melbourne area, and therein lies the clue to its identity. Closer inspection reveals distinct bevels forming a low pyramid on the side of the slab which bears the spider. Clearly, the huntsman was lurking in the cavity of a brick when a dollop of mortar came down on top of it. The mortar set and the huntsman died, leaving its mould in the 'lime-cemented sandstone'. Years later, the wall was demolished and the recently formed huntsman 'fossil' came to light.

This survey of Australian fossil chelicerates is now complete and what it reveals is interesting. The few eurypterid specimens described in comparison with the many fragments reported and in collections suggests that many more could be found with little difficulty. There must be a few prize specimens lurking in the Silurian rocks. The Dargile Formation along the Yarra Track is worth searching, and some fragments have been found in Devonian rocks in western New South Wales. The xiphosuran fauna is particularly rich in comparison to the eurypterids; it includes some very unusual forms, and many occur in freshwater deposits. Arachnid fossils are sparse but tantalising. Non-marine deposits should be search for these; spiders are usually quite distinct (they look just like the squashed spiders) but may be faint and require wetting before they show up well on the bedding plane. Any amber is worth searching, of course. Because chelicerates are relatively rare as fossils it is not usually worthwhile to look for them specially, they normally turn up while collecting generally, or accidentally. It is only amateurs who can do this kind of collecting, and it is through their generosity, releasing fine specimens for study and donating collections to museums, that we have any knowledge of the chelicerate life of the past in Australia.

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