

THE SILURIAN TRILOBITES OF NEW SOUTH WALES,
WITH REFERENCES TO THOSE OF OTHER
PARTS OF AUSTRALIA.

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PART V.

The ENCRINURIDÆ.

(Plates liv.-lvii.)

i. INTRODUCTION.

It is now some years since the Fourth Part of our joint studies on the Silurian Trilobites of New South Wales appeared. This lapse of time is easily accounted for by the pressure of public duties entailed on both of us.

The last family described was that of the Odontopleuridæ. We now purpose describing the members of the Encrinuridæ. In this family are placed the following limited number of genera, viz. :—

Encrinurus, Emmrich.

Cromus, Barrandé.

Cybele, Loven.

Dindymene, Hawle and Corda.

Of these, the first is the only genus yet found in Australia with certainty.

ii. The Genera *Encrinurus* and *Cromus*.

Some authors regard these as synonymous; by others, on the contrary, they are accepted as closely allied but distinct genera.

Encrinurus was proposed by Emmrich, in 1845, to include the *Trilobites punctatus* of Brünnich, which we presume (we have not

access to the original description) became the generic type. We are, however, able to refer to Hawle & Corda's work,* published only two years after the appearance of Emmrich's description. These authors describe the above trilobite as it is now generally accepted, and very carefully traced the course of that most important feature, the facial suture, in the following words:—"The frontal suture arises on the exterior margin of the cephalon below the spine (genal) passes obliquely upwards and inwards to the posterior angle of the eye, round the eye operculum [palpebral lobe] and curves inwards from the anterior angle of the eye and the two (facial sutures) unite on the point of the forehead above the inflected somewhat serrated head margin." They also note eleven segments in the thorax, and the non-segmented condition of the pygidial axis; but no remarks whatever are made about the existence of glabella furrows.

The type, *Encrinurus punctatus* (as *Cybele punctata*), was described from Wenlock Limestone specimens by Mr. J. W. Fletcher;† and his remarks are important in that his description of the glabella clearly indicates the difference existing between that portion in *Encrinurus* and *Cromus* respectively. He said that "two or three large tubercles arranged on each side of the lower half of the glabella, occupying the situation of the lateral lobes, the *furrows between which are not visible*" (the italics are ours). To follow the whole literature bearing on *Encrinurus* would be tedious, and is unnecessary, but two references in particular may be quoted. The first comprises the beautifully engraved figures of three species (*E. sexcostatus*, Salter, *E. variorialis*, Brongniart, and *E. punctatus*, Brünnich).‡ In the three views of the glabella of the first of these, lateral furrows are clearly represented and described, but in the other two these furrows are not. *E. sexcostatus* is, therefore, from our point of view, a *Cromus*, and no doubt would have been so designated by

* Hawle & Corda, Prod. Mon. böhem. Trilobiten, 1847, p.90.

† Fletcher, Quart. Journ. Geol. Soc., 1850, vi., p.403, Pl. xxxii., figs.1-5.

‡ Salter, Mem. Geol. Survey U. Kingdom. Figs. and Descriptions Brit. Org. Remains, 1853, Dec. vii., No.4, Pl. iv.

Salter, had he been familiar with the latter genus. It must not be forgotten, however, that as Salter's memoir was published in 1853, and Barrande's description of *Cromus* only appeared in 1852, it is quite probable the English Palæontologist was unaware of his French colleague's labours.

We know of no more instructive and complete figures of *Encrinurus punctatus* than those by Mr. E. Hoffmann,* of specimens from the Island of Oesel, in the Baltic. Herein are shown the course of the facial sutures on the front of the glabella centre, the peduncular eyes, and the characteristic granulation of the pygidium.

On the other hand, an equally good illustration of a non-testiferous example is that of Hawle & Corda's generic figure.† Here are shown the large marginal tubercles along the axial furrows of the glabella, and when in this condition, the spaces between them simulate very short lateral glabella furrows; but, as a matter of fact, this simulation is only produced by the projection of the tubercles in question. Similar features are shown in Angelin's figure of *E. punctatus*.‡

Barrande's enumeration of *Cromus* appeared in his monumental work "Système Silurien du Centre de la Bohême."§

In general features, *Cromus* resembles *Encrinurus*, particularly in the form of the thoracic segments, test-ornamentation, outline of the pygidium, etc. On the contrary, the glabella bears four pairs of distinct lateral furrows, the hypostome lacks the forward prolongation of that of *Encrinurus*, the eyes are sessile, poorly developed, and, so far as known, there are but ten segments in the thorax as against eleven in that of *Encrinurus*.

It is perhaps worthy of remark that Zittel, in his "Handbuch der Palæontologie,"|| retained *Encrinurus* and *Cromus* as distinct

* Hoffmann, Verhandl. Rus.-Kaiserl. Min. Gesellschaft. St. Petersburg, 1857-58(1858), Pl. iii., fig. 5a.

† Hawle & Corda, *loc. cit.*, Pl. v., fig. 55.

‡ Angelin, Pal. Scandinavica, 1878, Pt. 1, Pl. iv., fig. 4 (as *Cryptonymus punctatus*).

§ i., 1852, p. 821.

|| Zittel, i., Abh., ii. Band, p. 621.

genera, and in this instance is followed by his French translator, Dr. C. Barrois,* but in Eastman's English translation, Prof. C. E. Beecher, who edited the *Trilobita*, made *Cromus* a synonym of *Encrinurus*.†

In the face of Barrande's detailed description and finely executed figures, we fail to see how it is possible to unite the genera under discussion. Failure to thoroughly grasp the importance of some of the structural details disclosed above, has caused us, in the past, to make erroneous determinations, but now that we have an opportunity of studying the Australian Encrinurids as a whole, we hope to rectify these.

The following are the more important characters of *Encrinurus* :—

A pyriform, forwardly inflated glabella, devoid of lateral furrows, highly clothed with tubercles of which five pairs border the axial grooves, and the three pairs of these placed between the anterior and posterior pairs are larger than the others; facial sutures either openly V-shaped or bi-sigmoidal, meeting anteriorly in the middle line of the glabella and cutting the anterior cephalic margin as a single suture; eyes pedunculate and faceted; axial grooves curve outwards to the antero-lateral margins of the cephalon, crossed by the facial sutures, and distinctly divide the free cheeks into two unequal portions; hypostome subrhomboidal, anteriorly cucullate; thorax of eleven somites; pygidium triangular, its axial rings anchylosed, and the pleuræ composed of from seven‡ to thirteen or more simple, rounded, and unfurrowed segments.

iii. AUSTRALIAN HISTORY OF THE ENCRINURIDÆ.

1. NEW SOUTH WALES.

The first writer to detect the presence of this family in Australian Silurian rocks was Mr. J. W. Salter, for amongst his

* Barrois, *Traité de Paléontologie*, ii., pp.617-18.

† Zittel's *Textbook Pal.*, 1900, i., p.634.

‡ *E. ornatus*, Hall & Whitfield, of the Niagara Group of Ohio, possesses but seven (*Geol. Survey Ohio, Pal. ii., Pt. ii., p.154, Pl. vi., fig.16*); probably an abnormal form.

determinations of fossils from the "Southern Districts of New South Wales," collected by the Rev. W. B. Clarke, occurs the name of *Encrinurus australis*, Salter.* No locality was mentioned, and nothing beyond the name is known of it. It appears this was included in a collection "forwarded to the Woodwardian Museum, Cambridge; borrowed from Prof. Sedgwick by Sir R. I. Murchison, in 1856, for examination and description by Mr. Salter, from whose MS. notes sent to Mr. Clarke in 1858, the following are named, etc."† In a letter to Clarke, Salter wrote as follows‡—"The abstract sent to you by Sir Roderick (Murchison) will have clearly answered one of your important queries, since there can be no doubt of a true Upper Silurian formation among your fresh fossils; the presence of *Calymene*, *Encrinurus*, and a plaited pentamerus quite settles that question."

The study of Clarke's great collection of New South Wales Palæozoic fossils, as a whole, was ultimately undertaken by Prof. L. G. de Koninck of Liège, Belgium. He recorded the presence of four species of Encrinurids from New South Wales Silurian rocks, as follows:—§

<i>Encrinurus punctatus</i> , Brünnich.	{ Yass District—a pygidium. { Duntroon—a nearly complete specimen.
<i>Encrinurus barrandei</i> , De Koninck.	{ Yarralumla—several examples.
<i>Cromus bohemicus</i> , Barrande.	{ Yarralumla—cephalon and pygidium.
<i>Cromus murchisoni</i> , De Koninck,	{ Yarralumla—a cephalon. { Quedong—a cephalon.

In 1880, a short paper by one of us was published|| on a small series of New South Wales Palæozoic fossils presented by Prof. A. Liversidge to the British Museum. Amongst these were

* Clarke, S. Goldfields of N. S. Wales, 1860, p.286.

† Clarke, Remarks Sed. Formtn. N. S. Wales, 4th Ed., 1878, p.151.

‡ Salter in Clarke, Remarks, *ibid.*, p.154.

§ De Koninck, Foss. Pal. Nouv.-Galles du Sud, Pt.1, 1876, pp.49-55, Pl. i., figs.8, 9, 9a-b.

|| Etheridge, Journ. Roy. Soc. N. S. Wales, 1880, xiv., p.251, Pl., figs. 11 and 12.

several pygidia and portion of a cephalic shield from Bombala. These were referred to *Encrinurus punctatus*, but now, from an extended knowledge of Australian Encrinurids, we have reason to doubt the accuracy of this determination. The figured examples of pygidia, judging by the outlines, may be those of *E. rothwellæ*, nobis, but, in connection with those figures, an admission of carelessness must be made. The illustrations in question show a continuously annulated axis, whereas, in the text, a centrally unsegmented axis is described. The latter is probably correct; but under the circumstances is practically of no value.

The only other descriptions of members of this family we are acquainted with from New South Wales, are those of *Encrinurus mitchelli* and *E. bowningensis* by Mr. A. F. Foerste,* of the Denison University, Granville, Ohio, from material supplied by one of us. This was of poor preservation, but Foerste's descriptions render it quite easy to recognise the species proposed by him.

It will save repetition if we now proceed to make a few critical remarks on these organic remains, rather than with the descriptions of the species it is our intention to describe later.

Of *Encrinurus australis*, Salter, nothing is known, and, in accordance with a remark already made, is dismissed from further consideration.

E. punctatus, Brünnich, a fossil highly typical of the Wenlock division of the Upper Silurian, notwithstanding the very extensive series of *Encrinuri* that have passed through our hands, we have never seen. Both the cephalon, in the possession of genal spines, and the pygidium in that of a mucro or telson, are so conspicuous, it is hardly possible we would have neglected to notice them had they come under our review. In this instance, as in some others throughout his work, we cannot divest our minds of the suspicion that De Koninck, in his remarks on this trilobite, did not describe the Australian fossil at all, but simply indicated the principal features of *E. punctatus*, leaving it to be inferred

* Foerste, Bull. Sci. Lab. Denison Univ., 1888, iii., Pt. 2, pp. 121-126, Pl. xiii., figs. 2, 3, 7, 20.

that the Australian fossil exhibited the same characters. Indeed, it seems to us that his opening paragraph can have no other construction put upon it. He said:—"Cette espèce a été si bien décrite et figurée par M. Fletcher et par Salter, que je puis me dispenser d'entrer dans le détail des caractères qui la distinguent et dont le principal et le plus facile à reconnaître, consiste . . ."* but not a word as to which of these characters were visible on the Australian specimen. De Koninck's *E. punctatus* may be the equivalent of *E. mitchelli*, Foerste. As to De Koninck's qualified identification of *Cromus bohemicus*, Barr., but which he did not figure, we can only say we have no evidence of a *Cromus* in Australian rocks, but that in itself cannot be accepted as a proof of non-occurrence. De Koninck's remark "Elle est garnie de chaque côté de quatre sillons étroits," if it be an actual description of the Australian fossil, so completely accords with the principal characters of *Cromus*, that we must accept the determination in the meantime. Mr. Foerste regarded his *E. mitchelli* and *C. bohemicus*, De Koninck, as "distinct although clearly related." The identification of De Koninck's two remaining species is rendered very uncertain by an unfortunate difference between his description in the text, and the figure-references in the explanation of Plate i. As *Encrinurus barrandei* were described a cephalon and a pygidium, and the former was figured under its name,† the latter not so. Several specimens were found at Yarralumla, but how many cephalons or how many pygidia is not stated. Whatever this may be, it is not *E. mitchelli*, Foerste. As *Cromus murchisoni* were included two cephalons,‡ and a pygidium referred to in the explanation of Plate i,§ but there is no description of, nor reference to this tail in the text.

In the first place, the structure of neither of the glabellæ of these cephalic shields accords with Barrande's definition of *Cromus*. One (Fig.9a) displays no trace of the four pairs of

* De Koninck, *Loc. cit.*, p.50.

† De Koninck, *Loc. cit.*, Pl. i., fig.8.

‡ De Koninck, *Loc. cit.*, Pl. i., figs.9 and 9a.

§ De Koninck, *Loc. cit.*, Pl. i., fig.9b.

glabella furrows of *Cromus*, the other (Fig.9) is said to “porte quatre sillons transverses non interrompus,” which is not a character of the genus in question. Now what happened we believe to be this. The pygidium referred to *C. murchisoni* (Fig.9b) is probably that described (but not ostensibly figured) under *E. Barrandei*, for De Koninck says of the former—“La joue mobile et l’angle génal me sont inconnus. *Il en est de même du thorax et du pygidium*” (the italics are ours). If, therefore, the pygidium is unknown, how can the subject of Fig.9b be referred to *Cromus murchisoni*, as it is in the explanation of Plate i.? Accepting the illustrations of the two cephalons in good faith, they appear to us to represent distinct forms of *Encrinurus* pure and simple, one with a broad-necked glabella (Fig.9a), and scattered small granules, the other with a distinctly pyriform glabella, and four very marked, continuous, posterior, transverse lines of granules parallel to the neck-ring, in addition to the scattered ones on the fore part of the glabella.

2. VICTORIA.

One species only is so far known from this State—*Encrinurus* (*Cromus*) *spryi*, Chapman,* from the Upper Silurian rocks exposed in the progress of the Improvement Works, South Yarra, Melbourne, and other neighbouring localities. It appears to differ from our type-species, *E. mitchelli*, chiefly by the presence of “two deep transverse sulci above the neck rings interrupted in the middle.” The presence of these sulci forbids a reference to *Encrinurus* as here understood by us, and equally the existence of only two pairs is fatal to the inclusion of this trilobite in *Cromus*, as established and defined by Barrande, in which there are four pairs of glabella furrows.

3. TASMANIA.

In the “Report of the Secretary for Mines [of Tasmania] for 1895-6” are the descriptions of Tasmanian Silurian fossils presented to the Australian Museum by Mr. A. Montgomery, Gov-

* Chapman, Proc. Roy. Soc. Vict., 1911, xxiv. (n.s.), Pt.1, p.397, Pl. lxii., fig.1.

ernment Geologist. In the blue-grey schistose rock of both Heazelwood, County Russell, and Zeehan, County Montagu, occurs, amongst other trilobites, one referred to *Cromus murchisoni*, De Koninck,* but which can no longer be admitted as this species or even genus. There were the larger portion of a cephalic shield and four pygidia. The former is certainly of the type of *E. silverdalensis*, nobis.

iv. NEW SOUTH WALES.

Species admitted and described.

In New South Wales, *Encrinurus* is confined to beds of Upper Silurian age in the Upper Murrumbidgee Valley, at Delegate, and in the upper reaches of the Tarlo River, County Argyle. We are not aware of its occurrence in any other portion of the State.

The Species admitted by us are:—

Encrinurus mitchelli, Foerste.

E. bowningensis, Foerste.†

E. silverdalensis, nobis.

E. etheridgei, Mitchell.

E. rothwellæ, nobis.

E. duntroonensis, nobis.

Besides the above species, several cephalons and pygidia are described and figured; but to which we refrain at present to give specific names.

v. SOME STRUCTURAL FEATURES.

There are a few structural matters we wish to refer to in particular, two of which we at first thought might prove to be of generic importance, but although they do seem to occupy this position in Australian forms of the *genus*, there is not the same community of structure in foreign species. In every instance examined, there are constantly five pairs of primary tubercles along the axial edge of the glabella irrespective of any similar tubercles which may occur in a like position on the neck-ring. In testaceous specimens, these are but little seen; on the other hand, in non-testiferous, or decorticated ones, they become a very

* Etheridge, p. xliv., Pl. figs. 7 and 8.

† Emended from *Browningi*, as written by Foerste.

prominent and important feature. In *Encrinurus punctatus*, Fletcher described two or three large tubercles, "arranged on each side of the lower half of the glabella."* Hawle and Corda figure four pairs in this species.† Angelin four pairs,§ and Schmidt figures five pairs.‡ Under these circumstances, in view of these discrepancies, if the separate descriptions are correct, the number of tubercles in the positions referred to can only be regarded as of specific value. But from the constancy with which the five pairs of axial glabella tubercles occur on all the Australian *Encrinuri* [except the singular *E. duntroonensis*, on which only four are visible, but in this species the fifth pair may be present and hidden by the clasping frontal portion of the free cheek] which have come under our notice, we are inclined to accept Schmidt's declaration of the presence of five pairs in *E. punctatus*, as correct. In Australian species, when the free cheeks are in place, it is often difficult to see the anterior pair, and they are still more obscure when the test is also present. Reviewing all the evidence available to us, we must confess to a strong inclination to look upon the presence of five pairs of axial glabella tubercles as probably of generic significance.

It would appear also to us that these tubercles may mark internal indentations of the cephalic shield made by muscles which operated mandibulary or other appendages of the cephalon, just as in many Pelecypoda the adductor muscles indent the interior of their shells; and when such shells become fossilised so that only internal casts remain, the muscular indents are represented by more or less tubercular-like prominences.

Along the axial furrows of the thorax, these tubercles are even more noticeable features in non-testiferous Australian thoraces, showing up as large tubercular bodies at the outer ends of the axial annulations, but, when the test is preserved, dwindle to

* Fletcher, Quart. Journ. Geol. Soc., 1850, p.403.

† Hawle and Corda, Prod. Mon. böhm. Trilobiten, 1847, Pl. v., fig.55.

‡ Angelin, Pal. Scandinavica, 1878, Pt.1, Pl. iv., fig.4.

§ Schmidt, Revision Ostbaltischen Sil. Trilobiten, Obth. i., 1881, Pl.xiv., fig.11a.

mere thickenings. On the other hand, in the figure of *E. punctatus* by A. Brongniart,* these prominences appear to be, in the perfect form, definite tubercles, and, in consequence, this feature does not appear to have generic value, although they, too, whether mere thickenings or distinct tubercles, may have been produced by muscular insertions at these points.

We have already stated our disbelief in the presence of glabella furrows in *Encrinurus*, i.e., in the perfect testaceous condition. On the other hand, in non-testaceous specimens or "casts," as they are often called, there are short spaces between the axial tubercles which simulate furrows, but we believe these arise solely, (1) from the projection of the tubercles in question into or over the cephalic axial furrows, and (2) by the removal of the test from between them during the process of decay. Hence the size and amount of projection of these prominences becomes a specific character. Amongst Australian species, the false furrows are shown at their greatest development in *E. etheridgei*. At the same time, should there be a census of opinion that these are true furrows, then we are prepared to admit the identity of *Cromus* with *Encrinurus*, but not otherwise.

The pygidial axes of all the five species, *E. mitchelli*, *E. bowringensis*, *E. etheridgei*, *E. silverdalensis*, and *E. rothwellæ*, in the non-testiferous condition, possess a central longitudinal area across which the annulation grooves are discontinuous; when, however, the test is preserved, in some of these species these annulations are continuous, and no interruption is visible along the whole length of the pygidial axis. This is the case in some pygidia from Bowning, which, at present, we place with *E. etheridgei*; and some pygidia from Duntroon are similar in this respect. In *E. mitchelli*, testaceous specimens indicate continuity of the pygidial axial annulations. *E. bowringensis* and *E. silverdalensis* appear to possess a well marked central axial area on their pygidia even in the testaceous state, and in this resemble *E. punctatus*. These variations are of specific value.

* A. Brongniart, Hist. Nat. Crust. Foss.: Les Trilobites, 1822, Pl. i., fig. 3A (as *Calymene variolaris*).

Another feature we have observed is, that the cephalic axial grooves anteriorly do not terminate or pass out in the same way in all the species of our Australian *Encrinuri*. For instance, in *E. mitchelli* they do not cross the anterior border of the cephalon; but merely communicate with the furrows on those portions of the free cheeks outward and laterally from them; and neither axial grooves nor free cheek furrows extend along the inner and frontal portions of the free cheeks. On the other hand, the axial grooves of *E. bowningensis* and *E. silverdalensis* pass outward (or backward) and laterally into the free cheek furrows, and also branch inwardly and obliquely downward along the frontal lobe-like portions of the free cheeks, issuing with the facial sutures medially in front. Another variation of the anterior termination of these axial grooves occurs in *E. dunroonensis*. In this species, they communicate with the axial furrows of the outward portion of the cheeks, and also turn inwards and extend rather more than half-way across the inner lobes of the free cheeks, ending abruptly. These different variations of the axial grooves as they traverse the free cheeks and terminate, appear to us to be of much specific value.

vi. DESCRIPTION OF THE SPECIES.

ENCRINURUS MITCHELLI, Foerste.

(Pl. liv., figs. 1, 2, 3, 4, 5; Pl. lv., figs. 1, 2, 3, 15; Pl. lvi., figs. 2, 10; Pl. lvii., fig. 9.)

Encrinurus mitchelli, Foerste, Bull. Sci. Lab. Denison Univ., 1888, iii., Pt. 2, p. 124, Pl. xiii., figs. 2, 3, 20.

(?) *Cromus murchisoni*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1876, Pt. 1, Pl. i., fig. 9 (exclude figs. 9a and 9b).

*Sp. chars.**—Complete form subellipsoidal to some extent, with a flattened appearance. *Cephalon* subsemicircular, length approximately seven-sixteenths of the width between the genal angles; glabella subpyriform with greatest convexity midway between

* Where not otherwise stated, the descriptions of all the *Encrinuri* in this paper have been made from *non-testiferous* specimens.

the anterior and posterior extremities, whence it slopes gently to the anterior border, widest between the anterior pair of lateral tubercles (pseudo-lobes); front border, when the free cheeks are absent, having a subbattlexe contour; general surface copiously granulated, granules variable in size, imperforate, posteriorly arranged in two or three transverse parallel rows, anteriorly one or more rows concentric with the front cephalic border, but on the general surface a quincuncial arrangement is assumed, or in oblique irregular rows; five pairs of tubercles bordering the axial furrows only of moderate size, the anterior and posterior pairs much smaller than the intermediate pairs; neck-furrow inconspicuous, but its lateral extensions across the fixed cheeks rather wide and shallow; neck-ring similar to the adjoining thoracic ring but rather more arched; axial furrows pronounced (inconspicuous in testiferous specimens); fixed cheeks tumid, similarly granulated to the glabella centre, tubercles along the inner border abutting the axial grooves only moderately prominent; palpebral, or ocular lobes, prominent and bounded by well marked sulci, posterior border narrow but distinct; genal angles rounded and thickened. Free cheeks tumid, granulate, the anterior portions lobe-like, the latero-posterior portions rising abruptly to support the pedunculate, faceted, convex eyes; peduncles bounded by sulci, border thickened, bearing one row of conspicuous, and other irregularly placed tubercles, furrow within the border distinct and posteriorly communicates with the transverse furrow of the fixed cheeks, and anteriorly with the axial grooves and stops there, the transverse distance between the eyes is about equal to the length of the glabella. Facial sutures bisigmoidal or rolling V-shaped, the sigma anterior to the eyes, the shorter and more acute, the posterior terminating in front of the genal angles. Hypostome rhomboidal; tumid, centrally non-lobate, but anteriorly cucullate. *Thorax*: length about equal to that of the combined width of the axis and one pleura, finely granulate. Axis slightly subfusiform, width about five-sixths of that of a side-lobe, the annulations tuberculate at their extremities, and moderately arched transversely and anteriorly. Pleural seg-

ments moderately geniculate. *Pygidium* wider than long and only moderately tumid. Axis terminating submucronately, annulations twenty-six, and cease at two-elevenths short of the whole length, the first two or three usually continuous (*vide Obs.*); free central area bears five small tubercles, rarely more. Pleuræ of ten segments (doubtfully in some cases there appear to be eleven); more acutely geniculate than those of the thorax, the first pair with strong facets; last pair almost parallel with the axis.

Obs.—Foerste assigned twelve thoracic segments to *E. mitchelli*; such, however, is not the case. There are constantly eleven, in accordance with the generic definition.

From *Ecrinurus punctatus*, Emmrich, the generic type, this, the Australian type, differs by (1)—blunt instead of spined genal angles; (2)—absence of spines on the fourth and tenth thoracic axial segments; (3)—faceted instead of smooth lentiferous eyes; (4)—absence of a true or extended pygidial mucro or telson; (5)—a much less inflated and straighter-sided glabella; (6)—a larger number of segments in the pygidial pleuræ; and (7)—smaller tubercles on the central area of the pygidial axis. Other than these differences, there is a rather close affinity between the Australian and European species.

If De Koninck's description of the Duntroon specimen referred by him to *E. punctatus* is that of the actual fossil, it must have been not merely "presque complet" as he terms it, but a remarkably well preserved trilobite for a New South Wales fossil. Were it not for certain points in the description of the Duntroon specimen, we would have felt inclined to regard it as *E. mitchelli*, but the presence of genal spines and a full pygidial mucro, or telson, in the former is fatal. It is strange no Encrinurid from the Silurian rocks of this State has come under our notice, possessing the above features.

An important point in nomenclature, to say nothing of the morphological aspect, is the relation between *E. mitchelli* and *Cromus murchisoni* De Koninck. We have already expressed our disbelief in the occurrence of *Cromus* in New South Wales, so far as published evidence enables us to judge, and our belief

that, under this name, De Koninck figured cephalons of two distinct species. To which of these is the name of *C. murchisoni* to be restricted in the first place? To the Quedong example most certainly! because it is that one "qui a servi à ma description," and because it accords with the description in having a glabella "in the form of a club," and four transverse non-interrupted grooves, which are not grooves at all, but merely interspaces between lines of granules. Therefore, the name *Cromus murchisoni* should be restricted to De Koninck's Pl. i., fig.9. Now, whether or no this restricted cephalon is identical with that of Foerste's *E. mitchelli* is very difficult to say, but we have a lurking suspicion that it may be, on account of a pyriform glabella and transverse lines of granules at its base parallel with the neck-ring and furrow in both; in some young specimens this is very marked indeed, and we figure one such. But against this, is the apparent absence of the large axial tubercles in De Koninck's figure, and the very differently situated eyes; this absence of the large axial tubercles in the illustration referred to was also noticed by Mr. Foerste. There also occurs here one of those little errors which we are all liable to, for although Prof. De Koninck said "la joue mobile et l'angle géral me sont inconnus," the free cheeks are shown in his fig.9.

By what name is this trilobite to be known? In consideration of the doubts raised in the preceding paragraphs, it appears to us that Foerste's name must be recognised. Any claim to recognition of De Koninck's appellation would seem to be in a great measure nullified by the inclusion under it of more than one form, but had it been possible to show that *Cromus murchisoni* and *Encrinurus mitchelli* were one and the same, then certainly the former would have precedence.

In the numerous specimens of *E. mitchelli* examined by us, there appears to be no definite proportion between the axial length of the glabella and thorax, as the following proportions will show—6:10, 8:11, 9:11, 5:9, etc. The equality between the antero-posterior length of the glabella and the distance between the eye-lobes is very constant. In some specimens, the

eye-section appears to be subelliptical, but this arises from lateral compression. Nor does there appear to be any constant ratio, in most specimens, between the entire length of the body and that of either the cephalon or pygidium, but, in a few mature individuals, the length of the thorax and pygidium were found to be equal, yet in many cases the former exceeded the latter in length. It should be noted, too, that the whole of the submucronate extension of the pygidial axis is seldom preserved, and, therefore, the actual length of the pygidium rarely determinable. Although nearly all the pygidia, which are very many, show only ten pleural segments in each side-lobe, two or three have come under notice which faintly indicate an additional one very intimately fused to the submucronate tail terminal. Hence it may be that, in this species, the normal number of segments in the pleural lobes of the tail is eleven instead of ten, as indicated in our description.

E. konghsaensis, Reid,* from the Lower Palæozoic rocks of Burma, presents many points in common with *E. mitchelli*, particularly in the form and position of the cephalic axial tubercles; the two species, however, are distinct. *E. mitchelli* is the commonest trilobite in the Lower Trilobite Bed of the Bowning (Yass and Hume) Series.

Loc. and Hor.—Lower Trilobite Bed, Bowning Series, Parish Bowning, County Harden, N. S. Wales; Hatton's Corner, Yass River, Parish Yass, County Harden, N. S. Wales; Silverdale Limestone and Jones' or Derrengullen Creeks, Parish Bowning, County Harden, and Parish Derrengullen, County Murray; Warroo Creek, Parish Warroo, County Murray (J.M.); shale and limestone bands west of contorted shales, Boambola Crossing, Murrumbidgee River (A. J. Shearsby; Coll. Aust Mus.); Hatton's Corner, shale below the limestone, Hardy's or Limestone Creek, Parish Derrengullen, County King (Coll. Aust. Museum; presented by A. J. Shearsby).

* Reid, Lower Pal. Foss. N. Shan States, Burma (Pal. Ind., N.S. ii., Mem.3), 1906, Pl. vii., fig.21.

ENCINURUS BOWNINGENSIS, Foerste (emend.).

(Pl. liv., figs. 6, 7, 8, 9, 10, 12, 14; Pl. lv., figs. 5, 6, 12; Pl. lvi., fig. 8.)

E. Browningi (in error) Foerste, Bull. Sci. Lab. Denison Univ., iii., Pt. 2, 1888, p. 122, Pl. xiii., fig. 7.

Sp. Chars.—*Cephalon* subsemicircular, length half its width, highly tuberculate; glabella very tumid, strongly pyriform, very contracted posteriorly, front portion semiglobular; tubercles large and strawberry-like, with a fairly constant and symmetrical arrangement, thus—protruding into the axial furrows are the generic five pairs (the anterior and posterior pairs of which are not conspicuous), on the contracted glabella neck are two or three pairs (small), and in advance of these latter is the general cluster which usually assume a more or less circular arrangement around a central one; these are nearly all large and bear fine granules; axial furrows impinged upon by the marginal glabella tubercles, neck-furrow indistinct but its lateral extension across the fixed cheek narrow and deep, neck-ring strongly arched, its lateral extension narrow and prominent. Fixed cheeks inflated, tuberculate, axial border margined by fine tubercles interspacing with those on the sides, the others of variable size and arrangement, but longitudinally rows of three occupy the median lines of the cheek, and a posterior transverse line overhangs the lateral extensions of the neck-furrow; genal angles rounded and bearing a few small tubercles. Free cheeks relatively large, the smaller portions which clasp the front of the glabella subrectangular and densely covered with large, low tubercles; the larger lateral portions widely triangular but densely covered with low irregularly sized tubercles, borders on the posterior larger portions relatively large and tumid, furrows distinct, axial grooves in crossing the borders of the free cheeks bifurcate, one branching backward joining the free cheek furrow and the other proceeding inward and forward, passing out just before the middle line of the glabella is reached. Eyes prominent, pedunculate, highly convex, circular in cross-section, surrounded by distinct sulci, which are made increasingly pronounced by rows of bordering tubercles. Facial sutures openly V-shaped.

Thorax.—Length approximately two-thirds of the width; axis strongly arched, of uniform width to the eighth annulation, the three remaining ones narrower; all the annulations tuberculate at their bases, and granulate along their medial lines; pleural segments wider than the axis, moderately geniculate, finely granulate.

Pygidium widely triangular, relatively large, but bearing no constant ratio to other parts of the body; axis moderately prominent, bearing twenty or more annulations, the first only continuous; median free area bearing usually seven or eight tubercles of which five or six are prominent, yet not restricted to any particular annulations, but the second mostly bears one, pleural lobes transversely convex, and as compared with those of the thorax depressed, the segments increasingly inclined backwards until the last pair, which are nearly parallel with the pygidial axis.

Obs.—The cephalon of this trilobite, or rather a portion of a cephalon, was described by Mr. Foerste from material supplied by one of us.

E. bowningensis differs from the European *E. punctatus* in precisely the same manner as does *E. mitchelli*, except that, unlike the latter, it agrees with it in the shape and tuberculation of the glabella. When examples of the two Australian forms are compared, the differences are so obvious, and at once apparent as to hardly need comment. The form of the glabella, tuberculation, outline of the pygidia, and the manner in which the axial furrows traverse the free cheeks can be relied on for separation,

De Koninck's *E. barrandei*, from Yarralumla, was compared by Mr. Foerste with the present species, and his words referring to the former are as follows:—"This is evidently the most closely related species, but if his [De Koninck's] is at all correct then our species [*E. bowningensis*] is quite distinct." Mr. Foerste's specimen was devoid of eyes; had it not been so, De Koninck's remark that these organs were only raised a little above the surface in *E. barrandei*, his remark would have probably been still more emphatic.

The prominence and subglobular form of the eyes are just as characteristic features of *E. bowningensis* as is the tuberculation of the glabella. We can only again express our regret at our absolute inability to unravel the identity of De Koninck's Australian trilobites.

The tuberculation of the glabella is a most marked feature in this trilobite. In an exceptionally well preserved example, the tubercles on the semiglobular anterior portion of the glabella are in three concentric rows around a central one. The first is a circlet round this last, formed of five or six tubercles, the second is a semicircle commencing at the anterior pair at the anterior (third) pair on the glabella *neck*, and the third, also semicircular, passes round the front bordering the anterior branches of the facial sutures, and is continuous with the marginal tubercles overhanging the axial grooves.

The hypostome, so far as a mutilated specimen enables us to judge, resembles that of *E. mitchelli*. As in the preceding species and in accordance with the generic formula, there are eleven thoracic segments. In the pygidium there is no constant ratio between its length and that of either the cephalon or thorax. In a number of specimens the length appears about equal to the axial length of nine of the thoracic segments.

Both Mr. A. Brongniart and Mr. Fletcher stated the tubercles of *E. punctatus* to be perforate, and the latter so figured them,* but we have not detected this in either *E. mitchelli* or *E. bowningensis*. In the tuberculation of the central area of the axis of its pygidium, *E. bowningensis* closely resembles *E. punctatus*.

Loc. and Hor.—Bowning Creek, Parish Bowning, County Harden (J.M.); Limestone Creek, Parish Yass, County King (J.M.); Jones' or Derrengullen Creek, Parish Yass, County King (J.M.); Hatton's Corner, shale below the limestone, Parish Yass, County King; Burrowa Road, near Bowning, Parish Bowning, County Harden. (Coll. Aust. Mus., presented by A. J. Shearsby).

Lower Trilobite Bed, Bowning Series. Upper Silurian, = ?Wenlock Beds of Great Britain.

* Fletcher, Quart. Journ. Geol. Soc., 1850, vi., p. 403, Pl. xxxii., fig. 9b.

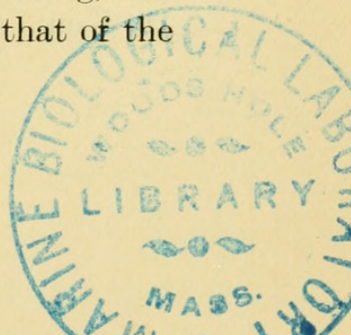
ENCINURUS SILVERDALENSIS, *sp. nov.*

(Pl. liv., fig. 11; Pl. lv., figs. 4, 9; Pl. lvi., figs. 4, 5, 6, 14; Pl. lvii., figs. 3, 10.)

Sp. Char.—General form suboval. *Cephalon* subsemicircular, and therefore approximately half as long as wide, moderately inflated, densely tuberculate, tubercles variable in size, many very large, conical, and all microscopically granulate. Glabella separated, pyriform, tubercles in oblique rows or quincuncially arranged, the large ones along the axial grooves somewhat flattened. Neck-furrow narrow and inconspicuous, its lateral extension across the fixed cheeks also narrow but deep. Neck-ring strong, wide, and moderately arched. Fixed cheeks moderately inflated, bearing tubercles similar to those of the glabella and arranged similarly; posterior border (extension of neck-ring) narrow, but strong; genal angles rounded, thickened, and bearing a few irregularly arranged tubercles. Free cheeks large, especially so are those portions inside of the axial grooves, and rest on the glabella front; tuberculated in a similar way to that of the glabella, border wide, bearing one row of large, rather flat tubercles along its inner border, and another row of smaller and less regularly arranged ones along the outer margin; on both inward and outward portions above the furrow the tubercles are arranged in three more or less regular rows. Axial grooves join the outward or lateral cheek-furrows, and also trend inward and obliquely downward along the inner or frontal portions of the cheek, passing out in front with the facial sutures. Eyes pedunculate, convex or subconical, peduncles surrounded by inconspicuous sulci. Facial sutures are of the usual generic type.

Thorax almost rectangular, about two-thirds as long as wide, microscopically granulate. Axis tapering almost imperceptibly posteriorly, the last annulation being much stronger and wider than first one of pygidial axis, annulations not tuberculate at their bases but somewhat thickened; pleuræ only moderately geniculate.

Pygidium large, widely triangular, much wider than long, and longer than the thorax, granulated in a similar way to that of the



thorax; axis tapering very gradually from before backwards, and terminating in a rather fine point; annulations thirty or more, the first only continuous, and, together with the next three or four succeeding, tuberculate; central area distinct, bearing seven or more tubercles, five of which are usually very conspicuous, only the first annulation decidedly arched, the others flat above with steep sides; pleural lobes very moderately geniculate, anteriorly about twice as wide as the anterior width of the axis; annulations are of the usual Encrinurid character, and are twelve in number.

Obs.—This is a robust species, and reaches a length of two or more inches. Its cephalon in general form and tuberculation approaches more nearly to that of *E. variolaris* than to any other European member of the genus, but its relatively enormous pygidium separates it from this species. The coarse cephalic tuberculation at first sight might cause it to be mistaken for *E. bowningensis*; but the larger size, more acutely conical nature, and conspicuous granulation of the tubercles of *E. silverdalensis* easily separate it from that species. The general form of the cephalic shield, and larger pygidium with the greater number of pleural segments of *E. silverdalensis* renders its distinction from *E. bowningensis* and other species we are acquainted with very simple. The pygidium is only approached in size by that of *E. etheridgei*, Mit.; but other features in the two widely differ. In its inconspicuous neck-furrow, coarse tuberculation of the cephalon, the strong tubercles on the central space of the pygidial axis, it resembles the typical Wenlock forms, *E. punctatus*, Brün., and *E. variolaris*, Brong.; but the tubercles in both instances are of a different type. The genal angles are not produced into spines, nor the pygidium into a telson as in *E. punctatus*. This trilobite was evidently very local in distribution, and restricted stratigraphically, for it is only known from the Lower Trilobite Bed of the Bowning Series (= Hume Beds) at the one locality. It is there associated with *Mucophyllum crateroides*, Eth. fil., *Heliophyllum yassense*, Eth. fil., *Rhizophyllum interpunctatum*, De Kon., and other corals typical of the Bowning-Yass beds.

There is a close similarity between this species and the Tasmanian form erroneously named *Cromus murchisoni*, De Kon., by one of us, and already referred to. It is possible the two may be identical. •

Loc. and Hor.—Silverdale, Limestone Creek, and doubtfully from Bowning Creek, Parish Bowning, County Harden. Lower Trilobite Bed = Upper Silurian (Wenlock), Coll. J.M. Hardy's or Limestone Creek, Parish Derrengullen, County King. (Coll. Aust. Mus.; A. J. Shearsby).

ENCRINURUS ETHERIDGEI, *sp.nov.* (Mitchell).

(Pl. liv., fig. 13; Pl. lv., figs. 7, 8, 10, 11.; Pl. lvi., fig. 9; Pl. lvii., figs. 1, 2, 4, 8.)

Sp. Chars.—Complete form elongately oval. *Cephalon* subsemicircular, rugo-tuberculate, approximately length equal to the width between the genal angles, or as long as nine thoracic segments. Glabella elongately pyriform, tapering from the anterior pair of axial tubercles forward to a rather acute point, giving it a mucronate appearance when the free cheeks are absent, tuberculate, tubercles rather small and subeven in size, the five pairs of axial tubercles very even in size and distinctness, the second, third, and fourth pairs, as is usual with other species, the most distinct. Neck-furrow moderately distinct, its extension across the posterior border of the fixed cheeks similarly so. Neck-annulation narrow and prominently arched, its lateral extension narrow. Axial furrows narrow and deep; fixed cheeks tumid, rather small, faintly tuberculate; axial tubercles only moderately distinct, rugoid, and between the eye-lobe and the posterior furrow arranged in three irregular rows, which, towards the genal angle, converge to one; genal angles rounded and only slightly thickened, sulci of the eye-lobes distinct. Free cheeks large, tuberculation similar to that of the fixed cheeks, border and furrow pronounced; eyes very prominent, conical, pedunculate, and surrounded by sulci. Facial sutures of the usual character.

Thorax subrectangular, length approximately two-thirds the width, very lightly if at all granulate; axis almost of uniform width throughout, arched transversely and anteriorly, basal ends

strongly thickened; axial grooves pronounced; side-lobes flat between the axial grooves and fulcra, thence steeply deflected.

Pygidium triangular, wider than long and longer than the thorax, surface apparently smooth; axis wide anteriorly, but the first annulation narrower than the last of the thoracic axis; each of the first three annulations contract somewhat rapidly, and thence the contraction is gradual to the blunt termination, rings approximately thirty-six, of which the first three are continuous, anterior half prominent and arched, but becomes decreasingly so posteriorly; medial tubercles inconspicuous; pleuræ normally of thirteen pairs of annulations; each pleura much wider than the greatest width of the axis; only the anterior pair have distinct fulcra, the others more or less slope steeply from the axial grooves downwards and increasingly backwards, the last being parallel with the axis terminal; anterior pair very strongly faceted; axial grooves distinct anteriorly, but becoming quite indistinct posteriorly.

Obs.—This is the largest of the Australian *Encrinuri* known to us, the type-specimen having a length of two and a half inches, of which the tail accounts for one inch. In several features, as for instance the general form of the complete fossil, glabella, and the anterior portion of the pygidial axis, this species resembles *E. mitchelli*. The much greater relative size of the pygidium, greater number of segments in the pleuræ and axis of the pygidium, the more prominent eyes, and wrinkled nature of the cephalic tubercles, easily separates it from that species. It is so evidently distinct from all other species that we deem it quite unnecessary to note the differences.

Named after Mr. Robert Etheridge, J.P., Curator of the Australian Museum, Sydney, N. S. Wales, as a small token of the appreciation in which he is held as a friend and collaborator by me (J.M.). The type-specimen was found by Mr. Etheridge during one of our geological excursions.

Loc. and Hor.—Yarralumla Plains (Limestone Plains), Parish of Narrabundah, County Murray (Etheridge and Mitchell). Gurnett's Farm, Parish Bowning, County Harden, (J.M.). ?Up. Sil.

ENCINURUS ROTHWELLÆ, *sp. nov.*

(Pl. lvi., figs. 1, 3; Pl. lvii., fig. 5.)

Sp. Chars.—Body long, narrowly suboval, with high steep sides. *Cephalon* approximately semicircular, length about half the width between the genal angles, densely covered with small tubercles. Glabella markedly pyriform and with a narrow neck, front broad, rounded, tumid, and relatively very wide between the anterior pair of axial tubercles; on the bulbous anterior portion the tubercles are arranged more or less concentrically around a central one, on the contracted posterior part in irregular transverse rows, one row extending around the front, between the anterior axial pair; all the tubercles fairly even in size; neck-furrow narrow, as is also its lateral extensions; neck-ring stout and strongly arched; axial tubercles prominent and of moderate size, interspaces between them wide and fairly deep; axial furrows very deep. Fixed cheeks relatively large, very tumid, granules between the eye-lobe and posterior furrow arranged in transverse and longitudinal rows, the axial ones (five) being the larger; the succeeding outward parallel row also consists of five, the other rows diminishing in number of tubercles until they converge to one at the junction of the posterior lateral cheek furrows; eye-lobe situated far forward and inward, sulci very faint; genal angles rounded. Free cheeks unknown. Facial sutures of the usual character.

Thorax steep-sided and practically subrectangular, width greater than the length, finely granulate; axis very prominent, almost of uniform width throughout, annulations moderately thickened at their bases: axial grooves deep; pleuræ highly geniculate, steep-sided.

Pygidium triangular, almost equiangularly so; axis very prominent between the front and the point where segmentation ceases, terminates rather acutely, but nonmucronate, and with a decided droop, twenty-two or more annulations, the first only continuous; central tubercles small and inconspicuous, five or six in number. Pleuræ strongly deflected, arched, the four anterior pairs strongly geniculate, the others sloping very steeply from the axial furrows, front pair highly faceted.

Obs.—The subrectangular and steep-sided thorax, very prominent thoracic and pygidial axes, acicular terminal of the tail-axis, eleven pleural segments in the pygidium, widely expanded, rounded and tumid glabella anteriorly, forward eye-lobes, and strong drooping of the pygidium posteriorly, separate this species from *E. mitchelli*, its nearest relative. When specimens of the two are placed side by side, the differences become at once apparent, and more particularly in that of the outline. In the Australian type-species, this is broad-oval forwards, whereas *E. rothwellæ* is narrow-oval. Another marked difference is that in *E. rothwellæ* the axes of the thorax and pygidium diminish gradually and regularly from the neck-ring to the pygidial terminal, whereas in *E. mitchelli* the axis of the thorax is subfusiform, and the last ring of the thorax is much wider than the first ring of the pygidial axis, which narrows rapidly in the distance between the first and third annulations, thence gradually becoming narrower and ending in a submucronate appendage. Again, the entire body of *E. mitchelli* presents an appearance of flattening, as compared with *E. rothwellæ*.

As regards the pygidium, in outline it resembles very much that of *E. etheridgei*, but the latter usually has thirteen pleural segments instead of the eleven normal in *E. rothwellæ*.

Named after Miss Rothwell, Headmistress of the District School, Lismore, who was associated with one of us as student and assistant.

Loc. and Hor.—Railway Cutting just west of Bowning Railway Station, Parish Bowning, County Harden; Upper Trilobite Bed, Bowning Series. Upper Silurian (= ?Wenlock).

ENCINURUS(?) DUNTROONENSIS, *sp. nov.*

(Pl. lvi., figs. 11, 13.)

Sp. Chars.—Complete form unknown. *Cephalon* transversely subelliptical, much wider than long, moderately inflated and tuberculate. Glabella approximately one-third as long as the width between the genal angles, elongately subpyriform, sides subparallel, anterior portion or lobe bluntly rounded in front and tumid, strongly arched transversely, sparsely granulate, four

large lateral (axial) tubercles visible and separated by wide, deep furrow-like spaces, anterior or fifth apparently covered by the embracing and inner lobe of the free cheek; neck-furrow absent, but its lateral extension over the fixed cheek very deep; neck-ring also absent, and its lateral extension narrow and strongly geniculate; axial grooves very deep; fixed cheeks very tumid, ridge-like, decidedly geniculate, rising very abruptly both from axial and posterior furrows, tuberculate, tubercles small, uneven in size and sparse, hence the eye-lobes are also close to these furrows; genal lobe very small, narrow, bearing one row of small tubercles and overhanging the posterior transverse furrows; genal angles rounded and only slightly thickened, granulate; free cheeks relatively large, placed anteriorly, tuberculation inconspicuous and tubercles of variable size, borders moderately thickened, furrows shallow, joining inwardly with the axial furrows and outward with the posterior furrows of the fixed cheeks, inwardly they pass about half-way across the inner lobe; that is, the axial grooves, instead of distinctly crossing the front border of the cephalon, bifurcate, and one branch proceeds outward and the other inward along the free cheek furrows. Facial sutures anteriorly pass out in the manner usual in the *Encrinuri*; the posterior portion passes straightly outward from about the middle of the lateral side of the eye, cutting the border well in front of the genal angles; this portion is practically at right angles with the axial grooves. Eyes conical, faceted, prominent, pedunculate, and surrounded by distinct sulci.

Obs.—The fragmentary cephalon and detached free cheeks described above are so strikingly different from all other Australian, as well as from foreign species of *Encrinurus* known to us, that we have no hesitation in giving it specific rank.

The features which separate it from other species are— (1) the transversely elongate elliptical form of the cephalon, with its nearly straight anterior border; (2) the closeness of the anterior branches of the facial sutures and the perpendicularity of the posterior branches of these, with the axial furrows, or central axial line; (3) the long, narrow and straight-sided glabella; (4) the anteriorly situated free cheeks; (5) the sparse tuberculation;

(6) the backward and inward situation of the eyes; and (7) the manner in which the axial furrows bifurcate outward and inward on reaching the frontal borders of the free cheeks.

So different are the posterior branches of the facial sutures of this species, in more than one particular, we are rather inclined to the opinion that in this fossil we have a new genus.

Besides the portions above-described, several pygidia were found associated with them, which may or may not prove to belong to the same species; and because of their association and dissimilarity to all other pygidia, it is not unreasonable to assume that they probably do. They will be described separately.

Loc. and Hor.—Near Duntroon Homestead, Parish Canberra, County Murray, N. S. Wales. Upper Silurian(?). Coll. Mitchell.

vii. PORTIONS OF ENCRINURI.

1. *Cephala*.

a.—Portion of a single cephalon (Pl. lvi., fig. 7) differs from all the others described *ante*, in the form and proportions of the fixed cheeks. The entire shield is unknown, but probably possessed a subsemicircular outline. It is strongly inflated and granulate on all parts preserved. The pyriform glabella is very convex and bold anteriorly, the neck-ring narrow but distinct and much arched, but the neck-furrow narrow and shallow. The features which distinguish this cephalon are the form of the fixed cheeks, position of the eyes, and the course of the facial sutures. These latter, between the eye-position and the lateral borders of the cephalon, are straight, *i.e.*, practically parallel to the neck segment, with the result that the fixed cheeks, instead of being sublunate in some degree or other, as in most of our *Encrinuri*, are more or less parallelogramatic, the facial sutures cutting the lateral borders some distance in advance of the bluntly rounded genal angles. The eye-positions are close to the axial furrows, and as between anterior and posterior, almost median. The fixed cheeks also appear to be much more inflated than ordinarily. We are not able to associate this specimen with any of the preceding remains, but found in company with pygidia described later on, and a Brachiopod resembling *Meristella tumida*.

Loc. and Hor.—Gurnett's Farm, three miles west of Bowning, on the Binalong Road, and the west side of the Bowning Anticline, Parish Bowning, County Harden; Bowning Series (probably Lower Trilobite Bed), Upper Silurian.

b.—With the above occurs a form of cephalon (Pl. lv., fig. 8) which to us seems to agree so closely with the cephalon of *E. etheridgei*, that we place it with that species provisionally. The occurrence of pygidia in association with it which we, at present, are unable to separate from the pygidia of *E. etheridgei*, gives support to this conclusion.

c.—Still another cephalon (Pl. lvi., fig. 12) occurs with the two preceding ones, which we are unable to determine specifically. Its fixed cheeks resemble those of *E. mitchelli*; but its glabella is much more robust and more strongly tuberculate than is that of the latter. The neck-annulation and its lateral extensions are more strongly arched and tuberculate than is the case in *E. mitchelli*. No portions of the latter species have been found in the same locality.

Loc. and Hor.—Gurnett's Farm, Parish Bowning, County Harden, (?) Upper Silurian (Coll. Mitchell).

2. *Pygidia.*

a.—The following (Pl. lv., figs. 10, 11) are the specific characters of a number of pygidia collected from Gurnett's Farm, west of the Bowning Anticline, and which have been referred to in our description of some cephalæ from the same place. Acutely triangular, slightly wider than long, very much arched transversely and longitudinally, evidently finely granulate; axis very wide in front, decreasing gradually posteriorly and terminating in a moderately fine point closely invested by the last pair of pleuræ, not at all prominent, very slightly arched, annulations continuous throughout when testaceous as are most of the specimens under our notice; but on nontestaceous specimens a distinct central space appears to be present, and only the first three annulations or so are continuous; medial tubercles seldom visible, and when so are faint (testaceous); pleuræ of twelve to thirteen pairs of

segments, sloping very steeply from the axis, only the first pair strongly geniculate; axial grooves faint.

The triangular outline is close to that of *E. rothwellæ*, but the very prominent axis and smaller number of pleural annulations in the latter clearly separate it from this form. In contour, it approaches the pygidium of *E. siebachi*; but most of all it resembles our *E. etheridgei* in the nontestaceous condition, and until we obtain further evidence and material, we are unable to determine the species with certainty. The fragmentary cephalæ already described as agreeing in specific features with that of *E. etheridgei*, which were found associated with these pygidia, and the occurrence of free cheeks, which at present appear to us to be practically identical with those of *E. etheridgei*, also in association, still further incline us to the belief that their specific identity is the same. If, however, a testaceous specimen of the pygidium of *E. etheridgei* be discovered later on, and be found in that state not to have the axial rings wholly continuous, we would then be disposed to give this fossil specific rank under the name of *E. loomesi*, as a mark of gratitude for assistance received by one of us from Mr. F. Loomes, of Bowning, in the collection of specimens.

Loc. and Hor.—Gurnett's Farm, three miles west of Bowning township, Parish Bowning, County Harden. Lower Trilobite Beds(?), Bowning Series (Hume Beds, etc.). Upper Silurian = (?) Wenlock. (Coll. Mitchell).

b.—From Duntroon, several pygidia (Pl. lv., fig. 14) have been collected, associated with *E. duntroonensis*, nobis. They probably include two types. Of the first, the specific characters are—Acutely triangular, length greater than width (4:3 approximately), very faintly or microscopically granulate, droops intensely posteriorly. Axis very narrow and prominent, tapering gradually and ending in a fine point between the last pair of pleural segments; annulations continuous and numerous; medial tubercles not apparent; axial grooves faint. Pleuræ with twelve pairs of annulations at least, sloping *very* steeply from the axial grooves, having generally a compressed aspect.

The outstanding features of this pygidium are its narrowness, steep compressed high sides, narrow, prominent, posteriorly strongly deflected axis, continuity of the axial rings, and the absence of medial axial tubercles.

Although this pygidium occurs associated with *E. duntroonensis*, from its small width we are disinclined to consider it as belonging to this species, neither are we disposed to give it a specific name.

Loc. and Hor.—Same as *E. duntroonensis*.

c.—The other type (Pl. lv., fig. 13) referred to as occurring with the above, is wider than long, almost equiangularly triangular and steep-sided, finely granulate. Axis not prominent, rather wide in front, contracting somewhat rapidly between the first and third annulations, thence gradually, and terminating in a fine point between the last pair of pleural annulations, apparently a little short of the margin; annulations continuous, some very fine; medial granules visible with the aid of a lens, posteriorly very steeply depressed; axial grooves faint. Pleuræ of twelve segments, granulate, and sharply deflected.

This pygidium closely resembles the preceding, with which it occurs, and only differs from it in the less prominent and anteriorly wider axis, greater width, distincter granulation of the pleuræ, and the apparently more rapid contraction of the axis posteriorly. It is possible they are identical; and the differences in the forms under notice arise from compression. The present pygidium very closely resembles those from Gurnett's Farm, and which we, for the time being, have placed with *E. etheridgei*. Like the latter, it approaches the *E. siebachi* type of pygidium.

Loc. and Hor.—Same as *E. duntroonensis*.

d.—From a new locality, one of us collected in March, 1914, a few fragments of trilobites among which were specimens of a free cheek and a tail referable to *Encrinurus*. The free cheek (Pl. lvii., fig. 6) belongs to the type in which the axial furrows communicate with lateral cheek furrows outwardly and inwardly, proceed obliquely downward along the inner and smaller cheek lobes, passing out at the frontal passage of the facial sutures, and

of which, perhaps, the free cheeks of *E. bowningensis* afford the most typical examples of this feature. The border of the larger cheek lobe is prominent and tuberculate, but less so on the smaller one; the furrow also is distinct on the larger portion. The palpebral lobe bearing the eye is small and very narrow between the latter and the marginal furrow, also sparsely tuberculate; the eye, front to back, is relatively long, and occupies practically the whole of the space between the axial furrow anteriorly and the posterior branch of the facial suture; it is slightly pedunculate and subconical, with the peduncle surrounded by a sulcus.

The vertical shallowness of the lobe which bears the eye and its great relative size place the specimen apart from other Australian *Encrinuri*. Found associated with an *Odontopleura*, near *O. rattei*, E. & M.

Loc. and Hor.—Tarlo River, near its head-waters, Parish Turrallo, County Argyle. Upper Silurian(?).

e.—The imperfect pygidium (Pl. lvii., fig. 7) is moderately tumid, axis moderately arched, twelve annulations are present, but the posterior portion is missing; annulations are apparently continuous. Only six segments of the pleural lobes are present; but when complete would seem to have possessed eight. Regarding it, we can only say definitely that it is the pygidium of an *Encrinurus*, and probably belongs to the same species as does the preceding free-cheek.

Both the preceding free-cheek and this pygidium are distinct from any we are acquainted with.

Loc. and Hor.—Tarlo River, Parish Turrallo, County Argyle. (?) Upper Silurian.

EXPLANATION OF PLATES LIV.-LVII.

Plate liv.

ENCINURUS MITCHELLI, *Foerste*.

Fig. 1.—An almost entire specimen, with the free cheeks turned outwards; slightly enlarged. Bowning. *Coll. Mitchell*.

Fig. 2.—Another nearly complete specimen. Bowning. *Coll. Mitchell*.

Fig. 3.—A cephalon with free cheeks in position, the left one being imperfect. On the right side, the eye and the tubercles bordering the

axial groove are clearly visible, also the two rows of tubercles at the base of the glabella parallel with the neck-furrow. Bowning. *Coll. Mitchell.*

Fig.4.—Another almost perfect specimen; the form of the glabella, especially the semielliptical contour of its frontal margin, is distinctly shown. The pygidium of this specimen is about perfect, and distinctly shows the axis of the pleural lobe-divisions. Bowning. *Coll. Mitchell.*

Fig.5.—A perfect specimen, slightly enlarged. The lobe-like character of the portions of the free cheeks embracing the front portion of the glabella is well shown, as are also the natural outline, and the various parts of the animal as viewed from above. Bowning. *Coll. Mitchell.*

ENCINURUS BOWNINGENSIS, *Foerste.*

Fig.6.—A complete specimen except for the absence of the free cheeks, exhibiting all the features of the glabella, thorax, and pygidium. Bowning. *Coll. Mitchell.*

Fig.7.—A cephalon with the right free cheek in position, and showing the character of the tuberculation, the deep axial grooves, and the manner in which these traverse the free cheeks. Bowning. *Coll. Mitchell.*

Fig.8.—A cephalon and thorax, showing the concentric and quincuncial arrangement of the tuberculation on the glabella. Bowning. *Coll. Mitchell.*

Fig.9.—A cephalon showing the tuberculation of the glabella very distinctly. Bowning. *Coll. Mitchell.*

Fig.10.—A perfect pygidium, which exhibits very clearly all the pygidial features of the species. Bowning. *Coll. Mitchell.*

Fig.12.—A very fine and mature specimen ($\times \frac{4}{3}$), to show the general outline and glabella tuberculation.

Fig.14.—The same as the above, natural size. Bowning. *Coll. Mitchell.*
[The light line across the figure arises from a crack in the negative from which the print was made].

ENCINURUS SILVERDALENSIS, *E. & M.*

Fig.11.—A portion of a cephalon ($\times \frac{4}{3}$), showing the character of the tuberculation and the terminal conical tubercles surmounting the larger ones, and the fixed cheeks, inconspicuous neck-furrow, but strong neck-annulation, the rounded and tuberculate genal angle. Silverdale, near Bowning. *Coll. Mitchell.*

ENCINURUS ETHERIDGEI, *Mit.*

Fig.13.—A cephalon without the free cheeks ($\times \frac{4}{3}$). It shows the subtriangular or acutely elliptical contour of the anterior portion of the glabella, the deep axial grooves, the five pronounced lateral tubercles, and the deep spaces between these latter. Yarralumla. *Coll. Aust. Museum.*

Plate lv.

ENCINURUS MITCHELLI, *Foerste.*

- Fig. 1.—A nearly perfect testiferous specimen, the test being absent from the glabella and pygidial axis only. The submucronate termination of the pygidium is well shown. Bowning. *Coll. Mitchell.*
- Fig. 2.—Shows the almost perfect hypostome in position. Bowning. *Coll. Mitchell.*
- Fig. 3.—Another testiferous specimen, exhibiting the much greater size of the last annulation of the thoracic axis than that of the first of the pygidial axis, and which is very characteristic in this species; also continuity of six of the annulations of the pygidial axis anteriorly, whereas, in non-testiferous specimens, three only are usually so. Bowning. *Coll. Mitchell.*
- Fig. 15.—A left free cheek, to show the eye and the non-inward trend of the axial groove. Bowning. *Coll. Mitchell.*

ENCINURUS SILVERDALENSIS, *E. & M.*

- Fig. 4.—An imperfect tail showing eight or nine tubercles on the central area. Bowning. *Coll. Mitchell.*
- Fig. 9.—Hypostome showing lobation, etc. Silverdale. *Coll. Mitchell.*

ENCINURUS BOWNINGENSIS, *Foerste.*

- Fig. 5.—A portion of a cephalon, to show the prominent eye. Bowning. *Coll. Mitchell.*
- Fig. 6.—Left free cheek ($\times 2$), to show how the axial furrow passes outwardly into the side-furrow of the cheek, and obliquely inwardly across the inner lobes. [The artist has here intensified the obliquity]. Bowning. *Coll. Mitchell.*
- Fig. 12.—A right free cheek, to show the same features as Fig. 6 more correctly. Bowning. *Coll. Mitchell.*

ENCINURUS ETHERIDGEI, *Mitchell.*

- Fig. 7.—A portion of a cephalon [*vide* Pl. liv., fig. 13, *ante*].
- Fig. 8.—Portion of a cephalon ($\times 2$), showing identity of features with the above Fig. 7. Bowning. *Coll. Mitchell.*

ENCINURUS *sp. (?) undet.*

- Fig. 13.—Pygidium with continuous axial annulations, and twelve pairs of pleural segments. Found associated with *E. duntroonensis*. This and the following (Fig. 14) are distinct from all pygidia known to us, and if not belonging to *E. duntroonensis*, represent one, if not two, new species. Duntroon. *Coll. Mitchell.*

ENCINURUS *sp. (?) undet.*

- Fig. 14.—Pygidium with axial annulations continuous, and ten pairs of pleural segments. (See remarks above, Fig. 13). Duntroon. *Coll. Mitchell.*

ENCRINURUS (?) ETHERIDGEI, *Mit.*

Fig.10.—An almost completely testiferous specimen ($\times 2$), with continuous axial annulation, and thirteen pairs of pleural segments. Found associated with the cephalon represented in Fig.8, and tentatively is placed specifically with it ($\times 2$). Bowning. *Coll. Mitchell.*

Fig.11.—A side-view of another pygidium of the same species showing thirteen pleural segments. Bowning. *Coll. Mitchell.*

Plate lvi.

ENCRINURUS ROTHWELLÆ, *E. & M.*

Fig.1.—An almost complete individual; the free cheeks are absent, and the artist has incorrectly shown the eyes apparently present; also the pleural lobes of the thorax are too intensely spread marginally; otherwise it is a good figure. Bowning. *Coll. Mitchell.*

Fig.3.—A side-view of another specimen to show the rather prominent axis. Bowning. *Coll. Mitchell.*

ENCRINURUS MITCHELLI, *Foerste.*

Fig.2.—A very fine specimen, complete except the free cheeks. Bowning. *Coll. Mitchell.*

ENCRINURUS SILVERDALENSIS, *E. & M.*

Fig.4.—A nearly complete specimen of an almost mature individual. Silverdale. *Coll. Mitchell.*

Fig.5.—A large pygidium showing seven tubercles distinctly on the central area of the axis, and the eighth faintly. Silverdale. *Coll. Mitchell.*

Fig.6.—A portion of a cephalon of a mature individual showing the general tuberculation, the large lateral tubercles of the glabella, the stout neck-ring and its lateral extensions, and the rounded, thickened, and tuberculate genal angles. [See Pl. liv., fig.11, of the same specimen]. Silverdale. *Coll. Mitchell.*

Fig.14.—Another pygidium.

ENCRINURUS *sp. (?)*, *undet.*

Fig.7.—Imperfect cephalon, *undet.* Bowning. *Coll. Mitchell.*

ENCRINURUS BOWNINGENSIS, *Foerste.*

Fig.8.—An imperfect cephalon, which shows the tuberculation of the glabella.

ENCRINURUS (?) ETHERIDGEI, *Mit.*

Fig.9.—Free cheek with prominent conoid eye. Bowning. *Coll. Mitchell.*

ENCRINURUS MITCHELLI, *Foerste.*

Fig.10.—Hypostome.

ENCRINURUS DUNTROONENSIS, *E. & M.*

Fig.11.—Right half of a cephalon showing all the features referred to in the description.

Fig.13.—Left free cheek of the above showing prominent conical eye, small inner lobe, and the inward trend of the axial groove reaching about half-way along the inner cheek-lobe. The posterior or outward part bordered by the posterior suture is incomplete. *Coll. Mitchell.*

ENCRINURUS *sp. undet.*

Fig.12.—Not correctly represented. *Coll. Mitchell.*

Plate lvii.

ENCRINURUS *ETHERIDGEI*, *Mit.*

Fig.1.—An almost complete specimen of a mature individual, showing most of the specific features fairly well. Yarralumla. *Coll. Australian Museum.*

Fig.2.—A pygidium showing 12-13 pairs of pleural divisions. Yarralumla. *Coll. Aust. Museum.*

Fig.4.—A smaller specimen. Yarralumla. *Coll. Mitchell.*

Fig.8.—Another pygidium, thirteen pleural segments. Yarralumla. *Coll. Aust. Museum.*

ENCRINURUS *SILVERDALENSIS*, *E. & M.*

Fig.3.—Axis and right pleural lobe of a large pygidium showing seven large tubercles and several smaller ones on the central area of the axis, and twelve pleural segments.

ENCRINURUS *ROTHWELLÆ*, *E. & M.*

Fig.5.—A nearly complete specimen, showing the characteristic features fairly distinctly. Bowning. *Coll. Mitchell.*

ENCRINURUS *sp. undet.*

Fig.6.—A right free cheek. Tarlo River. *Coll. Mitchell.*

Fig.7.—Portion of a pygidium. Tarlo River. *Coll. Mitchell.*

ENCRINURUS *MITCHELLI*, *Foerste.*

Fig.9.—A left free cheek, to show that the axial furrow does not traverse inwardly along the smaller lobe of the cheek. Bowning. *Coll. Mitchell.*

ENCRINURUS *SILVERDALENSIS.*

Fig.10.—A right free cheek, to show the passage of the axial groove inwardly along the small lobe of the cheek, and passing out at the junction of the facial sutures in front of the glabella. Silverdale. *Coll. Mitchell.*

ENCRINURUS *BOWNINGENSIS.*

Fig.11.—A right free cheek, showing the passage of the axial groove inwardly along the smaller lobe of the cheek, as is the case in *E. Silverdalensis*. Slightly enlarged-

[Photos by H. B. and J. M.]



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<https://doi.org/10.5962/bhl.part.18886>.

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