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DEPARTMENT OF MINES.

MEMOIRS OF THE GEOLOGICAL SURVEY OF NEW SOUTH WALES.

E. F. PITTMAN, A.R.S.M., GOVERNMENT GEOLOGIST.

PALÆONTOLOGY, No. 5.

R. ETHERIDGE, JUNR., PALÆONTOLOGIST.

A MONOGRAPH

OF THE

CARBONIFEROUS AND PERMO-CARBONIFEROUS INVERTEBRATA

OF

NEW SOUTH WALES.

PART II.—ECHINODERMATA, ANNELIDA, AND CRUSTACEA.

BY

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Letter of Transmittal.

Geological Survey, N. S. Wales,
Department of Mines,
Sydney, 25 March, 1892.

Sir,

It becomes my duty to submit for publication the accompanying Memoir, No. 5, of the *Palæontological Series* of the Geological Survey, being Part II of the *Carboniferous and Permo-Carboniferous Invertebrata of New South Wales*, by Mr. Robert Etheridge, Junr., Palæontologist.

The present Memoir deals with the representatives—hitherto found in the above-named formations—of three Classes, viz., *Echinodermata*, *Annelida*, and *Crustacea*, and it will be found to comprise twenty-nine species, of which no less than seventeen species, new to science, have been named, figured, and described.

The Work is another illustration of the untiring industry of Mr. Etheridge in the domain in which his previous exertions have already made his name so well known amongst Scientists. The importance of such work in connection with the mapping of the Carboniferous areas of the Colony is too obvious to need comment by me, and it will lend additional interest to the Geological Survey of the Newcastle and Maitland Coal-field, which has recently been completed by Professor T. W. E. David, B.A., F.G.S., whose map and report will, it is hoped, be soon issued.

The illustrations reflect great credit upon the artist, Mr. G. H. Barrow, of the Australian Museum.

I cannot conclude without a tribute to the memory of my lamented friend and predecessor in office, the late Mr. C. S. Wilkinson, F.G.S., F.L.S., under whose direction the previous numbers of this Series were published,

and upon whose advice the Department succeeded in obtaining the services of Mr. Etheridge, the Author of this and several of the preceding Memoirs. Mr. Wilkinson's courteous and unassuming demeanour, as well as his large hearted sympathetic nature, will be remembered as long as any of those who enjoyed the privilege of his acquaintance survive him. The record of his scientific labours will endure much longer.

I have the honour to be,
Sir,
Your obedient servant,
EDWARD F. PITTMAN, A.R.S.M.,
Government Geologist.

HARRIE WOOD, ESQ., J.P.,
Under Secretary for Mines.

Author's Preface.

The Second Part of the Monograph of the Carboniferous and Permo-Carboniferous Invertebrata of New South Wales includes the Echinodermata, Annelida, and Crustacea known to the Writer.

The whole of the specimens figured, with the exception of five, are contained in the cabinets of the Mining and Geological Museum. For an opportunity of illustrating the first of the exceptions (*Phialocrinus nodosus*, Eth. fil., Pl. XIV, Figs. 4 and 5) thanks are due to the Trustees of the Australian Museum; similarly for the second (*Tribrachiocrinus corrugatus*, Ratte—Pl. XVI, Figs. 5–10); and for the third, the magnificent subject of Pl. XVIII, Fig. 1 (*Phialocrinus princeps*, Eth. fil.), to the Council of the Maitland Scientific Society; for the fourth (Radial plate, Pl. XX, Fig. 9), again to the Trustees of the Australian Museum; and for the fifth (*Phillipsia grandis*, Eth. fil., p. 128, Fig. 5), to Mr. D. A. Porter, Inspector of School Buildings, Tamworth.

Mr. John Waterhouse, M.A., Inspector of Schools, has, with his usual liberality, presented several specimens of Echinodermata to the Collection, and so has Mr. B. G. Engelhardt, of the Public School, Jamberoo, which have materially assisted in the elucidation of difficult problems. Two of the beautiful Star-fish (*Palæaster Clarkei* and *P. giganteus*) have been presented by Mr. T. Browne, of Ravensfield, West Maitland, and for the presentation of the peculiar Crinoid, *Phialocrinus? Stephensi*, Eth. fil., we are indebted to the Executors of the late Mr. David Berry, of Cooloomgatta. The Rev. W. H. Yarrington, M.A., has also lent an example of *P. Clarkei* for comparison. The remainder of the specimens were obtained under the direction of the late Mr. C. S. Wilkinson, Geological Surveyor-in-Charge, by the Collector, Mr. C. Cullen, or, under the superintendence of Prof. T. W. E. David, B.A., when surveying the Maitland District. The fine example of *Phialocrinus Koninckii*, Clarke (Pl. XVI, Fig. 1), was collected by Mr. E. F. Pittman, Government Geologist.

I am indebted for cordial services to my Assistant, Mr. W. S. Dun; for his accustomed skill in depicting the fossils to Mr. G. H. Barrow, of the Australian Museum; and for the Photo-lithographs to Mr. P. T. Hammond. As in Part I, the Plates have been reproduced by the Heliotype Process, at the Government Printing Office, by Mr. A. E. Dyer, under the direction of the Government Printer.

R. ETHERIDGE, Jnr.

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I.—INTRODUCTION.

The distribution of the Permo-Carboniferous Echinodermata is equally fitful with that of the Actinozoa, and the life history of this Class would seem to have been governed by the same causes as those which yielded so powerful an influence on the latter. From a specific point of view the occurrence of Echinoderms in the rocks in question is rare; at any rate this would appear to be the case from the geological researches that have so far progressed. In two out of the three groups represented this would also appear to be the case numerically, for the Crinoidea is the only Class in which anything like a redundance of individuals predominated. This fact is only arrived at from the abundance of skeletal fragments in some deposits, chiefly stem joints, anything like perfect calices, not to speak of the entire organism being rare. In the Carboniferous rocks, or those beds below the Lower Marine Series, several horizons have been discovered at which extensive traces of Crinoid life have been found, chiefly consisting of stem fragments entering into the composition of limestones.

We are now, for the first time, made aware of the existence in our rocks of the Palæozoic section of the Echinoidea, whilst the Asteroidea, formerly known from the presence of one species, is now represented by three, and these of large size.

So far the Crinoidea are known to occur in the Carboniferous and the Upper Marine Series of the Permo-Carboniferous; the Asteroidea, in both the Lower and Upper Marine Series, but the Echinoidea only from the Upper Marine Series. The Cystoidea and Blastoidea are not represented at all in our New South Wales Carboniferous or Permo-Carboniferous rocks, although the latter class is known to occur in beds of the last-named age in Queensland.

I am not aware that the remains of Annelids have been before noted; and although the evidence is but meagre, sufficient is before us to raise a hope of future additions.

With regard to the Crustacea, two Orders are known to exist—the Ostracoda and Trilobita. The first occurs both in the Carboniferous and Permo-Carboniferous, the second only, so far as I have been able to ascertain, in the second division of this series of our rocks.

II.—DESCRIPTION OF THE GENERA AND SPECIES.

Sub-Kingdom—**ECHINODERMATA.**

Division—ECHINOZOA.

Class—**ECHINOIDEA.**

Order—**Palæchinoidea.**

Sub-order—**Perischoëchinidæ.**

Obs.—In addition to the specimens hereinafter described as *Archæocidaris? Selwyni*, and *Archæocidaris, sp.*, a few fragments of spines have been met with, but in no case sufficiently well marked or preserved to warrant description. A single plate has been found in the Permo-Carboniferous of the Rockhampton District, Queensland.

Family—ARCHÆOCIDARIDÆ.

Obs.—This family is represented in our Permo-Carboniferous rocks by one genus only. It is unknown from Western Australia, but a single plate impression has been found by Mr. C. W. de Vis, in the Gympie Series, of the Rockhampton District, Queensland.

Genus—ARCHÆOCIDARIS, *McCoy*, 1844.

(Synop. Carb. Lime. Foss. Ireland, p. 173.)

ARCHÆOCIDARIS ? SELWYNI, *sp. nov.*

Pl. XV, Figs. 1–3.

Sp. Char.—Test fully four and a half inches in diameter at the greatest periphery. Interambulacral plates very large, quite a quarter of an inch in diameter, with prominent rim-like edges; surfaces concave from the edges to the miliary rings, which, with the primary tubercles are large and

prominent; plates arranged in four and perhaps five series; if so, the central row much smaller than the others. Ambulacral areas apparently three-eighths of an inch wide. Teeth large and strong, quite two-thirds of an inch in length.

Obs.—So far as I am aware, the existence of the interesting group of the Perischoëchinidæ has not hitherto been recognised in the Permo-Carboniferous rocks of this Continent. The fine, although much maltreated, specimen now figured, was rescued from the *débris* of the Departmental Collection at the Garden Palace fire in 1882. Previous to this disaster a description of some utility might have been drawn up, but in the present state of the fossil this is hardly possible.

The portion remaining consists of rather less than the ventral half, with the "Lantern of Aristotle" *in situ*. The test was fully four and a half inches in diameter, and must have been that of a robust individual, but in its present state the approximate height cannot be arrived at. The positions of two of the ambulacra are indicated by faint impressions of the plates, and those of the others can be fixed by measurement. The two rows of plates appear to have been three-eighths of an inch wide, but all trace of the pores is quite lost.

The interambulacral plates were very large, fully half-an-inch in diameter, with prominent edges, and the surface between these and the miliary rings concave. There is, in relation to these plates, an obscure point, which I am not at present prepared to explain. The rows of plates in each inter-ambulacral area are certainly four, but in the middle line of the three best preserved areas, between the two contiguous rows of tubercle bearing plates, are smaller pieces devoid of tubercles. This central line of each inter-ambulacrum is also its most prominent position. The state of preservation is so indifferent that too much stress cannot be laid on this point, but from their appearance on three of the interambulacra one is led to regard this feature as a structural arrangement. In such a case it would have equal value with the somewhat analagous arrangement met with in *Perischodomus*, M'Coy,* and must be looked upon as of generic importance, and a new name coined for its reception. The characters of the interambulacral plates are, however, so manifestly those of *Archæocidaris* that the specimen is for the

* Ann. Mag. Nat. Hist., 1849, III, p. 253.

present placed in that genus, with the trivial name of *A.? Selwyni*, in honour of Dr. A. R. C. Selwyn, F.R.S., Director of the Geological and Natural History Survey of Canada, and formerly Director of the Geological Survey of Victoria, Australia. The teeth are large, quite two-thirds of an inch in length, and very strong.

Locality and Horizon.—Nowra, Shoalhaven River, Co. St. Vincent:—Nowra Grit (equivalent of the Muree Rock of the Hunter River Coal-field)—**Upper Marine Series.**

Archæocidaris, *sp. ind.*

Pl. XXII, Fig. 1.

Obs.—In all probability a second species of *Archæocidaris* exists in our Permo-Carboniferous rocks, as exemplified by the fragmentary specimen represented in Pl. XXII, fig. 1, for which we are indebted to Mr. John Waterhouse, M.A., Inspector of Schools, Dungog. The specimen consists of portions of eight rows of interambulacral plates, four close together, practically in apposition, separated from two of the others by the faint impression of an ambulacrum. The remaining portions of rows are at the opposite extremity. The more or less radiating manner in which these rows are disposed leads me to believe that the central unoccupied space of a lighter coloured matrix may represent one or other of the poles.

I believe this to be a species distinct from *A. Selwyni* on account of the more transverse shape of the plates, the almost square-hexagonal outline of those of the latter species being one of its chief characters. The primary tubercles of the present species are particularly well marked. One of the ambulacra is just indicated by the impressions of a few plates, but too imperfectly for description.

Locality and Horizon.—Quarry near road passing Dagworth, about five miles south of West Maitland, Co. Northumberland (*J. Waterhouse, M.A.*) :—**Upper Marine Series.**

Class—**ASTEROIDEA.**

Obs.—Starfish are not known to occur either in the Carboniferous or Permo-Carboniferous rocks of Western Australia, or Queensland.

Order—**Encrinasteriæ.**

Family—*PALÆASTERIDÆ.*

Genus—PALÆASTER, *Hall*, 1852.

(Pal. New York, ii. p. 247)

Obs.—The genus *Palæaster* ranges from the Upper Silurian to the Carboniferous, but its representation in rocks of the latter period is far more limited as regards species than in those of the former. The three species from the Permo-Carboniferous of New South Wales, now referred to *Palæaster*, although possessing the general features of the genus, differ in an important particular from Hall's original types, *P. matutina*[1] and *P. eucharis*.[2] In both of these, and in other Silurian and Devonian forms, the adambulacral plates, bordering the ambulacral avenues, are small and quadrangular, followed by large transverse marginal plates. In our Permo-Carboniferous species, on the contrary, the adambulacral plates (Pl. XV, Fig. 4) are transversely elongated, and occupy nearly the whole of the actinial surface on each side the avenues.[3] The marginal plates, in contradistinction to those of Hall's Silurian species, are here smaller and subdorsal in position (Pl. XIV, Fig. 2). The question now presents itself, of what value in a classificatory sense is this character? Hall lays particular stress on the position of these plates on the actinial side of *Palæaster*. He says[4] it "has two ranges of plates on each side of the ambulacral groove; marginal and adambulacral plates on the lower side, besides ambulacral or poral plates. The upper or dorsal side has three or more ranges of plates." In the case of our specimens, only one set of plates, excepting those of the ambulacral grooves, are, as before stated, absolutely actinial; the marginal are strictly so, or, at the least, sub-dorsal. Under these circumstances, I

[1] Twentieth Ann. Report N. York State Cab. Nat. Hist., 1867, p. 283, t. 9, f. 2.

[2] *Loc. cit.*, p. 287, t. 9, f. 3, 3*, 3^b, and 4.

[3] This feature is also visible in De Koninck's figure, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 7, f. 6^b.

[4] Twentieth Ann. Report N. York State Cab. Nat. Hist., 1867, p. 283.

purpose distinguishing our Australian species under the sub-generic name of *Monaster*.[1] The genus *Urasterella*, McCoy,[2] likewise only possesses the adambulacral plates on the ventral surface; but in this case neither are there marginal plates, so far as I can glean from Sir F. McCoy and the late Professor Forbes's descriptions.

Palæaster (Monaster) Clarkei, *De Koninck*.

Pl. XIV, Figs. 1 and 2; Pl. XV, Fig. 4.

Palæaster Clarkei, De Koninck, Foss. Pal. Nouv.-Galles du Sud., Pt. 3, 1877, p. 166, t. 7, f. 6, 6ª.

Sp. Char.—Body large, shortly stellate, robust; disc large, strongly pentagonal, raised above the level of the tumid rays, straight walled, surface flat, or a little concave, bearing five tubercles. Rays broad, thick, and tumidly petaloid; margins convexly curved; abactinial surface arched; actinial surface flat or somewhat concave; interbrachial areas sharply V-shaped. Abactinial plates hexagonal, thick, and convex, arranged in three rows, eight to ten in a row, the median the smallest, and alternating with the lateral series, which are transversely elongated. Ambulacral avenues rather broad and elongately petaloid, gaping, and deep; ambulacral plates small, and apparently in two rows. Adambulacral plates eighteen to twenty in a row, large, very transverse, narrow, and convex. Marginal plates subdorsal in position, convex, narrow, and triangular, more or less resembling the plates of the abactinial surface, but differing in ornament. Madreporiform plate large, oval, situated on the straight wall of the disc. Oral plates not preserved. Ornament of plates tubercular, the abactinial ray plates being covered with densely packed small granules radiately arranged, but the marginal plates bear large tubercles, which carry short, fine, projecting spines.

Obs.—There is doubtless much truth in the late Prof. de Koninck's statement that *Palæaster Clarkei* is one of the largest of the known Palæozoic starfish; but that it is not the largest is shown by comparison with the two succeeding species, nor does *P. Clarkei* precisely resemble any species of the genus with which I am acquainted.

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[1] From the one or single row of adambulacral plates on each side of an ambulacral avenue.

[2] Brit. Pal. Foss., 1851, Fas. I, p. 59. *Stenaster*, Billings, is generally said to be identical with this. (Hall, *Loc. cit.*, p. 289.)

The plates termed ambulacral by De Koninck are in reality the adambulacral, the ambulacral elements being contained in the ray avenues; but the tubercle-bearing auxiliary plates mentioned in his description I have not seen.

The only specimen showing the actinial surface is much destroyed, and does not display this portion distinctly. In De Koninck's figure of this aspect of the body the oral plates each appear to be composed of two small, rounded, tubercle-like halves. The disc, when viewed from the abactinial side, is seen to be prominent and straight-walled externally, either flat or concave on its upper surface, with five node-like projections answering to each median interradial line.

The madreporiform plate has been seen in two examples. It is a large oval piece, placed on the steep wall of the disc, and between two rays in the usual manner, with the component radiating laminæ distinctly visible.

In one specimen the arms are two and four-eighths inches long, and in another example one and five-eighths inches long from the centre of the body.

I have not seen an ambulacrum with the plates *in situ*, but De Koninck's figure (*Loc. cit.*, Pl. VII, Fig. 6ª) represents them as opposite, a character which, if correct, would not only remove the species from *Palæaster*, but also from the Encrinasteriæ.

Very few Carboniferous species of *Palæaster* have been described. One has been figured [1] by Prof. Trautschold from the Russian Carboniferous Limestone as *Palæaster montanus*, Stschurovsky, sp., but the size and general proportions are so different to ours that the comparison need not be carried further. Mr. S. A. Miller has also described a *Palæaster* from the Keokuk Group of the American Sub-Carboniferous System, under the name of *P. crawfordsvillensis* [2], but the description is not within my reach.

Cribellites carbonarius, G. Tate [3], the Carboniferous Limestone species met with in Northumberland (England) is also a small form, with rays only 1·5 inch in length. The rays are rounded and lanceolate, with the dorsal surface covered with tubercles.

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[1] Kalkbruche von Mjatschkowa, Pt. 3, 1879, p. 9, t. 2, f, 2a and b.
[2] Journ. Cincinnati Soc. Nat. Hist., 1880, II (*fide* S. A. Miller).
[3] Report Brit. Assoc. Adv. Sci. for 1863 [1864], Pt. 2, p. 88.

Locality and Horizon.—Russell's Shaft, Farley, Co. Northumberland (*The late Rev. W. B. Clarke*) :—**Upper Marine Series**; Nicholson's Quarry, near north-east corner of Owen's 1,100 acres, near West Maitland, Co. Northumberland (*Prof. T. W. E. David, B.A., Rev. W. H. Yarrington, M.A.*, and *Mr. T. Browne*) :—**Lower Marine Series.**

The first locality is a very typical and interesting one, being referred to by the late Rev. W. B. Clarke, F.R.S., in a "Section of Coal Pits at Stony Creek, New South Wales, near West Maitland,"[1] in the third bed from the surface, in Pit B. His note is as follows :—"Grey grit and conglomerate of quartz porphyry, &c., sandstone and soapy clay, muddy and blue; consistency variable, with Spirifer, Fenestella, Conularia, Orthoceras, Asteridæ, &c." The specimens described by Prof. de Koninck were also from the same locality and horizon.[2]

Palæaster (Monaster) Stutchburii, *sp. nov.*

Pl. XIII, Fig. 1.

Sp. Char.—Body elongate; disc probably of medium size, but general proportions unknown. Rays long, very slowly tapering, straight sided, forming with one another an angle of from 60° to 75°; abactinial surface moderately convex, bearing several (five or six) rows of small convex polygonal plates, inclusive of the marginal pieces, and becoming much crowded at the apices of the rays, where they form oblique rows; marginal plates strong, short, thick, high, or somewhat pyramidal, and subhexagonal in outline. Actinial surface more or less flattened; avenues narrow, straight sided; ambulacral plates unknown; adambulacral plates transversely oval, thick, and arched, clothed with short, subulate, stout spines, arranged in about three alternating rows; oral plates very small, the two halves of each, pustuliform. Madreporiform plate unknown.

Obs.—*Palæaster Stutchburii*, although vieing with *P. Clarkei* in size is a straight rayed, and non-petaloid form, of the true *Palæaster* outline, and so differing from the latter, as well as in the increased number of plates on the abactinial surface.

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[1] Sedimentary Form. N. S. Wales, Fourth Edition, 1878, Vert. Section 1 (3rd plate). (8vo. Sydney. By Authority, 1878.)

[2] Foss. Pal. Nouv.-Galles du Sud, Pt. 3, 1877, p. 168.

The spines clothing the adambulacral plates are subulate and short, measuring about three millimetres in length, and are ranged in three subalternating rows, the inner row, in each case, bordering the edge of the ambulacral avenues, but the rows of spines increase in number in the angles between the rays. In the present condition of the fossil, the spines are represented only by impressions. I believe they were delicately striate, but this is open to confirmation. The rays were as much as three inches long, and at the base three quarters of an inch wide.

Locality and Horizon.—Ravensfield Quarry, near Farley, Co. Northumberland (*Mr. T. Browne*) :—**Lower Marine Series.**

Palæaster (Monaster) giganteus, *sp. nov.*

Pl. XII.

Sp. Char.—Body large, extended, abactinial surface unknown. Rays long, from three to three and a-half inches, narrow in proportion to their length, barely three quarters of an inch in transverse measurement, widely separated at their bases, with a diverging angle varying from 75° to 90°, decreasing in width towards their apices but slowly, comparatively straight sided ; avenues narrow and deep. Marginal plates in the angles of the rays very large, transversely elongated, arched, and with more or less flattened surfaces, and rapidly decreasing in size along the margin of the rays. Adambulacral plates comparatively small, transversely elongated, convex, each bearing a row of prominent "primary" tubercles (probably more than three in a row), supporting strong spines, at least three millimetres in length ; oral plates very large, the twins in each case forming a somewhat cordate plate.

Obs.—I have separated the present form from the preceding species for three reasons. In the first place, the general proportions of the Starfish are quite different, especially in the size of the disc and length of the rays. In the second, the angle of divergence of the rays differs greatly from that of *Palæaster Stutchburii* ; in the former it is from 60° to 75°, in the present species from 75° to 90°. Thirdly, the form of the oral plates is here very different, and if I mistake not so also are the marginal plates. The greater angle of divergence of the rays leaves a much larger space between the bases of the latter, occupied by the large transversely elongated plates previously

referred to. In *P. giganteus* the corresponding plates of the body, it is true, are hid by spine impressions, but there is, practically speaking, no room for similarly large structures, and on this ground their absence is conjectured.

The oral plates are certainly very large, and quite different from the small node-like bones in *P. Stutchburii*. In all probability the adambulacral plates will be found to be smaller than those of the last-named fossil, but to possess larger and better developed tubercles. In fact, the latter have much the appearance of the primary tubercles of *Archæocidaris*.

As regards the extent of the body, *P. giganteus* is even a larger species than *P. Clarkei*, measuring no less than seven inches from the apex of one ray to that of another across the disc.

Locality and Horizon.—Ravensfield Quarry, near Farley, Co. Northumberland *(Mr. T. Browne)* :—**Lower Marine Series.**

Division—PELMATOZOA.

Class—**CRINOIDEA.**

Obs.—The first Writer to chronicle the remains of this Class in the Permo-Carboniferous rocks of New South Wales was Sir F. McCoy,[1] who brought to notice the interesting, and apparently aberrant *Tribrachiocrinus, Clarkei*. Later, the presence of the United States Exploring Expedition, under the orders of Commander Charles Wilkes, U.S.N., afforded Prof. J. D. Dana, Naturalist to the Expedition, the opportunity of examining some portions of the coast districts of New South Wales, resulting in the discovery of some very strange plates, to which he applied the generic name of *Pentadia*.[2] These will be referred to in detail later on.

As the original collection of the late Rev. W. B. Clarke, F.R.S., afforded Prof. McCoy the first introduction to our Permo-Carboniferous Crinoids, so the second, accumulated by the same energetic Geologist, enabled the late Prof. L. G. de Koninck to advance our knowledge[3] by adding to the

[1] Ann. Mag. Nat. Hist., 1847, XX, p. 228.
[2] Wilkes' U. S. Explor. Exped., 1849, X (Geology), p. 712.
[3] Foss. Pal. Nouv.-Galles du Sud, Pt. 3, 1877, pp. 158-166.

list one of the largest fossil Crinoids known, *Cyathocrinus Koninckii*, Clarke, to redescribe *Tribrachiocrinus Clarkei*, McCoy, and to indicate the probable presence of other genera from their fragmentary remains.

In 1884 the list was increased by the late Mr. Felix Ratte describing a second species of *Tribrachiocrinus*;[1] and lastly, by Messrs. Wachsmuth and Springer, in their most comprehensive "Revision of the Palæocrinoidea," defining[2] *Tribrachiocrinus* according to the more recently accepted nomenclature, and relegating it to its proper place in the classificatory scale.

The abundance of Crinoid skeletal remains has already been referred to, particularly stem joints, and portions of the united column; in some cases, as in the Carboniferous Limestone of other parts of the world, forming the great mass of entire beds. Such deposits have been found by the Collector near Ulladulla; at the head of Flat-rock Creek, Nowra Hill; Rouchel Brook, about six miles from the Hunter River Junction, and other places.

At Flat-rock Creek the portions of stems obtained are fairly large, and resemble those of *Poteriocrinus crassus*, of the European Carboniferous Limestone.

The chief horizons from whence determinable Crinoids have been obtained are the Muree Rock, of the Upper Marine Group in the Hunter Valley, and its southern equivalent, the Conjola Grits of the Shoalhaven District, and a few localities in the more strictly Carboniferous area north of the River Hunter.

One very strong fact, however, stands prominently forward, that so far as our field operations have as yet disclosed, the genera *Tribrachiocrinus* and *Phialocrinus* are not known out of the Permo-Carboniferous, and are particularly characteristic of the Upper Marine Series.

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[1] Proc. Linn. Soc. N. S. Wales for 1884 [1885], IX, Pt. 4, p. 1158.
[2] Revision of the Palæocrinoidea, 1886, Pt. III (2), p. 251 (175).

Order—Coadunata.

Family—*ACTINOCRINIDÆ.*

Genus—ACTINOCRINUS, *Miller*, 1821.

(Nat. Hist. Crinoidea, p. 90.)

Obs.—In Queensland, the impressions of a few highly ornamented plates have been found in the Star Series of Corner Creek, and Gympie Series of the Rockhampton District, which are provisionally referred to this genus.[1]

ACTINOCRINUS, *sp. ind.*

Pl. XX, Figs. 6 and 7.

Obs.—The late Prof. de Koninck described an internal crushed cast from Glen William, referring it to Miller's *Actinocrinus polydactylus*[2] of the European Carboniferous Limestone.

The only specimens that have come under my notice referable to *Actinocrinus* are the subjects of Pl. XX, Figs. 6 and 7. The first of these (Fig. 6) is a portion of a calyx, an internal cast, showing the three basal plates and some of the primary radials, particularly a large heptagonal and contiguous hexagonal plate. The crushed example is in all probability the same species, and I believe them both to be identical with De Koninck's *A. polydactylus*. Their identity, however, with the European species of that name is, I think, very problematical, as all the specimens lack the highly ornate plates of the latter. De Koninck's figure and our Fig. 7 show no ridges on the plates at all; although on our Fig. 6 four principal ridges are to be seen, but the other plates are quite plain. Under these circumstances it is better, I believe, to leave the specific identification of these specimens an open question until others in a better state of preservation throw further light on the subject.

In addition to the plates described by De Koninck, Prof. F. McCoy had previously noted the occurrence of "fragments of pelvic plates of this genus" in the Dunvegan Shale.[3]

Locality and Horizon.—Greenhills, Paterson to Dungog Road, Co. Durham (*C. Cullen*) :—Mirari Limestone, Carboniferous.

[1] Geol. and Pal. Queensland and New Guinea, *in lit.*, t. 7, f. 9.
[2] Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 160, t. 6, f. 3.
[3] Ann. Mag. Nat. Hist., 1847, XX, p. 229.

Genus—PERIECHOCRINUS, Austin, 1842.

Periechocrinites, Austin, Ann. Mag. Nat. Hist., 1842, X, p. 110.

„ Austin, *Ibid*, 1843, XI, p. 203.

Saccocrinus, Hall, Pal. N. York, 1852, II, p. 205.

„ Meek and Worthen, Illinois Geol. Report, Pal., 1868, iii, p. 347.

Periechocrinus, Wachsmuth and Springer, Revision of the Palæocrinoidea, Pt. 2, 1881, p. 127 (301).

Obs.—A single imperfect specimen is provisionally referred to this genus of the Actinocrinidæ, from its close concordance with the general appearance and order of the plates of those forms termed by many American Palæontologists *Saccocrinus*, which were united by Messrs. Meek and Worthen with *Periechocrinus*, Austin.

Periechocrinus indicator,[2] *sp. nov.*

Pl. XXII, Fig. 4.

Obs.—Portions of two basals are preserved, surmounted by three hexagonal first radials, much longer than wide, and subangular in the direction of their longest diameter. The middle radial bears, evidently in the direct line of a ray, a second radial, also hexagonal, but less vertically elongated than the first. This again supports a third radial, the length and breadth of which is about equal, although hexagonal in shape. On the third radial are placed two smaller secondary radials of doubtful form, arising from imperfect preservation. The first inter-radial plate is quite as large, if not larger, than the second radials, and is hexagonal in outline. It is surmounted by two second inter-radial plates, apparently heptagonal, and these support two other rows of smaller plates of doubtful form, arising from their rather crushed condition. A similar structure to that now described is repeated in the inter-radius on the opposite side of the centrally-placed radial.

The specimen consists of a portion of an internal cast, on which the positions of the sutures are represented by raised lines. The general arrangement of the plates indicates that it is a member of the Actinocrinidæ, whilst

[1] Emended, Wachsmuth and Springer, Revision of the Palæocrinoidea, 1881, Pt. II, p. 130.
[2] Indicative of the presence of the genus in our rocks.

the partially ob-conic or urn-shaped outline which the calyx evidently possessed originally indicates *Periechocrinus* (*Saccocrinus*), or *Strotocrinus*, or some other near ally, as its resting place. From the list of species given by Wachsmuth and Springer, *Periechocrinus* appears to be essentially an Upper Silurian genus, with the exception of two American Carboniferous species, *P. amplus*, M. and W., sp., and *P. Whitei*, Hall, sp., to neither of which does our species bear any great specific resemblance. It is, however, with an American Crinoid from the Niagara Group, *P.* (*Saccocrinus*) *Christyi*, Hall, sp.[1]; that our Permo-Carboniferous fossil agrees so closely in the form of its plates and outline of the calyx, and also with many of the species so beautifully figured in Angelin's posthumous work[2] on the Silurian Crinoids of Sweden.

An equally strong resemblance exists between *P.* (*Saccocrinus*) *indicator*, and the American Carboniferous genus *Strotocrinus*, which agrees "exactly with *Actinocrinus* in the number and arrangement of the pieces composing all that part of the body below the divisions of the rays."[3] *Strotocrinus regalis*, Hall, sp.,[4] possesses the same ob-conic outline and succession of radials and inter-radials, but there is about our specimen no trace of the characteristic horizontally expanded rim of the former genus, and without which it would not be possible to employ *Strotocrinus* for the reception of *P. indicator*.

One of the elevated ridges of the radials which pass from plate to plate in *Periechocrinus* is indicated in our specimen by a marked angularity of the surface.

Locality and Horizon.—Chalky Gully, Wollumba River, Co. Gloucester (*Pres. E. Twynam, Chief Surveyor*) :—? Carboniferous.

PERIECHOCRINUS ? *sp. ind.*

Photo-litho., Fig. 1.

Obs.—Some flattened and decorticated plates, more or less apposed to one another, probably represent either another species of this genus, or simply an *Actinocrinus*. The specimen is, however, of interest from its geological position.

[1] See Illinois Geol. Report, Pal., 1868, III, p. 347, t. 5, f. 1.
[2] Iconographia Crinoideorum in Stratis Sueciæ Siluricis fossilium (folio, Holmiæ, 1878).
[3] Meek and Worthen, Illinois Geol. Report, Pal., II, 1866, p. 189.
[4] See Illinois Geol. Report., Pal., 1866, II, p. 192, f. 7, t. 16, f. 6*a* and *b*.

Fig. 1.

The almost complete basals are visible, three hexagonal first radials, a second radial, and two first inter-radials, also hexagonal. The radials and inter-radials are all higher than wide. The resemblance in general to *P. indicator* is strong, although the specific distinction is evident.

Locality and Horizon.—Greenhills, Paterson to Dungog Road, Co. Durham (*J. Waterhouse, M.A.*) :—**Mirari Limestone, Carboniferous.**

Family—PLATYCRINIDÆ.

Obs.—The presence of this family depends upon the discovery of some fragmentary remains at Glen William, Burragood, and at a locality between the River Hunter and the Rouchel Brook. These consisted of portions of a column and a small basal cup referred by De Koninck to *Platycrinus lævis*, Miller, or an allied species[1].

The basal plates in *Platycrinus* are three in number, but in the figure cited there are four distinctly shown, subdivided in a sufficiently perplexing manner to leave the question of identity in some doubt.

No member of this family is known to me from Western Australia; but the Middle Bowen Group, near Mount Britton Township, Queensland, has yielded a nut-shaped calyx, partly preserved, to which I have given the name of *Platycrinus? nux* [2].

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[1] Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 160, t. 6, f. 6, 6*a*.
[2] Geol. and Pal. Queensland and New Guinea, *in lit.*, t. 38, f. 3.

Order—INADUNATA.

Family—SYNBATHOCRINIDÆ.

Obs.—Prof. de Koninck described a small calyx under the name of *Synbathocrinus ogivalis*[1], from Burragood on the Paterson River. It would appear to be easily detected by two folds or ridges ornamenting the radial plates. De Koninck speaks of the basal plates as of one piece. They are, however, three in number, the sutures being obliterated by anchylosis. On comparing his *S. ogivalis* with the British species, *S. conicus*, De Koninck speaks of the latter as "la seule espèce du genre actuellement connue," but this contrasts strangely with a previous statement, "comme dans toutes les espèces de ce genre" (*i.e.* of *Synbathocrinus*). As a matter of fact, Messrs. Wachsmuth and Springer enumerate[2] no less than ten species which were known at the time Prof. de Koninck's Work was written.

I have not personally met with *S. ogivalis*. The horizon from which it was obtained will be within the Carboniferous.

Family—CYATHOCRINIDÆ.

Obs.—We do not possess any certain evidence of the presence of members of this family in our Carboniferous or Permo-Carboniferous rocks. Prof. McCoy noticed some large columns in the Rev. W. B. Clarke's collection "apparently of *Cyathocrinus*," from the limestone at Wagamee, and Wollamhoola.[3]

Family—POTERIOCRINIDÆ.

Obs.—The presence of the type genus of this family is evinced, according to the late Prof. de Koninck, by the occurrence of two plates. One of these is a basal, and the other a radial. The former, says the describer, may belong to *Poteriocrinus tenuis*, Miller[4], and the latter to *P. radiatus*, Austin[5], "or they may both belong to the same species." The fragments come

[1] Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 158, t. 6, f. 1*a-b*.
[2] Revision of the Palæocrinoidea, 1866, Pt. III (2), p. 166.
[3] Ann. Mag. Nat. Hist., 1847, XX, p. 229.
[4] Pal. Foss. Nouv.-Galles du Sud, 1877, Pt. 3, p. 159, t. 6, f. 7.
[5] *Loc. cit.*, t. 6, f. 2.

from the limestone at Burragood, on the Paterson River, and in Europe are characteristic of the Carboniferous Limestone. Specimens of this nature, although fragmentary, and sometimes difficult of determination, are of importance geologically, as indicating the probable presence of an otherwise unrecorded genus in our Permo-Carboniferous rocks.

The Poteriocrinidæ is however chiefly represented with us by the genus *Tribrachiocrinus*, McCoy. In Queensland a possible *Poteriocrinus* will be described[1] as *P.? Smithi*, Eth. fil., in memory of the late Mr. James Smith, of the Geological Survey of Queensland. Like so many of the fossils from that Colony, the state of preservation does not allow of an exact generic determination being made. In addition to this fossil, the impressions of large stems have been found in the Gympie Series of the Rockhampton District[2], very similar to some of those from Flat-rock Creek, Ulladulla, Shoalhaven District. As in the case of the latter, the Queensland specimens are almost indistinguishable from the stems of *Poteriocrinus crassus*, Miller. Other fragmentary fossils found during the progress of the Queensland Geological Survey, will be described in the work cited below, but it is not necessary to quote them in detail now.

Genus—TRIBRACHIOCRINUS, *McCoy*, 1847.

Tribrachyocrinus, McCoy, Ann. Mag. Nat. Hist., 1847, XX, p. 228.

Pentadia (pars), Dana, American Journ. Sci., 1847, IV, p. 152.

Pentadia (pars), Dana, Wilkes' U.S. Explor. Exped., 1849, X (Geology), p. 712.

Tribrachyocrinus, Pictet, Traité de Pal., 1859, IV, p. 321.

Tribrachyocrinus, Ratte, Proc. Linn. Soc. N.S. Wales for 1884 [1885], IX, Pt. 4, p. 1158; *Ibid* for 1886 [1887], I (2), Pt. 4, p, 1069.

Tribrachiocrinus, Wachsmuth and Springer, Revision of the Palæocrinoidea, Pt. III (2), 1886, p. 250 (174).

Tribrachiocrinus, Bather, Ann. Mag. Nat. Hist., 1890 V (6), p. 385, t. 14, f. 35.

Gen. Chars.—Dorsal cup globose, composed of heavy plates. Infrabasal plates three, comparatively large; two of them larger than the other, and pentagonal, but not of equal size; the smaller piece placed in a vertical line with the anterior radial. Basal plates five, extremely large, very irregular

[1] Geol. and Pal. Queensland and N. Guinea, *in lit.*, t. 8, f. 1.
[2] Geol. and Pal. Queensland and N. Guinea, *in lit.* t. 7, f. 6.

in form; the posterior one heptagonal, and larger than any of the rest; that to the left pentagonal; the three others hexagonal; upper side in four of the plates angular, in the other truncate, supporting the right postero-lateral radial. Radial plates five, irregular in form and size, the postero-lateral considerably smaller than the others; two posterior radials as well as the anterior one pentagonal, truncate above, and supporting a short subquadrangular costal; the two anterior ones hexagonal, angular above, supporting on each side an arm; line of articulation between the three former radials and their respective costals is widely gaping, and the mode of articulation is similar to that of all later Poteriocrinidæ; the two other radials, which have angular upper faces, are slightly constricted along their upper ends so as to indicate an anchylosis of costals and radials. Costals, although short, are twice as wide at their union with the radials as along their upper ends, which are truncate and moderately concave, each supporting a single arm; azygous[1] plate is unusually large, pentagonal, placed obtusely between the posterior basal and right postero-lateral radial; its upper angle, which extends almost to the top of the radials, is slightly truncated, and supports the first plate of the ventral tube, and its left upper side abuts against a large pentagonal anal plate. Column apparently small and circular. (*Wachsmuth and Springer*).[2]

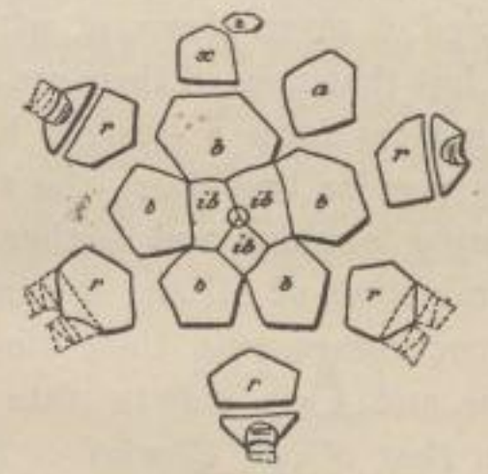

Fig. 2.

Obs.—This "singular crinoid," as Sir F. M'Coy aptly termed it,[3] or as Prof. de Koninck said,[4] "genre un peu anomal," was little understood until the appearance of the third part of Messrs. Wachsmuth and Springer's "Revision of the Palæocrinoidea."

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[1] *Azygous*, unpaired; or, parts that are apparently single, or have no symmetrical fellow.
[2] Slightly emended, R. Etheridge, junr., 1892.
[3] Ann. Mag. Nat. Hist., 1847, XX, p. 228.
[4] Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 161.

"The generic name *Tribrachyocrinus*," said the late Mr. Felix Ratte,[1] "was proposed by Professor M'Coy on the supposition that there were only three arms; but if, according to Wachsmuth and Springer, the two anchylosed brachials supported two arms each, more than mere rudimentary, then our fossil would have had three large and four smaller arms. This being so, the name etymologically considered is now a misnomer; nevertheless it conveys to the mind the notion that there were three conspicuous arms."

Examples of the type species are usually more or less distorted, produced more towards the posterior side than even the unsymmetrical arrangement of the plates would warrant. Such, however, is not the case in *T. corrugatus*, Ratte. This asymmetry is well expressed by M'Coy, who says, "The cup is not symmetrical in form, like that of other Crinoids, but is, as it were, humped on one side."

The plates of the calyx have been hitherto described by M'Coy, De Koninck, and Ratte as three in the articular ring, five in the succeeding ring, followed in the next tier by three radials, three interradials, and one or two anal plates. To these Ratte has added costals. Messrs. Wachsmuth and Springer, on the other hand, from an examination of a cast of *T. corrugatus*, supplied to them by the late Mr. Ratte, inferred that the third ring of plates "was composed of seven pieces, of which five were radials, the two others azygous plates, but that none of them are interradials. In three of the radials, the articulating faces form a straight horizontal line, and only these plates are opposed by regular brachials; the two others, those of the two antero-lateral rays being angular and higher at their distal ends."[2] After a very careful examination of all the specimens within my reach, I must express my entire concurrence with their view, so far, of the calyx structure of *T. corrugatus*, and I am able to state that precisely the same features are observable in that of *T. Clarkei*. The cause of the asymmetrical posterior side of the last-named species will naturally be inferred from the reading of its structure by the light of Wachsmuth and Springer's remarks. The region of the anal plates in the majority of Palæocrinoids seems to be the point of least resistance, and the "humped on one side" appearance described by M'Coy is simply caused by the peculiar form of the posterior basal, as shown by De Koninck,[3] and the displacement, to a

[1] Proc. Linn. Soc. N.S. Wales for 1886 [1887], I (2), Pt. 4, p. 1075.
[2] Revision of the Palæocrinoidea, 1886, Pt. III (2), p. 250 (174).
[3] Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 162.

greater or less extent, of the anal and large azygous plate. It is not, however, caused by the introduction of these plates, as Sir F. M'Coy suggested, "by the interpolation of the large irregular intercostal . . . . . and the second costal."[1]

A marked diversity exists between the descriptions of the form of the basal plates and those of the second ring, as given by M'Coy and Wachsmuth and Springer on the one hand, and De Koninck and Ratte on the other. De Koninck figured the anterior basals as pentagonal—they are hexagonal as figured by M'Coy, and described by Wachsmuth and Springer,—but the left posterior basal as pentagonal, and the right posterior basal as hexagonal, wherein he was right. The posterior basal De Koninck figured as hexagonal, whereas it is heptagonal. Ratte was correct in his description of the anterior basals as hexagonal, and the left posterior basal as pentagonal, but on the other hand, he called the right posterior basal heptagonal instead of hexagonal, and the posterior as octagonal instead of heptagonal. By M'Coy, and Wachsmuth and Springer, the description of these plates is correctly rendered. In the more recent nomenclature of Mr. F. A. Bather,[2] the azygous plate of Wachsmuth and Springer becomes the radianal, or as the late Dr. P. H. Carpenter expressed it, a radial "that has assumed anal functions." The anal plate is then termed by Mr. Bather the brachianal. The argument adduced by him in support of this change of nomenclature is too long for reproduction here, but a perusal of his remarks on the "Anal Plates" in his paper on British Fossil Crinoids"[3] will well repay the student. I have, however, taken the liberty of reproducing his dissection of the anal region of the *Tribrachiocrinus* calyx. The outline of the plates as given in his diagram in chief is strictly accurate.

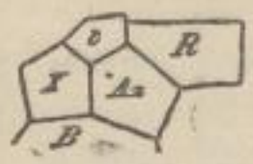

Fig. 3.

[1] Ann. Mag. Nat. Hist., 1847, XX, p. 228.
[2] Ann. Mag. Nat. Hist., 1890. V (6), p. 333, t. 14, f. 35.
[3] *Ibid*, p. 319.

The following table shows the equivalent terms for the plates in the calyx of *Tribrachiocrinus* used by the Authors who have written on the genus, including those now employed :—

TABLE showing equivalent terms for the plates in the calyx of *Tribrachiocrinus* used by different Authors.

Plates.	McCoy, 1847.	De Koninck, 1877.	Ratte, 1885–87.	Wachsmuth and Springer, 1886.	Bather, 1890.	Herein used, 1892.
1st Cycle...	Pelvis, or dorso-central plate.	La base.	Basals.	Under-basals	Infra-basals.	Infra-basals.
2nd Cycle...	First costals.	Sous-radiales	Sub-radials.	Basals	Basals.	Basals.
3rd Cycle	Interscapulars.	Premières pièces radiales.	Radials.	Radials.	Radials.	Radials.
	Scapulæ, or ray-bearing plates.	Pièces inter-radiales.	Inter-radials.			
	Intercostal.	Pièces anales (3.)	Anals.	Azygous plate.	Radianal.	Azygous plate.
	Second costal.	.. ..	.....	Anal piece, or subquad-rangular anal plate.	Brachianal.	Anal.
	.....	.....	.....	Brachials.	Costals, or brachials.	Costals.

Messrs. Wachsmuth and Springer describe the azygous plate in *Tribrachiocrinus* as subquadrangular, or trapezoidal in outline, and the anal as subquadrangular; but in their diagramatic dissection[1] of the calyx, the latter is figured as pentagonal, and such in reality is the form of both. By Sir F. M'Coy the azygous plate, his intercostal, is correctly figured,[2] but

[1] Revision of the Palæocrinoidea, 1885, Pt. III (1), t. 6, f. 5.
[2] Ann. Mag. Nat. Hist. 1847, XX, t. 12, f. 2*c*.

the anal plate, his second costal, is represented as hexagonal; in the description it is said to be "obscurely hexagonal," but as previously stated the true outline is pentagonal. On the other hand, the late Prof. de Koninck represented[1] the outline of both these plates correctly.

Messrs. M'Coy, De Koninck, and Ratte described *Tribrachiocrinus* as possessing three arms only, and the two last named authors believed in the presence of inter-radial plates. Sir F. M'Coy says—"The arm-bearing plates or scapulæ, which are so generally five in the other genera, are only three in the present animal, forming a strong peculiarity, which it shares only with the genus *Triacrinus* of Count Münster."[2] Professor de Koninck, speaking of his "premières pièces radiales," remarks—"Elles ne sont qu'au nombre de trois, ce qui constitue une véritable anomalie dans la structure générale des Crinoïdes."[3] It naturally follows that, if *Tribrachiocrinus* possessed only three arms, we should expect to find only three radials bearing brachial plates for their support. On the other hand, according to the weighty opinion of Messrs. Wachsmuth and Springer,[4] "in three of the radials, the articulating faces form a straight horizontal line, and only these plates are opposed by regular brachials, the two others (those of the antero-lateral rays) being angular and higher at their distal ends. The general outline of the two last mentioned plates indicates that they are compound plates, each representing a radial and a bifurcating brachial, which probably became anchylosed." Messrs. Wachsmuth and Springer thus differ from the other authors named in regarding all the plates of the third cycle, except, of course, the anal plates, as radial to the exclusion of any inter-radial. At the same time, they suggest the presence of five instead of three arms, one attached to each of the radials with horizontal articulating faces, and one each to the two high and angular antero-lateral plates. Speaking of the two last-named plates, their words are[5]: "They evidently supported two arms, one at each side; while the three radials, with articulating brachials, apparently bear but a single arm like Cronyocrinus simplex, Trautschold."

A most careful examination of all available examples of *Tribrachiocrinus* has been made, including the specimen from which the cast was taken, and forwarded by Mr. Ratte to Messrs. Wachsmuth and Springer; and, although I must admit that there is every appearance of constricted distal ends to these

[1] Foss. Pal. Nouv. Galles du Sud, 1877, Pt. 3, p. 23.
[2] Ann. Mag. Nat. Hist., 1847, XX, p. 228.
[3] Foss. Pal. Nouv.-Galles du Sud, Pt. 3, 1877, p. 162.
[4] Revision of the Palæocrinoidea, 1886, Pt. III (2), p. 250 (174).
[5] Revision of the Palæocrinoidea, 1886, Pt. III, p. 250 (174).

plates, still I am quite unable to find any trace of an articular surface such as these Authors suggest. It appears to me that Mr. Ratte more apropriately explained these plates in his "Second Note on *Tribrachiocrinus corrugatus*," wherein he remarked that the "Ankylosed brachials are very much reduced in size and thickness, and that if, according to Messrs. Wachsmuth and Springer, 'they evidently supported two arms, one on each side,' these arms were probably abortive, or at any rate very much reduced, or reduced next to nothing, as I do not see any sockets for them, nor any strength to support them."[1]

In *Tribrachiocrinus Clarkei* and *T. corrugatus*, the basal cup of the calyx is generally convex; in *T. ornatus* it seems to be somewhat flattened, whilst in *T. granulatus* it presents a semblance of concavity. The scar of attachment for the first stem-joint is small in all the species, but proportionately largest in *T. corrugatus*. In the form of the under-basals and basals there is a very close resemblance between all the species, except in outlines of the heptagonal, and its adjacent posterior hexagonal basals. These plates in *T. corrugatus* and *T. granulatus* are much more transversely-obliquely hexagonal than in *T. Clarkei*, and the suture between them is far shorter than between those of the type species. A great similarity exists in the form of all the radials, except that in *T. corrugatus* and *T. granulatus* the anterior radial is much more transversely pentagonal than in either *T. Clarkei* or *T. ornatus*. In both of these species the pentagon is decidedly deltoid-triangular.

The most important points of difference between the species, however, lie in the position and form of the azygous and anal plates. In *T. corrugatus*, and, apparently also in *T. granulatus*, were it not for the small truncated apex, the azygous plate would be quadrangular; but, in *T. Clarkei*, it is far less of this shape and more irregularly pentagonal in outline; and, besides, it is not thrust upwards between the anal and right posterior radial to anything like the same extent as in the species named. A similar difference is perceptible between the anal plates of the respective species. In *T. corrugatus*, the anal plate is roughly triangular, extending upwards a little beyond the azygous plate, and supporting with that plate, on their truncated upper edges, either a second anal, or the proximal plate of the ventral tube, which is thus interpolated between two of the radials.

[1] Proc. Linn. Soc. N. S. Wales for 1886 [1887], I (2), p. 1074.

In *T. Clarkei*, on the other hand, the triangular outline of the anal is lost, whilst the plate I have called the second anal assumes a comparatively large size, is in shape elongately-triangular, or somewhat lanceolate, and extends well downwards between the anal and right posterior radial, and lies horizontally against the truncated apex of the azygous plate.

As regards the sculpture, the plates appear to be plain in *T. Clarkei*, radiately-carinate in *T. ornatus*, vermicular-rugose in *T. corrugatus*, and granular in *T. granulatus*.

As to the systematic position of *Tribrachiocrinus*, it is satisfactory to find that McCoy's view, that the general disposition of the plates is most analogous to that of *Poteriocrinus*, is generally upheld by Messrs. Wachsmuth and Springer, who say, "the radials enclose the azygous plate proper and an anal piece, as in most of the *Poteriocrinidæ*." On the other hand, Mr. F. A. Bather in his classification[1] of the Inadunata-Fistulata entirely separates *Tribrachiocrinus* from *Poteriocrinus* and its allies, by placing it in a separate Family, the Decadocrinidæ, associating the genus with *Eupachycrinus*, *Cromyocrinus*, and *Agassizocrinus*, in the section Cromyocrinites. But, whilst acknowledging the force of the retention of the "three anal plates . . . . in the cup" as a strong character welding these genera together, I prefer to retain the old classification until Mr. Bather has elaborated his in a more ample form. By Prof. K. Zittel, *Tribrachiocrinus* is erroneously ascribed to Austin.

The genus, as regards its species, clearly dissolves itself into two well marked groups :—

A. Calyx highly asymmetrical as to its form, with a protuberant posterior side—

Tribrachyocrinus Clarkei, *McCoy*.
„ ornatus, *Eth. fil.*

B. Calyx more or less symmetrical as to its form, with the posterior side hardly at all protuberant—

Tribrachiocrinus corrugatus, *Ratte*.
„ granulatus, *Eth. fil.*

Type—*Tribrachiocrinus Clarkei*, McCoy.

Range—Permo-Carboniferous—New South Wales and Tasmania.

[1] Ann. Mag. Nat. Hist., 1890, V (6), p. 383.

Tribrachiocrinus Clarkei, *McCoy*.

Pl. XIII, Figs. 2–4; Pl. XIV, Fig. 3; Pl. XV, Figs. 6–8, and ? 5; Pl. XVII, Figs. 2–4.

Tribrachyocrinus Clarkei, McCoy, Ann. Mag. Nat. Hist., 1847, XX, p. 228, t. 12, f. 2.
" *Clarkei*, McCoy, Proc. R. Soc. V. D. Land, 1851, I, p. 315, t. 12, f. 2.
" *Clarkei*, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 161, t. 6, f. 5, 5 *a-d*.
" *Clarkei*, Etheridge, fil., Cat. Australian Foss., 1878, p. 41.
Tribrachiocrinus Clarkei, Wachsmuth and Springer, Revision of the Palæocrinoidea, 1886, Pt. III (2), p. 231 (175).
" *Tasmanicus*, Johnston, Proc. R. Soc. Tas. for 1886 [1887], p. 231.

Sp. Char.—Calyx large, deeply cup-shaped, always produced asymmetrically towards the posterior side; plates thick, with strongly bevelled edges; greatest periphery at about one-third from the articular surfaces of the costals, or as near as possible along the basi-radial sutures; above this point the calyx is usually depressed or somewhat flattened. Infra-basal plates forming a shallow, asymmetrical, saucer-shaped cup. Heptagonal basal very large. Radials bearing costals, strongly shield-shaped, extended laterally along the articular margin into short angular processes. Azygous plate very large, always convex, and sometimes subangular in the middle line, according to the asymmetry of the calyx, its upper edge not extending to a point in line with the top ventral margin of the radials, but truncated and supporting the basal plate of the ventral; anal plate pentagonal, large, its ventral margin on a line with the ventral margin of the radials; second anal, or basal plate of the ventral tube, apparently quadrangular in shape, and much higher than broad. Costal plates large and transverse, with large articular facets. Columnar facet small; column unknown. Test unsculptured externally, but when decorticated[1] the plates present close concentric subimbricating ridges, which, towards the usually convex centres of the plates give place to undulating or festoon-shaped lines, resulting in a pentagonal or hexagonal star-shaped figure, according to the outline of the respective plates.

Obs.—I have included the asymmetrical form of the calyx as one of the specific characters from the fact that every specimen which has come under my notice is protruded towards the posterior side. One other species is similarly formed, but the remaining two are symmetrical in shape.

[1] By far the much more common condition.

In some instances, the two pentagonal infra-basal plates are grooved by sulci passing from the columnar facet to the middle of their respective infra-basio-basal sutures. This, at first sight, gives rise to a deceptive subdivision of the infra-basal cup into five, instead of three plates, and is at times very marked. Such a subdivision is shown in one of Prof. de Koninck's figures.[1] Of the construction of the body on the ventral side above the radial plates little or nothing is known.

Sir F. McCoy states that the plates seem in some cases to overlap each other. This, I think, only arises from a partial bevelling of the edges, which many of them appear to possess.

Both McCoy and De Koninck have mentioned a partial ornamentation of the calyx plates. The former observes: "The surface is smooth, with the exception of a few irregular radiating plicæ at the margin of some of the plates." The latter Author's description is similar, but along the edges of some of the plates he observed a few irregular concentric growth lines, instead of radiate markings. I have only met with two examples in which the calcareous test was preserved, all others having been in the form of casts. The two in question have smooth plates, quite devoid of ornament of any kind, but in every instance of an internal cast, or with decorticated plates, markings are present, and highly interesting and peculiar.

It will be remembered that Prof. de Koninck identified[2] Dana's anomalous genus *Pentadia* with the plates of the so-called *Cyathocrinus Koninckii*, Clarke, but an incidental remark of Ratte's carries equal weight, and is almost as near the truth. Speaking of the relation of the plates in question to *Cyathocrinus*, he says: "But they might as well be separate plates of *Tribrachiocrinus*.[3]" Quite so! But, as a matter of fact, both Authors are correct, for I have no doubt that Dana's larger plate, known as *Pentadia corona*, is one of the large radials of *Phialocrinus Koninckii*, whilst the form of sculpture is common both to this and *Tribrachiocrinus Clarkei*.

First, as to the appearance of this so-called ornament on internal casts. It is faintly exemplified in De Koninck's figures[4] of the present species, and more strongly so in our Pl. XIII, Figs. 2–4, both as regards the concentric lines, and two or three radiating ridges; but in McCoy's figures,[5] which represent calices with the test preserved, the plates are practically plain.

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[1] Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 6, f. 5*d*.
[2] *Loc. cit.*, p. 165.
[3] Proc. Linn. Soc. N. S. Wales for 1884 [1885], IX, Pt. 4, p. 1159.
[4] Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 6, f. 5,5 *a–d*.
[5] Ann. Mag. Nat. Hist., 1847, XX, t. 12, f. 2 *a* and *b*.

Let us now turn our attention to what I have termed decorticated, or, perhaps it should more correctly speaking be decalcified casts. In such instances, the major portion of the substance of the plate has gone, leaving the concentric and radiating lines behind, possibly from a different chemical composition to the remaining portion of the plates. Such casts are seen in our Pl. XV, Figs. 5–8, and are always accompanied by a hollow space above them representing the thickness of the removed plate substance. Through the exertions of Mr. B. G. Engelhardt, of the Public School, Jamberoo, I am able to demonstrate the presence of this ornament on the interior, rather than the exterior of *Tribrachiocrinus* plates. Pl. XXII, Fig. 6, represents the exterior of one of the basals of *T. Clarkei*, whilst Fig. 7 of the same plate shows the interior of this plate. The former is plain and without sculpture, the latter exhibits the described markings in an excellent manner. Again, Pl. XXII, Fig. 8, is the convex exterior of another plate, probably one of the radials[1] of the same species; whilst Pl. XXII, Fig. 9, is its interior, in which, if anything, the sculpture is more strongly marked than on the inner surface of the basal plate. In his earlier description of the Australian fossils, collected by the Wilkes' United States Exploring Expedition, Prof. Dana described the fossils called *Pentadia* as with "one side quite smooth, the other delicately and closely marked with parallel subcrenulate ridges, having the angles of a regular pentagon and concentric."[2] It may, therefore, I think, be accepted that this form of sculpture in *Tribrachiocrinus* is confined to internal casts and decorticated plates.

Pl. XV, Fig. 6, is the heptagonal basal, one of the angles of the heptagon being hid by the overhanging matrix; Fig. 7 of the same plate is one of the hexagonal basals; whilst Fig. 8 is the left non-arm-bearing anterior radial. As regards Fig. 5, I am somewhat in doubt, it may be either the left anterior basal of *T. Clarkei*, or the hexagonal anal-supporting basal of *Phialocrinus Koninckı*, and I am inclined to believe the latter from the strong radiating ridges, which coincides with the structure of Dana's *Pentadia corona*.

A hasty glance at the basal plate portrayed in Pl. XXII, Fig. 6 would lead one to regard it as the three infra-basals anchylosed, especially the appearance of the almost central depression, resembling that of the columnar scar. The figure of the interior (Pl. XXII, Fig. 7), however,

[1] The edges being broken, it is difficult to trace the exact form.
[2] American Journ. Sci., 1847, IV, p. 152.

dispels this impression, for, in addition to the sculpture being concentric to the margins of the plate, as a whole, and not to three parts individually, the planeness of the plate is opposed to the convexity of the ordinary dorsal cup.

The first or bottom plate of the ventral tube (Pl. XXII, Figs. 10 and 11) reposing on the top of the azygous plate, and wedged in between the posterior radial and anal plates is oblong in shape. Its position thus brings it within the ring of radials.

Tribrachiocrinus Clarkei, not only differs from *T. corrugatus*, Ratte, in size, sculpture of the plates, and its protuberant posterior end, but also in a more important structural point, the much greater ventral extension of the anal plate in the former species; that is to say, this plate is longer in *T. Clarkei* than it is in *T. corrugatus*, and the second anal correspondingly shorter. From *T. ornatus*, which resembles it in possessing an asymmetrical calyx, the present species is distinguished by the absence of the cristiform centre and radiating ridges on the various plates. From *T. granulatus*, by size, proportions of the calyx, and the symmetrical outline of the latter. Lastly, Mr. R. M. Johnston has described,[1] in words much too brief to be of specific value, a Crinoid from the Pachydomus beds of Darlington, Maria Island, Tasmania, as *Tribrachiocrinus tasmanicus*. From his remarks I take it to be no other than our *T. Clarkei*; in fact, Mr. Johnston appears to have been very doubtful about its specific value, for he remarks:—"The above species comes very close to, and perhaps may not be specifically distinct from, the smaller form with large perforation in tripartite pelvis described by Prof. M'Coy as *T. Clarkei*." The length, three inches, is quite equalled by our Pl. XIV., Fig. 3. The only peculiarity about Mr. Johnston's fossil seems to be the absence of the columnnar perforation in the base of the calyx. The plates shown in Mr. Johnston's figures, besides the infra-basals, are the left posterior, heptagonal, and pentagonal basals.

Another point is worthy of consideration. I was at first inclined to believe that two species had been included within the illustrations of *T. Clarkei* now given. For instance, Pl. XIII, Fig. 2–4, represent one, the true species, corresponding with M'Coy and De Koninck's figures, whilst a larger form, illustrated by Pl. XIV, Fig. 3, and Pl. XVII, Fig. 2–4, differed from the preceding in its larger size. As, however, I am not able to detect any morphological difference, it appears better to allow them to remain under one

[1] Proc. R. Soc. Tas. for 1886 [1887], p. 233, Pl. (central figure).

name pending the discovery of more perfect specimens. Especially is this the case in the light of Pl. XVII, Fig. 2–4, wherein is exemplified the difference in outline produced by distortion due to pressure.

Locality[1] *and Horizon.*—Near the Reservoir, West Maitland (*H. D. Walsh*); and back of the College, Campbell's Hill, West Maitland, Co. Northumberland (*W. D. Filmer and J. Mitchell*); Singleton, Co. Northumberland (*S. Dodds*); Railway Cutting at Wollongong, Co. Camden (*C. Cullen*); Banks of the Minumurra River, near Jamberoo, Co. Camden (*B. G. Engelhardt*):—**Upper Marine Series.** Nowra, Co. St. Vincent (*C. Cullen*):—**Nowra Grit**[2]**, Upper Marine Series.**

It will be seen from this that *Tribrachiocrinus Clarkei*, M'Coy, has not been met with out of the Upper Marine Series.

Tribrachiocrinus ornatus, *sp. nov.*

Pl. XIX.

Sp. Char.—Calyx large, cup-shaped, but asymmetrical, produced towards the posterior side; greatest periphery along the basi-radial sutures. Base flattened, gently concave inwards to the columnar facet. Ornament of the test very characteristic; each basal plate bears a central boss, from which four ridges radiate to the basi-radial sutures; the arm-carrying radial plates each bear two diverging ridges from a central point on the costo-articular margin to those points on the basi-radial sutures cut by the ridges of the basal plates, where the union of the two sets again produces prominent bosses.

Obs.—I regard the subject of Pl. XIX as specifically distinct from *Tribrachiocrinus Clarkei*, on account of the ornamented condition of the radial and basal plates. The condition of the fossil, a cast in the Nowra Grit, a matrix by no means lending itself well to the preservation of organic remains, does not permit of a more definite or extensive specific diagnosis than the above. As I have laid considerable stress on the non-appearance of sculpture externally on the plates of *T. Clarkei*, some explanation of the adoption of this character as a specific feature is necessary.

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[1] By M'Coy *T. Clarkei* was recorded from Darlington, in soft grey shale (*Ann. Mag. Nat. Hist.*, 1847, XX, p. 229); and by De Koninck, from the Muree Quarries, Raymond Terrace. (*Foss. Pal. Nouv.-Galles du Sud, Pt.* 3, 1877, p. 163.

[2] The equivalent horizon in the Illawarra Coal-field, of the Muree Rock in the Hunter River Coal-field, from which *T. Clarkei* was recorded by Prof. L. G. de Koninck.

It will be observed, in the first place, that the ridges and tubercles are very plainly visible on the cast, notwithstanding the inhospitable matrix containing it. In the second place, the relative thickness of the test is exemplified by the vacuity between the cast and surrounding matrix. Within this vacuity, but impossible to be shown on the plate, are a number of projections from the bosses, showing that there were particularly strong portions of the plates, reaching and indenting the matrix around. These are visible, and, I take it, represent what would have been the external appearance of the calyx when perfect. Moreover, by turning the fossil about in various directions, so as to admit light between the cast and the matrix, the surface of the latter can be seen to be sufficiently undulating to correspond with the various inequalities visible on the surface of the former. These points admitted, it is impossible to unite the present fossil with that figured by Sir F. M'Coy, in which the test is preserved, or those of *T. Clarkei*, of a similar nature, given in the present plates.

This is the only species of *Tribrachiocrinus* in which any trace of the arms has been observed; but, from causes mentioned above, it is impossible to give details regarding them. The first costals appear to be succeeded by two others, followed by an axillary costal, which supports two arm-branches.

Locality and Horizon.—Nowra, Co. St. Vincent (*The late Rev. W. B. Clarke*) :—**Nowra Grit, Upper Marine Series.**

Tribrachiocrinus corrugatus, *Ratte.*

Pl. XVI, Figs. 5-10.

Tribrachiocrinus corrugatus, Ratte, Proc. Linn. Soc. N. S. Wales for 1884 [1885], IX, Pt. 4 p. 458, t. 68.

Tribrachiocrinus corrugatus, Wachsmuth and Springer, Revision of the Palæocrinoidea, 1885, Pt. III (1), t. 6, f. 5; *Ibid*, 1886, Pt. III, (2), p. 251 (175).

Tribrachiocrinus corrugatus, Ratte, Proc. Linn. Soc. N. S. Wales for 1886 [1887], I (2), Pt. 4, p. 1069.

Sp. char.—Calyx globose, of medium size, symmetrical; plates thick; greatest periphery at about the basi-radial suture; dorsal surface gently convex, and depressed around the columnar centre; ventral surface depressed; all sutures wide and deep; infra-basal plates forming a shallow, wide, saucer-like cup, concave in the centre, which is visible in a side view when the calyx is placed in its normal position. Pentagonal basal wide and large. Azygous plate flatter than in the type species, and relatively extending higher

in the calyx; anal plate much less transverse than in the type species, acutely pointed at its dorsi-lateral angle; second anal or basal plate of anal tube, small and quadrangular. Three arm-bearing costals large, their articular surfaces forming an isosceles triangle, with deeply excavated facets; radio-costal sutures wide and gaping. Disk plates small, polygonal, chiefly pentagonal and quadrangular. Columnar facet small; column unknown. Sculpture in the form of pits and anastomosing, tubercular, vermicular grooves on the infra-basal and basal plates; divaricating tubercular ridges on the radials; cast plain.

Obs.—*Tribrachiocrinus corrugatus* is an excellent and well defined species, and may be at once distinguished from the two preceding Crinoids by the sculpture of the plates; and, as regards shape, the nearly perfect symmetry of the calyx. I say nearly perfect, because there is the slightest possible tendency to bulge towards the posterior side, but hardly noticable unless closely looked for.

The late Mr. F. Ratte described the impressions of very small plates between the arm-plates, which he believed to be those of the vault. Wachsmuth and Springer, on the other hand, remark—"We seriously doubt if these plates . . . . are any such thing as vault-plates; we believe, if they are plates at all, that they formed a part of the disk, and as such were covering pieces." Mr. Ratte was unquestionably right in referring to the impressions in question as those of plates, but Messrs. Wachsmuth and Springer are probably correct in their interpretation.

The sculpture is seldom well preserved, the ridges dividing the vermicular grooves becoming worn; but when in a perfect condition are tubercular, as described by Mr. Ratte. A peculiarly marked pentagonal plate is represented in Pl. XIV, Fig. 7, probably a basal. The sculpture has the general appearance of that of the present species; but the ridges in the centre are distinctly radiate, and the surrounding pits circular and separate. It may possibly be a slight variation in the ornament of *T. corrugatus*, or even a distinct species.

The vermiculate-tubercular sculpture of the calyx of *T. corrugatus* is reproduced in a great measure in that of *Eupachycrinus magister*, Miller and Gurley,[1] from the Upper Coal Measures of Missouri. We are indebted to Mr. B. G. Engelhardt for the presentation of some fragmentary specimens from Jamberoo. Mr. Ratte's originals are in the Australian Museum.

[1] Journ. Cincinnati Soc. Nat. Hist., 1890, XIII, No. 1, t. 1, f. 1 and 2.

Locality and Horizon.—Jamberoo, Co. Camden *(C. Cullen and B. G. Engelhärdt)*; Railway Cutting at Wollongong, Co. Camden *(C. Cullen)*; Northern bank of the Minumurra River, near Jamberoo, Co. Camden *(B. G. Engelhardt)* :—**Upper Marine Series.**

Tribrachiocrinus granulatus, *sp. nov.* ?

Pl. XXII, Figs. 2 and 3.

Sp. Char.—Calyx depressed, and generally saucer-shaped, practically symmetrical; infra-basal cup flattened around its periphery, and concave inwards from just within the infra-basi-basal sutures, producing a wider and more open concavity than that in *T. corrugatus*. Suture between the heptagonal and hexagonal posterior basals shorter than that in *T. corrugatus*, with the result that the plates named and the azygous plate are transversely wider in comparison to the height of the more depressed calyx. Anal plate apparently pentagonal; second anal deltoid, and very prominent. Columnar facet large in comparison to that of *T. corrugatus*. Sculpture, on the cast of concentric lines parallel to the outlines of the plates, on the test of a minute compact granulation.

Obs.—This provisional species undeniably comes very near to *Tribrachiocrinus corrugatus*, but it appears to differ from it in three very marked features. In the first place, the calyx is much depressed in comparison with that of *T. corrugatus*, the only species with which it need be compared. The basal cup is much flatter and more depressed, and, above all, the brevity of the suture between the heptagonal and hexagonal basal plates is most marked. In addition to these, there is the external sculpture. In Pl. XXII, Fig. 3, is represented the internal cast of the calyx, with the concentric lines edging the various plates. Fig. 2 portrays the matrix and external mould of a part of this cast, on which the close, fine, granulation of the test is faintly preserved. Such an ornament can hardly be mistaken for the vermiculate-tubercular sculpture of *T. corrugatus*. If the external ornament in the latter species does not vary in a diminutive sense, and I have not any evidence of such a fact before me, but rather the opposite, the species must be separate. We owe a knowledge of this interesting fossil to the researches of Mr. B. G. Engelhardt, of the Public School, Jamberoo.

Locality and Horizon.—Banks of the Minumurra River, near Jamberoo, Co. Camden *(B. G. Engelhardt)* :—**Upper Marine Series.**

Genus—PHIALOCRINUS—*Trautschold*, 1879.[1]

Pentadia (pars), Dana, American Journ. Sc., 1879, IV, p. 152.
„ (pars), Dana, Wilkes' U.S. Explor. Exped., 1849, X (Geology), p. 712.
Phialocrinus, Trautschold (*non*. Eichwald), Kalkbrüche von Mjatschkowa, Pt. 3, 1879, p. 24[1].
Cyathocrinus, De Koninck (*non*. Miller), Foss. Pal. Nouv.-Galles du Sud, Pt. 3, 1877, p. 23.
Phialocrinus, Zittel, Handb. Palæontologie, I Bd., I Abth., 1880, p. 360.
„ Wachsmuth and Springer, Revision of the Palæocrinoidea, Pt. I, 1879, p. 124; *Ibid*, Pt. III (2), 1886, p.p. 191 (115) and 253 (177).
„ Bather, Ann. Mag. Nat. Hist., 1890, V (6), p. 385.

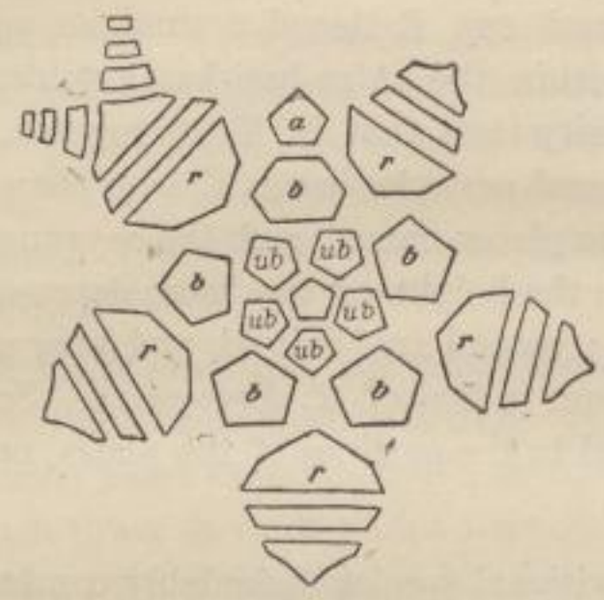

Fig. 4.

Gen. Chars.—Calyx, basin-shaped or globular, varying greatly in size, but attaining large proportions. Infra-basals five, pentagonal or quadrangular, the left anterior lateral usually the largest. Basal plates large, generally more or less arched, four pentagonal, the fifth or posterior hexagonal. Radial plates large, irregularly pentagonal, much wider than high, and their ventral margins sharply truncated; articular surfaces extending the whole length of the plates. Anal plate pentagonal or quadrangular, resting on the truncated ventral margin of the posterior basal, and interpolated between the right and left posterior radials, and thus not extending above the plane of the radials. Costals large, transversely elongated; the second or third axillary. Arms long, heavy, composed of strong, single pieces. Stem pentagonal, as a rule.

Obs.—The foregoing description is drawn up from the characters assigned to *Phialocrinus* by Mr. Trautschold, aided by the structure of the Australian species. The Author in question explained that Eichwald's genus

[1] *Non*. Eichwald, Lethæa Rossica, I, p. 579; *nec Philocrinus*, De Koninck, Quart. Journ. Geol. Soc., 1863, XIX, p. 4 Nouv. Mém. Soc. Imp. Nat. Moscou, 1879, XX (XIV), Livr. 1.

Phialocrinus, as originally proposed by the former, was established on very unsatisfactory and imperfect material, such as stem-joints, and is therefore quite inadmissable. In this step Trautschold is followed by Messrs. Wachsmuth and Springer, who regard[1] *Phialocrinus*, Trautschold, as a sub-genus of *Graphiocrinus*, De Koninck[2]. Their remarks are as follows[3]:—"Closely related to *Graphiocrinus* are *Bursacrinus*, Meek and Worthen, and *Phialocrinus*, Trautschold. We can perceive slight structural differences by which the two might be distinguished from the first, but it can *only be a sub-generic division*, and it is somewhat questionable whether even this can be maintained as to *Phialocrinus*." And again[4]:—"The resemblance to *Graphiocrinus*, as already mentioned, is so close that we doubt whether the group *can be upheld even sub-generically*. So far as known, *Phialocrinus patens* differs from *Graphiocrinus*, as now revised, only in having two brachial pieces instead of one, and in the under-basals, which here project slightly beyond the column. The latter is unimportant, and a comparison will show that the two brachials combined have exactly the form of the single plate in *Graphiocrinus;* their division involves no structural change, but merely facilitates articulation."

It is, therefore, clear that *Phialocrinus* is clearly related to *Graphiocrinus*, but it appears to me that further consideration of the characters of the former, aided by the structure of certain Australian Crinoids, will enable a separation to be made. It may be remembered that the late Prof. de Koninck described a large Crinoid from our Permo-Carboniferous as *Cyathocrinus Koninckii*, Clarke.[5] This is not congeneric with *Cyathocrinus*, but, apparently, with another and much larger Crinoid, described later as *P. princeps*, and discovered since Prof. de Koninck wrote, thus forming a very natural group allied to *P. patens*, Trautschold. To these may, perhaps, be added a third, of which only the calyx is known, and, possibly, a fourth and somewhat abnormal form.

In *Graphiocrinus*, there is a single small anal plate situated half way between the radials and the costals.[6] In *Phialocrinus patens*, *Cyathocrinus Koninckii*, and in at least two of the new forms referred to above, the anal plate is wedged between two of the radials simply. In *Graphiocrinus*, this

[1] Revision of the Palæocrinoidea, Pt. I, 1879, p. 124.
[2] Rech. Crinoïdes Terr. Carb. Belgique, 1854, p. 114.
[3] *Loc. cit.*, p. 122.
[4] *Ibid*, p. 124.
[5] Foss. Pal. Nouv.-Galles du Sud, Pt. 3, 1887, p. 164, t. 6 f. 4.
Revision of the Palæocrinoidea, Pt. I, 1879, p. 122

anal plate rests either on the posterior basal, or is separate from it; but, in the species named, it is invariably perched on the top of the truncated apex of that plate. Again, in *Graphiocrinus*, whether on the posterior basal or separated from it, this anal plate extends above the plane of the radials; but, in the group of species, never; at any rate, not in the Australian. It further appears, from Trautschold's description, that there may be a few small supplementary plates.[1] I therefore propose to restore *Phialocrinus*, Trautschold, to the rank of a genus, a step which had the cordial approval of my late friend and co-writer, Dr. P. H. Carpenter, F.R.S., to whom I submitted casts and facts bearing on the generic relations of the Crinoids in question, at a time when much perplexed with their affinities. He was kind enough to favour me with his views on the matter in writing, and his permission was obtained to their insertion here.

Dr. Carpenter's remarks on the relation of *Phialocrinus* to *Graphiocrinus* are as follows:—

"In my opinion Messrs. Wachsmuth and Springer committed a great mistake when they redefined De Koninck's genus *Graphiocrinus*, and added a number of American species to it. No doubt they were right in supposing that *Graphiocrinus* has under-basals, concealed by the top stem-joint, but this has yet to be proved in *G. encrinoides*. In this, however, the type, and to my mind the *only* species of the genus, the five basals are all equal, the radials form a closed ring, and the anal plate rests upon the upper angles of two of them, separating the two costals (second, or axillary radials, *auctorum*). Wachsmuth and Springer refer the following species to *Graphiocrinus*:—

A.

Scaphiocrinus carbonarius.
" rudis.
" striatus.
" simplex.
" Wachsmuthi.

B.

Scaphiocrinus M'Adamsi.
" spinobrachiatus.
" tortuosus.

[1] Possibly the basal plates of the anal tube.

I know nothing about the anal side in the three species of Group B, but in all the five species of Group A, the anal plate enters the ring of radials and rests on a basal, just as in the case in *Cyathocrinus;* and I cannot comprehend how the Authors in question can have placed these species in the same genus with *Graphiocrinus encrinoides.* Their doing so is the more remarkable as they separate *Ceriocrinus* from *Erisocrinus* for a precisely similar difference.

"*Scaphiocrinus simplex*, one of the species in Group A, was Hall's type of *Scaphiocrinus*, and he distinguished it clearly enough from *Graphiocrinus*, expressly stating that the basal of the anal side 'is truncated above by the first anal plate."[1] Wachsmuth and Springer, however, transferred this and similar species to *Graphiocrinus*, and enlarged the definition of the latter accordingly. This left *Scaphiocrinus* without a type, and so they made Hall's second species, *S. dichotomus*, the type of the genus, in which they have been followed by S. A. Miller and others.

"What, then, are we to do with *Scaphiocrinus simplex*, and its four or more allies? Strictly speaking, I suppose that Hall's name should be restored, and a new one found for *S. dichotomus* and the rest. This should, I think, be done, were it not that *S. simplex*, &c., all agree with Trautschold's *Phialocrinus patens*, in having the posterior basal truncated by the anal plate, which rests upon it, and forms part of the ring of radials, and I would therefore transfer *S. simplex*, and its four or more allies to *Phialocrinus*, making this character the generic difference between the latter and *Graphiocrinus*. *Scaphiocrinus M'Adamsi* and *S. tortuosus* (*?*) are described as having the basals unequal, and should probably be called *Phialocrinus* also. Of *Graphiocrinus longicirrifer*, W. and S.,[1] Wachsmuth and Springer themselves remark that the basal of the azygous side 'is considerably larger and heptagonal, supporting on its truncate upper face a large anal plate, which extends far beyond the top of the radials, and actually forms a part of the ventral tube.' How can they place this in the same genus with *G. encrinoides?* In fact, they seem to have entirely forgotten the structure of this, the type species of the genus! for they say of *Graphiocrinus*—'It has only an anal, and this is small and placed between the radials, resting upon the truncate upper side of the posterior basal.' And yet in the type species De Koninck pointed out how the anal plate is 'adjacente à quatre autres

[1] Illinois Geol. Survey Report, 1890, VIII, p. 193, t. 17, f. 14.

pièces qui l'enclavent et qui, à cet effet, ont chacune une partie de l'un de leur bords latéraux un peu echancrée.'[1] These are, of course, the first and second radials (*auctorum*), or radials and costals as we now call them.

"Again, in Wachsmuth and Springer's last paper on the perisomic plates of the Crinoids, they refer to the plate x as resting on the posterior basal, and supporting a 'quite capacious' ventral tube. This is not the case in the type of *Graphiocrinus*.

"I do not think that any importance, from a generic point of view, is to be attached to the extent to which the under-basals are visible beyond the stem articulation. Neither can anything be made of the fact that *Phialocrinus patens* has two costals, while the American species resemble *Graphiocrinus* in having but one; for Hall says that there may be two in the anterior ray of *Graphiocrinus tortuosus*, which seems to have the anal structure of *Phialocrinus*, while Trautschold says that there may sometimes be only one costal in the latter genus.

"Miller and Gurley have recently described a new genus, *Æsiocrinus*, which has a dicyclic and bowl-shaped calyx, with the posterior basal truncated for the reception of an anal plate and two costal plates. I cannot see in what respect this genus differs from Trautschold's *Phialocrinus*, though the authors think that 'probably a new family should be defined for its reception.'[2] They describe three species, each with two costals, which thus resemble the Russian rather than the other American species of the genus.

"*Bursacrinus*, M. and W., to which Wachsmuth and Springer have united *Synyphocrinus*, Trautschold, and I think rightly so, has the same arrangement on the anal side as *Phialocrinus*, but differs in having a more funnel-shaped cup, and more branching arms. The type species, *B. Wachsmuthi*, has six to eight distichals, but in *B. cornutus* there are but two. In either case, however, there are twenty arms, while *Phialocrinus*, so far as known, has but ten, and not always that, for there is no costal axillary on the anterior ray of *P. rudis*."

Phialocrinus, therefore, as now understood by us, is distinguished from *Graphiocrinus*, De Koninck, by the position of its anal plate, resting on the truncated ventral edge of the posterior basal, and thus entering the ring

[1] Rech. Crinoïdes Terr. Carb. Belgique, 1853, p. 116.
[2] Journ. Cincinnati Soc. Nat. Hist., 1890, XIII, p. 15.

of basals, without projecting above their ventral margin. In *Graphiocrinus*, on the contrary, the anal plate rests on the upper angles of two radials, or, according to De Koninck's figures,[1] it is placed between two rays, wedged between two radials and two costals. It is to be regretted that the utility of Messrs. Wachsmuth and Springer's grand work is sometimes marred by a contradictoriness of statement, which renders their actual views difficult of comprehension. In the revised generic diagnosis of *Graphiocrinus* given by them, they assign to the anal a somewhat analagous position—"either resting on the posterior basal or separated from it, but in either case extending above the plane of the radials." On the other hand, in a subsequent note on the genus,[2] they say, as quoted by Dr. P. H. Carpenter, that the anal is "small, and placed between the radials, resting on the truncated upper side of the posterior basal." I prefer, however, to accept their first definition, which practically causes *Graphiocrinus*, vobis, to differ from *Phialocrinus* as much as *Graphiocrinus*, De Koninck, does.

The separation of *Bursacrinus* from *Phialocrinus* has already been referred to by Dr. Carpenter.

Cromyocrinus, Trautschold, is another genus to which our Australian species of *Phialocrinus* bear a strong general resemblance. In the words of Messrs. Wachsmuth and Springer, when discussing the relations of the two first-named genera,[3]—"The species of both agree in the bowl-shaped, sometimes nearly globular form of the calyx, its comparatively very large size, its large and heavy plates, the massive and simple arms, and the exceedingly slender column"—but the structure of the anal side quite separates them from *Cromyocrinus*. The anals are three in number, the lower being the largest, and rests obliquely between the posterior basal and right radial. The second anal is placed between the first anal and left radial, and above the basal, whilst the third is much swollen, and only the lower half of it is included in the calyx.

Dr. Carpenter referred to the fact that *Æsiocrinus*, S. A. Miller, does not differ from *Phialocrinus*. Messrs. Miller and Gurley say of the latter that the calyx is bowl-shaped, with five infra basals (their basals), the basals (their sub-radials) large, four hexagonal and one heptagonal, the radials pentagonal, wider than high, and truncated their entire width, azygous plate

[1] Rech. Crinoïdes Terr. Carb. Belgique, 1853, p. 115.
[2] Revision of the Palæocrinoidea, 1886, Pt. III, No. 2, p. 252 (176).
[3] Ibid., 1879, Pt. I, p. 133.

resting on the truncated ventral edge of the heptagonal basal, and placed between two radials, whilst there are one or more costals in each ray, supporting strong arms of a single series of plates. Now, dismissing from consideration the proboscis, which they also describe in *Æsiocrinus*, it is manifest that this is, without exception, quite the structure of *Phialocrinus*. The basal plates are said by Miller and Gurley to be four hexagonal and one heptagonal, whilst those of *Phialocrinus* are now described as pentagonal and hexagonal respectively; at the same time it would be possible, without being absolutely incorrect, to describe these plates in the latter genus under similar terms—in this way—a glance at the figure of *Æsiocrinus Harei*, M and G.[1] will show that the four basal plates are rendered hexagonal by having their dorsal edges angled to fit into the emarginate ventral edges of every two and alternately conjoined infra-basals. Similarly with the dorsal edge of the heptagonal basal. As a matter of fact, on dissecting a worn example of *Phialocrinus Clarkei*, and separating the plates, I find that they also possess a tendency to a like outline, but when united *in situ* this is imperceptible. Under these circumstances therefore, it appears that there is little or no difference in the construction of the calices in *Phialocrinus* and *Æsiocrinus*.

It is satisfactory to find the views of the late Dr. P. H. Carpenter, of the affinities of *Phialocrinus* so much in accord with those of Mr. F. A. Bather, who places the genus with *Graphiocrinus*, *Ceriocrinus*, and *Bursacrinus* in a section of his family Decadocrinidæ, termed the Graphiocrinites. In the latter "the radianal is lost, but . . . . the brachianal remains in the limits of the dorsal cup." It may be explained that Mr. Bather's radianal is, as already pointed out, a radial "that has assumed anal functions"; whilst the brachianal is that plate termed in the present pages the anal.

Now a word as to the name *Pentadia*, Dana, lest any should contend for its adoption as the generic appellation of this group. I presume the giving a name to a single, or two or three Crinoid plates, is not sufficient warranty for its adoption in a generic sense. Such was the origin of *Pentadia*[3], but fortunately there is every reason to believe, as will be explained hereafter, that the plates of two distinct genera correspond to the structure of these *Pentadia* plates, and that in consequence it must be relegated without further discussion to the synonymic list.

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[1] Journ. Cincinnati Soc. Nat. Hist., 1890, XIII, Pt. 1, t. 4., f. 1.
[2] Ann. Mag. Nat. Hist., 1890, V. (6), pp. 383 and 385.
[3] American Journ. Sci., 1845, IV., p. 152.

The form of the calyx is practically identical in *P. Koninckı* and *P. princeps*, but is much more saucer-shaped in *P. nodosus*, the two former being characterised by the very large size and massiveness of their plates.

The infra-basals are usually almost equal, but in *P. Koninckı* an inequality does certainly exist, the right antero-lateral plate being decidedly the larger. It is, however, more generally apparent in casts than in calices with the plates preserved. The projection of these plates cannot in any way be accepted as a generic distinction, as partly suggested by Wachsmuth and Springer, in the case of *Scaphiocrinus*. The infra-basals are retired from view in *P. Koninckı* and *P. nodosus*, but project in *P. princeps*.

The basal plates are very similar in the three species, five pentagonal and one hexagonal, and in the two larger forms are comparatively smooth and unornamented, but in *P. nodosus* are produced into large central nodes.

The radials are alike in *P. Koninckı* and *P. princeps*, the articular facets for the costals extending the whole width of the plates, so that the lower portions of the rays are of nearly the same width as the radials, a strong Neocrinoid character. The radials of *P. nodosus* are unknown to me.

The anal plate occupies precisely the same position in all three Australian species, perched on the top of the posterior basal, and interpolated between two radials, in a manner similar to that of the American species, *P. carbonarius*, *P. rudis*, &c. Such also is the case in *Æsiocrinus magnificus*. In the Australian Crinoids it is a quadrangular plate, but in the last named it is irregularly so.

The costals of *P. nodosus* are unknown, but in those with which we are acquainted some slight variation appears to exist in the number at the base of a ray. *Phialocrinus patens* has two costals in each ray, *P. Koninckı* has three, and so *P. princeps* appears to have. On the other hand, the American species proposed to be referred to the genus by the late Dr. P. H. Carpenter have but one, except *Æsiocrinus*, wherein there are "one or more brachials in each ray." The costal axillary is said to be absent in the anterior ray of *P. (Scaphiocrinus) rudis*. In *P. princeps* there certainly is a costal axillary, and the same exists in *P. Koninckı*, so that in this respect our Australian species seem to follow the Russian rather than the American.

The costals below the axillaries in the two last named species are of the same width as the radials, and therefore quite unlike many other Palæocrinoids, such as the Platycrinidæ and Cyathocrinidæ, in which these plates are very much less, and occupying a much smaller extent of the articular surface. There seem to be irregularities in the number of costals in each ray of *P. princeps*, which will be referred to in the specific description of that form.

The quadrangular plates figured by De Koninck,[1] resting on the ventral edge of the anal, are repeated in *Æsiocrinus*, for Miller and Gurley say that the anal in their genus "is followed by two plates that connect with the base of the proboscis."[2] In *P. princeps* the posterior side is not presented to view, and in *P. nodosus* it is not preserved above the anal plate. In neither of the Australian species is any trace of the proboscis visible.

The stem-facet is practically obliterated in *P. nodosus*, or at any rate represented by the merest tubercle; it is very small in *P. Koninckı*, but much larger in *P. princeps*. The stem in the last named was also moderately large (Pl. XVIII, Fig. 1); but of the stems of the other Australian forms, specifically, I am unable to afford any information. It is possible that the apparently stemless condition of *P. nodosus* may be akin to the obliteration of the stem-facet in *Agassizocrinus*. In *Comatula* the same thing occurs, and we again find a like occurrence in the Neocrinoid *Marsupites*.

As here defined, *Phialocrinus* is recognised as occurring in the Carboniferous areas of Russia and America, and in the Permo-Carboniferous of Eastern Australia, and probably India. Dr. William Waagen has described, from the middle division of the Productus Limestone of the Salt Range, in the Punjaub, a species as *Cyathocrinus goliathus*, which, from his remarks, in comparing his detached plates with *P. Koninckı*, certainly appear to place *C. goliathus* in congeneric relation with the Australian Crinoid. A second species was described by Waagen as *Cyathocrinus virgalensis*, but it is unimportant.

Type.—*Phialocrinus patens*, Trautschold.

Australian Type.—*Phialocrinus Koninckı*, Clarke, sp.

Range.—Carboniferous and Permo-Carboniferous.

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[1] Foss. Pal. Nouv.-Galles du Sud, 1877, Part 3, t. 6, f. 4.
[2] Journ. Cincinnati Soc. Nat. Hist., 1890, XIII, No. 1, p. 14.

Phialocrinus Koninckı, *Clarke, sp.*

Pl. XVI, Figs. 1–4.

Pentadia spatangus, Dana, American Journ. Sci., 1845, IV, p. 152.

Pentadia corona, Dana, Wilkes' U. S. Explor. Exped., 1849, X (Geology), p. 713, t. 10, f. 10, 10*a* (non figs. 11 and 12).

Cyathocrinus Koninckı, Clarke, in De Koninck's Foss. Pal Nouv.-Galles du Sud, 1877, Pt. 3, p. 164, t. 6, f. 4–4*b*.

Cyathocrinus Koninckı, Etheridge, fil., Cat. Australian Foss., 1878, p. 40.

Pentadia corona (pars), Etheridge, fil., *Loc. cit.*, p. 40.

Sp. Char.—Calyx very large, massive, globular and globose; greatest periphery more or less along the basi-radial sutures; all sutures deep and well marked; plates of considerable thickness, more or less convex. Infra-basal plates quadrangular, slightly unequal in size, forming an inverted or reversed cup, on the outer margin of which the calyx rests when placed in its natural position. Basal plates large and massive, wider than high, irregularly convex, their relative sizes, as compared with the infra-basals being very disproportionate; four pentagonal, but the posterior basal hexagonal. Radial plates transversely elongated, pentagonal, articular surface large, with the internal edges sigmoidal. First and second costal plates broad and tabular; third costals axillary, and much higher than the others. Anal plates flattened, quadrangular, wider than high; supplementary anal plates (? or proximal plates of the proboscis) two, side by side, resting on the horizontal ventral edge of the anal plate. Columnar facet small; column unknown. Sculpture, apparently none, but highly weathered or decorticated specimens with lines concentric to the plate outlines, supplemented with radiating ridges.

Obs.—This fine species is second only in size to the still larger *Phialocrinus princeps*, described later on. Prof. de Koninck's figure represents a specimen three and a-half inches wide by two and a-quarter inches high, whilst the largest of our examples (Pl. XVI, Fig. 2) is but little less.

Prof. de Koninck referred *P. Koninckı*, Clarke, to *Cyathocrinus*, and it no doubt presents a resemblance to many species of that genus; but although the anal plate rests directly on the truncated apex of the posterior basal, as is also the case in *Cyathocrinus*, yet the width of the articular facets

of the radial plates forbids a reference to that genus. In *Cyathocrinus* the articular facets seldom occupy more than one-half the width of the plates, and sometimes less. Furthermore, in some of the American species, now placed in *Phialocrinus*, and referred to *Graphiocrinus* by Wachsmuth and Springer, the first two, or proximal plates of the "ventral tube," or "proboscis," rest on the anal plate, as they do in the present case. The impressions of these proximal plates are distinctly visible in the side view of De Koninck's large figure,[1] and are referred to by him as anals; but so far I have only been able to distinguish one of these in the specimens before me.

Phialocrinus Koninckı is only known to me in the form of internal casts. In this condition, the base on which the calyx would otherwise rest (Pl. XVI, Fig. 1) is represented by a depression of variable depth and width, but usually of considerable proportions, in which the five infra-basals would lie. This marked dorsal hollow is very characteristic of the species, and all specimens from the chief locality yielding *P. Koninckı*, Nowra, in the Shoalhaven District, exhibit it. The calyx, in this condition, when placed in its natural position rests as near as possible on the inter-basi-infra-basal sutures, and, in consequence, the infra-basal plates are invisible in a side view. It not infrequently happens that specimens from the Nowra Grit are more or less pressed out of shape, a fact which should always be taken into consideration when comparing them with others from different localities.

I was for some time doubtful as to the relations of *Phialocrinus Koninckı* to *P. princeps*, whether or no the basal hollow of the latter, when in the condition of casts, would be entirely filled by the plates *in situ*. I have, however, come to the conclusion that such would not be the case, and that the two forms are quite distinct, separated by the combined form of their respective infra-basal plates. With neither of the other species need *P. Koninckı* be compared.

Prof. de Koninck suggested the identity of the bodies described by Prof. J. D. Dana in the Geological Report of the "United States Exploring Expedition," under Commodore Charles Wilkes, U.S.N., as *Pentadia corona*[2], with the basal plates (his sub-radials) of the present species. De Koninck remarked[3]:—"In carefully examining each sub-radial impression, one can easily see five folds, faintly indicated, springing from a common central,

[1] Foss. Pal. Nouv.-Galles du Sud. Pt. 3, 1877, t. 6, f. 4.
[2] Wilkes' U.S. Explor. Exped., 1849, X (Geology), p. 713.
[3] Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 165.

well defined point, and directed perpendicularly towards the middle of each of the five sides. This arrangement presents an unmistakeable analogy to the fossil figured and described by Dana under the name of *Pentadia corona*. Indeed, this fossil corresponds so well in form and size with the sub-radials of our *Cyathocrinus*, that I am led to believe it may be nothing more than one of these pieces. In that case, these sub-radials would be ornamented not only with the radiating costæ that I have just mentioned, but also with concentric granulated striæ parallel to the margins." De Koninck is, no doubt, correct in describing such radiating folds and concentric granular ridges on the basal plates of *P. Koninckı*, for such are visible in his figures, and more satisfactorily on one of our own (Pl. XVI, Fig. 2). But, as regards the identity of Dana's *Pentadia* plates wholly with the basals of the present species, this, I think, can only be admitted in part, for it has already been shown that some of the plates of *Tribrachiocrinus Clarkei*, when in a particular state of preservation, also display a similar arrangement of concentric lines and radiating ridges. Such a reference was evidently conceived by Prof. Dana himself[1] when describing the several plates under the united name of *Pentadia corona*.

The figure of *P. corona*[2] given by Dana bears about six folds passing from the node-like centre to the middle of the plate margins, not to the angles. To the latter are other subsidiary ridges, rather than folds, thus dividing the surfaces of the plate into twelve triangular spaces. The object is further crossed concentrically by a series of semi-imbricating laminæ, becoming coarser and more distant from one another towards the centre. It must be borne in mind that so perfect an example as figured by Dana is seldom seen, but a glance at our Pl. XVI, Fig. 2, and the upper figure of De Koninck's illustration[3] exhibit the points referred to sufficiently well to warrant the assumption that his *Pentadia spatangus*[4], as it was originally termed, is identical with the basals of *P. Koninckı*. At the same time, I must confess that, should the two Crinoids *P. Koninckı* and *Tribrachiocrinus Clarkei* be found together in a disintegrated form, it would require a critical study of the outlines of the plates to differentiate between the respective species in that condition. The reference of Pl. XV, Figs. 6–8, and Pl. XXII, Figs. 6–9, to the latter species is based on the fact that more perfect remains of *T. Clarkei* occur in company with them at the same locality.

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[1] Wilkes' U.S. Explor. Exped., 1849, X (Geology), Atlas, Expl. Pl. 10, f. 10.
[2] *Loc. cit.* t. 10, f. 10, 10*a*.
[3] Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, t. 6, f. 4.
[4] American Journ. Sci., 1847, IV., p. 152; Wilkes' U.S. Explor. Exped., 1849, X (Geology), Atlas, t. 10, f. 10, 10*a*.

With regard to the identity of *Pentadia reniformis* and *P. trigona*[1], I am not at present able to offer any suggestion.

Another marked peculiarity in the casts of *P. Koninckı* is the line of small nodes along the basi-radial and inter-basal sutures (Pl. XVI, Fig. 2), also to some extent visible in De Koninck's figures. Do these represent vacuities or depressions along the articular margins of the plates, in which were lodged fibre-bundles for the firmer union of the plates, otherwise loosely articulated?

In *P. patens*, Trautschold, each radial is succeeded by two costals, the second being axillary. In the present species, however, judging from the cast, there appears to be three, with the third axillary.

The fine example represented in Pl. XVI, Fig. 1, was collected by Mr. E. F. Pittman, Government Geologist.

Locality and Horizon.—Nowra, Co. St. Vincent (*Messrs. E. F. Pittman and C. Cullen*):—**Nowra Grit, Upper Marine Series.**[2]

Phialocrinus princeps, *sp. nov.*

Pl. XVII, Fig. 1; Pl. XVIII, Fig. 1; Pl. XXII, Fig. 5.

Sp. Char.—Calyx very large, globular-globose, with a protuberant base, on which the calyx rests when placed in its normal position; greatest periphery about the basi-radial sutures; sutures all deeply marked; plates very thick. Infra-basals forming an expanded shallow cup visible in a side view, the left antero-lateral the larger. Radial plates very large, their convexity so slight that the surfaces present a more or less flattened appearance. Costals strong and massive, the radio-costal sutures gaping; in the anterior ray the first costal transversely triangular-quadrate, second transversely tabular (? axillary), succeeded by three sub-alternate more or less triangular smaller pieces (? distichals), the third of which is axillary; succeeding pieces (? palmars) thick, alternate, and triangular. Column of large joints. Sculpture none.

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[1] *Loc. cit.* p. 152; *Ibid*, t. 10, f. 11 and 12.

[2] Prof. L. G. de Koninck gives as the original locality for this species, Osterley, Hunter River (*Foss. Pal. Nouv.-Galles du Sud*, Pt. 3, 1877, p. 166). Osterley is three miles from Hinton.

Obs.—The present noble species is probably one of the largest, if not the largest, of the Palæocrinoidea known, equalling if not exceeding the large *Barycrini*, of the American Carboniferous Limestone. The calyx is four and a-half inches in diameter, and about three and a-half inches in height. The anal or posterior side has not been observed, as it is broken away in all other examples other than that of the subject of Plate XVIII, Fig. 1, where it is hopelessly imbedded in an exceedingly hard silicious matrix.

It differs essentially from *P. Koninckı* in the possession of protuberant infra-basals, and in consequence, when the calyx is normally placed, they are visible laterally.

The stem-joints in this species are fairly large, measuring quite three-quarters of an inch in diameter.

The form of the two anterior basals is precisely similar to that of those of *P. Koninckı*, and in the large figured specimen (Pl. XVIII, Fig. 1) the breadth of the two plates is equal to that of an entire calyx of an ordinary sized individual of the species named. A separate plate is represented in Pl. XXII, Fig. 5, seen from the interior, with the concentric structure-sculpture seen both superficially and in section.

In all the three exposed rays in *P. Koninckı* there are two arms to the ray. There are two on the left hand ray of *P. princeps* (Pl. XVIII, Fig. 1) but the right-hand ray is so defective that the number is doubtful. On the other hand two are definitely present on the central ray (anterior), and perhaps a third. The anterior radial is followed by two costals, the first triangularly quadrate, the second transversely elongate, or tabular. Whether or no this plate is axillary I am undecided, but the three next pieces are triangular and subalternate. If the second costal is axillary, these plates will I presume be termed distichals; the third of them is certainly axillary, and the pieces beyond will, with the above reading, become palmars. At the same time, the second of these triangular plates (distichals) has the appearance of being axillary, although too much stress must not be laid on this point, from the state of preservation, but it is from this cause that I have above suggested the presence of a third arm.

The figured example is from the Collection of the Maitland Scientific Society, and was obtained during an excursion of that body to Mount Vincent

by Messrs. J. Waterhouse, M.A., and G. Steward, under considerable difficulties, and the Department is indebted to the Council of the Society for permission to use the specimen for illustrative purposes.

Locality and Horizon.—Bow-wow Creek, Mount Vincent, near East Maitland, Co. Northumberland (*Messrs. J. Waterhouse, M.A.*, and *G. Steward*—Collection Maitland Scientific Society):—**Muree Rock, Upper Marine Series.**

PHIALOCRINUS ? NODOSUS, *sp. nov.*

Pl. XIV, Figs 4 and 5.

Sp. Char.—Calyx very depressed saucer-shaped; basal concavity wide and open, wholly containing the infra-basals, and a portion of the basal plates. Infra-basals relatively large. Basals proportionately very large, thick, strong, and arched, each bearing centrally a blunt, prominent boss, on which the calyx rests when placed in its normal position; posterior basal less convex than the others. Radial plates not preserved, but their impressions convey the idea of low, transversely elongated, thick plates, and the anal on the truncated surface of the posterior basal similar in character. Sculpture (of the cast) consisting of concentric lines parallel to the margins of each plate surrounding the central boss. Stem-facet apparently absent.

Obs.—The number, form, and arrangement of the infra-basals and basals, and almost certainly that of the radials also, render this Crinoid congeneric with *P. Koninckii*, and *P. princeps*. The low height of the calyx, the wide, open basal concavity, and the central elevations of the basal plates are features which at once tend to separate *P. nodus* from the foregoing species. It rests on the apices of the basal nodes after the manner of a tripod on its three legs.

The basi-radial sutures are so much curved that a quadrangular aspect is given to the basals, but the articular margins are all sufficiently angular to give a pentagonal outline to the plates.

The specimen is a decorticated cast, and consists of infra-basals and basals, with the wide, low, articular surfaces of thick radials, and the anal plate. A cast was submitted to the late Dr. P. H. Carpenter, who agreed with the Writer as to its affinity with *P. Koninckii* and *P. princeps*.

There is no scar of a stem-facet, the apical or inner ends of the infra-basals converging only to an initial point. If a column existed, it must have been excessively small; the probability is, however, that it was lost at an early stage of the Crinoid's existence, the scar closing over as in *Comatula*, and *Agassizocrinus*. The question arises, is it not one of those *Encrinus*-like forms which mark the transition from Palæo- to Neocrinoids.

Locality and Horizon.—Copper Point, Co. St. Vincent (*R. Barnes*—Collection Australian Museum) :—**Upper Marine Series.**

Phialocrinus ? Stephensi, *sp. nov.*

Pl. XX, Figs. 1–5.

Sp. Chars. (Cast).—Body pyramido-conical, height two and a quarter inches, diameter two and a half inches. Calyx depressed, low, wide, greatest periphery along the basi-radial sutures; dorsal surface very concave, deeply hollowed out, and generally resembling the base of a wine-bottle. Infra-basal plates confined to the basal concavity, and entirely hidden from view when the calyx is placed in its normal position, unequal in size, quadrangular. Basal plates in two planes, much bent along a circumferential line at about one-third from the infra-basi inter-basal sutures, so that their dorsal margins are hidden in the basal concavity; four pentagonal, the anal or posterior hexagonal; inter-basal sutures prominent, each rising into a blunt tubercle, where it cuts the edge of the basal concavity. Radial plates transversely elongated, pentagonal, wider than high, the lateral portions convex, the middle lines concave and inwardly pressed, especially at their dorsal apices; basi-radial sutures prominent, produced into a prominent oblique crest, converging towards one another in pairs; articular ventral margins long, and rather concave. First costals (?) large, transversely elongated, flat and tabular; second and third costals (?) transverse also, but larger, and apparently anchylosed together, and the latter axillary. Anal plate quadrangular, supporting smaller proboscis plates. Column unknown, probably absent, judging from the minute size of the scar of the first stem-joint.

Obs.—The above description has been drawn up from an internal cast, and it is only after some hesitation that I have placed it congenerically with *Phialocrinus Koninckı*, and *P. princeps*. The diagnosis is therefore purposely

enlarged beyond strict specific limits. The low calyx, deep ventral concavity, into which the basal plates fairly enter, and the diminished scar of the first stem-joint, recall the characters of *P. nodosus*, but our want of knowledge of the latter above the basi-radial sutures prevents further comparison.

The most interesting point in the structure of *P. Stephensi* is the relatively small calyx as compared with the preponderating mass composed of what I regard, for the want of a better explanation, as the anchylosed first, second, and third costals. A glance at Pl. XX, Figs. 1–3, will show that the infra-basals, basals, and radials compose the saucer-shaped calyx, as in *P. nodus*; whilst in Fig. 3, is visible the anal plate reposing on the truncated basal, as in *P. Koninckı* and *P. nodosus*. So far the structure seems to be simple enough, and corresponds with its fellow species, but above the radio-costal sutures we are confronted with the heavy, and apparently anchylosed mass seen in Pl. XX, Figs. 1–5.

On the radials are placed five more or less tabular plates, the two posterior separated by the impressions of the plates of the ventral tube, and which, I presume, represent the five first costals, with well marked vacuities representing the articular surfaces, between them and the radials, and again between them and the plates above. The latter seem to be the impressions of the second and third costals, if the prominent terrace-like ridge running round the specimen represents the sutures between the plates otherwise anchylosed together. This explanation is advanced tentatively, for at present I see no other reading of the structure of this specimen. The long radio-costal articular surfaces are similar to those of *P. Koninckı*, and to the exposed rays of *P. princeps*. The inter-costal articulation between the first and second is also similar.

The question that naturally presents itself to one's mind is—Do the lateral union and consolidation of the costals—presuming the pieces to be so united in the perfect organism, similar to this cast—infer generic distinction, the other portions of the calicicular structure being on the same plan? It appears to me that the answer to this question depends on the classificatory value placed on the structure of the arm-pieces in a Crinoid generally. Amongst the best characters assigned by Messrs. Wachsmuth and Springer[1] for generic separation, the construction of the arms is placed last, and may,

[1] Revision of the Palæocrinoidea, Pt. I, 1879, p. 24.

therefore, be looked upon as of the least importance. Mr. Bather also appears to be of the same opinion, for he says:—"Arm characters in general may, however, be used as a check on other methods of classification; they enable us to correct possible errors in phylogeny."[1] Under these circumstances, unless other more important differences can be pointed out by those having a closer knowledge of Crinoid structure than myself, *P. Stephensi* must remain associated with *P. Koninckı* and *P. princeps.*

In the description of *Phialocrinus Koninckı*, reference was made to the peculiar broken appearance in the cast of some of the sutures, taking the form of distinctly separated pimplets or small nodes. Similarly, in *P. Stephensi* are the elongated prominences along the basi-radial sutures. These crests could hardly exist in their present position without some outward sign of their presence on the plates proper, and it is, therefore, assumed that they did so, and moreover were not of precisely the same nature as those in *P. Koninckı.*

I was, in the first instance, indebted to the late Prof. W. H. Stephens, M.A., after whom the species is named, for its loan. It was subsequently presented to the Mining and Geological Museum by the Executors of the late Mr. David Berry, of Cooloomgatta, who obtained it from the late Mr. William Berry, the finder.

Locality and Horizon.—Nowra, Co. St. Vincent (*The late W. Berry*):—
Nowra Grit, Upper Marine Series.

CRINOIDEA INCERTÆ SEDIS.

Column.

XIII, Figs. 5 and 6.

Obs.—Portion of a large column, consisting of close set stem-joints, twelve in the space of one inch vertical, and with a diameter of one inch. These figures illustrate a common form of column found extensively throughout the Upper Marine Series of the Shoalhaven District.

Locality and Horizon.—Shoalhaven District (*Pres. J. Maclean*):—
Upper Marine Series.

[1] Ann. Mag. Nat. Hist. 1890, V (6), p. 376.

ACTINOCRINUS ?

Pl. XIV, Fig. 6; Pl. XVI, Fig. 11.

Obs.—An impression of a plate, perhaps a primary radial, ornamented with diverging ridges or costæ. It appears to represent an undescribed Australian Crinoid, as none of the calyx plates, so far discovered, exhibit a similar sculpture, with the exception of that figured in Pl. XVI, Fig. 11.

Locality and Horizon.—Nowra, Co. St. Vincent (*C. Cullen*) :—**Nowra Grit, Upper Marine Series.**

TRIBRACHIOCRINUS ?

Pl. XIV, Fig. 7.

Obs.—Impressions of a basal-plate of a form probably allied, from the style of the ornamenting tubercles, to *T. corrugatus*. The centre of the plate bears radiating costæ, bordered by two rows of coarse granules or nodes. The radii are to some extent elongately club-shaped.

Locality and Horizon.—Shoalhaven Heads, Co. Camden, (*C. Cullen*) :—**Upper Marine Series.**

COLUMN.

Pl. XVII, Fig. 5.

Obs.—Portion of a column about four and a-half inches long with parts of three verticils of cirri still attached, from three-quarters to one inch apart. The cirri would appear to have been of some length. Every fourth stem-joint seems to be somewhat larger than the intermediate ones.

Locality and Horizon.—Gerringong, Co. Camden, (*C. Cullen*) :—**Upper Marine Series.**

COLUMN.

Pl. XVIII, Fig. 2.

Obs.—Portion of a column, with a well marked nodal-joint, supporting bases of three cirri, which are circular. The ordinary stem-joints are one-sixth of an inch high; the nodal-joints one-fourth, and the latter also have a wavy outline. The internodal-joints are plain and all similar.

Locality and Horizon.—Flat Rocks Creek, near Nowra, Co. St. Vincent (*C. Cullen*) :—**Upper Marine Series.**

Column.

Pl. XVIII, Fig. 4.

Obs.—Portion of a smaller column, also with a nodal-joint, which has a rounded periphery, and is larger and projects beyond the internodal-joints. Every fourth joint amongst the latter is, as in Pl. XVII, Fig. 5, larger than the others, and slightly rounded, the internodal being flat.

Locality and Horizon.—Ellalong, Mt. Vincent, Co. Northumberland (*C. Cullen*) :—**Muree Rock, Upper Marine Series.**

Radial Plate.

Pl. XX, Fig. 9.

Obs.—An impression of a thick radial with a large, clearly marked articular margin, and bearing diverging lines of coarse granules or small tubercles, and a medium line extending down the centre of the plate. Probably *Tribrachiocrinus*.

Locality and Horizon.—Mt. Terry, Jamberoo, Co. Camden (*B. G. Engelhardt*, Collection Australian Museum) :—**Upper Marine Series.**

ENLARGED STEMS.

Obs.—Crinoid stems in the Carboniferous of other countries are frequently found enlarged and of irregular growth, arising from the action of parasitic organisms within and without the stems. A full description of these will be found in the paper quoted below.[1] Irregularities of this nature are usually accompanied by a depression of the stem surface, or a hole, leading to the interior of the latter. Instances of this nature are correspondingly rare in our Permo-Carboniferous, one only having come under notice. (Pl. XVIII, Fig. 3.)

It was shown by the late Mr. J. Rofe[2] that one form of enlargement was caused by the work of a parisitic coral, *Monilopora crassa*, M'Coy, sp., and other methods of distortion have been described by the Writer, through the

[1] R. Etheridge, jun. Observations on the Swollen Condition of Carboniferous Crinoid Stems. *Proc. Nat. Hist. Soc. Glasgow*, 1879.

[2] Note on the Cause and Nature of the Enlargement of some Crinoidal Columns. *Geol. Mag.*, 1869, VI, p. 351.

agency of some encrusting Corals, Polyzoa, and a peculiar species of Productidæ called *Etheridgella complectens*, mihi, sp. The enlargement does not generally appear to be effected so much by a perforation of and burrowing into the stems, as by irritation set up by the foreign organism, and a consequent effort on the part of the Crinoid to secrete calcareous matter and invest the pest.

A similar enlargement and irregularity of growth is also very marked in stems of the Jurassic genera *Apiocrinus*, and *Millericrinus*. The former was also studied by Mr. Rofe, and both have been by Dr. L. von Graff,[1] who ascribes themischief to *Myzostoma*, a genus of Anarthropoda. No doubt some of the appearances produced in Carboniferous Crinoids are also due to the action of a Myzostomid, for I have figured[2] a column in which the occupant of the burrow appeared to be an Annelid.

Dr. P. H. Carpenter says[3] that the external parasites of living Crinoids are many and various, such as "small bivalves, Sertularian Hydroids, Polyzoa, tube-worms, and corals," but chief amongst them is *Myzostoma*, Graff. The latter attaches itself to the stalk, disc, and arms, usually causing an abnormal growth of the calcareous tissue so as to form a cyst. He adds, "I have never met with any distortion of the stem [of a living Crinoid] which could be considered as resulting from the action of a parasite, and it is therefore curious that abnormal growths in the stems of fossil Crinoids should have attracted the attention of so many Palæontologists."

The portion of column represented in Pl. XVIII, Fig. 3, is unfortunately broken short off about midway on the swelling, but not without showing that the enlargement was accompanied by the usual depression of the surface, and apparent perforation. The former breaks the continuity of six ossicles of the column from its fracture upwards, but this is possibly only half the original depression. The swelling or enlargement is above the latter, the column at its upper end having a diameter of three-eighths of an inch, whilst at the most inflated part it is five-eighths. This specimen was obtained by Mr. C. Cullen at Ellalong, near East Maitland. A second swollen stem has been presented by the Chief Surveyor, Mr. Twynam, from the parish of St. Aubin, Rouchel Brook District. A section has distinctly revealed the cavity, which seems to have given the penetrating

[1] Ueber einige Deformitäten an fossilen Crinoiden. *Palaeontographica*, 1885, XXXI, p. 185, t. 16.
[2] *Loc. cit.*, t. 4, f. 18 and 19.
[3] Challenger Report, Zool. XII, 1884. Report on the Crinoidea, pp. 133 and 135.

agent access to the central canal. The substance of this has been removed, and on subsequent pressure being applied the stem shell has caved in more or less in a vertical direction.

Class—**CYSTOIDEA.**

Obs.—Evidence is entirely lacking of the presence of this Class in the Carboniferous and Permo-Carboniferous rocks, either of New South Wales, Queensland, or Western Australia.

Class—**BLASTOIDEA.**

Obs.—Blastoids have not been met with either in New South Wales or Western Australia, but the Gympie Series of Queensland has yielded three genera, comprising three species. The descriptions of these have so far not been published, but will appear in the work on "The Geology and Palæontology of Queensland and New Guinea," by Mr. R. L. Jack and the Writer.

The genus *Mesoblastus* has been provisionally used as the receptacle for a rather aberrant species described as *M.? australis*, Eth. fil;[1] but it is pointed out that a new genus may be required for its reception. A fragmentary specimen, but nevertheless quite distinct from either of the other Australian Blastoids, is described as *Granatocrinus? Wachsmuthi*, Eth. fil.,[2] and, lastly, a peculiar form fulfilling most of the characters of *Tricœlocrinus*, is figured as *T.? Carpenteri*.[3]

Sub-Kingdom—**ANNULOSA.**

Section—Anarthropoda.

Class—**ANNELIDA.**

Obs.—I am not aware that the shelly tubes of the Tubicola, or the horny jaws of the Errantia have been, so far, met with in our Permo-Carboniferous, although the latter are known from the Upper Silurian of New South Wales,[4] having been collected, with a large number of other interesting organisms, at Bowning by Mr. John Mitchell, of Narellan Public School.

[1] *Loc. cit.*, t. 44, f. 2.
[2] *Loc. cit.*, t. 7, f. 10.
[3] *Loc. cit.*, t. 44, f. 3.
[4] R. Etheridge, jun. Geol. Mag., 1890, VII (3), p. 337.

From Western Australia, on the other hand, Dr. G. J. Hinde has recorded[1] a *Spirorbis* from the rocks of the Gascoyne River, believing it to be referable to the Devonian *S. omphalodes*, Goldf. It does not appear to me, however, that the Devonian age of these rocks is yet sufficiently well proven.

Amongst the later collections made by Mr. Cullen were a number of Encrinite stems from near Mount Vincent, on which a few microzoa were seen adhering. Amongst them was a small loosely coiled *Serpula*, hereinafter described as *S. testatrix*.

A few Carboniferous fossils have lately been presented to the Mining and Geological Museum by Mr. Connelly from twenty-five miles west of Coerdawandy, Yaltra Mountains, Gascoigne River District, Western Australia, and amongst them, reposing on a small Crinoid stem, is a pretty little *Spirorbis*, after the type of *S. ambiguus*, Fleming,[2] from which I am unable to distinguish it.

It has always been a matter of surprise to me considering the great thickness of brackish or fresh-water strata connected with our Palæozoic Coal Measures, that examples of a *Spirorbis*, representing the adherent *S. carbonarius*, Murchison, of the European beds of more or less similar age have never been discovered.

Order—Tubicola.

Family—SERPULIDÆ.

Genus—SERPULA, *Linnæus*, 1758.

(Syst. Nat., Ed. X, p. 786.)

SERPULA TESTATRIX, *sp. nov.*

Pl. XVIII, Figs. 4 and 5.

Sp. Char.—Tube minute, coiled, of four or five irregular whorls, the exterior projecting above the inner ones, and all in contact, without a perspective umbilicus.

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[1] Geol. Mag., 1890, VII (3), p. 199.

[2] *See* R. Etheridge, junr., Geol. Mag., 1880, VII (2), p. 258, t. 7, f. 9-11.

Obs.—It is difficult to assign characters to a species whose fellows all resemble one another as closely as do those of *Serpula;* but as this is the first yet noted from the Permo-Carboniferous Series of New South Wales, I venture to assign the above name to it. The manner in which the tube is coiled on itself allies this species closely with *S. torbanensis*, mihi,[1] a worm very characteristic of a black band winstone above and below the celebrated Torbane-hill mineral at Bathgate, Scotland.

Locality and Horizon.—Two miles north-west of Mount Vincent, near East Maitland, Co. Northumberland (*C. Cullen*):—**Upper Marine Series.**

Section.—Arthropoda.

Class.—**CRUSTACEA.**

Sub-Class.—**Entomostraca.**

Order.—**Ostracoda.**

Family.—LEPERDITIDÆ.

Genus.—CARBONIA, *Rupert Jones*, 1870.

(Geol. Mag. VII., p. 218.)

CARBONIA AUSTRALIS, *sp. nov.*

Pl. XXI, Figs. 9-12.

Sp. Char.—Carapace oval-oblong; anterior and posterior ends practically equal, although one appears to be very slightly more pointed than the other; muscle spot large, circular, with a contiguous granular wrinkling; surface pitted and wrinkled microscopically.

Obs.—Specimens of this interesting form, collected by Mr. John Waterhouse, M.A., were forwarded to Prof. T. Rupert Jones, F.R.S., who, after a careful examination with Mr. J. W. Kirkby, pronounced them a possible *Carbonia*. The valves are so firmly embedded in the matrix that it was found impossible to obtain an absolutely correct outline, but it is believed

[1] Geol. Mag., 1880, VII (2), p. 364, t. 7, f. 33.

that the present figures, from sketches contributed by Prof. Jones, are accurate. He remarks, in a letter to the Writer, that *Carbonia* "is the only genus to which they are nearly allied."

Locality and Horizon.—Wollombi Road, ten miles south of West Maitland, Co. Northumberland (*J. Waterhouse, M.A.*) :—**Upper Marine Series.**

Family.—CYPRIDINIDÆ.

Obs.—A species of *Entomis* was recorded by the late Prof. de Koninck under the name of *E. Jonesi*, from the Muree Rock, Upper Marine Series. It is allied to *E. nitida*, F. A. Roemer, of the German Devonian Rocks.

Genus.—ENTOMIS, *Rupert Jones*, 1861.

(Mem. Geol. Survey Scotland, No, 32, p. 137.)

Entomis Jonesi, *De Koninck.*

Entomis Jonesi, De Koninck, Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 346, t. 24 f. 6, a and b.

Sp. Char.—Carapace valves oval-oblong, convex, a little attenuated anteriorly in outline; dorsal margin nearly straight; ventral margin curved; anterior and posterior ends nearly equal, but the latter probably somewhat the larger; sulcus frequently indistinct, separating the valves into two unequal portions, the posterior the larger; surface smooth.

Obs.—The sulcus in De Koninck's figures is too long and broad, and should possess less dimensions. I have examined specimens from the typical locality, and feel sure that we have both had before us similar specimens. It occurs on weathered surfaces of the Muree Rock, both as external impressions and internal casts, freely associated with the little bodies called by De Koninck *Polycope simplex*. The present species differs from *Entomis nitida*, according to De Koninck, in the transverse and longitudinal measurements.

Locality and Horizon.—Tokal Quarry, Paterson (*Prof. T. W. E. David, B.A.*) :—**Muree Rock, Upper Marine Series.**

Family.—POLYCOPIDÆ.

Obs.—Weathered surfaces of the Muree Rock are in places covered with more or less depressed pea-like bodies. These were referred[1] by Prof. de Koninck to the British Carboniferous Limestone Ostracod *Polycope simplex*, J. and K. I much regret that I cannot accept these little organisms, of which the collection contains a large number of specimens, as Ostracoda. They appear to me to bear evidence of an undoubted Molluscan affinity, and are probably the fry of Pelecypoda. In this view I am fortified by the opinions of Profs. T. R. Jones, and T. W. Edgeworth David.

In the first place De Koninck's description is not that of the fossils he had before him, but is a free rendering, and in some points word for word, with that of the species given by Messrs. Jones, Kirkby, and Brady, in their "Monograph of the British Fossil Bivalved Entomostraca from the Carboniferous Formations"[2]. The Molluscan affinity is based on the following evidence:—

a. The generally oval form is irregularly so within certain wide limits, *i. e.*, it does not show the defined regularity it should, to bring the organisms within the diagnosis of *Polycope*.

b. A curved striated dorsal area exists in all the specimens, large and small, similar to that of many so called Monomyarian molluscs.

c. The largest examples seen begin to take on the appearance of a Mytiliform or Inoceramiform shell.

d. Incipient umbones can be traced in many specimens.

A close inspection of De Koninck's Fig. 7 will reveal the incipient umbones, and the dark shadow surrounding each, representing the cast of the striated area. It is more than probable that these are the fry of a species of *Aphania*, or even perhaps an *Aviculopecten*.

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[1] Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 346, t, 24, f. 7 and 7a,

[2] Pt. 1, 1874, p. 54, (Pal. Soc).

Family—CYTHERIDÆ.

Obs.—A species of the type genus *Cythere* was many years ago recorded[1] by Sir F. McCoy, from Dunvegan. Comparing it with the British forms of the same species, he says: "The agreement in outline, central hollow, and its little marginal tubercle, &c., being absolutely perfect, and admitting of no doubt," when compared with the former. I have not met with the species, *C. impressa*, McCoy.

Family—CYPRIDÆ.

Obs.—The genus *Bairdia* represents this Family by two species in our Carboniferous, or Permo-Carboniferous beds: *B. affinis*, Morris,[2] and *B. curtus*, McCoy.[3] The first is from Booral, on the Karuah River, collected originally by the late Count Paul de Strzelecki; the second was described by McCoy from Dunvegan.

Order—Trilobita.

Family—PROETIDÆ.

Obs.—Until the appearance of De Koninck's work, the only Trilobite of Carboniferous age described from New South Wales was McCoy's *Brachymetopus Strzelecki*,[4] from Dunvegan. Prof. De Koninck figured two others, referring them to the European *Griffithides seminiferus*, Phill.,[5] and *Phillipsia Eichwaldi*, Fischer.[6] With the second of these I am unacquainted, but the fragment figured under the first name, with the pustulose test, is possibly Phillips' species, although more perfect material must be obtained before a definite opinion can be passed. The fossil described as *P. Eichwaldi* does not, in my opinion, appertain to that species, but is more probably identical with a *Griffithides* I have named *G. Sweeti* from the Permo-Carboniferous rocks of Queensland. Small tubercles or pustules are visible on the glabella in De Koninck's figure cited, similar to those of the Queensland species.

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[1] Ann. Mag, Nat. Hist., 1847, XX, p. 229.
[2] Strzelecki's Phys. Descrip. N. S. Wales, &c., 1845, p. 291, t. 18, f. 10.
[3] Ann. Mag. Nat. Hist., 1847, XX, p. 229.
[4] Ann. Mag. Nat. Hist., 1847, XX, p. 231, t. 12, f. 1.
[5] Foss. Pal. Nouv.-Galles du Sud, 1877, Pt. 3, p. 348, t. 24, f. 9.
[6] *Griffithides, Loc. cit.*, p. 350, t. 24, f. 8.

The five or, perhaps, even six species, known to me personally in Queensland and New South Wales are briefly distinguished as follows[1] :—

Phillipsia dubia, *Etheridge.*[2]—Pl. XXI, Figs. 1–4. Glabella long, more or less pyriform, impinging on the anterior border of the shield. Pygidium generally triangular ; thoracic axis narrow and broad, 18–20 segments. *New South Wales and Queensland.*

Phillipsia Woodwardi, *Eth. fil.*—Glabella broad and round, separated from the anterior border by a deep channel, (?) surface pustulose. Pygidium unknown definitely. *Queensland.*

Phillipsia grandis, *Eth. fil.*—Pl. XXI, Fig. 5, and Photo-lith No. 5 p. 5 Glabella unknown. Pygidium very large, semicircular, and generally and gently convex ; axis broad, about fourteen segments. *New South Wales and Queensland.*

Phillipsia, *sp. ind.* (*a*).—Pl. XXI, Figs. 6–8. Glabella unknown. Pygidium more or less oval with the general characters of *P. grandis*, but much smaller, and with a larger number of segments in the axis. *New South Wales, and possibly Queensland.*

Phillipsia, *sp. ind.* (*b*).—Pl. XXII, Fig. 14. Glabella unknown. Pygidium with the general characters of the last, and *P. grandis*, but the segments ornamented with rows of very minute pustules. *New South Wales.*

Griffithides Sweeti, *Eth. fil.*—Glabella rounded and pustulose, the basal lobes very prominent, and supplementary ones at the distal ends of the neck segment. Axis of pygidium with from 12–14 segments. *Queensland.*

I am not aware that any Carboniferous Trilobite has been described from West Australia, but our collection has been enriched by the impression of a pygidium, apparently a *Phillipsia*, presented by Mr. Connelly, purporting to come from twenty-five miles west of Coerdawandy and the Yaltra Mountains, Gascoigne River, but the matrix does not correspond with that of other fossils from the same locality. On the contrary, it is highly ferruginous and

[1] The Queensland Trilobites will be found described in a work, now passing through the press, by Mr. R. L. Jack and the Writer, "The Geology and Palæontology of Queensland and New Guinea" (Government Printer, Brisbane). See also the additional *Griffithides*, p. 130.

[2] Quart. Journ. Geol. Soc., 1872, XXVIII, p. 338, t. 18, f. 7.

glazed, like those from the Yeeda Station District, Fitzroy River, Kimberley, in the Macleay Museum, and described by myself.[1] Either, therefore, a mixing of fossils has taken place, or a similar glazed ironstone deposit occurs in the district collected from by Mr. Connelly. The pygidium in question is not distinctly preserved, but appears to possess seven or more axial segments.

The interesting fact now stands revealed that we are unacquainted with the occurrence of Trilobites in New South Wales in any beds that can with certainty be referred to the Permo-Carboniferous. So far they are wholly Carboniferous.

Genus.—PHILLIPSIA, *Portlock*, 1843.[2]

(Geol. Report Londonderry, &c., p. 305.)

PHILLIPSIA DUBIA, *Etheridge.*

Pl. XXI, Figs. 1–4; Pl. XXII, Figs. 12 and 13.

Griffithides dubius, Etheridge, Quart. Journ. Geol. Soc., 1872, XXVIII, p. 338, t. 18, f. 7.

Griffithides dubius, Etheridge, fil., Cat. Australian Foss., 1878, p. 42.

Sp. Char.—Body elongately oval. *Cephalic-shield* more or less semicircular; anterior border flattened, broad, and generally well defined; glabella ob-pyriform, slightly convex, and gently attenuated forwards, extending to, but not overhanging, the anterior border; glabella furrows, all three pairs visible (in casts), the two anterior pairs short and close together, oblique, the anterior pair shortest, and on a level with the anterior termination of the eye, the posterior pair almost circumscribing the basal lobes, which are oblong; palpebral lobes narrow; neck lobe narrow, not greatly differentiated from the glabella, without a tubercle, or supplementary distal lobes. Eye large, markedly semilunar, and highly facetted. Free cheeks small, with wide flat borders. Genal angles obtuse.[3] Thorax.—Axis narrow, very convexly arched; angular in the middle line, distal or outer halves bent downwards. Pygidium large, subtriangular, but varying in degree, axis and pleuræ similar in character to those of the thorax; axis narrow, and rapidly attenuating to

[1] Proc. Linn. Soc. New South Wales, 1889, IV, Pt. 2, p.p. 200 and 202.
[2] Amplified, H. Woodward, Mon. Brit. Carb Trilobites (Pal. Soc.), 1883, Pt. 1, p. 11.
[3] *i.e.* no trace of spines preserved.

an obtuse apex, segments eighteen to twenty, the apical segments slightly emarginate backwards in the middle line; pleuræ fourteen to sixteen, the facets of the anterior segment large, and rather triangular; limb narrow, striate. Test and its sculpture unknown.

Obs.—This species was originally described by Mr. R. Etheridge from a very small and therefore probably young specimen. Such a one I have now before me from the Star Carboniferous Basin, Queensland, collected by Mr. R. L. Jack, corresponding in every particular, but one, with the larger New South Wales examples. The difference lies simply in the number of somites in the pygidium, the Queensland example possessing but eight to ten in the axis, our specimens, on the contrary, being constantly eighteen to twenty. Furthermore, those of the northern form are all emarginate backwards in the middle line, except the two anterior segments. In the southern variety it is the apical six or eight which are so emarginate. The probable explanation of this is that of age. There are also indications of indistinct tubercles along the sides of the axis at the distal or apical end, but so indefinite that too much stress need not be laid on them.

From the British species of *Phillipsia* the present Trilobite is distinguished by the much more oval and longer body, generally larger number of segments, especially in the pygidium, and particularly in the form of the glabella. It approaches nearest to *P. Eichwaldi*, but the glabella of *P. dubia* is again longer and narrower, and our form does not possess genal spines, nor, so far as known, a granular ornament to the test. The resemblance chiefly lies in the somewhat triangular pygidium, although I have never seen a mucronate variety from Australian rocks. In similar terms *P. dubia* differs from the Russian species described by Valerian von Möller,[1] from the Carboniferous Limestone of that country.

The descriptions of the American species I have not full access to, but in its proportions *P. dubia* resembles *P. sangamonensis*, M. and W.,[2] but the glabellas of the two species are wholly unlike. The great increase in the number of coalesced axial segments in the pygidium is similar in *P. major*, Shumard, but the very deep and pointed limb at the axial apex is not present in our species.

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[1] Über die Trilobiten der Steinkohlenformation des Ural, &c. *Bull. Soc. Imp. Nat. Moscou*, 1867, No. 1.
[2] Vogdes, The Genera and Species of North American Carboniferous Trilobites. *Ann. N. York Acad. Sci.*, IV, t. 3, f. 8.
[3] Meek in Hayden, Final Report U.S. Geol. Survey Nebraska, 1872, Pt. 2, t. 3, f. 2.

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, Co. Durham (*C. Cullen*); Allyn River, half a mile north-east of Gresford, Co. Durham (*C. Cullen*); Upper Muscle Creek, Musclebrook, Co. Durham (*Prof. T. W. E. David, B.A.*); Torryburn, twelve miles from Paterson (*J. Waterhouse, M.A.*) :—Carboniferous.

Phillipsia grandis, *sp. nov.*

Pl. XXI, Fig. 5; and Photo-litho. No. 5.

Sp. Char.—Cephalic shield and thorax unknown. Pygidium very large, one inch three-eighths broad, and one inch one-eighth long, semi-circular, gently convex; axis broad, tapering rapidly, segments about fourteen; pleuræ very gently convex, along the anterior edge as wide as the axis, the ridges of the coalesced segments reaching the margin of a narrow, steep limb. Test apparently unornamented.

Obs.—Judging from the relative proportions of thorax, pygidium, and cephalic shield in *Phillipsia dubia*, the present pygidium must represent a Trilobite nearly three inches in length, an exceedingly large size for a Carboniferous form; unfortunately, the pygidium is the only part known, and in consequence the generic identity must for the present remain in doubt. In all probability the nearest species to this in size is *Phillipsia major*, Shumard, of which Vogdes[1] gives the following measurements :—"Width of pygidium, $1\frac{20}{100}$ inch; length, $1\frac{10}{100}$."

Fig. 5.

The late Mr. C. S. Wilkinson collected a fragmentary pygidium (Pl. XXI, Fig. 5) near Mount Morgan, one inch in length, as preserved, which probably indicates the presence of this species in Queensland.

[1] Vogdes, *loc. cit.*, p. 85.

We are indebted for the loan and knowledge of *P. grandis* as a New South Wales species to Mr. D. A. Porter, of Tamworth, in whose cabinet the specimen given in the Photo-lithograph is preserved.

Locality and Horizon.—Swain's Conditional Purchase, about seven miles south-east of Carroll, Co. Buckland (*D. A. Porter*):—Carboniferous.

Phillipsia, *sp. ind.* (*a*).

Pl. XXI, Figs. 6–8.

Obs.—I have separated from the foregoing species a few pygidia, having a more oval outline, flatter, or less convex surface, and a very much wider axis, with from sixteen to eighteen coalesced segments. The flatter surface and wider axis seem to me to be clearly indicative of a distinct species. In two cases the test is preserved, and is unornamented.

A pygidium very much resembling this has been forwarded to me by Mr. R. L. Jack from the Stanwell beds, near Rockhampton.[1]

Mr. Geological Surveyor G. A. Stonier has also collected a pygidium in Portion 7, Parish of Goonoo Goonoo, Co. Parry, which in outline corresponds to the above figures, but indications of segmentation are very faintly preserved.

Locality and Horizon.—Binge Berry, Rouchel Brook, Hunter River, Co. Durham (*C. Cullen*); Upper Muscle Creek, Musclebrook, Co. Durham (*T. W. E. David, B.A.*):—Carboniferous.

Phillipsia, *sp. ind.* (*b*).

Pl. XXII, Fig. 14.

Obs.—Cephalic shield and thorax are unknown. Pygidium of medium size, five-eighths of an inch long, fourteen segments on the axis, and twelve on the pleuræ; the general outline is much flattened, and there is a narrow, flat border. Each segment of the axis, and each rib of the pleuræ are ornamented with very minute intermingled pustules.

[1] Geol. and Pal. Queensland and New Guinea, *in lit.*, t. 8, f. 6.

As I have failed to trace sculpture on any other pygidium from New South Wales, strictly referable to *Phillipsia*, this example is placed on one side as possibly distinct from the others. It may be related to the Trilobite I have named from Queensland, *Griffithides Sweeti*. As regards its general characters, it certainly is more nearly allied to the last indicated species (Pl. XXI, Figs. 6 and 7), and *P. grandis* (Pl. XXI, Fig. 5) in the flattened axis and pleuræ, than it is to *P. dubia* with its strongly arched subdivisions.

Locality and Horizon.—Greenhills, Paterson to Dungog Road, Co. Durham (*C. Cullen*):—**Mirari Limestone, Carboniferous.**

Genus—GRIFFITHIDES, *Portlock*, 1843.

(Geol. Report Londonderry, &c., p. 310.)

GRIFFITHIDES ? *sp. ind.*

Pl. XXII, Figs. 15 and 16.

Sp. Char.—Pygidium semi-circular to ovate-triangular; axis long, arched, of thirteen segments and a terminal appendage, gradually tapering; pleuræ of ten segments, curved downwards laterally; limb nearly vertical, of about equal width throughout, except at the immediate apex; axial groove deep and wide, the pleuræ and limb separated by other very marked lateral grooves. Ornamentation consists of tubercles arranged in a single transverse series on each segment; on the axis and pleuræ four to eight, but commonly six, graduating downwards; on the limb, two opposite each pleura, the inner always much the larger of the two.

Obs.—This pygidium is obviously allied to *Griffithides seminiferus*, Phill. sp.,[1] and possibly to the Australian fossil figured under that name by the late Prof. de Koninck.[2] From the species proper it is at once distinguished by the absence of the tuberculated limb; but as Prof. de Koninck made no mention of a similarly ornamental limb, I am constrained to regard it as distinct from the already known New South Wales fossil also. As I am only acquainted with the pygidium, I refrain from proposing a specific name, although satisfied that the Trilobite is quite different from any of our Australian forms so far correctly determined.

[1] Ill. Geol. Yorkshire, Pt. 2, 1836, t. 22, f. 8–10. Woodward, Mon. Brit. Carb. Trilobites (Pal. Soc., Pt. 1, 1883, t. 5.
[2] Foss. Pal. Nouv.-Galles du Sud, Pt. 3, 1877, p. 348, t. 24, f. 9, 9a.

The ornamenting tubercles were, I believe, in the perfect condition prolonged into spines. In Pl. XXII, Fig. 16, is figured the right pleura of a tail in which the tubercles are so extended.

Now a word as to Prof. de Koninck's *Phillipsia seminifera*, Phill. That it is not *Griffithides seminiferus*, Phill., sp., as this Trilobite is now called, is more than probable; indeed, the description of the glabella given by De Koninck, wherein he refers to the middle and anterior glabella grooves ("les sillons moyens et antérieur"), sets at rest in the negative the question of this being a *Griffithides* even. In all probability De Koninck's Trilobite and the present pygidium are identical, and for this reason I have placed after the generic name at the head of these paragraphs a note of interrogation.

Locality and Horizon.—Gardner and Cameron's Conditional Purchase, Back Creek, Parish of Doon, Co. Durham (*Pres. E. Twynam, Chief Surveyor*); Kean's Gully, Parish of Tudor, Co. Durham (*Ibid*); Rouchel Brook, Hunter River, Co. Durham (*Ibid*) :—**Carboniferous.**

ADDENDUM.

Family—PLATYCRINIDÆ.

Obs.—Pl. XX, Fig. 8 represents a portion of a calyx, referable, I believe, to *Platycrinus*. The figure is defective in so far that the downward curvature of the exposed basals is not shown, nor are the excavated margins for the arms in the two radial plates facing the observer, but between these, and partly resting on both is an interadial. The plates are ornamented with radiating lines of very peculiar wart-like tubercles, concave at their apices.

The specimen will be refigured and described more in detail.

Locality and Horizon.—Greenhills, Paterson to Dungog Road, Co. Durham (*C. Cullen*) :—**Mirari Limestone, Carboniferous.**

INDEX TO THE GENERA AND SPECIES.

EXPLANATION OF THE PLATES.

NOTE.—Unless otherwise stated, the figures are of the natural size; they have been reversed in the process of reproduction.

PLATE XII.

Page.

Palæaster giganteus, Eth. fil. ... ...

A remarkably fine specimen, with the actinial surface exposed.

Ravensfield Quarry, near Farley.

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PLATE XIII.

Page.

Palæaster Strutchburii, Eth. fil. 73

Fig. 1. The actinial surface exposed, but at the apices of two of the rays the abactinial plates are visible.

Tribrachiocrinus Clarkei, McCoy 90

Fig. 2. Lateral aspect with the heptagonal basal in view.

Fig. 3. The opposite side of the calyx, with one of the hexagonal basals visible.

Fig. 4. The posterior side exhibiting the two posterior basals, the azygous plate, the anal plate, and the bottom plate of the ventral tube.

Portion of a Column 115

Fig. 5. Large stem joints illustrative of one form commonly met with in the Permo-Carboniferous of the Shoalhaven District.

Fig. 6. Transverse view of the same.

Fig. 1, from Ravensfield Quarry, near Farley.
Figs. 2–4, „ Waterworks, West Maitland.
„ 5–6, „ Shoalhaven District.

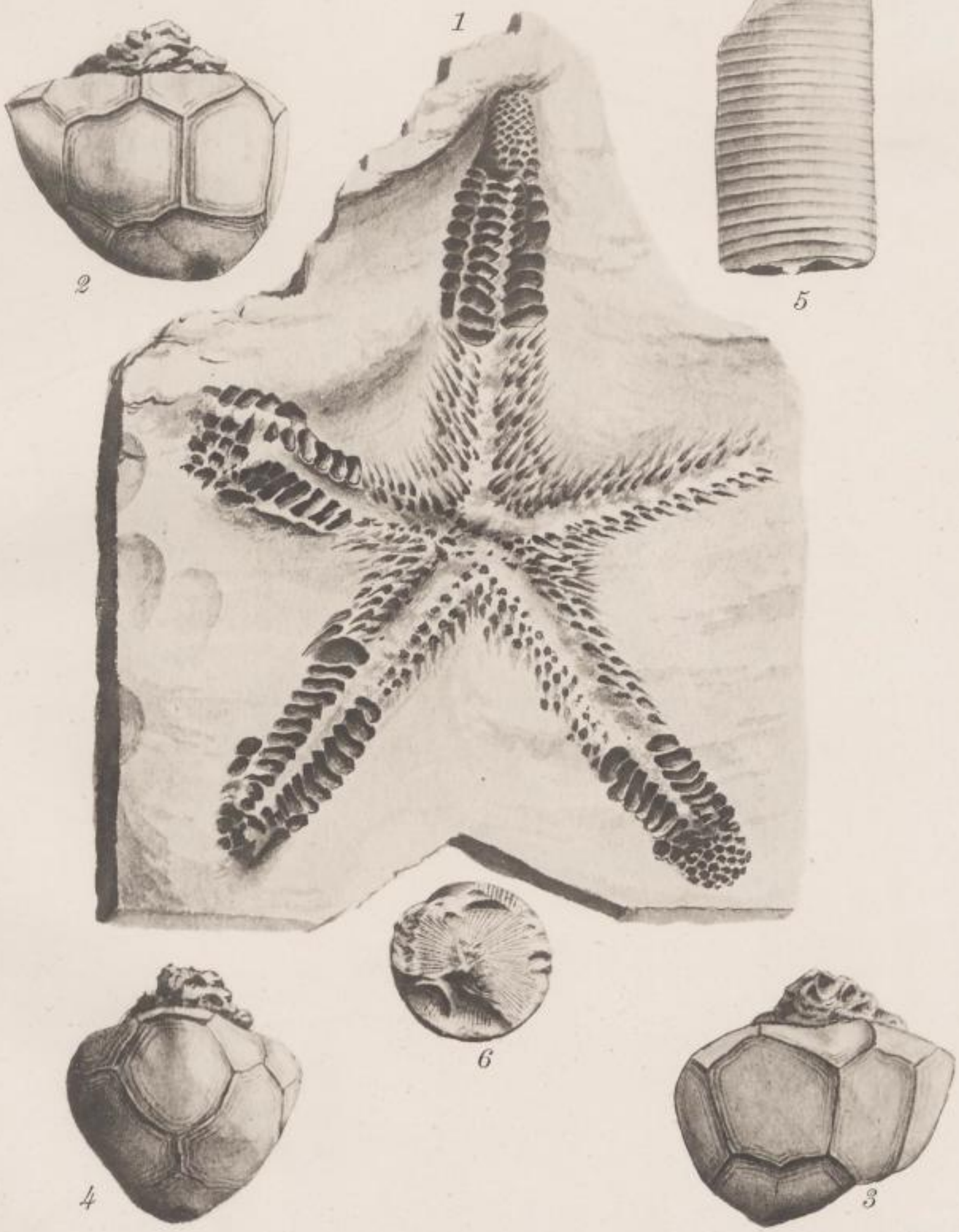
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PLATE XIV.

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Palæaster Clarkei, De Koninck 71

Fig. 1. Impression of the abactinial surface, with the madreporiform plate *in situ*.

Fig. 2. A similar impression, with some of the imprints of the marginal plates preserved.

Tribrachiocrinus Clarkei, McCoy 90

Fig. 3. An internal cast of the calyx, showing the infra-basal plates, the heptagonal basal plate, and the anal plate.

Phialocrinus ? nodosus, Eth. fil. 112

Fig. 4. An internal cast, seen from below, with the five infra-basal and five basal plates in position.

Fig. 5. The same, side view, reversed upwards, to bring prominently forward the large nodes of the basal plates.

Radial Plate ? 116

Fig. 6. Impression of an undetermined radial plate (*? Actinocrinus*), with radiating sculpture.

Basal Plate 116

Fig. 7. Impression of a basal plate (*? Tribrachiocrinus*), the sculpture consisting of tubercles and radiating ridges.

Figs. 1 and 2, from Ravensfield Quarry, near Farley.

3 and 6 „ Nowra.

„ 4 and 5, „ Copper Point, Shoalhaven.

Fig. 7, „ Jamberoo.

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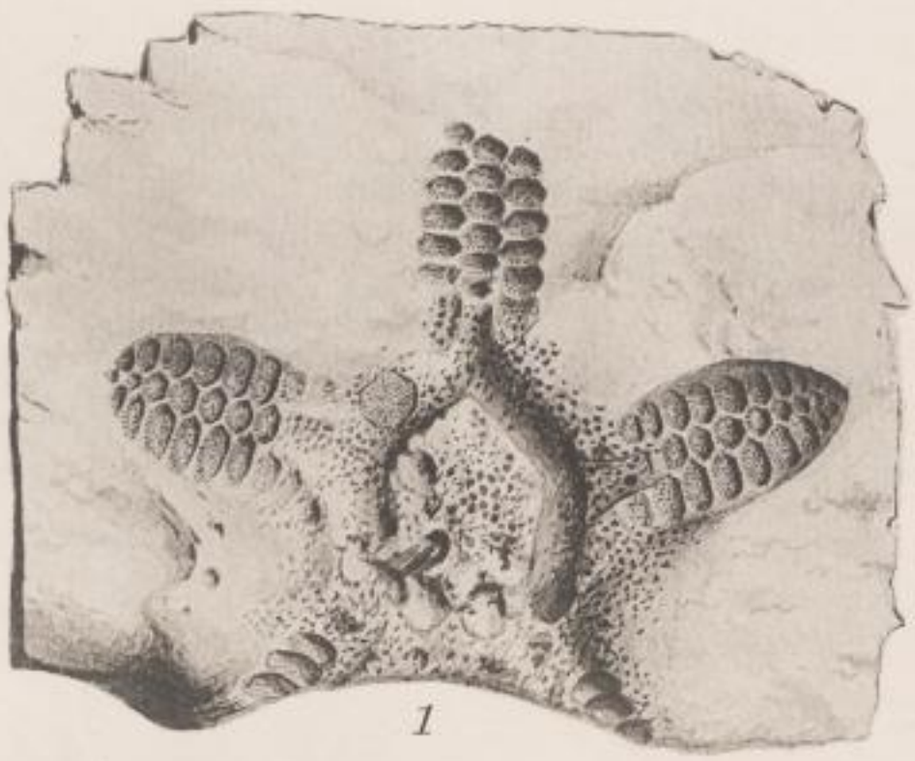

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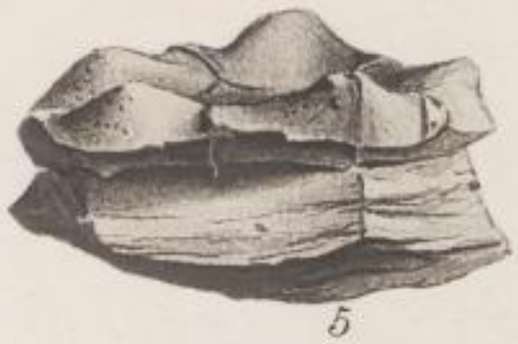

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PLATE XV.

Page.

Archæocidaris Selwyni, Eth. fil. 67

Fig. 1. Ventral surface of the test, as a cast in coarse sandstone, showing the remains of large interambulacral plates, and the peristome occupied by the remains of the masticatory apparatus.

Fig. 2. Portion of the same specimen, in side view.

Fig. 3. A cast, in relief, of some of the interambulacral plates, showing the perforated primary tubercle.

Palæaster Clarkei, De Koninck 71

Fig. 4. Impression of the actinial surface of a large specimen, with well marked petaloid rays, and large adambulacral plates.

Tribrachiocrinus Clarkei, M'Coy 90

or,

Phialocrinus Koninckí, Clarke, sp. 107

Fig. 5. Either the left anterior basal of *T. Clarkei*, or the hexagonal anal-supporting basal of *Phialocrinus Koninckí*, probably the latter.

Tribrachiocrinus Clarkei, M'Coy 90

Fig. 6. Heptagonal basal in a decorticated condition, with some of the angles hidden by overhanging matrix.

Fig. 7. One of the hexagonal basals—similarly preserved.

Fig. 8. Left non-arm bearing anterior radial in a similar condition.

Figs. 1–3, from Nowra.
Fig. 4, „ Farley.
Figs. 5–8, „ Wollongong.

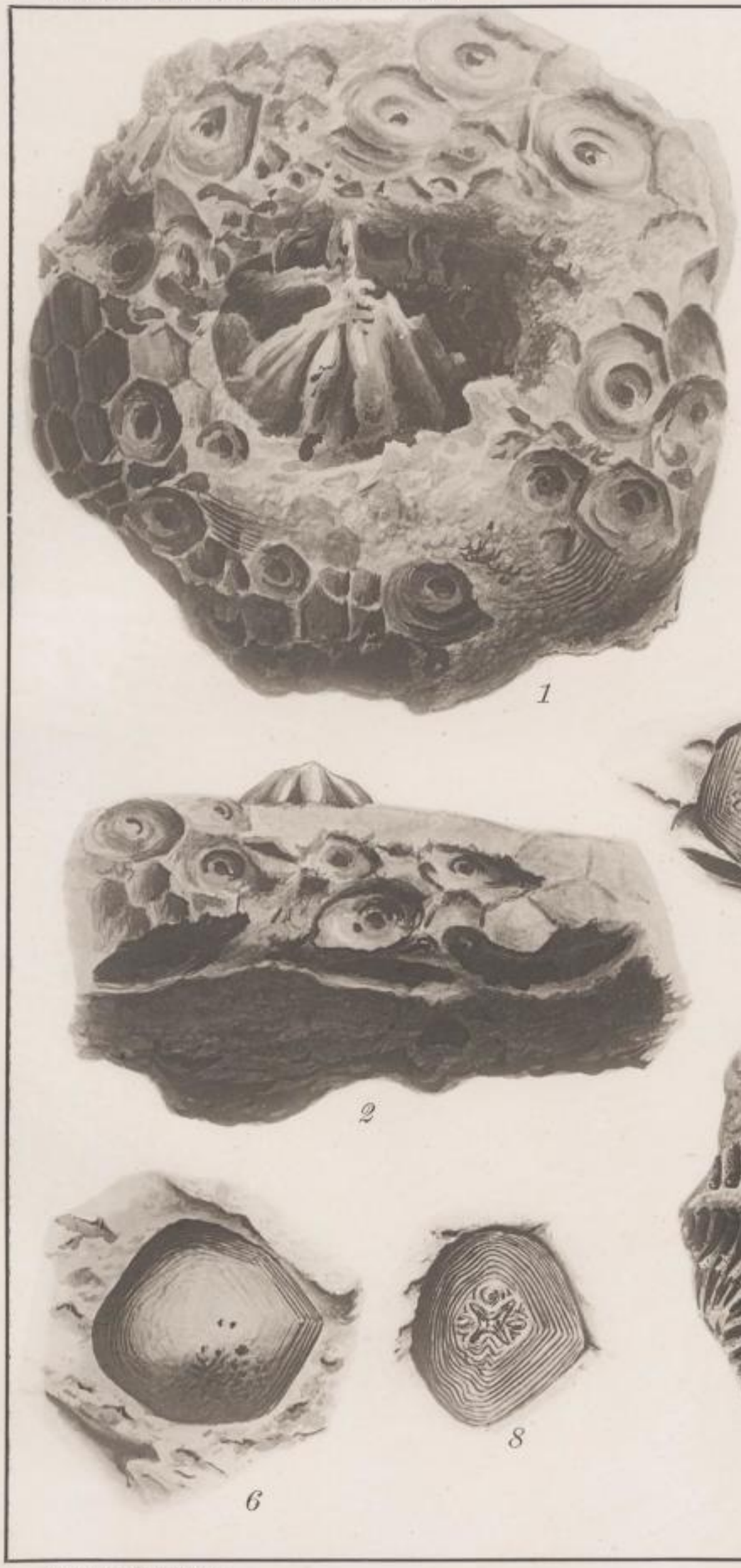

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PLATE XVI.

Fig. 1. Internal cast of the calyx, and external impression of the arms in sandstone, anterior side.

Fig. 2. A similar specimen of the calyx only, but the basal plates showing the characteristic bosses, radii, and concentric lines, whilst the radials are radiately sculptured only. The sutures exhibit the line of small nodes along the inter-basal and basi-radial sutures.

Fig. 3. Another like and rather crushed calyx, viewed from the posterior side, with the anal plates in position, truncating the hexagonal basal.

Fig. 4. The base of the same specimen, showing the inverted base for the reception of the infra-basal plates.

Fig. 5. View of the base or dorsal surface, a reproduction from an external inpression.

Fig. 6. The upper or ventral surface, showing the three articular surfaces for the arms, and the impressions of disk plates.

Fig. 7. Left half-side, posterior view, exposing the heptagonal basal surmounted by the anal plate.

Fig. 8. Left side view, with basals and radials visible.

Fig. 9. Right side view.

Fig. 10. An internal cast of the calyx, seen from above, with further traces of disk plates.

Fig. 11. Impression of a small basal plate similar to Pl. XIV, Fig. 7.

Figs. 1–4, from Nowra.
„ 5–11, „ Jamberoo.

[The originals of Figs. 5–10 are in the Australian Museum.]

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PLATE XVII.

Page.

Phialocrinus princeps, Eth. fil. 110

Fig. 1. Portion of the calyx, including the infra-basals, four of the basal plates, and one of the radials in relief.

Tribrachiocrinus Clarkei, M'Coy 90

Fig. 2. Right lateral view, showing two large basals in the centre, and the azygous plate to the right.

Fig. 3. The same internal cast taken more from the posterior, in a rather oblique direction, with the azygous plate protruding on the right hand.

Fig. 4. Dorsal view of the same specimen, with the azygous plate shown at the upper end.

Stem. 116

Fig. 5. Portion of a stem with verticillate cirri.

Fig. 1, from Singleton.
Figs. 2–4, „ Nowra.
Fig. 5, „ Gerringong.

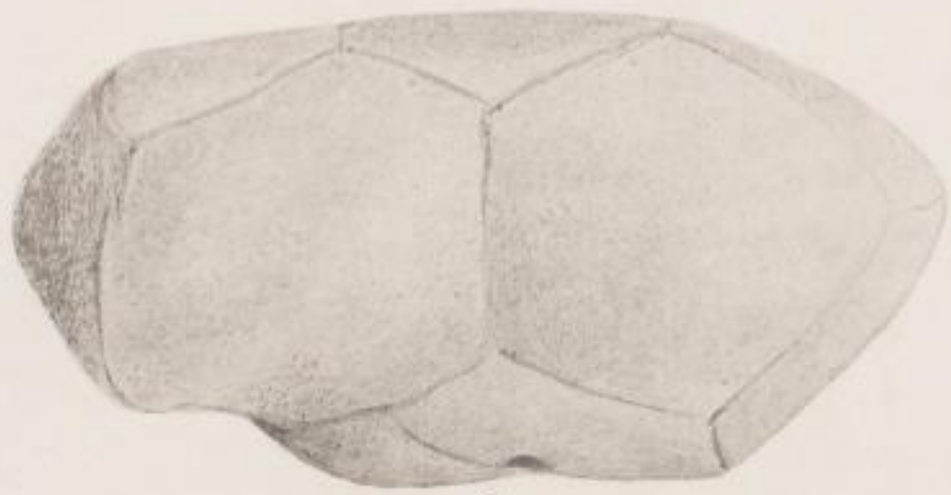

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PLATE XVIII.

Fig. 1. Calyx, top stem joint, and portion of the arms in relief.

Fig. 2. Portion of a stem with verticillate cirri articulations.

Fig. 3. Portion of an enlarged or distorted stem with perforation.

Fig. 4. The test attached to a Crinoid stem.

Fig. 5. The same, x 4

Figs. 1, 3–5, from Mount Vincent.
Fig. 2, „ Shoalhaven District.

[The original of Fig. 1 is in the Branch Technological Museum (Maitland Scientific Society) at West Maitland.]

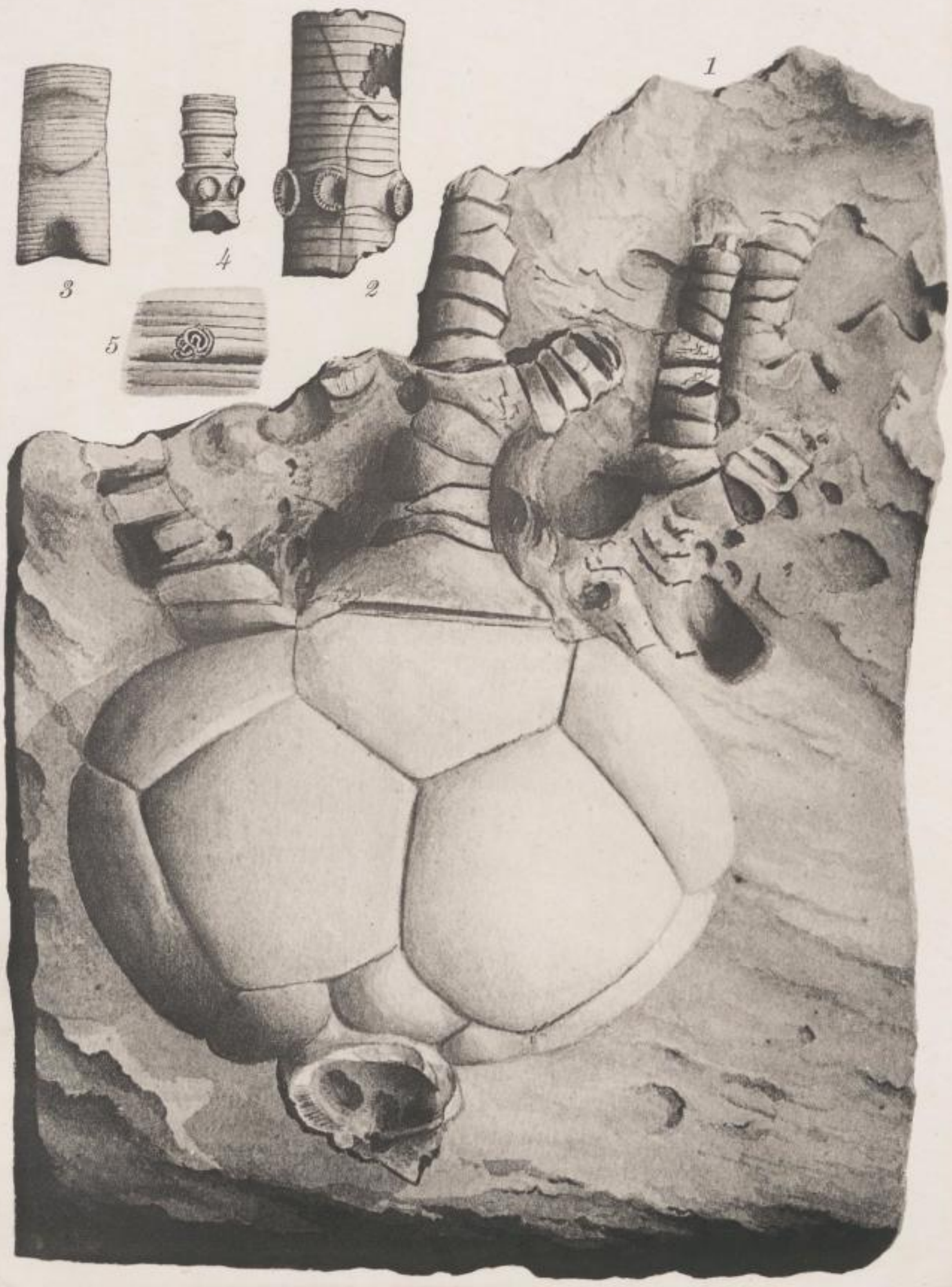

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PLATE XIX.

An internal cast of the calyx, and an impression of the arms in coarse grit from Nowra.

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PLATE XX.

Fig. 1. Cast of the calyx, seen from the right side, showing portions of the basals, radials, and costals.

Fig. 2. The same specimen, seen from the left side.

Fig. 3. The same specimen, seen from the posterior or anal side.

Fig. 4. The same specimen, seen from "above," or the ventral end.

Fig. 5. The same specimen, seen from "below," or the dorsal end, exposing the infrabasals and basals.

Fig. 6. Portion of an internal cast, probably identical with *Actinocrinus polydactylus*, De Kon. (non Miller), from Glen William, N. S. Wales.

Fig. 7. A crushed example of the same species as Fig. 6, in all probability.

Fig. 8. Three plates, forming an apparently shallow basal cup, ornamented with radially arranged granules.

Fig. 9. A large radial plate, probably of *Tribrachiocrinus*, allied to *T. corrugatus*, Ratte.

Figs. 1–5, Nowra.
„ 6–8, Greenhills, near Paterson.
Fig. 9, Jamberoo.

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PLATE XXI.

Page.

Phillipsia dubia, Etheridge... ... ... 125, 126

Fig. 1. A decorticated individual, with half the cephalic shield preserved, of which the glabella is rather pinched up along the middle line, x 2.

Fig. 2. A decorticated pygidium and impression of the glabella of another specimen, showing the true outline of the latter, x 2.

Fig. 3. Glabella and portion of the thorax of a third individual. The outline of the former is intermediate between that of Figs. 1 and 2, x $\frac{1}{2}$.

Fig. 4. The largest known pygidium of this species—a portion of the left pleura wanting, x 2.

Phillipsia grandis, Eth. fil.... ... ... 125, 128

Fig. 5. Portion of a very imperfect pygidium, but with the proportions correctly shown in outline.

Phillipsia, sp. ind. (a) 125, 129

Fig. 6. Pygidium, in outline much more semicircular than that of *P. dubia*, and with the axis and pleuræ much less angled, x 2.

Fig. 7. Another example of the same form.

Fig. 8. A third pygidium, imperfect along the lower margin, but differing in a similar manner from *P. dubia*.

Carbonia australis, Eth. fil.... 121

Fig. 9. General side view of valve, x 24.

Fig. 10. Elevation, or edge view, to show the convexity of the valve, x 24.

Fig. 11. End view, x 24.

Fig. 12. Muscle spot, highly magnified.

Figs. 1–4, 6 and 7, from Binge Berry, Rouchel Brook.
Fig. 5, „ Crow's Nest, Mount Morgan, Queensland.
Fig. 8, „ Musclebrook.
Figs. 9–12. „ Wollombi Road, near West Maitland.

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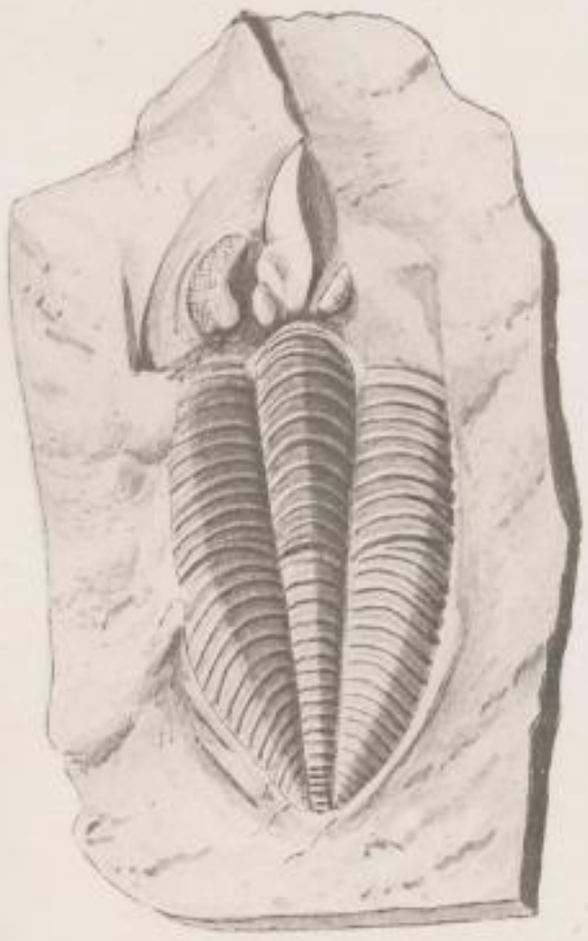

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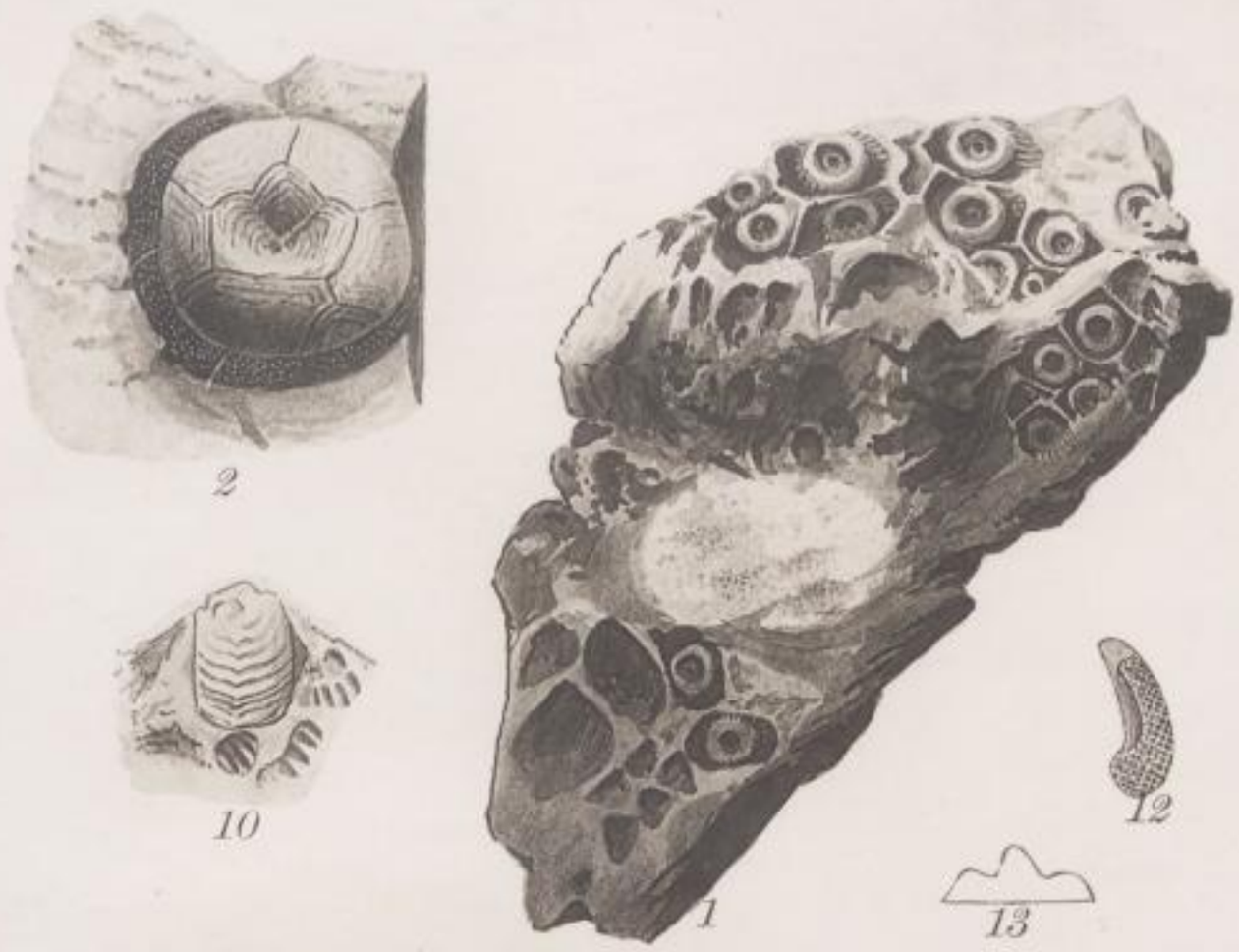
PLATE XXII.

Figs. 1, 3, from Dagworth.
Fig. 4, „ Wallumba.
„ 5, „ Co. Northumberland.
Figs. 6–10, „ Minumurra River.
Fig. 11, „ Ulladulla.
Figs. 12–13, „ Binge Berry, Rouchel Brook.
Fig. 14, „ Green Hills, Paterson.
„ 15, „ Back Creek, Co. Durham.
„ 16, „ Parish of Tudor, Co. Durham.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