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SILURIAN AND LOWER DEVONIAN FOSSILS FROM THE COBAR AREA OF NEW SOUTH WALES

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SUMMARY

The fossils dealt with in this paper consist mainly of Silurian trilobites from the Mallee Tank Beds and include a new species *Harpes nymageensis*. Two new species of lamellibranchs, *Kochia rayneri* and *Goniophora hermitagensis* are described from the Barrow Range Beds which are considered to be of early Lower Devonian age. These fossils are from a large collection in the Australian Museum from many localities in the Cobar area and consists of materials from the Mallee Tank Beds, the Barrow Range Beds and the Amphitheatre Group.

INTRODUCTION

The collection of fossils was accumulated by the author during a number of visits to the Cobar area with Dr E. O. Rayner, Department of Mines, Sydney. Additional material collected by Messrs C. C. Brooks and R. T. Russell while carrying out geological investigations in the area was presented to the Australian Museum by Cobar Mines Ltd.

The fossil fauna to a great extent bears a marked resemblance to that described by Philip (1962), and Talent (1963, 1965) from the Upper Silurian and Lower Devonian of Victoria. At the present time research is being carried out by Richard Landrum, Australian National University, Canberra, on a comprehensive collection of fossils recently collected by him from the Barrow Range Beds and the Amphitheatre Group in the Cobar district. Similar material in the Australian Museum collection has been made available to Mr Landrum to assist, if necessary, in his research.

MALLEE TANK BEDS

Outcrops of the Mallee Tank Beds, mainly shales and sandstones, occur in an area about 43·5 km (27 miles) east of Cobar and south of the railway line with a southeasterly trend towards Nymagee. Fossils are fairly numerous in most outcrops and include *Plasmopora*, *Favosites*, a species of small rugose coral (internal casts), *Mycophyllum liliiforme*, *M. crateroides*, trilobites described in this paper and a variety of brachiopods with other groups less represented. The age of the Mallee Tank Beds is generally considered to be late Silurian (i.e.) Pridelian. An interesting trilobite however, *Thomastus thomastus*, was found in considerable numbers at a locality 7·6 km (4·7 miles) northeast of Nymagee on the Hermidale Road, thence

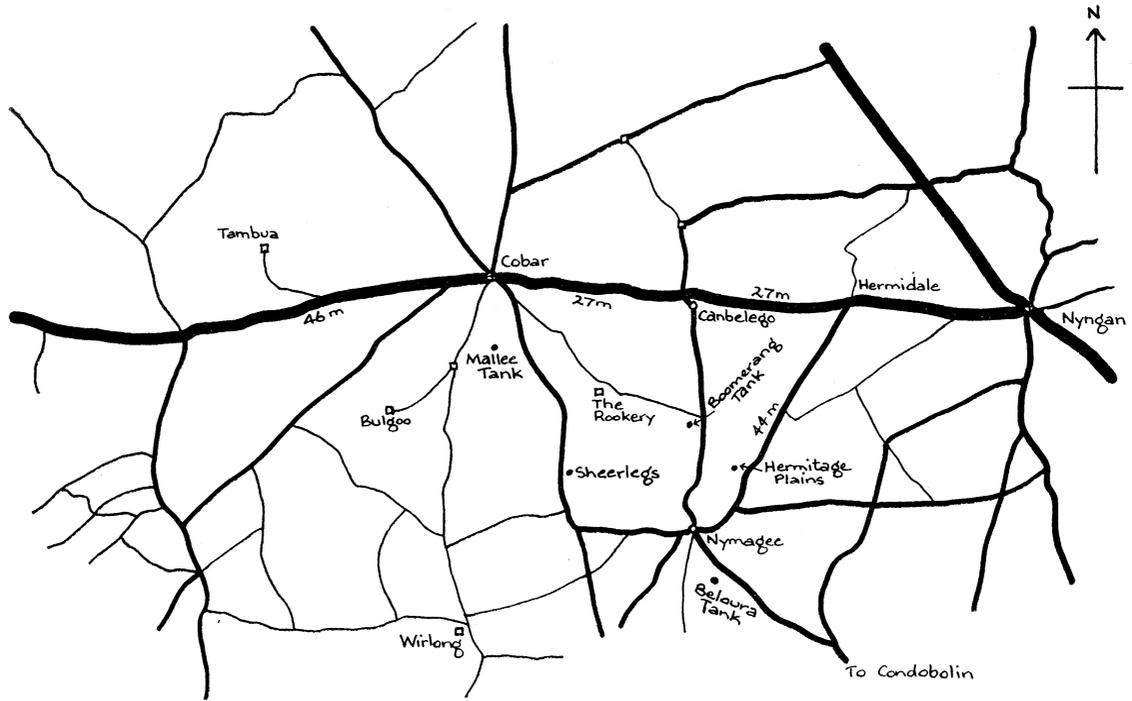


FIGURE 1. Map of the Cobar district, Western New South Wales, showing the main locations mentioned in the accompanying paper.

0.4 km ($\frac{1}{4}$ mile) southeast. It was found in association with *Harpes nymageensis*, *Cheirurus (Crotalocephalus) silverdalensis* and various brachiopods. Öpik (1953, p. 23) described and named *Thomastus thomastus* from the "Illaenus Band" at the base of the Wapentake Formation at Heathcote, Victoria, which is of Lower Silurian age. The species has also been collected by the writer, but not previously recorded, from the Rosyth Limestone Member of the Panuara Formation near Borenore, New South Wales, where it is a common form. A relatively large, poorly preserved pygidium, collected from Scrubby Valley, 13.6 km ($8\frac{1}{2}$ miles) east of Cobar on the Nyngan Road, thence 2.8 km (1.7 miles) south, closely resembles that of *Encrinurus borenorensis*, so far known only from the Rosyth Limestone Member where it is found associated with *Thomastus*. The presence of these two forms in the Mallee Tank Beds, particularly *Thomastus*, suggests they may be lower in the Silurian sequence than usually recognized.

Isolated limestone outcrops are found at Boomerang Tank, 26 km (16 miles) south of Canbelago, at the Rookery, 33.79 km (21 miles) southeast of Cobar, at Beloura Tank, 18 km (11 miles) southeast of Nymagee, and also near Mallee Tank, 18 km (11 miles) south of Cobar. The rich faunas of these limestones are generally very similar and a late Silurian age has usually been attributed to them. Öpik, following the identification of brachiopods and trilobites from the Rookery (*in* Iten and Carter, 1951) concluded that the age is late Silurian or early Devonian. Following an examination of conodonts from the Rookery Limestone, Pickett (1974, p. 1) supported an early Devonian age, as he suggested an age equivalent with the lower part of the Siegenian Garra Formation.

Lloyd (1939) recorded *Calymene australis*, identified by the writer, from a bed of chert in Parish Howgill, County Flinders, which he placed in the Ballast Group. The trilobites were collected from Boomerang Tank on Kopyge station, a locality within the Parish Howgill, by J. Harrison (pers. comm.), who accompanied Lloyd, but it is doubtful if the bed is part of the Ballast Group. The occurrence of *Gravicalymene australis*, now recognized in this paper as *G. angustior*, in the Ballast Group, was queried by Moye (1969, p. 99). This species is not uncommon in the early Devonian. At a locality 5.6 km ($3\frac{1}{2}$ miles) due south of Mafeesh Homestead, 9.65 km (6 miles) east-southeast of Shearleg's Tank, C. Brooks collected specimens of *G. angustior* in a chert with a similar state of preservation as those from Boomerang Tank. Calymenids have also been collected from Vambi Homestead and Beloura Tank but to my knowledge not from the older Mallee Tank Beds. Furthermore, a tuberculate pygidium of *Scutellum* from Boomerang Tank has a close resemblance to *Scutellum* sp. indet., described by Strusz (1964, p. 92) from the Garra Formation of the Wellington-Canobolas District of New South Wales.

THE BARROW RANGE BEDS

The Barrow Range Beds are exposed on the eastern margin of the Cobar Basin and particularly at Hermitage Plains Station, in the Barrow Ranges, 48.28 km (30 miles) from Hermidale on the Nymagee Road where outcrops are richly fossiliferous. Extensive outcrops occur at Prince's Tank, northwest of the Homestead, and also form a low range about 0.8 km (0.5 miles) southeast of Prince's Tank which extends to the Hartwood area.

The fauna of the Barrow Range Beds is quite distinct from that of the Mallee Tank Beds and the limestone outcrops. In the vicinity of Prince's Tank a shallow water assemblage of heavy-shelled lamellibranchs include a new species, *Kochia rayneri*, a genus known previously only from early Lower Devonian of Western Europe. Also a new large-shelled species, *Goniophora hermitagensis*, which has a close relationship with species from the Hamilton Stage (Lower Devonian) of New York, U.S.A., while many species of actinopterids are identical with forms described and figured by Talent (1965, pp. 38–39) from the Mt Ida Formation of the Heathcote District and from the Kilgower Member (1963, pp. 88–89) of the Wentworth Group in eastern Victoria. A different type of fauna is found in the low range to the southeast of Prince's Tank with brachiopods the dominant group and is of a deeper-water origin than the fossils already referred to.

A narrow band of fine shale outcropping below a hill-top on the western bank of a small creek about 2·10 km (0·9 miles) north-northwest of Prince's Tank contained *Encrinurus mitchelli*, *E. silverdalensis*, *Stropheodonta* sp., a small rugose coral and *Favosites* sp. The bed containing these forms which are typical of the Mallee Tank Beds fauna and were found nowhere else in the Prince's Tank area overlies, and is conformable with, a considerable thickness of beds considered to be of Lower Devonian age. This is the occurrence of *Encrinurus* mentioned by Webby (1972, p. 101) and, as he states, raises the possibility of the Barrow Range Beds being in part Late Silurian. It is an interesting occurrence and a more detailed examination of the area should be made so that the exact relationships of the beds can be resolved.

THE AMPHITHEATRE GROUP

Shales and sandstones of the Amphitheatre Group are recorded as cropping out over a triangular area west of Cobar, the apex of which is about 130 km (80 miles) west of Cobar, the base a roughly meridional line through Cobar and extending for about 80 km (50 miles) to the north and the same distance south. Outcrops are numerous and generally have yielded a rich fauna of late Lower Devonian age. Brachiopods are numerous and a wide variety include dominant forms such as *Howellella* spp., *Isorthis* spp., and *Iridistrophia*. Lamellibranchs are also common and include species of *Leptodesma*, *Leiopteria*, *Goniophora* (small forms), *Actinopteria* and *Modiomorpha*. Many of the species are similar to those described and figured by Talent (1963, 1965) and others from Lower Devonian beds of Victoria.

Practically all the species recorded by Dun (1898, pp. 160–174) from Devonian boulders in the Cretaceous of White Cliffs, New South Wales, are represented in the fauna of the Amphitheatre Group. Of these, an incomplete brachial valve, named and figured by Dun (1898, p. 163, pl. 17, fig. 1) as *Schizophoria* sp. indet., was perhaps the most abundant form found in the Amphitheatre outcrops and particularly those to the west and north-west of Cobar. The figured specimen, A.M. F.50979, now in the Australian Museum collection, has been placed in the genus *Iridistrophia* by Landrum (per. comm.). Rose and Brunker (1969) have suggested that the Barrow Range Beds are a littoral facies of the Amphitheatre Group.

Recent research by Ritchie (1969, 1973) on fish remains collected from the lower part of the Mulga Downs Formation led him to the conclusion that the beds in which they occur are older than originally thought and he assigned them to the late Lower Devonian–early Middle Devonian (Emsian-Eifelian). It seems therefore, that the age of the underlying Amphitheatre Group, from which similar fish remains have been collected from several localities, is younger than the Barrow Range Beds which with its distinctive fauna, including *Kochia*, is probably early Lower Devonian.

SYSTEMATIC PALAEOLOGY

PHYLUM MOLLUSCA

Class Lamellibranchiata

Superfamily Pteriacea Dall

Family Kochiidae Mallieux, 1931

Genus *Kochia* Frech, 1889*Kochia rayneri* sp. nov.

Figure 5, A-F

Holotype A.M. F.47467, paratype A.M. F.55041—Australian Museum Collection.

Description: Shell capuliform and very inequilateral. Left valve large, inflated, somewhat reversed S-shaped and strongly arched, narrow dorsally and gradually widening towards the ventral margin and terminating in a bluntly pointed, somewhat wedge-shaped, postero-ventral extremity. Dorsal half of the valve twisted anteriorly and strongly curved to form a sharply pointed and abruptly incurved umbo which is in close contact with the anterior margin of the valve at its dorsal extremity. Anterior margin is highly arched, particularly in the dorsal area where it is bordered by a well defined groove. Posterior margin almost straight then slightly curving to the posterior triangular wing. In the dorsal area the valve surface slopes steeply to the posterior margin and is much greater in depth than the slightly curved and narrow anterior slope. Hinge-line straight and relatively short. Surface ornament is limited to coarse growth lamellae. The right valve is unknown but is probably operculate, thin and flattened.

Dimensions: Height of left valve (holotype) 36 mm, length 21 mm, but specimens attaining a length of up to 53 mm were collected.

Remarks: This outstanding species occurs in considerable numbers at the type locality and is represented in the collection by about eighty left valves. A close and extensive search failed to locate any right valves.

The only Australian reference to the genus *Kochia* is by Dun and Benson (1920, p. 353) when they described and figured a new species, *K. striata*, from the Lower Carboniferous near Carroll, New South Wales. The single specimen, a left valve, differs from *K. rayneri* in being much less convex, the anterior margin is not highly arched and the surface ornamentation consists of radial folds. It is doubtful if *K. striata* is correctly placed in the genus *Kochia*, so far known only from the early Lower Devonian.

Kochia rayneri differs from the type species, *K. capuliformis* Frech (1891, pp. 72-78, pl. 6) in that the groove bordering the highly arched anterior margin is less developed, the beak is more twisted and closely incurved and the ventral half of the valve is much wider.

The specific name of this species is given for Dr E. O. Rayner, former Assistant Under-Secretary, Department of Mines, Sydney, in recognition of his geological investigations in the Cobar district.

Localities: Slope from creek about 0.10 km (0.6 mile) north of Prince's Tank, Hermitage Plains Station, 48.28 km (30 miles) from Hermidale on the Nymagee Road (Type Locality); near an old mine-shaft about 3.21 km (2 miles) south of Prince's Tank.

Geological Age: Early Lower Devonian.

Family Modiolopsidae Fischer, 1887

Genus *Goniophora* Phillips, 1848

Goniophora hermitagensis sp., nov.

Figure 4C and D

Holotype A.M. F.47967; paratype A.M. F.46822, Australian Museum Collection.

Description: Shell large, equivalve, length three times the height, compressed anteriorly and inflated posteriorly. An oblique sinus extending from the umbo to the ventral margin causes a constriction of the shell about the mid-line. Umbo small and incurved only slightly raised above the hinge-line and situated in less than the anterior one-fifth of the valve. Anterior end short, compressed, somewhat attenuated, the margin extending almost straight from the umbo and rounded below. Posterior end of valve very much elongated, inflated and somewhat wedge-shaped; a prominent and angular umbonal ridge extends from the umbo to the postero-ventral extremity. Posterior margin obliquely truncate. Ventral margin curved anteriorly with a wide sinus in the middle beyond which it is almost straight posteriorly. Internal characters of the hinge have not been observed. Surface ornament consists of moderately coarse concentric growth lines which are acutely recurved at the umbonal ridge.

Dimensions: The holotype is 100 mm long and 33 mm high; paratype 95 mm long and 32 mm high. One specimen (F.47962) has a length of 118 mm and a height of 34 mm.

Remarks: This species is represented by three fairly complete and well preserved left valves, a right valve and several incomplete specimens. It is characterized by its large size, the extreme length of the valves in comparison with the height, the compressed, short anterior end, the depressed area anterior to the middle and the elongated, inflated, posterior. The species is not close to any previously described forms of *Goniophora* from Australia which have been shells of relatively small size. It differs considerably from *G. hendersoni* from the Reefton Beds (Lower Devonian) in New Zealand, described by Allan (1935, p. 25), specimens of which attained a length of 55 mm and a height of 25 mm. In general outline there is a close resemblance between *G. hermitagensis* and *G. acuta* Hall (1885, pp. 295–296, pl. 43, figs 1–3) from the Hamilton Stage (Middle Devonian) of New York, U.S.A., specimens of which are 80 mm in length.

Locality: About 0.4 km (0.25 miles) east of Prince's Tank, Hermitage Plains Station, 48.25 km (30 miles) from Hermidale on the Nymagee Road.

Geological Age: Early Lower Devonian.

PHYLUM TRILOBITA

Family Thysanopeltidea Hawle and Corda, 1847

Genus *Scutellum* (*Scutellum*) Pusch, 1833

Scutellum (*Scutellum*) sp. indet.

Figure 2A

Description: Pygidium broadly semi-circular in outline; surface flattened, elevated, narrow lateral and posterior marginal areas concave with a well-defined smooth border. Axis small and triangular without longitudinal furrows, evenly convex, the surface covered with irregularly arranged tubercles. Each pleural field

bears seven radiating flat lateral ribs separated by narrow well pronounced pleural furrows. The median rib is relatively wide, undivided, slightly expanded at its junction with the axis, then narrowing before gradually widening posteriorly. Five curved ribs on each side of the median rib are somewhat pointed at their junction with the axis and gradually expand towards the border. The two uppermost ribs in each field show little curvature, are wider than the preceding ribs and their greatest width is in the central area. Thorax and cephalon are unknown.

Dimensions: Width 25 mm, length 15 mm.

Remarks: This specimen (F.46829), an incomplete but well preserved pygidium, closely resembles that of *Scutellum* sp. indet., described and figured by Strusz (1964, p. 92) from the Garra Formation (Lower Devonian), but differs in that the axis is not trilobed and also in the more widely semi-circular outline. Other tuberculate species of *Scutellum* from New South Wales, described by Etheridge and Mitchell (1917), consist of *S. bowringensis* from the Upper Trilobite Bed of the Yass district and *S. mesembrinus* from limestone beds adjacent to Molong (? Upper Silurian). In the former species the axis of the pygidium is trilobed and there is only faint evidence of granulation while in the latter species the axis is not trilobed but it differs markedly from the present form in that the ribs are narrow, angulate, with moderately wide furrows and each rib bears a single row of tubercles. Chapman (1915, p. 160) described two tuberculate species as *Bronteus (Goldius) greeni* and *B. (Goldius) creswelli* from the Yeringian of Victoria. The former species is not a *Scutellum* and the latter species bears little resemblance to the present form from Boomerang Tank. Öpik (in Iten and Carter, 1951) recorded *Scutellum*(?) from the Rookery, southeast of Cobar, but I have no information concerning this specimen.

Locality: Boomerang Tank, 26 km (16 miles) south of Canbelago.

Geological Age: Late Upper Silurian.

Family Illaenidae Hawle and Corda, 1847

Subfamily Bumastinae Raymond, 1916

Genus *Thomastus* Öpik, 1953

Thomastus thomastus Öpik

Figure 2, B-D

1937 *Illaeus* sp. Thomas, D. E., *Min. geol. Jour. Victoria*, 1, (1), p. 66.

1953 *Thomastus thomastus* Öpik, A. A., *Mem. geol. Surv. Victoria*, 19, p. 23, pl. 8, figs 61-71, text fig. 8.

1965 *Thomastus thomastus* Talent, J. A., *Ibid.*, 26, p. 47.

Remarks: Numerous cephalae and pygidia of this species are present at the locality near Nymagee but in most cases are somewhat crushed and distorted. The tests are somewhat worn on the surface and show little or no trace of ornamentation. External moulds of two shields (F.44318a and F.42699) show traces of terraced lines on the surface and doublure.

This species was originally described and figured by Öpik from the "Illaenus Band" at the base of the Wapentake Formation (Lower Silurian) at Heathcote, Victoria, where it is a widely distributed and characteristic fossil. Similar specimens have been collected by the author, but not previously recorded, from the Rosyth Limestone Member (Lower Silurian) at "Rosyth", a property near Borenore, New South Wales. At this locality the species is also very common and is associated with an abundance of halysitid species and trilobite genera, *Encrinurus*, (?)*Acernaspis* and *Dicranogmus*. Specimens of *T. thomastus* from Nymagee and Borenore are identical in dimensions and characters with the type material of the species in the collection of the Bureau of Mineral Resources, Canberra.

Locality: 7.6 km (4¾ miles) northeast of Nymagee on the Nymagee-Hermidale Road, then 0.4 km (0.25 miles) southeast.

Geological Age: Mallee Tank Beds, (?) Lower Silurian.

Family Harpidae Hawle and Corda, 1847

Genus *Harpes* Goldfuss, 1839

Harpes nymageensis sp. nov.

Figure 2E

Holotype: A.M. F.50030, counterpart A.M. F.50029 (incomplete cephalon), Australian Museum Collection.

Description: Cephalon moderately large, approximately 30 mm wide and including the occipital ring 26 mm long. Outline rather narrowly curved in front with almost straight, slight inwardly sloping long genal prolongations. Glabella strongly convex with faint posterior lateral lobes, alae small and depressed. Eye tubercles slightly posterior of the anterior glabella extremity. Two furrows diverging forward from the glabella to the inner margin of the fringe enclose a small elevated preglabellar field. Genae narrow with steeply sloping sides. Brim broad and flattened. Thorax and pygidium unknown.

Remarks: This species is known only by an incomplete cephalon. Its outstanding characters are quite dissimilar to those of *Harpes trinucleoides* Etheridge and Mitchell (1917, p. 496) from the Upper Silurian at Bowning, New South Wales, but in some respects resembles a cephalon of *Harpes* figured by Talent (1963, p. 105, pl. 77, figs 13-14) from the Kilgower Member of the Tabberaberra Formation of Victoria. There appears to be a similarity in general appearance between *H. nymageensis* and *H. ungula* Sternberg, which however occurs in the Middle and Upper Silurian of Czechoslovakia. In both species the genae and glabella are very much elevated above the brim and the sides of the genae are steeply sloping but *H. nymageensis* is larger in size and differs in the shape of the glabella. De Koninck (1877, p. 59) recorded a complete head-shield of *H. ungula*, only 3 mm long, from a limestone at Boree Caves, New South Wales.

Locality: 7.6 km (4.75 miles) northeast of Nymagee on the Nymagee-Hermidale Road, then 0.4 km (0.25 miles) southeast.

Geological Age: Mallee Tank Beds, (?) Lower Silurian.

Family Cheiruridae Salter, 1864

Genus *Cheirurus* Beyrich, 1853

Subgenus *Crotalocephalus* Salter, 1853

Cheirurus (Crotalocephalus) silverdalensis Etheridge and Mitchell.

Figure 2, F-G

1917 *Crotalocephalus silverdalensis* Etheridge and Mitchell, *Proc. Linn. Soc. N.S.W.*, 42 (3), p. 490, pl. 24, fig. 10; pl. 25, figs 1-3 and 9.

1962 *Cheirurus (Crotalocephalus) silverdalensis* Philip, *Proc. R. Soc. Vict.*, 75 (2), p. 228.

Remarks: The glabella in three specimens of this species, one with portions of the fixigenae attached, is approximately 21 mm in length and 12 mm wide. The characters agree with those of the type material described by Etheridge and Mitchell from the Hume Series of the Yass district, New South Wales, and also with specimens recorded by Philip from the Boola Beds of the Tyers areas in Victoria. A closely allied species, *C. sculptus* Etheridge and Mitchell (1917, p. 492) differs from *C. silverdalensis* in the slightly larger glabella being more anteriorly placed and the glabella furrows more acutely V-shaped. Strusz (1964, p. 98) in describing a new species *C. packhami* from the Garra Formation of New South Wales included in the synonymy a cephalon figured by Etheridge and Mitchell (1917, pl. 26, fig. 11) as *C. sculptus*. This specimen is not included in the type material of the species in the Australian Museum collection and is apparently missing. *C. packhami* differs from *C. silverdalensis* in the parallel-sided glabella, the gently V-shaped trans-glabella furrows and the fixigenae being narrower than the occipital ring.

Localities: 7.6 km (4¾ miles) northeast of Nymagee along the Nymagee-Hermitdale Road, then 0.4 km (0.25 miles) southeast; 7.2 km (4.5 miles) southeast of Nymagee along Nymagee-Condobolin Road, then 2.4 km (1.5 miles) northeast.

Geological Age: Mallee Tank Beds, (?) Lower Silurian.

Family Encrinuridae Aneglin, 1854

Subfamily Encrinurinae Angelin, 1854

Genus *Encrinurus* Emmrich, 1844

Encrinurus cf. *silverdalensis* Etheridge and Mitchell

Figure 3, C-E

1915 *Encrinurus silverdalensis* Etheridge and Mitchell, *Proc. Linn. Soc. N.S.W.*, 40 (4), p. 665, pl. 54, fig. 11; pl. 55, figs 4, 8; pl. 56, figs 4-6, 14; pl. 57, figs 3, 10.

1948 *Encrinurus* cf. *silverdalensis* Gill, *Rec. Queen Vic. Mus.*, 2 (2), p. 68, pl. figs 7-8.

Remarks: Two free cheeks and several incomplete pygidia have been tentatively identified as the above species. One well preserved right free cheek bears two rows of tubercles on the border consisting of an inner row of relatively large flattened, elongate tubercles and an outer row of smaller ones. This appears to be a characteristic feature of *E. silverdalensis* and is not present in allied species of comparable size such as *E. bowringensis* and *E. etheridgei*. Several pygidia possess features consistent with *E. silverdalensis* in that they are of comparatively large size and widely triangular.

The type locality of *E. silverdalensis* is Yass, New South Wales, where the species is found in the Lower Trilobite Bed—Hume Series. Gill (1948, p. 168) recorded *E. cf. silverdalensis* from an horizon in the Eldon Group near Queenstown, Tasmania, which he suggested was on the Siluro-Devonian boundary but Philip (1960, p. 154) later considered the fauna of the horizon is Upper Silurian.

Localities: (1) Scrubby Valley, 13.6 km (8.5 miles) from Cobar on the Nyngan Road, thence 2.8 km (1.7 miles) south (A.M. F. 50873, A.M. F.49927); (2) 7.6 km (4.5 miles) southeast of Nymagee along Nymagee-Condobolin Road, thence 2 km (1.25 miles) northeast; F.50037 (3) below hill-top on western bank of small creek about 2.10 km (1.9 miles) north-northwest of Prince's Tank, Hermitage Plains Station (A.M. F.47673).

Geological Ages: Localities (1–2)—Mallee Tank Beds, (?)Lower Silurian; locality (3)—(?)Barrow Range Beds, Lower Devonian.

Encrinurus mitchelli Foerste

Figure 3A; Figure 4I

1877 (?)*Cromus murchisoni* De Koninck, *Soc. des. Sci. Nat. Liege, Mem. Ser. 2*, p. 54, pl. 1, fig. 9.

1888 *Encrinurus mitchelli* Foerste, *Bull. Denison Univ.*, 3, p. 124, pl. 15, figs 2–3, 20.

1915 *Encrinurus mitchelli* Etheridge and Mitchell, *Proc. Linn. Soc. N.S.W.*, 40 (4), p. 657, pl. 54, figs 1–5; pl. 55, figs 1–3, 15; pl. 56, figs 2, 10; pl. 57, fig. 9.

Remarks: A slightly crushed pygidium with eight attached thoracic segments is similar to a specimen figured by Etheridge and Mitchell (1915, pl. 54, fig. 5) from the Lower Trilobite Bed at Bowring, New South Wales. The pygidium is approximately twice as long as wide with ten pleural ribs. The axis tapers to form a bluntly pointed extremity and has about twenty-six axial ribs with occasional tubercles developed on smooth areas. An incomplete cranidium is smaller in size than typical examples of *E. mitchelli* but in all other aspects is identical.

Vogdes (1907, p. 77) considered that *Cromus murchisoni*, described and figured by De Koninck from the Silurian at Quidong, New South Wales, and placed doubtfully as a synonym of *E. mitchelli* by Etheridge and Mitchell, was distinguished from that species and *E. bowringensis* by the shape of the glabella and depth of the furrows which separate it from the fixigenae.

Locality: Below a hill-top on the western bank of a small creek about 2.10 km (1.9 miles) north-northwest of Prince's Tank, Hermitage Plains Station, 48.28 km (30 miles) from Hermidale on the Nymagee Road.

Geological Age: (?)Barrow Range Beds, Lower Devonian.

Encrinurus af. *borenorensis* Fletcher

Figure 5G

1950 *Encrinurus borenorensis* Fletcher, *Rec. Aust. Mus.*, 22 (3), p. 227, pl. 15, figs 1-7; pl. 16, figs 1, 5-6.

Remarks: An incomplete and poorly preserved pygidium consisting of a left pleural lobe and axis is doubtfully referred to the above species. The pygidium is the largest found in the Mallee Tank Beds and its dimensions agree with those of *E. borenorensis*. The pleural ribs are ten in number, divided by wide furrows, almost straight for some distance from the axial furrow and then bend rather sharply posteriorly. The axis, although only partly preserved, show numerous axial rings which in *E. borenorensis* number twenty-two. This species, the largest known Australian encrinurid and was described from "Rosyth", a property near Borenore, New South Wales, where it is a common form in the Rosyth Limestone Member (Panuara Formation). Associated with it are numerous halysitids and trilobites including *Thomastus thomastus*, *Dicranognmus bartonensis* and (?)*Acernaspis macdonaldi*.

Locality: Scrubby Valley, 13.8 km (8.5 miles) from Cobar on the Nyngan Road, thence 2.8 km (1.7 miles) south.

Geological Age: Mallee Tank Beds, (?)Lower Silurian.

Encrinurus sp. indet.

Figure 5H

Remarks: A small incomplete pygidium, approximately 8 mm wide and 6 mm long, with steeply sloping pleural lobes, is practically identical with a pygidium from the Silurian of Duntroon, A.C.T., which was figured but not specifically named by Etheridge and Mitchell (1915, p. 674, pl. 55, fig. 14). The axis prominent, keel-like and tapers to an acute termination posteriorly. Axial rings do not appear to be developed, at least on the lower part of the axis, the only portion preserved on the specimen.

Locality: Below hill-top on western bank of small creek about 2.10 km (1.9 miles) north-northwest of Prince's Tank, Hermitage Plains Station.

Geological Age: (?)Barrow Range Beds, Lower Devonian.

Family Calymenidae Burmeister, 1843
Subfamily Calymeninae Burmeister, 1843
Genus *Gravicalymene* Shirley, 1936
Gravicalymene angustior (Chapman)

Figure 2G-H; Figure 3A-B.

1915 *Calymene angustior* Chapman, *Proc. R. Soc. Vict.*, 28 (1), p. 165, pl. 15, figs 8-10.

1938 *Calymene (Gravicalymene) (?)angustior* Shirley, *Q. Jl. geol. Soc. Lond.*, 94 (4), p. 487, pl. 44, fig. 17.

1945 *Gravicalymene angustior* Gill, *Proc. R. Soc. Vict.*, 56 (N.S.), (2) p. 176, pl. 7, figs 5-10.

1962 *Gravicalymene angustior* Philip, *Proc. R. Soc. Vict.*, 75 (2), p. 231, pl. 35, figs 16-17.

1963 *Calymene* (?*Gravicalymene*) *angustior* Talent, *Mem. geol. Sur. Vict.*, 24, p. 100, pl. 74, figs 5-9; pl. 75, figs 12-15.

1965 *Gravicalymene* cf. *angustior* Talent, *Ibid.*, 26, p. 49, pl. 26, figs 3-5.

Remarks: A series of well preserved but incomplete cranidia and pygidia from Boomerang Tank and from near the Mafeesh Homestead possess features similar to those attributed to *G. angustior*. Doubt still persists with some authors whether the characters of *G. australis* and *G. angustior* are specific or simply variations. Philip (1962, p. 231), in describing a cranidium and pygidium from the Boola Beds of the Tyers Area of Victoria as *G. angustior*, was not fully convinced that the two species are separable and also that they and other closely related eastern Australian species are rightfully placed in the genus *Gravicalymene*.

Shirley (1938, p. 487) in recording *G. (?angustior)* from the Baton River Beds of New Zealand placed *Calymene australis* Etheridge and Mitchell (1917, p. 481) in the synonymy of that species with the exception of specimens figured on pl. 24, fig. 5 (F.36172), pl. 27, fig. 1 (F.36168) and with some doubt pl. 24, fig. 4 (F.36173). In the opinion of B. Chatterton specimen F.36168 is not the same genus or species as the other paralectotypes of *C. australis* (pers. comm.).

Gill (1945, p. 176) considered that the two species were synonymous but later (1948, p. 69), following an examination of the type material, decided they should be separated. He concluded that *G. angustior* has a far more highly inflated glabella than *G. australis*, that the rolled edge on the margin of the pre-glabellar field is less developed and that *G. australis* has one axial segment less in the pygidium.

Strusz (1964, p. 95) believes that *G. angustior* is specifically different from *G. australis* and pointed out that in the latter species the three posterior glabellar lobes are larger and more clearly separated from the axis of the glabella and the frontal lobe is more quadrate in outline. These are reasonably well marked points of difference and together with the characters defined by Gill appear to warrant separation of the two species.

The specimens from Boomerang Tank are those recorded by Lloyd (1939) and originally identified as *G. australis* by the author. This occurrence is mentioned earlier in this paper.

Localities: Boomerang Tank, 26 km (16 miles) south of Canbelago (A.M. F.38571); 5.6 km (3.5 miles) due south of Mafeesh Homestead, 9.65 km (6 miles) east-southeast of Shearlegs Tank (A.M. F.50015).

Geological Age: Late Silurian.

Calymene duni Etheridge and Mitchell

1917 *Calymene duni* Etheridge and Mitchell. *Proc. Linn. Soc. N.S.W.*, 42 (3), p. 487, pl. 24, fig. 8; pl. 27, fig. 12.

Remarks: This species was founded on two pygidia and to my knowledge has not been recorded since publication of the original description. Some years ago Dr J. Shirley examined the pygidium in the Australian Museum collection, figured by Etheridge and Mitchell (pl. 24, fig. 8) and he was of the definite opinion that it originally came from near Oslo, Sweden (pers. comm.). The recorded locality of

this specimen is Wee Jasper Crossing, Goodradigbee River, New South Wales, but was *in situ* when collected. At the time of its description the pygidium was in Mitchell's private collection which included a considerable number of foreign specimens. Later in 1933, when the collection was purchased by the Australian Museum, it was found that the pygidium was labelled "Bowning, N.S.W.", a most unlikely locality for a specimen with its type of preservation. The second pygidium (S. 533-4, Geological and Mining Museum Collection), figured by Etheridge and Mitchell (pl. 27, fig. 12) is labelled from "near Yass" and although poorly figured has little similarity with the previously mentioned pygidium which I feel must be accepted as a European species.

Family Odontopleuridae Burmeister, 1843
 Subfamily Odontopleurinae Burmeister, 1843
 Genus *Leonaspis* Richter and Richter, 1917
Leonaspis rattei (Etheridge and Mitchell)
 Figure 3F

- 1887 *Acidaspis* near *A. leonhardi* Ratte (non Barr.) *Proc. Linn. Soc. N.S.W.*, 2 (2), p. 99, pl. 2, figs 2-4.
 1896 *Odontopleura rattei* Etheridge and Mitchell, *Ibid.*, 10 (4), p. 699, pl. 50, fig. 7; pl. 51, figs 8-9; pl. 52, figs 1-4; pl. 53, figs 4-5.
 1971 *Leonaspis rattei* Chatterton, *Palaeontographica*, 137, Abt A, p. 90, pl. 22, figs 8-14; pl. 23, fig. 14.

Remarks: A fairly well preserved cranidium (A.M. F.50058) and an imperfect impression (A.M. F.50061) are referred to this species although some of the diagnostic features are somewhat obscure.

Strusz (1964, p. 96) suggested that of the four species of *Odontopleura* described by Etheridge and Mitchell (1896) only *O. rattei* should perhaps be referred to the genus *Leonaspis*. Chatterton (1971, p. 46) listed the characters of *L. rattei*, *L. ienkinsi* and a new species *L. clavatus*, described by him, from the Warroo Limestone, Taemas Formation, 2 miles south of Hume Park, near Yass, New South Wales. This species has a number of characters in common with *L. rattei* and he suggests that it may be ancestral to *L. clavatus*.

Locality: 17.69 km (11 miles) southeast of Nymagee along the Nymagee-Hermidale Road, thence 1.6 km (1 mile) northeast.

Geological Age: Mallee Tank Beds, (?) Lower Silurian.

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FIGURE 2

Scutellum (Scutellum) sp. indet.

A—Dorsal view of incomplete pygidium, F.46829, $\times 2$.

Thomastus thomastus Öpik

B—Pygidium showing general outline and doublure, anterior angles missing, F.50360, $\times 2$.

C—A pygidium from the Roysth Limestone Member near Borenore, N.S.W. Portion of the test is missing showing the doublure, F.44318, $\times 2$.

D—Non-testiferous pygidium, F.50358, $\times 2$.

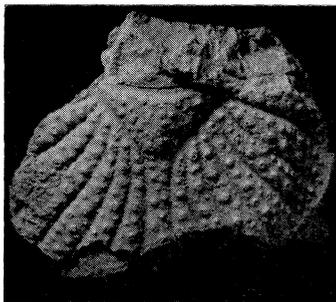
Harpes nymageensis sp. nov.

E—The holotype, F.50030, $\times 2$.

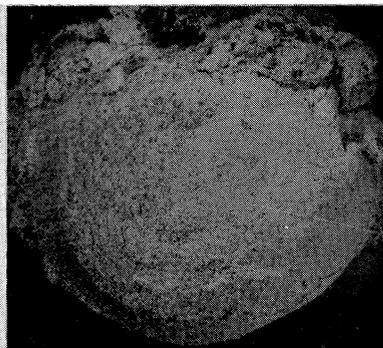
Cheirurus (Crotalocephalus) silverdalensis Etheridge and Mitchell

F—Distorted glabella, F.55037, $\times 2$.

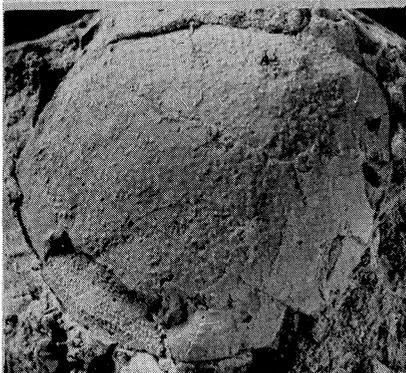
G—Glabella with incomplete fixigenae F.55038, $\times 2$.



A



B



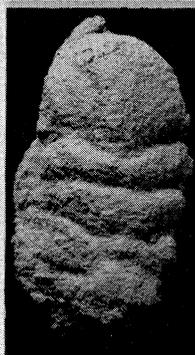
C



D



E



F



G

FIGURE 3

Encrinurus mitchelli Foerste

A—Pygidium with attached thoracic segments, F.47670, $\times 4$.

Encrinurus cf. silverdalensis Etheridge and Mitchell

B—Right free cheek, F.50873, $\times 2$.

C—Left free cheek, F.47673, $\times 2$.

D—Pygidium, F.49927, $\times 4$.

Leonaspis rattei Etheridge and Mitchell

E—Well preserved cranidium, F.50058, $\times 4$.

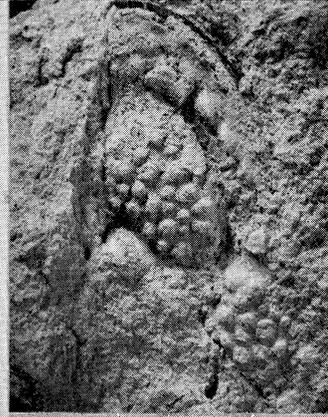
Gravicalymene angustior Chapman

F—Crushed glabella showing distorted lobes, F.38571, $\times 2$.

G—Incomplete cranidium, F.38571a, $\times 2$.



A



B



C



D



E



F



G

FIGURE 4

Gravicalymene angustior Chapman

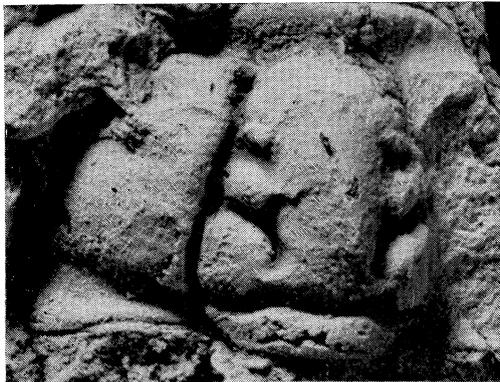
A—Incomplete cranidium showing well preserved glabella and lobes, F.50015, $\times 4$.

B—An immature incomplete cranidium, F.50015, $\times 4$.

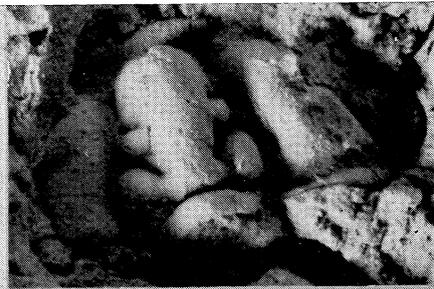
Goniophora hermitagensis sp. nov.

C—Left valve of the holotype, F.47967 (nat. size).

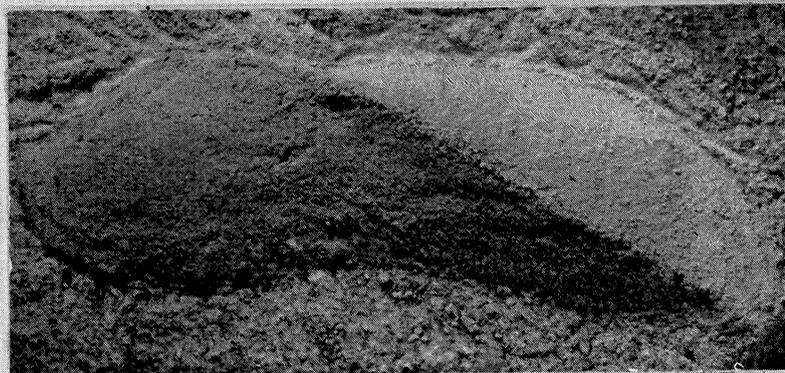
D—Incomplete left valve (paratype), F.46822 (nat. size).



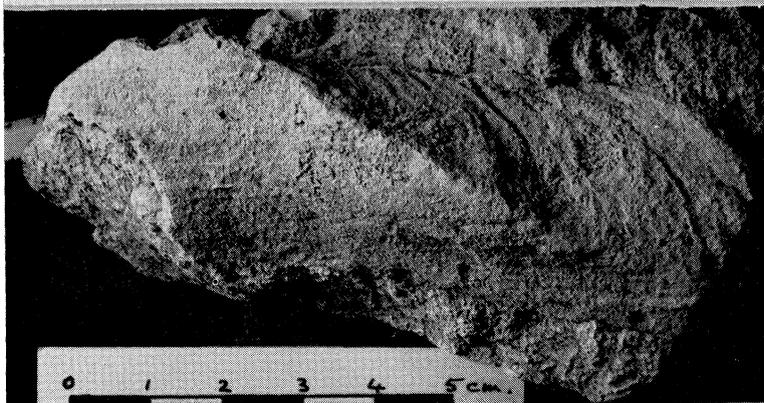
A



B



C



D

FIGURE 5

Kochia rayneri sp. nov.

- A—Dorsal view of left valve (holotype) showing general outline, F.47467 (nat. size)
B—Side view of fig. 1 showing valve curvature.
C—Front view of fig. 1 showing strongly incurved and twisted beak.
D—Side view of left valve (paratype), F.55041 (nat. size).
E—Dorsal view of fig. 4.
F—An immature valve, F.47472 (nat. size).

Encrinurus cf. *borenorensis* Fletcher

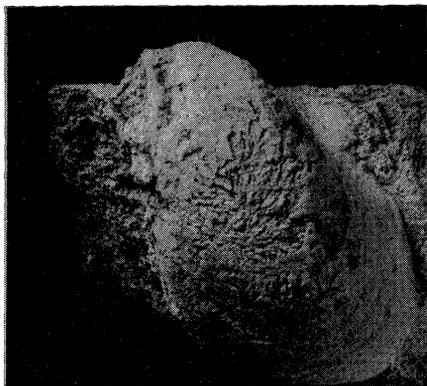
- G—A poorly preserved pygidium, F.55039, $\times 2$.

Encrinurus sp. indet.

- H—Small keel-shaped pygidium, F.47729, $\times 3$.

Encrinurus mitchelli Foerste

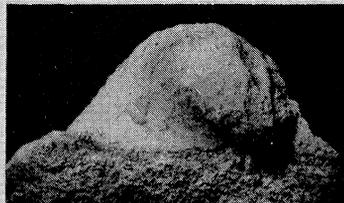
- I—Incomplete cranidium, F.47717, $\times 4$.



A



B



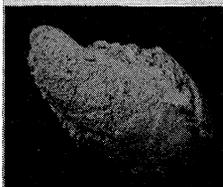
C



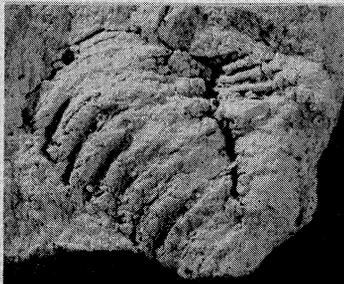
D



E



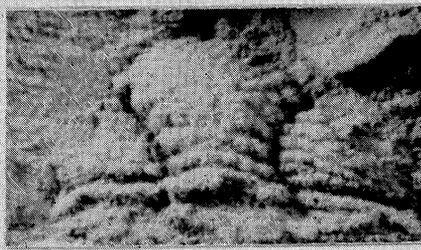
F



G



H



I